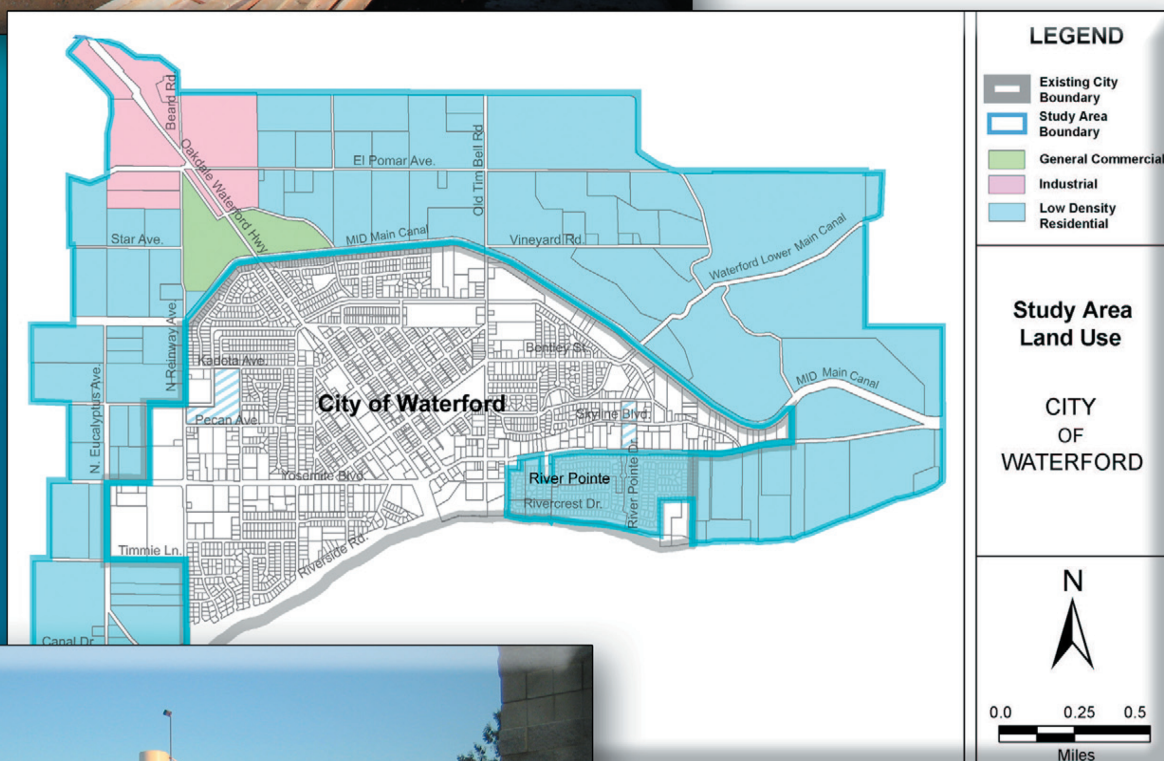

Water System Master Plan

FINAL

March 2006

RMC Water and Environment

RMC
Water and Environment

Los Angeles
Sacramento
San Francisco
San Jose
Walnut Creek

March 7, 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 final 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 E. Hermanson

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City of Waterford
Water System Master Plan

Final Report

Prepared by:

RMC
Water and Environment

March 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
RWMP	Recycled Water Master Plan
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

