MORGAN HILL
California

Water System Master Plan

ADMINISTRATIVE DRAFT

AUGUST 2017

AKEL
ENGINEERING GROUP, INC.

CITY OF MORGAN HILL

2017

WATER SYSTEM MASTER PLAN

Administrative Draft

August 2017

AKEL ENGINEERING GROUP, INC.

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ENGINEERING GROUP, INC.

Smart Planning Our Water Resources

August 16, 2017

City of Morgan Hill
17575 Peak Avenue
Morgan Hill, CA 95037-4128

Attention: Karl Bjarke, P.E.
Director of Public Works/City Engineer

Subject: 2017 Water System Master Plan – Draft Report

Dear Karl:

We are pleased to submit the draft report for the City of Morgan Hill Water System Master Plan. This master plan is a standalone document, though it was prepared as part of the integrated infrastructure master plans for the water, sewer, and storm drainage master plans. The master plan documents the following:

- Existing distribution system facilities, acceptable hydraulic performance criteria, and projected water demands consistent with the Urban Planning Area
- Development and calibration of the City's GIS-based hydraulic water model.
- Capacity evaluation of the existing water system with improvements to mitigate existing deficiencies and to accommodate future growth.
- Capital Improvement Program (CIP) with an opinion of probable construction costs and suggestions for cost allocations to meet AB 1600.

We extend our thanks to you, Dan Repp, Deputy Director of Public Works, and other City staff whose courtesy and cooperation were valuable components in completing this study.

Sincerely,

AKEL ENGINEERING GROUP, INC.

Tony Akel, P.E.
Principal

Enclosure: Report

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CITY OF MORGAN HILL

Acknowledgements

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Larry Carr, Mayor Pro Tempore

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Rene Spring

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Scott Creer, Deputy Director for Engineering

John Baty, Senior Planner

Other City Engineering, Planning, and Operations Staff

City of Morgan Hill
Water System Master Plan

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APPENDICES

EXECUTIVE SUMMARY

This executive summary presents a brief background of the City's water distribution system, the planning area characteristics, the system performance and design criteria, the hydraulic model, and a capital improvement program.

The hydraulic model was used to evaluate the capacity adequacy of the existing distribution system and for recommending improvements to mitigate existing deficiencies, as well as servicing future growth. The prioritized capital improvement program accounts for growth throughout the City of Morgan Hill.

ES.1 STUDY OBJECTIVES

The City of Morgan Hill recognizes the importance of planning, developing, and financing the City's water system infrastructure. The City retained the services of Placeworks to develop a comprehensive, long-term General Plan for the orderly development of the community, while integrating the City's social, economic, and environmental goals. On July 27, 2016, the City Council adopted the Morgan Hill 2035 General Plan, a comprehensive update of the City's General Plan.

As a part of the General Plan update, the City also initiated the update of the infrastructure master plans. These master plans, which were closely coordinated and paralleled the preparation of the General Plan, included:

- 2017 Water System Master Plan
- 2017 Sewer System Master Plan
- 2017 Storm Drainage System Master Plan

City Council approved the preparation of the General Plan in June of 2013, which included authorizing Akel Engineering Group Inc. to prepare this master plan. The 2017 WSMP evaluates the City's water system and recommends capacity improvements necessary to service the needs of existing users and for servicing the future growth of the City. This 2017 WSMP is intended to serve as a tool for planning and phasing the construction of future domestic water system infrastructure for the projected buildout of the City of Morgan Hill.

The area and horizon for the master plan is stipulated in the City's General Plan. Should planning conditions change, and depending on their magnitude, adjustments to the master plan recommendations might be necessary.

This master plan included the following tasks:

- Summarizing the City's existing domestic water system facilities

- Documenting growth planning assumptions and known future developments
- Updating the domestic water system performance criteria
- Projecting future domestic water demands
- Updating and calibrating a new hydraulic model using Geographic Information Systems (GIS) data
- Evaluating the domestic water facilities to meet existing and projected demand requirements and fire flows
- Evaluating the existing groundwater conditions
- Performing a capacity analysis for major distribution mains
- Performing a fire flow analysis
- Recommending a capital improvement program (CIP) with an opinion of probable costs
- Performing a capacity allocation analysis for cost sharing purposes
- Developing a 2017 Water System Master Plan report

ES.2 INTEGRATED APPROACH TO MASTER PLANNING

The City implemented an integrated master planning approach and contracted the services of Akel Engineering Group to prepare the following documents:

- Water System Master Plan
- Sanitary Sewer System Master Plan
- Storm Drainage System Master Plan

While each of these reports is published as a standalone document, they have been coordinated for consistency with the City's General Plan. Additionally, each document has been cross referenced to reflect relevant analysis results with the other documents.

ES.3 STUDY AREA

The City of Morgan Hill is located in Santa Clara County, approximately 22 miles southeast of the City of San Jose and 24 miles northwest of the city of Hollister. The City's closest neighbor, the City of Gilroy, is located 8 miles to the southeast. U.S. Route 101 bisects the eastern boundary of the City in the north-south direction. The City limits currently encompass 12.9 square miles, with an approximate population of 42,000 residents.

The City is generally bound to the north by Tilton Avenue, to the east by Anderson Lake, to the southeast by Foothill Avenue, to the west by Sunnyside Drive, and to the south by Middle Avenue. The unincorporated community of San Martin is located to the south of the City. The City's topography is generally flat in the center of the City with increasing slopes on the east and west.

Figure ES.1 displays the planning area showing city limits, the Urban Growth Boundary of the City and the City's Sphere of Influence Boundary.

ES.4 SYSTEM PERFORMANCE AND DESIGN CRITERIA

This report documents the City's performance and design criteria that were used for evaluating the domestic water system. The system performance and design criteria are used to establish guidelines for determining future water demands, evaluating existing domestic water facilities, and for sizing future facilities. **Table ES.1** documents the system performance and design criteria for the domestic water system. This criterion was used in the capacity evaluation and for sizing recommended improvements.

ES.5 EXISTING WATER SYSTEM OVERVIEW

The City's municipal water system consists of 16 active groundwater wells, a total of 10.5 million gallons in storage, distribution mains, and fire hydrants. The City's topography is generally flat in the center of the City with increasing slopes on the east and west; based on this topography, the water distribution system is comprised of 20 pressure zones, with 12 storage tanks regulating system operation.

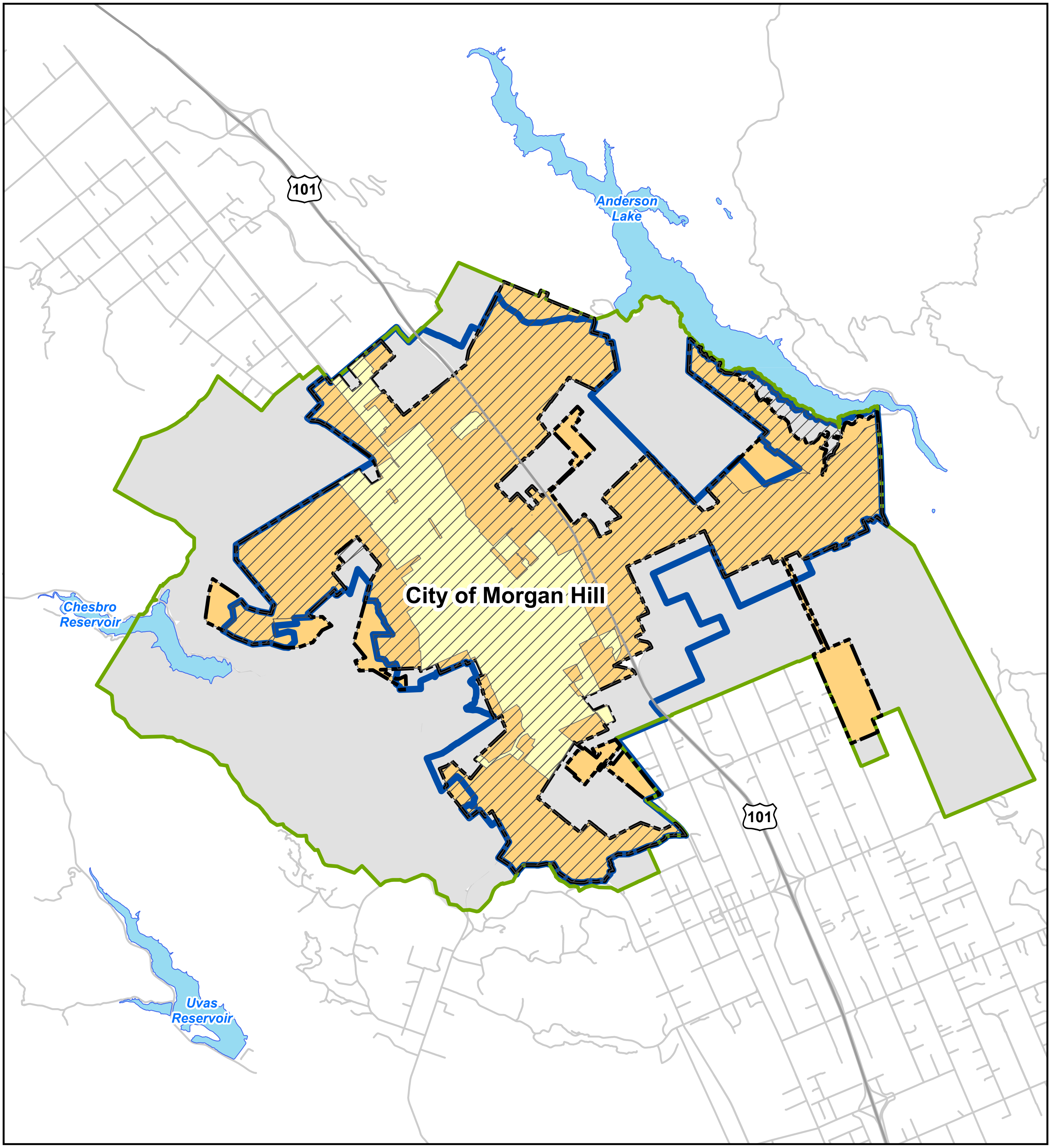
The City's existing domestic water distribution system is shown in **Figure ES.2**, which displays the existing system by pipe size. This figure provides a general color coding for the distribution mains, as well as labeling the existing wells and the storage reservoir.

ES.6 EXISTING AND FUTURE DOMESTIC WATER DEMANDS

The City's existing average day domestic water demand was documented at 6.4 mgd. Accounting for losses in the system, the average daily production is 7.2 mgd. **Table ES.2** documents the future land use categories, and their corresponding domestic water demands. The average day domestic water demands from existing and future developments is estimated at 9.4 mgd, and parallels the 2035 water demand projections documented in the 2015 Urban Water Management Plan. These demands were used in sizing the future infrastructure facilities, including transmission mains, storage reservoirs, and booster stations. Demands were also used for allocating and reserving capacities in the existing or proposed facilities.

ES.7 HYDRAULIC MODEL DEVELOPMENT

Hydraulic network analysis has become an effectively powerful tool in many aspects of water distribution planning, design, operation, management, emergency response planning, system reliability analysis, fire flow analysis, and water quality evaluations. The City's hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated future growth. The City's previous model was developed using Innovyze's H2OMAP, which utilizes a GIS interface and uses the effective EPANET hydraulic engine for processing the hydraulic calculations. As part of this master plan, the hydraulic model was



Legend

- City Limits
- City Limits Area
- Redevelopment Area
- Urban Service Area
- Urban Growth Boundary
- Sphere of Influence Boundary
- General Plan Area
- Roads
- Highways
- Lakes

PRELIMINARY

0 0.25 0.5 1 Mile

Updated: February 24, 2017

AKEL ENGINEERING GROUP, INC.

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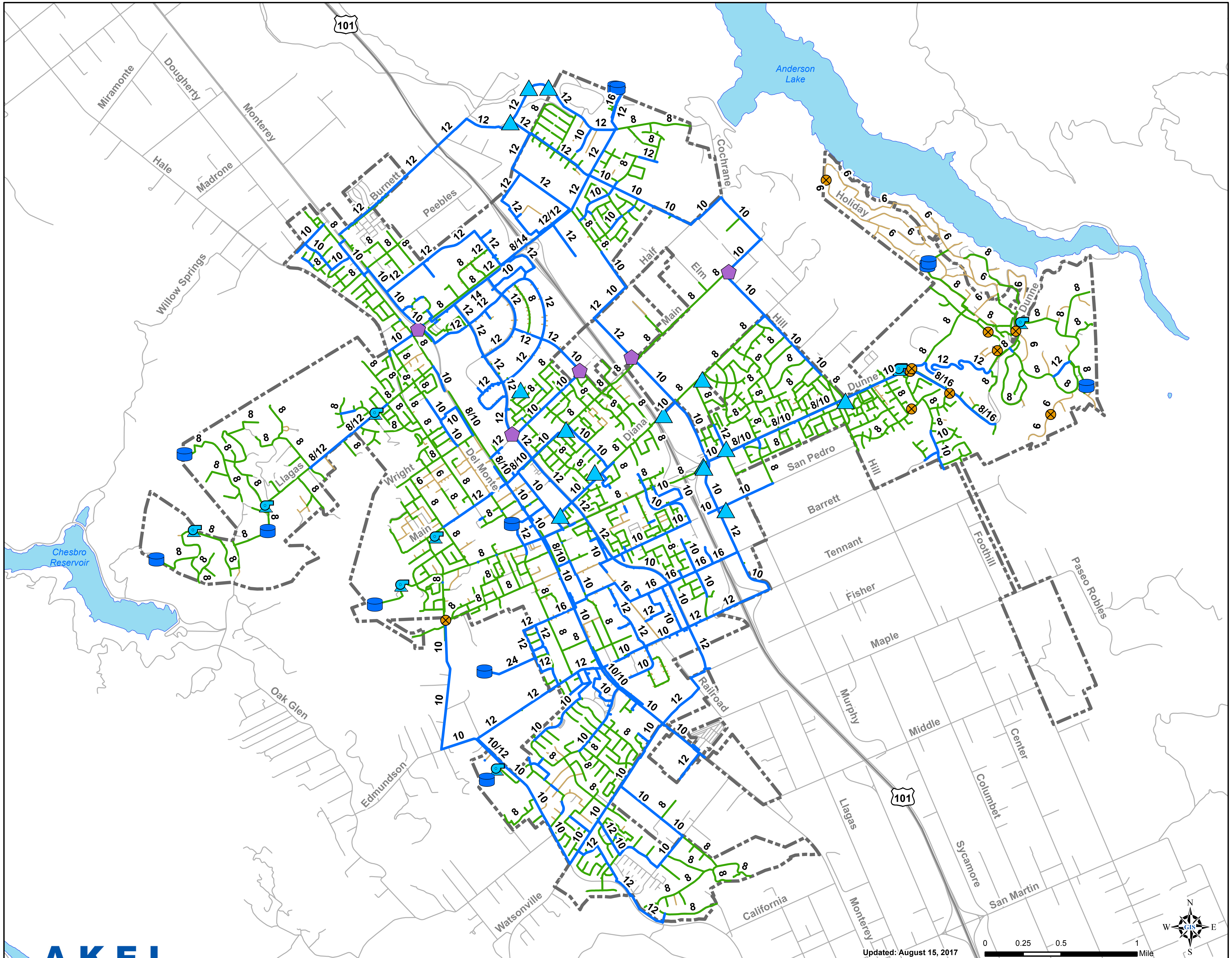
ES. 1
Planning Area

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL



Legend

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs

Pipes by Size

- 4" - 6"
- 8"
- 10" - 24"
- Roads
- City Limits
- Lakes

PRELIMINARY

ES. 2
Existing Water System

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

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Table ES.1 Planning and Design Criteria Summary

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Design Parameter	Criteria		
Supply	Supply to Meet Maximum Day Demands with Firm Capacity		
	Firm Capacity excludes largest well for possible maintenance and emergency		
	Largest well is currently Diana #2 at approximately 1,500 gpm		
	Assume Future Well Capacities at 800 gpm each.		
Storage	Total Required Storage = Operational + Fire + Emergency		
	Operational Storage	25% of Maximum Day Demand	
	Emergency Storage	25% of Maximum Day Demand	
	Fire Storage	Residential = 0.18 MG (1,500 gpm for 2 hours)	
		Commercial = 0.30 MG (2,500 gpm for 2 hours)	
		Industrial = 0.63 MG (3,500 gpm for 3 hours)	
Pump Stations	Meet Maximum Day Demand with largest unit out of service		
	Hydropneumatic systems to meet Maximum Day Demand plus fire flow		
Pressure Reducing Valves	PRVs should be designed to meet the greater of:		
	Peak Hour Demand, or Maximum Day Demand + Fire Flow		
Service Pressures	Maximum Pressure		100 psi
	Minimum Pressure (during Maximum Day)		40 psi
	Minimum Pressure (during Peak Hour)		35 psi
	Minimum Pressure for New Development[1] (during Peak Hour)		40 psi
	Minimum Residual Pressure (during Fires)		20 psi
Demand Peaking Factors	Maximum Month Demand	1.75 x Average Day Demand	
	Maximum Day Demand	2.00 x Average Day Demand	
	Peak Hour Demand	3.00 x Average Day Demand	
Fire Flows	Residential	1,500 gpm for 2 hours	
	Commercial	2,500 gpm for 2 hours	
	Industrial	3,500 gpm for 3 hours	
Urban Water Use Targets			
2015 Urban Water Management Plan	Existing Coefficient	199 gpdc	
	2015 Interim Target	179 gpdc	
	2020 Target (20% Conservation)	159 gpdc	

Note:

1/14/2016

1. Source: California Department of Public Health Title 22, Chapter 16, Article 8 "Distribution System Operation"

Table ES.2 Average Daily Demands at Buildout of Project Area
Water System Master Plan
City of Morgan Hill

PRELIMINARY

Land Use Classifications	Water Demands at 100% Occupancy: Existing Development within City Limits			Future Development within City Limits			Total Development within City Limits		Future Development Outside City Limits		Total	
	Existing Development within City Limits (net acre)	Water Unit Factor (gpd/net acre)	Existing Average Daily Demand (gpd)	Future Development (net acre)	Future Water Unit Factor (gpd/net acre)	Future Development Average Daily Demand (gpd)	Development (net acre)	Total Development Average Daily Demand (gpd)	Future Development (net acre)	Future Development Average Daily Demand (gpd)	Development (net acre)	Average Daily Demand (gpd)
Residential												
Single Family												
Residential Estate	508	560	284,420	198	560	110,769	706	395,189	321	179,976	1,027	575,166
Residential Detached Low	979	1,050	1,028,440	171	1,050	179,351	1,150	1,207,791	239	250,528	1,389	1,458,319
Residential Detached Medium	1,252	1,700	2,129,123	187	1,700	317,128	1,439	2,446,251	411	699,255	1,850	3,145,506
Residential Detached High	30	2,140	64,644	4	2,140	9,297	35	73,941	20	41,858	54	115,799
Multi-Family												
Residential Attached Low	340	1,900	646,484	114	1,900	217,466	455	863,951	2	4,117	457	868,068
Residential Attached Medium	100	2,300	229,039	53	2,300	121,701	152	350,740	7	16,903	160	367,644
Residential Attached High	1	3,130	3,130	5	3,130	15,650	6	18,780	0	0	6	18,780
Subtotal	3,211		4,385,280	732		971,363	3,943	5,356,643	1,000	1,192,638	4,943	6,549,281
Non-Residential												
General Commercial	24	1,800	43,161	0	1,800	0	24	43,161	0	0	24	43,161
Commercial	260	1,350	350,326	130	1,350	175,975	390	526,301	4	4,995	394	531,296
Commercial / Industrial[1]	501	1,120	561,296	230	1,120	257,950	731	819,245	220	246,298	951	1,065,543
Mixed Use	93	1,350	125,991	6	1,350	8,242	99	134,233	0	0	99	134,233
Mixed Use Flex	64	1,390	88,967	40	1,390	56,273	104	145,240	8	11,421	113	156,661
Sports-Recreation-Leisure	0	1,680	0	0	1,680	0	0	0	251	421,974	251	421,974
Public Facility	302	400	120,657	12	400	4,695	313	125,352	46	18,556	360	143,908
Subtotal	1,244		1,290,397	419		503,135	1,663	1,793,532	529	703,244	2,192	2,496,776
Other (Demand Generating)												
Landscape Irrigation	201	1,680	338,263	0	1,680	0	201	338,263	0	0	201	338,263
Subtotal	201		338,263	0		0	201	338,263	0	0	201	338,263
Other (Non-Demand Generating)												
Open Space	605	0	0	581	0	0	1,186	0	2,737	0	3,922	0
Subtotal	605			581			1,186	0	2,737	0	3,922	0
Totals	**5,260**		**6,013,941**	**1,732**		**1,474,498**	**6,992**	**7,488,439**	**4,267**	**1,895,882**	**11,259**	**9,384,321**

Notes
1. "Commercial / Industrial" combines land use types "Commercial / Institutional" and "Industrial"

9/19/2016

redeveloped using InfoWater, a GIS-based hydraulic model also by Innovyze. The model has an intuitive graphical interface and is directly integrated with ESRI's ArcGIS (GIS).

ES.8 PRESSURE EVALUATION

The calibrated hydraulic model was used for evaluating the system pressures throughout the distribution system during peak hour demand, maximum day demands, and maximum day demands in conjunction with fire flows. Criteria for pressure and fire flows were also summarized in the System Performance and Design Criteria chapter. Since the hydraulic model was calibrated for extended period simulations, the analysis duration was established at 24 hours for analysis.

The hydraulic model indicates that the City's existing distribution system performed reasonably well during the pressure evaluation, with few exceptions noted in the Evaluation and Proposed Improvements chapter.

ES.9 SUPPLY AND STORAGE EVALUATION

Existing and future supply requirements were identified for the City, which is required to be able to meet the maximum day demand of the existing system with firm groundwater well capacity. Based on the City's existing groundwater well firm capacity, the City is capable of meeting the existing maximum day demand; based on the anticipated future growth, the City will be required to construct two new wells by the buildout of the General Plan.

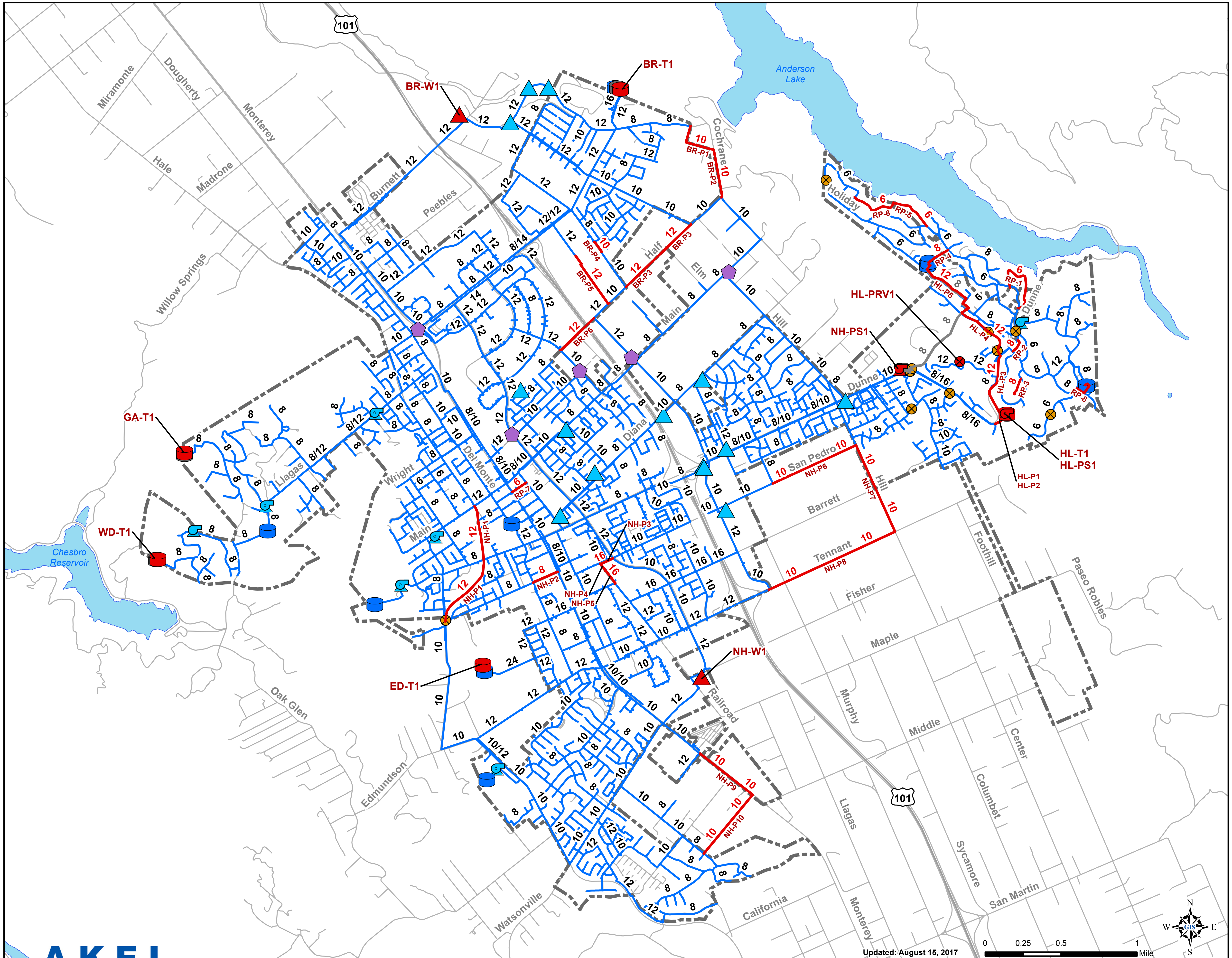
Existing storage requirements were identified for each existing pressure zone and included the operation, fire, and emergency storage components. The total City-wide required storage for existing domestic water demands is calculated at 8.7 MG.

