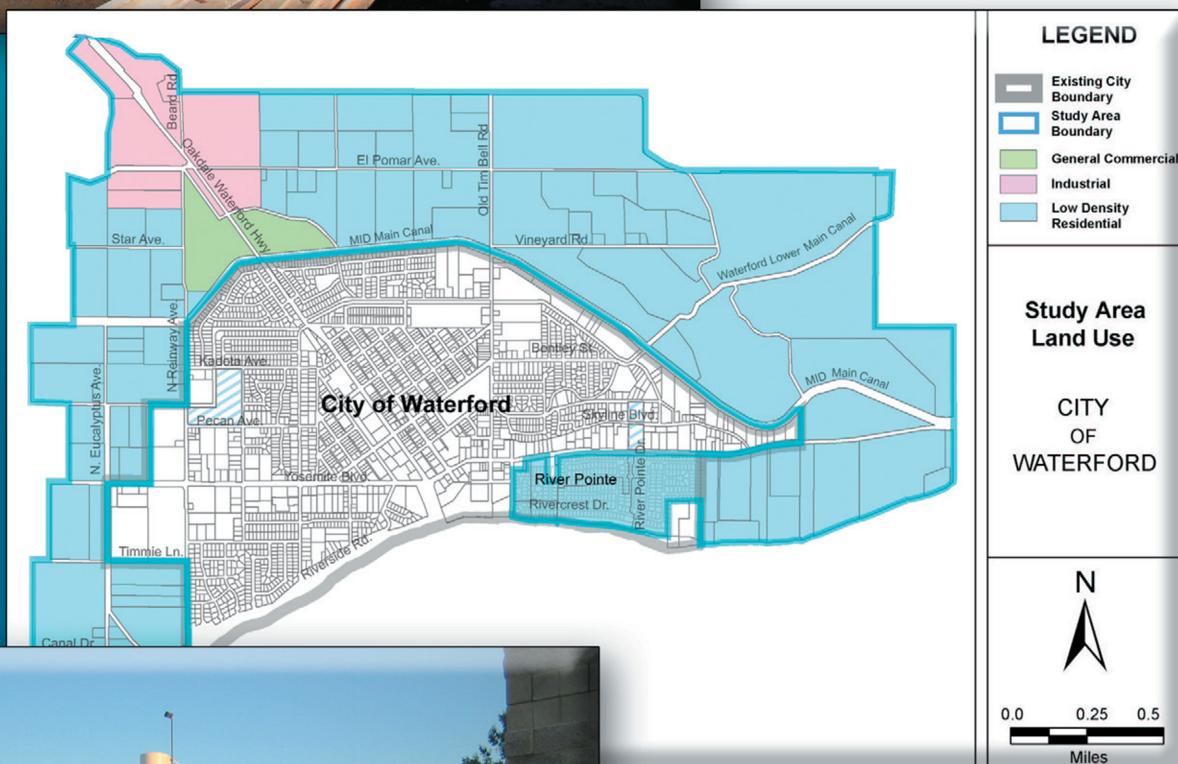

Water System Master Plan

FINAL

February 2006

RMC Water and Environment

RMC
Water and Environment

Los Angeles
Sacramento
San Francisco
San Jose
Walnut Creek

February 24, 2006

City of Waterford
Mr. Tony Marshall, P.E.
Consulting City Engineer
322 Sun West Place
Manteca, CA 95337

Subject: Final Water System Master Plan

Dear Mr. Marshall:

RMC is pleased to submit this draft version of the Water System Master Plan for the City of Waterford. This Plan documents the following:

- Land use analyses, demand projections, and the development of a hydraulic model for the City's study area;
- A Master Plan for the future water distribution system network for buildout expansion of the City within the study area boundary; and,
- A Capital Improvement Program (CIP) for water system improvements needed to serve this area

We greatly appreciate the support and guidance that we have received from the City throughout this process.

If you have any questions, please don't hesitate to contact us at (916) 273-1500.

Sincerely,
RMC Water and Environment

Glenn Hermanson, P.E.
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GLENN E. HERMANSON
No. 46659
Exp. 6-30-07
CIVIL
STATE OF CALIFORNIA

Andy Smith
Project Engineer

2868 Prospect Park Drive
Suite 130
Rancho Cordova, CA 95670
ph: 916.273.1500
fax: 916.273.1501
www.rmcwater.com

Innovative Solutions for Water and the Environment

City of Waterford
Water System Master Plan

Final Report

Prepared by:

RMC
Water and Environment

February 24, 2006

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Acknowledgements

The 2005 Water System Master Plan represents a collaborative effort between RMC and the City of Waterford. We would like to thank the following key personnel from the City whose invaluable knowledge, experience, and contributions were instrumental in the preparation of this Master Plan.

Tony Marshall – Consulting City Engineer, City of Waterford

Robert Borchard – Consulting City Planner, City of Waterford

List of Abbreviations

ADD	average day demand
AF	acre-feet
AFY	acre-feet annually (yearly)
AWWA	American Water Works Association
CAD	computer aided design
CCI	construction cost index
CIP	capital improvement program
City	City of Waterford
DHS	Department of Health Services
DU	dwelling unit
ft	feet
fps	feet per second
FY	fiscal year
gal	gallon
GIS	geographic information system
gpad	gallons per day per acre
gpm/acre	gallons per minute per acre
gpcd	gallons per capita per day
gpd	gallons per day
gpd/DU	gallons per day per dwelling unit
gpm	gallons per minute
GW	groundwater
in	inch
LF	linear feet
MDD	max day demand
MHD	max hour demand
MMD	max month demand
MG	million gallons
mgd	million gallons per day
MID	Modesto Irrigation District
NA	not applicable
PF	peaking factor
PS	pump station
psi	pounds per square inch
RW	raw water
SW	surface water
TW	treated water
UWMP	Urban Water Management Plan
WTP	water treatment plant
WUF	water use factor

Chapter 1 Introduction

This report presents the results of a study to develop a master plan for a water distribution system for proposed areas of annexation to the City of Waterford (City). The report was prepared by RMC Water and Environment (RMC) under a contract with the City dated March 20, 2005.

1.1 Project Purpose

The City is proposing to annex approximately 1,610 acres of agricultural land surrounding the existing City boundary as shown in **Figure 2-1**. To help plan for the development of the annexation area, the City contracted with RMC to develop the following planning documents:

- Water System Master Plan
- Sewer System Master Plan
- Storm Drainage Master Plan
- Urban Water Management Plan
- Wastewater Treatment Plant Master Plan

This Water System Master Plan provides information required for the City's planning and financial efforts, and defines the water system improvements necessary to accommodate the City's future land use development plans. The scope of this Master Plan includes the following major tasks:

1. Create a computerized hydraulic model of the future water system in the expansion area using H2OMap Water GIS, Suite 6.0;
2. Create a master plan for the future water distribution system network for buildout expansion of the City within the study area boundary; and,
3. Develop a Capital Improvement Program (CIP) for water system improvements needed to serve this area.

1.2 Report Content

The findings of this study are presented in the chapters outlined below:

CHAPTER 1 – Introduction

CHAPTER 2 – Service Area and Land Use Plans

CHAPTER 3 – Supply and Demand Analysis Methodology

CHAPTER 4 – Design Criteria and Modeling Results

CHAPTER 5 – Recommended Projects

This report also contains two appendices:

APPENDIX A – Model Data

APPENDIX B – CD with Model Input and Output & Report

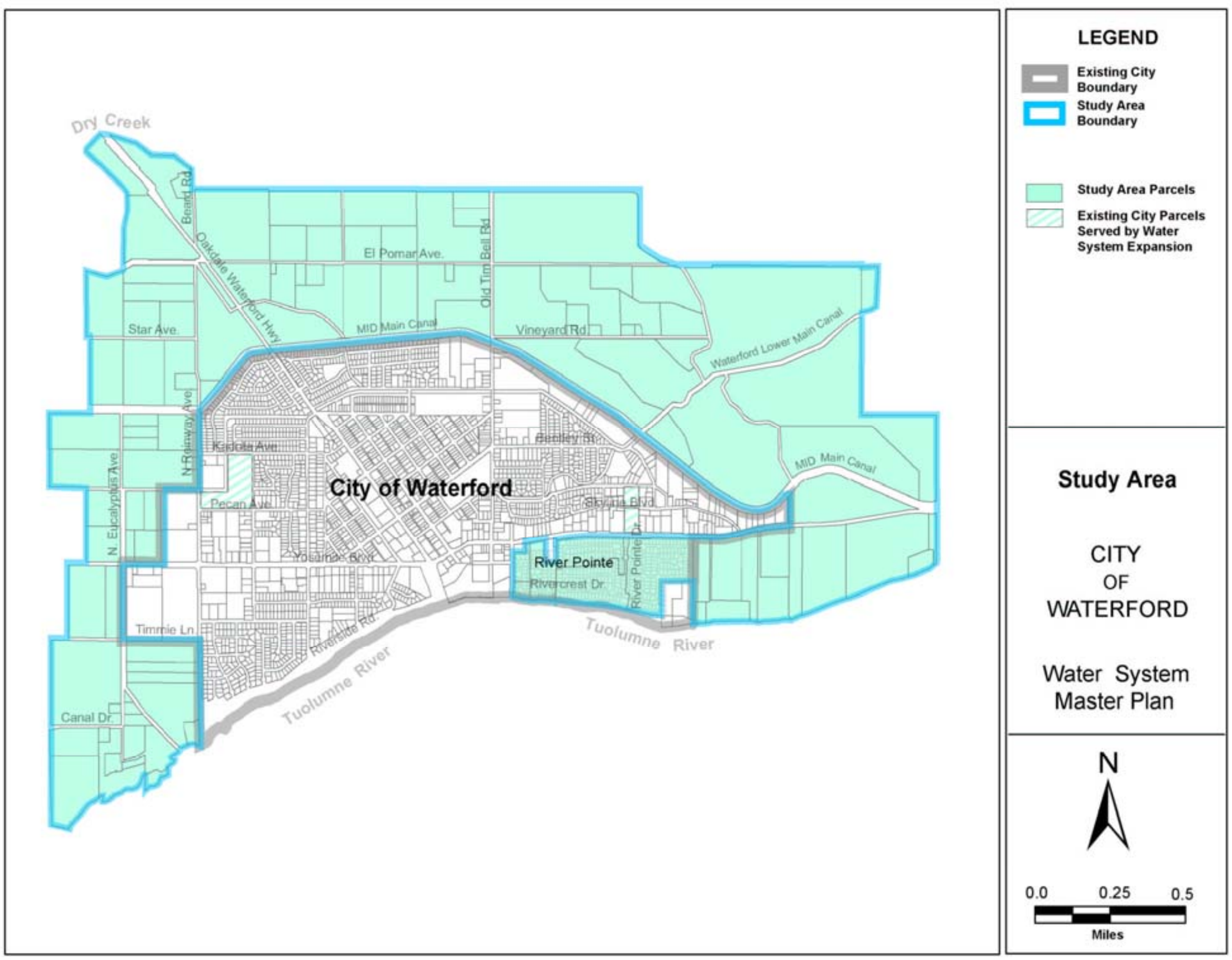
Chapter 2 Service Area and Land Use Plans

This chapter provides a summary of the City's proposed annexation area (study area), buildout land use estimates, and the corresponding land use databases that were created for the development of this Master Plan.

2.1 Study Area

The City of Waterford is located in the eastern portion of Stanislaus County, approximately 13 miles east of Modesto and 11 miles northeast of Turlock. The City is bordered on the south by the Tuolumne River, on the north by the Modesto Irrigation District (MID) Modesto Main Canal, on the west by Eucalyptus Avenue, and on the east by a parcel boundary south of MID Lateral Connection No. 8. The study area for this Master Plan comprises approximately 1,610 acres of agricultural land surrounding the City's existing boundary to the north, east, and west, as well as nearly 90-acres in and around the River Pointe development, which represents the last major infill project with the existing City boundaries. Terrain in the western half of the study area is very flat, with the exception of the southwestern corner of the study area that straddles the cliff north of the Tuolumne River. Terrain in the eastern half of the study area is more varied, rising from 160 feet above sea level to around 200 feet above sea level in the eastern and northeastern sections of the study area. Figure 2-1 presents the geographical limits of the study area.

Figure 2-1: Study Area



2.2 Land Use Database

The City's proposed annexation area consists primarily of agricultural lands surrounding the City's existing boundary. The proposed study area boundary, service area boundaries, land use maps, and databases were developed by incorporating the following information:

- GIS Parcel Map – Downloaded from the Stanislaus County GIS Library[1]
- Annexation Area Map – Hard copy provided by MCR Engineering, Inc.
- River Pointe Development files – AutoCAD files provided by TKC Engineering
- Land Use Map – Hard copy provided by MCR Engineering, Inc.

A GIS (Geographic Information System) land use database was developed for each parcel by assigning the land use category from the paper map provided by MCR Engineering to the downloaded GIS parcel map. The proposed land uses associated with the study area are discussed and quantified below.

2.3 Existing and Buildout Land Use

Table 2-1 presents a summary of the proposed buildout land use categories, their associated densities, and gross acreage developed as part of the land use evaluation task for this Master Plan. In addition to Table 2-1, **Figure 2-2** also indicates the portions of the study area that lie within Modesto Irrigation District's (MID) service area.