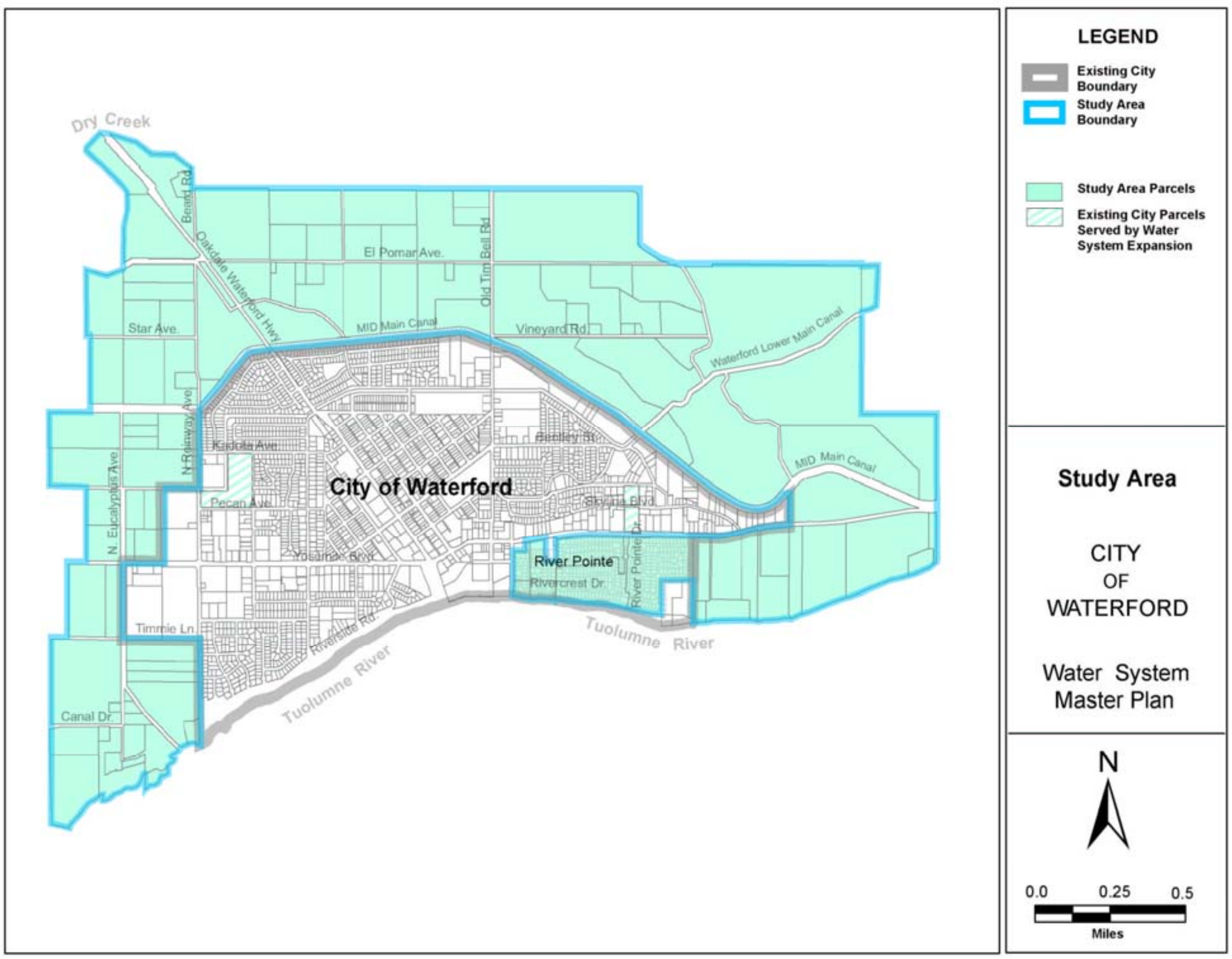
Chapter 2 Service Area and Land Use Plans

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.