Future storage requirements were identified based on the anticipated future growth, in each existing and future pressure zone, and will require an additional 3.3 MG of operational and emergency storage capacity.

ES.10 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program costs for the projects identified in this master plan for mitigating existing system deficiencies and for serving anticipated future growth throughout the City are summarized on **Table ES.3** and are graphically represented on **Figure ES.3**.

The estimated construction costs include the baseline costs plus **30 percent** contingency allowance to account for unforeseen events and unknown field conditions. Capital improvement costs include the estimated construction costs plus **30 percent** project-related costs (engineering design, project administration, construction management and inspection, and legal costs). The costs in this Water System Master Plan were benchmarked using a 20-City national average Engineering News Record (ENR) Construction Cost Index (CCI) of 10,532, reflecting a date of January 2017. In total, the CIP includes approximately 9.8 miles of pipeline improvements, two new wells, five new storage reservoirs, two new booster stations, a new pressure reducing valve station, as well as other plan updates and currently planned projects, with a project cost totaling over $48.4 million dollars.



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Legend

Proposed Improvements

- Tanks
- Wells
- Booster Stations
- Valves
- Pipes

To be Abandoned

- Tanks
- Booster Stations
- Pipes

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs
- Pipes
- Roads
- City Limits
- Lakes

PRELIMINARY

ES. 3
Proposed Water System Improvements

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

Table ES.3 Capital Improvement Program

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Pipeline Improvements: Existing Diameter (in)	Pipeline Improvements: New/Parallel/ Replace	Infrastructure Costs: Diameter (in)	Infrastructure Costs: Length (ft)	Infrastructure Costs: Unit Cost ($)	Infrastructure Costs: Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Const. Costs[1] ($)	Capital Improv. Costs[2] ($)	Suggested Expenditure Budget	Construction Trigger	Suggested Cost Allocation: Existing Users	Suggested Cost Allocation: Future Users	Cost Sharing: Existing Users	Cost Sharing: Future Users
Pipeline Improvements																		
Boys Ranch Pressure Zone																		
BR-P1	Boys Ranch	ROW	Cochrane Rd to Coyote Rd	-	New	10	1,600	207	331,932	331,932	431,512	560,965	2026-2030	As development occurs	0%	100%	0	560,965
BR-P2	Boys Ranch	Cochrane Rd	Half Rd to approx 1,700' n/o Half Rd	-	New	10	1,700	207	352,678	352,678	458,481	596,026	2026-2030	As development occurs	0%	100%	0	596,026
BR-P3	Boys Ranch	Half Rd	Mission View Dr to Peet Rd	-	New	12	3,150	229	720,763	720,763	936,992	1,218,089	2026-2030	As development occurs	0%	100%	0	1,218,089
BR-P4	Boys Ranch	Mission View Dr	Between Cochrane Rd and 2,100' nw/o Cochrane Rd	-	Replace	10	450	207	93,356	93,356	121,363	157,772	2018-2020	Immediate	100%	0%	157,772	0
BR-P5	Boys Ranch	Mission View Dr	Half Rd to 2,100' nw/o Half Rd	-	New	12	2,100	229	480,508	480,508	624,661	812,059	2026-2030	As development occurs	0%	100%	0	812,059
BR-P6	Boys Ranch	Half Rd	Serene Dr to Conduit Rd	-	New	12	1,650	229	377,542	377,542	490,805	638,047	2026-2030	As development occurs	0%	100%	0	638,047
						Subtotal - Boys Ranch Pressure Zone				**2,356,780**	**3,063,814**	**3,982,958**					**157,772**	**3,825,186**
Nob Hill Pressure Zone																		
NH-P1	Nob Hill	Hale Ave Extension	Spring Ave to Main Ave	-	New	12	4,550	229	1,041,102	1,041,102	1,353,432	1,759,462	2021-2025	As development occurs	100%	0%	1,759,462	0
NH-P2	Nob Hill	Spring Ave	Del Monte Ave to Monterey Rd	4	Replace	8	950	180	171,000	171,000	222,300	288,990	2018-2020	As development occurs	100%	0%	288,990	0
NH-P3	Nob Hill	San Pedro Ave	Butterfield Blvd to Railroad Ave	10	Replace	16	550	276	151,856	151,856	197,413	256,637	2021-2025	As development occurs	100%	0%	256,637	0
NH-P4	Nob Hill	Railroad Ave	San Pedro Ave to approx 600' n/o Mast St	10	Replace	16	350	276	96,636	96,636	125,626	163,314	2021-2025	As development occurs	0%	100%	0	163,314
NH-P5	Nob Hill	Railroad Ave	Approx 600' n/o Mast St to Mast St	6	Replace	16	600	276	165,661	165,661	215,359	279,967	2021-2025	As development occurs	0%	100%	0	279,967
NH-P6	Nob Hill	San Pedro Ave	Peppertree Dr to Hill Rd	-	New	10	3,200	207	663,864	663,864	863,024	1,121,931	2031-2035	As development occurs	0%	100%	0	1,121,931
NH-P7	Nob Hill	Hill Rd	San Pedro Ave to Tennant Ave	-	New	10	3,300	207	684,610	684,610	889,993	1,156,991	2031-2035	As development occurs	0%	100%	0	1,156,991
NH-P8	Nob Hill	Tennant Ave	Hill Rd to Conduit Rd	-	New	10	4,850	207	1,006,169	1,006,169	1,308,020	1,700,426	2031-2035	As development occurs	0%	100%	0	1,700,426
NH-P9	Nob Hill	Monterey Rd	John Wilson Way to Middle Ave	-	New	10	2,350	207	487,525	487,525	633,783	823,918	2031-2035	As development occurs	0%	100%	0	823,918
NH-P10	Nob Hill	ROW	Monterey Rd to Olive Ave	-	New	10	2,700	207	560,136	560,136	728,176	946,629	2031-2035	As development occurs	0%	100%	0	946,629
RP-7	Nob Hill	First St	From Monterey Rd to Depot St	6	Replace	6	600	160	96,000	96,000	124,800	162,240	2018-2020	Immediate	100%	0%	162,240	0
						Subtotal - Nob Hill Pressure Zone				**5,124,559**	**6,661,927**	**8,660,505**					**2,467,328**	**6,193,177**
Holiday Pressure Zones																		
HL-P1	Holiday 1	Dunne Ave	Flaming Oak Ln to Proposed E Dunne Tank	-	New	16	550	276	151,856	151,856	197,413	256,637	2018-2020	E. Dunne Pump Station 2 and 3 Abandonement	40%	60%	102,655	153,982
HL-P2	Holiday 1	Dunne Ave	Proposed E Dunne Tank to Flaming Oak Ln	-	New	12	550	229	125,847	125,847	163,602	212,682	2018-2020	E. Dunne Pump Station 2 and 3 Abandonement	40%	60%	85,073	127,609
HL-P3	Holiday Lake	Dunne Ave	Proposed E Dunne Tank to Flaming Oak Ln	-	New	12	2,450	229	560,593	560,593	728,771	947,403	2018-2020	Holiday Pump Station Construction	0%	100%	0	947,403
HL-P4	Holiday Lake	Oak Leaf Dr	Dunne Ave to 650' w/o Lori Dr	-	New	12	2,300	229	526,271	526,271	684,153	889,398	2021-2025	Holiday Pump Station Construction	0%	100%	0	889,398
HL-P5	Holiday Lake	Lake View Dr	Oak Leaf Dr to Holiday Lake Tanks	8	Replace	12	2,850	229	652,119	652,119	847,754	1,102,081	2021-2025	Holiday Pump Station Construction	0%	100%	0	1,102,081
RP-1	Holiday Lake	Shady Ln	From Holiday Dr to Holiday Dr	6	Replace	6	2,550	160	408,000	408,000	530,400	689,520	2018-2020	Immediate	100%	0%	689,520	0
RP-4	Holiday Lake	Holiday Tank Site	From Holiday Lake Tanks to Manzanita Dr	8	Replace	8	800	180	144,000	144,000	187,200	243,360	2018-2020	Immediate	100%	0%	243,360	0
RP-5	Holiday Lake	Manzanita Dr	From Holiday Dr to end of Manzanita Dr	6	Replace	6	1,650	160	264,000	264,000	343,200	446,160	2018-2020	Immediate	100%	0%	446,160	0
RP-6	Holiday Lake	Raccoon Ct	From Holiday Ct to end of Manzanita Dr	6	Replace	6	1,700	160	272,000	272,000	353,600	459,680	2018-2020	Immediate	100%	0%	459,680	0
						Subtotal - Holiday Pressure Zones				**3,104,686**	**4,036,092**	**5,246,920**					**2,026,447**	**3,220,473**

Table ES.3 Capital Improvement Program

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Pipeline Improvements: Existing Diameter (in)	Pipeline Improvements: New/Parallel/Replace	Infrastructure Costs: Diameter (in)	Infrastructure Costs: Length (ft)	Infrastructure Costs: Unit Cost ($)	Infrastructure Costs: Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Const. Costs[1] ($)	Capital Improv. Costs[2] ($)	Suggested Expenditure Budget	Construction Trigger	Suggested Cost Allocation: Existing Users	Suggested Cost Allocation: Future Users	Cost Sharing: Existing Users	Cost Sharing: Future Users
Jackson Oaks Pressure Zones																		
RP-2	Jackson Oaks	Hill Top Ct	From Jackson Oaks Dr to approx 550' ne/o Jackson Oaks Dr	8	Replace	8	550	180	99,000	99,000	128,700	167,310	2018-2020	Immediate	100%	0%	167,310	0
RP-3	Jackson Oaks	Oak View Ct	From Jackson Oaks Dr to approx 700' s/o Jackson Oaks Dr	8	Replace	8	700	180	126,000	126,000	163,800	212,940	2018-2020	Immediate	100%	0%	212,940	0
RP-8	Hydropneumatic Zone	Oak Canyon Dr	From Jackson Oaks Hydropneumatic tank to Jackson Oaks Dr	8	Replace	8	600	180	108,000	108,000	140,400	182,520	2018-2020	Immediate	100%	0%	182,520	0
						Subtotal - Jackson Oaks Pressure Zones				**333,000**	**432,900**	**562,770**					**562,770**	**0**
						Subtotal - Pipeline Improvements				**10,919,025**	**14,194,733**	**18,453,153**					**5,214,317**	**13,238,836**
Storage Reservoir Improvements						**Proposed Storage Capacity (MG)**												
BR-T1	Boys Ranch	Demolish existing 0.55 MG Boys Ranch tank and replace with 1.20 MG tank			Replace		1.20		2,063,412	2,063,412	2,682,436	3,487,167	2026-2030	420 EDUs	30%	70%	1,046,150	2,441,017
GA-T1	Glen Ayre	Demolish existing 0.10 MG Glen Ayre tank and replace with 0.25 MG tank			Replace		0.25		537,347	537,347	698,551	908,116	2021-2025	Immediate	80%	20%	726,493	181,623
ED-T1	Nob Hill	Existing Edmundson tank site			New		0.90		1,934,449	1,934,449	2,514,784	3,269,219	2026-2030	2,350 EDUs	0%	100%	0	3,269,219
WD-T1	Woodland	Demolish existing 0.03 MG Woodland tank and replace with 0.25 MG tank			Replace		0.25		537,347	537,347	698,551	908,116	2021-2025	Immediate	70%	30%	635,681	272,435
HL-T1	Holiday 1	Dunne Ave approx 500' ne/o Flaming Oak Ln			New		0.85		1,826,980	1,826,980	2,375,073	3,087,596	2018-2020	E. Dunne Pump Station 1, 2, and 3 Abandonement	40%	60%	1,235,038	1,852,557
						Subtotal - Storage Reservoir Improvements				**6,899,535**	**8,969,395**	**11,660,214**					**3,643,363**	**8,016,851**
Groundwater Well Improvements						**Proposed Pumping Capacity (gpm)**												
BR-W1	Boys Ranch	Burnett Ave	Approx 6,000' ne/o Monterey Ave		New		800		2,340,000	2,340,000	3,042,000	3,954,600	2031-2035	As development occurs	0%	100%	0	3,954,600
NH-W2	Nob Hill	Butterfield Blvd	400' E of Railroad Ave and Fisher Ave		New		800		2,340,000	2,340,000	3,042,000	3,954,600	2031-2035	As development occurs	0%	100%	0	3,954,600
						Subtotal - Groundwater Well Improvements				**4,680,000**	**6,084,000**	**7,909,200**					**0**	**7,909,200**
Pump Station Improvements						**Proposed Capacity (gpm)**												
NH-PS1	Nob Hill	Dunne Ave and Magnolia Wy			New		3 @ 900 gpm		1,300,533	1,300,533	1,690,692	2,197,900	2018-2020	E. Dunne Pump Station 1, 2, and 3 Abandonement	40%	60%	879,160	1,318,740
HL-PS1	Holiday 1	Dunne Ave approx 500' ne/o Flaming Oak Ln			New		4 @ 550 gpm		1,113,467	1,113,467	1,447,507	1,881,759	2021-2025	Holiday Tank Construction	90%	10%	1,693,583	188,176
						Subtotal - Pump Station Improvements				**2,413,999**	**3,138,199**	**4,079,659**					**2,572,743**	**1,506,916**
Pressure Reducing Valve Improvements						**Proposed Size (in)**												
HL-PRV1	Holiday 1	Thomas Gr approx 1,100' w/o Gnarled Oak Ln			New		3		47,300	47,300	61,490	79,937	2018-2020	Holiday Tank Construction	40%	60%	31,975	47,962
						Subtotal - Pressure Reducing Valve Improvements				**47,300**	**61,490**	**79,937**					**31,975**	**47,962**
Comprehensive Plan Updates																		
Water System Master Plan Updates (Years 2021, 2026, 2031, 2036)									200,000	-	-	800,000	2021, 2026, 2031, 2036		65%	35%	520,000	280,000
Urban Water Management Plan Updates (Years 2021, 2026, 2031, 2036)									100,000	-	-	400,000	2021, 2026, 2031, 2036		65%	35%	260,000	140,000
Water Rate Study Updates (Years 2021, 2026, 2031, 2036)									100,000	-	-	400,000	2021, 2026, 2031, 2036		65%	35%	260,000	140,000
						Subtotal - Comprehensive Plan Updates						**1,600,000**					**1,040,000**	**560,000**

Table ES.3 Capital Improvement Program

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Pipeline Improvements		Infrastructure Costs				Baseline Constr. Costs ($)	Estimated Const. Costs[1] ($)	Capital Improv. Costs[2] ($)	Suggested Expenditure Budget	Construction Trigger	Suggested Cost Allocation		Cost Sharing	
				Existing Diameter (in)	New/Parallel/ Replace	Diameter (in)	Length (ft)	Unit Cost ($)	Infr. Cost ($)						Existing Users	Future Users	Existing Users	Future Users
Currently Planned Projects																		
El Toro Tank Improvements										-	-	300,000	2018-2020		100%	0%	300,000	0
Water Supply Planning										-	-	1,000,000	2018-2020		65%	35%	650,000	350,000
Water Supply Facility Improvements										-	-	1,650,000	2018-2020		100%	0%	1,650,000	0
Well Demolition and Abandonment										-	-	400,000	2018-2020		100%	0%	400,000	0
Reservoir Recoating										-	-	200,000	2021-2025		100%	0%	200,000	0
Generator Replacement										-	-	1,000,000	2018-2020		100%	0%	1,000,000	0
Holiday Tank #2 Repair										-	-	90,000	2018-2020		100%	0%	90,000	0
									Subtotal - Currently Planned Projects			**4,640,000**					**4,290,000**	**350,000**
Total Improvement Cost																		
									Pipeline Improvements	**10,919,025**	**14,194,733**	**18,453,153**					**5,214,317**	**13,238,836**
									Storage Reservoirs	**6,899,535**	**8,969,395**	**11,660,214**					**3,643,363**	**8,016,851**
									Groundwater Wells	**4,680,000**	**6,084,000**	**7,909,200**					**0**	**7,909,200**
									Pump Stations	**2,413,999**	**3,138,199**	**4,079,659**					**2,572,743**	**1,506,916**
									Pressure Reducing Valves	**47,300**	**61,490**	**79,937**					**31,975**	**47,962**
									Comprehensive Plan Updates	**-**	**-**	**1,600,000**					**1,040,000**	**560,000**
									Currently Planned Projects	**-**	**-**	**4,640,000**					**4,290,000**	**350,000**
									Total Improvement Costs	**24,959,859**	**32,447,817**	**48,422,162**					**16,792,398**	**31,629,765**

8/15/2017

Notes:

1. Baseline construction costs plus 30% to account for unforeseen events and unknown conditions.
2. Estimated construction costs plus 30% to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.

CHAPTER 1 - INTRODUCTION

This chapter provides a brief background of the City's domestic water system, the need for this master plan, and the objectives of the study. Abbreviations and definitions are also provided in this chapter.

1.1 BACKGROUND

The City of Morgan Hill (City) is located approximately 22 miles southeast of the City of San Jose, and 8 miles northwest of the City of Gilroy (Figure 1.1). The City provides potable water service to more than 42,000 residents, as well as a myriad of commercial, industrial, and institutional establishments. The City operates a domestic water distribution system that consists of 16 groundwater wells, 12 storage tanks equating to 10.5 million gallons in storage, and over 177 miles of distribution pipelines.

In 2002, the City developed a Water System Master Plan (WSMP) that identified capacity deficiencies in the existing water system and recommended improvements to alleviate existing deficiencies and serve future developments in the Urban Growth Boundary.

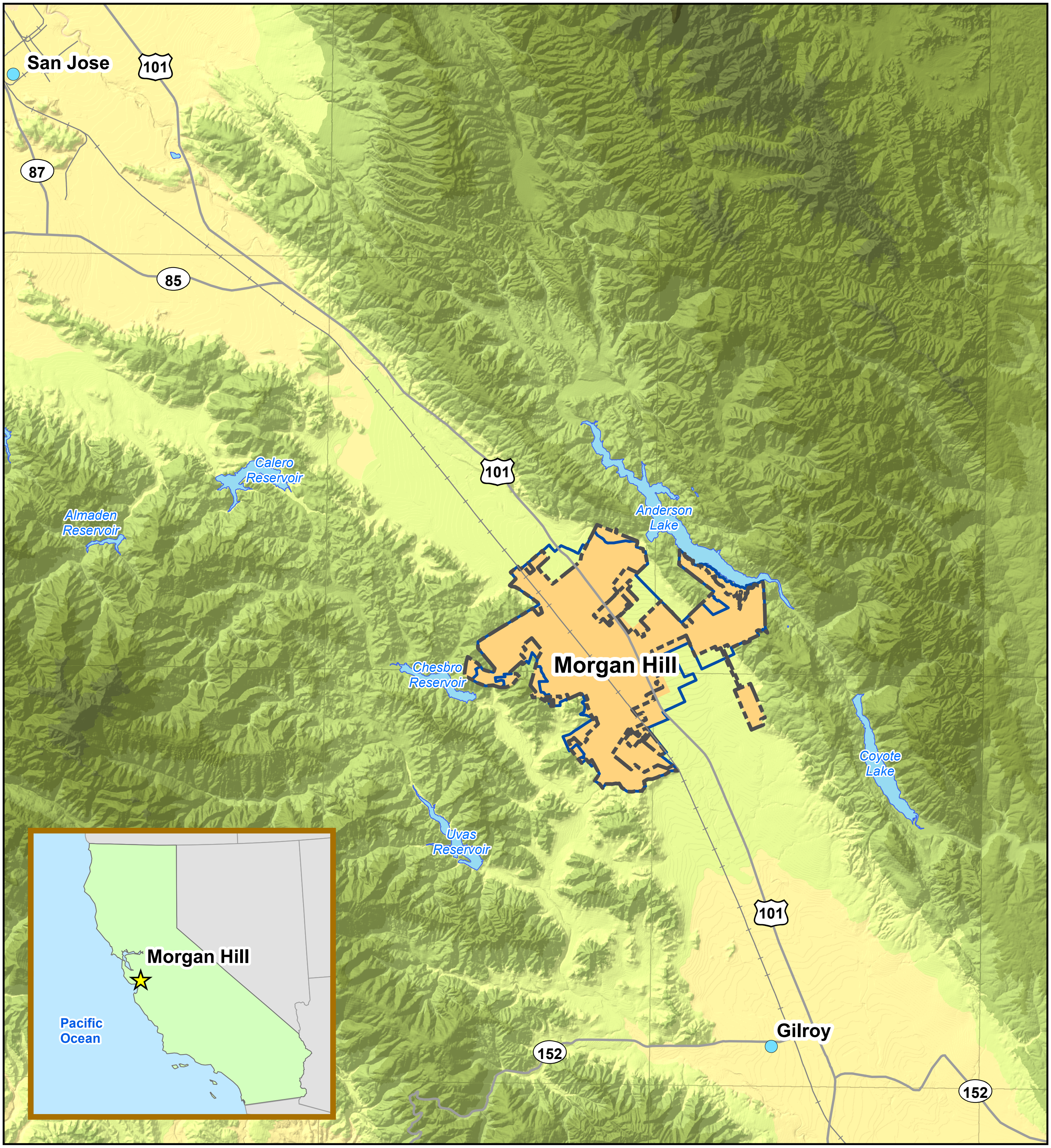
The City recognizes the importance of planning, developing, and financing the water system infrastructure. The City retained the services of Placeworks to develop a comprehensive, long-term General Plan for the orderly development of the community, while integrating the City's social, economic, and environmental goals. On July 27, 2016, the City Council adopted the Morgan Hill 2035 General Plan, a comprehensive update of the City's General Plan.

1.2 SCOPE OF WORK

As a part of the General Plan update, the City also initiated the update of the infrastructure master plans. These master plans, which were closely coordinated and paralleled the preparation of the General Plan, included:

- 2017 Water System Master Plan
- 2017 Sewer System Master Plan
- 2017 Storm Drainage System Master Plan

City Council approved the preparation of the General Plan in June of 2013, which included authorizing Akel Engineering Group Inc. to prepare this master plan. The 2017 WSMP evaluates the City's water system and recommends capacity improvements necessary to service the needs of existing users and for servicing the future growth of the City. This 2017 WSMP is intended to serve as a tool for planning and phasing the construction of future domestic water system infrastructure for the projected buildout of the City of Morgan Hill. The area and horizon for the master plan is stipulated in the City's General Plan. Should planning conditions change, and



Legend

- Cities
- Study Area
- City Limits
- Urban Growth Boundary
- Highways
- Railroads
- Lakes

Elevation (ft)

- 100 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 2,000
- 2,001 - 3,000
- 3,001 - 4,000
- > 4,000

PRELIMINARY

0 0.5 1 2 Miles

N W E S GIS

Updated: January 6, 2016

AKEL ENGINEERING GROUP, INC.

Figure 1.1
Regional Location Map

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

File Path: P:\xGIS\GIS_Projects\Morgan_Hill\Water\WSMP\MH_Fig1-1ProjLoc_010616.mxd depending on their magnitude, adjustments to the master plan recommendations might be necessary.

This master plan included the following tasks:

- Summarizing the City's existing domestic water system facilities
- Documenting growth planning assumptions and known future developments
- Updating the domestic water system performance criteria
- Projecting future domestic water demands
- Updating and calibrating a new hydraulic model using Geographic Information Systems (GIS) data
- Evaluating the domestic water facilities to meet existing and projected demand requirements and fire flows
- Evaluating the existing groundwater conditions
- Performing a capacity analysis for major distribution mains
- Performing a fire flow analysis
- Recommending a capital improvement program (CIP) with an opinion of probable costs
- Performing a capacity allocation analysis for cost sharing purposes
- Developing a 2017 Water System Master Plan report

1.3 INTEGRATED APPROACH TO MASTER PLANNING

The City implemented an integrated master planning approach and contracted the services of Akel Engineering Group to prepare the following documents:

- Water System Master Plan
- Sanitary Sewer System Master Plan
- Storm Drainage System Master Plan

While each of these reports is published as a standalone document, they have been coordinated for consistency with the City's General Plan. Additionally, each document has been cross referenced to reflect relevant analysis results with the other documents.

