City of Merced
Water Master Plan

January 2014

DRAFT

City of Merced
Water Master Plan

60297029

January 2014

City of Merced

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Table of Contents

Figures

Tables

Executive Summary

The City of Merced (City), located in Central California as shown in Figure ES-1, contracted with AECOM Technical Services, Inc. (AECOM) to prepare this Water Master Plan. This Master Plan is based on the City's Updated General Plan (*Merced Vision 2030*). It is designed to help the City plan and expand its water system to meet the potable water needs of its growing population through 2030. The City's existing and future water use, water supply, and water infrastructure were evaluated to develop this Master Plan.

City Growth

The *Merced Vision 2030* land use on which this Master Plan is based is shown in Figure ES-2. The City's water service area currently occupies approximately 13,905 acres and is projected to grow to approximately 28,730 acres by 2030.

The service area population (which includes UC Merced) is projected to grow by approximately 94 percent from 87,575 in 2012 to 169,585 by 2030, representing a growth rate of approximately 3.7 percent per year as shown in Table ES-1. Of this amount, the UC Merced campus is projected to contribute 32,185 people, comprising students, faculty, and staff, according to UC Merced's 2009 Long Range Development Plan. This increased population will place additional demand on the City's existing water system which will need to be expanded to serve existing and the new customers reliably.

Table ES-1. Existing and Projected Service Area Population

	Existing (2012)	2030
Population[a]	87,575	169,585
Annual Population Growth Rate	-	3.7%

[a] Includes City of Merced and UC Merced populations.

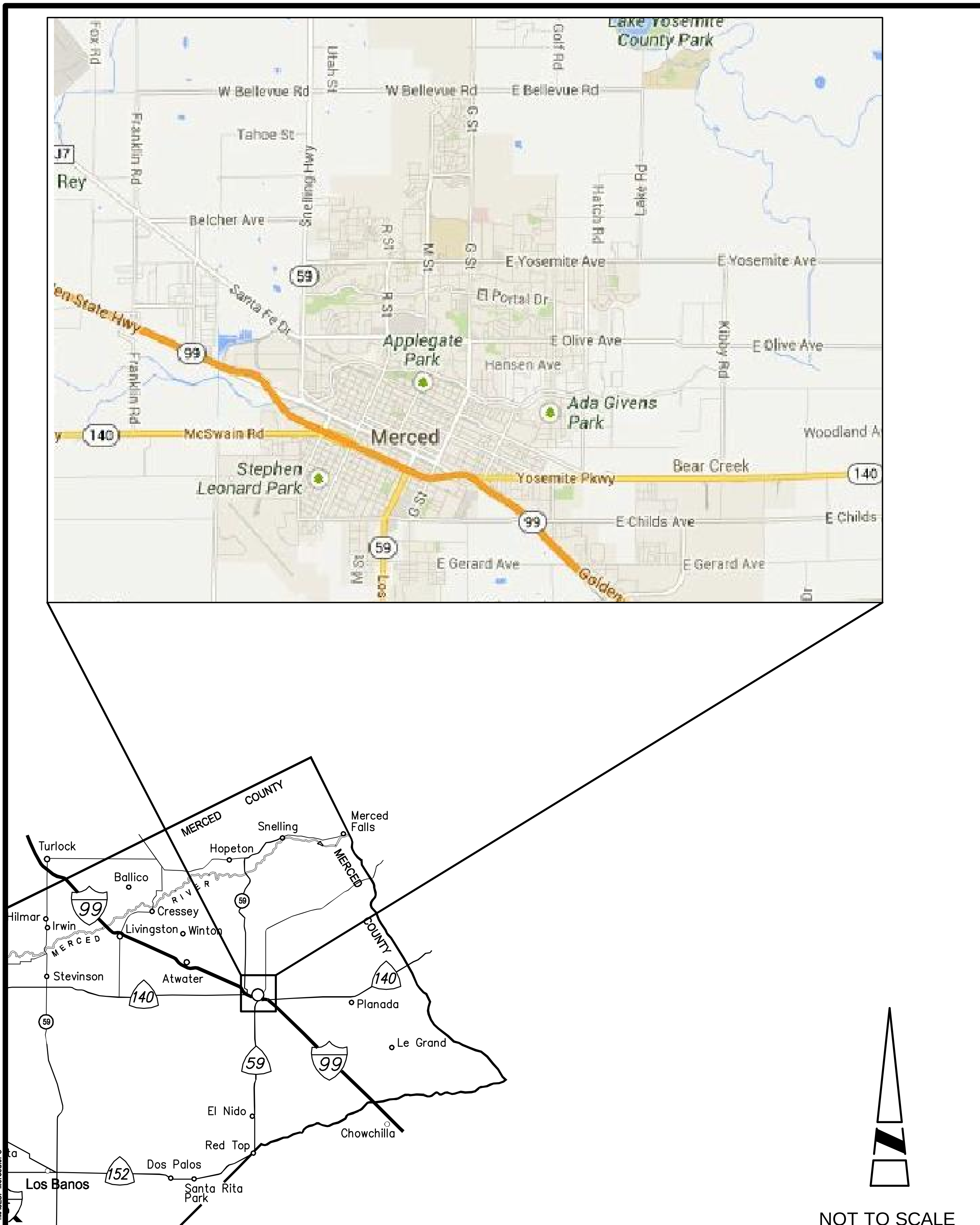
Water Demand

Existing and projected water demand of the City is summarized in Table ES-2. The water demand of the City is anticipated to increase by approximately 72 percent from 2012 to 2030. This increase will have great implications for the City's need for additional water supplies, transmission and distribution system improvements.

Table ES-2. Existing and Projected Water Demands

Demand Type	Existing (2012)	2030
Annual, acre-feet/year (afy)	25,899	44,596
Average Day, gpm	16,057	27,649
Average Day, mgd	23.4	40.3
Maximum Day, mgd[a]	44.5	76.6
Peak Hour, gpm[b]	44,960	77,417

[a] Maximum Day Demand is defined as 1.9 times the Average Day Demand.
[b] Peak Hour Demand is defined as 2.8 times the Average Day Demand.



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CITY OF MERCED
WATER MASTER PLAN

LOCATION MAP

AECOM PROJECT NO.
60297029

FIGURE
ES-1

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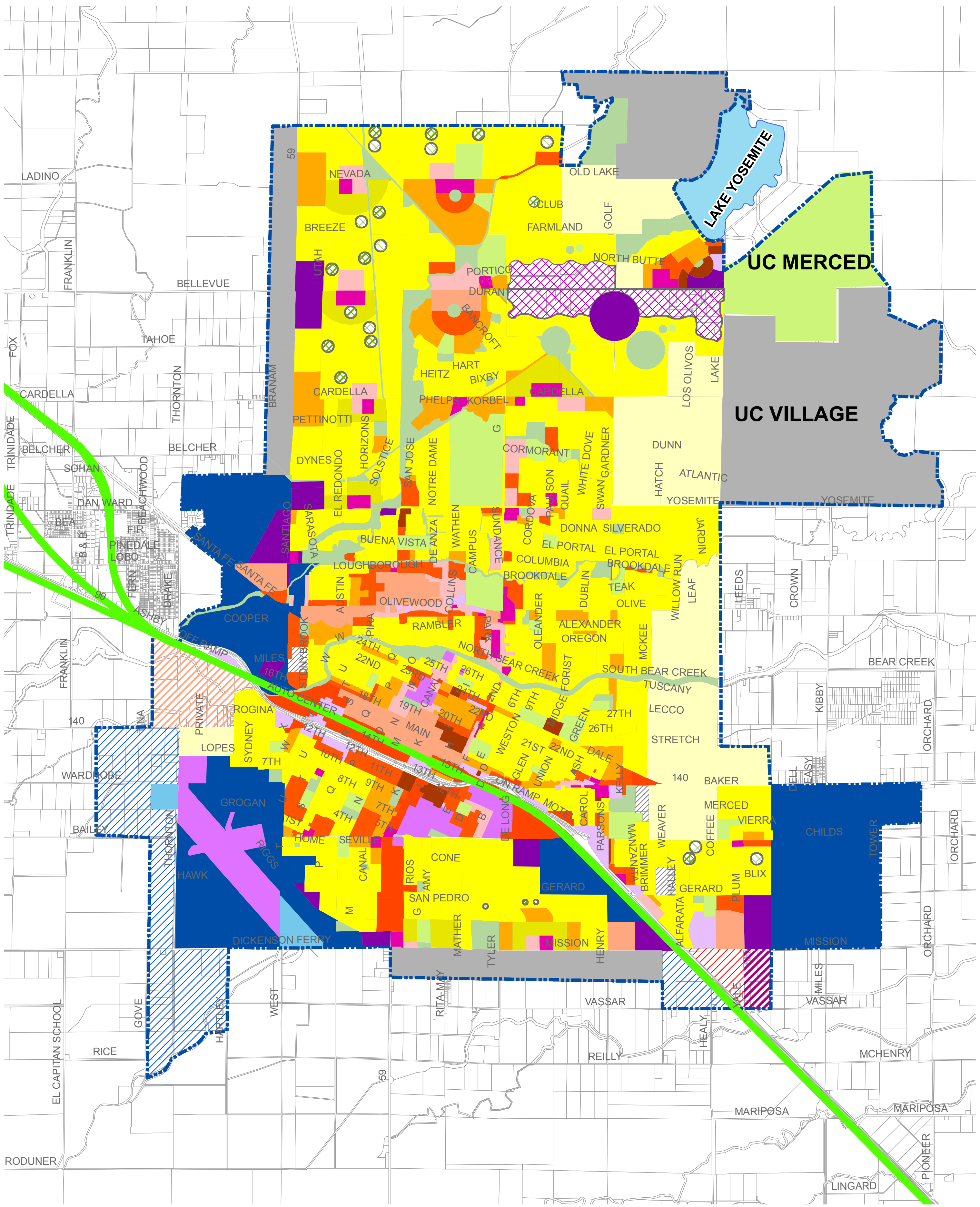

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LEGEND

- Future High Speed Rail Alignment
- Merced 2030 General Plan Boundary

2030 General Plan Land Use

- AGRICULTURAL
- BUSINESS PARK
- BUSINESS PARK RESERVE
- COMMERCIAL OFFICE
- COMMERCIAL RESERVE
- COMMUNITY PLAN
- FUTURE PARK
- FUTURE SCHOOL
- GENERAL COMMERCIAL
- HIGH DENSITY RESIDENTIAL
- HIGH TO MEDIUM RESIDENTIAL
- INDUSTRIAL RESERVE
- LOW DENSITY RESIDENTIAL
- LOW TO MEDIUM DENSITY RESIDENTIAL
- MANUFACTURING/INDUSTRIAL
- MIXED USE
- MOBILE HOME PARK RESIDENTIAL
- NEIGHBORHOOD COMMERCIAL
- OPEN SPACE - PARK RECREATION
- PUBLIC/GENERAL USE
- REGIONAL COMMUNITY COMMERCIAL
- RESIDENTIAL RESERVE
- RURAL RESIDENTIAL
- SCHOOL
- THOROUGHFARE COMMERCIAL
- VILLAGE RESIDENTIAL

Source: Merced Vision 2030

N

0 6,000 12,000

Feet

AECOM Water 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN	AECOM PROJECT NO.	FIGURE
	2030 LAND USE	602979029	ES-2

Water Supply

The City currently depends solely on groundwater supplied from 22 active wells located throughout the water service area, as shown in Table ES-3 and Figure ES-3. Each well is equipped with a vertical turbine that pumps water directly into the distribution system, with the exception of the wells at Pump Stations 1, 2, 3 and 7, which pump into onsite elevated tanks. The water then flows from these tanks by gravity into the distribution system. The pressures in the distribution system are therefore set by the height of water in the tanks. The wells at the tank sites produce sand because they are not screened. The tanks therefore act as sand traps.

A few of the wells have water quality issues with arsenic, percloroethylene (PCE), and nitrate concentrations in excess of the MCLs. The City is handling these issues with blending and well head treatment where appropriate. The City staff will be closing down Well 6 and constructing a new well (Well 20).

Existing Water System Analysis

A computer model developed using WaterGEMS was used to analyze the City's existing water system. Our analysis indicated that even though the City's water system currently has adequate pumping and potable water storage capacities, there is a need to improve portions of the water distribution system piping to better handle fire flows in the southeast portions of the City. Figure ES-4 shows the facility improvements recommended for improving the existing water system reliability.

Future Water System Analysis

Two main alternatives comprising combinations of water system facilities were explored for the City's future water system in 2030. These included:

- Alternative 1: Expansion by New Wells Only
- Alternative 2: Expansion by New Wells, Storage Tanks, Booster Pump Stations and a Water Treatment Plant

Alternative 1 depends on continued use of groundwater for supply. This is the easiest approach for the City as new wells are constructed as demand expands. Alternative 2 is preferred because it is based on conjunctive water use relying on a mixture of surface water and groundwater sources. It decreases the City's dependence on groundwater where groundwater quality and even unknown aquifer boundaries can be a concern. Figure ES-5 shows the preferred alternative of the distribution system expansion with wells, storage tanks, booster pump stations, and a surface water treatment plant.

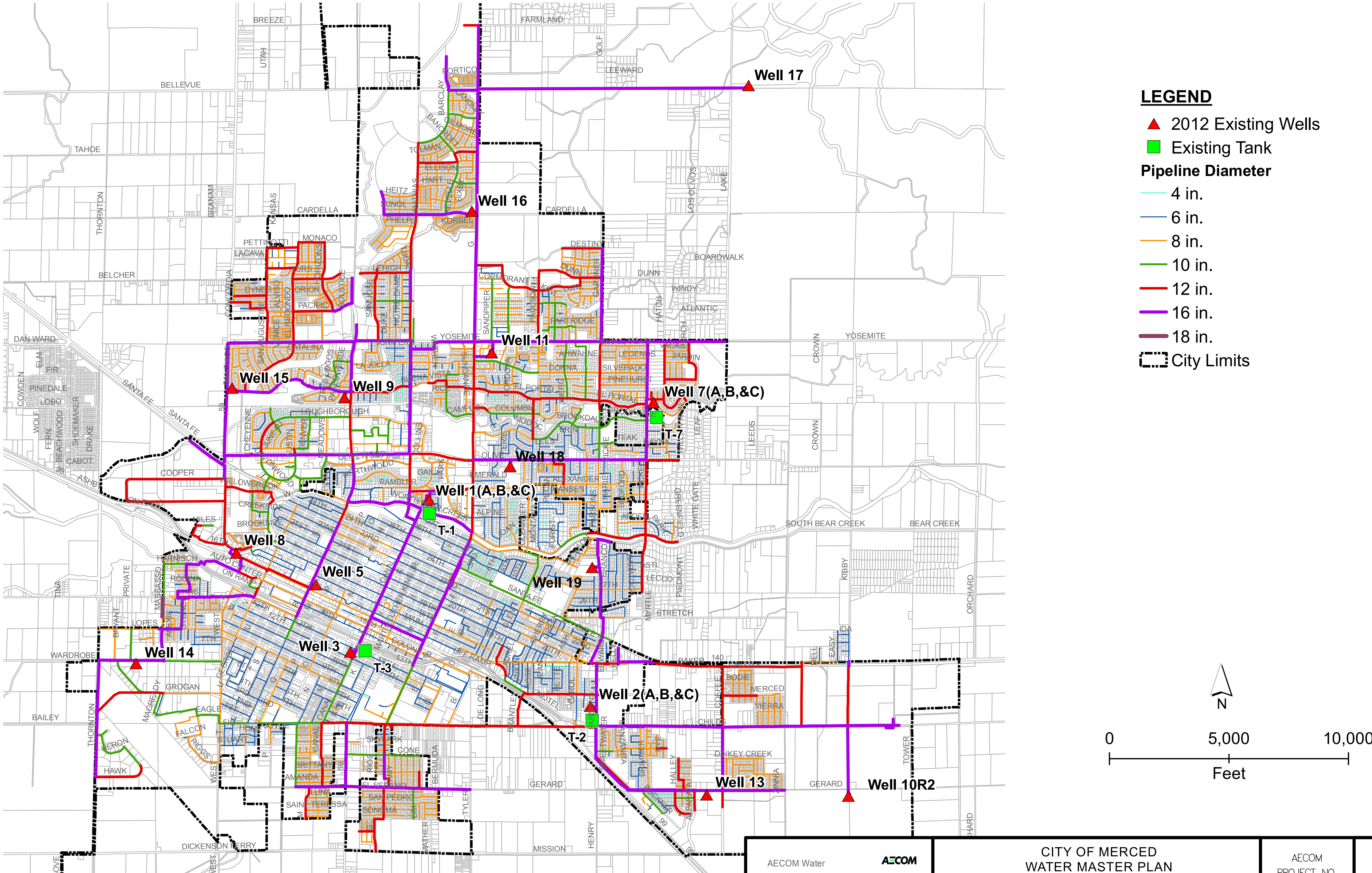
Table ES-3. Existing Groundwater Wells

Pump Station No.	Address	Well No.	Date Drilled	Completed Well Depth, ft	Pumping Water Level, ft[(a)]	Pump Type	Rated Capacity, gpm	Pump Test Production, gpm[(a)]	Energy Cost Per Hour, $	Pump Efficiency, %[(a)]	Approx. Run Time, hours/day[(b)]
1	477 St. Lawrence Dr	1A	1951/1959	174	69	VFD	2,200	2,386	11.77	70	0.5
		1B	1951	270	68	VFD	2,200	1,804	10.20	67	
		1C	1953	230	72	VFD	2,200	2,022	11.20	64	
2	1201 S. Parsons Ave	2A	1950	251	74	VFD	2,200	2,004	11.39	69	3
		2B	1950	161	89	VFD	2,200	2,487	24.55	43	
		2C	1991	685	230	VFD	2,500	2,322	23.37	65	
3	511 W. 12th St	3C	1987	594	110	Constant	3,000	2,467	18.69	53	6
5	1632 R St	5B	1987	546	88	VFD	3,000	2,141	13.34	69	8
7	3362 McKee Rd	7A	1963	344	74	VFD	2,500	1,773	9.99	70	19
		7B	1968	339	79	VFD	2,500	1,509	10.67	57	
		7C	1992	614	130	VFD	2,800	2,428	23.88	52	
8	1520 W.N. Bear Creek Dr	8	1974	400	74	VFD	2,000	1,840	NA	NA	8
9	3391 R St	9	1985	495	154	Constant	1,800	1,992	13.50	71	4
10	4250 E. Gerard Ave	10R2	2003	800	75	VFD	3,000	2,119	12.79	65	12
11	346 E. Yosemite Ave	11	1987	430	101	VFD	3,000	1,585	10.83	67	8
13	2890 E. Gerard Ave	13	1990	702	151	VFD	3,000	1,742	15.47	60	12
14	2110 Wardrobe Ave	14	1990	380	74	VFD	4,000	4,000	NA	NA	12
15	1855 Buena Vista Dr	15	2004	556	95	VFD	3,500	2,560	16.06	70	12
16	125 Cardella Rd	16	2004	500	61	VFD	3,500	2,451	13.59	68	12
17	5010 Lake Rd	17	2004	500	80	VFD	2,500	1,773	11.16	51	12
18	420 E. Olive Ave	18	2011	600	100	VFD	3,000	3,000	NA	80	12
19	2065 Parson Ave	19	2012	600	100	VFD	2,500	2,500	NA	80	12
Total		**22**					**59,100**	**48,905**			

(a) Based on pump tests conducted in late 2007 and early 2008.

(b) Source: Department of Public Health, Domestic Water Supply Permit, December 2006.

(c) NA = Data not available from the pump tests of 2007/2008.



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CITY OF MERCED
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EXISTING WATER SYSTEM FACILITIES

AECOM PROJECT NO.
60297029

FIGURE
ES-3

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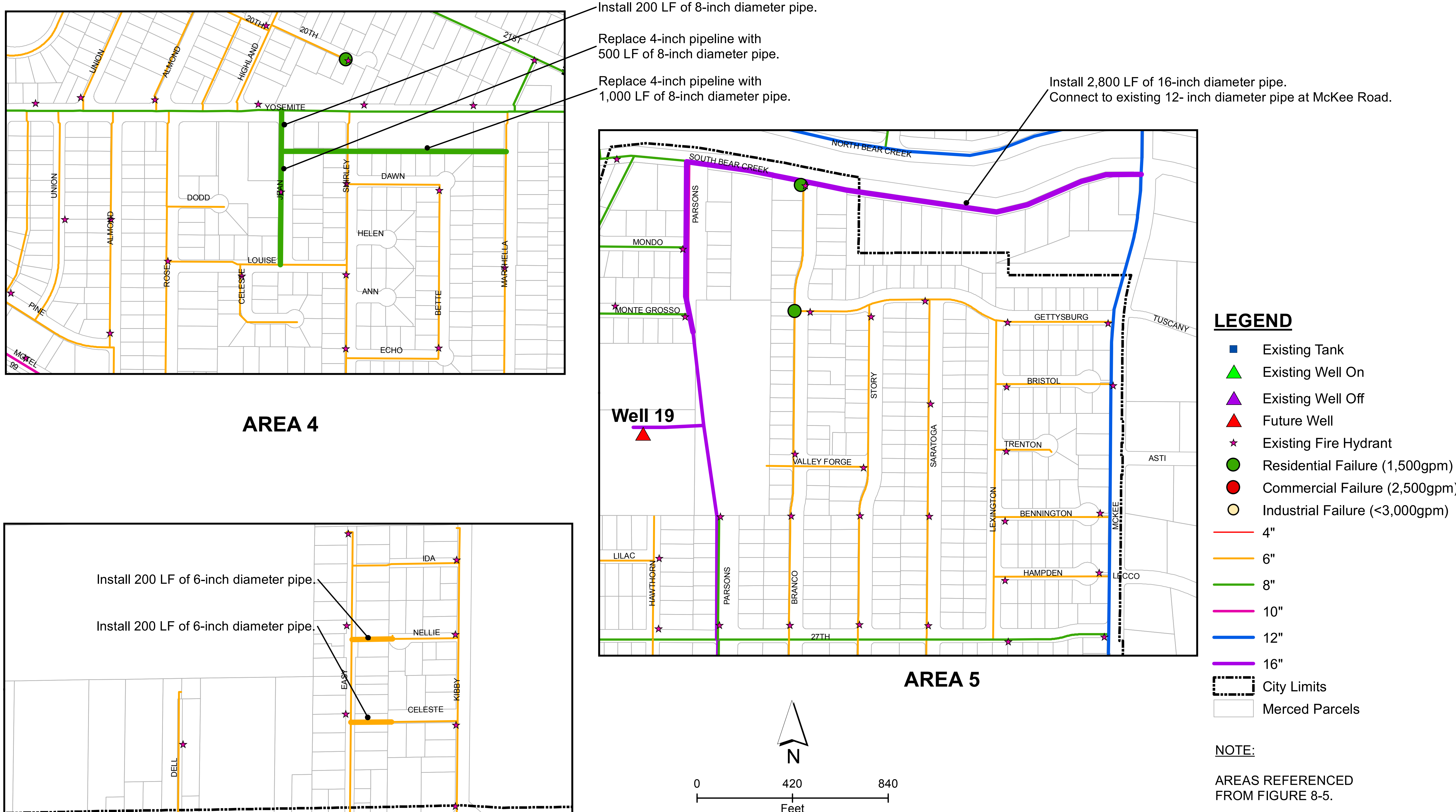

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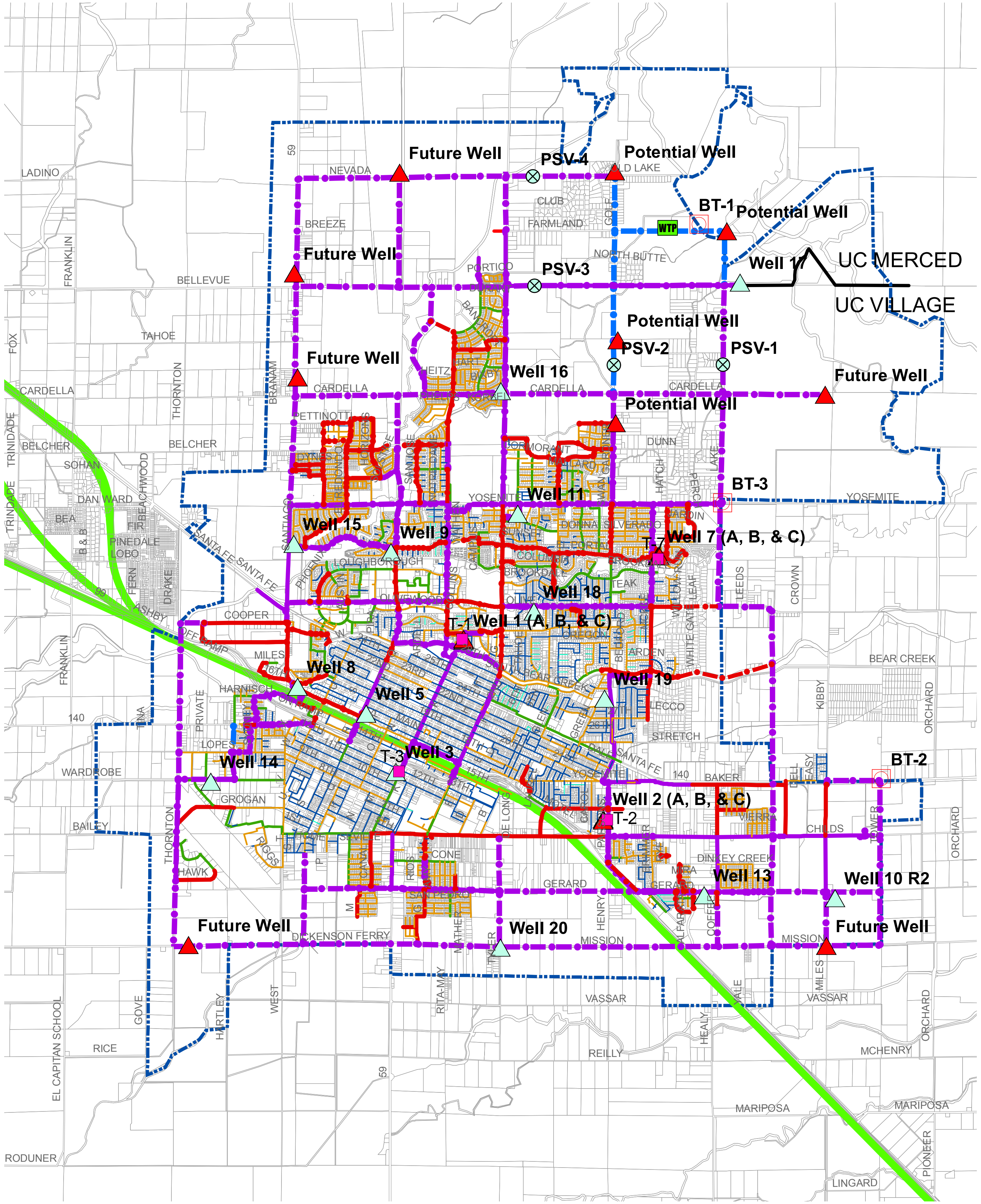
AECOM Water 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN RECOMMENDED IMPROVEMENTS TO EXISTING WATER SYSTEM	AECOM PROJECT NO. 60297029	FIGURE ES-4



LEGEND

- Existing Tank
- Existing Wells
- Future Wells
- 2030 Booster Pump
- 2030 Pressure Sustaining Valve
- Water Treatment Plant

Existing Pipelines

- 4 in.
- 6 in.
- 8 in.
- 10 in.
- 12 in.
- 16 in.
- 18 in.