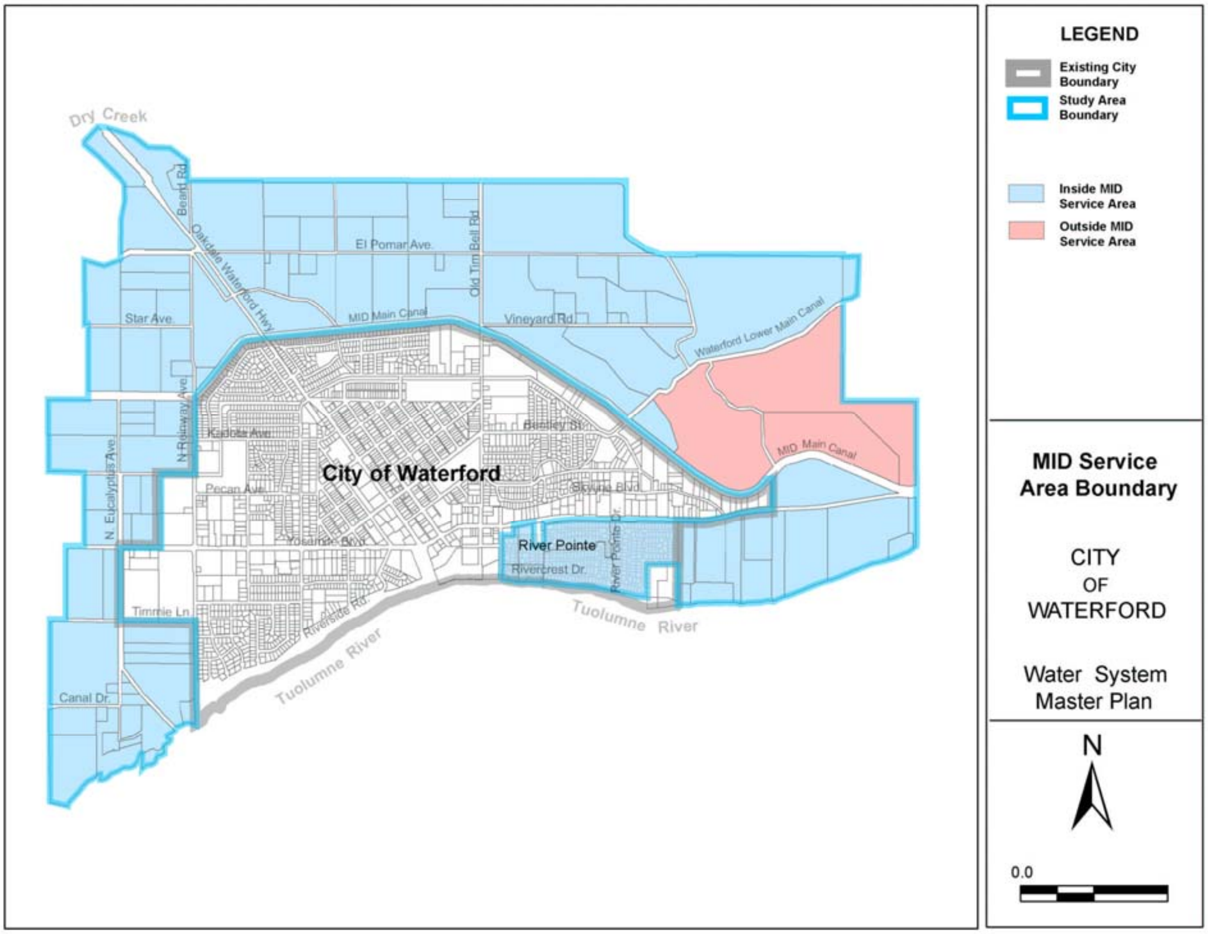
Table 2-1: Proposed Land Uses

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.