1.4 PREVIOUS MASTER PLANS

The City's most recent WSMP was completed in 2002. This master plan included an evaluation of servicing growth to the planning area boundary, evaluated existing demands and projected future demands, evaluated groundwater conditions and management, and recommended phased improvements to the water system for a horizon year of 2020.

1.5 RELEVANT REPORTS

The City has completed several special studies intended to evaluate localized growth. These reports were referenced and used during this capacity analysis. The following lists relevant reports that were used in the completion of this master plan, as well as a brief description of each document:

- **City of Morgan Hill Water System Master Plan, January 2002 (2002 WSMP).** This report documents the planning and performance criteria, evaluates the sewer system, recommends improvements, and provides an estimate of costs.

- **City of Morgan Hill 2035 General Plan, July 2016 (2035 General Plan).** The City's 2035 General Plan provides future land use planning, and growth assumptions for the planning areas. Additionally, this report establishes the planning horizon for improvements in this master plan.

- **Recycled Water Feasibility Evaluation, March 2016 (2016 RWFE).** The Recycled Water Feasibility Evaluation (RWFE) identified potential recycled water users through a market assessment. As part of the RWFE, infrastructure required to convey recycled water from the SCRWA WWTP in Gilroy to the potential users in Morgan Hill was identified. However, there are currently no plans to construct infrastructure for the purpose of providing recycled water to any of the identified potential users.

- **2015 Urban Water Management Plan (2015 UWMP).** The 2015 Urban Water Management Plan (UWMP) establishes a benchmark per capita water usage and targets in order to achieve higher levels of water conservation for the sustainability of water supply sources. This includes adopting an updated water shortage contingency plan, defining supply sources, addressing supply reliability, and projecting sustainable supply yields and future demands.

1.6 REPORT ORGANIZATION

The water system master plan report contains the following chapters:

Chapter 1 - Introduction. This chapter provides a brief background of the City's domestic water system, the need for this master plan, and the objectives of the study. Abbreviations and definitions are also provided in this chapter.

Chapter 2 - Planning Areas Characteristics. This chapter presents a discussion of the planning area characteristics for this master plan and defines the land use classifications. The planning area is divided into several planning sub-areas, as established by the City's planning division.

Chapter 3 - System Performance and Design Criteria. This chapter presents the City's performance and design criteria, which was used in this analysis for identifying current system capacity deficiencies and for sizing proposed distribution mains, storage reservoirs, and wells.

Chapter 4 - Existing Domestic Water Facilities. This chapter provides a description of the City's existing domestic water system facilities including the existing wells, pressure zones, distribution mains, storage reservoirs, and booster pump stations.

Chapter 5 - Water Demands and Supply Characteristics. This chapter summarizes existing domestic water demands, identifies potential recycled water demands, and projects the future domestic water demands.

Chapter 6 - Hydraulic Model Development. This chapter describes the development and calibration of the City's domestic water distribution system hydraulic model. The hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated future growth.

Chapter 7 - Evaluation and Proposed Improvements. This section presents a summary of the domestic water system evaluation and identifies improvements needed to mitigate existing deficiencies, as well as improvements needed to expand the system and service growth.

Chapter 8 - Capital Improvement Program. This chapter provides a summary of the recommended domestic water system improvements to mitigate existing capacity deficiencies and to accommodate anticipated future growth. The chapter also presents the cost criteria and methodologies for developing the capital improvement program. Finally, a capacity allocation analysis, usually used for cost sharing purposes, is also included.

1.7 ACKNOWLEDGEMENTS

Obtaining the necessary information to successfully complete the analysis presented in this report, and developing the long term strategy for mitigating the existing system deficiencies and for accommodating future growth, was accomplished with the strong commitment and very active input from dedicated team members including:

- Karl Bjarke, Public Works Director/City Engineer
- Dan Repp, Deputy Director of Utility Services
- Scott Creer, Deputy Director for Engineering
- John Baty, Senior Planner
- David Gittleson, Associate Engineer
- Mark Rauscher, Engineering Technician

1.8 UNIT CONVERSIONS AND ABBREVIATIONS

Engineering units were used in reporting flow rates and volumes pertaining to the design and operation of various components of the domestic water distribution system. Where it was necessary to report values in smaller or larger quantities, different sets of units were used to describe the same parameter. Values reported in one set of units can be converted to another set of units by applying a multiplication factor. A list of multiplication factors for units used in this report is shown on **Table 1.1**. Various abbreviations and acronyms were also used in this report to represent relevant water system terminologies and engineering units. A list of abbreviations and acronyms is included in **Table 1.2**.

1.9 GEOGRAPHIC INFORMATION SYSTEMS

This master planning effort made extensive use of Geographic Information Systems (GIS) technology, for completing the following tasks:

- Develop the physical characteristics of the hydraulic model (pipes and junctions, wells, and storage reservoirs)
- Allocate existing water demands, as extracted from the water billing records, and based on each user's physical address.
- Calculate and allocating future water demands, based on future developments water use
- Extract ground elevations along the distribution mains from available contour maps

Generate maps and exhibits used in this master plan

Table 1.1 Unit Conversions

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Volume Unit Calculations		
To Convert From:	To:	Multiply by:
acre feet	gallons	325,851
acre feet	cubic feet	43,560
acre feet	million gallons	0.3259
cubic feet	gallons	7.481
cubic feet	acre feet	2.296×10^{-5}
cubic feet	million gallons	7.481×10^{-6}
gallons	cubic feet	0.1337
gallons	acre feet	3.069×10^{-6}
gallons	million gallons	1×10^{-6}
million gallons	gallons	1,000,000
million gallons	cubic feet	133,672
million gallons	acre feet	3.069

Flow Rate Calculations		
To Convert From:	To:	Multiply By:
ac-ft/yr	mgd	8.93×10^{-4}
ac-ft/yr	cfs	1.381×10^{-3}
ac-ft/yr	gpm	0.621
ac-ft/yr	gpd	892.7
cfs	mgd	0.646
cfs	gpm	448.8
cfs	ac-ft/yr	724
cfs	gpd	646300
gpd	mgd	1×10^{-6}
gpd	cfs	1.547×10^{-6}
gpd	gpm	6.944×10^{-4}
gpd	ac-ft/yr	1.12×10^{-3}
gpm	mgd	1.44×10^{-3}
gpm	cfs	2.228×10^{-3}
gpm	ac-ft/yr	1.61
gpm	gpd	1,440
mgd	cfs	1.547
mgd	gpm	694.4
mgd	ac-ft/yr	1,120
mgd	gpd	1,000,000

Table 1.2 Abbreviations and Acronyms

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Abbreviation	Expansion	Abbreviation	Expansion
2002 WSMP	2002 Water System Master Plan	GIS	Geographic Information Systems
2016 WSMP	2016 Water System Master Plan	gpd	gallons per day
AACE International	Association for the Advancement of Cost Engineering	gpdc	gallons per day per capita
AC	acre	gpm	gallons per minute
ACP	Asbestos Cement Pipe	hp	horsepower
ADD	average day demand	HGL	hydraulic grade line
Akel	Akel Engineering Group, Inc.	HWL	high water level
CCI	Construction Cost Index	in	inch
CDPH	California Department of Public Health	LAFCO	Local Agency Formation Commission
cfs	cubic feet per second	LF	linear feet
CI	cast iron pipe	MDD	maximum day demand
CIB	Capital Improvement Budget	MG	million gallons
CIP	Capital Improvement Program	MGD	million gallons per day
City	City of Morgan Hill	MMD	maximum month demand
County	Santa Clara County	NFPA	National Fire Protection Association
DIP	Ductile Iron Pipe	PHD	peak hour demand
DU	dwelling unit	PRV	pressure reducing valve
EDU	equivalent dwelling unit	psi	pounds per square inch
ENR	Engineering News Record	ROW	Right of Way
EPA	Environmental Protection Agency	SCADA	Supervisory Control and Data Acquisition
EPS	Extended Period Simulation	SCVWD	Santa Clara Valley Water District
FRC	Facility Reserve Charge	SOI	Sphere of Influence
ft	feet	TBD	to be determined
fps	feet per second	ULL	Urban Limit Line
FY	Fiscal Year	WSMP	Water System Master Plan

CHAPTER 2 - PLANNING AREA CHARACTERISTICS

This chapter presents a discussion of the planning area characteristics for this master plan and defines the land use classifications. The planning area is divided into several planning sub-areas, as established by the City's planning division.

2.1 STUDY AREA DESCRIPTION

The City of Morgan Hill is located in Santa Clara County, approximately 22 miles southeast of the City of San Jose and 24 miles northwest of the city of Hollister. The City's closest neighbor, the City of Gilroy, is located 8 miles to the southeast. U.S. Route 101 bisects the eastern boundary of the City in the north-south direction. The City limits currently encompass 12.9 square miles, with an approximate population of 42,000 residents.

The City is generally bound to the north by Tilton Avenue, to the east by Anderson Lake, to the southeast by Foothill Avenue, to the west by Sunnyside Drive, and to the south by Middle Avenue. There are several creeks flowing through and along the boundaries of the City, including: Fisher Creek, West Little Llagas Creek, and Llagas Creek. The topography is generally flat in the valley portion of the city, with increasing slopes in east and west side of the city due to the Santa Cruz Mountain to the west and the Diablo Range to the east. The unincorporated community of San Martin is located to the south of the City. **Figure 2.1** displays the planning area showing City Limits, the Urban Growth Boundary of the City, and the City's Sphere of Influence Boundary.

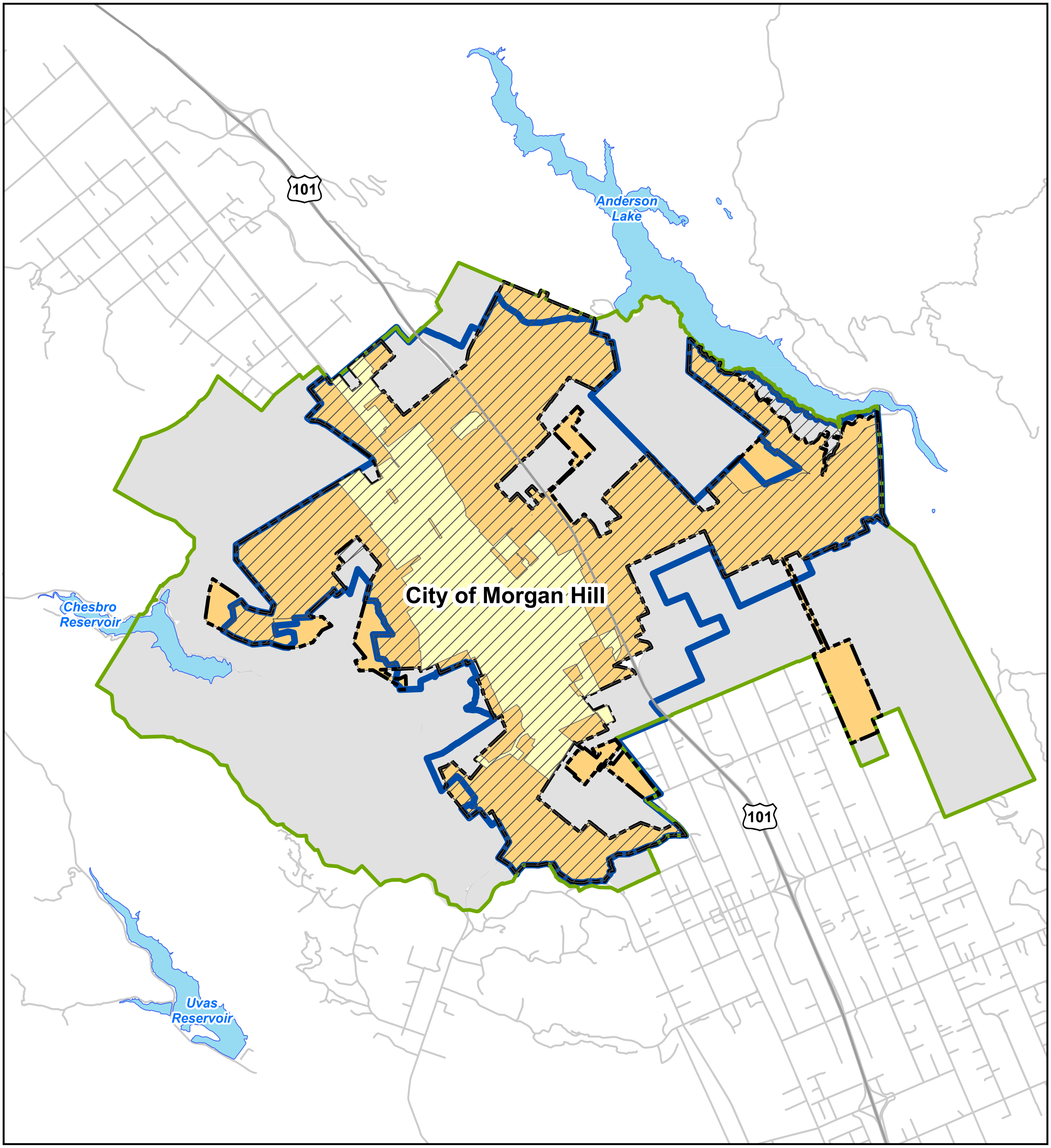
The City operates and maintains a domestic water system that covers the majority of the area within the City Limits. Currently, the water demands are provided from groundwater wells located throughout the City.

2.2 WATER SERVICE AREA AND LAND USE

The City's water system services residential and non-residential lands primarily within the City limits, as summarized on **Table 2.1**. This service area includes:

- 5,260 net acres of developed lands inside the service area.
- 1,732 net acres of undeveloped lands inside the service area.

The existing land use statistics were based on information received from Placeworks staff, the planning firm responsible for preparing the 2035 General Plan, and are shown on **Figure 2.2**. At the buildout of the Urban Growth Boundary of the General Plan, the City's water system is anticipated to service approximately 4,943 acres of residential land use and 2,393 acres of non-residential land use for a total water service area of 7,337 acres (**Table 2.1**). The land use designations utilized in this master plan are consistent with the Land Use Element of the City's General Plan, and as received from the City's planning division and shown on **Figure 2.3**.



Legend

- City Limits
- City Limits Area
- Redevelopment Area
- Urban Service Area
- Urban Growth Boundary
- Sphere of Influence Boundary
- General Plan Area
- Roads
- Highways
- Lakes

PRELIMINARY

Updated: February 24, 2017

0 0.25 0.5 1 Mile

N W E S GIS

Figure 2.1
Planning Area

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.

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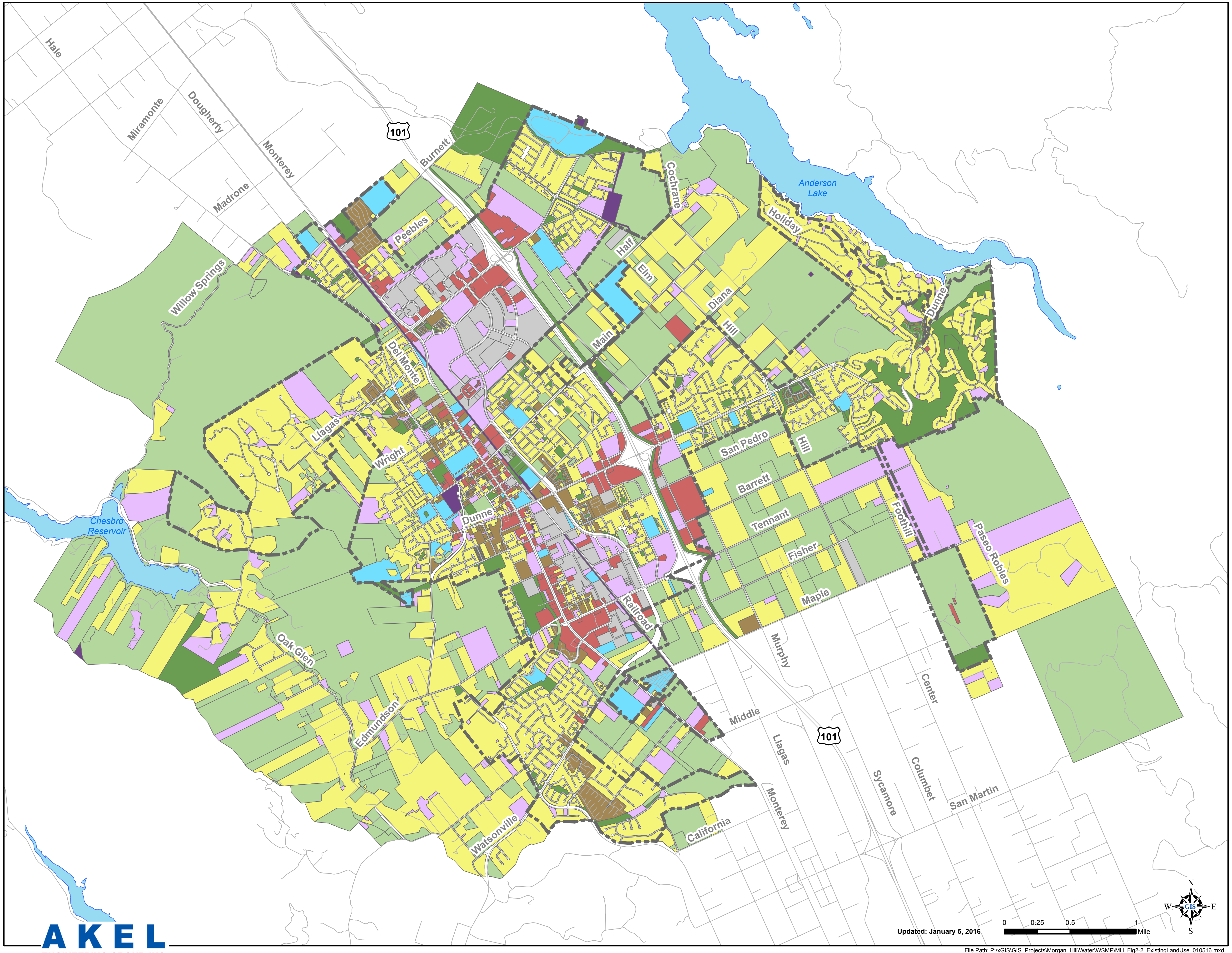

Figure 2.2
Existing Land Use
Water System Master Plan
City of Morgan Hill

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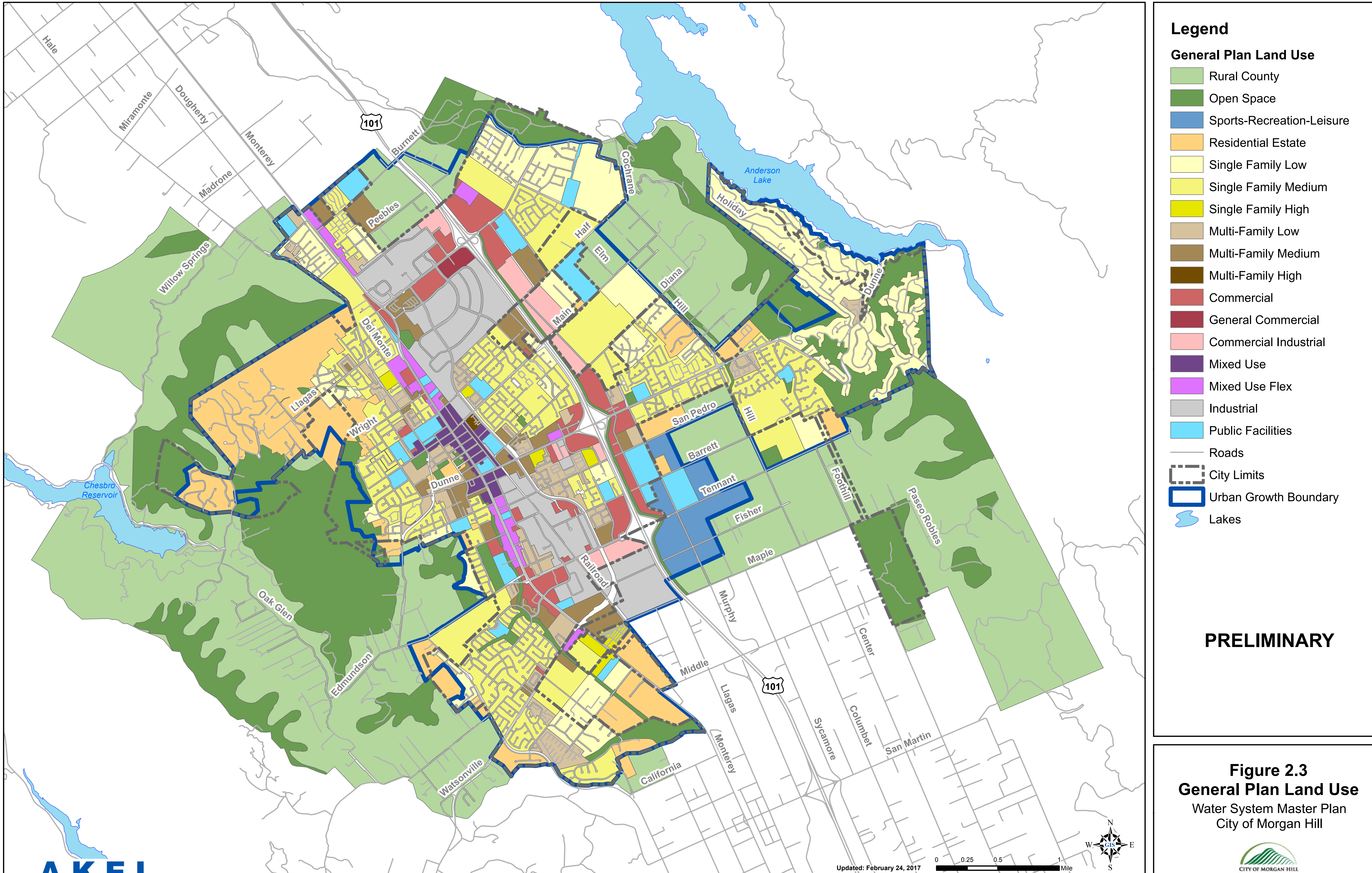

Figure 2.3
General Plan Land Use
Water System Master Plan
City of Morgan Hill

Table 2.1 Existing and Future Water Service Areas

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Land Use Classification	Existing Service Area (City Limits)		Development Outside City Limits	
	Developed (net acres)	Undeveloped (net acres)	Developed (net acres)	Undeveloped (net acres)
Residential				
Rural County	0	0	3,966	2,435
Residential Estate	508	198	228	94
Single Family Low	979	171	169	70
Single Family Medium	1,252	187	294	117
Single Family High	30	4	7	12
Subtotal - Single Family Residential	2,770	560	4,664	2,728
Multi-Family Low	340	114	2	0
Multi-Family Medium	100	53	0	7
Multi-Family High	1	5	0	0
Subtotal - Multi-Family Residential	441	173	2	7
Subtotal - Residential	**3,211**	**732**	**4,666**	**2,736**
Non-Residential				
General Commercial	24	0	0	0
Commercial	260	130	4	0
Commercial / Industrial[1]	501	230	145	75
Mixed Use	93	6	0	0
Mixed Use Flex	64	40	8	0
Sports-Recreation-Leisure	0	0	212	39
Public Facility	302	12	46	0
Subtotal - Non-Residential	**1,244**	**419**	**416**	**113**
Other				
Landscape Irrigation	201	0	0	0
Open Space	605	581	1,409	1,328
Subtotal - Other	**806**	**581**	**1,409**	**1,328**
Total	**5,260**	**1,732**	**6,491**	**4,177**

AKEL ENGINEERING GROUP, INC.

9/19/2016

Note:

1. "Commercial / Industrial" combines land use types "Commercial / Institutional" and "Industrial"

HISTORICAL AND FUTURE GROWTH

The City is a growing community, with over 2 percent of the Santa Clara County population residing within the City limits. DOF records estimate the 2015 population at more than 42,000. Between 1970 and 1980 the City saw dramatic growth, with the population increasing from 5,579 to 16,924 at an average annual growth rate of approximately 18 percent. This rapid growth led to the City's adoption of a growth management system, known as the Residential Development Control System (RDCS), which regulates growth by limiting the number of new homes approved annually. Following the implementation of the RDCS the average annual growth rate between 1980 and 2000 fell to approximately 4.7 percent. From 2000 to present the City has observed an average annual growth rate of approximately 2.4 percent.

The General Plan Update anticipates a 2035 population of 58,200 and this 2017 WSMP is consistent with the General Plan projections. The current and projected service area population is summarized in **Table 2.2**; it should be noted that projected service area populations are consistent with the City's 2015 UWMP.

The City's RDCS sets a maximum number of annual housing allotments that would not be exceeded and can only be reduced. Furthermore, if the number of allotments is reduced in a given year, they cannot be added to a future year. The population limit, which is a ceiling and not a target, is then a function of the maximum number of allotments.