2030 Pipelines

- 12 in.
- 16 in.
- 18 in.
- 12
- 16
- Future High Speed Rail Alignment
- Merced Vision 2030 Boundary

N

0 6,000 12,000

Feet

AECOM Water 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN RECOMMENDED WATER SYSTEM IMPROVEMENTS	AECOM PROJECT NO. 602979029	FIGURE ES-5

V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2030 Figures

Recommendations

The water system improvements needed for the City to meet its water system obligations to its customers by 2030 are shown in Figure ES-5. The estimated total capital cost for improvements that should be completed by 2030 is approximately $163.6 million. These costs, shown in Table ES-4, were developed based on a combination of similar construction projects in the Central Valley and reflect December 2013 costs at an Engineering News Record (ENR) Construction Cost Index (CCI) 20 Cities Average of 9667.77. These costs are to be used for conceptual cost estimates only, and should be updated regularly.

Table ES-4. Recommended Water System Capital Improvement Program

Planning Horizon	Facility Name	Item Description	Estimated Quantity	Unit of Measure	Unit Cost, $/unit[(a)]	Estimated Cost, x$1,000
		Improvements to Existing System				
		Groundwater Wells[(b)]				
2014 - 2019	Well 6	Abandon and demolish existing well	1	LS	50,000	50
2014 - 2019	Well 20	Construct new well at Corner of Mission and Tyler	1	LS	2,200,000	2,200
		Subtotal				2,250
		Water Pipelines				
2014 - 2019		6" diameter distribution pipeline	400	LF	134	54
2014 - 2019		8" diameter distribution pipeline	1,700	LF	151	256
2014 - 2019		16" diameter transmission main	2,800	LF	262	735
		Subtotal				*1,045*
		Existing Improvement Costs				***3,295***
		2030 Improvements				
		Groundwater Wells[(b)]				
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at the intersection of Thornton Rd and Dickenson Ferry R	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of HWY 59 and Bellevue Rd.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of Mission Ave and Kirby Rd.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at interstcion of Nevada St and R St.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of HWY 59 and Cardella Rd	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of Cardella Rd and Kirby Rd[(e)]				
		Subtotal				*11,000*
		Water Storage Tanks + Booster Pump Stations				
2015 - 2030	BT - 1	3.0 MG tank + 5.0 MGD booster pumps at the intersection of Lake Rd and Farmland Ave	1	LS	3,900,000	3,900
2015 - 2030	BT - 2	3.0 MG tank + 5.0 MGD booster pumps at the intersection of HWY 140 and Tower Rd	1	LS	3,900,000	3,900
2015 - 2030	BT - 3	3.0 MG tank + 5.0 MGD booster pumps at the intersection of Lake Rd and Yosemite Ave	1	LS	3,900,000	3,900
		Subtotal				*11,700*
		Pressure Sustaining Valves				
2015 - 2030	PSV - 1	Lake Rd between Cardella Rd and Bellevue Rd	1	LS	100,000	100
2015 - 2030	PSV - 2	Gardner Ave between Cardell Rd and Bellevue Rd	1	LS	100,000	100
2015 - 2030	PSV - 3	Intersection of Bellevue Rd and G St.	1	LS	100,000	100
2015 - 2030	PSV - 4	Nevada St. between G St and Golf Rd	1	LS	100,000	100
		Subtotal				*400*
		Water Pipelines				
2015 - 2030		12" diameter transmission main	1,800	LF	209	376
2015 - 2030		16" diameter transmission main	187,000	LF	262	49,086
2015 - 2030		18" diameter transmission main	18,500	LF	353	6,530
		Subtotal				*55,992*
		Surface Water Treatment Plant				
2015 - 2030		10 MGD Water Treatment Plant near Lake Yosemite[(c)]	1	LS	16,755,000	16,755
		Subtotal				*16,755*
		2030 Improvement Costs				***95,847***
		Capital Improvement Facilities Costs				**99,142**
		Design Costs (10%)[(d)]				9,914
		Permitting, Regulatory Compliance, CEQA Costs (10%)[(d)]				9,914
		Construction Management (10%)[(d)]				9,914
		Program Implementation (5%)[(d)]				4,957
		Project Construction Contingency (25%)[(d)]				24,786
		Land Acquisition (5%)[(d)]				4,957
		Other Related Project Costs (65%)[(d)]				**64,442**
		Total				**163,585**

[(a)] Present installed costs based on a combination of current construction costs and Engineering News Record Estimates.

[(b)] These costs do not include well head treatment.

[(c)] Surface Water Treatment Plant unit cost estimated at $1.675 per gallon.

[(d)] Other Costs based on the following components: design at 10%; permitting, regulatory compliance, CEQA at 10%; construction management at 10%; program implementation at 5%; project construction contingency at 25%, and land acquisition costs at 5%.

Chapter 1 Introduction

This chapter presents the purpose, scope, project approach, key definitions, and report organization for the City of Merced's 2013 Water Master Plan (Master Plan). This Master Plan is an update to the 2009 Draft Water Master Plan. It is based on the City's updated General Plan (*Merced Vision 2030*). It is recommended that the City review this Master Plan annually to compare actual water demands to projected water demands and to track the progress of the implementation of the recommended capital improvement program.

1.1 Purpose

This Master Plan documents information regarding the existing and planned water system infrastructure for the City of Merced through 2030. The City is located in Central California as shown in Figure 1-1 and is the largest incorporated community in Merced County. The City's growth is being driven primarily by the establishment of the tenth campus of the University of California system in Merced (UC Merced) in the fall of 2005 and the revitalization of downtown as an emerging entertainment center of the area. Annual events and festivals bring regional and even national recognition.

Another important impact on the City will be the connection to the state's proposed future high-speed rail system. Upon completion, the new rail system will link the City to major metropolitan areas in both the northern and southern portions of the state and may impact the City's population growth. This growth in population will place increasing demand on the City's water system infrastructure, requiring a systematic water master plan to adequately prepare for this growth. This Master Plan update is aimed at addressing the infrastructure planning to meet the City's growth through 2030.

1.2 Scope of Services

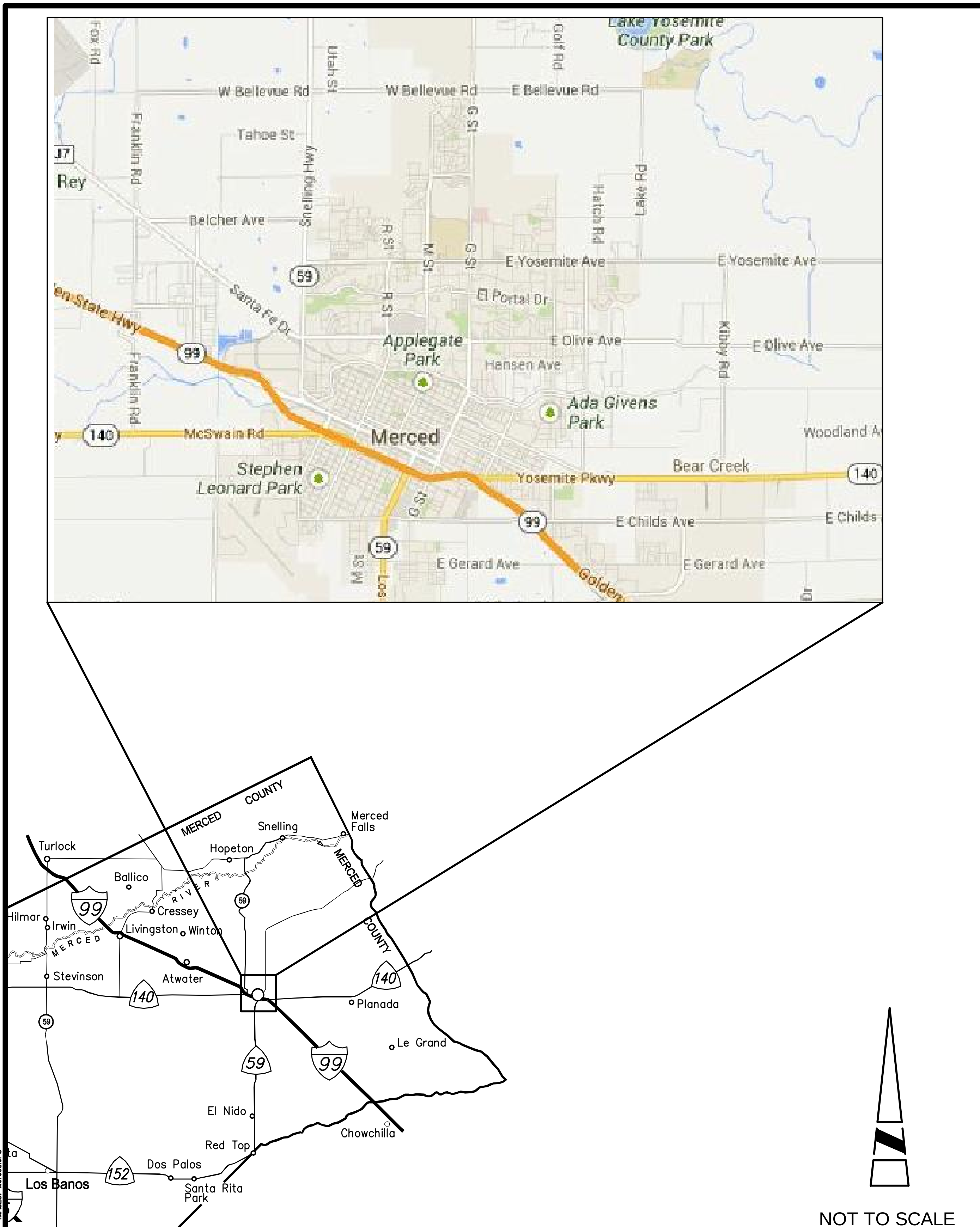
AECOM was contracted by the City to prepare this Master Plan. The scope of services can be summarized as:

- Updating the City's water system computer model to 2012 conditions
- Evaluating the City's existing water system
- Evaluating the City's future water system needs through 2030
- Recommending water system improvements and preparing a capital improvement plan

1.3 Project Approach

Previous reports and technical memoranda prepared for the City were used for background information. The information collected was supplemented by additional data collection on the City's existing water demands, supply, and operations as well as water system infrastructure.

Discussions were held with City staff to solicit their input through progress meetings and telephone conversations. The City's staff (Table 1-1) was instrumental in supplying the additional information needed for this Master Plan for which we are grateful.



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CITY OF MERCED
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LOCATION MAP

AECOM PROJECT NO.
60297029

FIGURE
1-1

Table 1-1. City of Merced Water Master Plan Project Staff

Name	Title	Phone/Fax	Address
Michael Wegley	Public Works Director of Water Reclamation	209-385-6803/ 209-725-3277	1776 Grogan Avenue Merced, CA 95340
Ken Elwin	City Engineer	209-385-6846/ 209-385-6211	678 W. 18th Street Merced, CA 95340
Daniel Amaral	Chief Operator	209-385-6856/ 209-725-3277	1776 Grogan Avenue Merced, CA 95340
Kim Espinosa	Planning Manager	209-385-6858/ 209-725-3277	678 W. 18th Street Merced, CA 95340

AECOM's team for this Master Plan is shown in Table 1-2.

Table 1-2. AECOM Project Staff

Name	Role	Phone Number
Steve Doe	Technical Lead	(559) 448-8222
Nick Jacobson	Staff Engineer	
Terry Chouinard	Technical Typist	
Henry Liang	Project Manager	

1.4 Definition of Key Terms

The key terms used in this Master Plan are defined as follows:

- **Average Day Demand:** The average volume of water used daily by customers throughout the year calculated as the total yearly demand divided by the number of days in the year.
- **Distribution Pipelines:** Generally pipelines less than 12 inches in diameter and used to distribute water to customers within the service area.
- **Diurnal:** A term used to describe the time variability of water demands over a given day.
- **Fire Flow:** Flow rate of a water supply that should be available for fire fighting.
- **Maximum Day Demand:** The maximum volume of water used in one day during a given year. Based on measured water use data for the City of Merced, this term is defined as 1.9 times the Average Day Demand.
- **Peak Hour Demand:** The maximum volume of water used during a single, one-hour period during a given year. This term is defined as 2.8 times the Average Day Demand for the City.
- **Tank:** A watertight structure, usually made of concrete, steel, or some other material, used to hold water. Other names for tanks include storage tank and reservoir.
- **Transmission Pipelines:** Generally pipelines equal to or greater than 12 inches in diameter, and used to convey water from sources of supply (water treatment plant or well) to storage tanks.
- **Water Demand:** The volume of water used by customers to satisfy their needs.
- **Water Supply:** Water supplied to customers from sources such as groundwater and/or surface water.

1.5 Report Organization

Following this introductory chapter, this Master Plan includes the following chapters:

- **Chapter 2 – Study Area** provides background information such as population and land use area on the City's water service area.
- **Chapter 3 - Existing Water System** provides background information on the City's water system including water supply, storage, transmission, and distribution facilities.
- **Chapter 4 - Water Demand** presents historical and projected water use which corresponds to the growth projections of the City's water service area.
- **Chapter 5 - Water Supply** describes the existing and future sources of water supply to satisfy the City's water demand.
- **Chapter 6 – Water System Design and Operational Criteria** presents planning and design criteria used as a basis for assessing the adequacy of the existing water system and for proposing future water system facilities.
- **Chapter 7 - Hydraulic Model Update** describes the update of the City's 2007 computer hydraulic model which was used in simulating the water system operations.
- **Chapter 8 - Existing Water System Evaluation** presents the analysis of the existing water distribution system facilities in comparison to the City's design and operational criteria.
- **Chapter 9 - Future Water System Analysis** presents the future system pipelines and water system facilities needed to satisfy the City's design and operational criteria.
- **Chapter 10 – Recommended Capital Improvement Program** details the proposed water system improvements and associated costs resulting from this Master Plan tasks.

Chapter 2
Study Area

2.1 Existing Water Service Area

The City of Merced is located in Merced County in the Central San Joaquin Valley 110 miles southeast of San Francisco and 310 miles northwest of Los Angeles. It is located at the intersection of Highway 99 and Highway 59. The City's existing water service area is over 21 square miles. Figure 2-1 shows the existing service area and corresponding land use.

The existing water service area comprises the area within the City limits and UC Merced campus. The City is the only potable water purveyor for the water consumers within the city limits, UC Merced campus and some small County islands outside the City limits. Merced Irrigation District provides irrigation water to Golden Valley High School and agricultural users, and has plans to provide water service to City parks (Brown and Caldwell, 2005; Carollo Engineers, 2011). However demand projections in this Master Plan do not account for this potential alternative source because the water volume is relatively small.

For the purposes of demand allocation in the City's water system model, the land use types were grouped in Table 2-1 as follows:

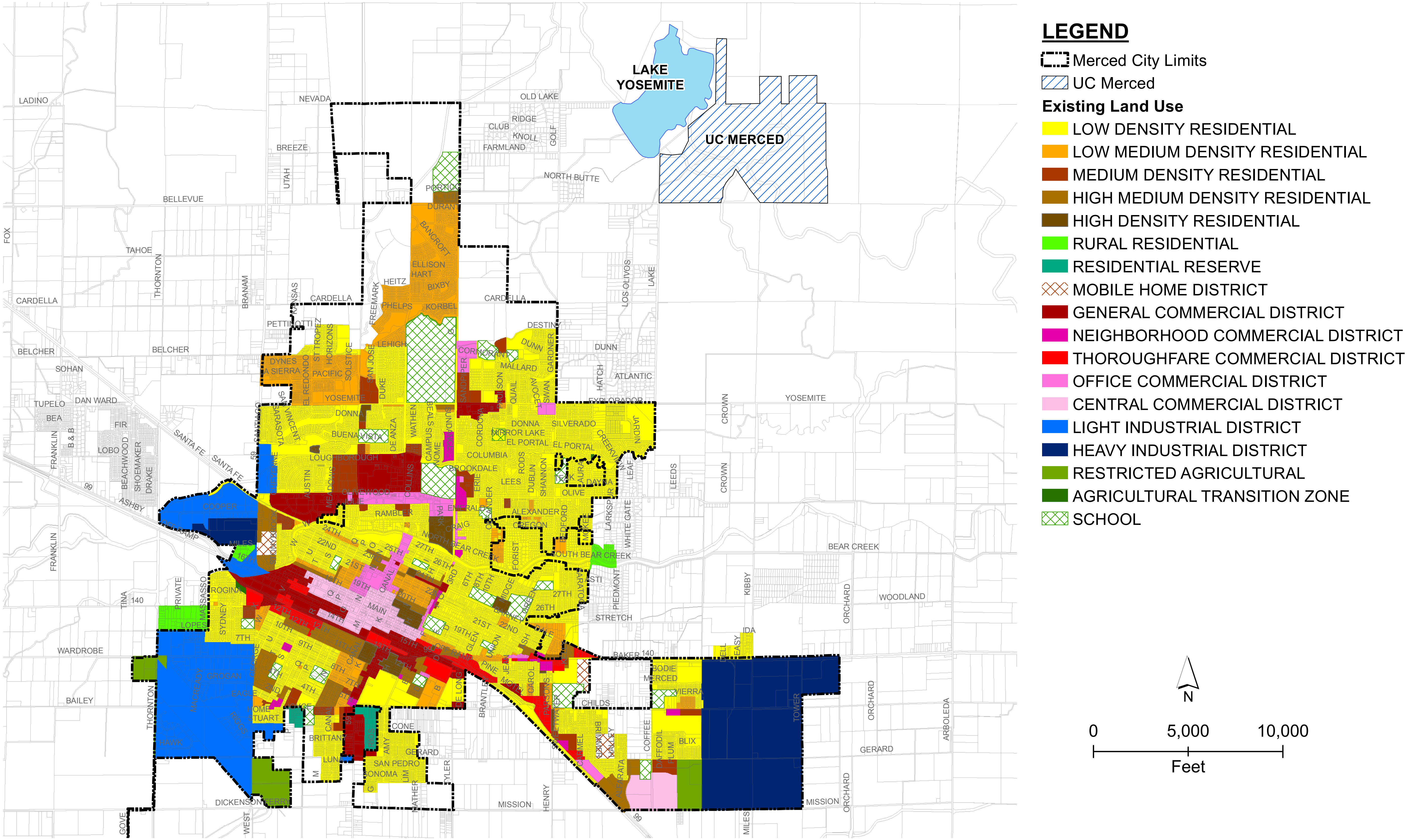
- Residential
- Industrial
- Commercial
- Agricultural
- Open Space
- Institutional

The predominant land use in the City is residential at approximately 57 percent of the existing service area. The second largest land use is industrial at 16 percent.

2.2 Projected Water Service Area

The projected land uses shown in Figure 2-2 and Table 2-2 are consistent with the City's *Merced Vision 2030* General Plan and have been agreed on by City staff for use for the future water system analysis. *Merced Vision 2030* has a planning horizon out to the year 2030.

The Specific Urban Development Plan (SUDP) boundary is recognized as the ultimate growth boundary of the City. UC Merced currently falls outside the northeastern boundary of the SUDP. However, UC Merced campus lies inside the City's Sphere of Influence (SOI) and receives water from the City. The boundary proposed by *Merced Vision 2030* incorporates UC Merced and the UC Village into the SUDP. The total water service area of the SUDP/SOI, including UC Merced and the UC Village, is projected to be 28,730 acres (45 square miles) by the year 2030.



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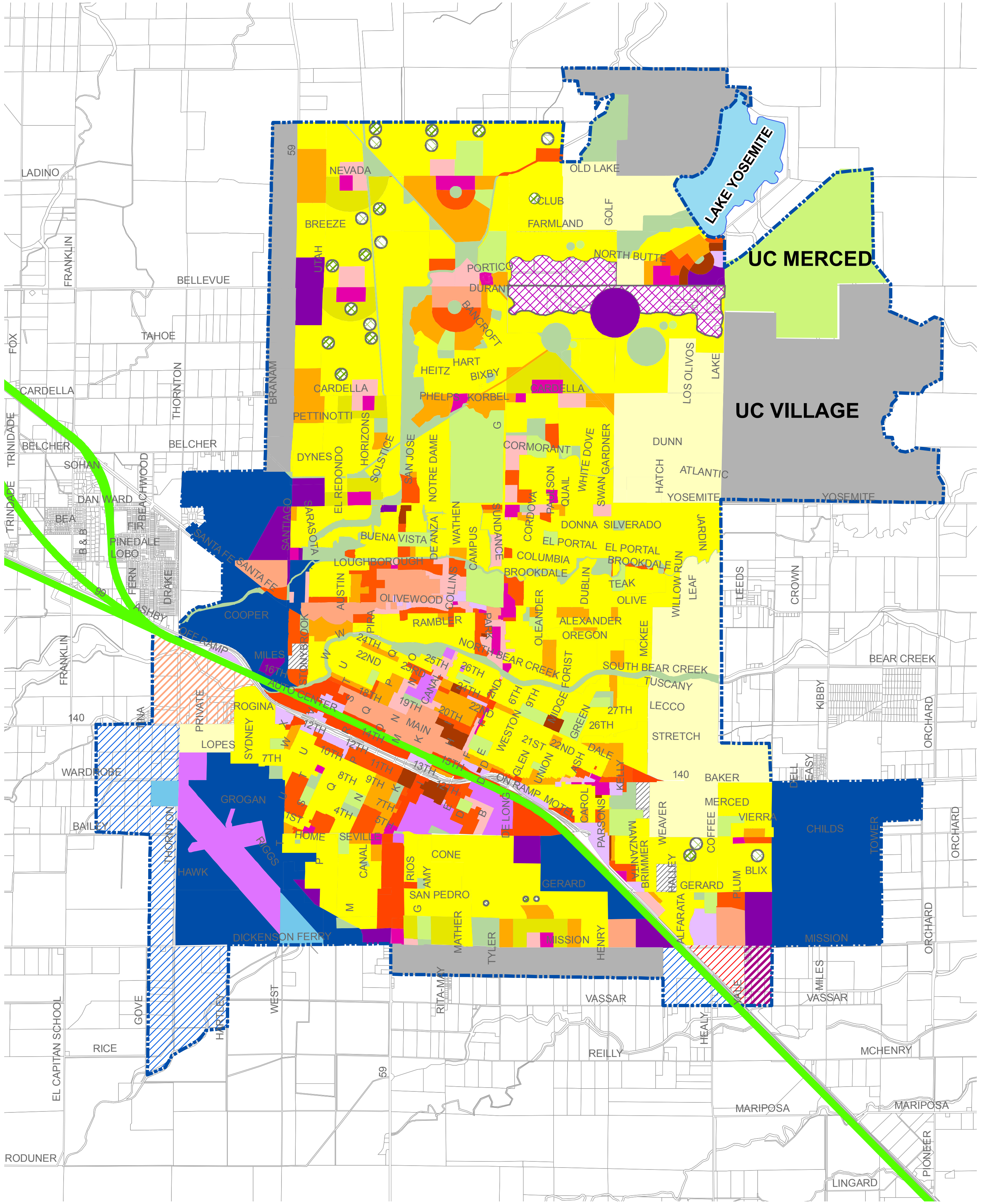
EXISTING LAND USE

AECOM PROJECT NO. 60297029

FIGURE 2-1

Table 2-1. Existing (2012) Land Use

Major Land Use	Sub-Land Use Type	Existing Area, acres	% of Major Land Use	% of Total Service Area
RESIDENTIAL	High Density Residential	150	2%	1%
	High Medium Density Residential	423	5%	3%
	Medium Density Residential	306	4%	2%
	Low to Medium Density Residential	1,173	15%	8%
	Low Density Residential	5,510	70%	40%
	Mobile Home Park Residential	79	1%	1%
	Residential Reserve	60	1%	0%
	Rural Residential	130	2%	1%
	Subtotal	**7,830**	100%	56%
INDUSTRIAL	Heavy Industrial District	1,155	51%	8%
	Light Industrial District	1,102	49%	8%
	Subtotal	**2,258**	100%	16%
COMMERCIAL	Central Commercial District	323	20%	2%
	General Commercial District	686	43%	5%
	Neighborhood Commercial District	84	5%	1%
	Thoroughfare Commercial District	235	15%	2%
	Office Commercial District	260	16%	2%
	Subtotal	**1,587**	100%	11%
AGRICULTURAL	Restricted Agriculture	235	98%	2%
	Agricultural Transition Zone	5	2%	0%
	Subtotal	**240**	100%	2%
OPEN SPACE	Park Recreation	1,225	100%	9%
	Subtotal	**1,225**	100%	9%
INSTITUTIONAL	Schools	687	90%	5%
	UC Merced	78	10%	1%
	Subtotal	**765**	**100%**	6%
	Total	**13,905**	**100%**	100%



LEGEND

Future High Speed Rail Alignment

Merced 2030 General Plan Boundary

2030 General Plan Land Use

- AGRICULTURAL
- BUSINESS PARK
- BUSINESS PARK RESERVE
- COMMERCIAL OFFICE
- COMMERCIAL RESERVE
- COMMUNITY PLAN
- FUTURE PARK
- FUTURE SCHOOL
- GENERAL COMMERCIAL
- HIGH DENSITY RESIDENTIAL
- HIGH TO MEDIUM RESIDENTIAL
- INDUSTRIAL RESERVE
- LOW DENSITY RESIDENTIAL
- LOW TO MEDIUM DENSITY RESIDENTIAL
- MANUFACTURING/INDUSTRIAL
- MIXED USE
- MOBILE HOME PARK RESIDENTIAL
- NEIGHBORHOOD COMMERCIAL
- OPEN SPACE - PARK RECREATION
- PUBLIC/GENERAL USE
- REGIONAL COMMUNITY COMMERCIAL
- RESIDENTIAL RESERVE
- RURAL RESIDENTIAL
- SCHOOL
- THOROUGHFARE COMMERCIAL
- VILLAGE RESIDENTIAL

Source: Merced Vision 2030

N

0 6,000 12,000

Feet

AECOM Water AECOM 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN 2030 LAND USE	AECOM PROJECT NO. 602979029	FIGURE 2-2

V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2030 Figures

Table 2-2. Existing and Projected Land Use

Major Land Use	Sub-Land Use Type	Existing Area (2012), acres	Future Area (2030), acres
RESIDENTIAL	High Density Residential	150	124
	High to Medium Density Residential	423	826
	Medium Density Residential	306	-
	Low to Medium Density Residential	1,173	1,172
	Low Density Residential	5,510	8,699
	Mobile Home Park Residential	79	80
	Residential Reserve	60	360
	Village Residential	-	444
	Rural Residential	130	2,303
	Mixed Use	-	447
	Subtotal	**7,830**	**14,455**
INDUSTRIAL	Heavy Industrial District	1,155	-
	Light Industrial District	1,102	-
	Industrial Reserve	-	1,195
	Manufacturing/Industrial	-	2,877
	Subtotal	**2,258**	**4,072**
COMMERCIAL	Regional Community/Central Commercial District	323	588
	General Commercial District	686	494
	Neighborhood Commercial District	84	286
	Thoroughfare Commercial District	235	232
	Office Commercial District	260	507
	Business Park	-	597
	Business Park Reserve	-	88
	Commercial Reserve	-	90
	Subtotal	**1,587**	**2,883**
AGRICULTURAL	Restricted Agriculture	235	114
	Agricultural Transition Zone	5	-
	Subtotal	**240**	**114**
OPEN SPACE/ PUBLIC USE	Community Plan	-	1,617
	Open Space - Park Recreation	1,225	1,225
	Future Park	-	71
	Public Use	-	538
	UC Village Planning Area	-	2,045
	Subtotal	**1,225**	**5,497**
INSTITUTIONAL	Schools	687	794
	Future Schools	-	49
	UC Merced	78	868
	Subtotal	**765**	**1,710**
	Total	**13,905**	**28,730**

2.3 Historical and Projected Population

The historical and projected population of the City is shown in Figure 2-3. The population data from 1978 to 1989 was estimated based on U.S. Census data while those from 1990 to 2012 are based on the California Department of Finance (DOF) reports. The DOF reports are based on the 2000 and 2010 US population census. The projected populations from 2012 to 2030 are based on *Merced Vision 2030* which reflect Merced County Association of Governments and UC Merced projections.