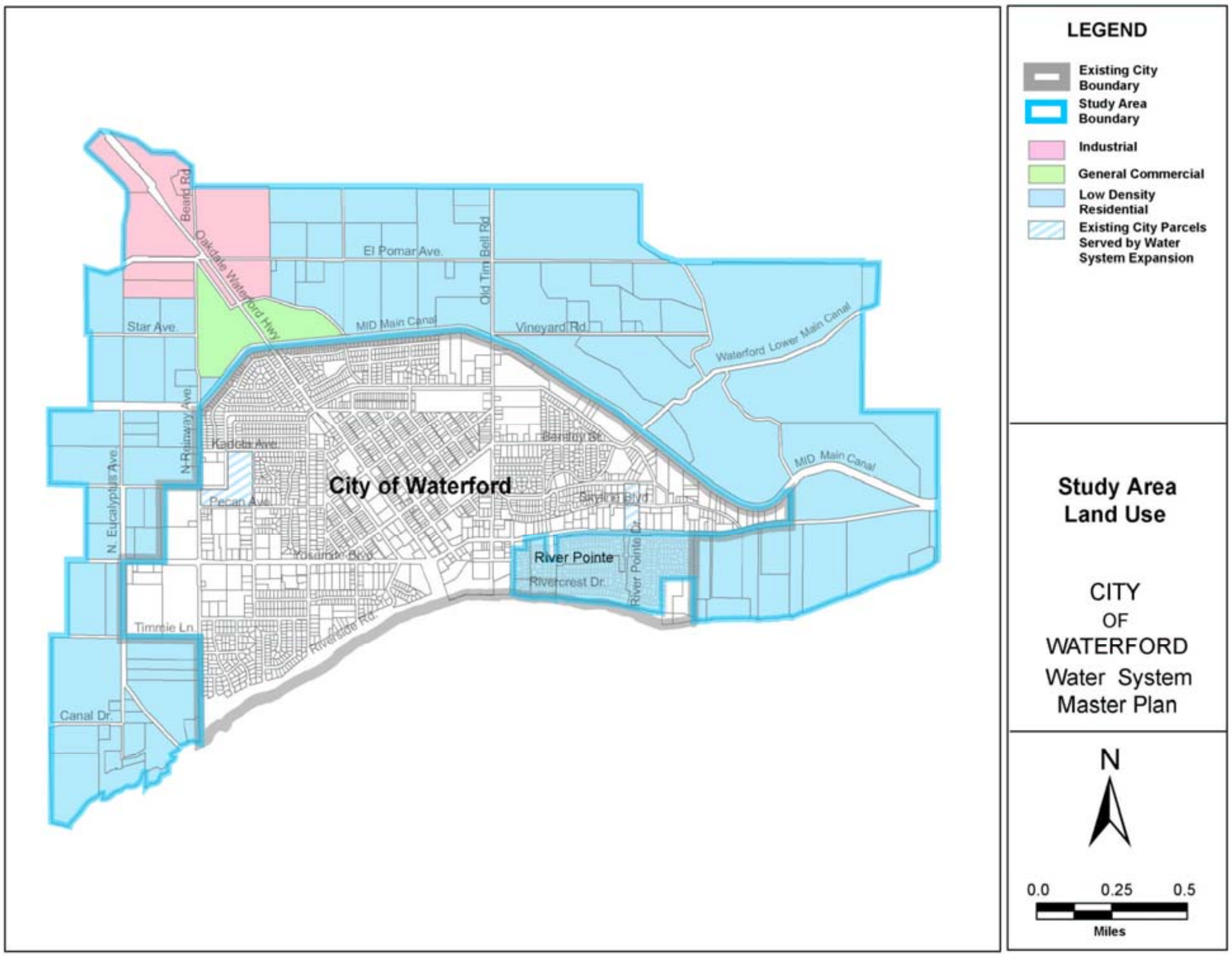
[1] http://regional.stangis.org/

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

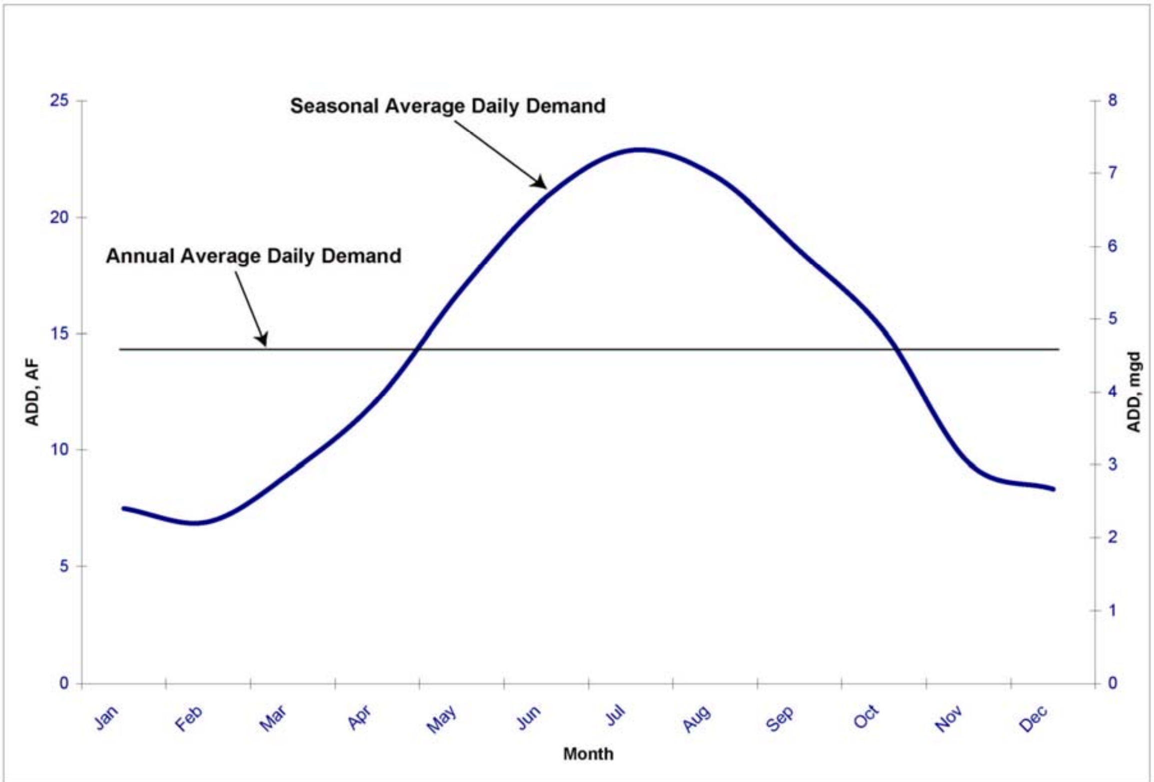
In order to plan for the City's future supply strategy, a more detailed examination was performed to determine the seasonal demands for the study area. Average monthly water demand data from the City of West Sacramento, which shares similar climate characteristics with the City of Waterford, were used 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.