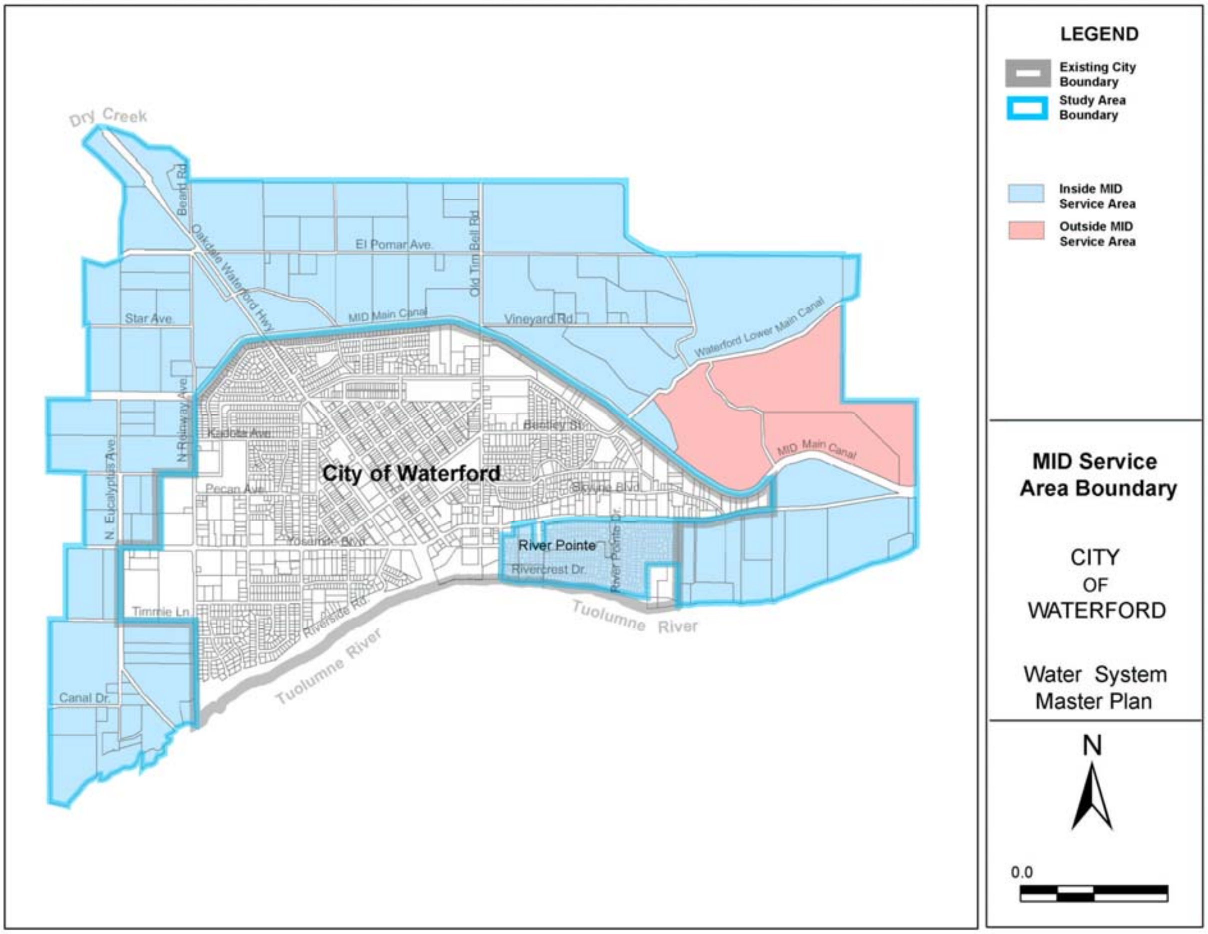
Table 2-1: Proposed Land Uses

Land Use Category		Residential Density (DU/acre)	Gross Acreage [a]	Percentage of Area
Inside MID Service Area	Low Density Residential	4.5	1,200	71%
	Industrial	n/a	126	7%
	General Commercial	n/a	48	3%
	Major roads and canals	n/a	117	7%
		Subtotal	**1,491**	**88%**
Outside MID Service Area	Low Density Residential	4.5	193	12%
	Major roads and canals	n/a	12	<1%
		Subtotal	**205**	**12%**
		TOTAL	***1,696***	***100%***

a. Gross acreage includes future roadways, medians, and sidewalks. Net acreage information is not available since the study area has not been subdivided into individual parcels and roadways. On average, net acreage is approximately 80 to 90 percent of the gross acreage. For the purposes of estimating demand, net acreage was assumed to be 85 percent of gross acreage.

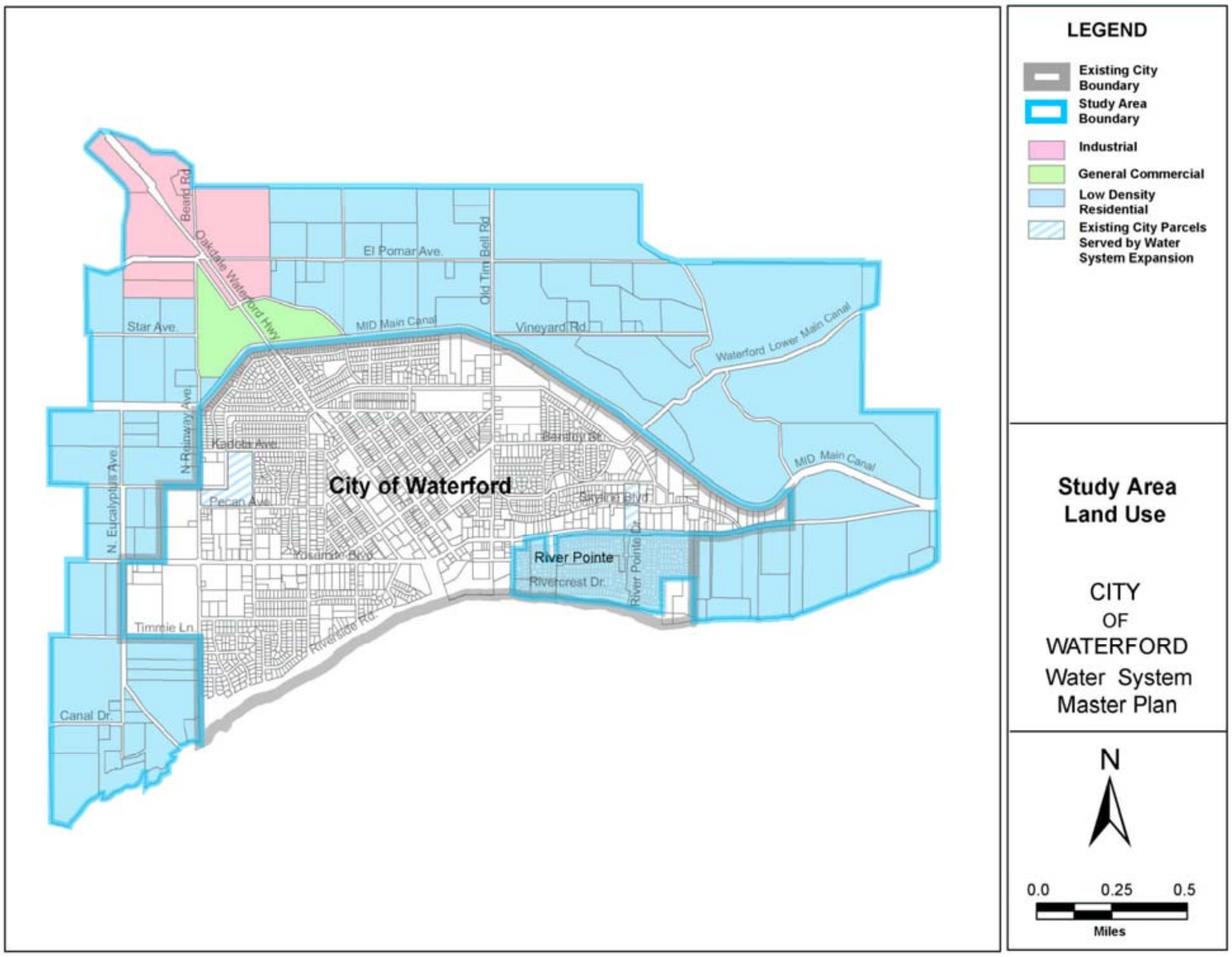
[1] http://regional.stangis.org/

Figure 2-2: MID Service Area Boundary



As shown in **Table 2-1**, and illustrated in **Figure 2-3**, the majority of existing vacant land is planned for future low density residential development. Specific land use plans for schools and parks had not been developed at the time this Master Plan was prepared, and are therefore not specifically addressed. Schools, parks, an artificial lake, and several stormwater detention basins will be located within the low density residential area.

Figure 2-3: Study Area Land Use



Chapter 3 Supply and Demand Analysis Methodology

3.1 Water Demands

Municipal water usage typically varies based on the season, the day of the week, and the hour of the day. Variations in water demand, and their corresponding effects on a distribution system, are important considerations in determining the size and layout of distribution system facilities. Variations in water usage are often expressed as ratios of the average daily demand, and are calculated with the use of peaking factors. Peaking factors are used in water master planning to estimate the maximum hourly, daily, and monthly demands in a water distribution system. For the purposes of this Master Plan, the standards set forth in the Standard City of Waterford Waterworks Specifications were used to determine peaking factors for maximum daily and maximum hourly demands. The water demand rates presented below are expressed in units of gallons per day per acre (gpad) or gallons per minute per acre (gpm/acre), and vary with the type of land use.

3.1.1 Average Day Demands

Because historical land use within the study area been has been primarily agricultural, historical data for non-agricultural water usage were not available for consideration in this Master Plan. Buildout Average Day Demand (ADD) was therefore determined by assuming land use specific water use factors (WUF) for each of the study area's land use categories. The WUFs developed for the study area reflect average values for the total volume of water consumed on an annual basis at buildout.

Residential

The City's Waterworks Specifications require that a per capita water usage of 220 gallons per capita per day (gpcd) be used when designing new infrastructure. The residential areal WUF for this Master Plan was developed using the following formula:

$$WUF_{RES} \text{ (gpad)} = [220 \text{ gpcd}] \times [3.5 \text{ persons/DU}] \times [4.5 \text{ DU/acre}] \times [0.85] = 2{,}945 \text{ gpad}$$

A scaling factor of 0.85 was applied to reflect the probable net acreage of the residential area.

Commercial and Industrial

Water use factors for general commercial and industrial land uses were generated based on a similar areal method, and were developed as shown:

$$WUF_{COM} \text{ (gpad)} = [2{,}600 \text{ gpad}] \times [0.85] = 2{,}210 \text{ gpad}$$

$$WUF_{IND} \text{ (gpad)} = [2{,}366 \text{ gpad}] \times [0.85] = 2{,}011 \text{ gpad}$$

Areal factors of 2,600 gpad and 2,366 gpad for general commercial and industrial land uses, respectively, are based on estimates used for similar development areas (MWH 2002), and reflect the planning values used in the City's 2005 UWMP. Similar to the residential WUF, a net acreage scaling factor of 0.85 was applied for commercial and industrial WUFs. Proposed buildout ADD water use factors, as well as the associated buildout ADD for each land use, are presented in **Table 3-1**.

3.1.2 Max Day and Max Hour Demands

The City's Waterworks Specifications require that Max Day Demand (MDD) and Max Hour Demand (MHD) peaking factors of 2.0 and 4.0, respectively, be used for domestic demands. Table 3-1 presents the total and land use specific MDD and MHD values for the study area.

Table 3-1: Water Use Factors and Water Demands

Land Use	WUF (gpad)	Acres	ADD (mgd)	MDD (mgd)	MHD (mgd)
Low Density Residential	2,945	1,392	4.10	8.20	16.40
General Commercial	2,210	48	0.11	0.21	0.42
Industrial	2,011	126	0.25	0.51	1.01
	TOTAL	*1,566*	*4.46*	*8.92*	*17.84*

3.1.3 Seasonal Demands

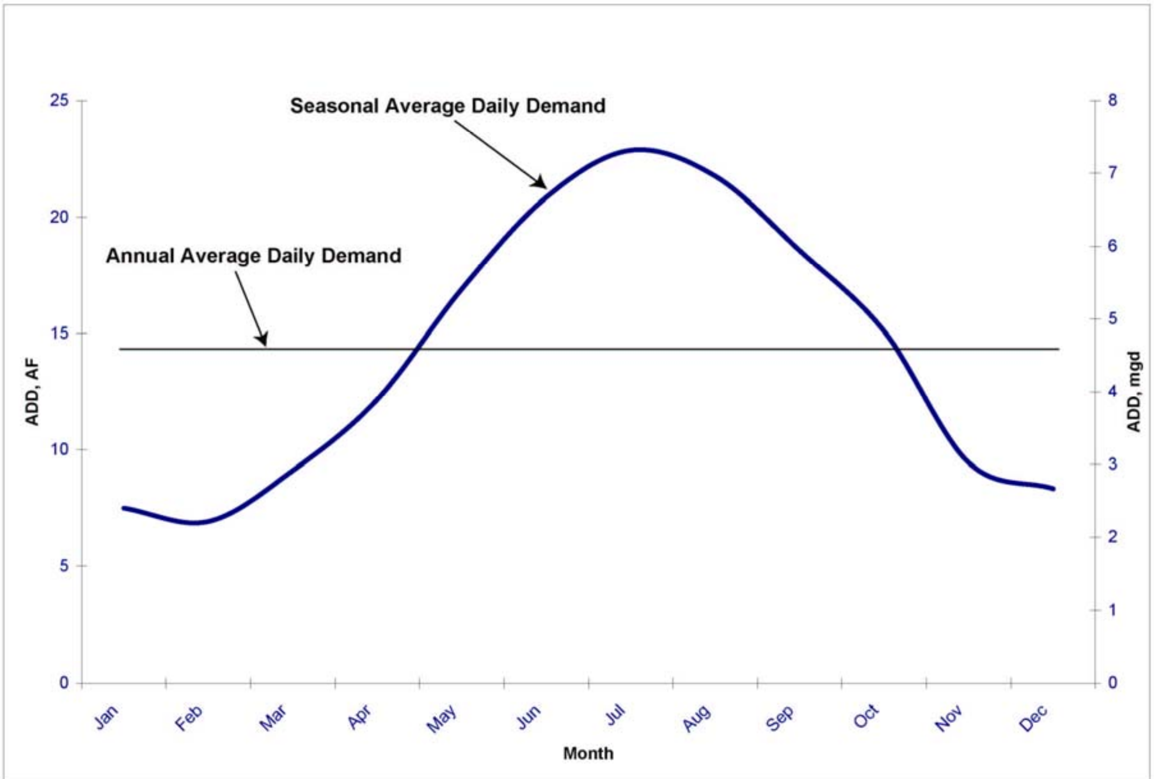
In order to plan for the City's future supply strategy, a more detailed examination was performed to determine the seasonal demands for the study area. Average monthly water demand data from the City of West Sacramento, which shares similar climate characteristics with the City of Waterford, were used to estimate the seasonal demands in the study area at buildout. Subsequent projections for ADD by month are presented in **Table 3-2** and **Figure 3-1.**

Table 3-2: Seasonal Study Area ADD

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Percentage of Annual Demand [a]	4.4	4.1	5.4	7.2	10.0	12.3	13.5	12.8	10.9	8.9	5.6	4.9	100%
Average Monthly Demand for Study Area (MG)	72.0	66.6	87.5	116.8	162.4	200.1	219.4	208.8	178.2	144.9	90.7	80.0	1,628 MG [b]
Average Daily Demand for Study Area (MG)	2.4	2.2	2.9	3.9	5.4[c]	6.7[c]	7.3[c]	7.0[c]	5.9[c]	4.8[c]	3.0	2.7	

a. Based on average annual water usage data from the City of West Sacramento.
b. Based on an annual ADD of 4.46 mgd.
c. Demands in excess of 4.0 mgd will be met by groundwater. Refer to Section 3.2.3.

Figure 3-1: Seasonal Study Area ADD



3.1.4 Unaccounted For Water Usage

Unaccounted-for-water usage in a distribution system is defined as the difference, expressed as a percentage, between the amount of water entering a system (supplied or purchased) and the amount of water sold (metered or billed). Unaccounted-for-water usage is always present in a water system and can result from many factors such as unidentified leaks in a pipe network, periodic fire-hydrant flushing, unauthorized use, inaccurate or nonfunctioning meters, etc. All recommendations made in this Master Plan, however, are for new facilities. In addition, water meters will be installed with all new residential, commercial, and industrial development. For these reasons, unaccounted for water usage is not expected to significantly impact near-term water demands in the study area. Unaccounted for water usage should be reevaluated during subsequent updates of this Master Plan.