Table 2.2 Historical and Projected Population
Water System Master Plan
City of Morgan Hill

PRELIMINARY

Year	Population[1]	Percent Growth (%)	Dwelling Units Added[2,3] (DU/year)
Historical			
2000	33,586	-	-
2001	33,914	1.0%	105
2002	34,210	0.9%	95
2003	34,109	-0.3%	-32
2004	34,618	1.5%	164
2005	35,011	1.1%	126
2006	35,535	1.5%	168
2007	36,467	2.6%	300
2008	37,107	1.8%	206
2009	37,653	1.5%	176
2010	37,882	0.6%	75
2011	38,456	1.5%	143
2012	39,432	2.5%	205
2013	40,486	2.7%	330
2014	41,562	2.7%	268
2015	42,382	2.0%	351
Projected			
2016 General Plan (RDCS Population Limit)			
	Population[2]		Dwelling Units Added (3.16 persons/DU) (DU/year)
2016	43,645	3.0%	275
2017	44,692	2.4%	275
2018	45,765	2.4%	275
2019	46,863	2.4%	275
2020	48,000	2.4%	275
2021	48,680	1.4%	215
2022	49,360	1.4%	215
2023	50,040	1.4%	215
2024	50,720	1.4%	215
2025	51,400	1.3%	215
2026	52,080	1.3%	215
2027	52,760	1.3%	215
2028	53,440	1.3%	215
2029	54,120	1.3%	215
2030	54,800	1.3%	215
2031	55,480	1.2%	215
2032	56,160	1.2%	215
2033	56,840	1.2%	215
2034	57,520	1.2%	215
2035	58,200	1.2%	215
2036	58,880	1.2%	215
2037	59,560	1.2%	215
2038	60,240	1.1%	215
2039	60,920	1.1%	215
2040	61,600	1.1%	215

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Notes:

1. Historical Populations per California Department of Finance estimates.
2. Historical values received from City staff August 17, 2016.
3. People per dwelling unit at approximate historical averages.

CHAPTER 3 - SYSTEM PERFORMANCE AND DESIGN CRITERIA

This chapter presents the City's performance and design criteria, which was used in this analysis for identifying current system capacity deficiencies and for sizing proposed distribution mains, storage reservoirs, and wells.

3.1 HISTORICAL WATER USE TRENDS

The historical domestic water consumption per capita was calculated to determine the average water use per capita per day. This was accomplished by dividing the City's historical water production, from groundwater production records and the previous master plan, by the historical population for the respective year.

The City's historical per capita consumption factors, for the period 1990-2015, are listed in **Table 3.1**. The City's per capita consumption has generally varied since 1990, with a maximum per capita consumption of 210 gallons per day per capita (gpcd) in 2007 and a minimum of 123 gpcd in 2015. This recent decrease in per capita consumption is largely attributed to the City's effort of implementing water conservation measures in response to the state-wide drought. **Table 3.2** lists three years (2013-2015) of monthly water production in the City for the years.

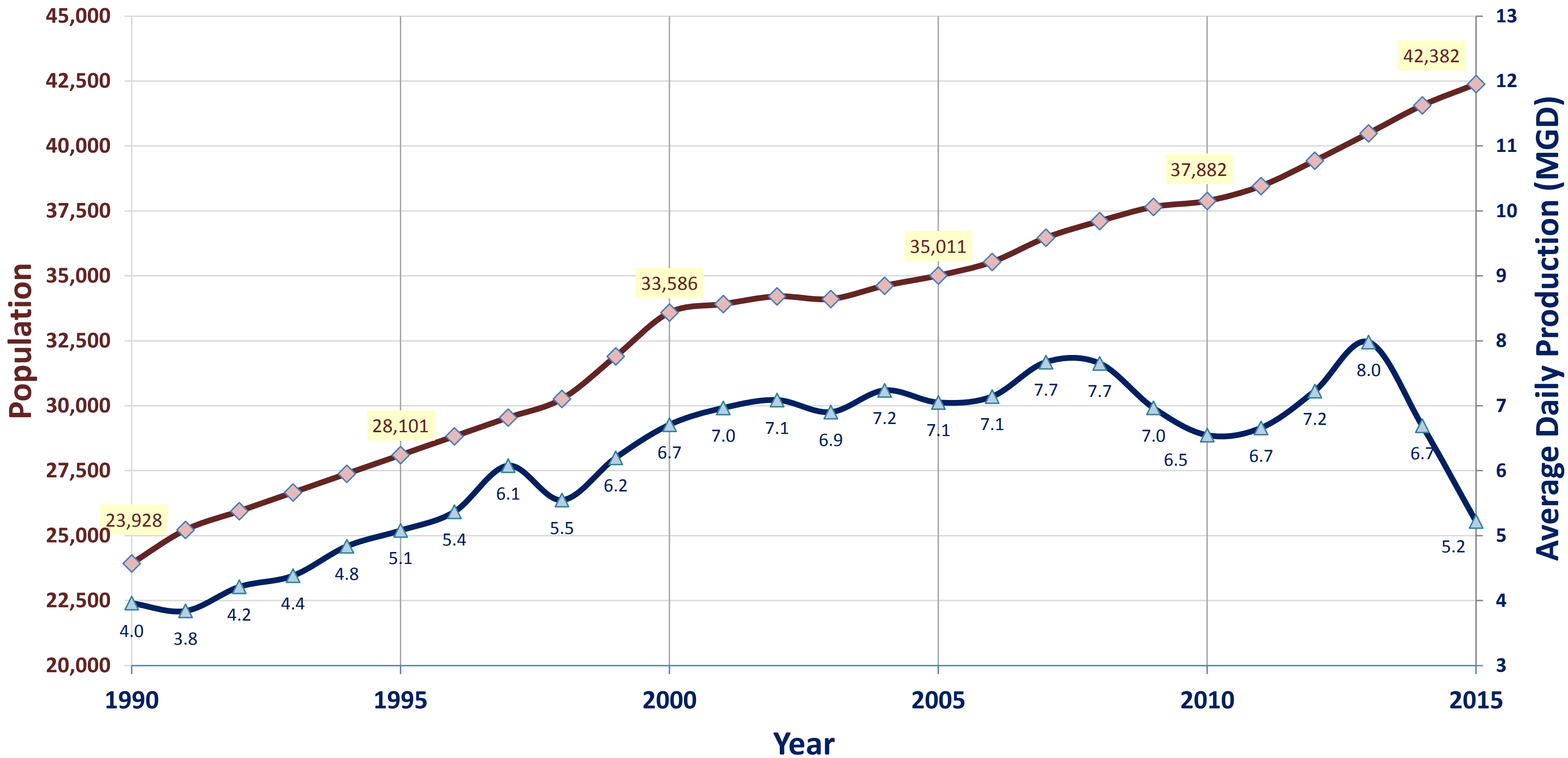
This master plan did not use the per capita consumption factor to project future domestic water demands, as was the case for the 2002 WSMP. Instead, this master plan forecasts domestic water demands for residential and non-residential land uses based on net acreages. However, to generalize trends in the City's water use, per capita water use was documented. **Figure 3.1** displays the historical population in relation to average daily water production. **Figure 3.2** displays a comparison in the per capita water use and average daily water production.

3.2 SUPPLY CRITERIA

In determining the adequacy of the domestic water supply facilities, the source must be large enough to meet the varying water demand conditions, as well as provide sufficient water during potential emergencies such as power outages and natural or created disasters.

Ideally, a water distribution system should be operated at a constant water supply rate with consistent supply from the water source. On the day of maximum demand, it is desirable to maintain a water supply rate equal to the maximum day rate. Water required for peak hour demands or for fire flows would come from storage.

As the City is currently using groundwater wells as a sole source of supply, groundwater should be viewed as a sustainable resource. The existing storage in the system is expected to supply water during peak period usage, while supply wells should be capable of meeting maximum day demand with the largest supply well out of service. Future system supply improvements should be



LEGEND

Population

Average Daily Production (MGD)

PRELIMINARY

February 11, 2016

Figure 3.1

Historical Population vs. Average Daily Production

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

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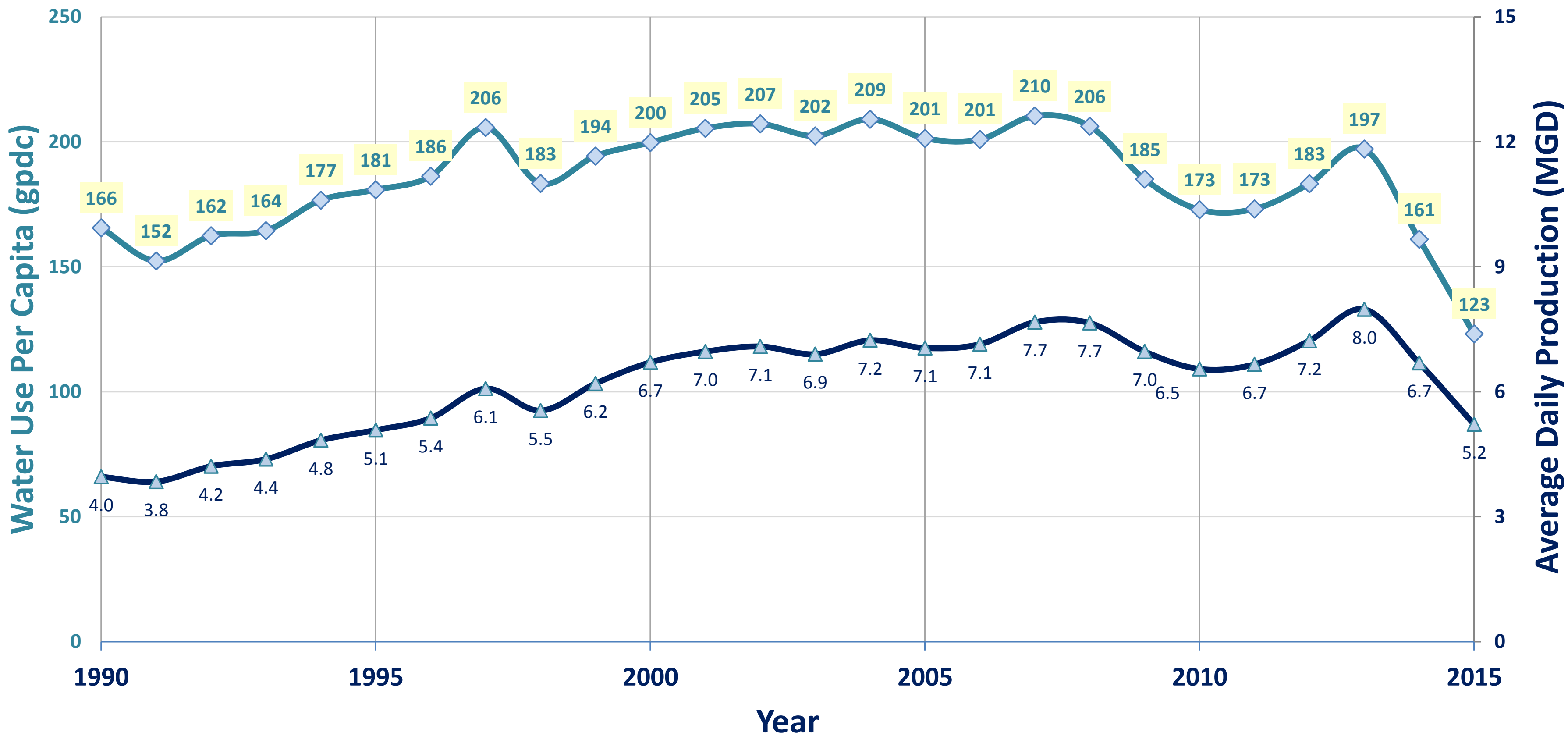

LEGEND

PRELIMINARY

Per Capita Consumption (gpdc)

Average Daily Production (MGD)

AKEL ENGINEERING GROUP, INC.

February 11, 2016

Figure 3.2

Water Use Per Capita vs. Average Daily Production

Water System Master Plan

City of Morgan Hill

CITY OF MORGAN HILL

Table 3.1 Historical Water Production and Maximum Day Peaking Factors (1990-2015)

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Year	Population[1, 2]	% Increase	Historical Water Production: Annual Production[3] (AF)	Annual Production (MGY)	Annual Production (gpm)	% Increase	Monthly Production: Average[3] (MGM)	Monthly Production: Maximum[2] (MGM)	Monthly Production: Month of Occur.	Monthly Production: Max-to-Avg Ratio	Daily Production: Average[4] (MGD)	Daily Production: Maximum[2] (MGD)	Daily Production: Max-to-Avg Ratio	Average Daily Water Use per Capita (gpdc)
1990	**23,928**	**1%**	4,437	1,446	2,751		121	n/a	-	-	4.0	-	-	166
1991	25,220	5%	4,303	1,402	2,668	-3%	117	n/a	-	-	3.8	-	-	152
1992	25,940	3%	4,718	1,538	2,925	10%	128	n/a	-	-	4.2	-	-	162
1993	26,661	3%	4,910	1,600	3,044	4%	133	212	August	1.59	4.4	6.8	1.55	164
1994	27,381	3%	5,417	1,765	3,358	10%	147	222	August	1.51	4.8	7.0	1.45	177
1995	**28,101**	**3%**	5,690	1,854	3,528	5%	155	255	August	1.65	5.1	7.1	1.40	181
1996	28,822	3%	6,012	1,959	3,727	6%	163	255	July	1.56	5.4	9.0	1.68	186
1997	29,542	2%	6,807	2,218	4,220	13%	185	276	July	1.49	6.1	10.7	1.76	206
1998	30,262	2%	6,214	2,025	3,852	-9%	169	282	August	1.67	5.5	10.3	1.86	183
1999	31,900	5%	6,942	2,262	4,304	12%	189	294	July	1.56	6.2	10.3	1.66	194
2000	**33,586**	**5%**	7,512	2,448	4,657	8%	204	304	August	1.49	6.7	10.6	1.58	200
2001	33,914	1%	7,802	2,543	4,837	4%	212	335	July	1.58	7.0	11.7	1.68	205
2002	34,210	1%	7,939	2,587	4,922	2%	216	343	July	1.59	7.1	11.8	1.66	207
2003	34,109	0%	7,731	2,519	4,793	-3%	210	355	July	1.69	6.9	12.9	1.86	202
2004	34,618	1%	8,105	2,641	5,025	5%	220	338	July	1.54	7.2	11.3	1.56	209
2005	**35,011**	**1%**	7,897	2,573	4,896	-3%	214	347	August	1.62	7.1	11.6	1.64	201
2006	35,535	1%	7,999	2,607	4,959	1%	217	376	July	1.73	7.1	13.5	1.89	201
2007	36,467	3%	8,592	2,800	5,326	7%	233	378	July	1.62	7.7	11.7	1.53	210
2008	37,107	2%	8,571	2,793	5,313	0%	233	341	July	1.47	7.7	12.3	1.60	206
2009	37,653	1%	7,804	2,543	4,838	-9%	212	321	August	1.51	7.0	12.2	1.75	185
2010	**37,882**	**1%**	7,333	2,390	4,546	-6%	199	336	July	1.69	6.5	12.7	1.94	173
2011	38,456	2%	7,457	2,430	4,623	2%	203	320	August	1.58	6.7	12.2	1.83	173
2012	39,432	3%	8,093	2,637	5,017	9%	220	344	July	1.57	7.2	13.1	1.81	183
2013	40,486	3%	8,938	2,913	5,541	10%	243	364	July	1.50	8.0	13.7	1.71	197
2014	41,562	3%	7,495	2,443	4,647	-16%	204	301	July	1.48	6.7	12.0	1.79	161
2015	**42,382**	**2%**	5,845	1,905	3,623	-22%	159	206	July	1.30	5.2	8.5	1.62	123
Historical Maximum Peaking Factors														
10-Year Maximum (2006-2015)			8,938	2,913	5,541	10%	243	378		1.73	8.0	13.7	1.94	210
5-Year Maximum (2011-2015)			8,938	2,913	5,541	10%	243	364		1.58	8.0	13.7	1.83	197
3-Year Maximum (2013-2015)			8,938	2,913	5,541	10%	243	364		1.50	8.0	13.7	1.79	197
Last Year's Maximum (2015)			5,845	1,905	3,623	-22%	159	206		1.30	5.2	8.5	1.62	123
Recommended Demand Peaking Factor														
2002 Water System Master Plan Criteria										1.75			2.00	200
2016 Water System Master Plan										**1.75**			**2.00**	179

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Notes:

1. Source: South County Regional Wastewater Authority, Wastewater Flow Projections, Table 8
2. Source: City of Morgan Hill Public Works Water Production
3. Source: City of Morgan Hill, 2010 Urban Water Management Plan
4. Average production is based on the total annual production for that year.
5. The Peaking Factors conform to the Titles 17 & 22 of the California Code of Regulations, Section 64554, subsection b (California Waterworks Standards)

Table 3.2 Historical Monthly Water Production (2013-2015)

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Month	2013				2014				2015			
	Daily Production	Monthly		Peaking Factor	Daily Production	Monthly		Peaking Factor	Daily Production	Monthly		Peaking Factor
	Average Day (MGD)	Production (MGM)	Percent of Annual (%)	Month to Avg Factor	Average Day (MGD)	Production (MGM)	Percent of Annual (%)	Month to Avg Factor	Average Day (MGD)	Production (MGM)	Percent of Annual (%)	Month to Avg Factor
January	3.40	105	4%	0.43	5.74	178	7%	0.87	4.03	125	5%	0.79
February	4.12	119	4%	0.49	4.39	127	5%	0.63	3.73	108	4%	0.68
March	5.55	172	6%	0.71	4.45	138	6%	0.68	4.47	139	5%	0.87
April	8.12	244	8%	1.00	6.26	188	8%	0.92	5.32	160	6%	1.01
May	9.91	307	11%	1.27	8.18	254	10%	1.25	5.60	174	7%	1.09
June	9.86	296	10%	1.22	8.47	254	10%	1.25	6.31	189	7%	1.19
July	11.73	364	12%	**1.50**	9.70	301	12%	**1.48**	6.65	206	8%	**1.30**
August	10.25	318	11%	1.31	8.94	277	11%	1.36	6.60	205	8%	1.29
September	10.37	311	11%	1.28	8.97	269	11%	1.32	6.52	196	7%	1.23
October	9.40	291	10%	1.20	7.13	221	9%	1.09	5.96	185	7%	1.16
November	7.22	217	7%	0.89	4.22	127	5%	0.62	3.81	114	4%	0.72
December	5.44	169	6%	0.69	3.50	108	4%	0.53	3.37	104	4%	0.66
Total		**2,912**				**2,442**				**1,904**		
Average Value	**7.95**	**243**			**6.66**	**204**			**5.20**	**159**		
Maximum Value		**364**		**1.50**		**301**		**1.48**		**206**		**1.30**

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Notes:

1. Source: 2013 and 2014 monthly production as extracted from Well Production file received May 6, 2015.
2. Source: 2015 monthly production as extracted from Well Production file received March 17, 2016

assumed to have a supply capacity of 800 gallons per minute (gpm). Design criteria for water supply are documented on **Table 3.3**.

3.3 STORAGE CRITERIA

The intent of domestic water storage is to provide supply for operational equalization, fire protection, and other emergencies, such as power outages or supply outages. Operational or equalization storage provides the difference in quantity between the customer's peak hour demands and the system's available reliable supply.

3.3.1 Typical Storage Criteria

Typical storage criteria consist of three main elements: operational, emergency, and fire flow.

Operational Storage

Operational or equalization storage capacity is necessary to reduce the variations imposed on the supply system by daily demand fluctuations. Peak hour demands may require up to 2 times the amount of maximum day supply capacity. With storage in place, this increase in demand can be met by the operational storage rather than by increasing production from the supply sources.

Equalization storage also stabilizes system pressures for enhancing the service. Equalization storage requirements typically range from 25 percent to 50 percent of maximum day demand. The City criterion requires that 25 percent of the maximum day demand be reserved for operational storage.

Emergency Storage

Emergency storage is the volume of water stored to meet demand during emergency situations such as pipe failures, distribution main failures, pump failures, power outages, natural disasters, or other cases in which the supply sources are not able to meet the demand condition.

The amount of water reserved for emergencies is determined by policies adopted by the City and is based on an assessment of the costs and benefits including the desired degree of system reliability, risk during an emergency situation, economic considerations, and water quality concerns.

In California, the amount of emergency storage reserve in municipal water systems is usually between 50 percent and 100 percent of the maximum day demand.

Fire Storage

Fire storage is also needed to maintain acceptable service pressures within a pressure zone, in the event of a fire flow, which may occur during the maximum day demand. The recommended fire storage capacity varies by pressure zone and land use type, and is usually higher for

Table 3.3 Planning and Design Criteria Summary

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Design Parameter	Criteria		
Supply	Supply to Meet Maximum Day Demands with Firm Capacity		
	Firm Capacity excludes largest well for possible maintenance and emergency		
	Largest well is currently Diana #2 at approximately 1,500 gpm		
	Assume Future Well Capacities at 800 gpm each.		
Storage	Total Required Storage = Operational + Fire + Emergency		
	Operational Storage	25% of Maximum Day Demand	
	Emergency Storage	25% of Maximum Day Demand	
	Fire Storage	Residential = 0.18 MG (1,500 gpm for 2 hours)	
		Commercial = 0.30 MG (2,500 gpm for 2 hours)	
		Industrial = 0.63 MG (3,500 gpm for 3 hours)	
Pump Stations	Meet Maximum Day Demand with largest unit out of service		
	Hydropneumatic systems to meet Maximum Day Demand plus fire flow		
Pressure Reducing Valves	PRVs should be designed to meet the greater of:		
	Peak Hour Demand, or Maximum Day Demand + Fire Flow		
Service Pressures	Maximum Pressure		100 psi
	Minimum Pressure (during Maximum Day)		40 psi
	Minimum Pressure (during Peak Hour)		35 psi
	Minimum Pressure for New Development[1] (during Peak Hour)		40 psi
	Minimum Residual Pressure (during Fires)		20 psi
Demand Peaking Factors	Maximum Month Demand	1.75 x Average Day Demand	
	Maximum Day Demand	2.00 x Average Day Demand	
	Peak Hour Demand	3.00 x Average Day Demand	
Fire Flows	Residential	1,500 gpm for 2 hours	
	Commercial	2,500 gpm for 2 hours	
	Industrial	3,500 gpm for 3 hours	
Urban Water Use Targets			
2015 Urban Water Management Plan	Existing Coefficient	199 gpdc	
	2015 Interim Target	179 gpdc	
	2020 Target (20% Conservation)	159 gpdc	

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Note:

1. Source: California Department of Public Health Title 22, Chapter 16, Article 8 "Distribution System Operation"

commercial and industrial areas. Fire flow provisions for each pressure zone were calculated based on the governing (highest) land use type within a reservoir service area as follows:

- Residential: 1,500 gpm for 2 hours = 0.18 MG
- Emergency: 2,500 gpm for 2 hours = 0.30 MG
- Industrial: 3,500 gpm for 3 hours = 0.63 MG

Total Storage Requirement

The total storage is the summation of operational (equalization), fire, and emergency storage requirements as follows:

Qs = 25% MDD (equalization) + fire flow (varies) + 25% MDD (emergency)

where:

Qs is the Total Required Storage, in gallons

MDD is the Maximum Day Demand, in gallons

3.4 PRESSURE CRITERIA

Acceptable service pressures within distribution systems vary depending on city criteria and pressure zone topography. It is essential that the water pressure in a consumer's residence or place of business be maintained within an acceptable range. Low pressures below 30 psi can cause undesirable flow reductions when multiple faucets or water using appliances are used at once.

Excessively high pressures can cause faucets to leak and valve seats to wear out prematurely. Additionally, high service pressures can cause unnecessarily high flow rates, which can result in wasted water and high utility bills. The criteria for pressures in the domestic water system include the following:

- Maximum pressure, usually experienced during low demands and winter months
- Minimum pressure, usually experienced during peak hour demands and summer months
- Minimum pressure during fire flows and during the maximum day demand

The American Water Works Association Manual on Computer Modeling and Water Distribution System (AWWA M-32) indicates that maximum pressures are usually in the range of 90-110 pounds per square inch (psi). In some communities, the maximum pressure may be limited to 80 psi to mitigate the impact on internal plumbing. In this case, the distribution system is usually sized for the higher pressures, and individual pressure-reducing valves are installed on service lines where the pressure may be exceeded.

The minimum acceptable pressure is usually in the range of 40-50 psi, which generally provides for sufficient pressures for second story fixtures. When backflow preventers are required, they may reduce the pressures by approximately 5-15 psi. The recommended minimum pressure during fire flows is 20 psi, as established by the National Fire Protection Association (NFPA).

The City's pressure criteria are summarized as follows:

- **Maximum Pressure:** 100 psi
- **Minimum Pressure:**
  - Maximum Day Demand: 40 psi
  - Peak Hour Demand, Existing Development: 35 psi
  - Peak Hour Demand, Future Development: 40 psi
  - Maximum Day Demand + Fire Flow: 20 psi

3.5 UNIT FACTORS

Domestic water demand unit factors are coefficients commonly used in planning level analysis to estimate future average daily demands for areas with predetermined land uses. The unit factors are multiplied by the number of dwelling units or gross acreages for residential categories, and by the gross acreages for non-residential categories, to yield the average daily demand projections.