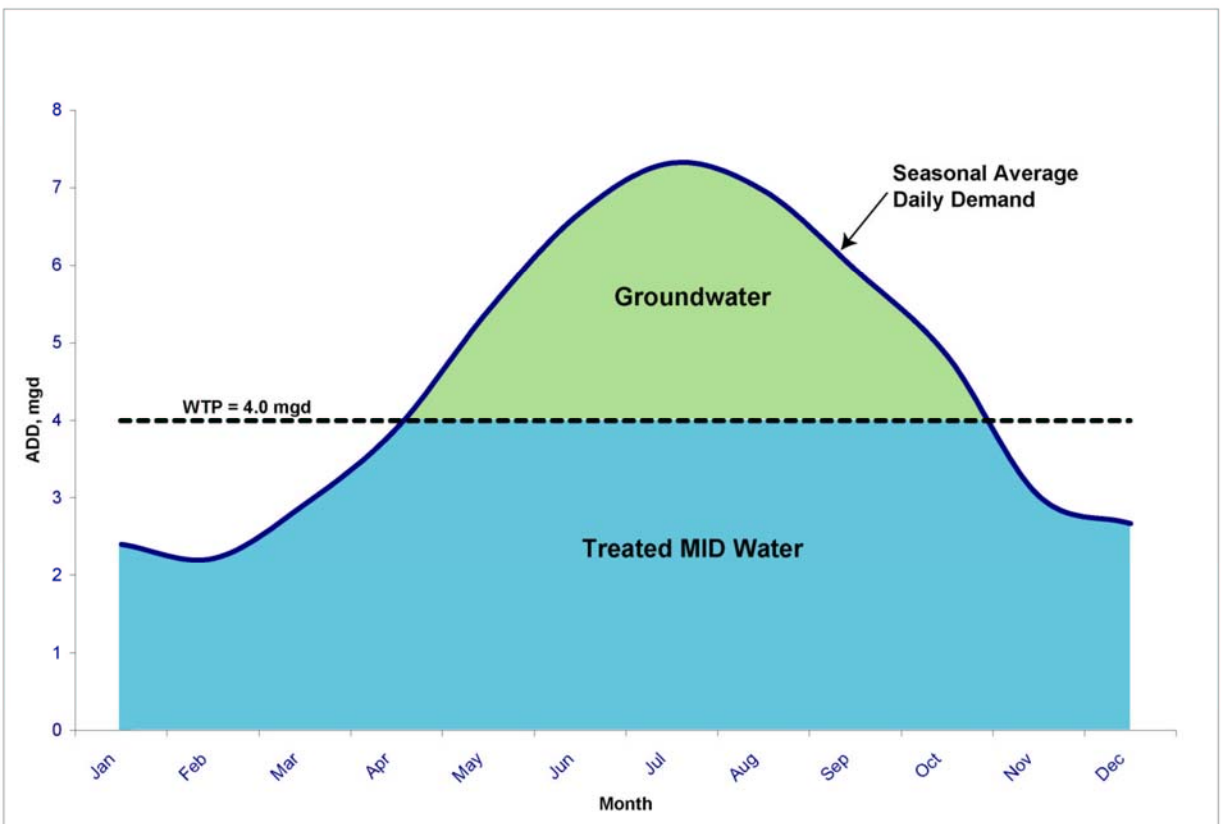
3.2.2 Modesto Irrigation District

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.