3.2 Water Supply

3.2.1 Groundwater

Currently, drinking water for the City of Waterford is supplied solely by groundwater wells. As development in the study area takes place, groundwater will continue to be used as a supply, as treated surface water from Modesto Irrigation District (MID) will not become available until 2018. When the Phase III expansion of MID's existing surface water treatment plant (WTP) is completed in 2018, the City will begin purchasing treated surface water to supply a portion of the study area; thus, total groundwater production will decrease, and will thereafter meet only a percentage of study area demands. However, because groundwater will be used to supply the entire study area prior to 2018, the groundwater facilities recommended in this Master Plan have been sized to accommodate the maximum demands expected in 2018. After the transition to surface water, groundwater will be used to meet seasonal demands that exceed the City's entitlement to the WTP's capacity.

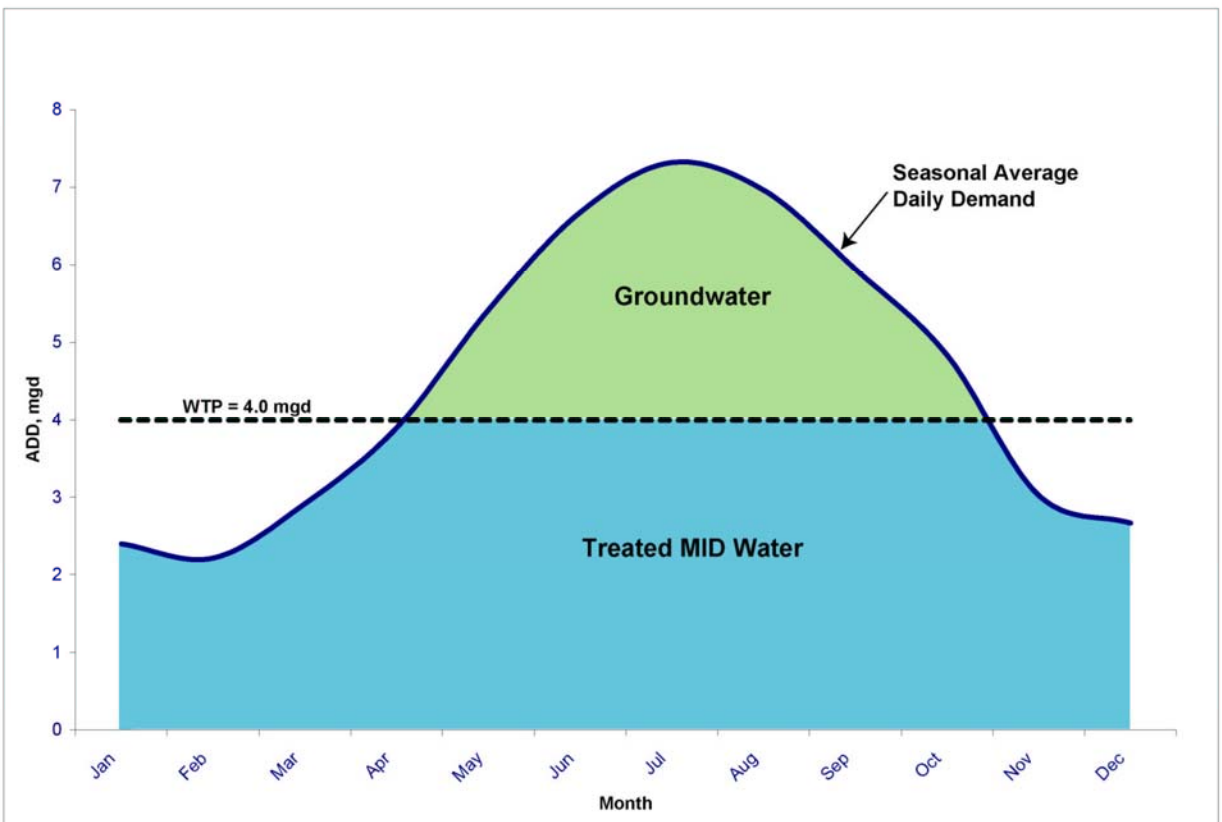
3.2.2 Modesto Irrigation District

The City anticipates participating in the Phase III expansion of MID's existing surface WTP, which has been scheduled for completion in 2018. Following completion of the Phase III expansion, treated surface water will be purchased by the City and will be used to supply drinking water to the majority of the study area. However, because MID's service area boundary is not contiguous with the study area boundary, MID will not supply water to all of the City's study area. For the 12 percent of the study area that falls outside MID service area boundaries, an annual volume of groundwater will be blended with surface water supplies such that the annual ratio of groundwater to MID water for the study area is equal to or greater than 12 percent. Based on the seasonal demand patterns presented in Table 3-2, groundwater will be used to supplement surface water supplies between the months of May and October during an average year. Such a conjunctive supply strategy will 1) ensure that the MID service area boundaries are respected, and 2) provide the same high quality drinking water to the entire study area.

3.2.3 Seasonal Supply

As part of this Master Plan, it is recommended that the City participate in a 4.0 mgd Phase III expansion of MID's existing WTP (see Section 5.2). As **Figure 3-2** illustrates, buildout study area demands during the warmest portions of the year will exceed 4.0 mgd. For the portion of the year that will typically experience these conditions, groundwater from a recommended centralized groundwater treatment facility will be used to meet demands in excess of 4.0 mgd. At buildout, it is expected that approximately 1,200 AFY (or 24 percent of the total annual demand for the study area) of groundwater will be treated in this manner, which satisfies the amount of groundwater required to meet non-MID service area demands.

Figure 3-2: Seasonal Study Area Supply



Chapter 4 Design Criteria & Modeling Results

4.1 Pressure Criteria

Water system pressure criteria are used to evaluate the ability of the system to provide acceptable pressures at points of delivery to customers under various demand conditions. It is important that the water pressure in a consumer's residence or place of business be neither too low nor too high. The desired range should encompass Average Day Demand, Max Day Demand, and Max Hour Demand conditions. Operating pressures for water distribution systems typically range from a minimum of 20 psi to a maximum of 150 psi. The recommended pressure criteria for this Water Master Plan are presented in **Table 4-1** and discussed in detail below.

4.1.1 Maximum Pressure

Maximum static (no flow) pressures for distribution system vary widely in the industry and are subject to available topography and pumping requirements; hence, AWWA does not provide recommendations for maximum static pressure. However, section 1007 of the Uniform Plumbing Code requires pressure-regulating valves on individual service connections where delivery pressures are greater than 80 psi. High pressures may cause faucets to leak, valve seats to wear out quickly, or water heater pressure relief valves to discharge. In addition, abnormally high pressures can result in water being wasted through system leaks. Based on the City's Waterworks Specifications, a maximum service pressure of 100 psi has been assumed for normal operations for this Master Plan.

4.1.2 Minimum Pressure

Minimum pressures experienced during the heaviest demand conditions should be adequate to meet customer needs. Typically, 40 psi is recommended as a minimum level of service for Max Day Demand conditions. If system pressures remain below 40 psi for extended periods, an increase in customer complaints becomes likely. In addition to the Max Day Demand criterion of 40 psi, many water systems follow the recommended AWWA minimum pressure criterion of 30 psi for Max Hour Demand conditions. Pressures below 30 psi can lead to frustrating flow reductions with the use of multiple water-using devices. Based on the City's Waterworks Specifications, a minimum pressure of 50 psi has been assumed for both Max Day and Max Hour Demand conditions for this Master Plan.

4.1.3 Fire Flow Pressure

Provision of adequate pressure during fire suppression events is critical to the acceptable performance of a distribution system, and a minimum system pressure of 20 psi is recommended by federal and state agencies for fire emergency conditions. Pressure adequacy during fire events is required to both suppress the fire and to maintain positive pressure, with a margin of safety, throughout the distribution system. Although negative pressures rarely occur in water distribution systems, the health concerns raised by backflow cross-contamination are addressed by defining appropriate minimum pressure criteria. Because fires are not scheduled events, fire events are often modeled during elevated demand conditions or during the simultaneous malfunction or inoperation of other system facilities. For the purposes of this Master Plan, fire events and Max Day Demand conditions were assumed to occur simultaneously.

Table 4-1 presents the pressure criteria recommended in this Master Plan:

Table 4-1: Recommended Pressure Criteria

Demand Scenario	Minimum Pressure	Maximum Pressure
Average Day	50 psi	100 psi
Max Day	50 psi	100 psi
Max Day + Fire Flow	20 psi	--
Max Hour	50 psi	100 psi

4.2 Pipeline Velocity and Headloss Criteria

Pipeline flow velocity and headloss criteria are interrelated, as headloss is a function of velocity and pipe roughness. The City's Waterworks Specifications set an acceptable maximum velocity of 5 feet per second (fps) for all pipe segments; hence, this criterion was assumed for this Master Plan. A maximum headloss criterion was also used to evaluate the performance of the distribution system recommended in this Master Plan. Headlosses exceeding 10 ft/1,000 ft of pipe may indicate insufficient pipeline capacity. Based on the City's Waterworks Specifications, a maximum pipe headloss criterion was assumed at 10ft/1,000 ft of pipe to reduce pressure variations within the transmission-distribution system.

For the purposes of this Master Plan, a minimum pipe diameter of 8 inches, as well as a pipe roughness coefficient of 125 for all pipe materials, was assumed based on the City's Waterworks Specifications.

4.3 Fire Flow Design Criteria

According to AWWA (Manual M31), hydraulic analyses of a distribution system should be performed under design flow conditions with fires occurring at different locations. Design flow should be based on the maximum hourly demand or the maximum daily demand plus the fire flow requirement, whichever is greater. For the purposes of this Master Plan, design fire flows were modeled as Max Day Demand conditions plus fire flow demands from separate locations within the study area, which differ according to land use designation. Fire flows for this Master Plan were based on current City of Modesto specifications, which require that for single family residential land uses, all water mains shall be sized to provide 1,000 gpm from each of two adjacent fire hydrants. Because individual fire hydrants were not modeled for the study area, fire flow was modeled as a lumped demand of 2,000 gpm from a single node. For multi-family, commercial, and industrial areas, Modesto requires that all water mains are sized to provide a fire flow of no less than 1,800 gpm from each of two adjacent fire hydrants (or 3,600 gpm from a single node) flowing simultaneously with a residual pressure of 20 psi. AWWA does not make any direct recommendations for fire flows at commercial and industrial sites. For the purposes of this Master Plan, it was assumed that only one fire event occurs at a time.

4.4 Storage Criteria

Water distribution systems should have sufficient storage capacity to meet peak hour demands, provide emergency supply, and provide supply for fire-fighting. Hence, storage volume is an integral aspect of operation and reliability for a water distribution system. As presented in the AWWA Hydraulic Design Handbook, the principal function of storage is to provide reserve supply for the following three components:

- Operational (equalization) storage;
- Emergency reserve storage; and
- Fire suppression storage

The storage volume criteria for a water distribution system is, therefore, a summation of the above three individual components.

4.4.1 Storage Components

Regulatory/Operational Storage

Also known as equalization storage, regulatory/operational storage is defined as the amount of stored water necessary to meet peak demands exceeding the normal supply delivery for a water distribution system. Since the supply source for a water distribution system should normally be able to meet the projected Max Day Demand at its equivalent hourly rate, operational storage is typically the component of total storage used for meeting normal demands that exceed the hourly rate of the Max Day Demand (i.e., Max Hour Demand). By using operational storage, fluctuations in demand are regulated so that extreme variations will not be imposed on the supply source, which in turn improves and stabilizes delivery pressures throughout the distribution system.

Based on the City's Waterworks Specifications, a volume equaling 80 percent of the Max Day Demand was assumed for regulatory storage.

Emergency/Fire Suppression Storage

Emergency/fire suppression storage is the amount of stored water required to provide a specific fire flow for a specified duration, particularly during Max Day or Max Hour Demand conditions. Fire storage volume requirements are sub-zone demands, as fire flow duration is directly related to potential fire demand durations in each zone. Insurance Service Offices (ISO) and AWWA recommend that fire storage volume be estimated by multiplying the required minimum fire flow rate required for the area served by a given reservoir by the projected duration.

For the purposes of this Master Plan, the following fire flow duration criteria for fire flow rates were assumed:

Required Fire Flow Rate (gpm)	Duration (hours)
Less than 3,000	2
3,000 to 4,000	3
Greater than 4,000	4

4.4.2 Recommended Storage Criteria

The storage criteria used in this Master Plan reflect the following storage criteria set forth in the City's Waterworks Specifications:

- Regulatory/Operational Storage: 80 percent of Max Day Demand
- Emergency/Fire Suppression Storage: One fire at 3,600 gpm for 3 hours

Table 4-2 presents the recommended total reservoir storage capacity, which was calculated based on buildout Max Day Demand conditions.

Table 4-2: Recommended Storage Capacity

Max Day Demand (mgd) [a]	Regulatory/ Operational Storage (MG)	Emergency/ Fire Suppression Storage (MG)	Total Required Storage (MG)
8.92	**7.14**	**0.65**	**7.78**

a. Assumes a buildout Average Day Demand of 4.46 mgd (3,100 gpm).

4.5 Hydraulic Model Development

The following sections provide descriptions of the hydraulic model computer software that was used for this study, the demand allocation process, and the model simulations used to analyze the proposed future distribution system for the study area.