The total domestic water demand was calculated from consumption data. The demand was adjusted to balance with current production records, and to account for transmission main losses and vacancies in existing land uses. The demand unit factor was then calculated using the total water production and total number of residential and non-residential land use acreages.

This analysis generally indicates that existing residential land uses have higher consumptive use factors than that of non-residential land uses. The existing unit factor analysis is shown on **Table 3.4**. In order to account for continued water conservation efforts implemented by the City, the unit factors for developing these demands were adjusted to be consistent with projected demands established in the City's 2015 UWMP.

3.6 SEASONAL DEMANDS AND PEAKING FACTORS

Domestic water demands within municipal water systems vary with the time of day and month of the year. It is necessary to quantify this variability in demand so that the water distribution system can be evaluated and designed to provide reliable water service under these variable demand conditions.

Table 3.4 Water Demand Unit Factor Analysis

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Land Use Classification	Development within City Limits: Number of D.U.[1]	Development within City Limits: Existing (net acre)	Consumption: Annual Consumption (gpd)	Consumption: Unadjusted Water Unit Factors (gpd/DU)	Consumption: Unadjusted Water Unit Factors (gpd/net acre)	Consumption: Balance to Consumption (gpd)	Production: Unaccounted-For-Water Rate[5] (%)	Production: Production (w/o Vacancy Rate) (gpd)	Production at 100% Occupancy: Vacancy Rate[1] (%)	Production at 100% Occupancy: Projected Production at 100% Occupancy (gpd/DU)	Production at 100% Occupancy: Projected Production at 100% Occupancy (gpd/net acre)	Production at 100% Occupancy: Projected Production at 100% Occupancy (gpd)	Water Unit Factor: Recommended Factor (gpd/net acre)	Water Unit Factor: Balance Using Recommended Unit Factor (gpd)	Recommended Factor (Consistent with 2015 UWMP): Recommended Factor (gpd/net acre)	Recommended Factor (Consistent with 2015 UWMP): Balance Using Recommended Unit Factor (gpd)
Residential																
Residential Estate		508	320,127		630	320,127	12%	359,351	1.0%		714	362,553	700	355,525	560	284,420
Residential Detached Low		979	1,124,021		1,148	1,124,021	12%	1,261,743	2.8%		1,320	1,293,216	1,325	1,297,793	1,050	1,028,440
Residential Detached Medium		1,252	2,297,438		1,834	2,297,438	12%	2,578,934	6.3%		2,175	2,723,672	2,150	2,692,714	1,700	2,129,123
Residential Detached High		30	0		0	0	12%	0	50.0%		0	0	2,700	81,561	2,140	64,644
Subtotal Single Family Residential	10,672	2,770	3,741,586	351	1,351	3,741,586	12%	4,200,028	4.6%	410	1,578	4,370,914	1,598	4,427,593	1,266	3,506,627
Residential Attached Low		340	694,577		2,041	694,577	12%	779,681	4.3%		2,379	809,548	2,400	816,612	1,900	646,484
Residential Attached Medium		100	333,687		3,351	333,687	12%	374,573	3.6%		3,882	386,586	2,900	288,788	2,300	229,039
Residential Attached High		1	1,008		1,008	1,008	12%	1,132	95.0%		2,090	2,090	3,950	3,950	3,130	3,130
Subtotal Multi-Family Residential	2,101	473	1,029,273	490	2,174	1,029,273	12%	1,155,386	4.0%	570	2,528	1,197,051	2,343	1,109,350	1,856	878,653
Non-Residential																
General Commercial		24	43,123		1,798	43,123	12%	48,407	14.3%		2,276	54,574	2,275	54,550	1,800	43,161
Commercial		260	351,322		1,354	351,322	12%	394,368	14.3%		1,713	444,607	1,700	441,151	1,350	350,326
Commercial / Industrial[2]		501	546,049		1,090	546,049	12%	611,575	14.3%		1,376	689,660	1,410	706,631	1,120	561,296
Mixed Use		93	120,928		1,296	120,928	12%	135,745	14.3%		1,640	153,037	1,700	158,655	1,350	125,991
Mixed Use Flex		64	90,401		1,412	90,401	12%	101,478	14.3%		1,787	114,405	1,750	112,008	1,390	88,967
Public Facility		302	134,428		446	134,428	12%	150,899	14.3%		564	170,123	500	150,822	400	120,657
Subtotal Non-Residential		1,244	1,286,252		1,034	1,286,252	12%	1,442,473	14.3%		1,309	1,626,407	1,320	1,623,818	1,038	1,290,397
Other (Demand Generating)																
Landscape Irrigation		201	378,727		1,881	378,727	12%	425,131	0.0%		2,111	425,131	2,125	427,863	1,680	338,263
Other (Non-Demand Generating)																
Other		605	0		0	0	0%	0			0	0	0	0	0	0
Total	**12,773**	**5,293**	**6,435,839**			**6,435,839**		**7,223,018**				**7,619,502**		**7,588,623**		**6,013,941**

9/19/2016

Notes:

1. Source: Dwelling Unit counts and Residential Vacany rates US Census Bureau American Community Survey.
2. "Commercial / Industrial" combines land use types "Commercial / Institutional" and "Industrial"
3. Water demand distribution was based on the 2012 Water Billing Records. These demands were verified and do not vary greatly from year to year.

Water use conditions that are of particular importance to water distribution systems include the average day demand (ADD), the maximum month demand (MMD), the maximum day demand (MDD), the peak hour demand (PHD), and the winter demand.
The average day demand represents the annual water demand, divided by 365 days, since it is expressed in daily units. The winter demand typically represents the low month water demands and is used for simulating water quality analysis.

3.6.1 Maximum Month Demand

The maximum month demand (MMD) is the highest demand that occurs within a calendar month during a year. The City's MMD usually occurs in the summer months in either July or August. The MMD is used primarily in the evaluation of supply capabilities.

Historical monthly water production records, obtained for the period between 1990 and 2015 (**Table 3.1**), indicate the maximum month to average month ratio ranging between 1.30 and 1.73. Over the reviewed period, this ratio neither showed significant increasing or decreasing trends. Therefore, an MMD factor of 1.75 was deemed representative of City trends. This is the same peaking factor that was used in the 2002 master plan. The following equation is recommended for estimating the maximum month demand, given the average day demand:

Maximum Month Demand = **1.75** x Average Day Demand

3.6.2 Maximum Day Demand

The maximum day demand (MDD) is the highest demand that occurs within a 24 hour day during a year. The City's MDD, which usually occurs during the summer months, is typically used for the evaluation and design of storage facilities, distribution mains, pump stations, and pressure reducing valves. The MDD, when combined with fire flows, is one of the highest demands that these facilities should be able to service while maintaining acceptable pressures within the system.

The maximum day demands were obtained from the City's water production records. Groundwater well production records indicate the date of occurrence and magnitude of the maximum day demand for each calendar year, as listed in **Table 3.1**. The maximum day to average day demand ratios for the period between 1990 and 2015 ranged from 1.40 to 1.94 and occurred in July or August.

Through an analysis of these maximum day demands it was determined that a ratio of 2.0 would be used in this master plan, which is consistent with the peaking factor used in the 2002 WSMP. The following equation is then used to estimate the maximum day demand, given the average day demand:

Maximum Day Demand = **2.0** x Average Day Demand

3.6.3 Peak Hour Demand

The peak hour demand (PHD) is another high demand condition that is used in the evaluation and design of water distribution systems. The peak hour demand is the highest demand that occurs within a one hour period during a year. The peak hour demand is considered to be the largest single measure of the maximum demand placed on the distribution system. The PHD is often compared to the MDD plus fire flow to determine the largest demand imposed on the system for the purpose of evaluating distribution mains.

An industry standard peak hour to maximum day ratio of 1.5 was applied to the maximum day demand to yield the peak hour demand ratio of 3.0.This is a decrease in peak use trends from the previous master plan peaking factor of 3.2. The peak hour demand can then be calculated using the average day demand and the following equation:

Peak Hour Demand = **3.0** x Average Day Demand

3.7 FIRE FLOWS

Fire flows are typically based on land use, with the potential for increased fire flow based on the building type. The following are the criteria for fire flows:

- **Category 1.** Fire flows for residential areas was calculated at 1,500 gpm for two hours.
- **Category 2.** Fire flows for commercial and institutional areas was calculated at 2,500 gpm for two hours.
- **Category 3.** Fire flows for industrial areas was calculated at 3,500 gpm for three hours.

3.8 TRANSMISSION AND DISTRIBUTION MAIN CRITERIA

Transmission and distribution mains are usually designed to convey the maximum expected flow condition. In municipal water systems, this condition is usually the greater of either the peak hour demand or the maximum day demand plus fire flow. The hydrodynamics of pipe flow create two additional parameters that are taken into consideration when evaluating or sizing water mains: head loss and velocity.

Head loss is a loss of energy within pipes that is caused by the frictional effects of the inside surface of the pipe and friction within the moving fluid itself. Head loss creates a loss in pressure which is undesirable in water distribution systems. Head loss, by itself, is not an important factor as long as the pressure criterion has not been violated. However, high head loss may be an indicator that the pipe is nearing the limit of its carrying capacity and may not have sufficient capacity to perform under stringent conditions.

Since high flow velocities can cause damage to pipes and lead to high head loss, it is desirable to keep the velocity below a predetermined limit. The criterion for maximum pipeline velocity used in this master plan is 15 feet per second. This criterion also ensures that the head loss is kept below an acceptable limit, as the head loss in a pipe is a function of the flow velocity.

CHAPTER 4 - EXISTING DOMESTIC WATER FACILITIES

This chapter provides a description of the City's existing domestic water system facilities including the existing wells, pressure zones, distribution mains, storage reservoirs, and booster pump stations.

4.1 EXISTING WATER SYSTEM OVERVIEW

The City's municipal water system consists of 16 active groundwater wells, 12 storage tanks totaling 10.5 million gallons in storage, distribution mains, and fire hydrants. The City's topography is generally flat in the center of the City with increasing slopes on the east and west; based on this topography, the water distribution system is comprised of 20 pressure zones.

The City's existing domestic water distribution system is shown in **Figure 4.1**, which displays the existing system by pipe size. This figure provides a general color coding for the distribution mains, as well as labeling the existing wells and the storage reservoirs.

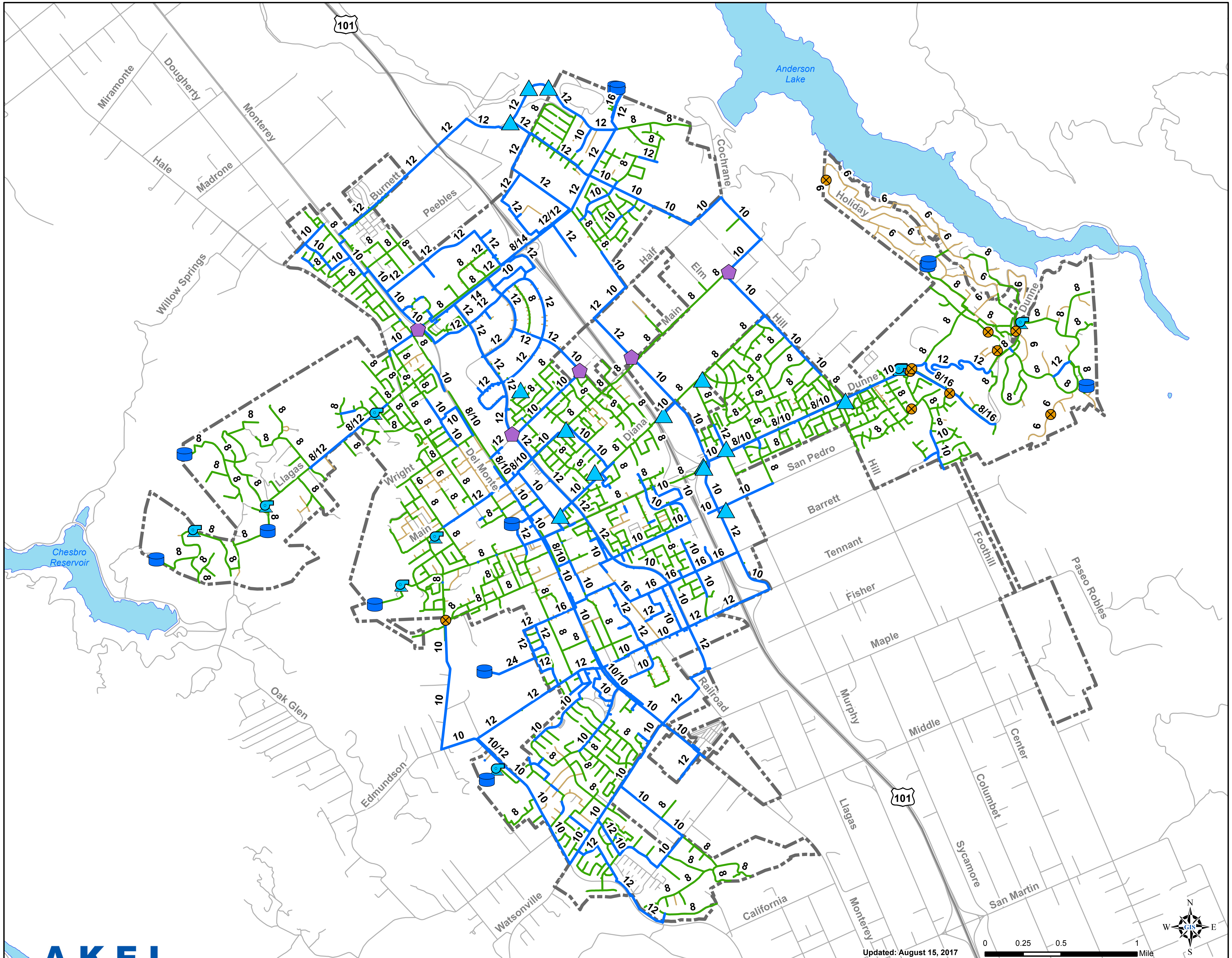
4.2 SOURCE OF SUPPLY

The City currently uses groundwater as the sole source of supply. There are 16 active groundwater wells in the City that are used for supply (**Figure 4.2**). During the preparation of this master plan, City operations staff provided well capacity ratings. It should be noted that, over time, well efficiencies may vary based on equipment conditions and groundwater levels. In periods of prolonged drought, well efficiency ratings may decrease due to a decline in groundwater levels. The opposite may occur in wet periods as well efficiencies may increase as the groundwater levels recover. As such, the City should monitor the well efficiencies on a frequent basis to adequately manage the groundwater supply. If periods of prolonged drought persist, it may be necessary to construct additional wells to maintain adequate supply capacity. **Table 4.1** lists the City's current total rated supply at approximately 19.3 million gallons per day (mgd). Consistent with the system performance and design criteria, the firm capacity was calculated as the capacity with the largest well out of service. The firm capacity of the well supply is estimated at 17.2mgd.

It should be noted that the Butterfield well is located near the boundary of the Nob Hill and Boys Ranch pressure zone; based on the existing pipe and valve configuration this well is capable of supplying either zone depending on the operational requirements of City staff. Under typical operating conditions it provides supply to the Nob Hill pressure zone.

4.3 RECYCLED WATER FEASIBILITY STUDY

In March 2016, a Recycled Water Feasibility Study (RWFE) commissioned by the City was published, which identified potential recycled water users through a market assessment. As identified in the market assessment, the potential future users of recycled water in the City include



Legend

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs

Pipes by Size

- 4" - 6"
- 8"
- 10" - 24"
- Roads
- City Limits
- Lakes

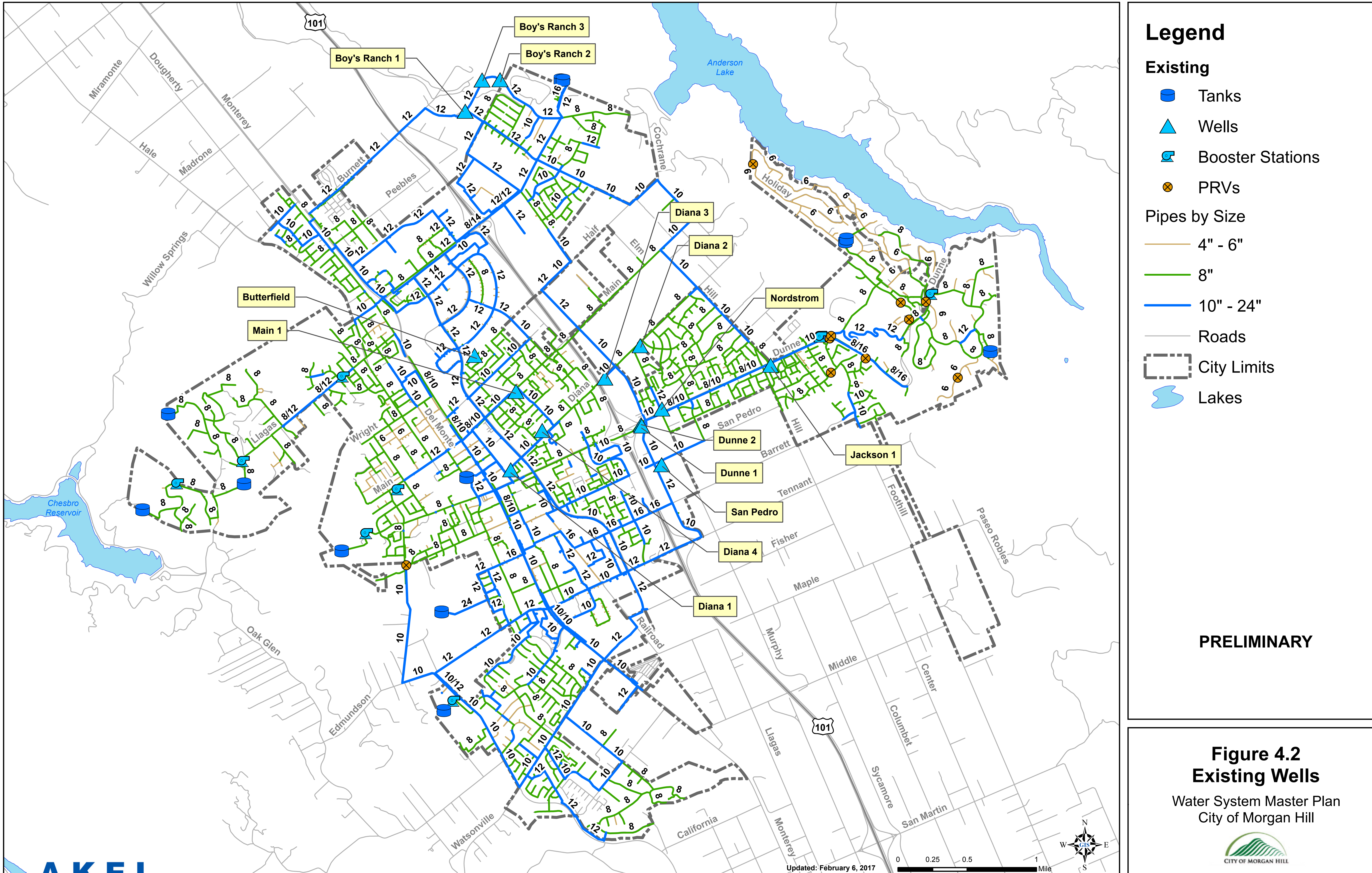
PRELIMINARY

Figure 4.1
Existing Water System

Water System Master Plan
City of Morgan Hill

AKEL ENGINEERING GROUP, INC.

CITY OF MORGAN HILL



Updated: February 6, 2017

AKEL ENGINEERING GROUP, INC.

Figure 4.2
Existing Wells
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

File Path: P:\xGIS\GIS_Projects\Morgan_Hill\Water\WSMP\MH_Fig4-2_ExistWells_020617.mxd

Table 4.1 Existing Groundwater Supply Capacity

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Supply Well	Design Capacity: Rated (gpm)	Design Capacity: Rated (MGD)	Current Actual Production[1]: Summer (gpm)	Summer (MGD)	Winter (gpm)	Winter (MGD)	Average (gpm)	Average (MGD)	Additional Information: Date Drilled (ft)	HP (HP)	Head (ft)	Ground Elevation (ft)
Boys Ranch Pressure Zone (HWL = 563 feet)												
Boys Ranch # 1	1,500	2.16	346	0.5	387	0.6	367	0.5	1982	150	384	380
Boys Ranch # 2	800	1.15	126	0.2	62	0.1	94	0.1	1982	60	352	390
Boys Ranch # 3	750	1.08	330	0.5	77	0.1	204	0.3	1962	60	363	380
Burnett [2]	900	1.30	n/a		n/a		n/a		1960	125	313	343
Nob Hill Pressure Zone (HWL = 516 feet)												
Butterfield	480	0.69	157	0.23	65	0.1	111	0.2	2004			
Condit	200	0.29	200	0.3	200	0.3	200	0.3	1979	100	395	343
Diana # 1	850	1.22	433	0.6	200	0.3	316	0.5	1949	100	242	343
Diana # 2	1,500	2.16	427	0.6	288	0.4	358	0.5	1986	150	271	373
Diana # 3	500	0.72	173	0.2	111	0.2	142	0.2	1998	60	415	365
Diana # 4	700	1.01	316	0.5	210	0.3	263	0.4	2009			
Dunne # 1	1,500	2.16	147	0.2	87	0.1	117	0.2	1965	75	366	357
Dunne # 2	520	0.75	217	0.3	140	0.2	178	0.3	1997	75	343	357
Jackson # 1	400	0.58	155	0.2	106	0.2	130	0.2	Pre 1950	60	589	367
Main # 1	1,000	1.44	377	0.5	258	0.4	317	0.5	Pre 1950	125	357	358
Main # 2	1,000	1.44	409	0.6	239	0.3	324	0.5	2002			
Nordstrom	850	1.22	534	0.8	326	0.5	430	0.6	1999	125	351	361
San Pedro	600	0.86	281	0.4	165	0.2	223	0.3	2002	75		351
Tennant	470	0.68	0	0.0	0	0	0	0	1979	75	344	325
Total and Firm Supply Capacity												
Total Supply Capacity	13,420	19.32	4,428	6.4	2,721	3.92	3,575	5.15				
Firm Capacity (Excluding largest Well Diana No. 2)	11,920	17.16	3,228	5.8	2,433	3.50	3,217	4.63				

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1/14/2016

Notes:

1. Source: "Well Production up to date 15 1st~2nd~3rd~4th Qtr Pro, received from City staff
2. Burnett Well is currently designated for Fire Protection only. It is not accounted for in the City's total water supply capacity.

landscape irrigation, agricultural irrigation, industrial processes, and potable reuse. As part of the RWFE, infrastructure required to convey recycled water from the South County Regional Wastewater Authority (SCWRA) Wastewater Treatment Plant (WWTP) in the City of Gilroy to the potential users was identified.

Based on the results of the RWFE, which included a technical and economic feasibility evaluation, the City elected to not pursue the development of a recycled water system at this time. However, the City is continuing to explore options for the purpose of utilizing recycled water within the City. As opportunities arise, funding sources for implementing a recycled water program should be evaluated.

4.4 PRESSURE ZONES

The City's current water system serves land ranging from approximately 320 feet above sea level to more than 1,100 feet. To adequately provide water in this service area requires the creation of multiple pressure zones that operate with varying pressures between 45 and greater than 100 psi. **Figure 4.3** shows the boundaries and names for these pressure zones.

The City's supply, and a majority of the service connections, are located in the Nob Hill and Boys Ranch pressure zones. Several gate valve interconnections between the Nob Hill and Boys Ranch pressure zones exist, which allow water to transfer between the zones; under typical operating conditions these gate valves remain closed.

4.5 WATER DISTRIBUTION PIPELINES

Groundwater is pumped into the City's distribution system via more than 175 miles of pipeline. As the City's sole source of supply is groundwater, which is distributed throughout the domestic water system, there are no dedicated transmission systems in the City. The pipelines are generally 24-inches and smaller, and convey water to the consumers' service connections.

An inventory of existing modeled pipes, extracted from the GIS-based hydraulic model and used in this analysis, is included in **Table 4.2**. For each pipe diameter, the inventory lists the length in feet, as well as the total length in units of miles.

4.6 STORAGE RESERVOIRS

Storage reservoirs are typically incorporated in the water system to provide water supply for operation during periods of high demand, for meeting fire flow requirements, and for other emergencies, as defined in the City's planning criteria.

The City's existing storage reservoirs are summarized in **Table 4.3**, along with their volumes, construction year and type, height, diameter, bottom elevations, and overflow height and elevations. These reservoirs are also shown on the hydraulic profile schematic (**Appendix B**), with the HWL and bottom tank elevations.