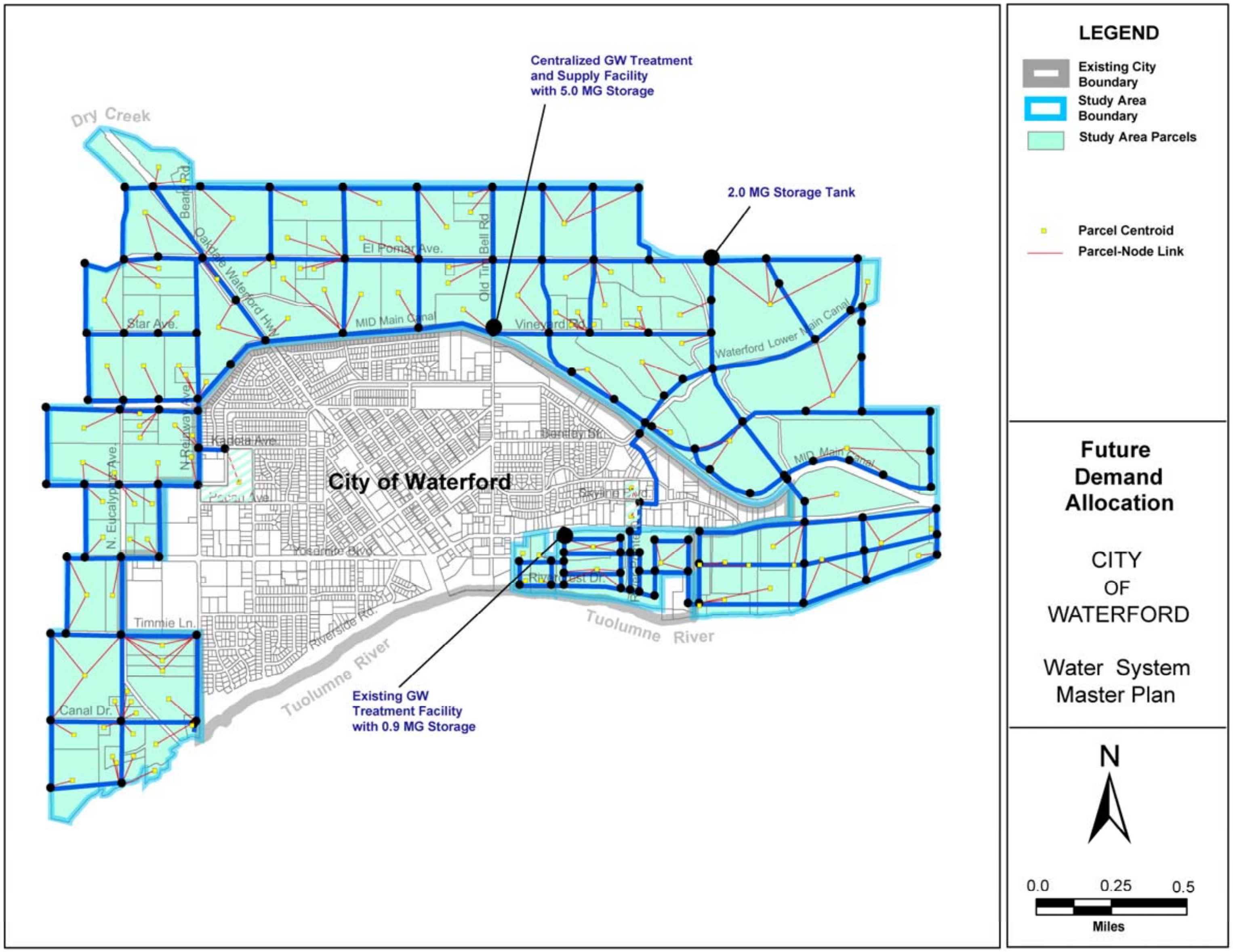
4.5.1 Software and Key Model Components

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. Pressures in nearly all areas in these scenarios will remain below 100 psi.