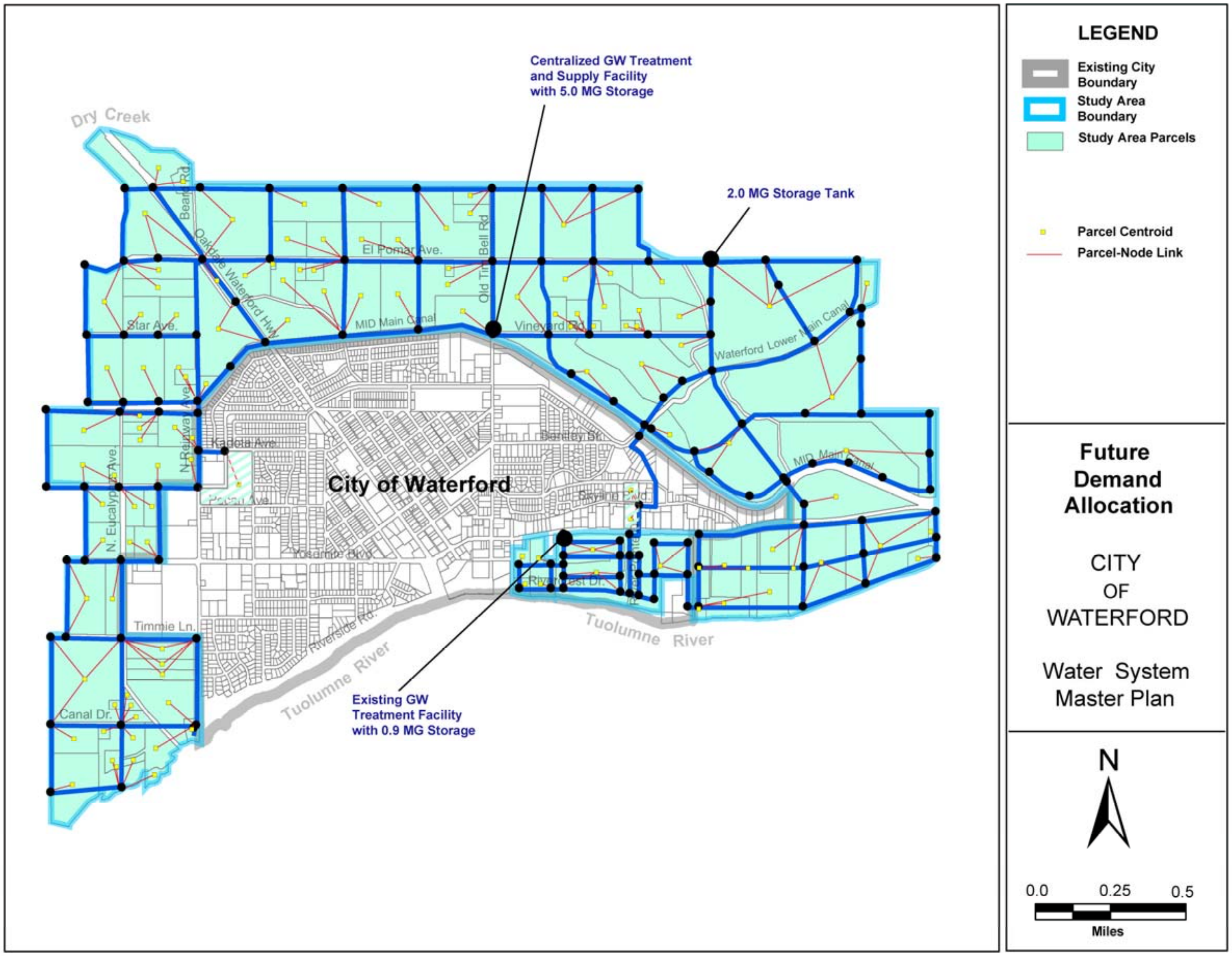
4.5.1 Software and Key Model Components

A steady-state, or static, hydraulic model of the study area's water distribution system was developed as part of this Water System Master Plan using H2OMap Water GIS, Suite 6.0. The model of the proposed distribution system includes only those water mains considered to be in the trunk network, as well as certain key mains within more developed areas of the study area (i.e., River Pointe). Water mains that will convey water from the trunk network to serve individual streets were not considered in laying out the modeled trunk system. All nodes and pipes were named using a numeric identifier. Maps showing the identification numbers of all nodes and pipes are included in **Appendix A**.

4.5.2 Demand Allocation

The parcel-node links shown in **Figure 4-1** represent the locations where projected demands from study area parcels were loaded into the modeled distribution system network. Certain larger parcels were loaded to more than one node, with each link representing an equal percentage of the total projected demands from a given parcel. The intent of this methodology was to distribute water demands as realistically as possible.

Figure 4-1: Demand Allocations for Proposed Future Distribution System



4.5.3 Model Simulations

There are two types of hydraulic models used to simulate a water distribution system: 1) a steady state/static simulation; and 2) an extended period/dynamic simulation. An extended period/dynamic model employs a continuous simulation of the changes in system flow rates, and is typically used to analyze the performance of the system over a 24-hour or longer period. Extended period/dynamic modeling requires more extensive data input than a steady-state model, including various 24-hour diurnal curves for various land use categories within the water distribution system and a representation of time-varying pumping responses. Simulations from a steady state model represent a snapshot of the system performance at a given point in time under specific water demand conditions (typically peak demand conditions), and are typically used for sizing of water mains and booster pump stations. Hence, for the purposes of this Master Plan, a steady-state hydraulic model has been used in system analyses to size water mains and pump stations. A total of six scenarios were modeled, and are described in further detail below.

4.5.4 Modeled Scenarios

Table 4-3 summarizes the six model scenarios that were developed and analyzed for this Master Plan. All scenarios reflect water demands under buildout conditions. Recommendations for the future water distribution system were based on the results of these simulations.

Table 4-3: Modeled Demand Scenarios

No.	Scenario	Demand Conditions	Minimum Pressure Criteria	Maximum Pressure Criteria
1	Average Day	Average Day Demand	50 psi	100 psi
2	Max Hour	Max Hour Demand (all storage tank booster pump stations online)	50 psi	100 psi
3	Max Day + Fire # 1	Max Day Demand with 2,000 gpm fire flow in NE corner of study area (node 64)	20 psi	--
4	Max Day + Fire # 2	Max Day Demand with 3,600 gpm fire flow on Oakdale Waterford Highway (node 84)	20 psi	--
5	Max Day + Fire # 3	Max Day Demand with 2,000 gpm fire flow in SW area of study area (node 102)	20 psi	--
6	Max Day + Fire # 4	Max Day Demand with 2,000 gpm fire flow along MID Main Canal (node 188)	20 psi	--

4.5.5 Model Results

Graphical results for each of the six modeled scenarios are presented in **Appendix A**.

Scenario 1

Based on modeled results, Average Day Demands will be met while maintaining a system pressure of at least 50 psi, with the lowest pressures in the system occurring in the areas with the highest elevation. Pressures in all areas in this scenario will remain below 100 psi.

Scenario 2

Results show that by bringing online the booster pump station adjacent to a 2.0 MG storage tank (Project 13), Max Hour Demands will be met while maintaining system pressures above 50 psi, meeting the proposed criterion. Pressures in all areas in this scenario will remain below 100 psi.

Scenarios 3 through 6

Based on modeled results, minimum pressures for Scenarios 3 through 6 range between 42 and 53 psi, well above the 20 psi criterion. Maximum pressures will remain below the 100 psi criterion.

Chapter 5 Recommended Projects

The recommended projects for the proposed future water system were developed based on the methodologies and criteria presented in the previous sections, and considered input from the City, River Pointe development plans, and available plans for the more recently proposed Grupe development (Lake Pointe). This chapter provides a summary of the future well expansion projects, future MID treated water expansion projects, future water distribution system expansion projects, as well as the costs, phasing, and other issues associated with implementation of the recommended projects.

5.1 Future Well Expansion Projects

Figure 5-2 presents the locations of the existing and proposed groundwater wells for the future water system, and identifies individual well siting and expansion projects (Projects 2 and 3). For the purposes of this Master Plan, it was assumed that the centralized groundwater treatment facility will consist of three duty wells and one standby well, each with a production capacity of approximately 1,200 gpm, or 1.73 mgd (Don Howard Engineers). The spacing between wells should ensure that the operation of any well will not significantly impact the production capacity of another; for this Master Plan, it has been assumed that all wells will be separated by a distance of at least 0.33 miles[2].

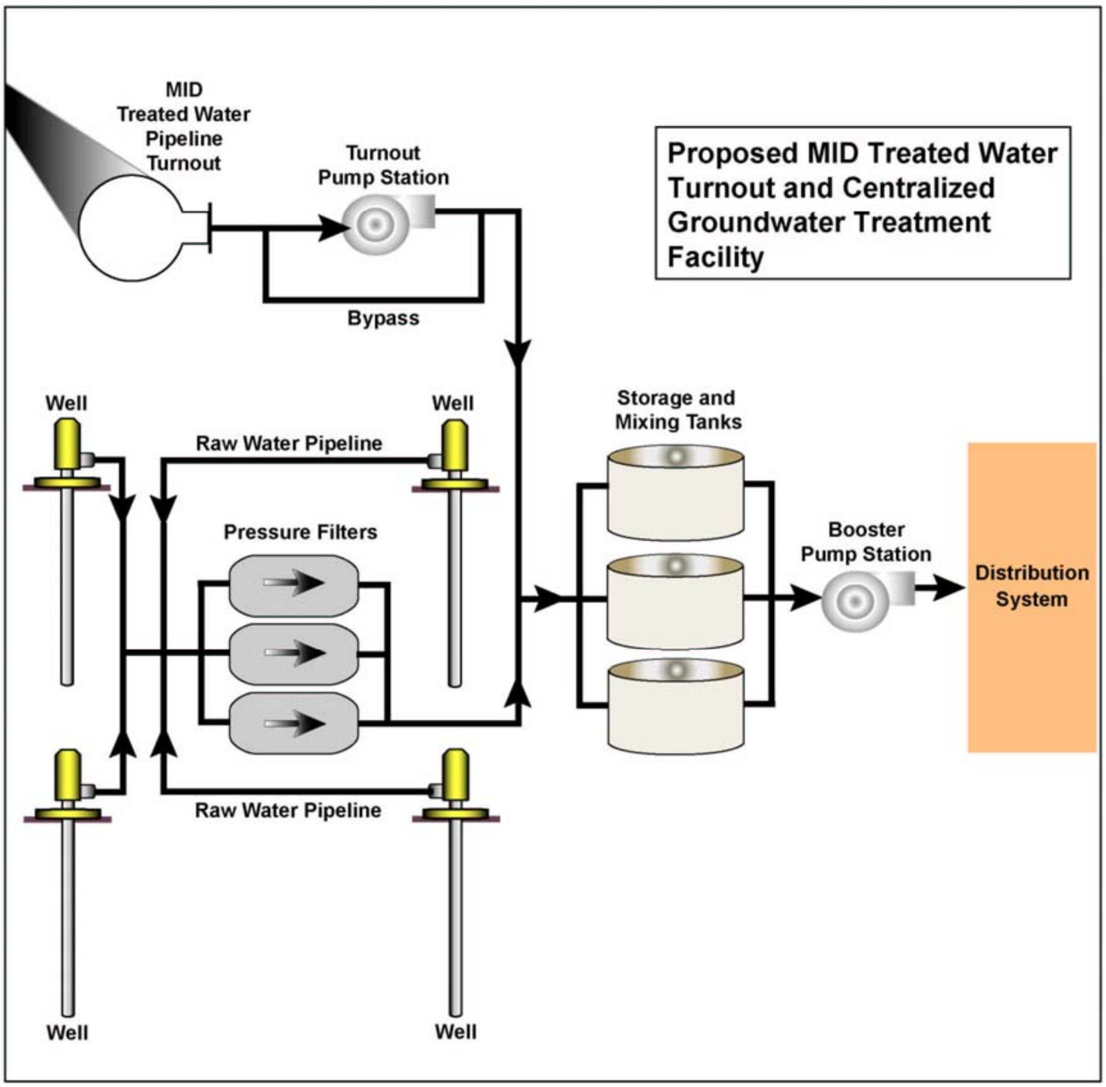
The decision to recommend pressure filters for the new wells was based upon the existing groundwater treatment facilities in River Pointe. Prior to the completion of a hydrogeological and well siting study, it will be difficult to determine if treatment is necessary or the type and number of groundwater treatment modules.

[2] The transparent circles in Figure 5-2 have radii of approximately 0.33 miles, and indicate the general areas in which the proposed well expansion projects should occur.

5.2 Future MID Treated Surface Water Expansion Projects

Figure 5-2 provides callouts for two recommended surface water expansion and delivery projects. Project 1 features the installation of pressure gauges at two locations along MID's existing treated water pipeline. Project 4 features a 4.0 mgd expansion of MID's existing surface water treatment plant (WTP) east of the existing City, as well as a turnout and booster pump station along the treated water pipeline. The 'raw' treated water pipeline will convey treated surface water to a centralized groundwater treatment facility where surface water and groundwater will be mixed and stored before entering the distribution system. **Figure 5-1** provides a schematic of the proposed centralized treatment facility.

Figure 5-1: Proposed Centralized Water Supply and Treatment Facility



5.3 Future Water Distribution System Expansion Projects

Figure 5-2 presents the locations of 14 individual expansion projects, including nine proposed water distribution system expansion projects.

5.4 Project Descriptions and Costs

A total of 14 projects have been developed and recommended for the future water distribution system in the study area. **Figure 5-2** presents the 14 recommended projects. **Figure 5-3** provides the diameters of all pipes[3] in the recommended distribution system. Descriptions, costs, and phasing of the recommended projects, as well as any associated implementation issues, are presented in the subsequent sections. The proposed projects include one pressure monitoring project, three well and water treatment/storage projects, one WTP expansion project, and nine water main projects. Individual project descriptions, including pipe diameters, pipe lengths, storage tank requirements, pump station parameters, and estimated costs, are presented in **Table 5-2**.

[3] Excludes raw water pipelines from proposed wells to the centralized groundwater treatment facility, as well as treated water pipelines from the proposed MID turnout to the proposed centralized groundwater treatment facility. These pipelines and their associated costs are addressed in Table 5-2.