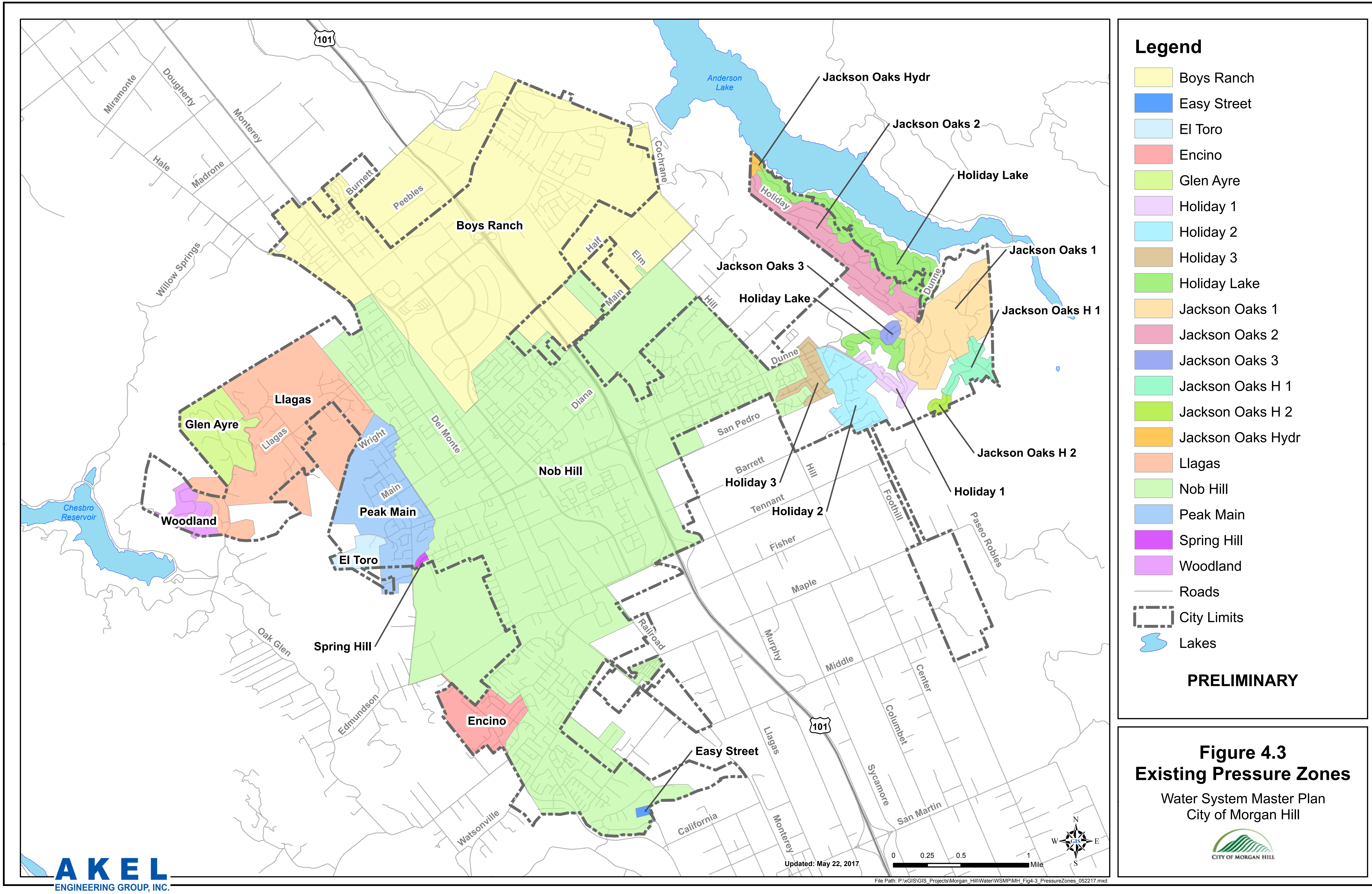

Figure 4.3
Existing Pressure Zones
Water System Master Plan
City of Morgan Hill

Table 4.2 Existing Pressure Reducing Valves

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Location	Size (in)	Pressure Zone	
		Upstream	Downstream
Spring Ave and De Witt Ave	6	Peak and Main	Spring Hill
2270 Fountain Oaks No. 1	8	Holiday 2	Holiday 3
2885 Vista Del Valle No. 1	6	Holiday 1	Holiday 2
17015 Oakleaf Drive	6	Jackson Oaks 1	Jackson Oaks 2
Jackson Oaks 1 to Jackson Oaks 2	8	Jackson Oaks 1	Jackson Oaks 2
3420 Oakwood Court	6	Jackson Oaks Hydro 1	Jackson Oaks Hydro 2
Llagas Booster	8	Llagas	Nob Hill
El Toro Booster	6	El Toro	Peak and Main
Encino Booster	8	Encino	Nob Hill
Jackson Oaks 3	8	Jackson Oaks 1	Jackson Oaks 3
Jackson Oaks 4	6	Jackson Oaks 2	Jackson Oaks 4
Woodland Booster Pump	8	Woodland	Llagas
Glen Ayre Booster Pump	8	Glen Ayre	Llagas
Holiday Lake to Holiday 1	8	Holiday Lake	Holiday 1
Holiday Lake to Holiday 2	8	Holiday Lake	Holiday 2
Jackson III	8	Jackson Oaks 1	Jackson Oaks 3

Table 4.3 Existing Modeled Pipe Inventory

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Pipe Size	Length	
(in)	(feet)	(miles)
2	1,342	0.3
4	9,813	1.9
6	94,903	18.0
8	538,375	102.0
10	160,040	30.3
12	112,641	21.3
14	4,437	0.8
16	12,202	2.3
24	2,062	0.4
Total	**935,816**	**177.2**

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2/10/2017

4.7 BOOSTER STATIONS

Water is conveyed from the lower supply pressure zones to the higher pressure zones via a series of booster pump stations (**Table 4.4**). There are a total of 12 booster stations in the City and **Table 4.4** lists of their ground elevation, source and destination pressure zones, total pump capacities, and additional station information.

4.8 PRESSURE REDUCING VALVES

Some pressure zones are served from higher pressure zones through pressure reducing valves (PRVs), which are summarized on **Table 4.5**. PRVs constructed at pressure zone intersections, allow the conveyance of water from higher pressure zones to the lower pressure zones in the City. Additionally, some PRVs provide a source of emergency supply to lower pressure zones in the case of booster station failure or other operational issue. The City currently operates 16 pressure reducing valves throughout its water system.

Table 4.4 Existing Storage Reservoirs

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Reservoir	Pressure Zone	Volume[1] (MG)	Date of Construction	Construction Type	Height (ft)	Diameter (ft)	Bottom Elevation (ft)	Overflow Height (ft)	Overflow Elevation (ft)
Boys Ranch # 1	Boy's Ranch Zone	0.55	1977	Steel	32.0	54	533	30	563
Boy's Ranch # 2	Boy's Ranch Zone	1.03	2006	Steel	32.0	74	533	30	563
Edmundson	Nob Hill Zone	4.25	2002	Steel	49.0	125	473	46	519
Nob Hill	Nob Hill Zone	2.00	1980	Steel	45.5	90	473	41	513
Holiday Lake # 1	Holiday Lake Zone	0.50	1980	Concrete	12.0	92	960	11	971
Holiday Lake # 2	Holiday Lake Zone	0.20	1962	Concrete	12.0	60	960	11	971
Jackson Oaks	Jackson Oaks Zone No. 1	0.35	1972	Steel	32.0	44	1,170	30	1,200
Encino	Encino Zone	0.60	1975	Steel	21.0	70	640	20	660
Llagas	Llagas Zone	0.35	1967	Steel	27.2	48	700	26	726
Glen Ayre	Glen Ayre Zone	0.10	1979	Steel	15.0	34.3	900	14	914
El Toro	El Toro Zone	0.50	1966	Steel	37.5	48	983	37	1,020
Woodland	Woodland Zone	0.03	1971	Steel	17.0	18	1,079	17	1,096
Total		**10.5**							

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1/14/2016

Note:

1. Source: City of Morgan Hill, Email received 02/18/2014

Table 4.5 Existing Booster Stations

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Booster Station	Ground Elevation (ft)	Pressure Zones: Source Pressure Zone	Pressure Zones: Destination Pressure Zone	Pressure Zones: Destination HWL (ft)	Booster Station Information: Total Pump Capacity [1] (gpm)	Total Pump Capacity [1] (mgd)	Design Head[2] (ft)	Pump Station Horsepower (hp)	No. of Pumps	Individual Pumps Information: Firm capacity	Pump No.	Individual Horsepower (hp)	Design Capacity (gpm)	Design Head (ft)	Actual [2] Capacity (gpm)	Actual [2] Head (ft)
East Dunne # 1	430	Nob Hill	Holiday Lake	911	**1,800**	2.59	**400**	375	3	1200	1A	125	600	400	635	415
											1B	125	600	400	635	415
											1C	125	600	400	680	415
East Dunne # 2	430	Nob Hill	Holiday Zone No. 1	864	**400**	0.58	**340**	50	2	200	2A	25	200	340	220	335
											2B	25	200	340	200	335
East Dunne # 3	430	Nob Hill	Holiday Zone No. 2	568	**925**	1.33	**100**	40	2	425	3A	20	425	100	425	115
											3B	20	500	100	485	104
Easy Street	335	Nob Hill	Easy Street Zone	535	n/a	n/a	**250**	1.5	1		A	1.5	n/a	250	n/a	75-110-psi
El Toro	520	Peak and Main	El Toro Tank	1,020	**380**	0.55	**340**	80	2	190	A	40	190	340	190	347
											B	40	190	340	190	347
Encino Booster	415	Nob Hill	Encino Tank	660	**900**	1.30	**150**	50	2	450	A	25	450	150	450	153
											B	25	450	150	450	153
Glen Ayre Booster	660	Llagas	Glen Ayre Zone	908	**330**	0.48	**200**	30	2	165	A	15	165	200	n/a	203
											B	15	165	200	n/a	203
					Domestic Service Pumps											
Hydropneumatic Booster	1,170	Jackson Oaks	Hydropneumatic Zone	1,380	**210**	0.30	**220**	22.5	3	140	A	7.5	70	220	-	-
											B	7.5	70	220	-	-
											C	7.5	70	220	-	-
					Fire Flow Pump											
					1,500	2.16	**170**	75	1		A	75	375	170	-	-
Jackson Oaks Booster	830	Holiday Lake	Jackson Oaks Zone	1,200	**970**	1.40	**250**	150	3	620	A	50	350	250	360	259
											B	50	320	250	490	259
											C	50	300	250	480	259
Llagas Booster	365	Nob Hill	Llagas Zone	726	**750**	1.08	**250**	80	2	300	A	50	450	250	450	252
											B	30	300	250	300	266
Peak and Main Booster	370	Nob Hill	Peak and Main Zone	660	**2,050**	2.95	**200**	160	4	1350	A	50	700	200	700	196
											B	50	650	200	640	203
											C	30	350	200	410	178
											D	30	350	200	140	178
Woodland Booster	620	Llagas	Woodland Zone	1,086	**430**	0.62	**320**	90	2	140	A	50	290	320	290	323
											B	40	140	320	140	323

Notes:

1. Source: Water System Schematic dated 4/2003.
2. Source: City of Morgan Hill 2002 Water System Master Plan.

CHAPTER 5 – DOMESTIC WATER DEMANDS

This chapter summarizes existing domestic water demands, identifies potential recycled water demands, and projects the future domestic water demands.

5.1 EXISTING DOMESTIC WATER DEMANDS

The existing water demands used for this master plan were based on the City's 2012 water billing consumption records as well as total annual production. The existing water demands in this analysis are adjusted to match the annual production records and account for system losses.

The existing demand distribution, by pressure zone, was obtained from the water billing records. Using GIS, each customer account was geocoded to its physical location within its existing pressure zone. The accounts were then sorted by pressure zone and the total demand in each zone was calculated.

The City's existing average day domestic water demand, as extracted from the water billing records, were lower than the total demands listed in the annual production records due to system losses that occurred between the groundwater wells and customer service connections. The total domestic water demands were increased proportionally to 7.2 mgd to reflect the total 2012 production and account for transmission main losses. The existing domestic water demands, for each pressure zone, are summarized on **Table 5.1**.

5.2 FUTURE DOMESTIC WATER DEMANDS

Future demands were projected using the unit factors for residential and non-residential land uses and included the developments within the Urban Growth Boundary. **Table 5.2** organizes the future land use categories and their corresponding domestic water demands. It should be noted that the existing domestic water demands in **Table 5.2** were calculated using the recommended water unit factors, which take into account future water conservation practices, and are intended to represent the water use of the existing users at the buildout of the master plan horizon. The total average day domestic water demands from existing and future developments is calculated at 9.4 mgd.

These demands were used in sizing the future infrastructure facilities, including distribution mains, storage reservoirs, and booster stations. Demands were also used for allocating and reserving capacities in the existing or proposed facilities. **Table 5.3** summarizes the buildout water demand for each pressure zone.

5.3 RECYCLED WATER DEMANDS

In 1977 SCVWD, the City of Gilroy, and Gavilan Water Conservation District embarked on a partnership to construct and operate a recycled water system extending from the South County Regional Wastewater Authority (SCRWA) Wastewater Treatment Plant in southeast Gilroy to

Table 5.1 Existing Demand by Pressure Zone

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Pressure Zone	Average Day Demand (gpm)	Existing Water Demands Maximum Day[2] (gpm)	Existing Water Demands Peak Hour[2] (gpm)
Central Pressure Zones			
Boys Ranch	899	1,799	2,698
Nob Hill	3,053	6,106	9,159
Subtotal	3,952	7,905	11,857
West Side Pressure Zones			
Llagas	146	292	439
Woodland	12	25	37
Glen Ayre	37	73	110
Peak and Main	194	387	581
Encino	89	177	266
Spring Hill	5	9	14
Easy Street	3	6	8
El Toro	2	3	5
Subtotal	486	972	1,459
East Side Pressure Zones			
Holiday Zone #3	63	126	189
Holiday Zone #2	118	237	355
Holiday 1	18	37	55
Holiday Lake Zone	97	195	292
Jackson Oaks Zone #2	115	229	344
Jackson Oaks Zone #1	117	234	350
Jackson Oaks Zone #3	8	17	25
Jackson Oaks HPZ #1	26	52	79
Jackson Oaks HPZ #2	7	15	22
Jackson Oaks PRV	6	11	17
Subtotal	576	1,152	1,728
Total Demand	**Average Day**	**Maxmium Day**	**Peak Hour**
Total	5,015	10,030	15,044

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9/19/2016

Notes :

1. Maximum Day Demand = 2.0 x Average Day Demand
2. Peak Hour Demand = 3.0 x Average Day Demand

Table 5.2 Average Daily Demands at Buildout of Project Area

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Land Use Classifications	Water Demands at 100% Occupancy											
	Existing Development within City Limits			Future Development within City Limits			Total Development within City Limits		Future Development Outside City Limits		Total	
	Existing Development within City Limits (net acre)	Water Unit Factor (gpd/net acre)	Existing Average Daily Demand (gpd)	Future Development (net acre)	Future Water Unit Factor (gpd/net acre)	Future Development Average Daily Demand (gpd)	Development (net acre)	Total Development Average Daily Demand (gpd)	Future Development (net acre)	Future Development Average Daily Demand (gpd)	Development (net acre)	Average Daily Demand (gpd)
Residential												
Single Family												
Residential Estate	508	560	284,420	198	560	110,769	706	395,189	321	179,976	1,027	575,166
Residential Detached Low	979	1,050	1,028,440	171	1,050	179,351	1,150	1,207,791	239	250,528	1,389	1,458,319
Residential Detached Medium	1,252	1,700	2,129,123	187	1,700	317,128	1,439	2,446,251	411	699,255	1,850	3,145,506
Residential Detached High	30	2,140	64,644	4	2,140	9,297	35	73,941	20	41,858	54	115,799
Multi-Family												
Residential Attached Low	340	1,900	646,484	114	1,900	217,466	455	863,951	2	4,117	457	868,068
Residential Attached Medium	100	2,300	229,039	53	2,300	121,701	152	350,740	7	16,903	160	367,644
Residential Attached High	1	3,130	3,130	5	3,130	15,650	6	18,780	0	0	6	18,780
Subtotal	3,211		4,385,280	732		971,363	3,943	5,356,643	1,000	1,192,638	4,943	6,549,281
Non-Residential												
General Commercial	24	1,800	43,161	0	1,800	0	24	43,161	0	0	24	43,161
Commercial	260	1,350	350,326	130	1,350	175,975	390	526,301	4	4,995	394	531,296
Commercial / Industrial[1]	501	1,120	561,296	230	1,120	257,950	731	819,245	220	246,298	951	1,065,543
Mixed Use	93	1,350	125,991	6	1,350	8,242	99	134,233	0	0	99	134,233
Mixed Use Flex	64	1,390	88,967	40	1,390	56,273	104	145,240	8	11,421	113	156,661
Sports-Recreation-Leisure	0	1,680	0	0	1,680	0	0	0	251	421,974	251	421,974
Public Facility	302	400	120,657	12	400	4,695	313	125,352	46	18,556	360	143,908
Subtotal	1,244		1,290,397	419		503,135	1,663	1,793,532	529	703,244	2,192	2,496,776
Other (Demand Generating)												
Landscape Irrigation	201	1,680	338,263	0	1,680	0	201	338,263	0	0	201	338,263
Subtotal	201		338,263	0		0	201	338,263	0	0	201	338,263
Other (Non-Demand Generating)												
Open Space	605	0	0	581	0	0	1,186	0	2,737	0	3,922	0
Subtotal	605			581			1,186	0	2,737	0	3,922	0
Totals	**5,260**		**6,013,941**	**1,732**		**1,474,498**	**6,992**	**7,488,439**	**4,267**	**1,895,882**	**11,259**	**9,384,321**

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Note:

1. "Commercial / Industrial" combines land use types "Commercial / Institutional" and "Industrial"

Table 5.3 Buildout Demand by Pressure Zone

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Pressure Zone	Average Day Demand (gpm)	Future Water Demands	
		Maximum Day[2] (gpm)	Peak Hour[2] (gpm)
Central Pressure Zones			
Boys Ranch	1,334	2,668	4,002
Nob Hill	4,002	8,004	12,006
Subtotal	5,336	10,672	16,007
West Side Pressure Zones			
Llagas	192	384	576
Woodland	12	25	37
Glen Ayre	32	64	95
Peak and Main	189	378	567
Encino	87	175	262
El Toro	1	3	4
Subtotal	514	1,027	1,541
East Side Pressure Zones			
Holiday Zone #3	60	121	181
Holiday Zone #2	233	467	700
Holiday 1	28	55	83
Holiday Lake Zone	92	184	276
Jackson Oaks Zone #2	97	194	291
Jackson Oaks Zone #1	101	202	304
Jackson Oaks Zone #3	7	14	21
Jackson Oaks HPZ #1	26	52	78
Jackson Oaks HPZ #2	6	12	18
Jackson Oaks PRV	5	9	14
Subtotal	655	1,311	1,966
Total Demand	**Average Day**	**Maxmium Day**	**Peak Hour**
Total	6,505	13,009	19,514

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Notes :

1. Maximum Day Demand = 2.0 x Average Day Demand
2. Peak Hour Demand = 3.0 x Average Day Demand
3. 1,000 gpm = 1.44 million gallons per day (MGD)

customers in the City of Gilroy. In 1999, a joint partnership between SCRWA, SCVWD, the City of Morgan Hill, and the City of Gilroy sought to develop a recycled water system that would enhance the wastewater treatment plant and the recycled water distribution system. In March 2016, the Recycled Water Feasibility Evaluation (RWFE) identified potential recycled water users through a market assessment; the potential future uses of recycled water in the City include landscape irrigation, agricultural irrigation, industrial processes, and potable reuse. The RWFE also identified infrastructure required to convey recycled water from the SCRWA WWTP in Gilroy to the City (**Figure 5.1**). Due to technical and economic infeasibility there are currently no plans to construct this infrastructure.

5.4 MAXIMUM DAY AND PEAK HOUR DEMANDS

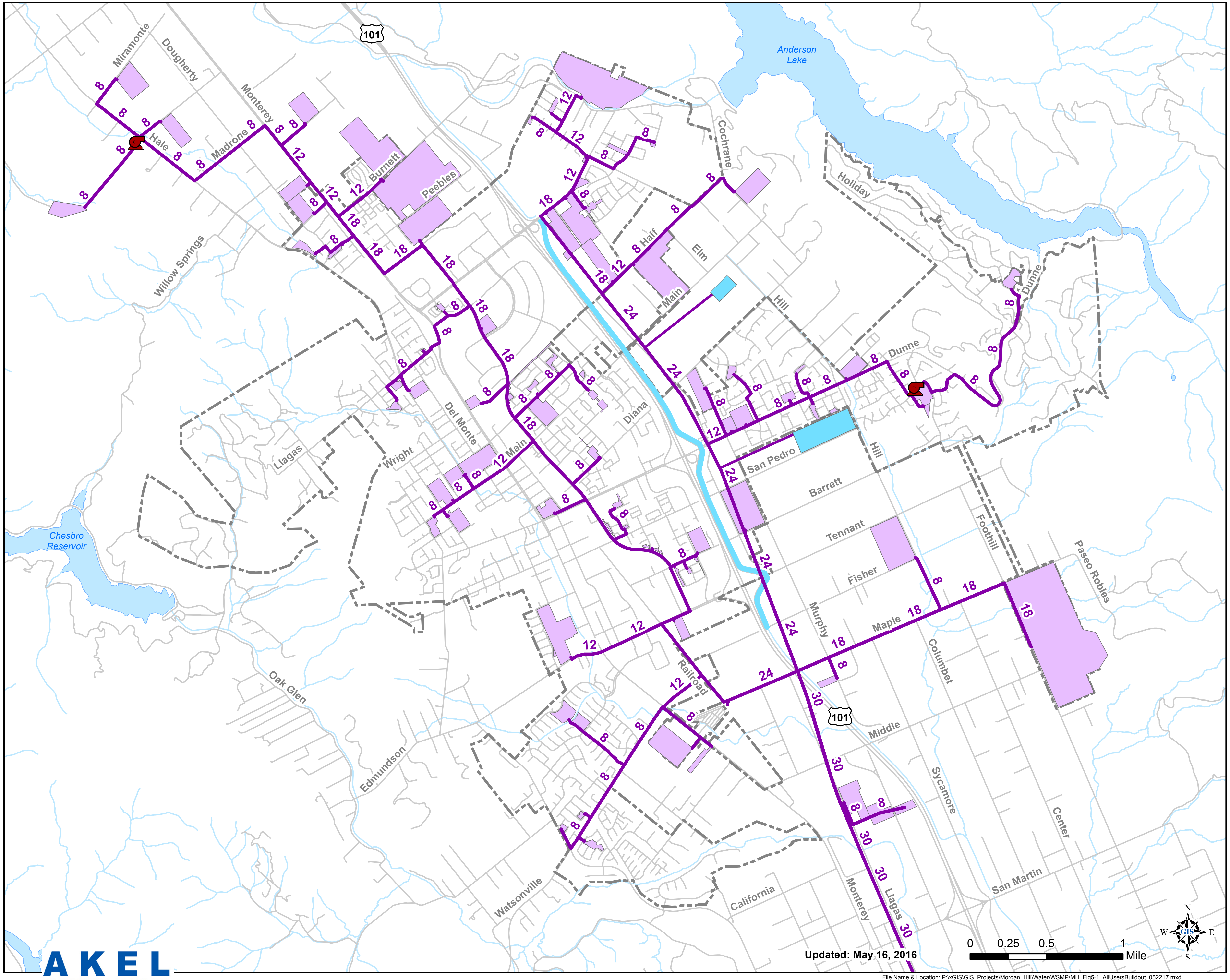
The maximum day and peak hour demands for the existing and future demands were calculated using the average day demands and City peaking factor criteria. The maximum day to average day ratio of 2.0, and peak hour to average day ratio of 3.0, were applied to the average day demands to obtain estimates of the higher demand conditions. The maximum day and peak hour demand estimates for the buildout of the Urban Growth Boundary are 18.7 mgd and 28.1 mgd, respectively; the maximum day demand is 1.80 times the average day demand and the peak hour demand is 2.80 times.

5.5 DIURNAL DEMAND PATTERNS

Water demands vary with the time of day and by account type according to the land use designation. These fluctuations were accounted for in the modeling effort and evaluation of the water distribution system. The diurnal demand patterns affect the water levels in storage reservoirs and amount of flow through distribution mains.

Three different diurnal curves (**Figure 5.2**) were used to model the demand patterns of 1) residential, 2) commercial, industrial, and other non-residential, and 3) irrigation use accounts. In the absence of data that can be used to develop these curves, they were based on industry acceptable demand patterns for these corresponding land use types. The diurnal patterns were confirmed during the calibration effort of the City's hydraulic model and corresponding SCADA information.

Each diurnal curve has a unique pattern that creates maximum and minimum flow conditions at different times of the day. Residential demands peak in the morning and evening and are at a minimum during the night hours. Non-residential demands, which include commercial, institutional, and industrial demands, are also at a minimum during the night; however, they remain at a constant maximum from the hours of 8 AM to 5 PM. The irrigation demands are highest at night and lowest during the day.