As shown in Figure 2-3, the population of the City grew steadily at an annual rate of 3.8 percent from 1978 to 1995. From 1995 to 2000, the City's population grew at only 0.5 percent. The population growth rate averaged 3 percent from 2000 to 2007 in agreement with the housing market expansion and the establishment of UC Merced. From 2007 to 2012, the population growth rate of the City's SOI slowed to 2.3 percent due to the housing market collapse that occurred in 2008. The growth in the population of the SOI was mainly due to UC Merced expansion. The City's population within the current SUDP is anticipated to grow by about 56,801 between 2012 and 2030, according to the Merced County Association of Governments (MCAG, 2010).

UC Merced's historical population is shown in Table 2-3. The student/worker ratio of UC Merced has increased from 1.8 in 2005 to 4.7 in 2012. The annual population growth rate ranged from approximately 40 percent in the earlier years to 11 percent in 2012. The average annual growth rate from 2005 to 2012 is approximately 26 percent.

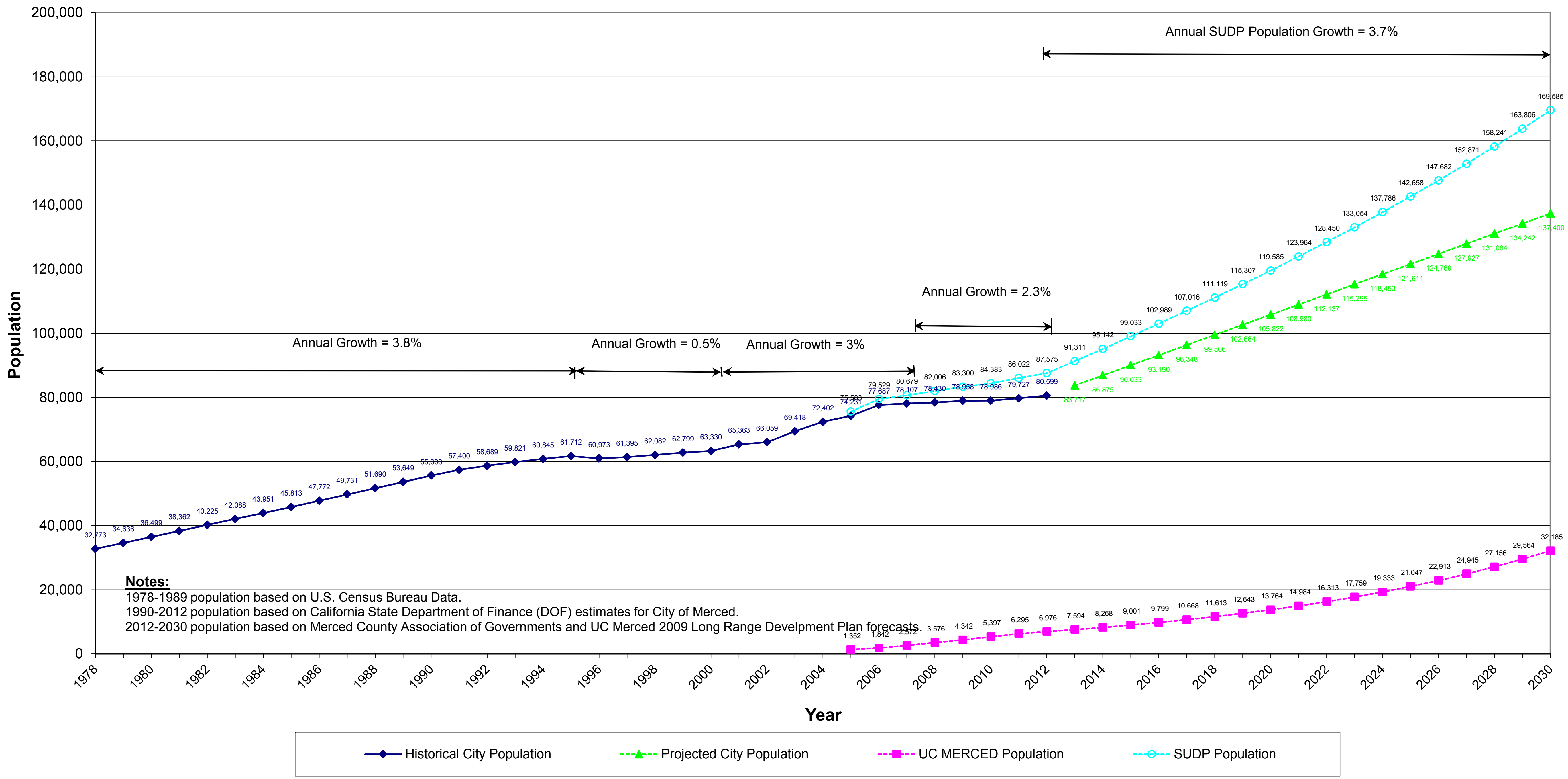
Table 2-3. UC Merced Population[(a)]

Year	Student Enrollment	Faculty, Staff & other Workers	Total
2005	875	477	1,352
2006	1,286	556	1,842
2007	1,871	701	2,572
2008	2,718	858	3,576
2009	3,414	928	4,342
2010	4,381	1,016	5,397
2011	5,198	1,097	6,295
2012	5,760	1,216	6,976
2013	6,195	-	-

[(a)]Data from UC Merced Institutional Planning and Analysis.

Projections for the growth of UC Merced are contained in the 2009 Long Range Development Plan (LRDP) approved by the UC Regents. The 2009 LRDP set forth a land use plan and principles for the development of a 25,000-student campus by 2030. This would bring the total population of UC Merced including faculty, staff and other residents to 32,185 by 2030, representing a growth rate of approximately 9 percent per year. This projected population is approximately 40 percent higher than the projection from MCAG (2010) of 22,500 which is in *Merced Vision 2030* and the City's 2010 Urban Water Management Plan. City staff have directed AECOM to use the larger projected population in the 2009 LRDP.

It is important to note that the Urban Land Institute has been tasked to help amend the 2020 Project in the 2009 LRDP. The 2020 Project was to support an enrollment level of 10,000 full time equivalent students by 2020. The proposed amendment, which was approved by the Regents, would allow for a single master-planned development and the revised 2020 Project would be located on a much smaller area within the larger development area originally envisioned. The implications of UC Merced land use changes in the LRDP for the City's water system are that the timing of water supplies, sizing of transmission mains and the proposed locations of future wells to supply UC Merced may have to be changed to accommodate UC Merced's changing land use.



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CITY OF MERCED
WATER MASTER PLAN

HISTORICAL AND PROJECTED POPULATION

AECOM PROJECT NO. 60297029

FIGURE 2-3

V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2012 Figures

A University community is envisioned to support UC Merced. A University Community Plan (UCP) contains the specific details. The size is approximately 2,045 acres based on the land use designation in the *Merced Vision 2030*. The area is sometimes referred to as UC Village and is generally bounded by the University of Merced Campus to the north, Lake Road to the west, Yosemite Avenue to the south, and the Fairfield Canal to the east. According *Merced Vision 2030*, UC Village is designed to provide over 11,000 housing units and house over 30,000 people.

The combined population in Merced's SUDP/SOI is anticipated to grow from 87,575 in 2012 to 169,585 by 2030, an increase of approximately 94 percent over the 18-year planning period. The associated average annual growth rate is approximately 3.7 percent. The increased population from the City and UC Merced will place additional demand on the City's existing water system which will need to be expanded to serve existing and new customers adequately.

Chapter 3
Existing Water System

This chapter describes the City's existing water system facilities. Understanding of the water system was gained by collecting and reviewing previous reports, maps, plans, operating records, and discussions with City staff. Figure 3-1 shows the City's existing water system facilities as of December 2012.

3.1 Water Supply Facilities

The City currently depends solely on groundwater supplied from 22 wells located throughout the water service area. Not all the wells are normally used by the City. Two of the wells are new. Well 18 became operational in 2010 and Well 19 in 2012. The pumped water level in the wells generally ranges from 60 to 230 feet, while the completed well depth varies from 160 to 800 feet below ground surface as shown in Table 3-1.

The design capacities of the wells range from 1,200 to 4,000 gpm and total approximately 60,300 gpm. Each well is equipped with a vertical turbine that pumps water directly into the distribution system, with the exception of the wells at Pump Stations 1, 2, 3 and 7, which pump into onsite elevated tanks. The water then flows from these tanks into the distribution system by gravity based on water system demand. The configuration at these sites is shown in Figure 3-2.

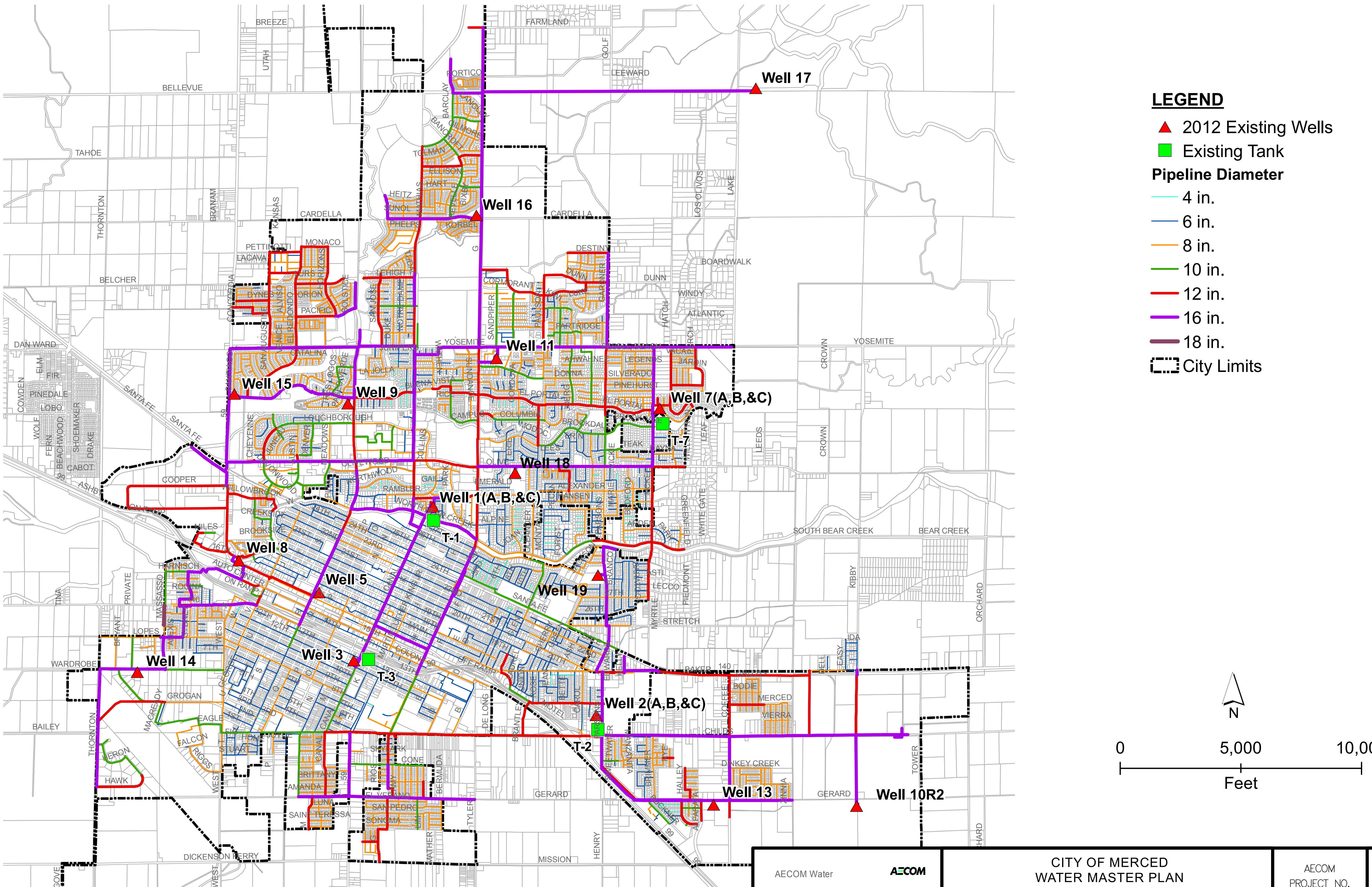
According to City staff, a few of the wells have water quality issues. Wells 2A and 2B are blended with Well 2C using the onsite tank because Well 2C has historically produced water with arsenic concentrations in excess of the 10-µg/L MCL (CDPH, 2006). Well 2C cannot pump water if either 2A or 2B is offline. Well 3 has water quality issues with percloroethylene (PCE). According to City staff, Well 5B is not operated unless absolutely necessary due to MTBE being detected in the overlying water. Well 6 is being decommissioned because it produces excessive sand. A new well (Well 20) is planned for construction at the intersection of Mission Avenue and Tyler Road.

Because Well 7B has historically produced water with nitrate concentrations in excess of the 45 mg/L MCL, its water is blended with Wells 7A and 7C in the onsite tank being discharged into the distribution system. Wells 7A and 7B have not been used in recent years. Well 13 has high arsenic concentrations.

Each well has chlorination and fluoridation equipment that dispense sodium hypochlorite and fluoride into the water before it is discharged into the distribution system. Wells are generally turned on based on water system pressure. Once the system demands exceed the supply capability of the wells online and system pressures begin to decline, other wells come online based on preset pressures. Each well has a standby generator. All wells, with the exception of those located at tank sites, have variable-frequency drives (VFD) that enable the pumps to accommodate fluctuating water demands.

3.2 Water Distribution System & Storage Facilities

The City's water distribution system consists of a single pressure zone since the terrain is generally flat with an average ground elevation of about 171 feet above mean sea level. The ground elevation ranges from 150 to 250 feet above mean sea level. The distribution system facilities are described below.



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CITY OF MERCED
WATER MASTER PLAN

EXISTING WATER SYSTEM FACILITIES

AECOM PROJECT NO.

60297029

FIGURE

3-1

V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2012 Figures

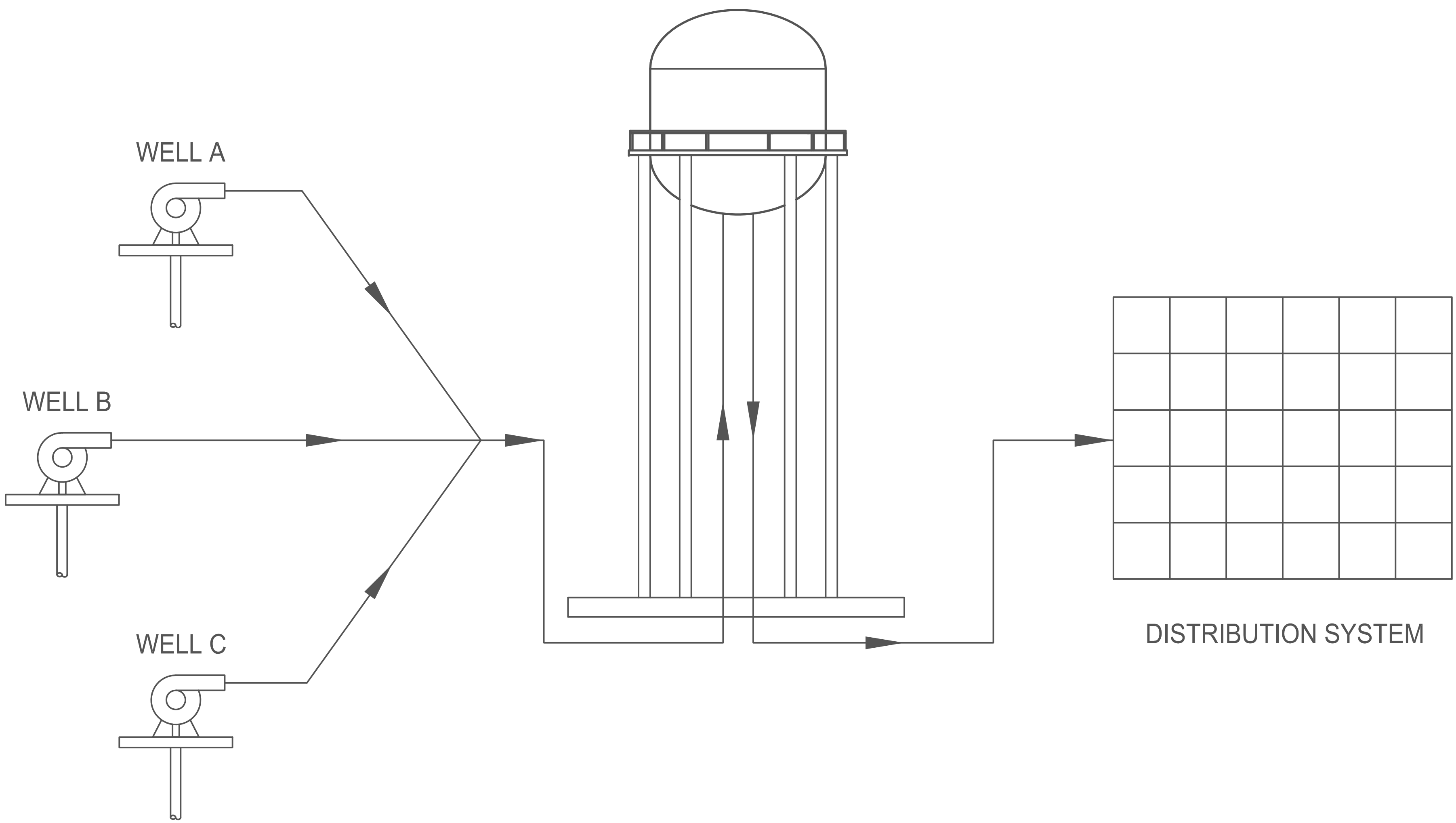
Table 3-1. Existing Groundwater Wells

Pump Station No.	Address	Well No.	Date Drilled	Completed Well Depth, ft	Pumping Water Level, ft[a]	Pump Type	Rated Capacity, gpm	Pump Test Production, gpm[a]	Energy Cost Per Hour, $	Pump Efficiency, %[a]	Approx. Run Time, hours/day[b]
1	477 St. Lawrence Dr	1A	1951/1959	174	69	Constant	2,200	2,386	11.77	70	0.5
		1B	1951	270	68	Constant	2,200	1,804	10.20	67	
		1C	1953	230	72	Constant	2,200	2,022	11.20	64	
2	1201 S. Parsons Ave	2A	1950	251	74	Constant	2,200	2,004	11.39	69	3
		2B	1950	161	89	Constant	2,200	2,487	24.55	43	
		2C	1991	685	230	Constant	2,500	2,322	23.37	65	
3	511 W. 12th St	3C	1987	594	110	Constant	3,000	2,467	18.69	53	6
5	1632 R St	5B	1987	546	88	VFD	3,000	2,141	13.34	69	8
7	3362 McKee Rd	7A	1963	344	74	Constant	2,500	1,773	9.99	70	19
		7B	1968	339	79	Constant	2,500	1,509	10.67	57	
		7C	1992	614	130	Constant	2,800	2,428	23.88	52	
8	1520 W.N. Bear Creek Dr	8	1974	400	74	VFD	2,000	1,840	NA	NA	8
9	3391 R St	9	1985	495	154	VFD	1,800	1,992	13.50	71	4
10	4250 E. Gerard Ave	10R2	2003	800	75	VFD	3,000	2,119	12.79	65	12
11	346 E. Yosemite Ave	11	1987	430	101	VFD	3,000	1,585	10.83	67	8
13	2890 E. Gerard Ave	13	1990	702	151	VFD	3,000	1,742	15.47	60	12
14	2110 Wardrobe Ave	14	1990	380	74	VFD	4,000	4,000	NA	NA	12
15	1855 Buena Vista Dr	15	2004	556	95	VFD	3,500	2,560	16.06	70	12
16	125 Cardella Rd	16	2004	500	61	VFD	3,500	2,451	13.59	68	12
17	5010 Lake Rd	17	2004	500	80	VFD	2,500	1,773	11.16	51	12
18	420 E. Olive Ave	18	2011	600	100	VFD	3,000	3,000	NA	80	12
19	2065 Parson Ave	19	2012	600	100	VFD	2,500	2,500	NA	80	12
Total		**22**					**59,100**	**48,905**			

(a) Based on pump tests conducted in late 2007 and early 2008.

(b) Source: Department of Public Health, Domestic Water Supply Permit, December 2006.

(c) NA = Data not available from the pump tests of 2007/2008.



FIGURE

3-2

CITY OF MERCED
WATER MASTER PLAN

WELL & TANK FLOW SCHEMATIC

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3.2.1 Water Pipelines

The City has approximately 1.5 million linear feet (280 miles) of water system pipelines. They generally range from 4 to 16 inches in diameter and are made of cast iron, ductile iron, and polyvinyl chloride (PVC). The cast-iron pipelines were installed between 1940 and 1960 while the ductile iron pipelines were installed from 1950 to 1992. All City water mains 12 inches and larger installed from 1990 to the present are ductile iron. Pipelines less than 12 inches in diameter that are installed in subdivisions are PVC.

3.2.2 Treated Water Storage Facilities

The City has four elevated storage tanks located at Pump Station Nos. 1, 2, 3 and 7 as stated previously. They have a total storage capacity of 1.5 million gallons (MG) as shown in Table 3-2. The elevations are based on USGS maps.

Table 3-2. Potable Water Storage Facilities

Storage Facility	Address	Capacity (MG)	Diameter (feet)	MSL Elevations (feet)		
				Ground	Base	Overflow
Tank 1	477 St. Lawrence Street	0.3	41	175	260	294
Tank 2	1201 S. Parsons Avenue	0.4	46	175	256	291
Tank 3	511 W. 12th Street	0.3	40	165	258	290
Tank 7	3362 McKee Road	0.5	50	180	258	295
Total	**--**	**1.5**	**--**		**--**	**--**

In addition to the four tanks, UC Merced has an at-grade 0.25-MG tank that receives water from the City's water system. This tank is not considered part of the City's water system.

The City's tanks fill and drain based on the relative hydraulic grade line of the connecting pipelines. Operation of the well pumps at the tank sites is based on the water level in the tanks. These pumps are programmed to turn on and off at preset tank water levels. The tanks drain in response to water demand in the distribution system.

Chapter 4
Water Demand

This chapter presents the existing and future water demand of the City of Merced. Water demand calculations are needed to identify the required water supplies and infrastructure to serve existing and future water users. The water demand estimates were updated as part of this 2013 Master Plan update. This water demand analysis comprises an evaluation of historical water production, peaking factors, and demand projections.

4.1 Historical Water Production

Water production is used as a surrogate for water demand because approximately 50 percent of all customers are not metered and unaccounted-for water was said by City staff to be less than 5 percent. Annual groundwater production from the City's operational records covering the period from 1978 to 2012 is summarized in Table 4-1. Water production increased from approximately 16,500 acre-feet per year (AFY) in 1990 to 25,899 AFY in 2012, which is equivalent to an annual increase of approximately 2 percent. Compared to the 2 percent annual population growth rate over the same period, it can be inferred that the City's water system has historically been expanded to keep pace with the population growth.

Table 4-1. Historical Water Production[a]

Year	Annual Production, afy	Annual Production, MG	Average Day Production, mgd
1978	11,500	3,748	10.3
1979	13,500	4,400	12.1
1980	14,000	4,563	12.5
1981	15,500	5,051	13.8
1982	17,000	5,540	15.2
1983	17,000	5,540	15.2
1984	19,500	6,355	17.4
1985	17,500	5,703	15.6
1986	17,000	5,540	15.2
1987	15,000	4,889	13.4
1988	16,000	5,214	14.3
1989	16,500	5,377	14.7
1990	16,500	5,377	14.7
1991	14,500	4,726	12.9
1992	16,000	5,214	14.3
1993	16,500	5,377	14.7
1994	18,000	5,866	16.1
1995	18,494	6,027	16.5
1996	20,649	6,730	18.4
1997	22,689	7,394	20.3
1998	20,990	6,841	18.7
1999	23,903	7,790	21.3
2000	22,209	7,238	19.8
2001	23,633	7,702	21.1
2002	23,658	7,710	21.1

Year	Annual Production, afy	Annual Production, MG	Average Day Production, mgd
2003	22,427	7,309	20.0
2004	23,977	7,814	21.4
2005	22,538	7,345	20.1
2006	22,166	7,224	19.8
2007	24,379	7,945	21.8
2008	24,164	7,874	21.5
2009	23,304	7,594	20.8
2010	23,659	7,709	21.1
2011	23,117	7,533	20.6
2012	25,899	8,439	23.1
Average	19,524	6,363	17.4

[a]Water Production data compiled from City records and annual reports submitted by the City to CDPH.

4.2 Water Demand Peaking Factors

Water demand peaking factors are multiplication factors used to calculate water use expected during demand periods higher than average demands. The most commonly used high demand periods for water supply and system evaluations include maximum day and peak hour. The demands during these periods are generally used to evaluate and size water distribution pipelines and storage facilities, and to define water supply needs.