Figure 5-2: Recommended Projects

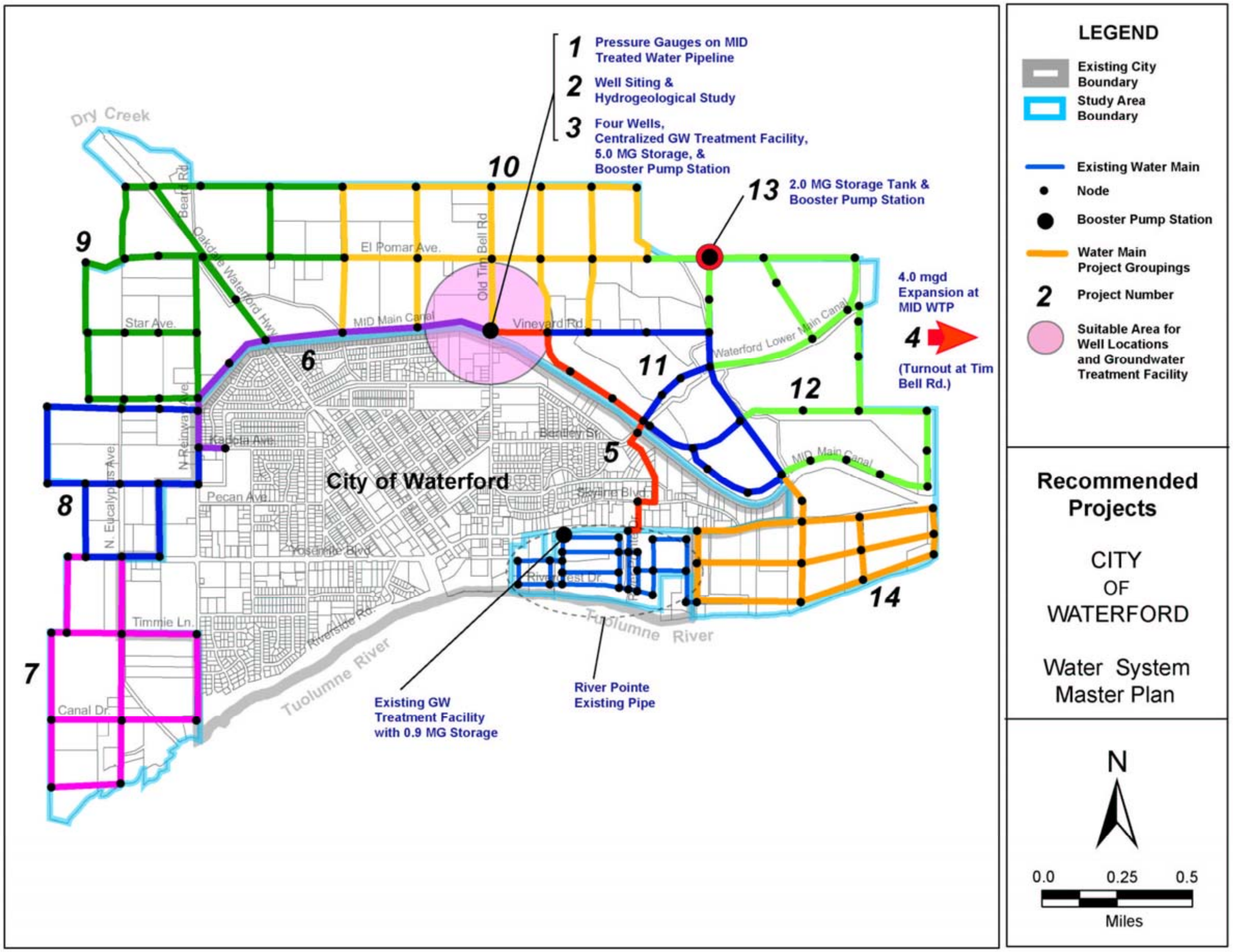
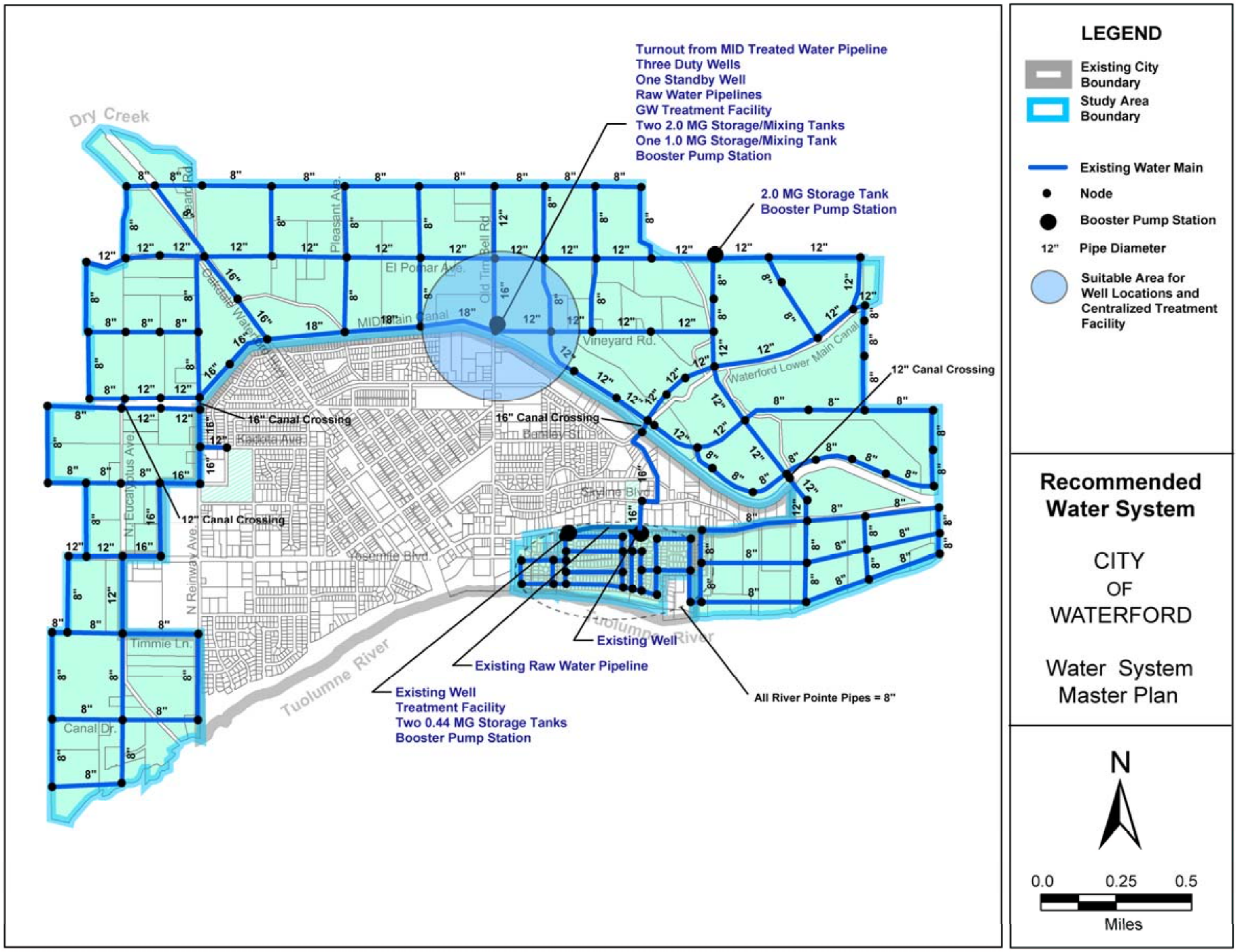


Figure 5-3: Recommended Water Distribution System



5.4.1 Cost Criteria

Table 5-1 presents the cost criteria used to develop cost estimates for the recommended water system expansion projects for the study area. It should be noted that the estimated capital costs presented in **Table 5-2** are considered conceptual planning level costs, and have an expected accuracy of -30% to +50%.

Surface Water and Groundwater Treatment Facility Costs

Costs for the various surface water and groundwater treatment facility projects recommended in this Master Plan are based on discussions with various water treatment plant engineers. The estimated construction cost for the future expansion of the MID surface water treatment plant (Project 4), which is not scheduled to be completed until 2018, is based on current WTP expansion costs and an assumed annual inflation rate of 3 percent[4]. As with all planning level costs, these costs should be refined during the Capital Improvement Program implementation period.

Water Main, Well, and Booster Pump Station Costs

Water main installation costs vary according to many factors, including pipe material, diameter, depth, soil and groundwater conditions, complexity of construction, and requirements for traffic control and surface restoration. The costs used in this Master Plan include mobilization, traffic control, trenching, dewatering, pipe installation and service connections, and pavement replacement. These baseline construction costs are based on recent northern California construction bids and cost estimates from similar projects.

Well construction costs vary according to several factors, including location, capacity, and complexity of construction. Construction costs in this Master Plan are based on the estimated project costs used by the City of Winters' for similar well construction projects.

Booster pump station costs were estimated based on cost curve data presented in Figure 29-3 of *Pumping Station Design* by Robert Sanks. The Sanks cost curve, considered to be the industry standard, was developed using historical construction costs of various pumping stations.

Construction Contingency and Project Implementation Multiplier

A construction contingency and project implementation multiplier of 1.625[5] was applied to each potential improvement project's estimated baseline construction cost. This allowance is assumed to include:

- Potential construction issues unforeseen at the planning level
- Administration costs
- Environmental assessments and permits
- Planning and engineering design
- Construction administration and management
- Legal fees

[4] [\$6.0 million] x $[1.03]^{\text{approx. 10 years}}$ = \$8.0 million

[5] The 1.625 multiplier is based on a 30% construction cost contingency plus a 25% engineering and administration factor to calculate the capital cost. Hence, for budgeting purposes, it is assumed that the contingency and project implementation multiplier is 1.625 (1.25 x 1.30 = 1.625).

Table 5-1: Cost Criteria for Recommended Projects

Facility Type	Size/Firm Capacity		Unit Cost	
			Not in Existing Street	In Existing Street
Water Main	8 in.		40 $/LF	60 $/LF
	10 in.		55 $/LF	75 $/LF
	12 in.		70 $/LF	90 $/LF
	14 in.		80 $/LF	100 $/LF
	16 in.		90 $/LF	110 $/LF
	18 in.		100 $/LF	130 $/LF
Groundwater Well	1,200 gpm		$1,500,000	
Pressure Filter	3,600 gpm		$2,000,000	
Storage/Mixing Tank	1.0 - 2.0 MG		0.80 $/gal	
Pump Station	MID Turnout Booster PS	5.00 mgd	$1,200,000	
	Centralized Treatment Plant Booster PS	8,110 gpm	$2,000,000	
	Storage Tank Booster PS	2,630 gpm	$800,000	

Table 5-2: Recommended Projects and Estimated Costs

Project No.	Description	Diameter (in)	Length (ft)	Pump Station Firm Capacity [a] /Well Production Capacity/Storage Tank Capacity	Baseline Construction Cost [b]	Estimated Capital Cost [c]
1	**Pressure Gauges on MID Treated Water Pipeline**					
	Pressure Gauges at Two Locations along MID Pipeline	---	---	---	$50,000	***$81,000***
				Subtotal	***$50,000***	
2	**Well Siting/Hydrogeological Investigation**					
	Hydrogeological and Well Siting Investigation	---	---	---	$65,000	***$163,000***
	Report	---	---	---	$35,000	
				Subtotal	***$100,000***	
3	**Centralized GW Treatment Facility**					
	Duty Well Construction	---	---	*1,200 gpm*	$1,500,000	***$26,853,000***
	Duty Well Construction	---	---	*1,200 gpm*	$1,500,000	
	Duty Well Construction	---	---	*1,200 gpm*	$1,500,000	
	Standby Well Construction	---	---	*1,200 gpm*	$1,500,000	
	Raw Water Pipelines to Treatment Facility [d]	10	7,000	---	$525,000	
	Centralized GW Treatment Plant	---	---	*3,600 gpm*	$4,000,000	
	Storage/Mixing Tank	---	---	*2.0 MG*	$1,600,000	
	Storage/Mixing Tank	---	---	*2.0 MG*	$1,600,000	
	Storage/Mixing Tank	---	---	*1.0 MG*	$800,000	
	Booster Pump Station	---	---	*8,110 gpm*	$2,000,000	
				Subtotal	***$16,525,000***	
4	**Water Treatment Plant Expansion & MID Turnout and Pump Station**					
	MID Surface WTP Expansion	---	---	*4.00 mgd*	$8,000,000	***$15,023,000***
	Turnout & Pump Station at Tim Bell Road	---	---	*5.00 mgd*	$1,200,000	
	Treated Water Pipeline to Storage/Mixing Tanks [e]	12	500	---	$45,000	
				Subtotal	***$9,245,000***	
5	**Eastern Transmission Main**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	12	3,450	---	$261,300	***$900,000***
		16	2,660	---	$292,600	
				Subtotal	***$553,900***	
6	**Western Transmission Main**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	12	470	---	$42,300	***$1,100,000***
		16	2,300	---	$224,400	
		18	4,100	---	$410,000	
				Subtotal	***$676,700***	
7	**Southwest Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	14,670	---	$718,800	***$1,168,000***
		12	1,680	---	$151,200	
				Subtotal	***$718,800***	

(continued on next page)

Project No.	Description	Diameter (in)	Length (ft)	Pump Station Firm Capacity [a] /Well Production Capacity/Storage Tank Capacity	Baseline Construction Cost [b]	Estimated Capital Cost [c]
8	**Western Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	5,960	---	$238,400	***$1,170,000***
		12	2,030	---	$155,000	
		16	3,330	---	$326,300	
				Subtotal	***$719,700***	
9	**Northwestern Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	15,550	---	$743,400	***$2,334,000***
		12	8,030	---	$692,700	
				Subtotal	***$1,436,100***	
10	**Northern Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	16,870	---	$700,000	***$2,348,000***
		12	6,700	---	$603,000	
		16	1,290	---	$141,900	
				Subtotal	***$1,444,900***	
11	**Near East Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	2,030	---	$81,200	***$1,282,000***
		12	9,280	---	$707,600	
				Subtotal	***$788,800***	
12	**Far East Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	11,000	---	$440,000	***$1,724,000***
		12	8,870	---	$620,900	
				Subtotal	***$1,060,900***	
13	**Storage Tank & Booster Pump Station**					
	Storage Tank	---	---	*2.0 MG*	$1,600,000	***$3,900,000***
	Booster Pump Station	---	---	*2,630 gpm*	$800,000	
				Subtotal	***$2,400,000***	
14	**Southwest Mains**					
	Refer to **Figures 5-2 and 5-3** for locations and diameters of water mains	8	17,530	---	$786,200	***$1,387,000***
		12	960	---	$67,200	
				Subtotal	***$853,400***	
15	**Master Plan Implementation and Management [f]**					***$2,972,000***
	TOTAL					***$62,405,000***

a. Firm capacity is the pump station capacity with the largest pump not operating.
b. Baseline Construction Costs were calculated based on the unit costs presented in Table 5-1.
c. Estimated Capital Cost = (Baseline Construction Cost) x (1.625). Refer to Section 5.4.1.
d. One 0.33-mile raw water pipeline was assumed for each GW well.
e. One 500-foot treated water pipeline was assumed for the MID Turnout.
f. See description below.

The length for these projects totals approximately one mile of raw water (RW) pipeline, and approximately 26.4 miles of water mains. Project 15, or Master Plan Implementation and Management, is assumed to be 5% of the total estimated capital cost for Projects 1 through 14. A small portion of the cost includes additional engineering analyses for certain recommended projects. The total estimated capital cost for all projects, including Project 15, is approximately $62.4 million.

5.5 Proposed Phasing

Project 1 should be constructed first in order to collect data that will be necessary to design the MID turnout facility (Project 4). The data collected will determine if a pump station will be necessary to pump treated water from the MID Treated Water Pipeline up into the storage tank. Initial calculations show that the available pressure may or may not be sufficient. Consideration should be given to constructing a portion of the turnout facility at the same time as the construction of Project 1. The proposed MID turnout and centralized groundwater treatment facility (Projects 3 and 4) will need to be constructed as development demands exceed the capacity of the current groundwater facilities. Projects 5 and 6 are main transmission projects which move water east and west and together will form the 'backbone' of the distribution system. As such, they should be constructed early to allow the existing groundwater supply facilities to work in conjunction with the groundwater facilities that will come on-line first. Project 4 (WTP Expansion and MID turnout) is a key project for Waterford. Early discussions with MID will be necessary to keep this project on schedule. Distribution projects should be constructed as development occurs. Additionally, it is recommended that the hydraulic model developed for this Master Plan is run as new developments come on-line.

5.6 Implementation Issues

A variety of issues may affect the implementation of the future water distribution system improvement projects presented in this Master Plan. These issues may include changes in road alignments, permitting issues for canal crossings or surface and groundwater treatment facilities, refinement of study area land uses (including school and park parcels), and future developer plans, among others. The proposed water distribution system layout in this Master Plan is intended to offer a conceptual solution to the City's future needs; more rigorous analyses will be required, including the analysis of existing and future road alignments, geotechnical analyses of proposed pipeline alignments, and environmental permitting analyses, before design and construction phases can begin.

5.7 Additional Recommendations

The following sections provide recommendations for projects that will improve maintenance of the City's water system. These projects and programs should be implemented to enhance the existing and future water system and provide the City with an improved understanding of customer water use.

5.7.1 Urban Water Management Plan

Per the Urban Water Management Planning Act, urban water suppliers that supply more than 3,000 AFY must adopt an Urban Water Management Plan (UWMP). Compliance with Urban Water Management Planning Act provides:

- Framework for regional cooperation and decision making;
- Balanced integration of supply and demand management;
- Sound basis for water supply assessments (SB 221 and 610 compliance);
- A foundation for securing additional supplies; and,
- Eligibility for state grant or loan funding

The City of Waterford prepared its first UWMP in 2005. It is recommended that the City take an aggressive approach to upholding the demand management measures discussed in the UWMP. Additionally, it is recommended that the City be proactive about UWMP updates, which are required every five years.