Legend

Proposed

- Booster Stations
- Pipes
- Potential Users

Existing

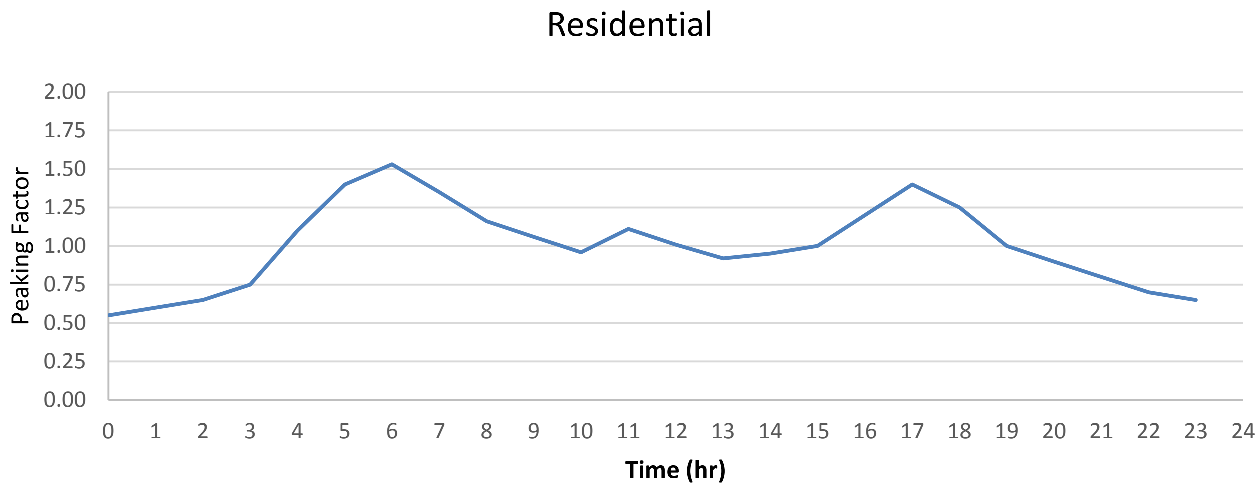
- Recharge Ponds
- City Limits
- Roads
- Creeks
- Lakes

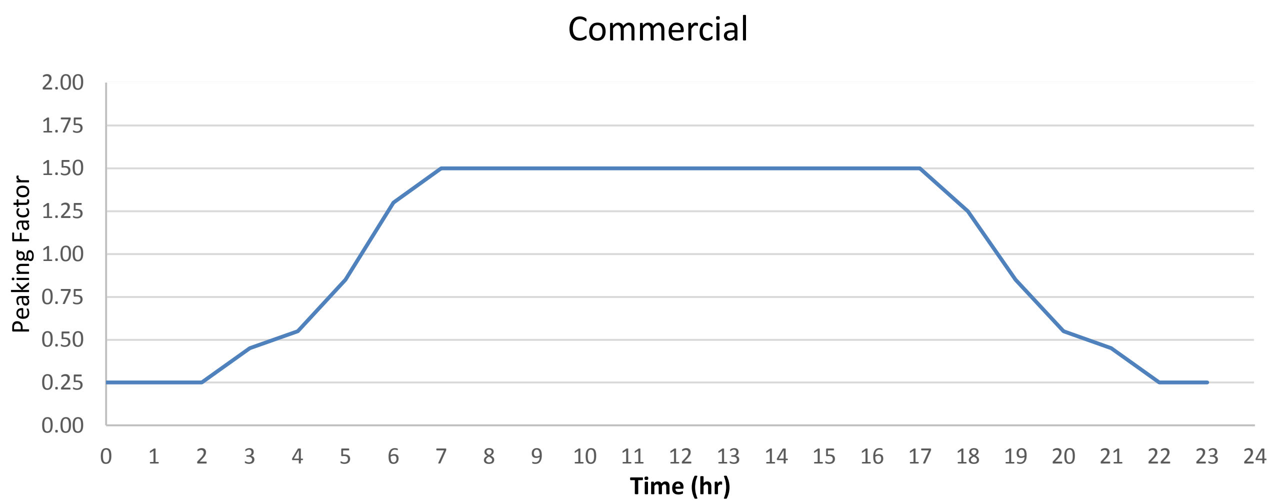
PRELIMINARY

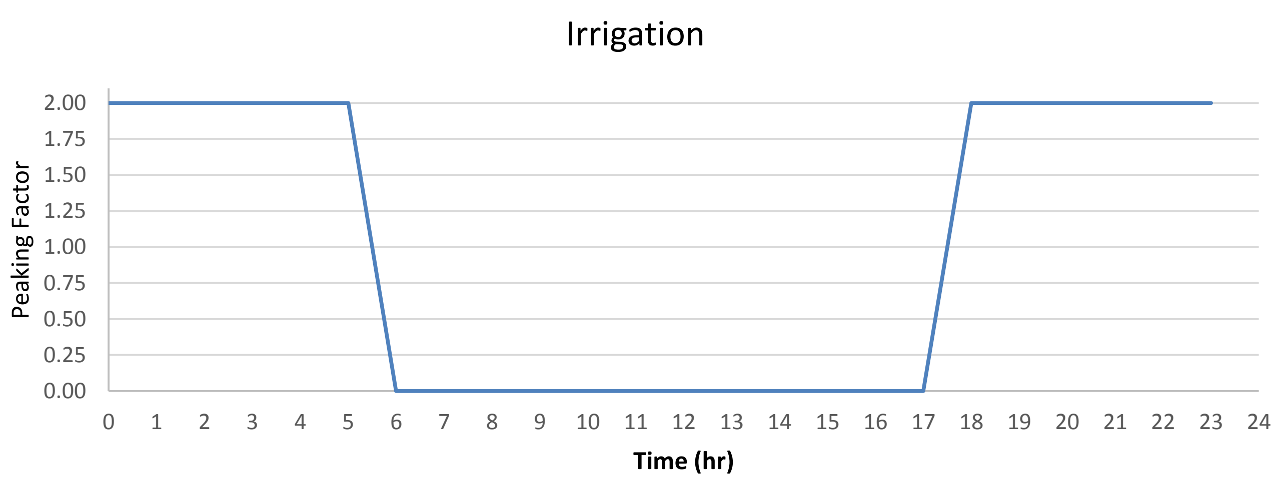
Figure 5.1
Potential Recycled Water System

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL







LEGEND

Water Demand

PRELIMINARY

October 25, 2016

Figure 5.2
Diurnal Curves
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

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CHAPTER 6 - HYDRAULIC MODEL DEVELOPMENT

This chapter describes the development and calibration of the City's domestic water distribution system hydraulic model. The hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated future growth.

6.1 OVERVIEW

Hydraulic network analysis has become an effectively powerful tool in many aspects of water distribution planning, design, operation, management, emergency response planning, system reliability analysis, fire flow analysis, and water quality evaluations. The City's hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated future growth.

6.2 MODEL SELECTION

The City's hydraulic model combines information on the physical characteristics of the water system (pipelines, groundwater wells, and storage reservoir) and operational characteristics (how they operate). The hydraulic model then performs calculations and solves series of equations to simulate flows in pipes and calculate pressures at nodes or junctions.

There are several network analysis software products that are released by different manufacturers, which can equally perform the hydraulic analysis satisfactorily. The selection of software depends on user preferences, the distribution system's unique requirements, and the costs for purchasing and maintaining the software.

The City's previous model was developed using Innovyze's (previously MWHSoft) H20Net, which runs inside AutoCAD and uses the effective EPANET hydraulic engine for processing the hydraulic calculations. As part of this master plan, the hydraulic model has been updated and redeveloped into the GIS-based hydraulic model InfoWater by Innovyze. The model has an intuitive graphical interface and is directly integrated with ESRI's ArcGIS (GIS).

6.3 HYDRAULIC MODEL DEVELOPMENT

Developing the hydraulic model included skeletonization, digitizing and quality control, developing pipe and node databases, and water demand allocation.

6.3.1 Skeletonization

Skeletonizing the model refers to the process where pipes not essential to the hydraulic analysis of the system are stripped from the model. Skeletonizing the model is useful in creating a system that accurately reflects the hydraulics of the pipes within the system, while reducing complexities of large systems, which will reduce the time of analysis while maintaining accuracy, but will also comply with limitations imposed by the computer program.

6.3.2 Pipes and Nodes

Computer modeling requires the compilation of large numerical databases that enable data input into the model. Detailed physical aspects, such as pipe size, pipe elevation, and pipe lengths, contribute to the accuracy of the model.

Pipes and nodes represent the physical aspect of the system within the model. A node is a computer representation of a place where demand may be allocated into the hydraulic system, while a pipe represents the distribution and transmission aspect of the water demand. In addition, reservoir dimensions and capacities, and groundwater well capacity and design head, were also included in the hydraulic model.

6.3.3 Digitizing and Quality Control

The City's existing domestic water distribution system was digitized in GIS using several sources of data and various levels of quality control. The data sources included the City's existing system as maintained by staff in GIS, as well as the previously developed hydraulic model and subsequent updates.

After reviewing the available data sources, the hydraulic model was updated and verified by City staff. Using the existing GIS version of the system, as well as the existing hydraulic model, this project updated the domestic water system in GIS. Resolving discrepancies in data sources was accomplished by graphically identifying identified discrepancies and submitting it to engineering and public works staff for review and comments. City comments were incorporated in the verified model.

6.3.4 Demand Allocation

Demand allocation consists of assigning water demand values to the appropriate nodes in the model. The goal is to distribute the demands throughout the model to best represent actual system response.

The existing demand distribution was obtained from the water billing records. Using GIS, each customer account was geocoded and spatially joined within its existing pressure zone. The accounts were then sorted by pressure zone and the total demand in each zone was calculated.

Domestic water demands from each anticipated future development, as presented in a previous chapter, were also allocated to the model for the purpose of sizing the required future facilities. The demands from the greater Urban Growth Boundary were allocated based on proposed land use and the land use acreages. As many of the areas were very large in size, demands were allocated evenly to the demand nodes within each area. Infill areas, redevelopment areas, and vacant lands were also included in the future demand allocation.

6.4 MODEL CALIBRATION

Calibration is intended to instill a level of confidence in the pressures and flows that are simulated. Calibration generally consists of comparing model predictions to field measured results and making necessary adjustments.

6.4.1 Calibration Plan and SCADA

In order to calibrate the hydraulic model pressure SCADA data was collected for points throughout the water distribution system, as well as water level data for the City's storage reservoirs. City staff provided 15-minute pressure data for each groundwater well and booster station as well as 15-minute water level data for the City's storage reservoirs, for a portion of the month of August 2014. The locations that were included in the calibration for tanks, booster stations, and wells were identified on **Figure 6.1**.

In addition, pressure loggers were installed throughout the system in an effort to enhance the calibration effort and document system conditions away from the vertical infrastructure. Three pressure loggers were placed at various intersections for a one-week period before moving to new locations. In addition to these three rotating pressure loggers, one pressure loggers was placed at a fixed point for the duration of the pressure logging program. The periods of installation for the pressure loggers are summarized on **Table 6.1**, while **Figure 6.2** documents the points used in the calibration of the hydraulic model.

6.4.2 EPS Calibration

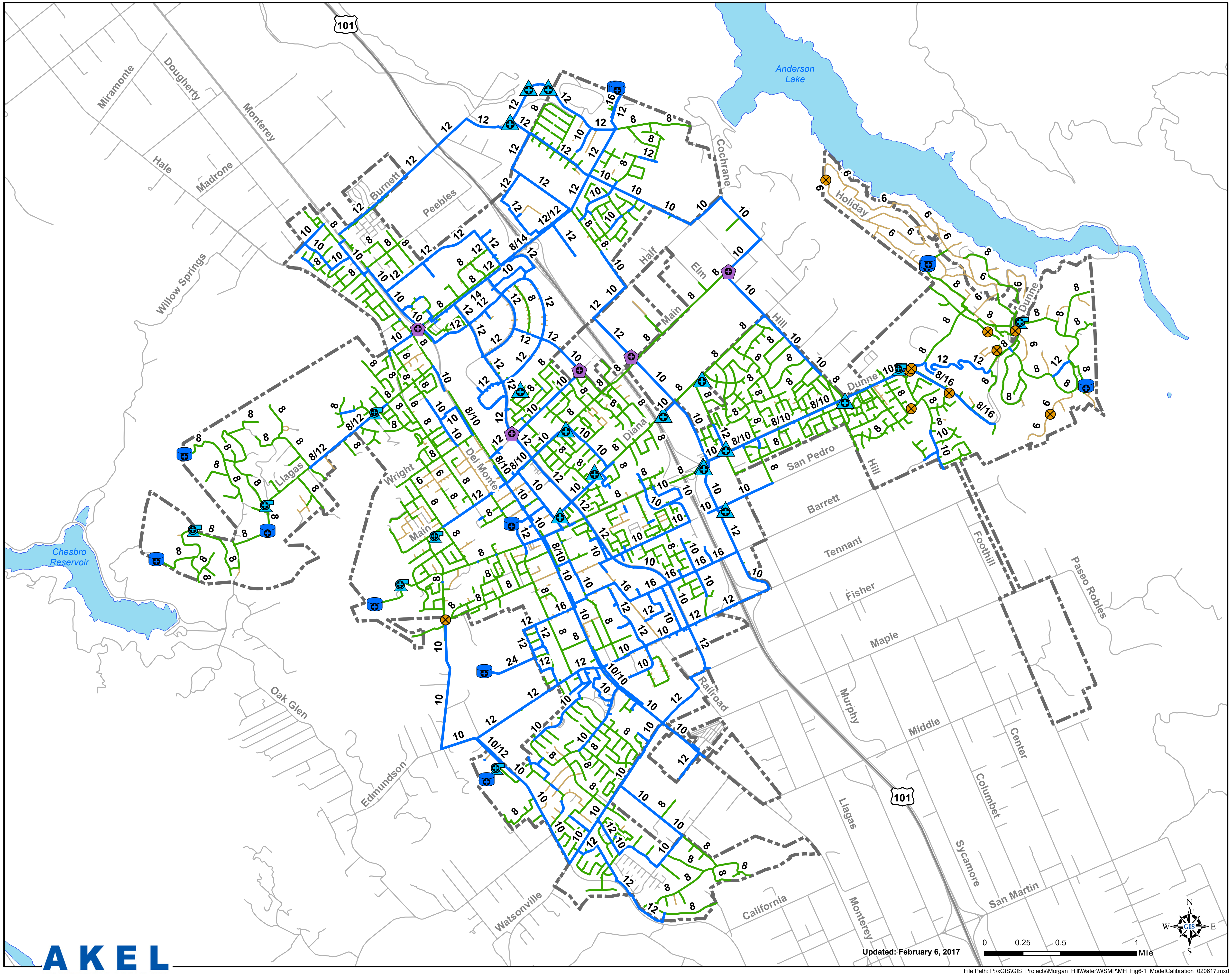
Calibration can be performed for steady state conditions or for extended period simulations (EPS). In steady state calibration, the model is compared to field monitoring results consisting of a single value, such as a single hydrant test. EPS calibration consists of comparing model predictions to diurnal operational changes in the water system.

The calibration process for the hydraulic model was extensive, and involved an iterative process which resulted with satisfactory comparisons between the field measurements and the hydraulic model predictions at each well site and the water tank. The calibration results were graphically summarized for each site and included in **Appendix A**.

Representative extracts from **Appendix A** are shown on **Figure 6.3** for calibration points at Diana Well Number 1 and the Edmundson tank.

6.4.3 Use of the Calibrated Model

The calibrated hydraulic model was used as an established benchmark in the capacity evaluation of the existing water distribution system. The model was also used to identify improvements necessary for mitigating existing system deficiencies and for accommodating future growth. This valuable investment will continue to prove its value to the City as future planning issues or other operational conditions surface. It is recommended that the model be maintained and updated with recent construction to preserve its integrity.



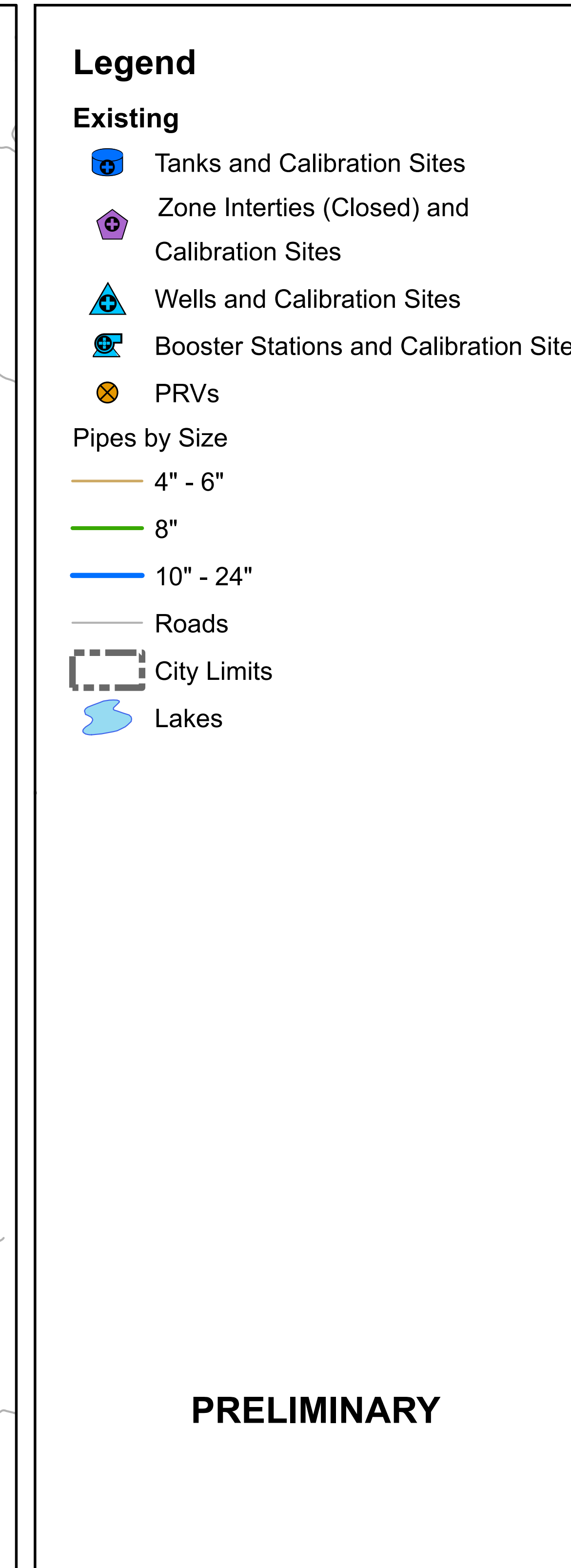
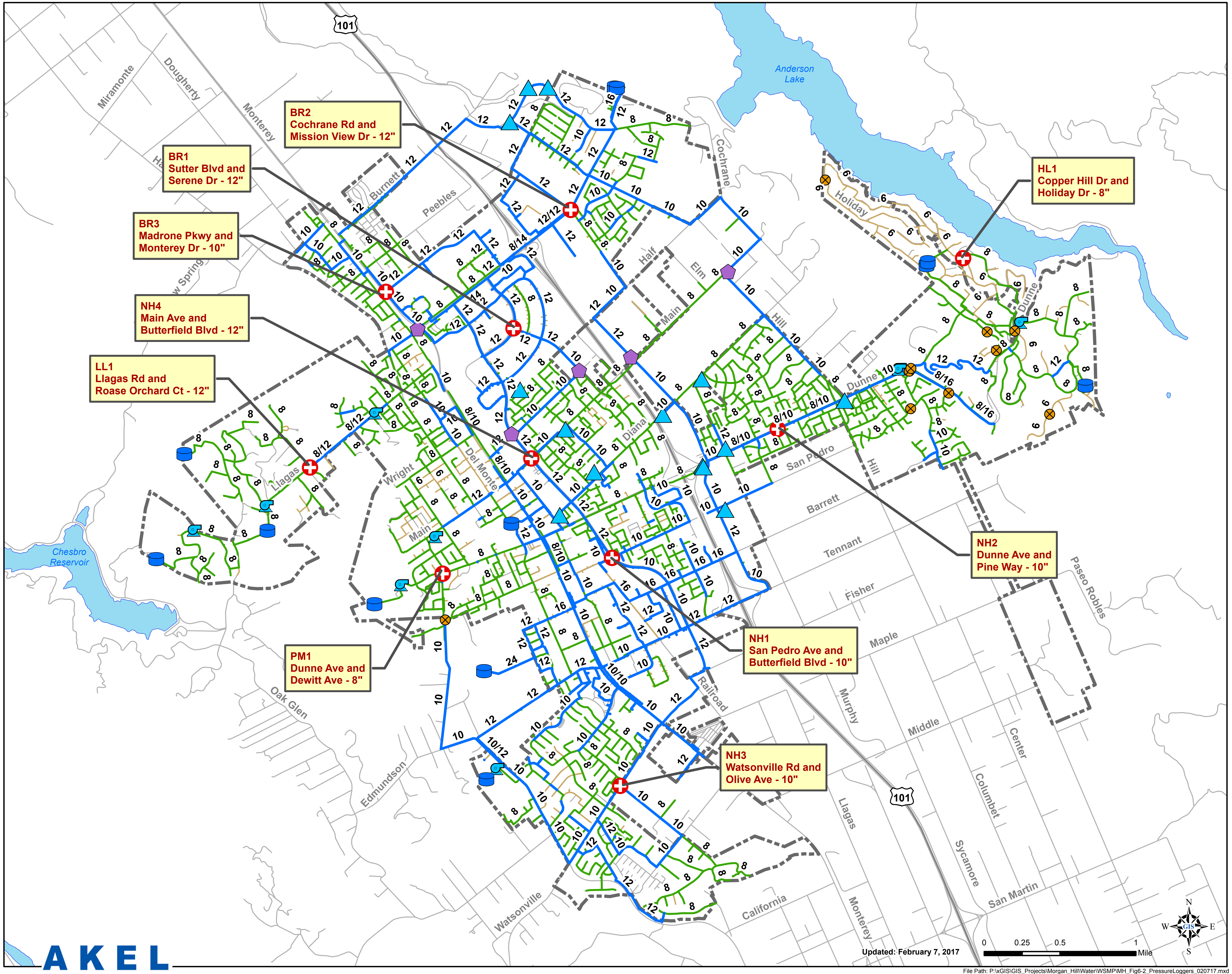


Figure 6.1
Hydraulic Model Calibration Program

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL



Legend

Pressure Loggers

Existing

Tanks

Zone Interties (Closed)

Wells

Booster Stations

PRVs

Pipes by Size

4" - 6"

8"

10" - 24"