Table 4-2 shows the historical Average Day and Maximum Day Demand for the City's water system. It was compiled from annual reports to the Drinking Water Program for Medium and Large Water Systems of California Department of Public Health (CDPH) and from City operational records. From 1999 to 2012, the Maximum Day Demand peaking factor varied from 1.7 to 2.0, and averaged 1.9. It is recommended that the historical Average Day to Maximum Day Demand factor of 1.9 be used for estimating Maximum Day Demand for the future.

Table 4-2. Maximum Day Peaking Factor[a]

Year	Average Day, mgd	Maximum Day, mgd	Peaking Factor
1999	21.3	40.4	1.9
2000	19.8	36.5	1.8
2001	21.1	35.9	1.7
2002	21.1	40.0	1.9
2003	20.0	39.6	2.0
2004	21.4	38.5	1.8
2005	20.1	39.0	1.9
2006	19.8	37.8	1.9
2007	21.8	-	-
2008	21.5	38.6	1.8
2009	20.8	37.2	1.8
2010	21.1	42.2	2.0
2011	20.6	40.4	2.0
2012	23.1	44.0	1.9
Average		1.9	

[a]Demand data from Annual Reports to the Drinking Water Program for Medium and Large Water Systems of CDPH. Maximum day peaking factor is the Maximum Day Demand divided by the Average Day Demand.

Due to the unavailability of historical data to calculate the Peak Hour Demand factor, it was agreed by City staff to use an Average Day to Peak Hour Demand factor of 2.8. This was based on City operations staff's experiences and AECOM's experiences with similar sized cities in the Central San Joaquin Valley. For example, the City of Ceres uses a Peak Hour Demand factor of 2.75 while the City of Fresno uses 2.9. Table 4-3 summarizes the peaking factors used in this Master Plan for the sizing of water system facilities.

Table 4-3. Water Demand Peaking Factors

Peaking Factor	Value
Average Day to Maximum Day Demand	1.9
Average Day to Peak Hour Demand	2.8

4.3 Water Demand Projections

The water demands of the City were generally calculated based on land use. The land use demand method was used because only 50 percent of City customers have metered data. Therefore, the demand projections cannot be done by using metered data exclusively. The total water demand estimated by this method was confirmed using an independent per-capita demand method based on population.

4.3.1 Land Use Based Demand Projection

Land use demand estimation is accomplished by estimating unit water demand factors for each land use type and multiplying the factors by the total area of the corresponding land use type. Unit water demand factors were estimated for the City's land use types based on previous water demand studies, the City's 2010 Urban Water Management Plan, and discussions with City staff. Table 4-4 shows the estimated unit water demand factors of the City. These unit demand factors assume a reduction of 5 to 10 percent demand reduction from the baseline demand to 2030 because of adding meters and the implementation of water conservation measures in agreement with the City's 2010 Urban Water Management Plan. Agricultural land use was not assigned any unit demand because the City's potable water system does not supply agricultural water.

Historical and projected demands are summarized in Table 4-5. The water demand of the City is anticipated to increase by approximately 72 percent from 2012 to 2030. This increase will have great implications for the City's need for additional supplies and additional water transmission and distribution system improvements. Use of the City's hydraulic model to analyze the City's water distribution systems to meet the demands is explained later in this report.

Table 4-4. Projected Unit Water Demands

Major Land Use	Sub Land Use Type	Existing Unit Demand, afy	2030 Unit Demand, afy
RESIDENTIAL	High Density Residential	3.2	2.9
	High Medium Density Residential	2.65	2.4
	Medium Density Residential	2.5	2.3
	Low to Medium Density Residential	2	1.8
	Low Density Residential	1.84	1.7
	Mobile Home Park Residential	1.5	1.4
	Residential Reserve	1.2	1.1
	Village Residential	0.5	0.5
	Rural Residential	0.5	0.5
	Mixed Use	1.9	1.7
INDUSTRIAL	Heavy Industrial District	2	1.8
	Light Industrial District	1.8	1.7
	Industrial Reserve	2	1.8
	Manufacturing/Industrial	2	1.8
COMMERCIAL	Regional Community/Central Commercial District	1.8	1.7
	General Commercial District	1.8	1.7
	Neighborhood Commercial District	1.8	1.7
	Thoroughfare Commercial District	1.8	1.7
	Office Commercial District	1.8	1.7
	Business Park	1.8	1.7
	Business Park Reserve	1.8	1.7
	Commercial Reserve	1.8	1.7
AGRICULTURAL	Restricted Agriculture	-	
	Agricultural Transition Zone	-	
OPEN SPACE/ PUBLIC USE	Community Plan	-	1.7
	Open Space - Park Recreation	0.5	0.5
	Future Park	0.5	0.5
	Public Use	0.5	0.5
	Golf Course	-	
INSTITUTIONAL	Schools	2	1.8
	Future Schools	2	1.8
	UC Merced	2	1.7
AREA OF INTEREST	Area of Interest	-	-

Table 4-5. Existing and Projected Water Demand

Demand Type	Planning Horizon		
	2007	2012 (Existing)	2030
Annual, afy	24,379	25,899	44,596
Average Day, gpm	15,115	16,057	27,649
Average Day, mgd	22	23.4	40.3
Maximum Day, mgd[(a)]	41	44.5	76.6
Peak Hour, gpm[(b)]	42,320	44,960	77,417

[(a)]Maximum Day Demand is defined as 1.9 times the Average Day Demand.
[(b)]Peak Hour Demand is defined as 2.8 times the Average Day Demand.

4.3.2 Population Based Water Demand Projection

To provide a reasonableness check on the total water demand projected by the land use method, a per-capita water demand method was used. A per-capita water use factor is usually computed by dividing the total annual water demand within a service area by the corresponding year's population. The resultant average per-capita water use factor can then be multiplied by the projected population for the future year to estimate the future demand. Although the per-capita projection method is considered fairly reliable, the primary purpose for the use of this method was to compare and confirm the results of the land use based projection. The City's per capita demand was calculated by subtracting UC Merced's water use from the total water production.

The City's per-capita water use from 1978 to 2012 averaged 298 gallons per capita per day (gpcd) as shown in Table 4-6. Water use over the most recent years has trended downwards reflecting the effect of metering and conservation measures. The projected 2030 unit demand of 276 gpcd was used for the City in estimating the future water use. This unit demand represents a historical average over the last 10 years and reflects water use reduction of approximately 8 percent from the existing water demand of the City.

UC Merced's per-capita water use from 2007 to 2012 ranged from 26 to 54 and averaged 39 gallons per capita per day (gpcd) as shown in Table 4-7. This declining per-capita water is reflective of UC Merced's effort to be a sustainable institution. The unit water demand used to project UC Merced's water use in the 2010 Urban Water Management Plan is 95 gpcd. Given the historical unit water use, this number is too high. The historical average unit water use of 39 gpcd was used to project demands for 2030 since this represents the most practical approach. The total projected water demand for the City of Merced and UC Merced is shown in Table 4-8. Of the total City of Merced water demand, UC Village is projected to account for approximately 3,477 acre-feet annually.

4.3.3 Comparison of Land Use and Population Based Demand Projections

A comparison of the projected demand for the City based on land use and population is shown in Table 4-9. The demand projections for 2030 are very close, with a difference of approximately 1.6 percent. This confirms that the unit demand factors used in distributing the future water demand in the model are reasonable.

Table 4-6. Per-Capita Water Use for Merced City Only

Year	Annual Water Production, MG	Merced City Population Only	Per Capita Water Use, gpcd
1978	3,748	32,773	313
1979	4,400	34,636	348
1980	4,563	36,499	342
1981	5,051	38,362	361
1982	5,540	40,225	377
1983	5,540	42,088	361
1984	6,355	43,951	396
1985	5,703	45,813	341
1986	5,540	47,772	318
1987	4,889	49,731	269
1988	5,214	51,690	276
1989	5,377	53,649	275
1990	5,377	55,608	265
1991	4,726	57,400	226
1992	5,214	58,689	243
1993	5,377	59,821	246
1994	5,866	60,845	264
1995	6,027	61,712	268
1996	6,730	60,973	302
1997	7,394	61,395	330
1998	6,841	62,082	302
1999	7,790	62,799	340
2000	7,238	63,330	313
2001	7,702	65,363	323
2002	7,710	66,059	320
2003	7,309	69,418	288
2004	7,814	72,402	296
2005	7,345	74,231	271
2006	7,224	77,687	255
2007	7,894	78,107	271
2008	7,814	78,430	269
2009	7,518	78,958	258
2010	7,645	78,986	263
2011	7,473	79,727	257
2012	8,366	80,599	288
		1978-2012 Average (35 years)	298
		2002-2012 Average (10 years)	276
		2007-2012 Average (5 years)	268

Table 4-7. Per-Capita Water Use for UC Merced

Year	Annual Water Use, MG	UC Merced Population	Per Capita Water Use, gpcd
2007	50.7	2,572	54
2008	59.8	3,576	46
2009	75.8	4,342	48
2010	64.1	5,397	33
2011	59.3	6,295	26
2012	73.0	6,976	29
		Average	39

Table 4-8. Projected 2030 Water Demand Based on Population

Year	Projected Population	Per Capita Water Demand, gpcd	Total Annual Demand, MG	Total Annual Demand, acre-feet
Merced SUDP	137,400	276	13,842	42,478[a]
UC Merced	32,185	39	458	1,406
Total	169,585		14,300	43,885

[a] Includes 3,477 acre-feet from UC Village.

Table 4-9. Comparison of Water Demand Projection Methods

Planning Horizon	Land Use Based Demand Projection, afy[a]	Population Based Demand Projection, afy[b]	Percent Difference
2030	44,596	43,885	-1.6

[a] Obtained from Table 4-5.
[b] Obtained from Table 4-8.

Chapter 5 Water Supply

This chapter describes the water supply required to satisfy the demand of the City of Merced. An evaluation of existing and future water supplies provides the basis for the planning of water supply infrastructure. The primary focuses of this chapter are water supply sources, quantity, quality, and reliability. This section is based on information from the City's 2010 Urban Water Management Plan, Merced Climate Action Plan, California Department of Water Resources, US Geological Survey (USGS), and discussions with City staff.

5.1 Existing Sources of Water Supply

The City currently relies solely on groundwater for its water supply. This groundwater is abstracted from the underlying Merced Subbasin, which is part of the larger San Joaquin Valley Groundwater Basin. The Merced Subbasin covers a surface area of 491,000 acres, with the City of Merced covering less than 3 percent of this total area.

5.2 Subsurface Geologic Conditions

Hydrogeologic units in the Merced Subbasin include consolidated and unconsolidated deposits. The unconsolidated deposits include continental deposits, lacustrine and marsh deposits, older alluvium, younger alluvium, and flood basin deposits. The continental deposits and older alluvium are the main water yielding units in the unconsolidated deposits.

The consolidated rocks include the Ione Formation, Valley Springs Formation, and the Mehrten Formation. The consolidated rocks generally yield small quantities of water to wells except the Mehrten Formation, which is an important productive aquifer (DWR, 2005b).

According to a USGS study (Page, 1977), there are four aquifers beneath the Merced area:

- A shallow unconfined aquifer with a maximum thickness of 100 feet composed of gravels, sand, and fine sand with moderate to high hydraulic conductivity.
- An intermediate aquifer below the shallow aquifer with a maximum thickness of 700 feet composed of gravels, sand, silt, and clay. The base of this aquifer is lined by E-Clay (Corcoran Clay). The hydraulic conductivity is moderate to high.
- A confined aquifer below the Corcoran Clay with a maximum thickness of 700 feet and composed of gravels, sand, silt and clay. It has moderate to high hydraulic conductivity.
- Below the confined aquifer is the Mehrten Formation, which has a maximum thickness of 700 feet. It is composed of sandstone, siltstone, and low to moderate hydraulic conductivity.

5.3 Well Production

Average well yields for the Merced Subbasin generally range from 1,500 to 1,900 gpm (DWR, 2003) with a maximum yield of 4,450 gpm. There are currently no known physical or legal constraints to limit the City's use of water from the Merced groundwater basin. However, in the future, if adequate recharge does not occur to limit overdraft, existing wells may need to be deepened to sustain required pumping levels. Deepening of wells has the potential to contribute to poorer water quality, land subsidence, and higher pumping costs for the City.

5.4 Groundwater Levels

Groundwater levels fluctuate over time depending on precipitation, aquifer recharge, and pumping demands. Static ground water levels generally fall in the winter and rise in spring. According to groundwater studies, depth to water in the Merced Subbasin has declined from 20 feet below ground surface in 1960 to about 90 feet below ground surface in 2004. It was estimated by the same source that by 2040 up to 85,000 acre-feet of surface water would be needed for treatment, intentional, and/or in-lieu recharge to stabilize groundwater levels within the basin. The declining groundwater level in the basin is the result of groundwater extraction by other stakeholders such as cities and private well owners. The City of Merced accounts for approximately 5 percent of the extracted groundwater annually with other cities and agricultural use accounting for the remaining 95 percent.

While groundwater has provided the City with a reliable water supply for many years, rapid growth has motivated the City to evaluate its groundwater supply. The City of Merced and the Merced Irrigation District (MID) entered into a Memorandum of Understanding in 1992 to develop a long-range water resources plan. As a result, the Merced Water Supply Plan was prepared in 1995 and updated in 2001. The City and MID are working to implement the updated water supply plan, which includes recommendations to curb overdraft and actions to restore the aquifer.

Further, pursuant to the 1993 Groundwater Management Act (AB 3030), the Merced Area Groundwater Pool Interests (MAGPI) entered into a memorandum of understanding (MOU) with the California Department of Water Resources (DWR) to support water management programs. In 1997, MAGPI published a groundwater management plan update (GWMP update) that describes the Merced subbasin's physical characteristics, water quality conditions, and methods to sustain groundwater. MAGPI recently published an update to the GWMP update in 2008 to incorporate new components and update existing components to address the legislative requirements of SB 1938 and SB 1672.

5.5 Groundwater Quality

The quality of the existing groundwater sources through 2030 is expected to be adequate (City's 2010 UWMP). However, the GWMP identifies several groundwater constituents, which lead to groundwater quality concerns in the area.

Contaminants in the area include groundwater salinity, nitrate, iron, manganese, arsenic, radio-nucleotides, bacteria, petroleum hydrocarbons, pesticides, trichloroethylene and perchloroethylene. The 2010 Merced Water Quality Report indicates that no substances exceed regulation concentration levels (GMP, 2008).

Salinity levels within the Merced subbasin range from 90 to greater than 1,250 milligrams per liter (mg/L), as measured by total dissolved solids (TDS). Groundwater salinity is generally lowest in the easterly portion of the Merced subbasin and in the adjoining Merced Irrigation District (MID). While the City measures a total of 24.6 ppm in the 2010 Water Quality Report, this falls below the 33-ppm maximum range.

A groundwater concern is nitrate levels from manmade sources, which is widespread through the San Joaquin Valley. While nitrate in irrigation water is not a major concern for most crops, high concentrations of nitrate in groundwater are primarily a concern for potable water supplies. The MCL for nitrate in public drinking water supplies is 45 mg/L. In their 2010 Water Quality Report, the City indicates finding nitrate levels of 15.5 ppm in 2008. This is well within a safe range, and should not pose a problem in the near future.

5.6 Water Supply Reliability

The factors affecting water supply reliability include legal, environmental, water quality, water quantity and climate change. The City's 2010 UWMP addressed the reliability of the City's water supplies. This includes supplies that are vulnerable to seasonal or climatic variations. In addition, an analysis was included to address supply availability in a single dry year and in multiple dry years. There are two aspects of supply reliability that can be considered. The first relates to immediate service needs and is primarily a function of the availability and adequacy of the supply facilities. The second aspect is climate-related, and involves the availability of water during mild or severe drought periods. The City's 2010 UWMP considered the City's water supply reliability during normal water year, single dry water and multiple dry water years. It was concluded that since the groundwater supplies are based on the anticipated demands, there is no difference between demand and supply for each planning under years 1, 2, or 3 of the multiple dry year condition.

Climate change may add many new uncertainties to the challenges of planning, and irrespective of the debate associated with the sources and cause of increasing concentrations of greenhouse gasses, changes in weather could significantly affect water supply planning. Since climatic pressures could potentially affect supply reliability, continual attention to this issue will be necessary in the future. To address climate change, the City's Economic Development Advisory Committee unanimously recommended approval of a Climate Action Plan in August 2012. The Climate Action Plan includes goals, strategies, and actions to reduce local community greenhouse gas emissions to 1990 levels by the year 2020. Merced's Climate Action Plan presents a comprehensive list of actions, that when implemented, will help to achieve broadly-supported community values including protecting the City's water and air resources; reducing the waste-stream to the landfill; improving energy-efficiency; enhancing choice in mobility; and creating healthy and livable communities, while at the same time reducing greenhouse gas emissions. Specifically, Goal 3 of the CAP is on Water Conservation and Technology. Strategy topics include:

- Water Conservation and Technology
- Reduce Groundwater Pumping
- Water Efficient Landscapes
- Water Conservation Development Review Policies

Five percent of the Green House Gas (GHG) Emissions targeted for reduction will be accomplished through water management practices. Implementation of Merced's CAP is envisioned to be accomplished with the help and participation of an engaged community.

5.7 Future Water Supply

In the immediate future (next 5 years), the City will continue to rely solely on groundwater. Beyond that, however, the City has indicated a desire to implement conjunctive use combining groundwater with surface water. The City and MID are considering a long-term transfer opportunity whereby the City will phase in surface water for City park irrigation, using imported water from the Merced River. According to the City's 2010 UWMP, the City anticipates utilizing surface water from Merced Irrigation District (MID) to supply up to 153 acre-feet per year (AFY) of demands associated with landscape irrigation. Further, the City is willing to consider the construction of a surface water treatment plant by Lake Yosemite to supplement the groundwater. This conjunctive use is beneficial to the City and will reduce groundwater pumping demands.

The 2001 Merced Water Reuse Strategic Plan identified reuse alternatives for the Wastewater Treatment facility (WWTF) to accommodate future flows based on secondary and tertiary treatment of wastewater. Secondary treatment reuse alternatives included limited agricultural reuse (some crops), discharge to a private wetland or duck club, and continued discharge to the wildlife management area wetland and Hartley Slough. Tertiary treatment reuse alternatives included unlimited agricultural reuse (all crops), urban landscape irrigation (with centralized and satellite treatment), industrial reuse, and discharge to a public access wildlife refuge.

The Stakeholders Advisory Group, consisting of community members representing agriculture, land development, wildlife and environmental, industry, commerce, and wastewater customers, recommended continued discharge of treated effluent to the City's wetland and Hartley Slough and increasing the treatment capacity of the WWTF to 12 mgd. Because the WWTF has had treatment performance and reliability issues since 1995, the selection of this alternative was based on it being the most expeditious to implement as well as the least expensive. Since this alternative provides for essentially 100 percent agricultural reuse and provides an alternative to groundwater pumping, it was also considered of maximum benefit to the environment.

The City recently completed the first of two construction phases (initial secondary and first tertiary expansion) at the WWTF to implement tertiary treatment and increase capacity. This increased the capacity of the WWTF to 12 mgd. In the short term, the treated effluent will continue to be used for agricultural irrigation and discharged to the wildlife management area. With the completion of the tertiary treatment, the effluent will be available for urban landscape irrigation in the future, though there are currently no plans to do so. For the purposes of this report, no recycled water for urban use within the City's service area is assumed for the next 20 years. The future use of recycled water within the City is still being evaluated, and this assumption may change in the future. Other future uses of reclaimed water include water exchange with MID, as well as opportunities to incorporate recycled water use on the UC Merced Community. As UC Merced continues to develop, the UC Merced long-range plan aims to maximize recycled water generated on-campus. Specifically, the potential uses of recycled water include toilet flushing, cooling tower use, or landscape irrigation.

Chapter 6
Water System Design and Operational Criteria

Design and operational criteria are required to evaluate the capabilities of water distribution systems and to guide the planning and design of water system infrastructure. A set of criteria was developed for the City of Merced's water distribution system based on industry standards (such as American Water Works Association [AWWA] Standards and the California Department of Public Health [CDPH] Guidelines) and discussions with City staff. These criteria are summarized in Table 6-1 and include the following components:

- Fire Flow Requirement
- Water Supply Capacity
- Pumping Facility Capacity
- Water Storage and System Peaking Capacity
- Water Transmission and Distribution Pipeline Sizing

6.1 Fire Flow Requirements

Many fire departments in California use the 2010 California Fire Code (CFC) Appendix B *Minimum Required Fire Flow and Flow Duration for Buildings* to assist them in establishing minimum fire flows and durations for individual structures. A typical set of criteria is proposed for the City as presented in Table 6-2.

Table 6-1. Planning & Design Criteria

Component	Criteria	Remarks / Issues
Fire Flow Requirement (flow [gpm] @ duration [hours])		
Single-Family Residential	1,500 gpm @ 2 hours (nonsprinklered)	1,000 gpm @ 2 hours (sprinklered)
Multi-Family Residential	2,500 gpm @ 2 hours (nonsprinklered)	1,500 gpm @ 2 hours (sprinklered)
Commercial	3,000 gpm @ 3 hours (nonsprinklered)	2,500 gpm @ 3 hours (sprinklered) based on review on a case-to-case basis
Industrial / Institutional	4,000 gpm @ 4 hours (nonsprinklered)	3,000 gpm @ 4 hours (sprinklered) based on review on a case-to-case basis
Water Supply Capacity		
Reliable Water Production	Provide capacity equal to peak hour demand	
Pumping Facility Capacity		
Pump Capacity	Provide capacity equal to maximum day plus fireflow or peak hour demand whichever is greater, with largest pump out of service	
Backup Power	To ensure pumping capacity equal to maximum day demand plus fire flow	
Water Storage and System Peaking Capacity		
Operational Flow	30% of Maximum Day Demand	
Fire Flow	4,000 gpm @ 4 hours = 0.96 MG	
Emergency Flow	100% of Average Day Demand	
Total Water Storage and System Peaking Capacity	Operational Flow + Fire Flow + Emergency Flow	Subtract credits for groundwater storage
Water Transmission Pipeline Sizing		
Diameter	12 inches in diameter or larger	
Average Day Demand Conditions		
Minimum Pressure [psi]	40	
Maximum Pressure [psi]	60	
Maximum Velocity [ft/sec]	3	
Maximum Day Demand Conditions		
Minimum Pressure [psi]	40	
Maximum Velocity [ft/sec]	5	
Peak Hour Demand Conditions		
Minimum Pressure [psi]	40	
Maximum Velocity [ft/sec]	7	
Hazen Williams "C" Factor	130	
Pipeline Material	Ductile Iron Pipe	12" or larger are DIP
Water Distribution Pipeline Sizing		
Diameter	Smaller than 12 inches in diameter	
Average Day Demand Conditions		
Minimum Pressure [psi]	40	
Maximum Pressure [psi]	60	
Maximum Velocity [ft/sec]	5	
Maximum Day w/ Fire Flow Demand Conditions		
Minimum Pressure [psi] (at fire node)	20	With largest pump out of service
Maximum Velocity [ft/sec]	10	
Peak Hour Demand Conditions		
Minimum Pressure [psi]	40	With largest pump out of service
Maximum Velocity [ft/sec]	7	
Minimum Pipeline Sizes		
Low Density Residential	8 inches in diameter or larger	
Commercial	12 inches in diameter or larger	
Industrial	12 inches in diameter or larger	
Distribution to cul-de-sac / dead end street	6 inches in diameter or larger	Beyond last fire hydrant
Distribution to fire hydrants	8 inches in diameter or larger	
Hazen Williams "C" Factor	140, 130	
Pipeline Material	PVC, DIP	

Table 6-2. Fire Flow Requirements[a,b]

Land Use	Fire Flow,[c/d] gpm	Duration, hours	Storage Volume, MG
Single Family Residential	1,500/1,000	2	0.18
Multi-Family Residential	2,500/1,500	2	0.30
Commercial	3,000/2500	3	0.54
Industrial	4,000/3,000	4	0.96
Institutional	4,000/3,000	4	0.96

[a] Construction type and fire area are not generally known during the development of a master plan; consequently, fire flow requirements set forth in this table are based on previous estimates for these land use types in similar communities.
[b] Unique projects or projects with alternate building materials may require higher fire flows and should be reviewed by the Fire Marshal on a case-by-case basis (e.g., proposed commercial/industrial areas and schools).
[c] Up to a 75 percent reduction in fire flow may be allowed if a building is sprinklered, but most jurisdictions allow a maximum reduction of 50%. However, the Fire Code requires that no fire flow be less than 1,000 gpm for single family residential or 1,500 gpm for all other building types.
[d] Specific fire flows are determined from Appendix B of the 2010 CFC, and depend on construction type and fire area. These fire flow requirements are based on buildings being fully sprinklered.

For planning purposes, minimum fire flows are assumed to be met concurrently with the Maximum Day Demand of the City, while maintaining a minimum residual system pressure of 20 pounds per square inch (psi) throughout the City. Fire flows and the expected duration have been used to establish treated water storage requirements, as described below. The criteria, as presented above, will be used for the evaluation of the existing and future water systems.

6.2 Water Supply and Pumping Capacity

Sufficient water system pumping capacity, in conjunction with available gravity storage, should be provided to meet the greater of the Maximum Fire Flow concurrent with the Maximum Day Demand or Peak Hour Demand of the City. The greater of the demands should be met assuming that the largest pump in the water system is in standby mode.

6.2.1 Maximum Day Demand Plus Fire Flow

Typical industry standards require that a City's water system have the capability to supply sufficient water to meet the City's Maximum Day Demand plus the Maximum Concurrent Fire Flow. Specific fire flows should be evaluated assuming the largest pump is offline (i.e., firm capacity of the pump station) regardless of whether or not fire flow is provided by gravity storage or booster pump station. This ensures the reliability of these systems to provide sufficient flow during emergency fire flow conditions. Pump stations without backup power capability (either an onsite generator or adaptor for a plug-in generator) should not be considered to be available during fire flow analysis.

6.2.2 Peak Hour Demand

If feasible, Peak Hour Demand should be met from a combination of supply sources and treated water storage reservoirs. This assumes that the City has potable water storage. Since the City of Merced does not have significant storage, it is recommended that it achieves a supply capacity equal to Peak Hour Demand until it constructs water storage facilities.

6.3 Water Storage and System Peaking Capacity

The AWWA standards recommend that the total treated water storage capacity requirements for a water system comprises the following components:

- Operational storage
- Fire storage
- Emergency storage

A discussion of these three components is followed by a discussion of credits for existing groundwater supply and total required water storage.