5.7.2 Valve Exercise and Location Program

Regular valve exercising is needed to identify broken, inoperable and/or leaky valves. Repairing such valves will help to reduce water quality problems, the time needed to repair leaks, and customer service complaints.

In many instances, valves may be paved over or buried too deep, making them difficult or impossible to locate. It is therefore recommended that the develop water atlas maps as a tool to confirm the locations of valves.

5.7.3 Main Flushing Program

Periodic flushing of water mains is necessary to prevent potential water quality problems, as well as corrosion caused by sediment buildup and biofilm growth in the distribution system. Flushing also increases flow through pipes and allows better mixing to occur between new and aged water.

5.7.4 Comprehensive Maintenance Plan

A comprehensive maintenance plan will provide the City with written policies and procedures on how to identify maintenance and field staffing/crew needs, schedule and track repairs, and perform outage planning. A comprehensive plan will also help the City to establish maintenance priorities.

5.7.5 Leak Detection Program

Leak detection and repair reduces the amount of “unaccounted for water” and allows for a more reliable and efficient water distribution system. Excessive leaking throughout the system can lead to increased headloss, flow discontinuity, and ultimately, service disruption.

5.7.6 Hydrant Maintenance Program

AWWA (Manual 17) recommends that inspection and testing of hydrants take place at least once per year to ensure proper functionality during an emergency or scheduled flow test. The City should consider coordinating this effort with the local fire department.

5.7.7 Hydrant and Valve ID Program

As discussed in Section 5.7.4, it is recommended that the City develop a system to track scheduled and performed maintenance. As part of this effort, it is recommend that the City assign each hydrant and valve an identification number (ID) to ensure efficient tracking of each repair.

References

1. Brown and Caldwell, River Pointe CAD files, August 2004.
2. City of Waterford, Standard City of Waterford Waterworks Specifications.
3. DeLorme, Waterford Annexation Area 3-D Topoquad, 2002.
4. MCR Engineering, City of Waterford Proposed Sphere of Influence Map, January 2005.
5. MCR Engineering, Waterford Land Use Map.
6. MCR Engineering, Waterford Annexation Area Map.
7. Stanislaus County, Waterford GIS Parcel Map.
8. RMC Water and Environment, "Draft 2005 Urban Water Management Plan," October 2005.
9. RMC Water and Environment, "Technical Memorandum 2: Proposed Water Use Factors, Design and Modeling Criteria – Draft," October 2005.
10. The Grupe Company, River Pointe CAD files, May 2005.
11. TKC Engineering, River Pointe CAD files.
12. Tri State Photogrammetry, Waterford Study Area Ortho Photos.