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].

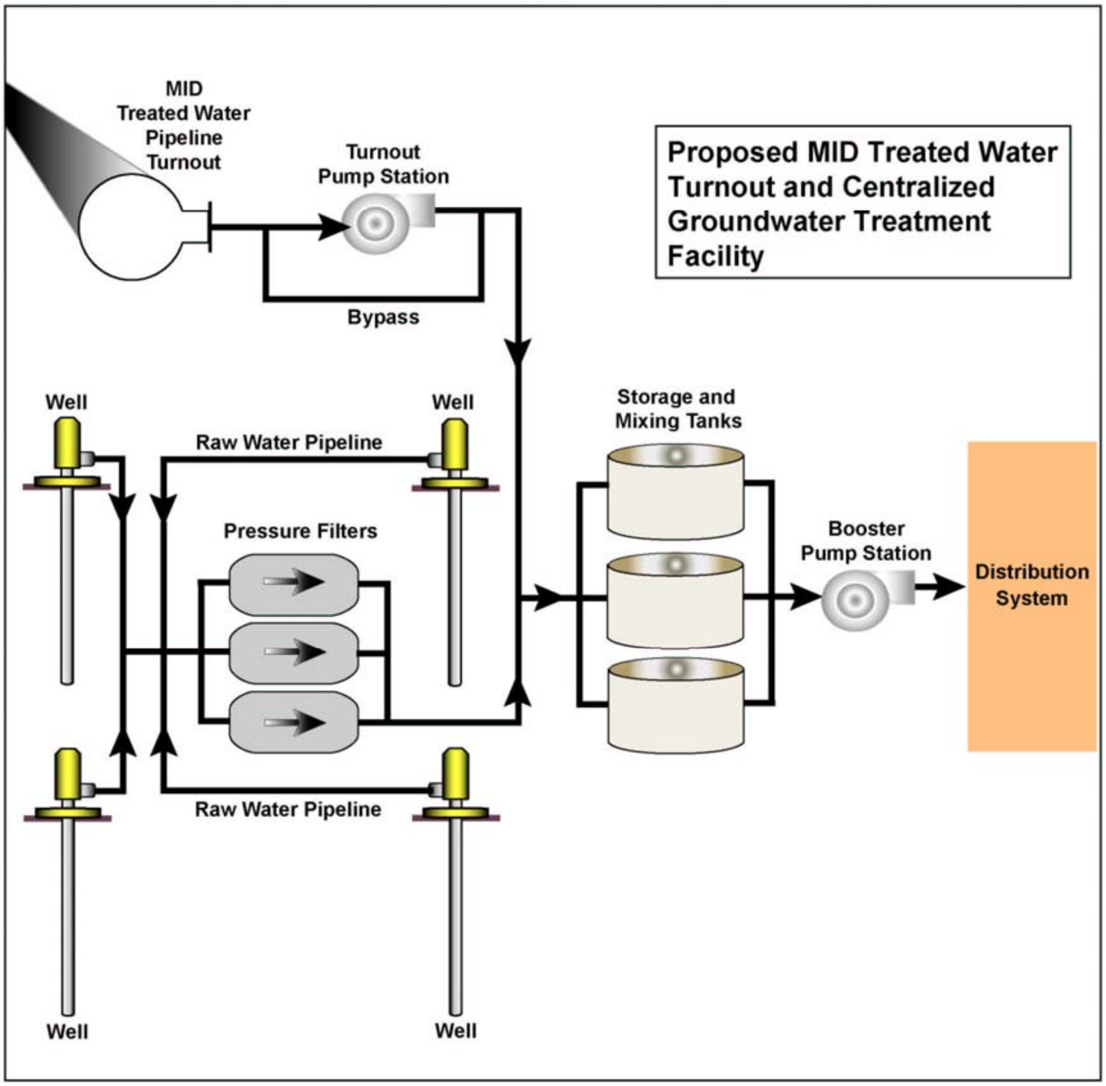
The decision to recommend pressure filters for the new wells was based upon the existing groundwater treatment facilities in River Pointe. Prior to the completion of a hydrogeological and well siting study, it will be difficult to determine if treatment is necessary or the type and number of groundwater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