6.3.1 Operational Storage

Water demands generally vary over any 24-hour period. Higher water demands occur during the early morning hours when people are irrigating landscape and getting ready to go to work or school. Water demands then decline to a nominal baseline level (depending on the proximity to and water use patterns of adjacent commercial/industrial areas) and then begin to increase again depending on outside water needs (and corresponding temperature) until it reaches a higher water demand in the early evening hours as people return home from work or school. Throughout the year, the peaks of this cycle will vary according to customer needs, thereby creating maximum day and Peak Hour Demands.

Typically, water treatment plants, supply turnouts, and/or wells are operated at a constant rate over a 24-hour period (baseline), augmented by flow from storage tanks, supply turnouts and/or wells during higher daily demand periods. Storage tanks are normally refilled when demands drop below the baseline water production flow rate. The storage used to meet peak water demand is called *operational storage*.

The operational storage requirements are calculated based on the diurnal demand in a service area. If sufficient data is not available to develop a diurnal demand, the recommended volume of water to be held in reserve for operational storage should be at least equal to 25 percent of the total volume of water used on a maximum day. Thirty (30) percent of Maximum Day Demand is recommended for the City.

6.3.2 Fire Storage

Fire fighting flow requirements are identified in the 2010 CFC based on flow (in gpm) for the building use type (i.e. commercial, residential, school, industrial, etc.), size of building (in square feet), and type of construction (wood frame, metal, masonry, installation of sprinklers, etc.). After a fire flow requirement is established, it is multiplied by the required fire fighting duration to produce an estimate of the total volume of fire flow required. Table 6-2 presents the recommended fire flow criteria.

The highest recommended fire flow requirement in the City of Merced is 4,000 gpm for a duration of 4 hours for industrial areas. The resulting volume needed for fire flow storage is 0.96 MG.

6.3.3 Emergency Storage

A reserve of stored water is also required to meet demands during an emergency. An emergency is defined as an unforeseen or unplanned event that may degrade the quality or quantity of potable water supplies available to serve customers. There are three types of emergency events that a water utility typically prepares for:

- Minor emergency. A fairly routine, normal, or localized event that affects few customers, such as a pipeline break, malfunctioning valve, hydrant break, or a brief power loss. Utilities plan for minor emergencies and typically have staff and materials available to correct them.

- Major emergency. A disaster that affects an entire or large portion of a water system, lowers the quality and quantity of the water, or places the health and safety of a community at risk. Examples include water treatment plant failures, raw water contamination, major power grid outages, and terrorist threats. Water utilities infrequently experience major emergencies.

- Major disaster. A disaster caused by natural forces or manmade events that create major water utility disruptions. Examples include earthquakes, forest or brush fires, hurricanes, tornados or high winds, floods, and other severe weather conditions such as freezing or drought, and terrorist events.

Determination of the required volume of emergency storage is a policy decision based on the assessment of the risk of failures and the desired degree of system reliability. The amount of required emergency storage is a function of several factors including the diversity of the supply sources, redundancy and reliability of the production facilities, and the anticipated length of the emergency outage. In developing an emergency storage requirement for the City of Merced, typical industry standards were used and the recommended criteria and assumptions are described in the following paragraphs.

The treated water emergency supply requirements, as published by CDPH in Title 22 Chapter 16, call for a minimum emergency supply in each pressure zone equivalent to the Average Day Demand. AWWA states that no formula exists for determining the amount of emergency storage required and that the decision will be made by the utility based on a judgment about the perceived vulnerability of the system.

For this Water Master Plan, it has been assumed that the emergency storage requirement will be based on minor emergencies and *specific* major emergency criteria as described in Section 6.3.4. It is recommended that the City use CDPH's suggested guideline of having a minimum quantity of emergency storage volume equivalent to the City's Average Day Demand.

6.3.4 Credits for Groundwater

Groundwater storage can account for a portion of the recommended water storage and system peaking capacity. The following must be true to use the groundwater supply to offset the need to provide treated water storage:

- The groundwater supply is of potable water quality and can be reliably accessed (wells are equipped with onsite emergency generators).

- The water extracted is not already being relied upon to meet the City's Average Day Demand requirements.

- Sufficient water transmission facilities are available to distribute this water to demand areas.

Based on data provided by the City, the current well capacity within the City of Merced's service area is approximately 87 mgd of groundwater. Every well in the City's water system is equipped with a standby emergency power generator. Therefore, assuming that 80 percent of the City's groundwater pumping capacity is available for one day, the City can assume a groundwater storage credit of up to approximately 69 MG (80 percent of 87 MG for one day) minus the City's Average Day Demand. This assumption (80 percent) accounts for wells lost for reasons other than power loss (e.g., well maintenance or water quality). The available portion of the groundwater for storage credits is therefore 46 MG (69-23) for Average Day Demand.

6.3.5 Total Storage Capacity

The City's minimum treated water storage capacity should be determined as follows:

- Operational: Volume of water necessary to meet diurnal peaks observed throughout the day, equivalent to at least 30 percent of the Maximum Day Demand, plus
- Fire Flow: Volume of water necessary to provide the maximum fire flow in the service area multiplied by the duration of the flow rate that must be maintained, plus
- Emergency: Volume of water necessary to provide an Average Day Demand, minus
- Groundwater Credit: Equal to 80 percent of the groundwater well capacity for one day minus Average Day Demand.

The total amount of system storage and peaking capacity required to meet these criteria will change over time as the City continues to grow and water demand increases. The recommended criteria was used in determining the adequacy of existing water storage in Section 8.3 and in estimating water storage in Section 9.3.

6.4 Water Transmission and Distribution Pipeline Sizing

The following criteria are to be used as guidelines for new transmission and distribution pipeline sizing. The City's existing system will be evaluated on a case-by-case basis. For example, if an existing pipeline experiences head loss in excess of the criteria described below during a Maximum Day Plus Fire Flow event, this condition, by itself, does not necessarily indicate a problem as long as the minimum pressure criterion is satisfied. Although these criteria and guidelines have been established and will be used to size new pipelines, the City's existing system will be evaluated using pressure as the primary criterion. Secondary criteria, such as velocity, headloss, age, and material type, may be used as indicators for where water system improvements may be needed.

6.4.1 Water Transmission Pipeline Sizing

The transmission pipelines in the City's water system are defined as 12 inches in diameter or larger and are designed based on the criteria described below for Average Day, Maximum Day, and Peak Hour Demand conditions.

- Average Day Demand
  - Service pressures are to be maintained at a minimum of 40 psi. This design criteria balances system performance with economy.
  - Maximum allowable velocity is 3 feet per second (fps).
- Maximum Day Demand
  - Maximum Day Demand is defined as 190 percent of the Average Day Demand based on the City's historical water use.
  - The minimum allowable water pressure in a transmission main is 40 psi.
  - The maximum allowable velocity within a transmission main is 5 fps.

- Peak Hour Demand
  - Peak Hour Demand is defined as 280 percent of the Average Day Demand based on AECOM's experience with similar cities in the Central San Joaquin Valley since this could not be reliably estimated using the City's historical water use data.
  - The minimum allowable pressure during a Peak Hour Demand is 40 psi.
  - The maximum allowable pipeline velocity is 7 fps.

6.4.2 Water Distribution Pipeline Sizing

Distribution pipelines are smaller than 12 inches in diameter and are sized based on the criteria described below for Average Day, Maximum Day Plus Fire Flow, and Peak Hour Demand conditions.

- Average Day Demand
  - Service pressures are to be maintained at a minimum of 40 psi. This limit represents design criteria that will protect the integrity of the system and improve system reliability.
  - Maximum allowable velocity within distribution system pipelines is 5 fps.
- Maximum Day Plus Fire Flow
  - Fire flows are assumed to be concurrent with Maximum Day Demand.
  - Fire flow at residential fire hydrants is a minimum of 1,000 gallons per minute (gpm) with a minimum pressure of 20 psi at the flowing fire hydrant (for sprinklered houses).
  - Fire flow at commercial fire hydrants is a minimum of 2,500 gallons per minute (gpm) with a minimum pressure of 20 psi at the flowing fire hydrant (sprinklered buildings).
  - The maximum allowable velocity within the distribution system pipelines is 10 fps.
- Peak Hour Demand
  - Service pressures are to be maintained at a minimum of 40 psi during Peak Hour Demand periods to ensure system reliability.
  - The maximum allowable pipeline velocity is 7 fps.

Chapter 7
Hydraulic Model Update

The City's water system model which was last updated in 2007 was updated again as part of this 2013 Master Plan to represent existing infrastructure conditions as of December 2012. This chapter describes the update process including an overview of the hydraulic modeling software, the modeling assumptions, and the element naming conventions used in the update of the City's hydraulic model.

7.1 Modeling Software

The City's water system model was updated in 2002 using EPANET software developed by the United States Environmental Protection Agency. In 2007, the City purchased WaterGEMS (a more sophisticated water distribution system software developed by Bentley Systems Inc.). AECOM converted the 2002 water system to the new software and updated it to reflect 2007 conditions. This current model update is being conducted using the latest version of WaterGEMS v8i, Select 4. This software transforms information about the physical water system into a mathematical model that solves for various flow conditions. For each set of specified demands, the model generates information on pressure, flow, velocity, and headloss that can be used to analyze the water system performance and identify deficiencies. The model can also be used to verify the adequacy of recommended water system improvements.

7.2 Modeling Assumptions

Modeling assumptions are important for developing a model and interpreting the results of model simulations. The following assumptions were used in developing the City's water system model:

- Headlosses through pipelines were calculated using the Hazen-Williams equation.
- Ground surface elevations were estimated using USGS elevation contour maps.
- Minor losses from pipe bends and fittings were assumed negligible.
- Pipe length accuracy was assumed to be ±25 feet.
- The water demands in the model were expressed in gallons per minute (gpm).

7.3 Hydraulic Model Element Naming Scheme

Models are set up with specific element names representing key hydraulic facilities because this allows the modeler to easily locate specific elements while modeling. As each facility (pipes, nodes, pumps, tanks, and valves) is created, it must be named logically and sequentially. Table 7-1 summarizes the hydraulic element functions.

Table 7-1. Hydraulic Network Elements

Type	Description	Prefix
Junction	Removes (demand) or adds (inflow) water from/to the system	J
Node	Represents transition in pipeline characteristic or point where pressure or water quality is monitored	N
Tank	Represents storage capacity	T
Reservoir	Represents an infinite external source	R
Pump	Raises the hydraulic grade to overcome elevation differences and friction losses	PMP
Control Valves	Controls flow or pressure in the system based on specified criteria	PRV/FCV
Pipelines	Conveys water from one node to another	P

Table 7-2 shows the hydraulic naming scheme used in the hydraulic model update. It is primarily based on the hydraulic element prefix.

7.4 Water System Facilities Update in Model

The model of the City's water system was checked and updated using the City's as-built subdivision maps and discussions with City staff. Updating the model to reflect the present conditions required the addition of facilities such as pipelines and wells that have been constructed since the last model update in 2007. The new facilities added to the model are shown in Figure 7-1, and the model update process is described as follows.

7.4.1 Pipelines

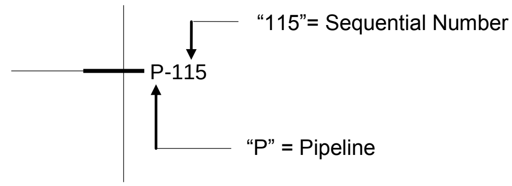
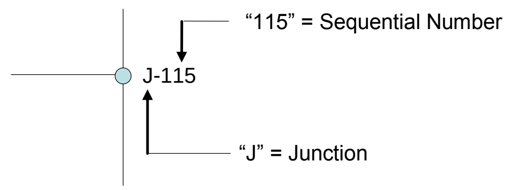
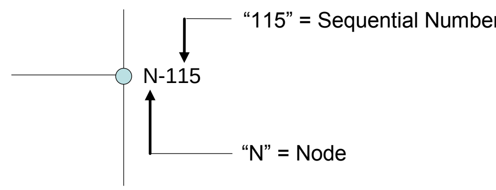
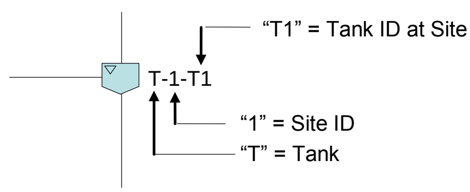
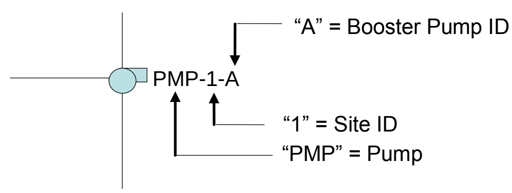
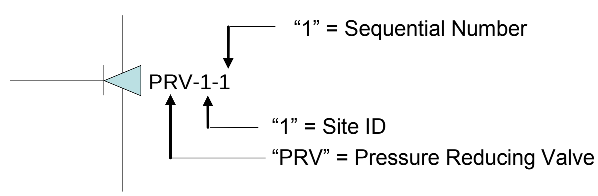
Modification to pipelines in the hydraulic model included the addition of newly constructed pipelines and the realignment of some pipelines already in the model. The input data for the pipelines consisted of length, diameter, material, and pipe C-factor. Pipe C-factors were determined based on AECOM's experience on pipeline age and material. The remaining input data was determined from as-built drawings and Geographical Information System (GIS) shapefiles provided by the City.

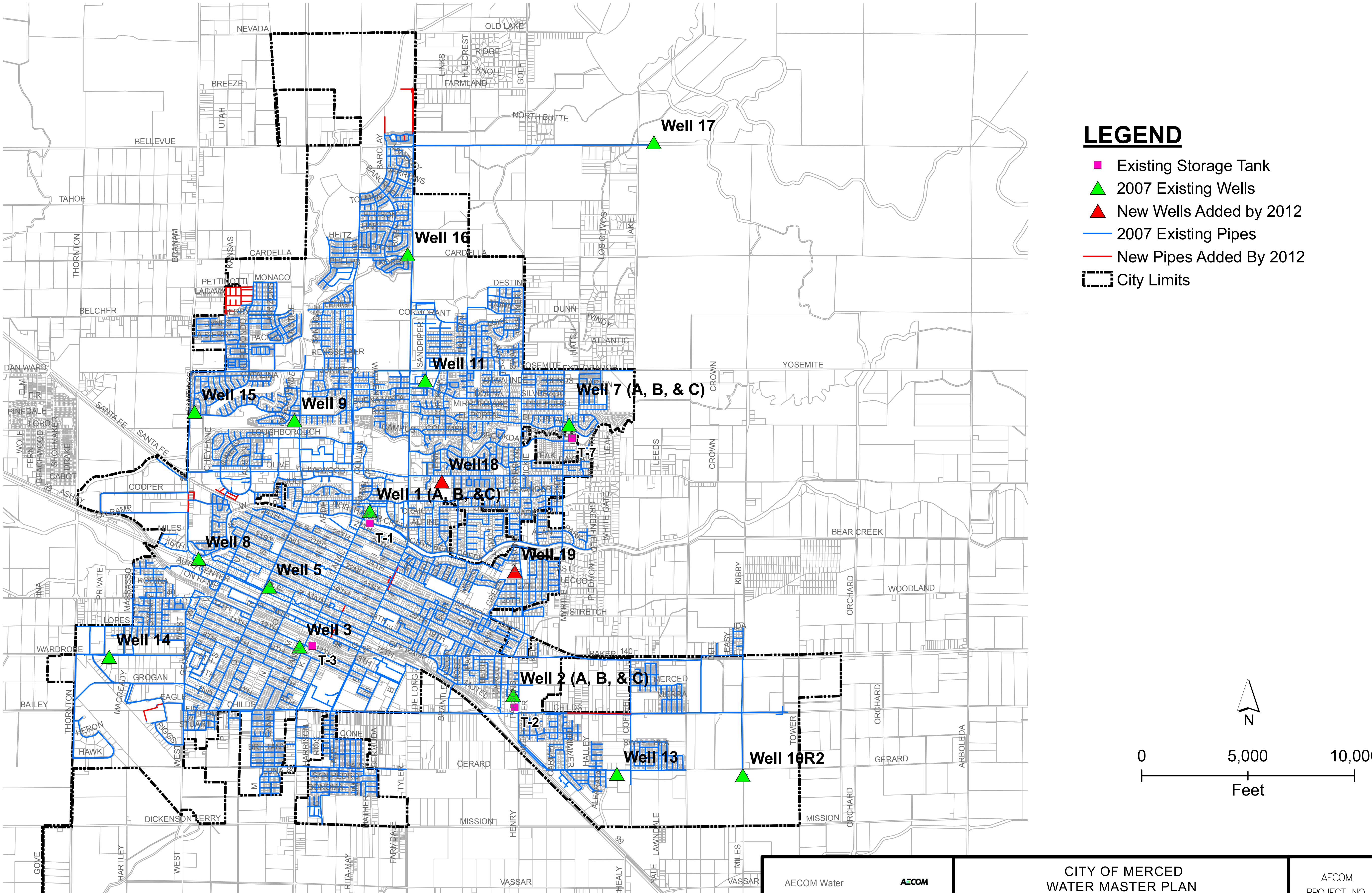
7.4.2 Junctions

The junctions in the model were assigned elevations based on topographical data from USGS maps. The contour lines from the maps were scaled and traced using AutoCAD. The AutoCAD drawing was then converted into a topographic shapefile. Elevations were then extracted and assigned to each junction in the model.

Demands were assigned to junctions in the model using the land use method. The demands were allocated based on direct spatial intersection between land use and Thiessen polygons. Junction demands were then converted from Average Day to Maximum Day and Peak Hour conditions by multiplying each junction demand by the appropriate global peaking factor.

Table 7-2. Naming Scheme for Hydraulic Network Elements

Model Element	Naming Scheme
Pipelines	
Junctions	
Nodes	
Tanks	
Booster Pumps	
Control Valves	



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EXISTING WATER SYSTEM WITH
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60297029

FIGURE
7-1

V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2012 Figures

7.4.3 Wells and Tanks

Wells were represented in the model using constant head reservoirs with pumped water elevations. Well pump curves were determined using pump test results provided by the City. The elevated tanks were modeled as varying-head tanks with the appropriate tank dimensions. The new Wells 18 and 19 were added to the model.

7.5 Water Demand Allocation in Model

The steps used to allocate the base (existing average day) demands in the hydraulic model include:

- Assign large water user demands based on actual meter records to specific nodal locations in the model.
- Allocate estimated demands (excluding large users identified in step 1) based on land use and water duty factors.

7.5.1 Large Water User Demand Assignment Based on Metered Data

There are approximately 20 large industrial/commercial/institutional water users in the City as shown in Table 7-3. Together they consumed approximately 5 percent of the City's 2012 demand. Their metered water use was received from the City and assigned manually to their respective locations in the model.

7.5.2 Remaining Demand Allocation

The remaining water demand in the model was allocated based on land use type and the associated unit demand factors. After the large water user demands were assigned, the remaining demand was allocated using the demand allocator in the modeling software.

The water demands were allocated based on direct spatial intersection between land use and Thiessen polygons that represent the demand node area coverage in the model. Nodal demands were then converted from Average Day to Maximum Day and Peak Hour conditions by multiplying each demand by the appropriate peaking factor.

7.6 Hydraulic Model Verification

Model verification is the process of comparing model results to field observations and, if necessary, adjusting the model parameters until model-predicted performance reasonably agrees with measured system performance over a wide range of operating conditions. The City's hydraulic model was verified to confirm that it can represent the operation of the water distribution system under varying conditions in 2007. No additional verification was necessary for this model update because of the very few system changes that took place from 2007 to 2012.

Table 7-3. Large Water Users

No.	Customer	Address	Average Day Demand, gpm 2007	2008	2009	2010	2011	2012
1	UC Merced	5200 Lake Road	96.5	113.5	144.2	122.0	112.8	138.6
2	Castle Apartments	3044 G St	-	10.0	-	9.9	8.3	128.2
3	Merced College	3600 M St	-	-	-	104.0	97.3	113.9
4	Glencort Grocery	2761 Cooper Ave	81.1	78.2	76.0	74.9	79.5	90.5
5	Quebecor World	2201 Cooper Ave	78.4	64.6	80.5	59.9	53.0	54.2
6	Merced High School-North Campus	205 w Olive Ave	-	32.6	-	52.4	42.0	50.5
7	The Villages	3300 M St	-	45.1	-	41.8	37.9	39.0
8	Merced Meadows Apartments	3125 Meadows Ave	-	42.5	-	32.7	37.8	32.0
9	Merced Estates	2551 E Gerard Ave	-	29.9	-	24.4	23.6	31.4
10	Sunnyside Apartments	988 D St	28.5	29.4	17.7	22.8	29.0	30.9
11	Zachman/Lazares	760 Olivewood Dr	31.1	29.5	19.7	28.7	21.5	22.2
12	Sierra Portal Mobile Home	2240 Yosemite Pkwy	22.1	22.2	22.1	18.8	15.7	19.9
13	Laurel Glenn	777 Loughborough Dr	21.0	22.2	20.2	16.4	17.8	19.0
14	Village Landing	3601 San Jose Ave	29.4	49.0	23.7	23.6	20.1	17.4
15	The Grove Apartments	324 S. Parsons Ave	32.9	15.0	15.0	15.3	15.6	15.0
16	Summertrace Apts	1201 Devonwood Dr	17.8	15.8	13.6	6.1	15.0	14.8
17	Hampshire Retirement Home	3460 R St	16.2	16.8	15.5	15.4	14.9	14.8
18	DPW Admin	2115 Wardrobe Ave	15.9	14.7	16.4	9.6	12.5	13.9
19	Wal-Mart Stores #2039	3055 Loughborough Dr	38.8	35.7	24.0	10.6	11.9	8.8
20	Villa Del Sol Condominiums	3350 M St	19.0	17.2	32.7	1.6	1.8	1.9
	Total		528.9	684.0	521.2	690.8	667.9	856.8

Chapter 8
Existing Water System Evaluation

The City of Merced's existing water system was evaluated based on the City's design and operational criteria in Chapter 6. The adequacy of the City's pumping and potable water storage capacities were evaluated against the City's criteria. The City's hydraulic model was used to analyze the existing water distribution system in terms of capability to supply the required demands at adequate pressures. The following sections describe the existing water system evaluation and the improvements recommended to address water system deficiencies.

8.1 Existing Potable Water Demand

The City's existing potable water demands as of December 2012 are summarized in Table 8-1. These demands represent the total water use of the customers in the City's existing water service area. The methodology for the estimation of these demands was presented in Chapter 4. The evaluations in this chapter are based on the City's water system being able to meet these demands throughout the year.

Table 8-1. Existing Water Demand[a]

Demand Scenario	Demand	
	mgd	gpm
Average Day	23.4	16,057
Maximum Day	44.5	30,508
Peak Hour	--	44,960

[a]Demands based on Chapter 4, Table 4-5 (2012 Conditions).

8.2 Existing Water Supply and Pumping Capacity Evaluation

The water supply and pumping capacity criteria for the City require the existing water system to have sufficient firm pumping capacity to meet Maximum Day Demand Plus Fire Flow or Peak Hour Demand, whichever is greater. Firm pumping capacity should account for pumps that are out of service at any given time due to mechanical breakdowns, maintenance, water quality, or other operational issues. For this analysis, it was assumed that the largest well pump will be out of service to calculate firm pumping capacity. The results of the pumping capacity evaluation are summarized in Table 8-2.

As shown in Table 8-2, the City's existing pumping capacity exceeds the pumping capacity criteria for the existing service area. It should be noted that wells at Pump Stations 1, 2, 3, and 7 that feed the water distribution system through onsite elevated tanks were counted among the reliable pumping capacity because they can be reconfigured to bypass the elevated tanks to pump directly into the water distribution system.

Table 8-2. Existing Water Supply and Pumping Capacity

Well No.	Address	Existing Pumping Capacity, gpm	Existing Maximum Day Demand Plus Fire Flow, gpm[a]	Existing Peak Hour Demand, gpm
1A		2,200		
1B		2,200		
1C		2,200		
2A		2,200		
2B		2,200		
2C		2,500		
3C		3,000		
5B		3,000		
7A		2,500		
7B		2,500		
7C		2,800		
8		2,000		
9		1,800		
10R2		3,000		
11		3,000		
13		3,000		
14		4,000		
15		3,500		
16		3,500		
17		2,500		
18		3,000		
19		2,500		
Total Capacity		**59,100**		
Total Firm Capacity[b]		**55,100**	**34,508**	**44,960**

[a]Based on a Maximum Day Demand of 30,508 gpm and a fire flow of 4,000 gpm.

[b]Defined as the total capacity of the individual wells with the largest well pump out of service. For this case Well 14 is the largest well and so was not considered in calculating firm pumping capacity.

8.3 Existing Water Storage Capacity Evaluation

To comply with the design and operational criteria, three storage components should be met by the existing water system:

- Operational Storage: 30 percent of Maximum Day Demand,
- Emergency Storage: 100 percent of Average Day Demand, and
- Fire flow Storage: The required maximum fire flow times the fire flow duration period.

As presented in Table 8-3, the existing storage capacity in the City is approximately 46 MG. This is entirely ground storage in wells. This storage volume assumes that all wells have standby power and accounts for 80 percent of the wells operating minus Average Day Demand as described in Section 6.5. The existing storage in wells is adequate to meet the existing operational, emergency and fire flow storage as shown in Table 8-3.

Table 8-3. Comparison of Existing Available and Required Storage Capacity

Available Storage Capacity, MG	Required Storage Capacity, MG				Excess Capacity, MG[c]
	Operational	Fire Flow	Emergency	Total	
44.96[a]	13.35	0.96[b]	23.40	37.71	7.25

[a]Available storage from groundwater wells. Based on the production of 80% of City wells minus Average Day Demand. 20% of City wells assumed out of service.
[b]Based on required institutional fire flow of 4,000 gpm flowing for four hours.
[c]Calculated as required storage minus available storage.

8.4 Existing Water Distribution System Evaluation

The City's existing water distribution system was evaluated using the hydraulic model developed. The evaluation focused on the ability of the existing water distribution system to supply existing customer demands at adequate pressures and within allowable pipeline velocities as specified in the planning criteria in Chapter 6.

Steady-state hydraulic conditions of the water system for Average Day, Maximum Day, Maximum Day plus Fire Flow, and Peak Hour Demand were simulated. Areas within the existing water service area that did not meet the pressure and velocity criteria were identified. Additional model simulations were conducted to evaluate potential water system improvements to correct existing deficiencies. The results of the model simulations are discussed as follows.