Appendix A - Model Data

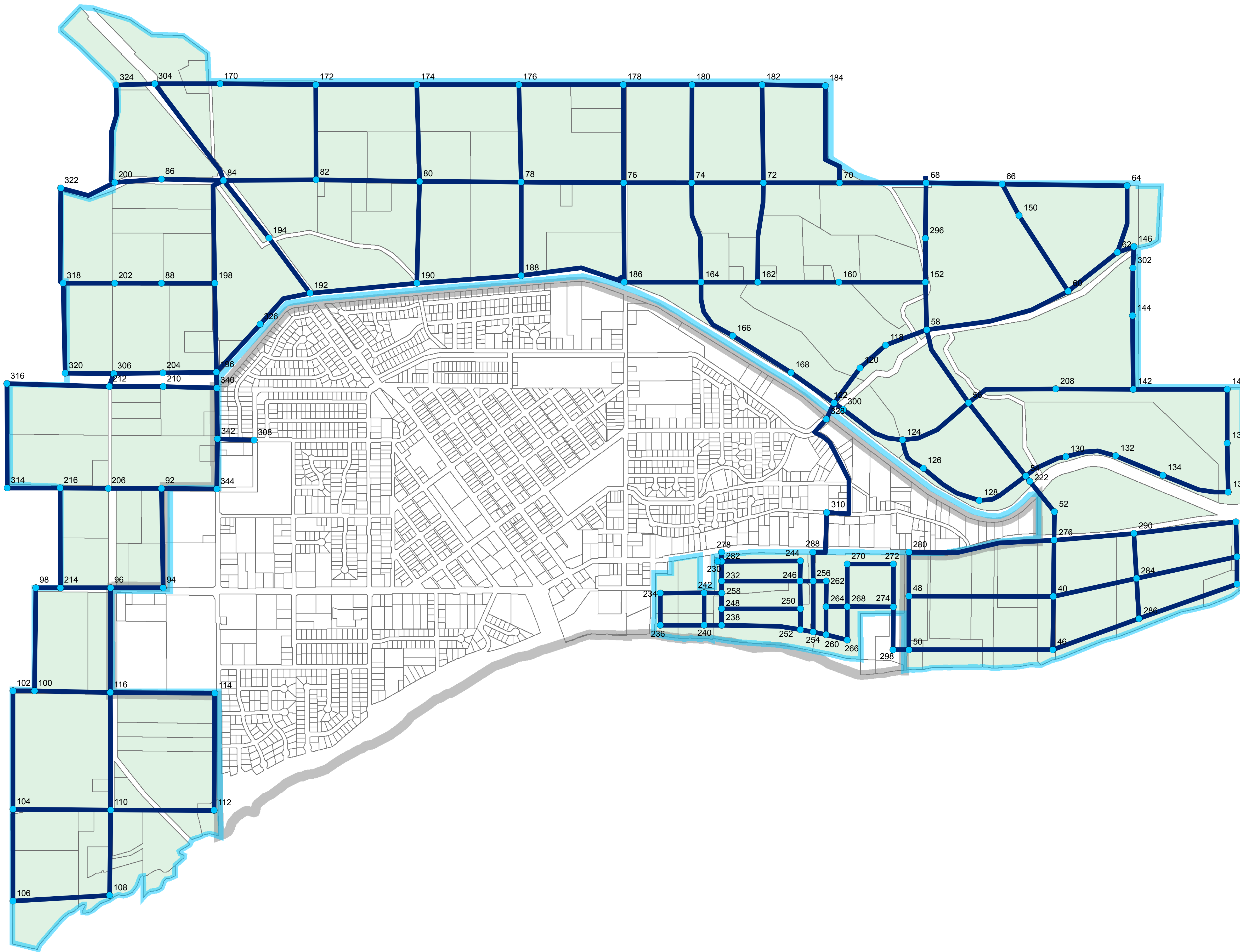


FIGURE A-1

Node ID Map

CITY OF WATERFORD

Water System Master Plan

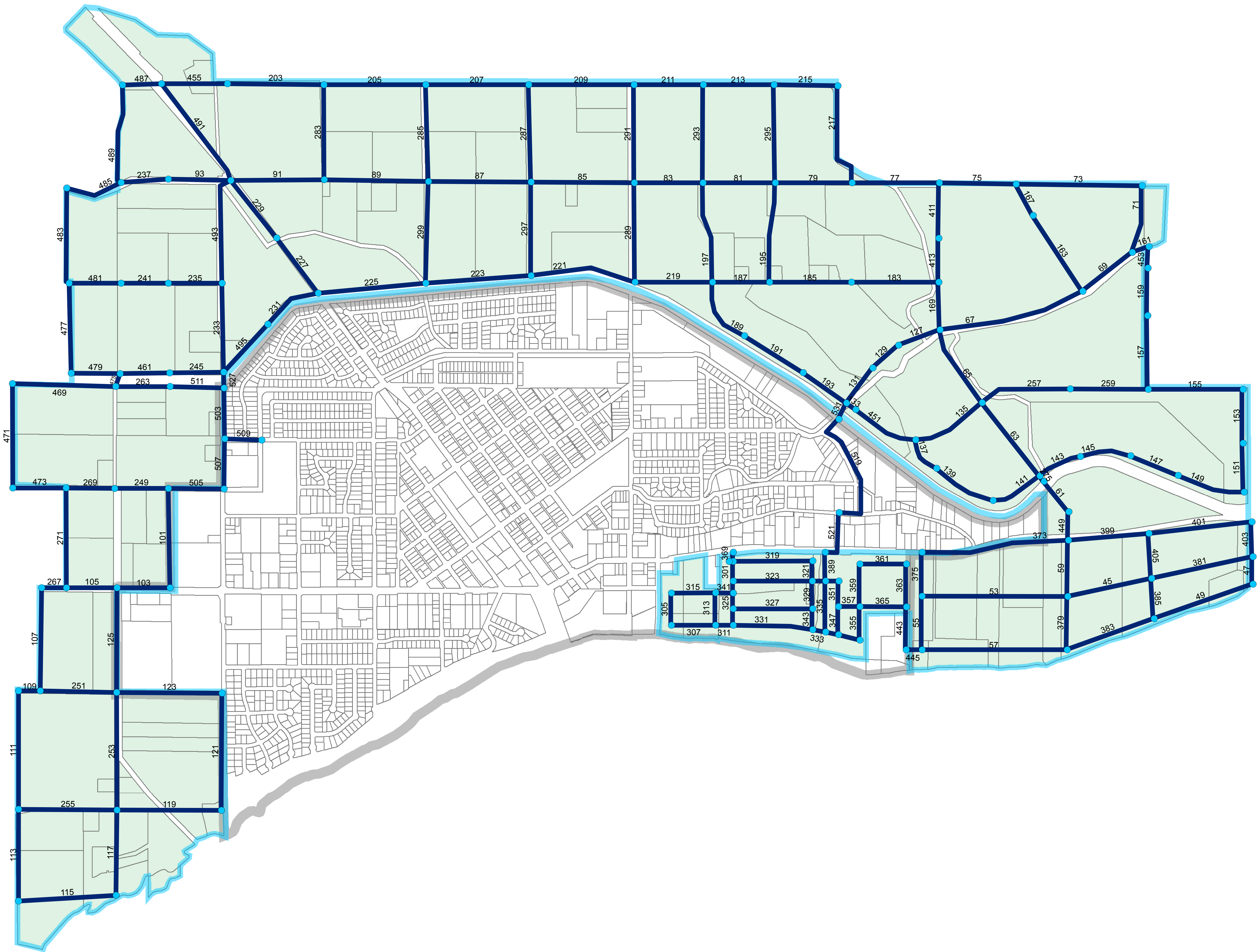


FIGURE A-2

Pipe ID Map

CITY OF WATERFORD

Water System Master Plan

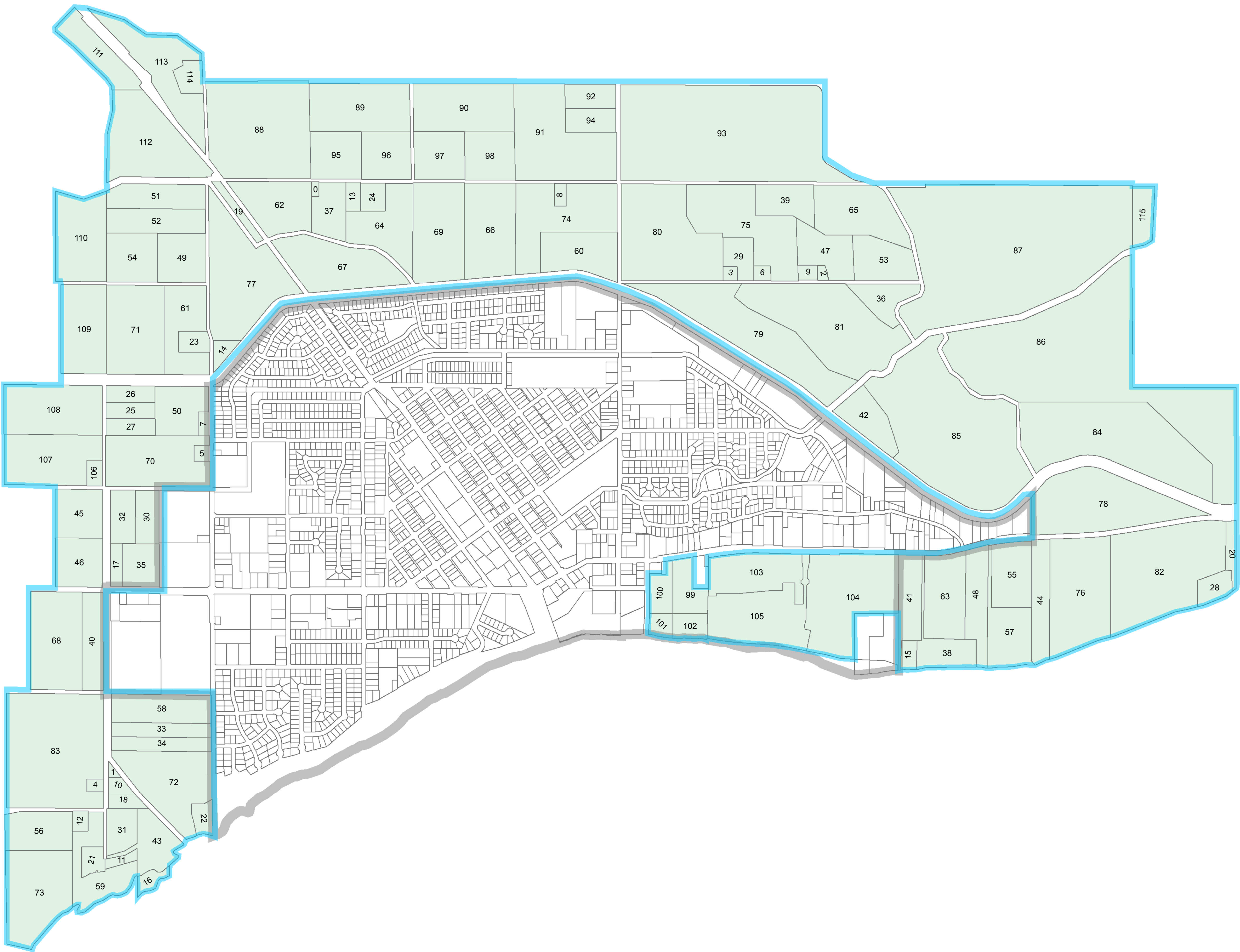


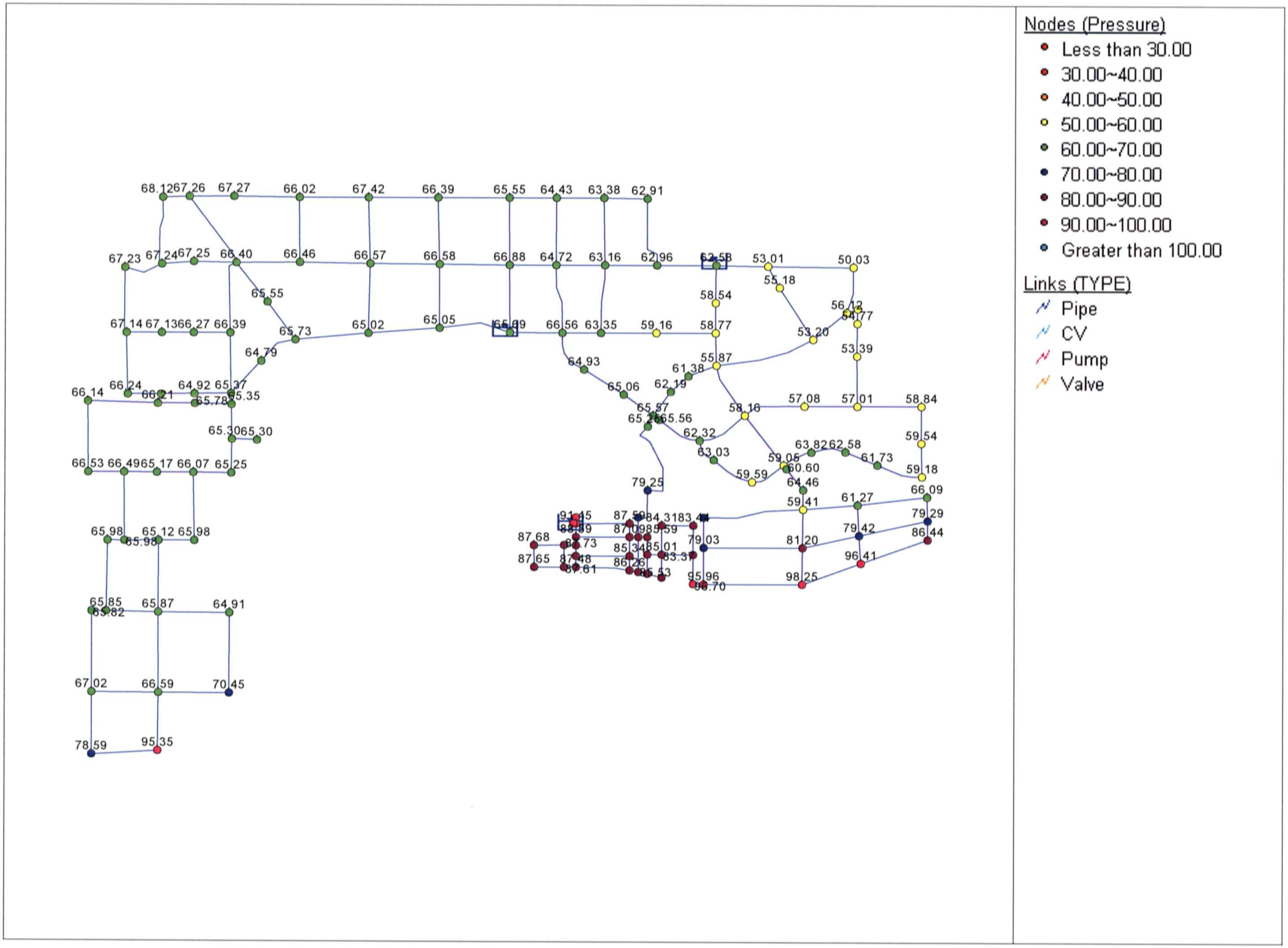
FIGURE A-3

Parcel ID Map

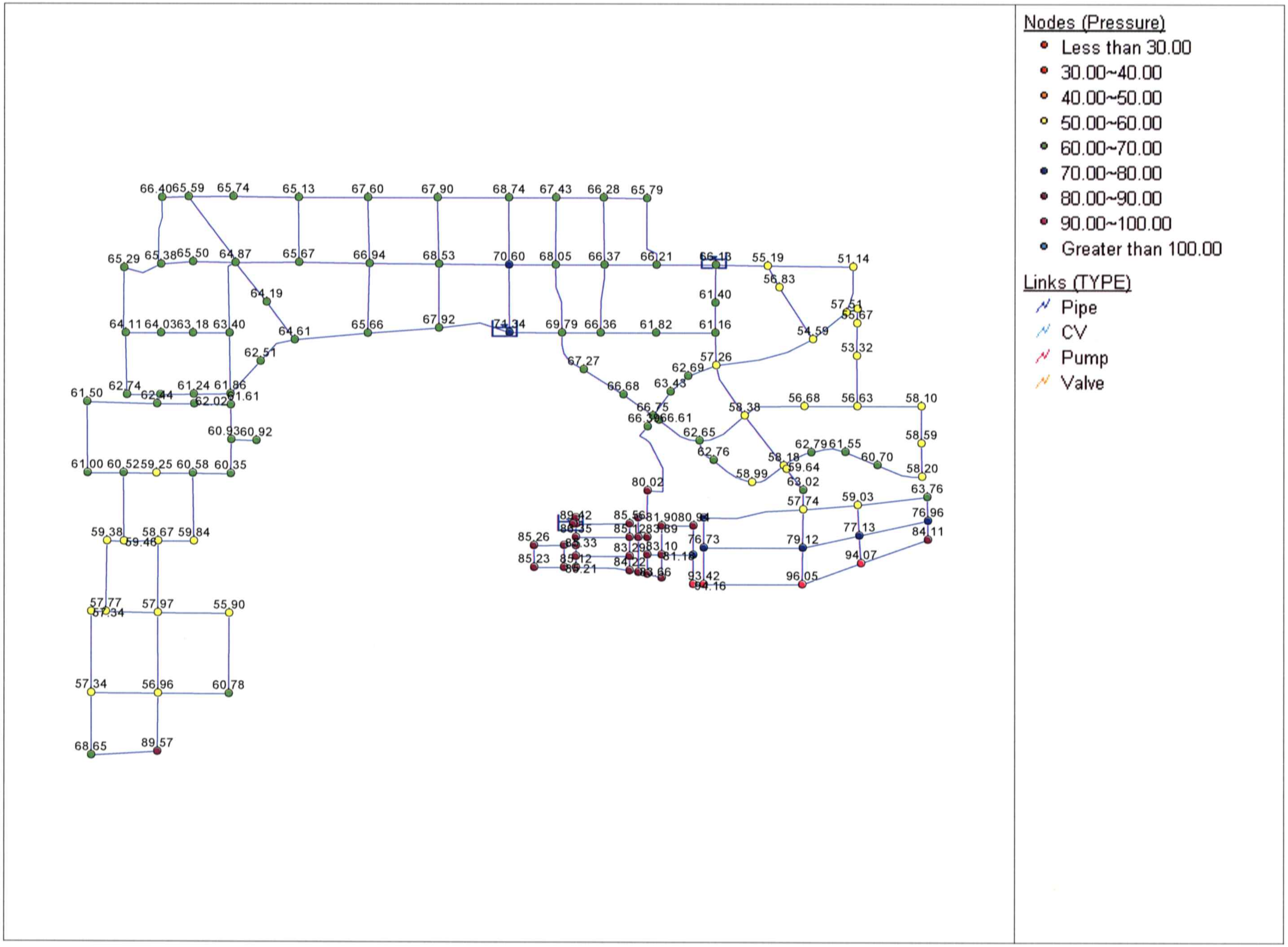
CITY OF WATERFORD

Water System Master Plan

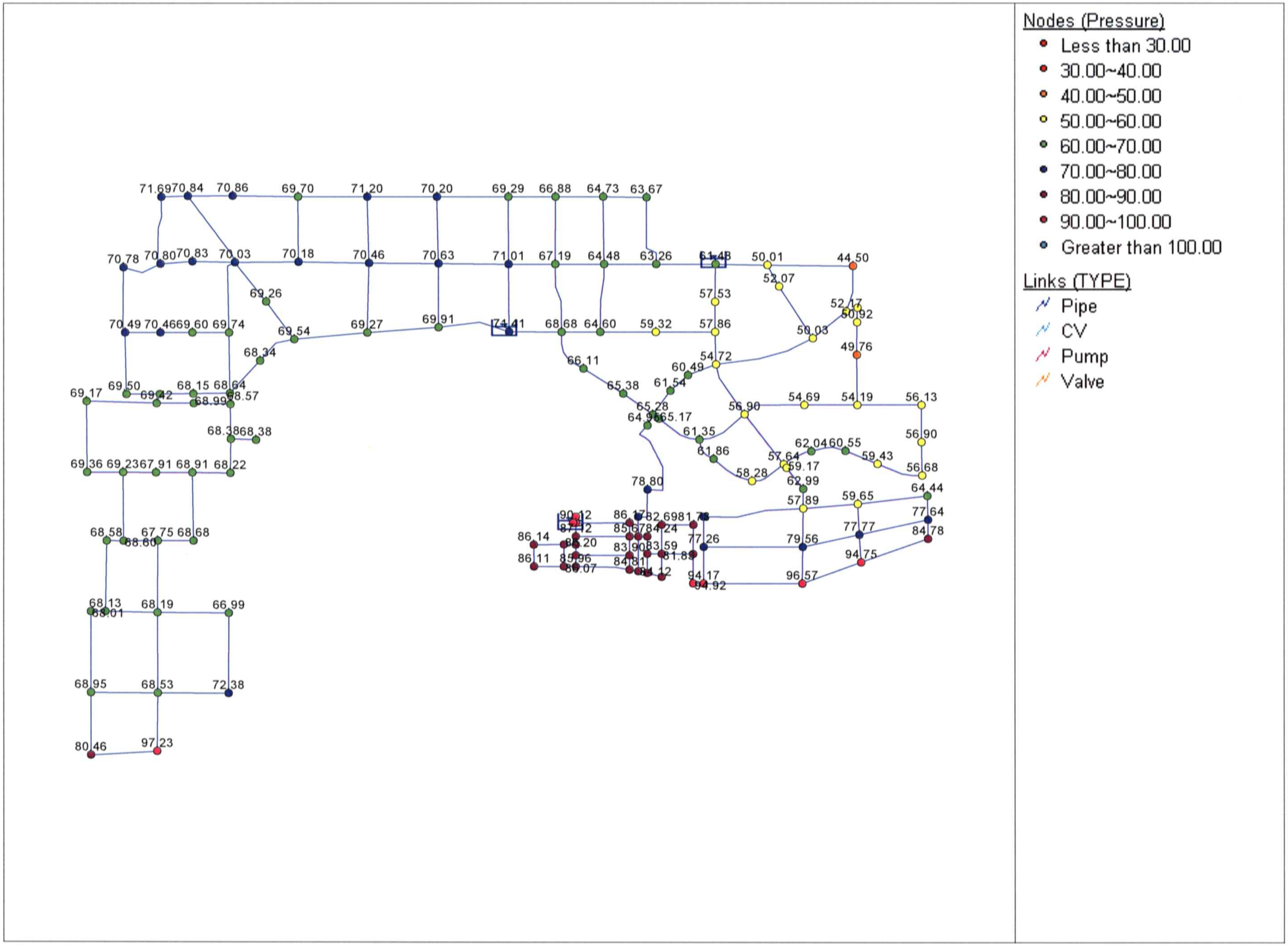
Scenario 1 - Average Day Demand



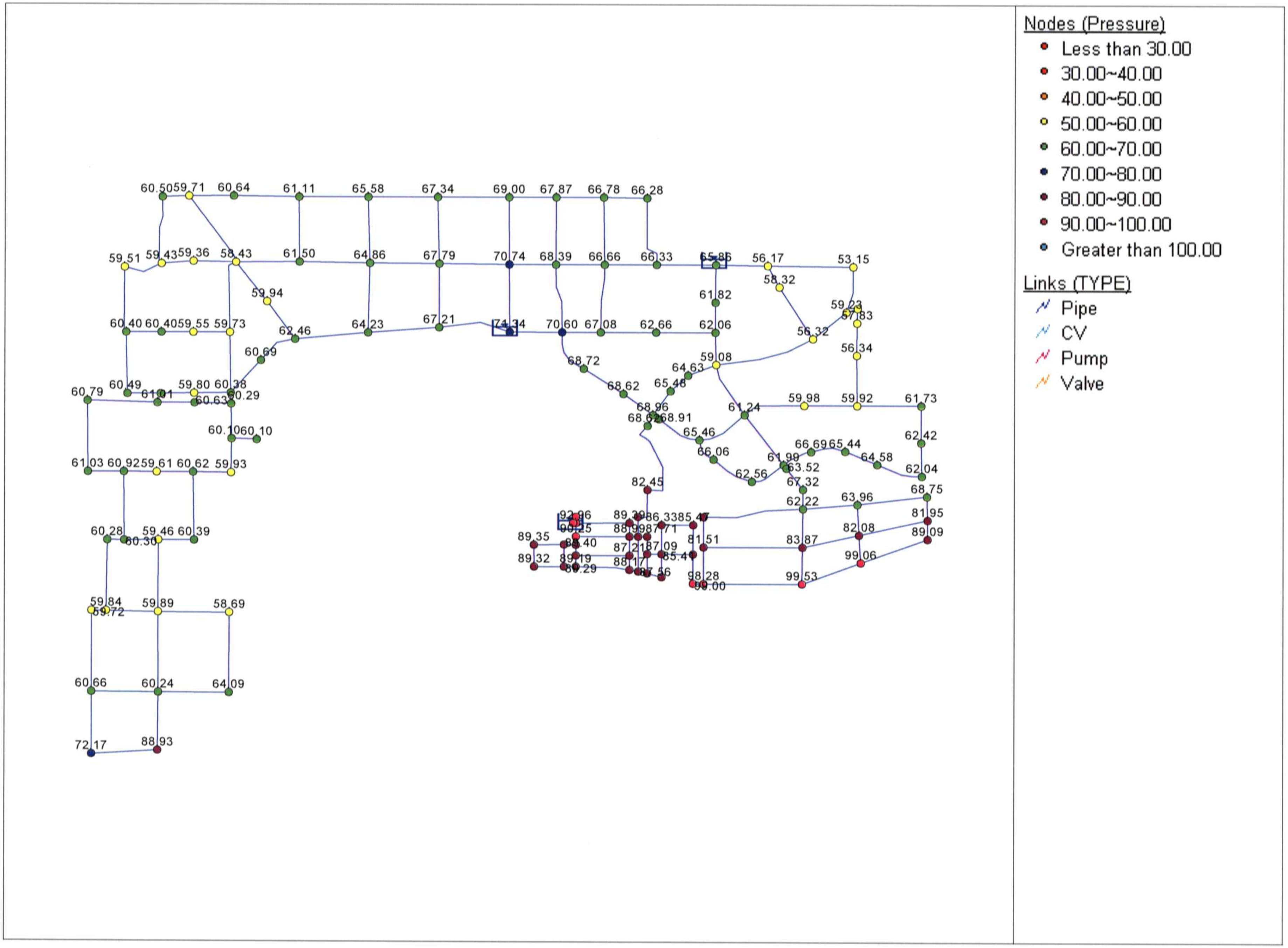
Scenario 2 - Max Hour Demand



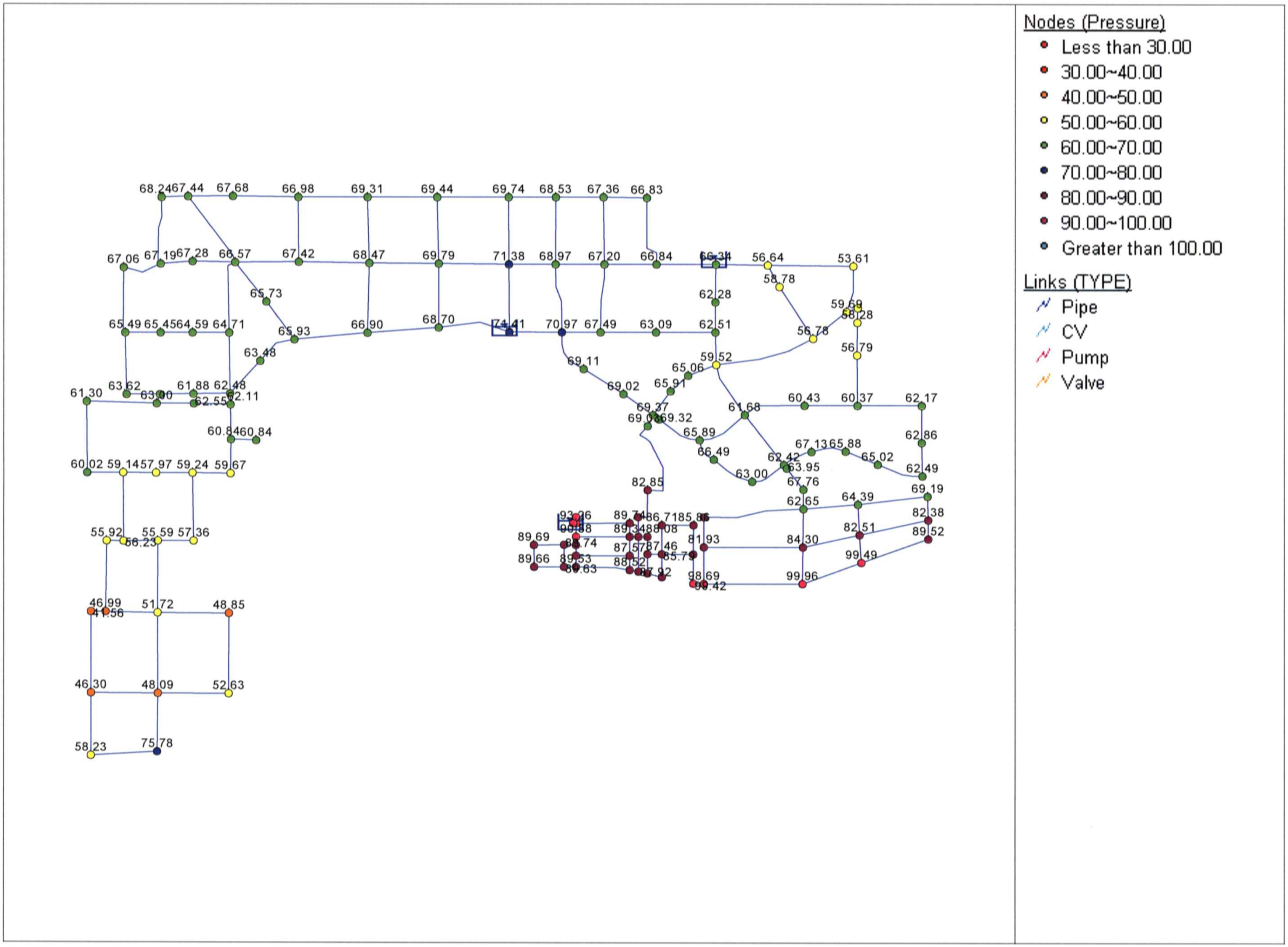
Scenario 3 - Max Day Demand + Fire #1



Scenario 4 - Max Day Demand + Fire #2



Scenario 5 - Max Day Demand + Fire #3



Scenario 6 - Max Day Demand + Fire #4

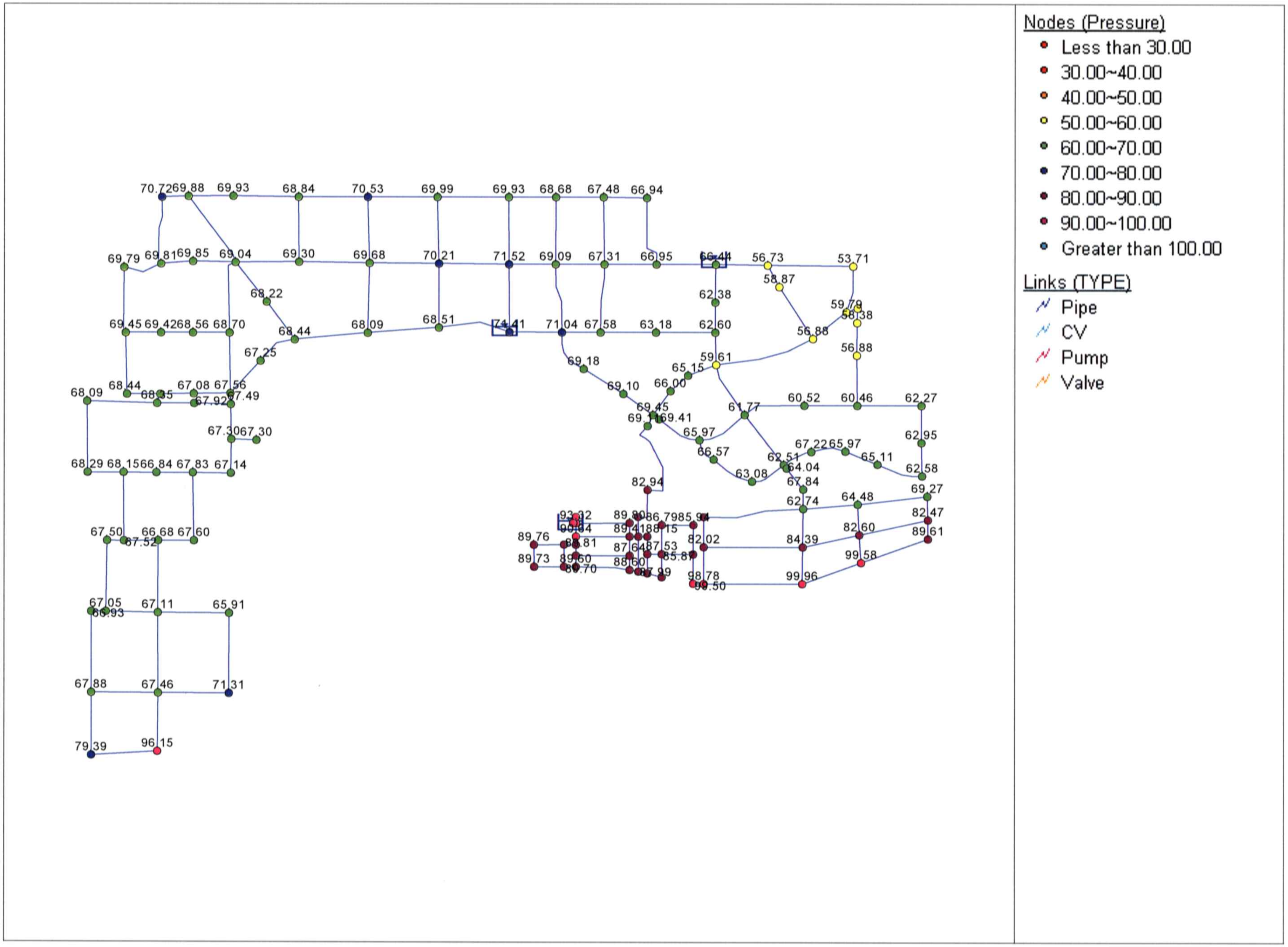


Table A-1: Study Area Nodes

ID	Demand (gpm)
40	24.44
42	19.16
44	28.72
46	105.40
48	249.56
50	162.68
52	235.36
54	0.00
56	167.28
58	0.00
60	242.32
62	0.00
64	207.88
66	207.88
68	207.88
70	134.48
72	248.44
74	127.52
76	187.80
78	152.08
80	186.16
82	76.76
84	210.92
86	93.92
88	74.48
92	159.76
94	65.96
96	64.36
98	79.32
100	79.32
102	114.16
104	199.92
106	173.60
108	133.72
110	85.72
112	253.32
114	89.24
116	203.40
118	141.72
120	141.72
122	0.00
124	167.28
126	167.28
128	0.00
130	118.04
132	0.00
134	118.04
136	0.00
138	118.04
140	0.00
142	0.00
144	242.32
146	38.96
150	207.88
152	51.40
160	86.80
162	49.12
164	127.52
166	126.44
168	126.44
170	105.12
172	150.76
174	151.68
176	230.96
178	76.52
180	206.80
182	206.80
184	206.80
186	99.48
188	151.24
190	328.16
192	204.52
194	87.80
196	136.44
198	0.00
200	172.48
202	147.88
204	160.64
206	166.40
208	242.32
210	50.84
212	178.48
214	73.24
216	144.64
222	0.00

230	28.52
232	28.52
234	30.64
236	16.80
238	41.92
240	27.64
242	47.84
244	28.52
246	28.52
248	41.88
250	41.92
252	41.88
254	0.00
256	0.00
258	16.68
260	0.00
262	0.00
264	0.00
266	0.00
268	58.04
270	58.04
272	58.04
274	58.04
276	151.60
278	0.00
280	0.00
282	0.00
284	70.04
286	205.60
288	0.00
290	100.20
292	100.20
296	77.44
298	0.00
300	66.00
302	0.00
304	119.48
306	127.92
308	75.12
310	13.88
314	0.00
316	0.00
318	0.00
320	0.00
322	0.00
324	0.00
326	0.00
328	0.00
340	0.00
342	83.24
344	7.52

Table A-2: Study Area Pipes

ID	Length (ft)	Diameter (in)	Roughness
45	1,096	8.000	125.000
47	359	8.000	125.000
49	1,340	8.000	125.000
53	1,868	8.000	125.000
55	695	8.000	125.000
57	1,859	8.000	125.000
59	731	8.000	125.000
61	506	12.000	125.000
63	1,204	12.000	125.000
65	1,107	12.000	125.000
67	1,913	12.000	125.000
69	812	12.000	125.000
71	886	12.000	125.000
73	1,614	12.000	125.000
75	982	12.000	125.000
77	1,117	12.000	125.000
79	984	12.000	125.000
81	922	12.000	125.000
83	881	12.000	125.000
85	1,322	12.000	125.000
87	1,311	12.000	125.000
89	1,332	12.000	125.000
91	1,198	12.000	125.000
93	800	12.000	125.000
101	1,291	16.000	125.000
103	676	16.000	125.000
105	645	12.000	125.000
107	1,342	8.000	125.000
109	277	8.000	125.000
111	1,537	8.000	125.000
113	1,188	8.000	125.000
115	1,251	8.000	125.000
117	1,108	8.000	125.000
119	1,336	8.000	125.000
121	1,521	8.000	125.000
123	1,345	8.000	125.000
125	1,361	12.000	125.000
127	565	12.000	125.000
129	445	12.000	125.000
131	564	12.000	125.000
133	142	12.000	125.000
135	1,005	12.000	125.000
137	486	8.000	125.000
139	847	8.000	125.000
141	696	8.000	125.000