8.4.1 Average Day Demand Analysis

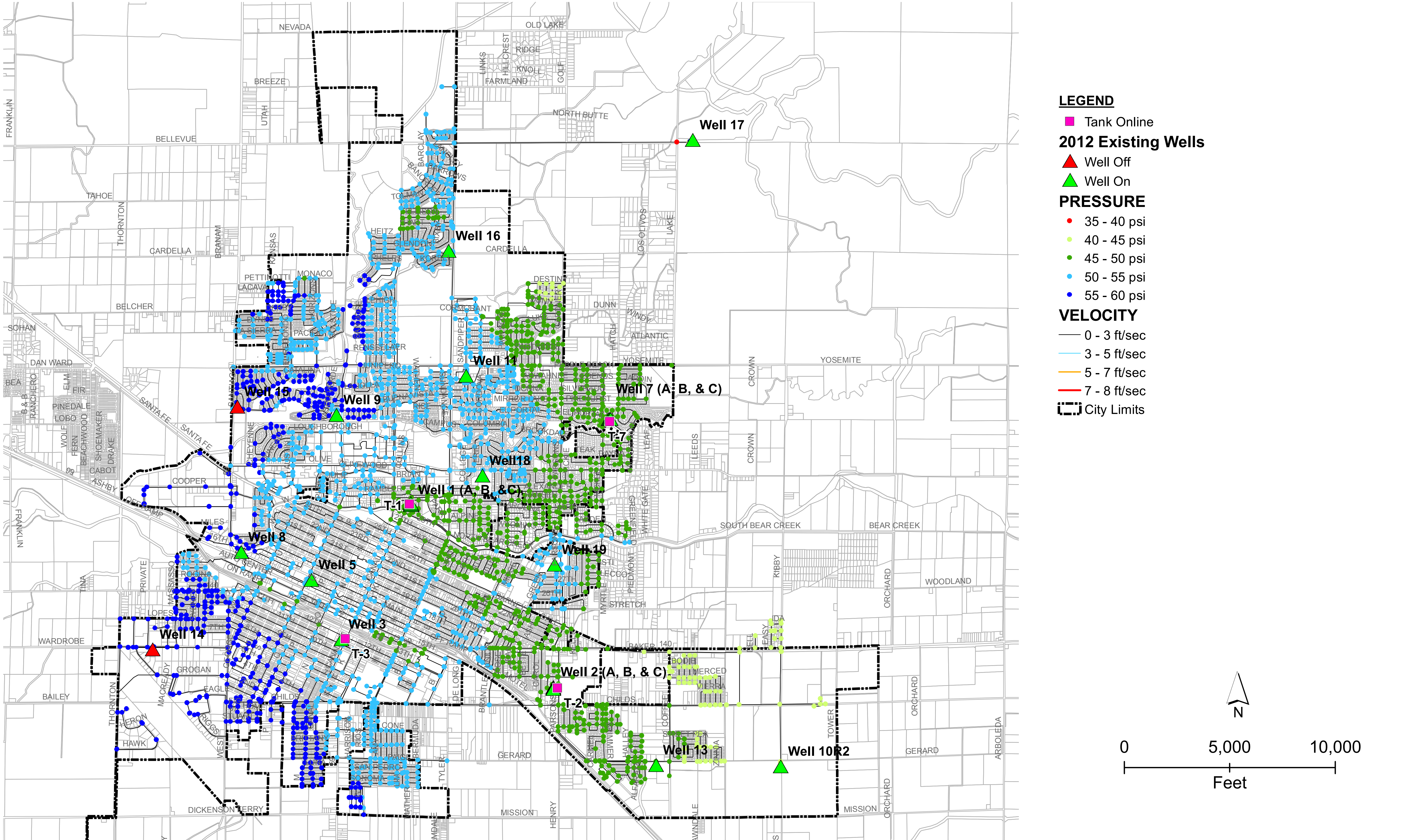
The City's 2012 Average Day Demand allocated in the model was used for this simulation. It was assumed that the existing Average Day Demand would be met from some of the existing wells.

As shown in Figure 8-1, the service area has pressures above the required minimum pressure of 40 psi. Pipeline velocities are below the 5-fps maximum velocity criterion for all areas.

8.4.2 Maximum Day Demand Analysis

The City's 2012 Maximum Day Demand was simulated in the model by applying the peaking factor of 1.9 (estimated in Section 4.2) to the allocated Average Day Demand. It was assumed that the existing Maximum Day Demand would be met from the existing elevated tanks and City wells.

As shown in Figure 8-2, the southeastern portion of the existing water distribution system has pressures at approximately 40 psi, close to the minimum pressure criterion of 40 psi. All pipeline velocities were below the 5-fps maximum criterion. Even though the southeastern portion falling slightly below 40 psi is close to Well 10R2, the VFD of this well is operated at a lower pressure because of Tank 2. A higher pressure would increase water system pressures, thus preventing water in Tank 2 from flowing via gravity into the distribution system.



V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2012 Figures

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FIGURE

8-1

8.4.4 Maximum Day Demand plus Fire Flow Analysis

The 2012 Maximum Day Demand was simulated concurrently with fire flows within the existing water service area. Fire flows were simulated at all fire hydrants within the distribution system. A fire flow of 1,500 gpm was simulated for residential land uses. Simulations of 2,500 gpm and 3,000 gpm, respectively, were used for commercial and industrial land uses. It is assumed that commercial and industrial facilities would be sprinklered.

Figure 8-3 shows the locations of the hydrants that could not supply their required fire flows while maintaining a residual pressure of 20 psi as specified in Chapter 6. Figures 8-4 through 8-6 show the simulated available fire flows. For many of the locations, the required fire flows could be satisfied by using two hydrants. Pipeline improvements to improve fire flows, where feasible, are recommended later in this chapter.

8.4.5 Peak Hour Demand Analysis

The 2012 Peak Hour Demand was simulated by applying a demand peaking factor of 2.8 to the existing Average Day Demands allocated in the model. This Peak Hour Demand is expected to be met from all existing water supply sources including the elevated storage tanks.

As shown in Figure 8-7, the Peak Hour Demand pressure distribution shows that only one portion of the distribution system to the east is slightly below the 40-psi minimum pressure criterion. Pipelines are adequately sized with pipeline velocities well below the maximum 7 fps as required by the City’s design and performance criterion.

8.5 Existing Water System Recommendations

The existing system analysis indicated that even though the City’s water system currently has adequate pumping and potable water storage capacities, there is a need to improve portions of the water distribution system to improve fire flows. The water distribution system piping needs to be improved to handle fire flows in the southeast portions of the City (Figure 8-6). The water system pressures also need to be increased in some eastern portions of the City (Figure 8-7). Any more pressure increase at this time would require operational changes. The City would have to bypass the four elevated tanks so that the wells at the tank sites can pump directly into the distribution system.

Figure 8-8 shows the facility improvements recommended for improving fire flows in the existing water system for water system reliability. They include:

- Installing a 200 feet of 8-inch-diameter pipeline along Jean Street, from Yosemite Park Way (Area 4).
- Replacing the 4-inch pipeline along Jean Street with 600 feet of 8-inch-diameter pipeline (Area 4).
- Extending the 16-inch-diameter pipeline from Monte Grosso Avenue to connect to the existing 12-inch pipeline at McKee Road (Area 5).
- Extending the 6-inch-diameter pipelines along Nellie Street and Celeste Avenue as shown in Area 6. This is in the Celeste Water District.
- The 16-inch pipeline additions as a result of the planned Well 20 construction are not included in these figures but are reflected in the capital costs.

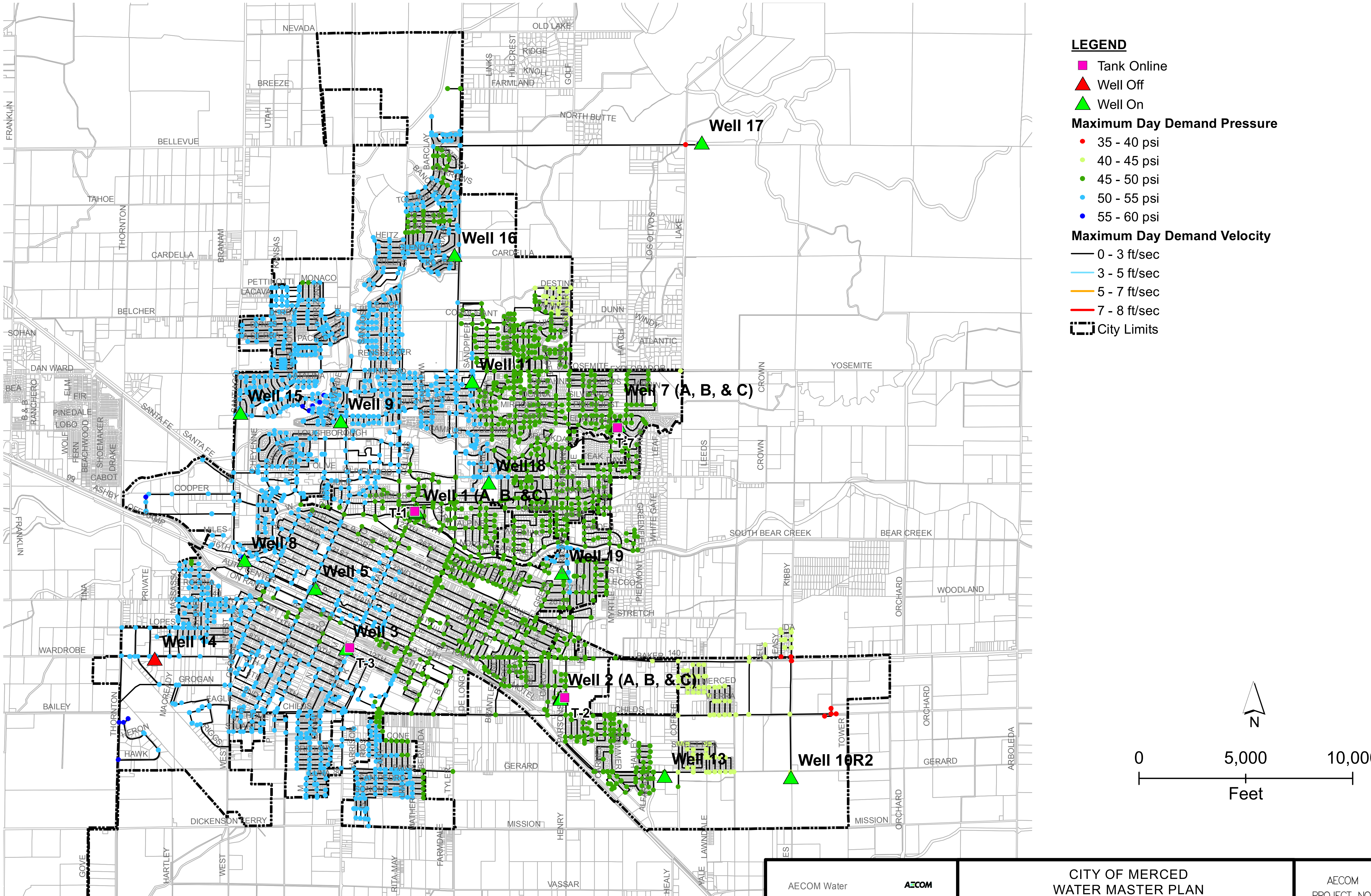

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FIGURE
8-2

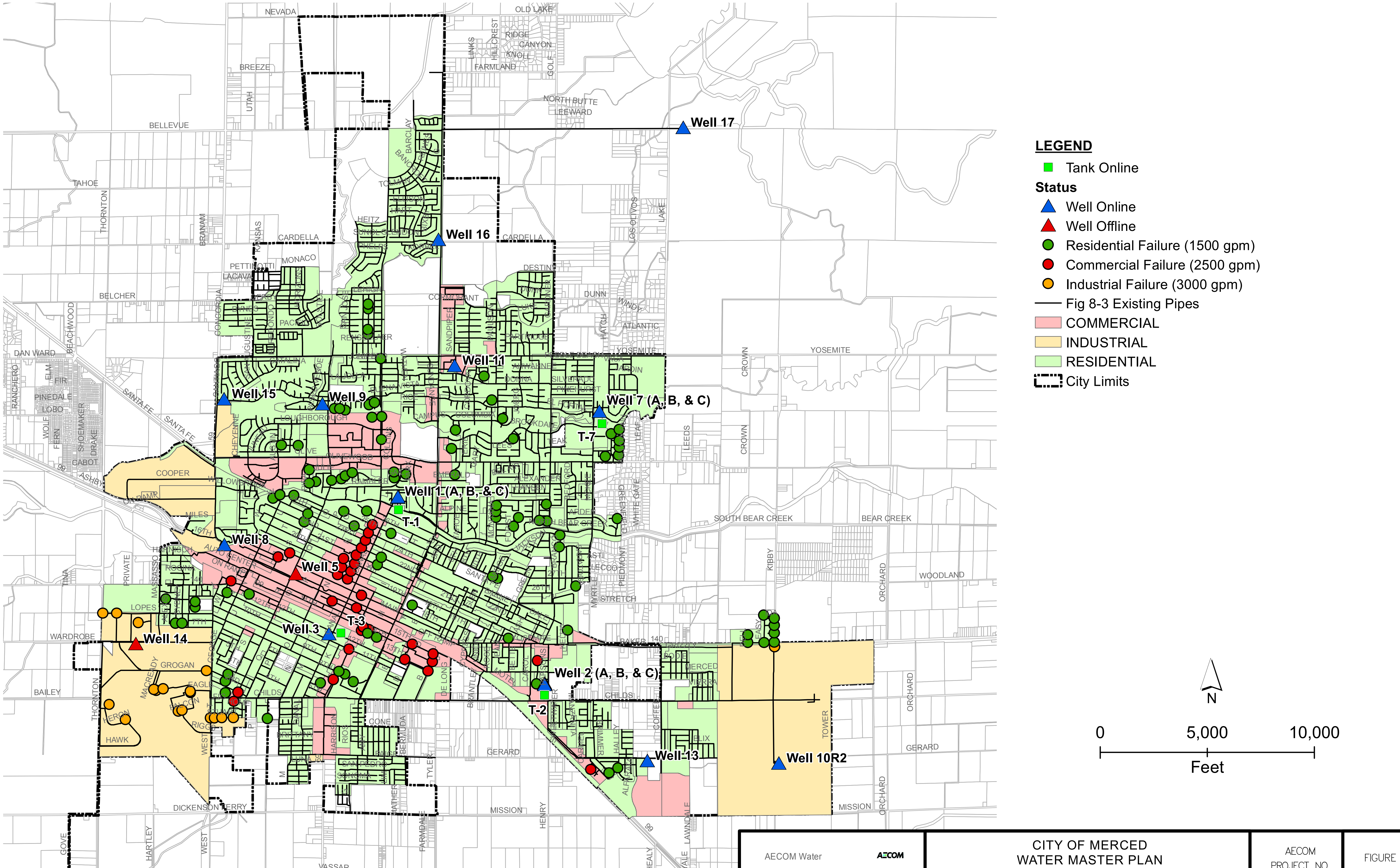

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FIGURE
8-3

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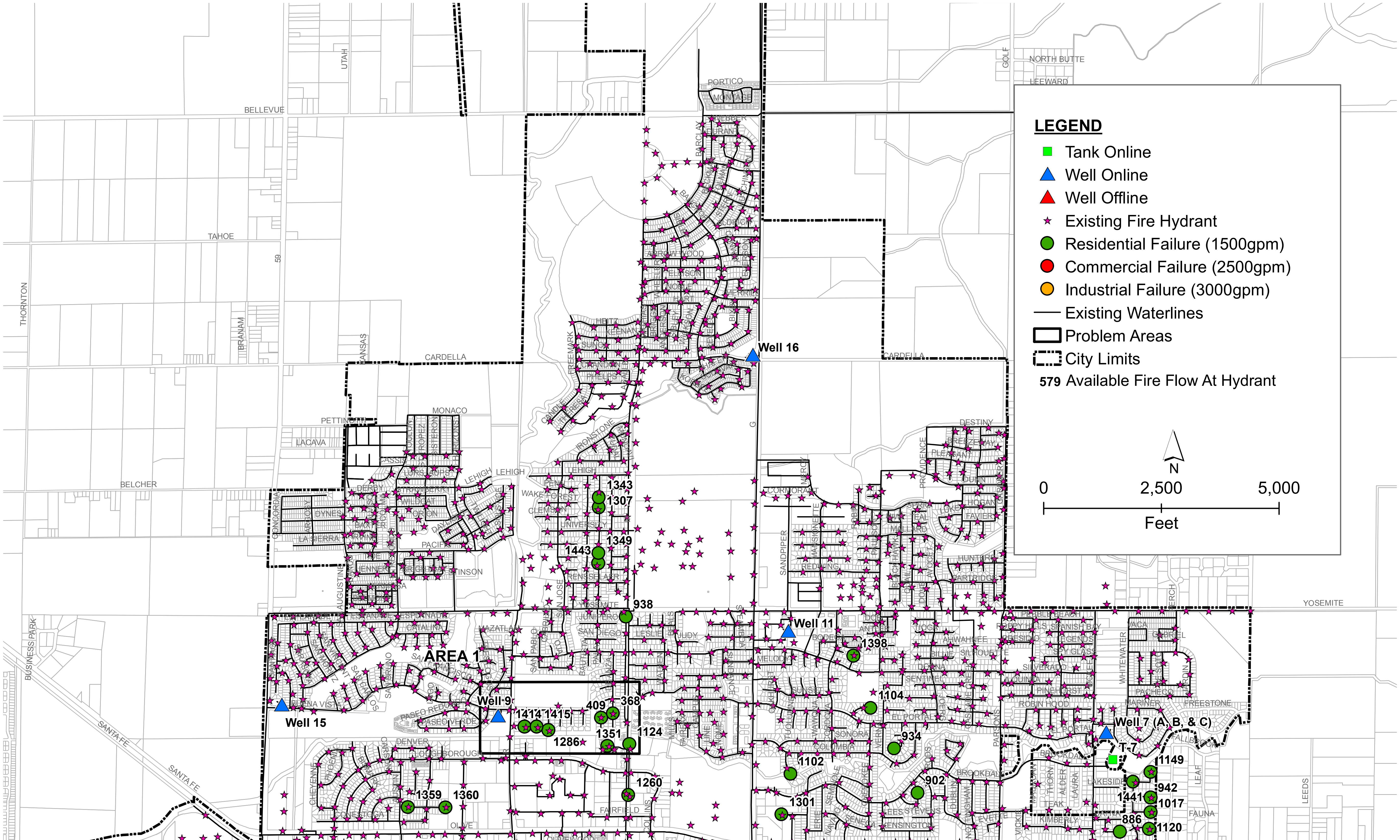

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NORTH - AVAILABLE FIRE FLOWS

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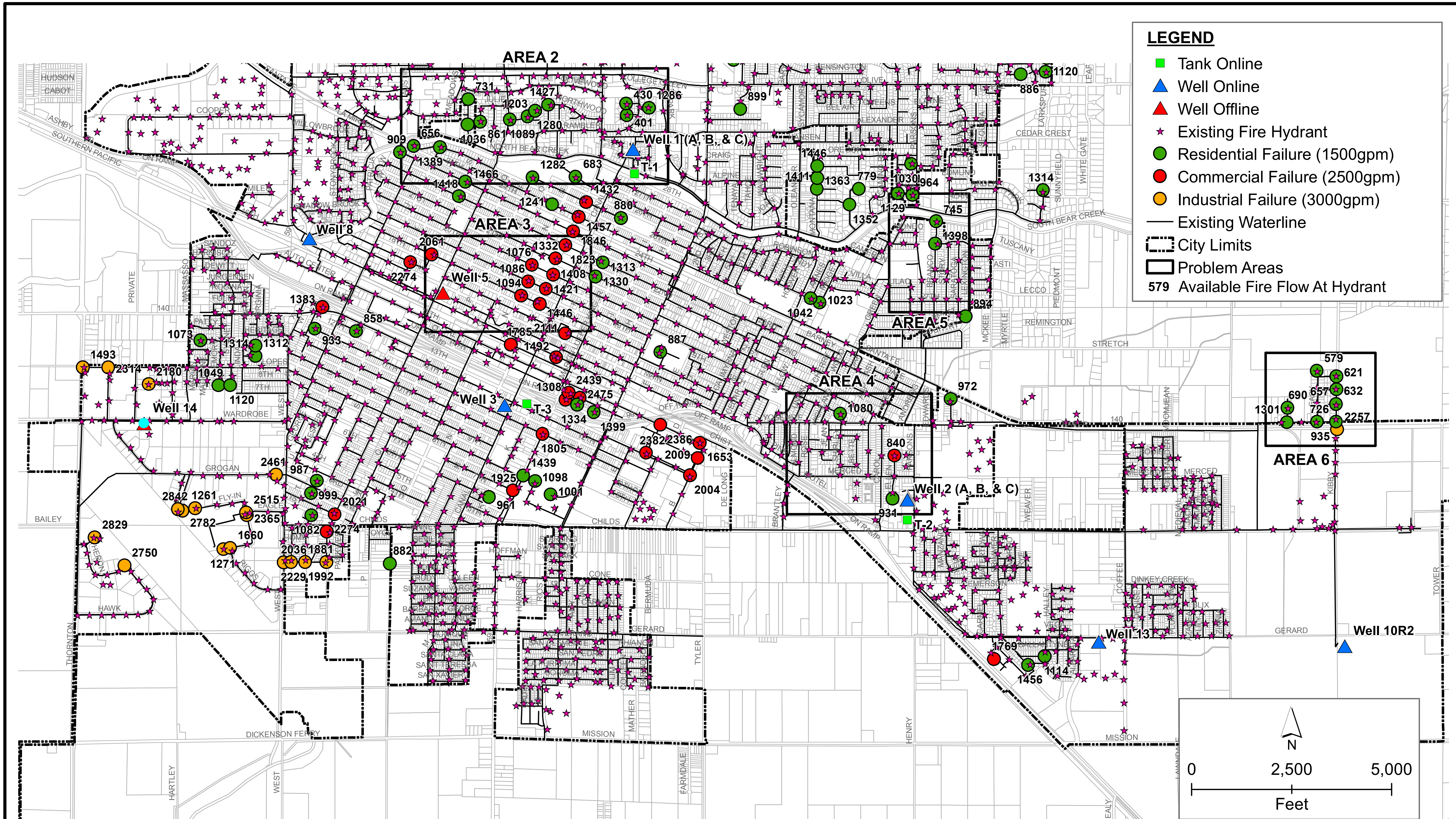
FIGURE

8-4

V:\Merced_City\MODELS\GIS\FIGURES\2012 WMP Figures\2012 Figures



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SOUTH - AVAILABLE FIRE FLOWS

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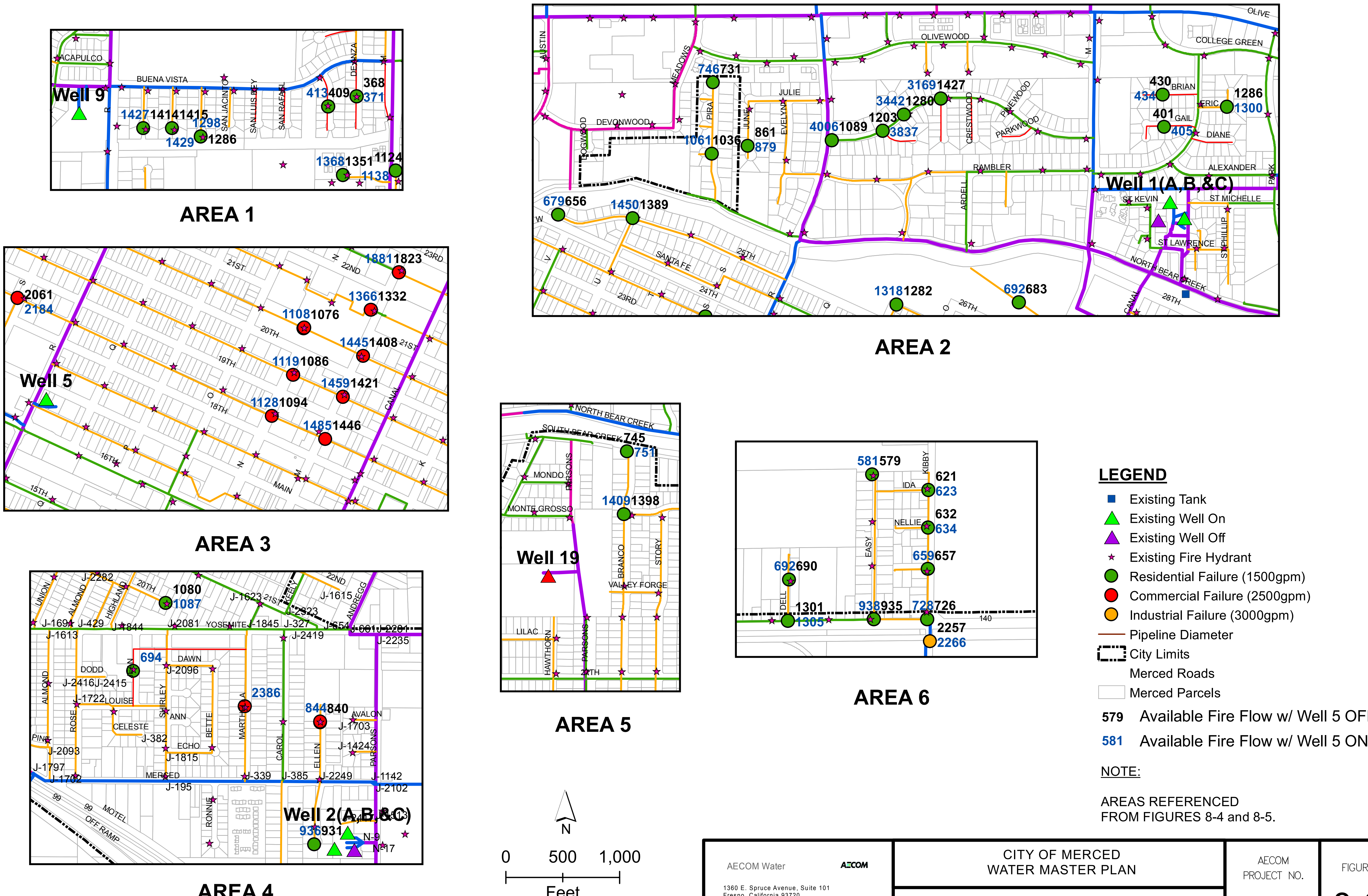
FIGURE
8-5