143	586	8.000	125.000
145	659	8.000	125.000
147	657	8.000	125.000
149	884	8.000	125.000
151	636	8.000	125.000
153	701	8.000	125.000
155	1,214	8.000	125.000
157	954	8.000	125.000
159	620	8.000	125.000
161	224	12.000	125.000
163	1,171	8.000	125.000
167	462	8.000	125.000
169	614	12.000	125.000
183	1,120	12.000	125.000
185	1,048	12.000	125.000
187	730	12.000	125.000
189	887	12.000	125.000
191	890	12.000	125.000
193	684	12.000	125.000
195	1,296	8.000	125.000
197	1,311	8.000	125.000
203	1,232	8.000	125.000
205	1,304	8.000	125.000
207	1,318	8.000	125.000
209	1,347	8.000	125.000
211	888	8.000	125.000
213	902	8.000	125.000
215	817	8.000	125.000
217	1,381	8.000	125.000
219	990	12.000	125.000
221	1,369	18.000	125.000
223	1,350	18.000	125.000
225	1,381	18.000	125.000
227	891	12.000	125.000
229	953	12.000	125.000
231	801	16.000	125.000
233	1,156	8.000	125.000
235	687	8.000	125.000
237	604	12.000	125.000

241	602	8.000	125.000
245	691	12.000	125.000
249	688	8.000	125.000
251	981	8.000	125.000
253	1,528	8.000	125.000
255	1,260	8.000	125.000
257	1,187	8.000	125.000
259	999	8.000	125.000
263	698	12.000	125.000
267	318	12.000	125.000
269	620	8.000	125.000
271	1,296	8.000	125.000
275	87	12.000	125.000
283	1,235	8.000	125.000
285	1,256	8.000	125.000
287	1,266	8.000	125.000
289	1,288	16.000	125.000
291	1,276	12.000	125.000
293	1,276	8.000	125.000
295	1,276	8.000	125.000
297	1,212	8.000	125.000
299	1,323	8.000	125.000
301	256	8.000	125.000
305	415	8.000	125.000
307	564	8.000	125.000
309	212	8.000	125.000
311	225	8.000	125.000
313	418	8.000	125.000
315	567	8.000	125.000
319	1,014	8.000	125.000
321	259	8.000	125.000
323	1,013	8.000	125.000
325	203	8.000	125.000
327	1,014	8.000	125.000
329	359	8.000	125.000
331	1,020	8.000	125.000
333	167	8.000	125.000
335	661	8.000	125.000
337	166	8.000	125.000
339	156	8.000	125.000
341	226	8.000	125.000
343	271	8.000	125.000
345	170	8.000	125.000
347	365	8.000	125.000
349	170	8.000	125.000
351	331	8.000	125.000
353	281	8.000	125.000
355	434	8.000	125.000
357	275	8.000	125.000
359	552	8.000	125.000
361	598	8.000	125.000
363	555	8.000	125.000
365	593	8.000	125.000
369	120	12.000	125.000
373	1,891	8.000	125.000
375	570	8.000	125.000
379	693	8.000	125.000
381	1,327	8.000	125.000
383	1,183	8.000	125.000
385	525	8.000	125.000
389	375	8.000	125.000
399	1,035	8.000	125.000
401	1,324	8.000	125.000
403	451	8.000	125.000
405	583	8.000	125.000
411	719	12.000	125.000
413	572	12.000	125.000
423	54	16.000	125.000
443	558	8.000	125.000
445	202	12.000	125.000
449	368	12.000	125.000
451	882	12.000	125.000
453	276	8.000	125.000
455	847	8.000	125.000
461	632	12.000	125.000
467	107	24.000	125.000
469	1,322	8.000	125.000
471	1,353	8.000	125.000
473	680	8.000	125.000
475	181	12.000	125.000
477	1,172	8.000	125.000
479	629	8.000	125.000
481	666	8.000	125.000
483	1,257	8.000	125.000
485	747	12.000	125.000
487	499	8.000	125.000
489	1,301	8.000	125.000
491	1,542	8.000	125.000

493	1,420	8.000	125.000
495	841	16.000	125.000
503	660	16.000	125.000
505	713	16.000	125.000
507	649	16.000	125.000
509	473	12.000	125.000
511	689	12.000	100.000
519	1,744	16.000	125.000
521	686	16.000	125.000
527	206	16.000	125.000
531	230	16.000	125.000
533	91	24.000	125.000

Appendix B - CD of Model Input and Output & Report

RMC Water and Environment 2868 Prospect Park Drive ▪ Suite 130 ▪ Rancho Cordova, CA, 95670 ▪ Phone: 916-273-1500 ▪ Fax: 916-273-1505