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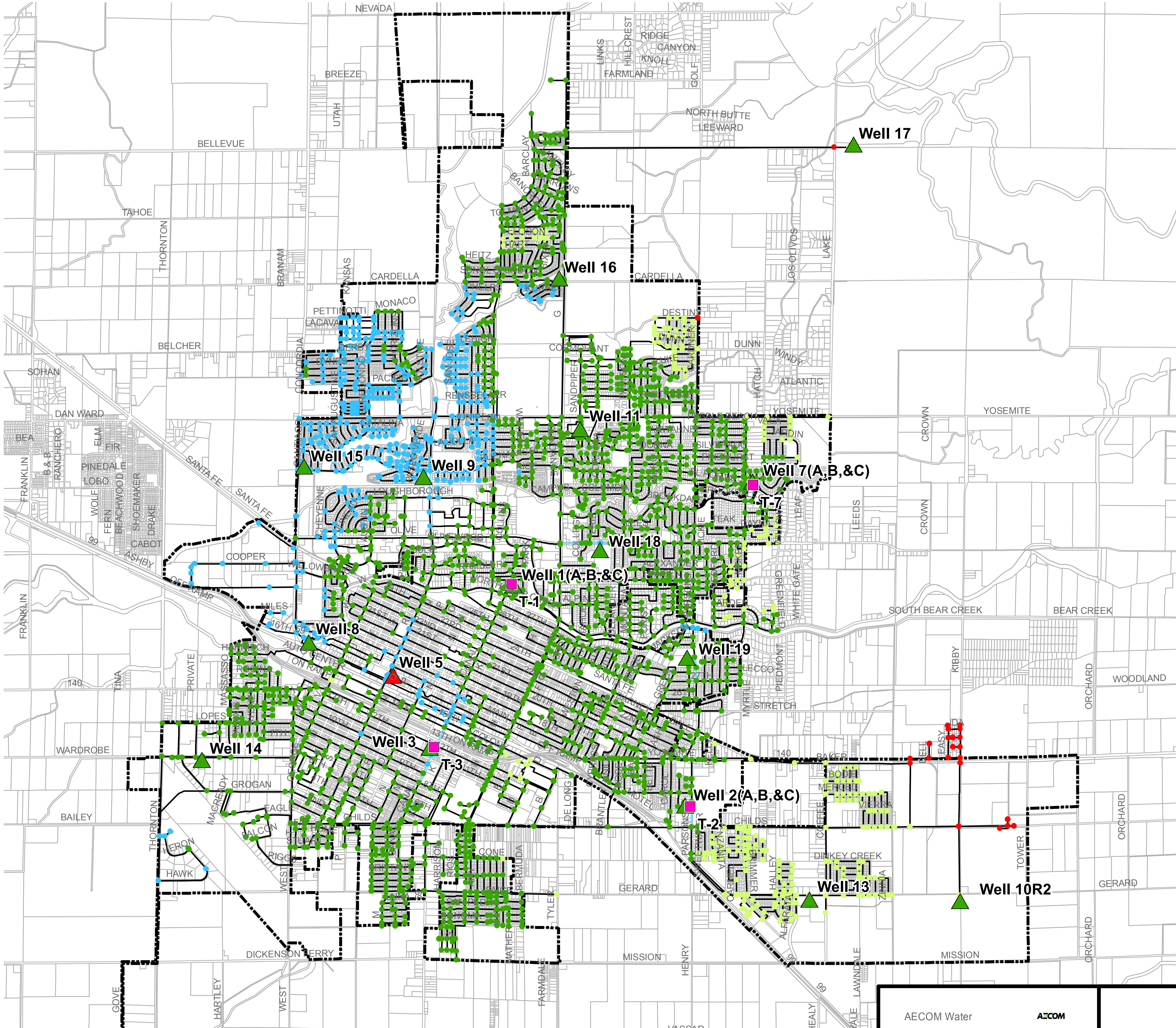

LEGEND

- Existing Tank
- Well On
- Well Off

Peak Hour Demand Pressure

- 35 - 40 psi
- 40 - 45 psi
- 45 - 50 psi
- 50 - 55 psi
- 55 - 60 psi

Peak Hour Demand Velocity

- 0 - 3 ft/sec
- 3 - 5 ft/sec
- 5 - 7 ft/sec
- 7 - 8 ft/sec
- City Limits

N

0 5,000 10,000
Feet

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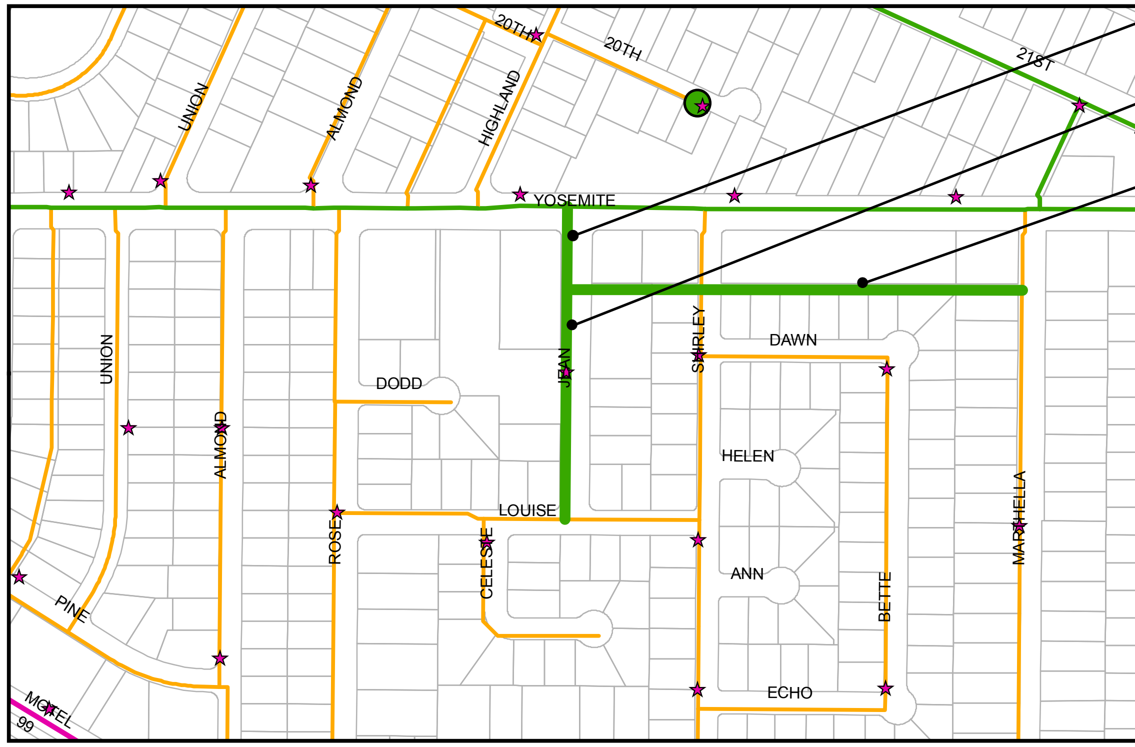
FIGURE
8-7

Install 200 LF of 8-inch diameter pipe.

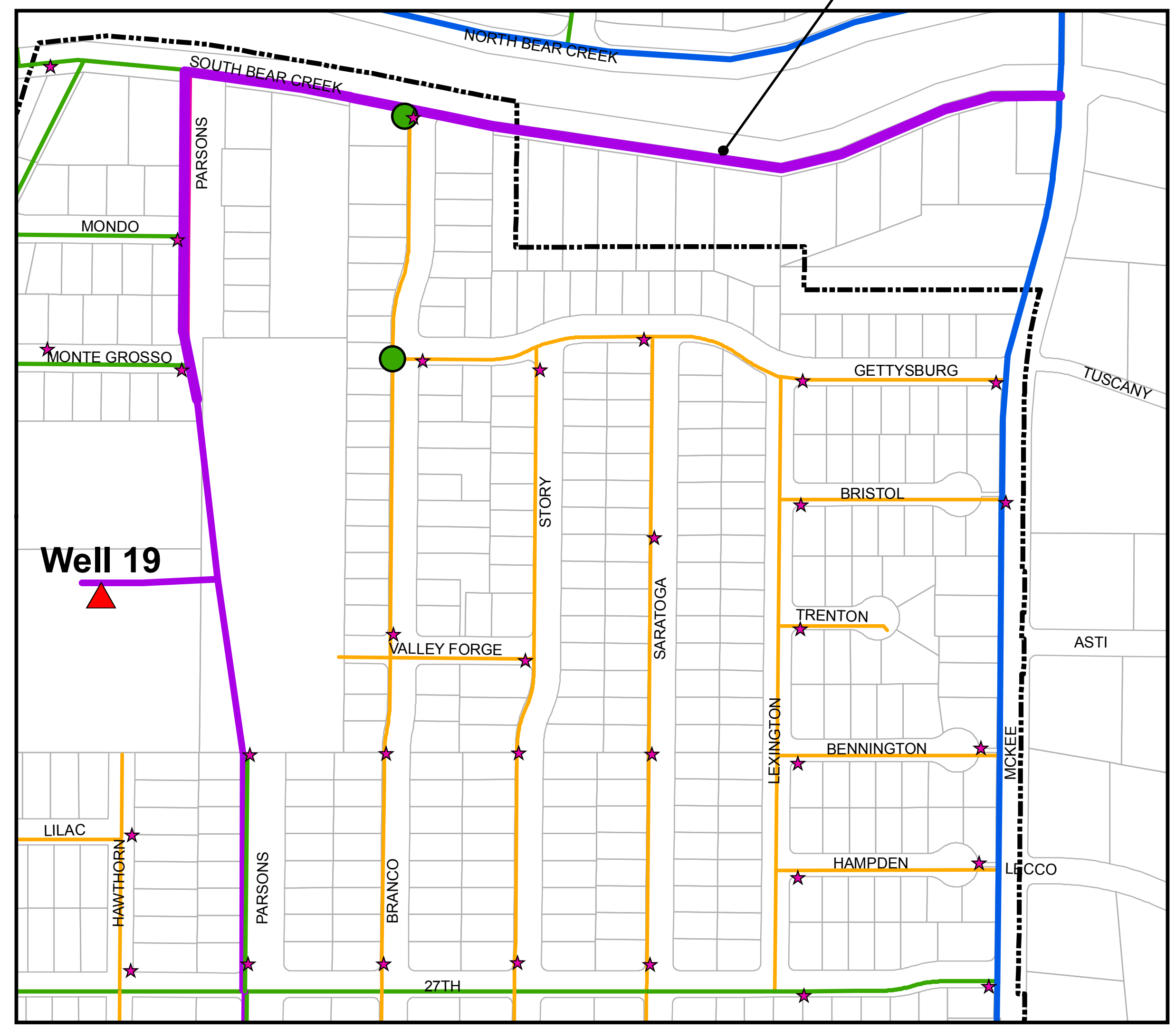
Replace 4-inch pipeline with 500 LF of 8-inch diameter pipe.

Replace 4-inch pipeline with 1,000 LF of 8-inch diameter pipe.



AREA 4

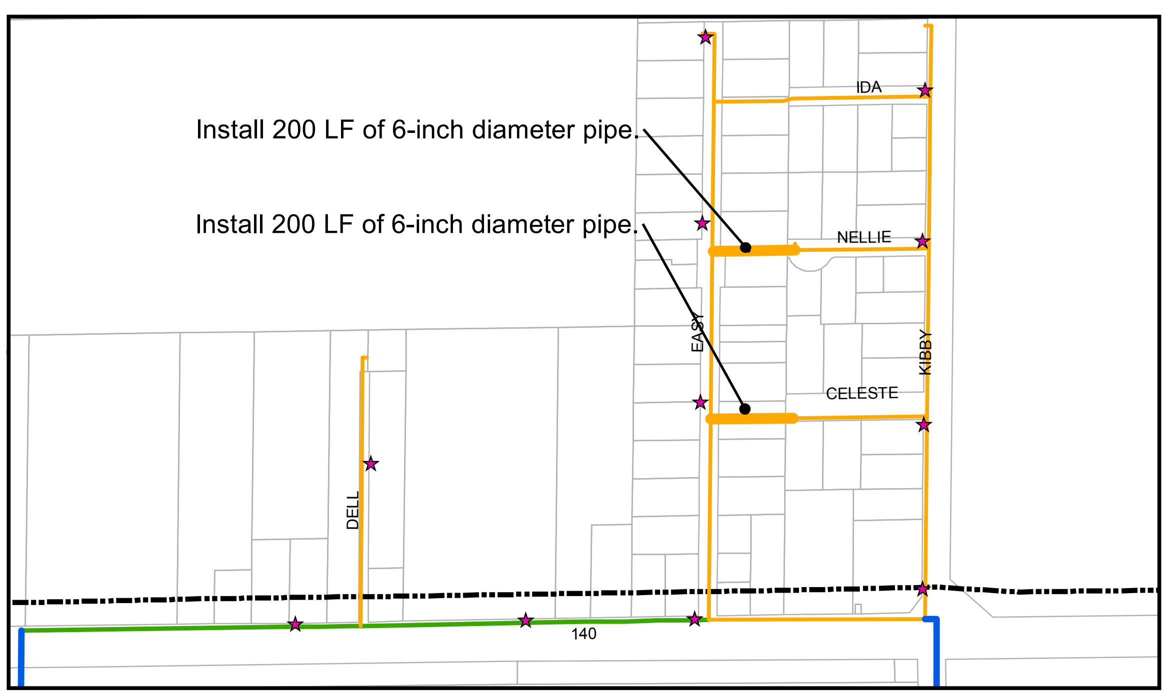
Install 2,800 LF of 16-inch diameter pipe.
Connect to existing 12- inch diameter pipe at McKee Road.



AREA 5

Install 200 LF of 6-inch diameter pipe.

Install 200 LF of 6-inch diameter pipe.



AREA 6

N

0 420 840
Feet

LEGEND

- Existing Tank
- Existing Well On
- Existing Well Off
- Future Well
- Existing Fire Hydrant
- Residential Failure (1,500gpm)
- Commercial Failure (2,500gpm)
- Industrial Failure (<3,000gpm)
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- City Limits
- Merced Parcels

NOTE:

AREAS REFERENCED FROM FIGURE 8-5.

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Chapter 9 Future Water System Analysis

This chapter presents an analysis to size the water infrastructure required to support the future growth of the City of Merced through 2030 in accordance with *Merced Vision 2030*. The future water system configuration comprises all existing operational facilities, recommended facilities to improve the existing water system, plus additional facilities needed to reliably satisfy demands in the future. Proposed water system facilities were discussed with City staff. This future water system analysis includes an evaluation of the capacities of pump stations, water storage facilities, and the water distribution system against the City's design and operational criteria.

9.1 Future Water Demand

The average day demand of the City is projected to be 27,649 gpm by 2030 as summarized in Table 9-1. Details of the demand calculations can be found in Chapter 4. This demand forms the basis of the future water system analysis and was modeled in the hydraulic model of the City's water distribution system.

Table 9-1. Projected Water Demand[a]

Demand Scenario	2030 Time Horizon
Average Day, gpm	27,649
Maximum Day, gpm	52,533
Peak Hour gpm	77,417

[a]Demands based on Chapter 4.

9.2 Future Water Supply and Pumping Capacity Evaluation

The City's water supply and pumping capacity criterion requires the water system to have sufficient pumping capacity to meet either Maximum Day Demand plus Fire Flow or Peak Hour Demand (whichever is higher). This evaluation was based on the pumping station's ability to deliver firm capacity with the largest pump out of service. The results of the pumping capacity evaluation for 2030 are summarized in Table 9-2.

Table 9-2. Comparison of 2030 Pumping Capacity and Demand

Description	Well No.	Available Firm Pumping Capacity, gpm	2030 Maximum Day Demand Plus Fire Flow, gpm[a]	2030 Peak Hour Demand, gpm	Satisfies Criterion?
2012 Existing Wells	-	55,100			
Total Firm Capacity[b]		55,100	56,533	77,417	No

[a]Based on a Maximum Day Demand of 52,533 gpm and nonsprinklered fire flow of 4,000 gpm.
[b]Defined as the total capacity of the pump stations with the largest pump station out of service.

This analysis indicates that the existing and planned pumping capacities do not meet the required pumping capacity for the 2030 Peak Hour Demand. An additional capacity of 22,317 gpm is needed. This can be provided from a combination of new wells and storage tanks with booster pump stations. Ten new wells at 2,500 gpm each would be needed. Alternatively, six new wells rated at 2,500 gpm can be constructed in addition to three storage tanks (3 MG each) plus three booster pump stations rated at 5 MGD each and a 10

MGD surface water treatment plant. City staff has indicated that a surface water treatment plant should be considered as part of this solution.

9.3 Future Water Storage Capacity Evaluation

Future storage capacity must satisfy the design and operational criteria in Chapter 6, which includes.

- Operational Storage: 30 percent of Maximum Day Demand
- Emergency Storage: 100 percent of Average Day Demand
- Fire flow Storage: The required maximum fire flow times the fire flow duration period.

The required storage must be located in above ground tanks or groundwater storage in wells. As shown in Table 9-3, the required storage of the City by 2030 is approximately 64 MG. The City's total existing storage will not be adequate to meet the 2030 storage requirements. A deficit of approximately 19.3 MG needs to be supplied from groundwater or aboveground storage.

Table 9-3. Required Water Storage Capacity by 2030

Available Storage Capacity, MG	Required Storage Capacity, MG				Storage Deficit, MG[(b)]
	Operational	Fire Flow	Emergency	Total	
44.96	22.98	0.96[(a)]	40.30	64.24	19.28

[(a)]Calculated based on required institutional fire flow of 4,000 gpm flowing for 4 hours.
[(b)]Calculated as required storage minus available storage.

The facilities recommended in the previous section for the pumping capacity requirements should be sufficient to meet the water storage requirements also.

9.4 Future Water Distribution System Analysis

The City's water distribution system was evaluated using a future water system hydraulic model developed based on the existing model. This evaluation focused on the ability of the proposed water distribution system to meet the design and operational criteria discussed in Chapter 6.

The adequacy of the proposed distribution system to serve the City's future water service area was analyzed under Average Day, Maximum Day, and Peak Hour Demand conditions. The hydraulic model was crucial in determining the appropriate location and size of water system facilities.

9.4.1 Future Water Distribution System Model

The future model of the City's water system was created by integrating water supply, pumping, and storage facilities proposed in the previous sections. Two main alternatives comprising combinations of water system facilities were explored. These included:

Alternative 1: Expansion by New Wells Only

Alternative 1 is based on the assumption that the City continues to rely solely on groundwater to meet its water demand by drilling new wells only. This assumes that the groundwater quality continues to be good and there is sufficient groundwater recharge to stabilize groundwater levels. Alternative 1 requires 10 new 2,500-gpm wells by 2030, as shown in Figure 9-1.

Alternative 2: Expansion by Water Treatment Plant, Storage Tanks and Booster Pump Stations

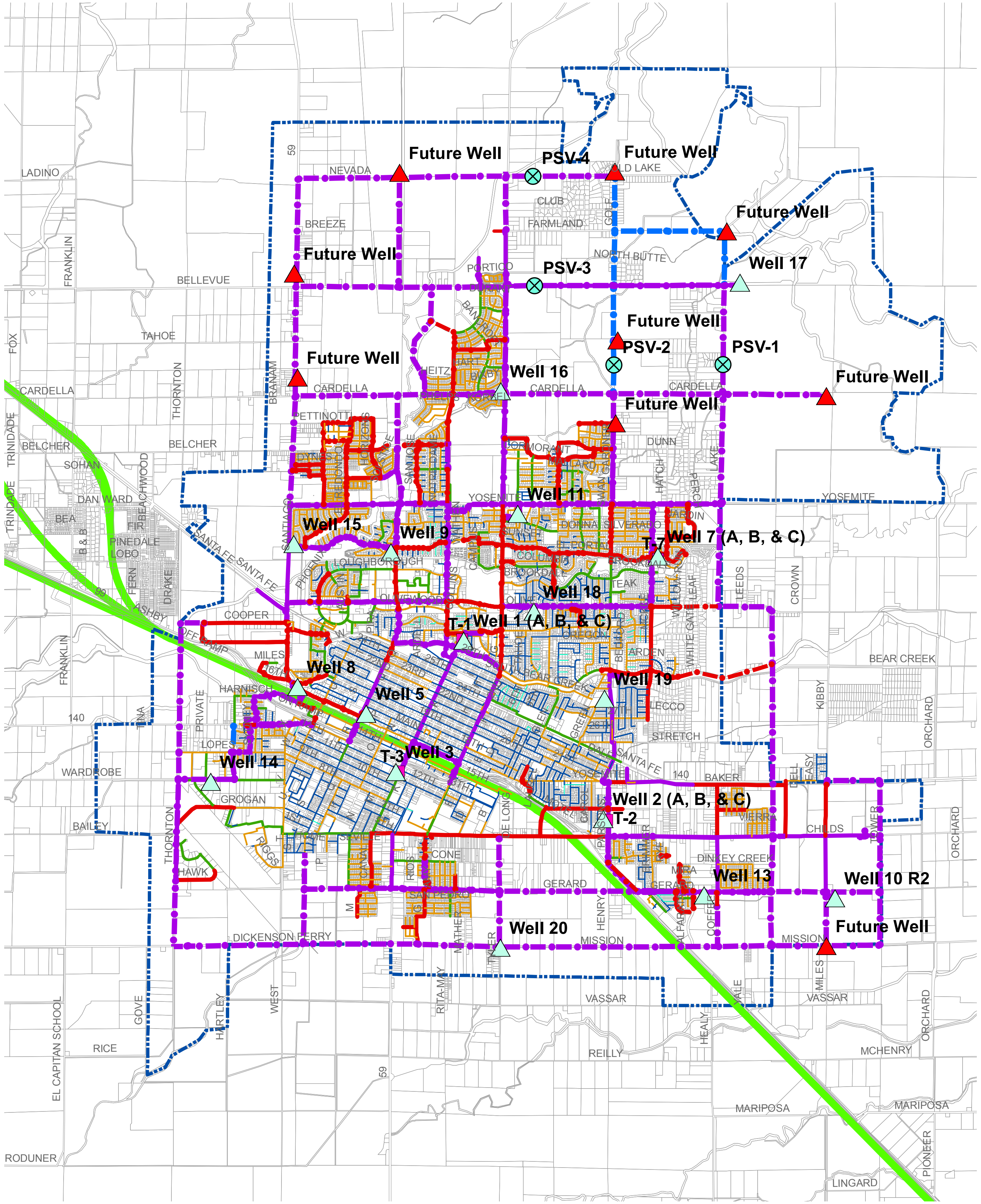
Alternative 2 is based on conjunctive water use relying on a combination of groundwater and treated surface water to meet future water demand. This is the most reliable mix of water supply and requires:

- Six 2,500-gpm wells by 2030.
- Three storage tanks (3 MG each) plus three booster pump stations (5 MGD each) by 2030.
- A new surface water treatment plant rated at 10 MGD by 2030.

Because of the need to reduce reliance on groundwater wells, it is not recommended to have only wells. Therefore, Alternative 1: Expansion by New Wells Only will not be analyzed further. Figure 9-2 shows Alternative 2 of the distribution system expansion with wells, storage tanks, booster pump stations, and a surface water treatment plant. Alternative 2 is preferred because it uses conjunctive water use and takes into account deterioration in the groundwater quality in the future. This was agreed to by City staff. Therefore, the remaining future water system evaluation will be based on Alternative 2.

9.4.2 2030 Hydraulic Analysis

The water system facilities required for Alternative 2 by 2030 were used for the hydraulic analysis because they show the most diversity of supply sources. Figures 9-3 to 9-5 show the results of the hydraulic analysis under Average Day, Maximum Day, and Peak Hour Demand scenarios. As shown in the figures, the recommended facilities are able to supply the required demand at adequate pressures while maintaining pipeline velocities below the maximum criteria. A separate pressure zone is required in the northeastern part of the City in order to provide the required minimum pressure of 40 psi to those customers.



LEGEND

- Existing Tank
- Existing Well
- Future Well
- 2030 Pressure Sustaining Valve

Existing Pipelines

- 4 in.
- 6 in.
- 8 in.
- 10 in.
- 12 in.
- 16 in.
- 18 in.

2030 Pipelines

- 12
- 16
- 18
- High Speed Rail Alignment
- Merced Vision 2030 Boundary

N

0 6,000 12,000

Feet

AECOM Water AECOM 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN	AECOM PROJECT NO.	FIGURE
	FUTURE WATER SYSTEM ALT 1: WELLS ONLY	602979029	9-1

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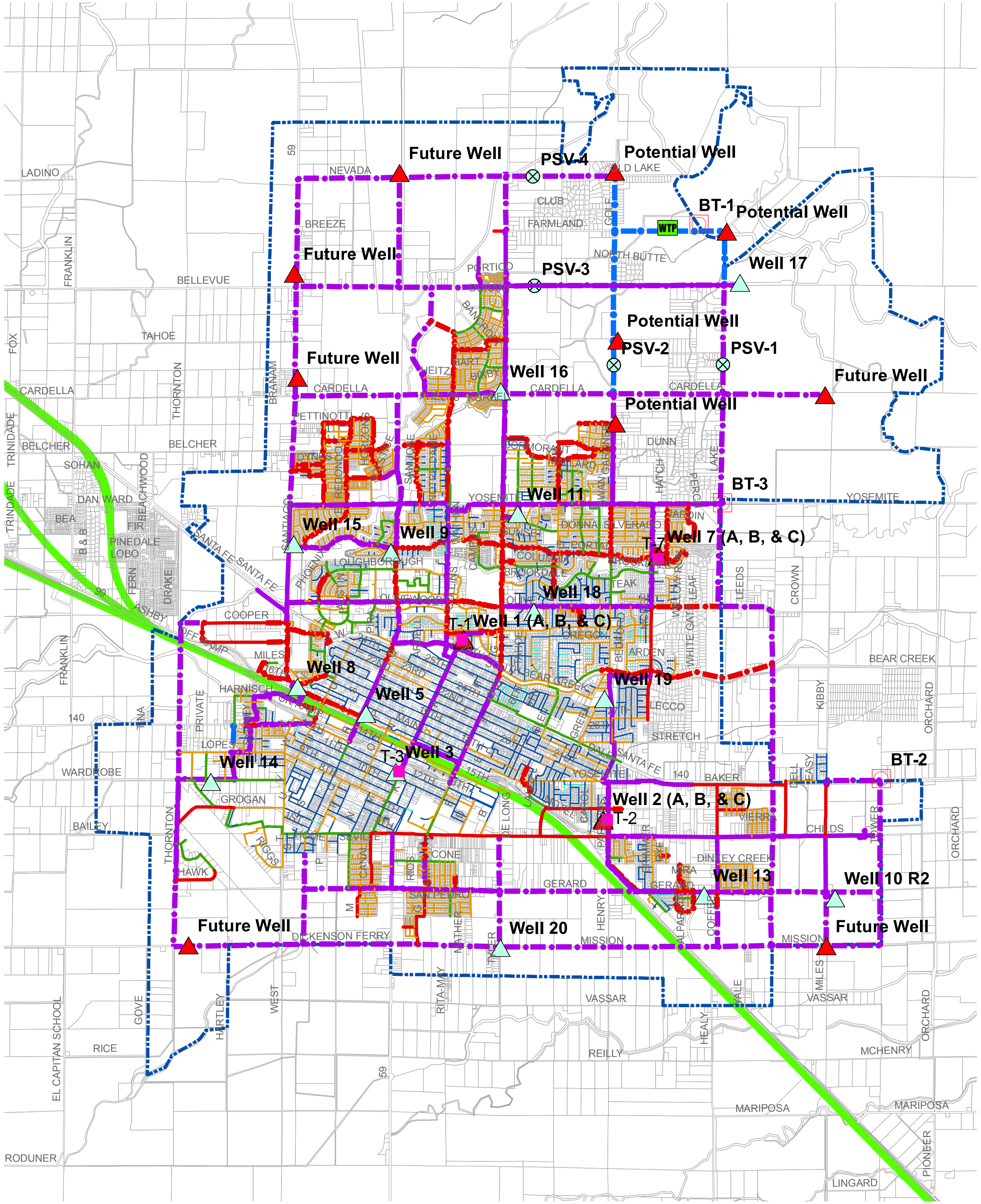

LEGEND

- Existing Tank
- Existing Wells
- Future Wells
- 2030 Booster Pump
- 2030 Pressure Sustaining Valve
- WTP Water Treatment Plant

Existing Pipelines

- 4 in.
- 6 in.
- 8 in.
- 10 in.
- 12 in.
- 16 in.
- 18 in.

2030 Pipelines

- 12 in.
- 16 in.
- 18 in.
- Future High Speed Rail Alignment
- 2030 Land Use Boundary

N

0 6,000 12,000

Feet

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CITY OF MERCED
WATER MASTER PLAN

FUTURE WATER SYSTEM
ALT 2: WATER TREATMENT PLANT AND WELLS

AECOM PROJECT NO.
602979029

FIGURE
9-2

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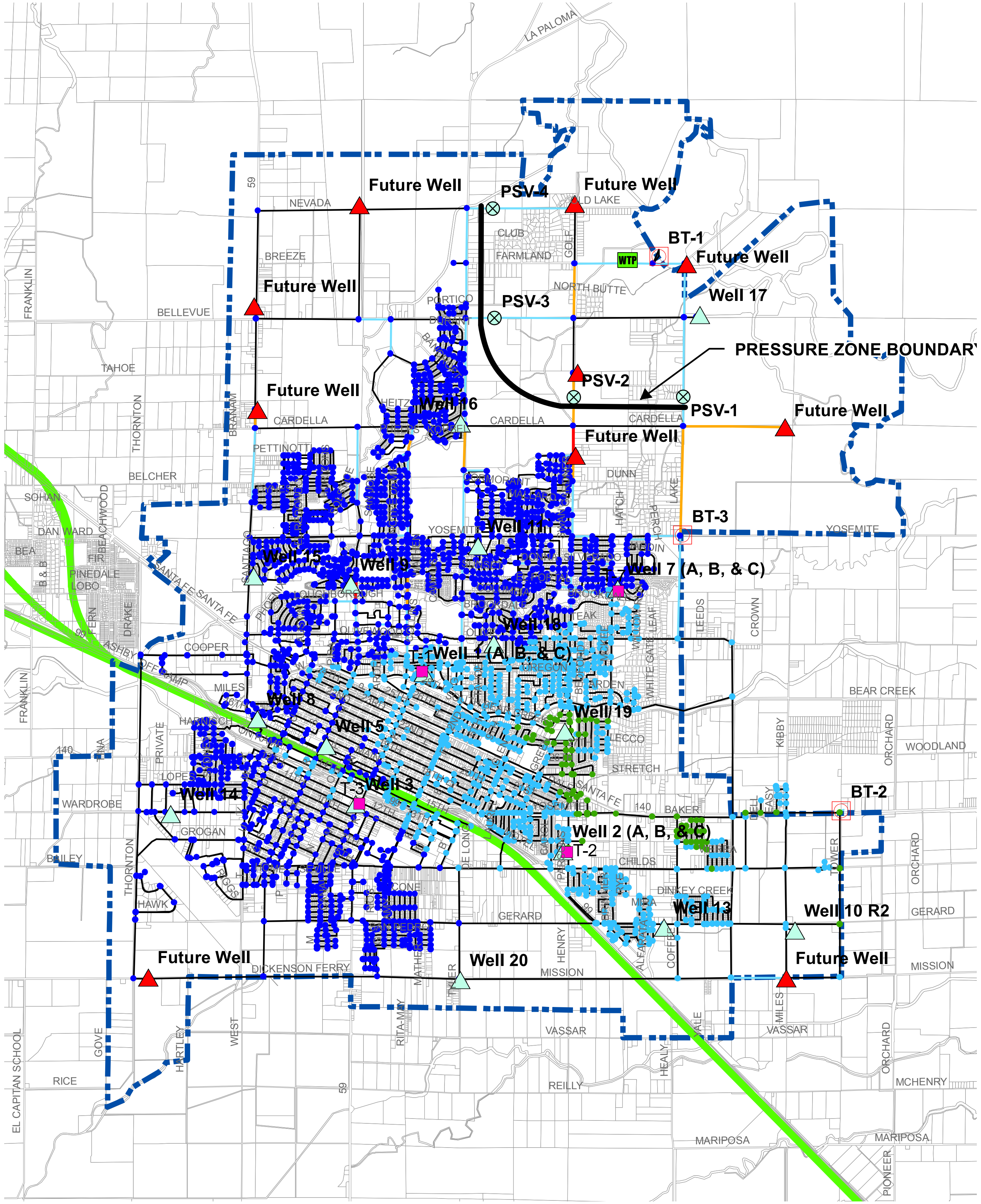

LEGEND

- Existing Tank
- Existing Wells
- Future Wells
- Water Treatment Plant
- 2030 Booster Pump
- 2030 Pressure Sustaining Valve

PRESSURE

- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60

VELOCITY

- 0 - 3 ft/sec
- 3 - 5 ft/sec
- 5 - 7 ft/sec
- 7 - 8 ft/sec
- Future High Speed Rail Alignment
- Merced Vision 2030 Boundary

N

0 6,000 12,000

Feet

AECOM Water AECOM 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN 2030 AVERAGE DAY PRESSURE AND VELOCITY	AECOM PROJECT NO. 602979029	FIGURE 9-3

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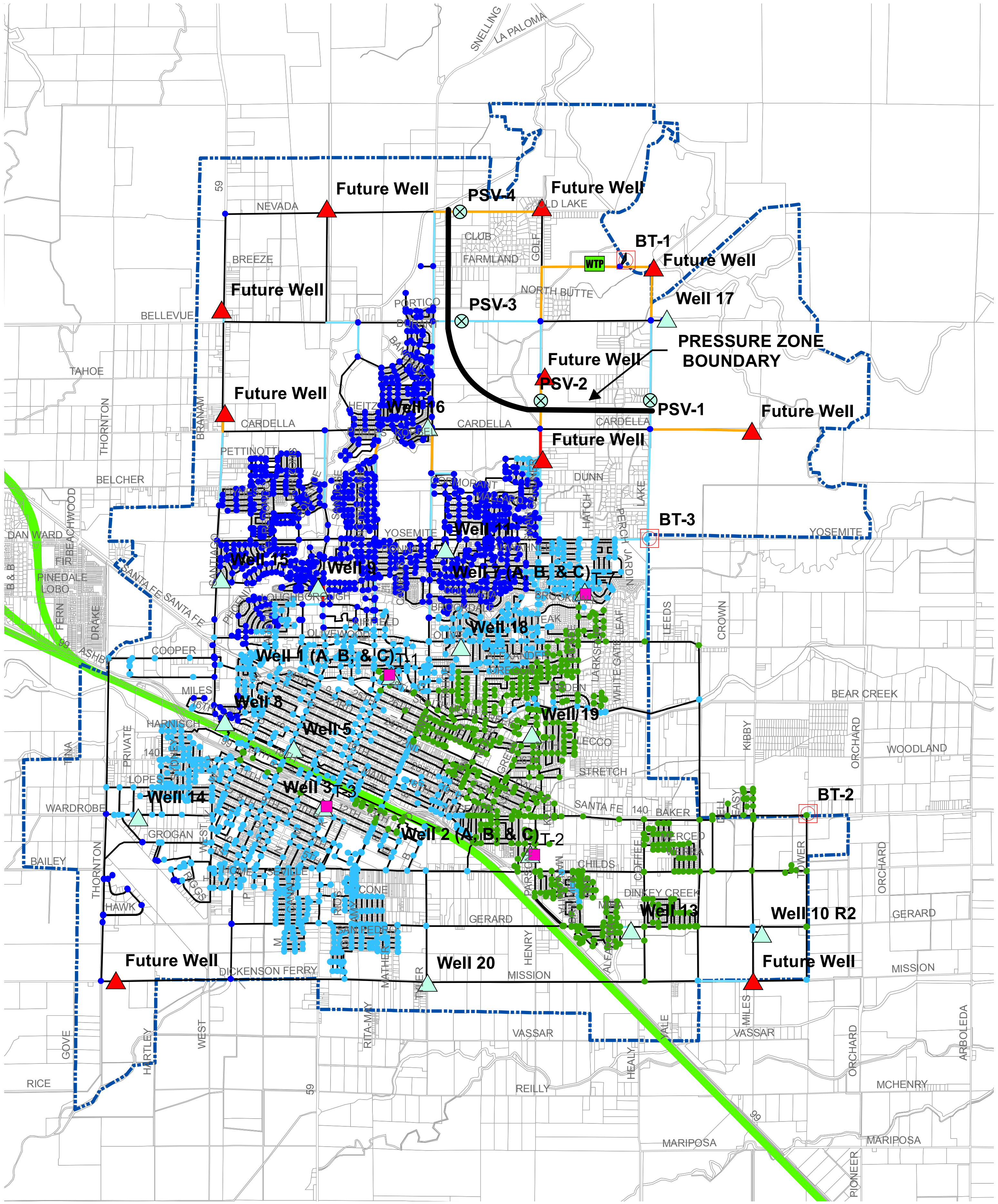

LEGEND

- Existing Tank
- Existing Wells
- Future Wells
- WTP Water Treatment Plant
- 2030 Booster Pump
- 2030 Pressure Sustaining Valve

PRESSURE

- 40 - 45 psi
- 45 - 50 psi
- 50 - 55 psi
- 55 - 60 psi

VELOCITY

- 0 - 3 ft/sec
- 3 - 5 ft/sec
- 5 - 7 ft/sec
- 7 - 8 ft/sec
- Future High Speed Rail Alignment
- Merced Vision 2030 Boundary

AECOM Water 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN 2030 MAX DAY PRESSURE AND VELOCITY	AECOM PROJECT NO. 602979029	FIGURE 9-4

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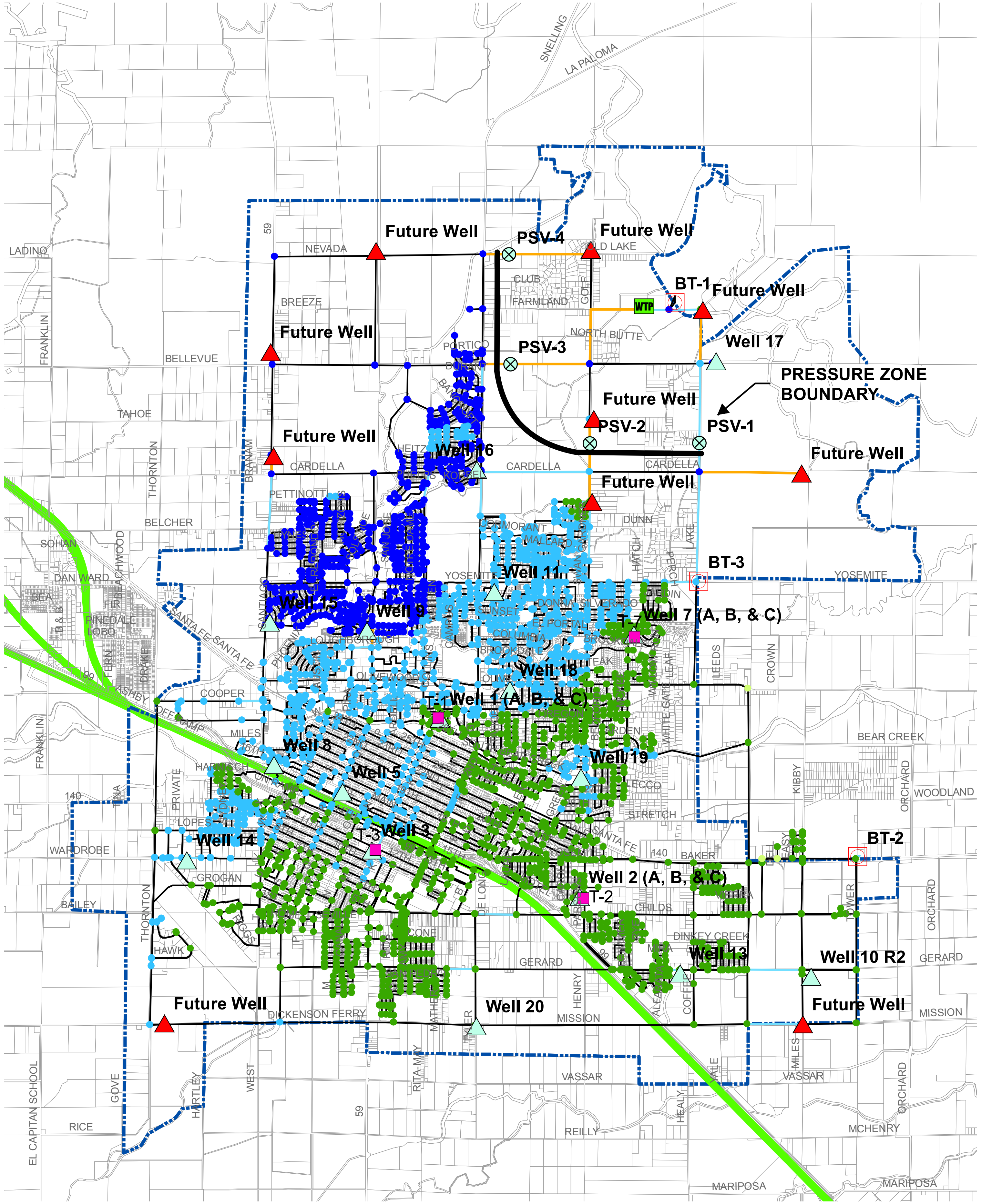

LEGEND

- Existing Tank
- Existing Wells
- Future Wells
- Water Treatment Plant
- 2030 Booster Pump
- 2030 Pressure Sustaining Valve

PRESSURE

- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60

VELOCITY

- 0 - 3 ft/sec
- 3 - 5 ft/sec
- 5 - 7 ft/sec
- 7 - 8 ft/sec
- Future High Speed Rail Alignment
- Merced Vision 2030 Boundary

N

0 6,000 12,000
Feet

AECOM Water

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CITY OF MERCED
WATER MASTER PLAN

2030 PEAK HOUR PRESSURE AND VELOCITY

AECOM PROJECT NO.
602979029

FIGURE
9-5

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Chapter 10
Recommended Capital Improvement Program

Chapters 8 and 9 identified the need for additional facilities for the City of Merced's water distribution system to meet existing and future demands in 2030. Figure 10-1 shows the preferred additional facilities needed to provide the required minimum system pressures and flows in the future, under the various demand conditions. Figure 8-8 shows the details of the existing system improvements. Table 10-1 shows the schedule of implementation (planning horizon) and associated capital costs for the recommended capital improvements. Generally, the costs associated with improving the existing system would be borne by existing customers, whilst the capital improvement costs associated with new developments would be borne by development costs. The following sections describe the cost components and the assumptions used.

10.1 Total Capital Costs

The estimated total capital cost for improvements that should be completed by 2030 for the City's water system to continue serving its customers adequately is approximately $163.6 million. The costs were developed based on a combination of cost curves, construction cost guidelines, and similar construction projects in the Central Valley. All construction costs have been adjusted to reflect December 2013 costs at an Engineering News Record (ENR) Construction Cost Index (CCI) 20 Cities Average of 9667.77. These costs are to be used for conceptual cost estimates only and should be updated regularly.

10.2 Groundwater Wells

Well construction was assumed to be consistent with and compatible with the look and functionality of current City wells. The costs include test hole drilling, water quality/soil sampling, and well drilling and development as well as the necessary housing, pump, motor, control equipment, discharge piping, SCADA, disinfection equipment, and standby generator. The completed well depth was assumed to be 700 feet deep based on the existing well information. These costs are representative of construction conducted under normal drilling conditions and would be higher for special or difficult locations. These costs do not account for wellhead treatment.

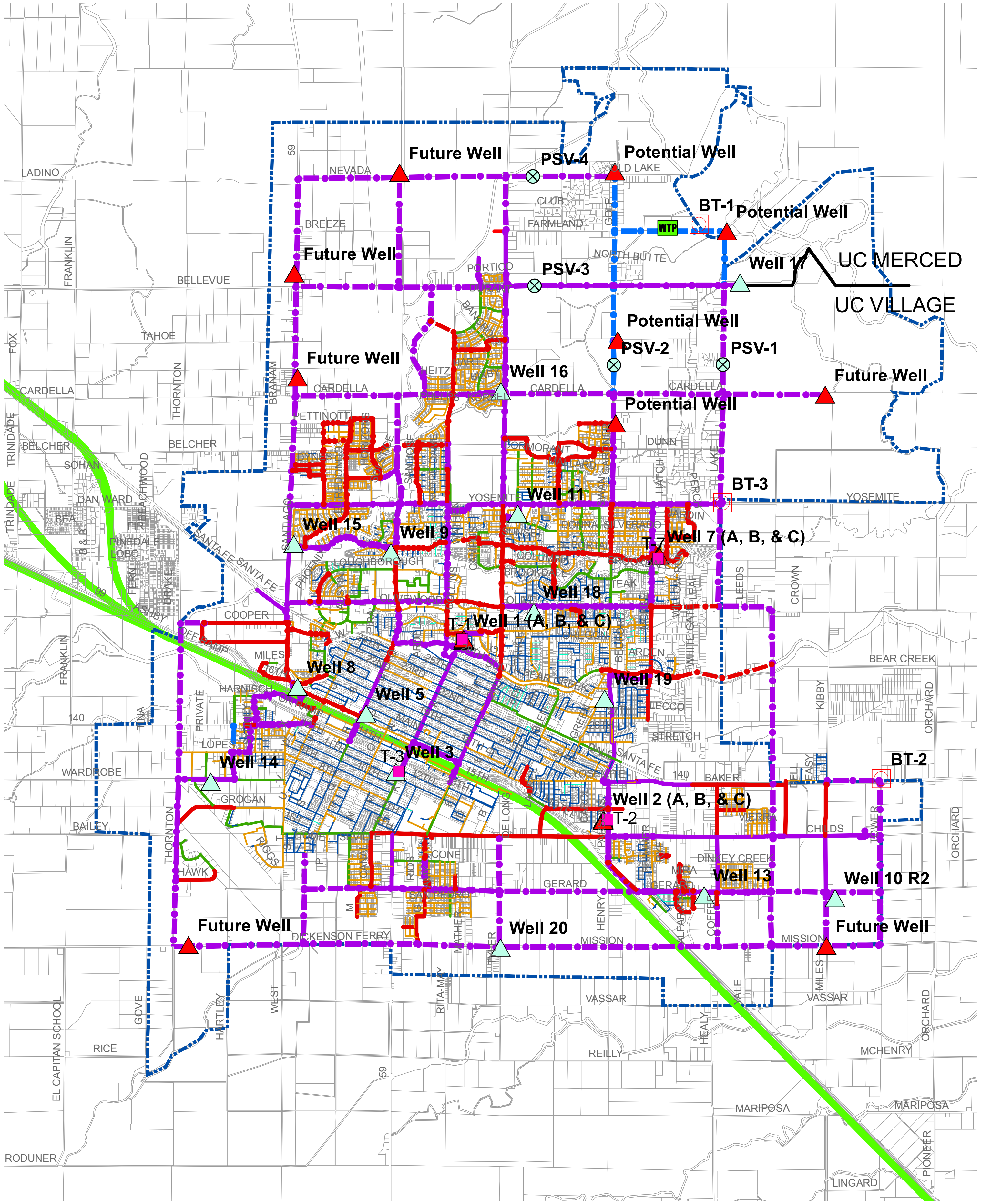
10.3 Water Storage Tanks and Booster Pump Stations

The cost of the water storage tanks are based on at-grade prestressed concrete material. These costs are representative of construction conducted under normal excavation and foundation conditions and would be higher for special or difficult foundation requirements.

Booster pump station costs generally vary considerably, depending on factors such as architectural design, pumping head, and station capacity. Estimated construction costs for the booster pump stations are based on enclosed stations with architectural and landscaping treatment suitable for residential areas. Pump station cost estimates include backup/standby generators and SCADA, and three to five pumps located adjacent to the storage tanks.

10.4 Water Pipelines

Pipeline costs generally include pipe materials, trenching, placing and jointing pipe, valves, fittings, hydrants, service connections, placing imported pipe bedding, native backfill material, and asphalt pavement replacement, if required. These costs do not include the cost of boring and pipe jacking.



LEGEND

- Existing Tank
- Existing Wells
- Future Wells
- 2030 Booster Pump
- 2030 Pressure Sustaining Valve
- WTP Water Treatment Plant

Existing Pipelines

- 4 in.
- 6 in.
- 8 in.
- 10 in.
- 12 in.
- 16 in.
- 18 in.

2030 Pipelines

- 12 in.
- 16 in.
- 18 in.
- 12
- 16
- Future High Speed Rail Alignment
- Merced Vision 2030 Boundary

N

0 6,000 12,000

Feet

AECOM Water AECOM 1360 E. Spruce Avenue, Suite 101 Fresno, California 93720 T 559.448.8222 F 559.448.8233 www.aecom.com	CITY OF MERCED WATER MASTER PLAN RECOMMENDED WATER SYSTEM IMPROVEMENTS	AECOM PROJECT NO. 602979029	FIGURE 10-1

V:\Merced_City\MODEL\GIS\FIGURES\2012 WMP Figures\2030 Figures

Table 10-1. Recommended Water System Capital Improvement Program

Planning Horizon	Facility Name	Item Description	Estimated Quantity	Unit of Measure	Unit Cost, $/unit[a]	Estimated Cost, x$1,000
		Improvements to Existing System				
		Groundwater Wells[b]				
2014 - 2019	Well 6	Abandon and demolish existing well	1	LS	50,000	50
2014 - 2019	Well 20	Construct new well at Corner of Mission and Tyler	1	LS	2,200,000	2,200
		Subtotal				2,250
		Water Pipelines				
2014 - 2019		6" diameter distribution pipeline	400	LF	134	54
2014 - 2019		8" diameter distribution pipeline	1,700	LF	151	256
2014 - 2019		16" diameter transmission main	2,800	LF	262	735
		Subtotal				*1,045*
		Existing Improvement Costs				***3,295***
		2030 Improvements				
		Groundwater Wells[b]				
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at the intersection of Thornton Rd and Dickenson Ferry Rd.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of HWY 59 and Bellevue Rd.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of Mission Ave and Kirby Rd.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at interstcion of Nevada St and R St.	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of HWY 59 and Cardella Rd	1	LS	2,200,000	2,200
2015 - 2030	Future Well	2500 gpm pump with 300 hp motor at intersection of Cardella Rd and Kirby Rd[e]				
		Subtotal				*11,000*
		Water Storage Tanks + Booster Pump Stations				
2015 - 2030	BT - 1	3.0 MG tank + 5.0 MGD booster pumps at the intersection of Lake Rd and Farmland Ave	1	LS	3,900,000	3,900
2015 - 2030	BT - 2	3.0 MG tank + 5.0 MGD booster pumps at the intersection of HWY 140 and Tower Rd	1	LS	3,900,000	3,900
2015 - 2030	BT - 3	3.0 MG tank + 5.0 MGD booster pumps at the intersection of Lake Rd and Yosemite Ave	1	LS	3,900,000	3,900
		Subtotal				*11,700*
		Pressure Sustaining Valves				
2015 - 2030	PSV - 1	Lake Rd between Cardella Rd and Bellevue Rd	1	LS	100,000	100
2015 - 2030	PSV - 2	Gardner Ave between Cardell Rd and Bellevue Rd	1	LS	100,000	100
2015 - 2030	PSV - 3	Intersection of Bellevue Rd and G St.	1	LS	100,000	100
2015 - 2030	PSV - 4	Nevada St. between G St and Golf Rd	1	LS	100,000	100
		Subtotal				*400*
		Water Pipelines				
2015 - 2030		12" diameter transmission main	1,800	LF	209	376
2015 - 2030		16" diameter transmission main	187,000	LF	262	49,086
2015 - 2030		18" diameter transmission main	18,500	LF	353	6,530
		Subtotal				*55,992*
		Surface Water Treatment Plant				
2015 - 2030		10 MGD Water Treatment Plant near Lake Yosemite[c]	1	LS	16,755,000	16,755
		Subtotal				*16,755*
		2030 Improvement Costs				***95,847***
		Capital Improvement Facilities Costs				**99,142**
		Design Costs (10%)[d]				9,914
		Permitting, Regulatory Compliance, CEQA Costs (10%)[d]				9,914
		Construction Management (10%)[d]				9,914
		Program Implementation (5%)[d]				4,957
		Project Construction Contingency (25%)[d]				24,786
		Land Acquisition (5%)[d]				4,957
		Other Related Project Costs (65%)[d]				**64,442**
		Total				**163,585**

[a] Present installed costs based on a combination of current construction costs and Engineering News Record Estimates.

[b] These costs do not include well head treatment.

[c] Surface Water Treatment Plant unit cost estimated at $1.675 per gallon.

[d] Other Costs based on the following components: design at 10%; permitting, regulatory compliance, CEQA at 10%; construction management at 10%; program implementation at 5%; project construction contingency at 25%, and land acquisition costs at 5%.

10.5 Surface Water Treatment Plant

The surface water treatment costs are for a conventional water treatment plant comprising master meter, flocculation/sedimentation basins, solids pump station, filters, clear well, pump station, and yard piping. A membrane system would be significantly higher at over $2 per gallon. The cost of land is not included in the water treatment plant capital costs. An approximate area of 10 acres would be needed for the water treatment plant. It is recommended that the City purchase the recommended land when land prices are low.

10.6 Other Costs

To assist the City in adequately budgeting for the recommended capital projects, an additional cost equivalent to 65 percent of the estimated capital cost for the recommended facilities has been included to cover "other" project-related costs such as:

- Design at 10 percent
- Permitting, regulatory compliance, and CEQA at 10 percent
- Construction management at 10 percent
- Program implementation at 5 percent
- Project construction contingency at 25 percent
- Land acquisition costs at 5 percent

Design services associated with the new facilities include preliminary, conceptual, and final design reports; preparation of drawings and specifications for construction; and start-up services. Construction management covers such items as contract management and inspection during construction. Program implementation costs cover such items as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, and interest during construction. Project contingency is for unexpected construction conditions, the need for unforeseen mechanical items, and variations. Land acquisition costs include all property costs associated with the new facilities recommended.

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