Roads

City Limits

Lakes

PRELIMINARY

Figure 6.2
Pressure Logger Locations

Water System Master Plan
City of Morgan Hill

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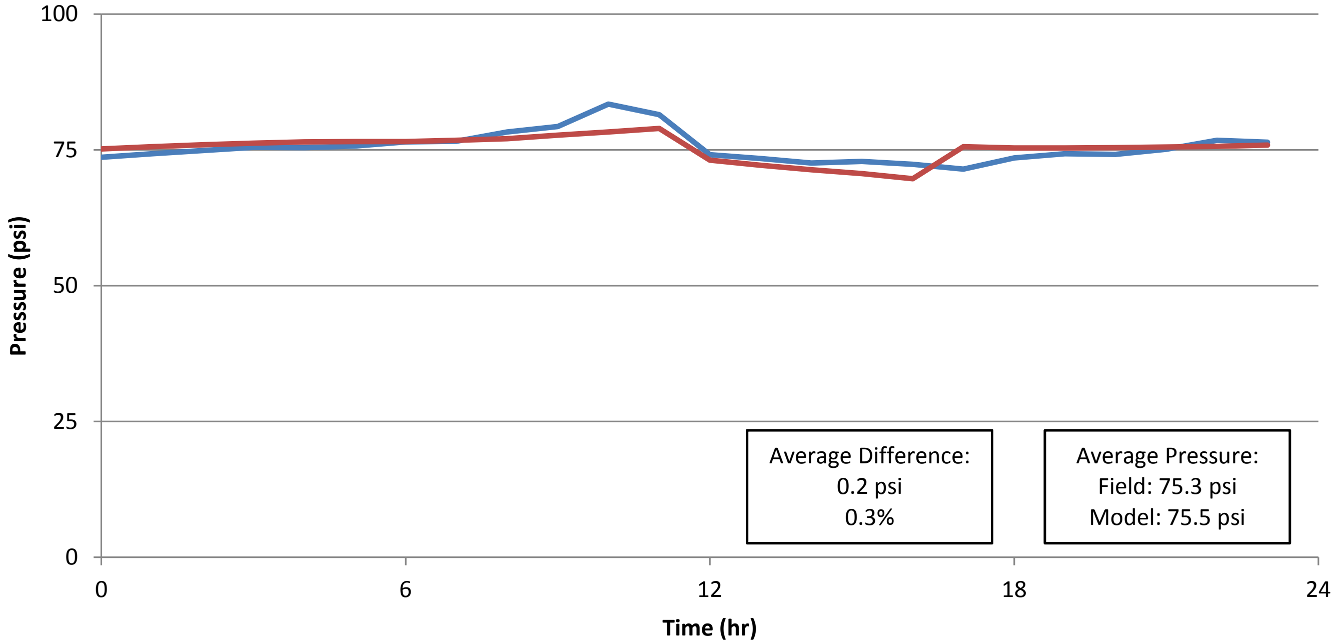
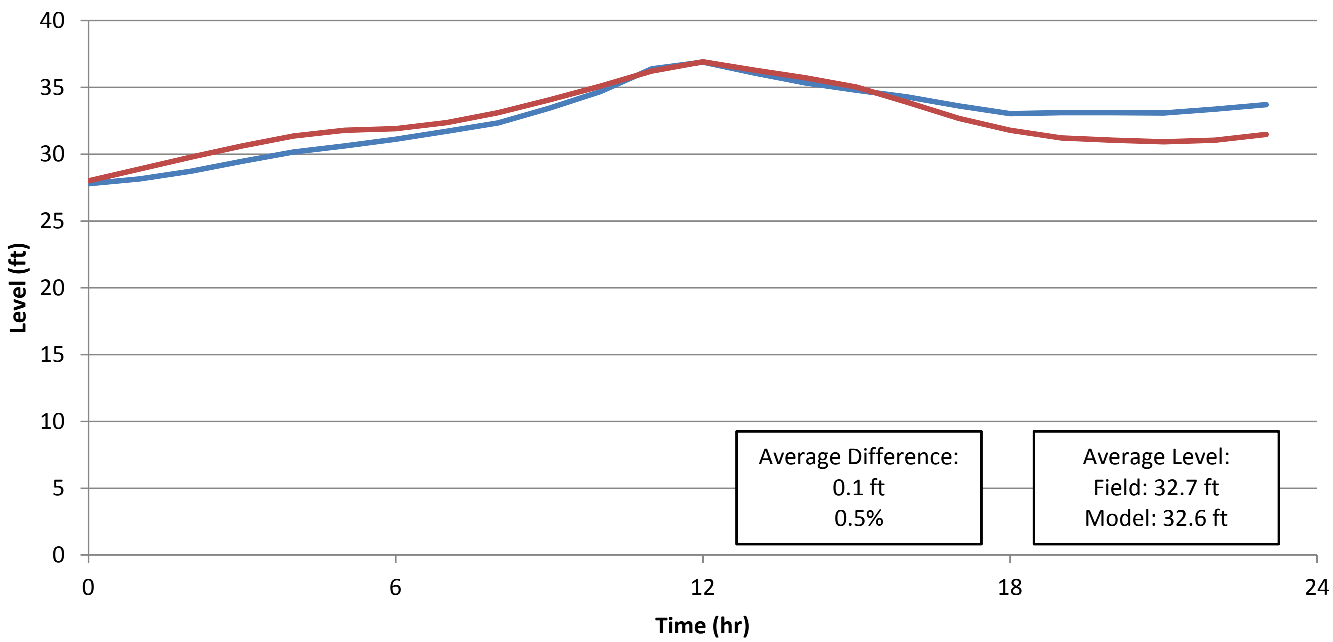
Diana Well No. 1 - Discharge Pressure



Edmundson Tank - Level



LEGEND

- SCADA
- Hydraulic Model

Field Monitoring Dates
7/31/14 - 8/31/14
Calibration Graphs Show
8/28/14

PRELIMINARY

February 19, 2016

Figure 6.3

Hydraulic Model Calibration

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

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Table 6.1 Pressure Logger Locations

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Pressure Logger ID	Location Description	Pressure Zone	Pipe Size (in)
	Weeks 1 - 3 (Permanent Meter)		
NH1	San Pedro Ave and Butterfield Blvd	Nob Hill	10
	Week 1 (8/18/2014-8/25/2014)		
NH2	Dunne Ave and Pine Way	Nob Hill	10
NH3	Watsonville Rd and Olive Ave	Nob Hill	10
NH4	Main Ave and Butterfield Blvd	Nob Hill	12
	Week 2 (8/26/2014-9/2/2014)		
BR1	Sutter Blvd and Serene Dr	Boys Ranch	12
BR2	Cochrane Rd and Mission View Dr	Boys Ranch	12
BR3	Madrone Pkwy and Monterey Dr	Boys Ranch	10
	Week 3 (9/3/2014-9/9/2014)		
LL1	Llagas Rd and Rose Orchard Ct	Llagas	12
PM1	Dunne Ave and Dewitt Ave	Peak and Main	8
HL1	Copper Hill Dr and Holiday Dr	Holiday Lake Zone	8

CHAPTER 7 - EVALUATION AND PROPOSED IMPROVEMENTS

This section presents a summary of the domestic water system evaluation and identifies improvements needed to mitigate existing deficiencies, as well as improvements needed to expand the system and service growth.

7.1 OVERVIEW

The calibrated hydraulic model was used for evaluating the distribution system for capacity deficiencies during peak hour demand and during maximum day demands in conjunction with fire flows. Since the hydraulic model was calibrated for extended period simulations, the analysis duration was established at 24 hours for analysis.

The criteria used for evaluating the capacity adequacy of the domestic water distribution system facilities (transmission mains, storage reservoirs, and booster stations) was discussed and summarized in the System Performance and Design Criteria chapter.

7.2 FIRE FLOW ANALYSIS

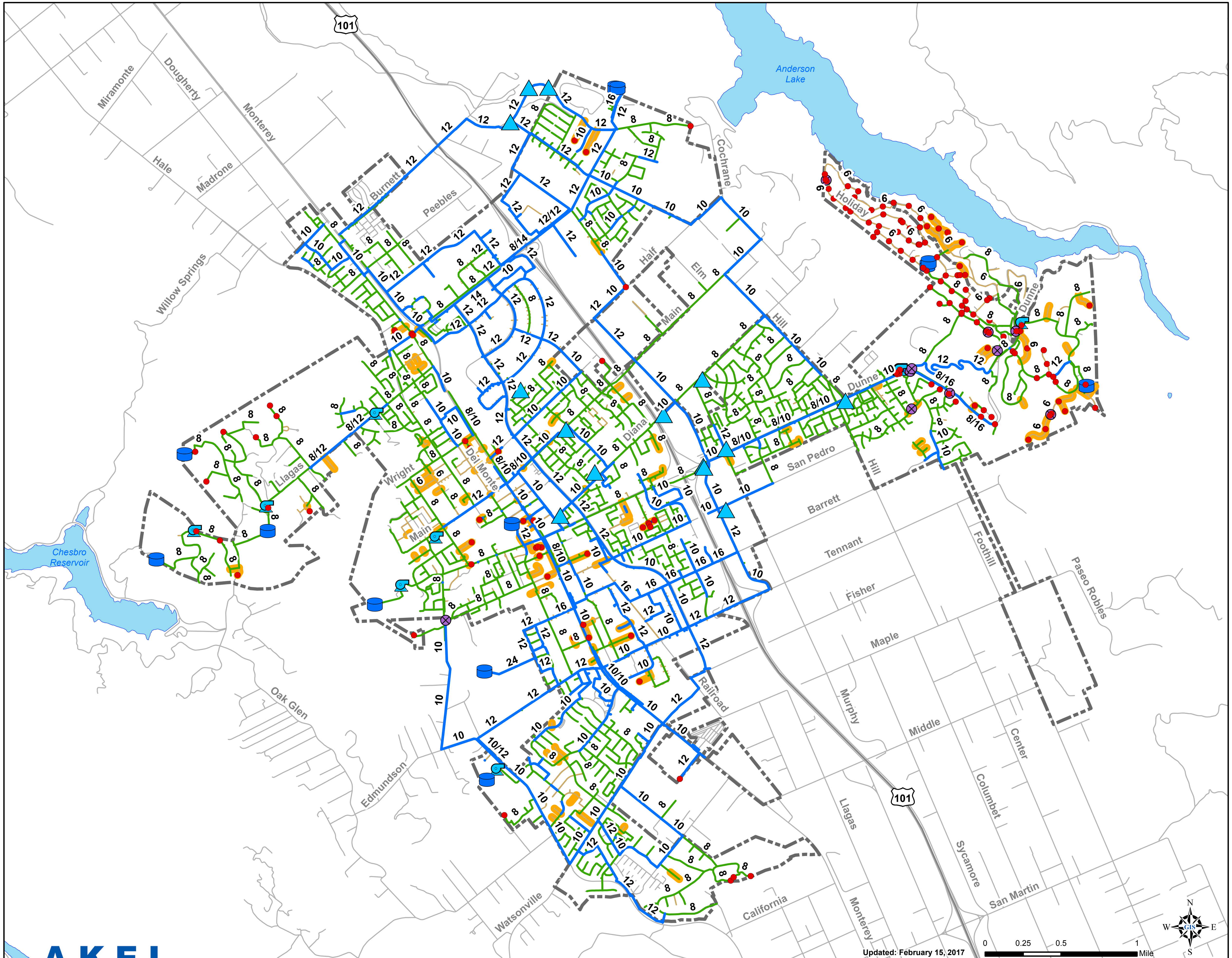
The fire flow analysis consisted of using the maximum day demand in the hydraulic model and applying hypothetical fire flows. The magnitude and duration of each fire flow was based on the governing land use type within proximity to the fire location. The criterion for fire flows was also summarized in the System Performance and Design Criteria chapter.

The hydraulic model indicates that the City's existing distribution system performed adequately during the fire flow analysis. Areas where the City water system did not meet the fire flow criteria are documented on **Figure 7.1**. The available fire flow at the City's residual pressure criteria of 20 psi is summarized on **Figure 7.2**. It should be noted that a majority of the service connections in the eastern foothills are unable to meet the pressure requirements under fire flow conditions. A majority of the distribution system serving this area is comprised of 6-inch and 8-inch water pipelines with minimal looping. It is recommended that as pipeline replacements occur, 6-inch pipelines be upsized to 8-inch pipelines to reduce the headloss and velocity impacts to this area. Additionally, where the cost is not prohibitive, it is recommended that looped connections be constructed for reliability.

Improvements to mitigate specific fire flow deficiencies are discussed below and include a corresponding coded identifier, which is consistent with the capital improvements chapter:

- **NH-P2.** Replace approximately 950 feet of 4-inch water main from Del Monte Avenue to Monterey Road along Spring Avenue with 8-inch water main.

- **BR-P5:** Replace an 8-inch pip with a new 10-inch pipeline in Mission View Drive between Cochrane Road and 2,100 feet northwest of Cochrane Road.



Legend

- Node Pressures <20 psi
- Pipe Velocities >15 fps

Existing

- Tanks
- Wells
- Booster Stations
- PRVs

Pipes by Size

- 4" - 6"
- 8"
- 10" - 24"
- Roads
- City Limits
- Lakes

PRELIMINARY

Figure 7.1
Fire Flow Analysis

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

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File Path: P:\xGIS\GIS_Projects\Morgan_Hill\Water\WSMP\MH_Fig7-1_FireFlowAnalysis_021517.mxd

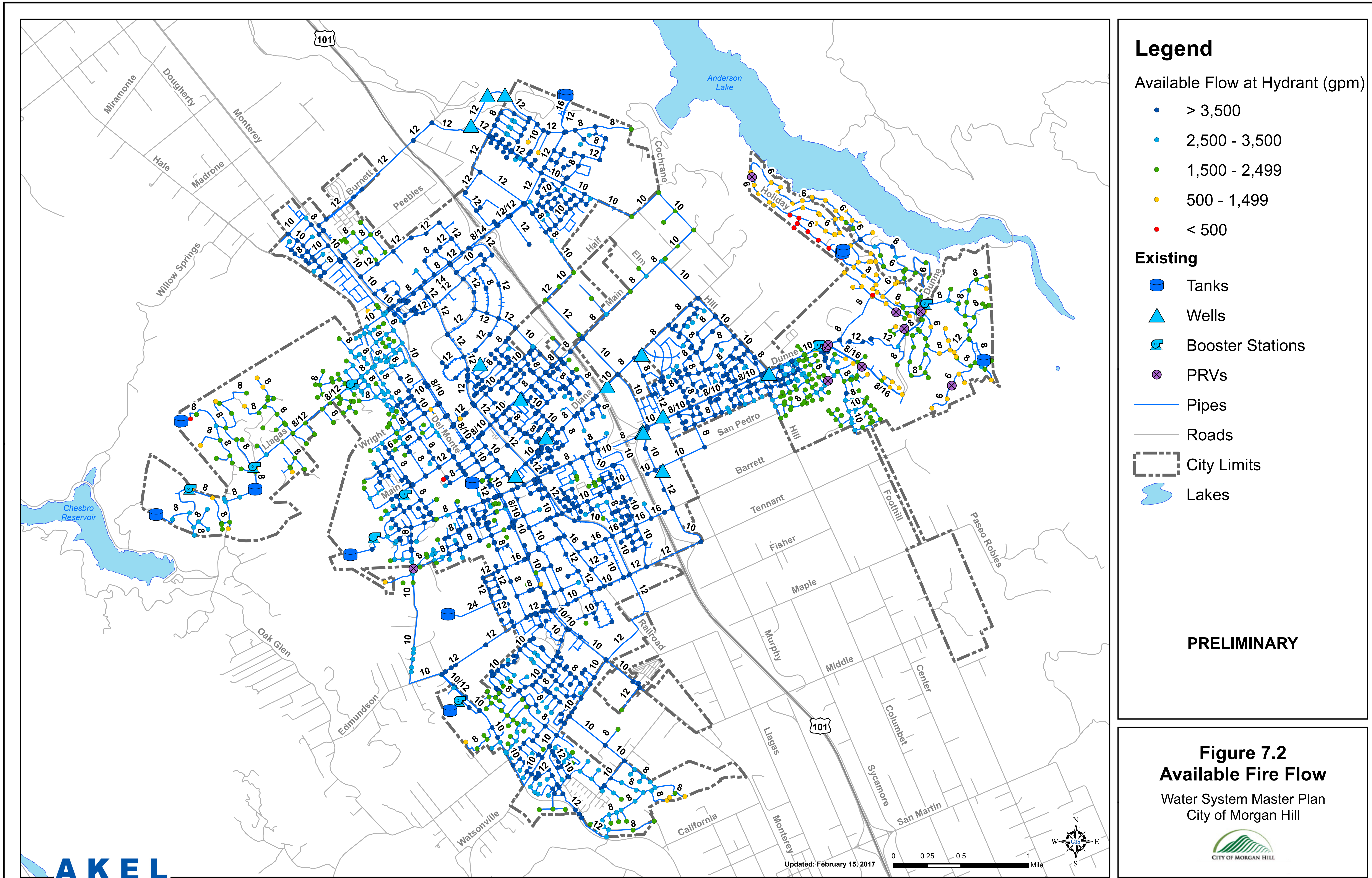


Figure 7.2
Available Fire Flow
Water System Master Plan
City of Morgan Hill

7.3 LOW PRESSURES ANALYSIS

The hydraulic model was also used to determine if the existing domestic water distribution system meets the City's System Performance and Design Criteria for maximum day and peak hour pressures, as discussed in a previous chapter. During maximum day demands the minimum pressure requirement is 40 psi, while during the peak hour demand, the minimum pressure requirement is 35 psi. The hydraulic analysis indicated the City's existing system performed reasonably well during under maximum day (**Figure 7.3**) and peak hour (**Figure 7.4**) operating conditions.

7.4 HIGH PRESSURE ANALYSIS

The hydraulic model was also used to identify areas in the City's existing domestic water distribution system that experience high pressure under maximum day demand conditions. The areas of high pressure are shown graphically on **Figure 7.5**. Areas of high pressure may be more susceptible to pipeline breaks and ruptures. The City's maximum desired pressure criterion is 100 psi. The areas experiencing high pressures are briefly described as follows:

- **Woodland Pressure Zone:** Development near Rocky Ridge Road and Rolling Hills Road, east of the Woodland Reservoir experience maximum pressures between 150 and 225 psi. These developments are served by the Woodland storage reservoir, which has a base elevation of approximately 1,080 feet and serves developments with elevations as low as 630 feet.

- **Llagas Pressure Zone:** Development along Llagas Road, east of Enderson Court, experience maximum pressures between 150 and 200 psi. These developments are served by the Glen Ayre Reservoir. These developments are served by the Llagas storage reservoir, which has a base elevation of 700 feet and serves developments with elevations as low as 360 feet.

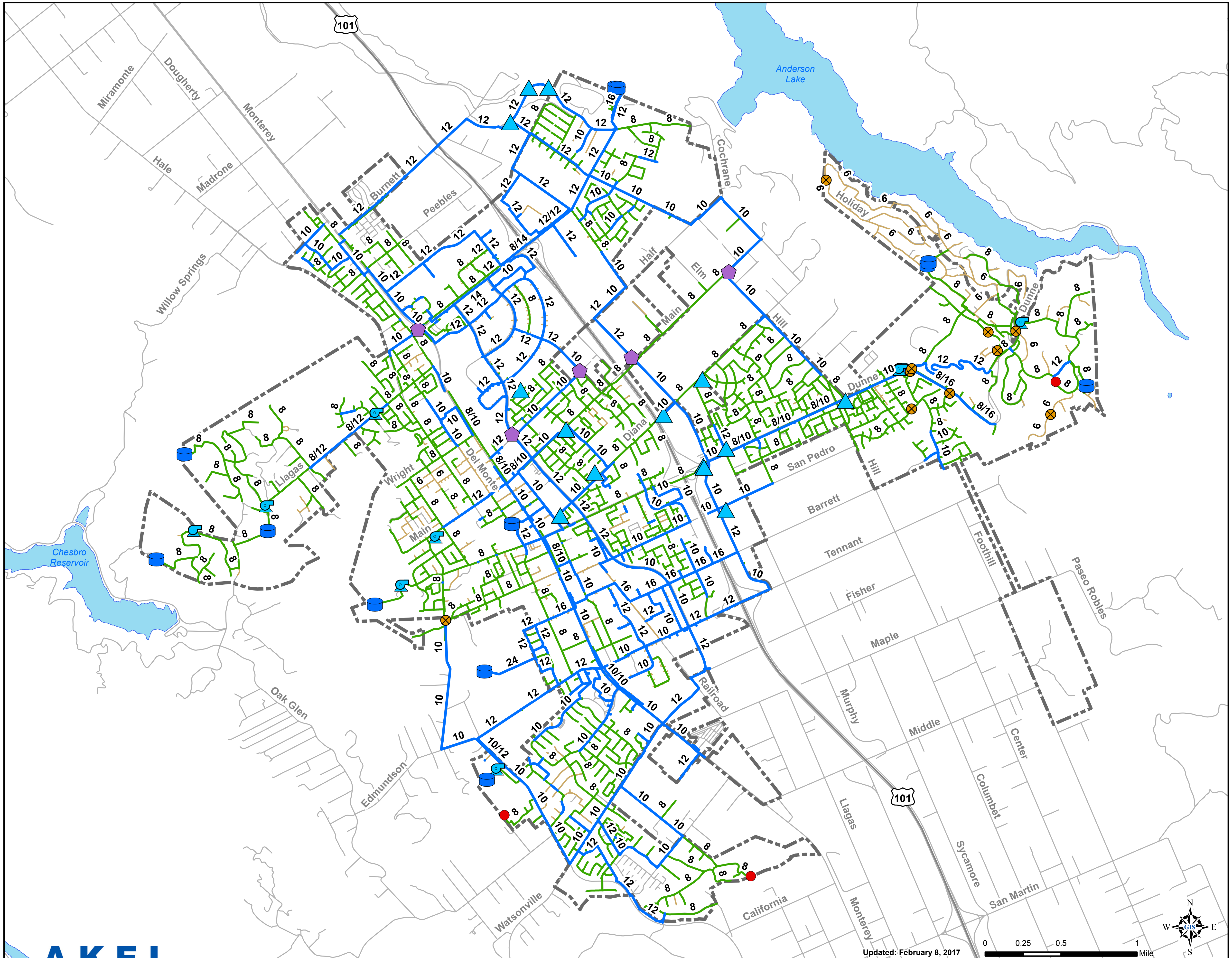
- **Holiday Lake Pressure Zone:** Development along Thomas Grade east of Dunne Avenue experience maximum pressures between 150 and 225 psi. These developments are served by the Holiday Lake Reservoirs, which have a base elevation of 960 feet and serve developments with elevations as low as 500 feet.

7.5 WATER SUPPLY REQUIREMENTS

The City's existing domestic water system supply capacity is identified in this section. Additionally, this section identifies the additional supply capacity required to meet the supply requirement, and consistent with the City's System Performance and Design Criteria.

7.5.1 Existing Supply Requirements

Existing supply requirements were identified for the City and are summarized on **Table 7.1**. The City's existing water supply requirement was based on the existing land use and recommended



Legend

Node Pressures

- 28 - 40 psi

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs

Pipes by Size

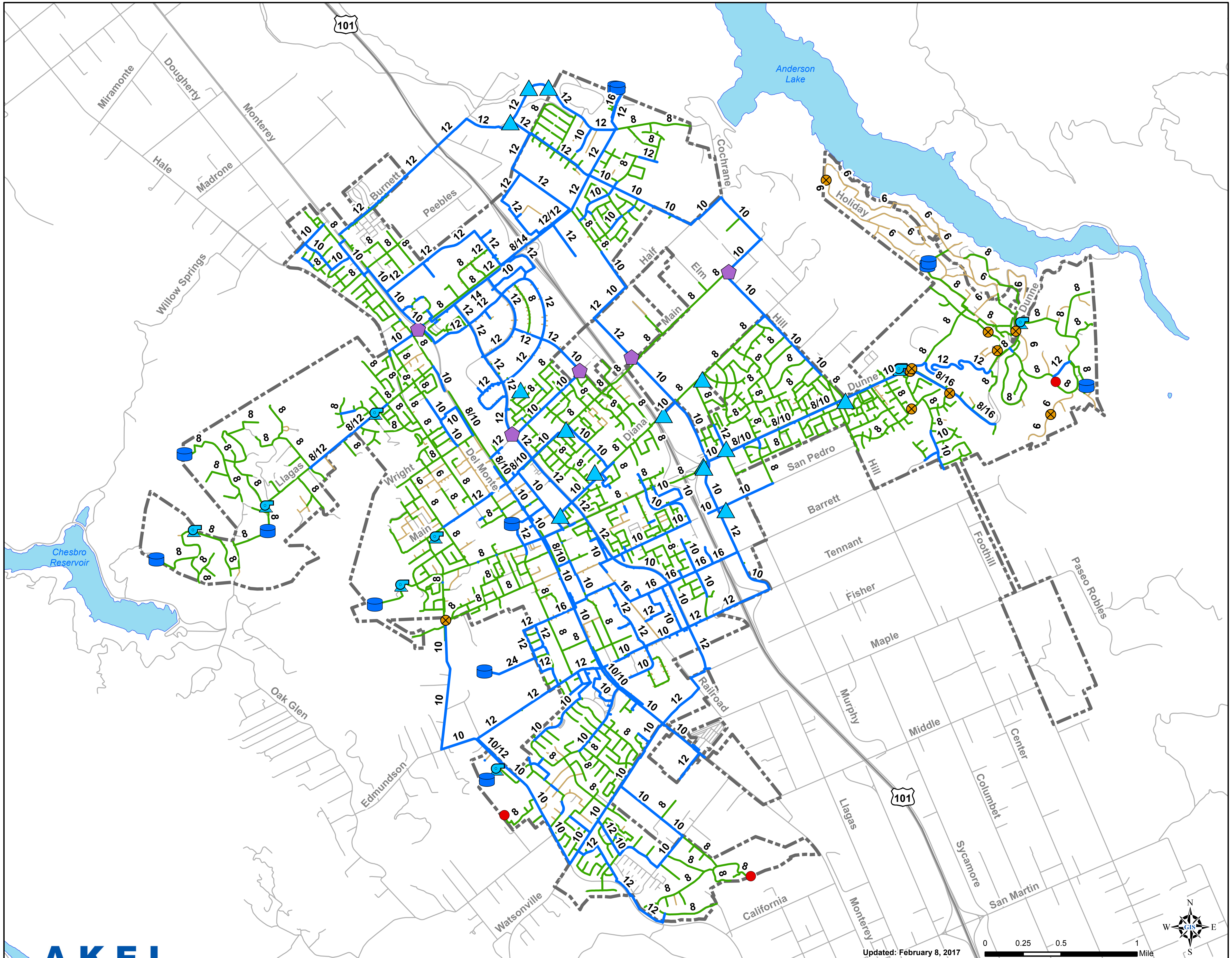
- 4" - 6"
- 8"
- 10" - 24"
- Roads
- City Limits
- Lakes

PRELIMINARY

Figure 7.3
Maximum Day Demand Low Pressures
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.



Legend

Node Pressures

- 24 - 35 psi

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs

Pipes by Size

- 4" - 6"
- 8"
- 10" - 24"
- Roads
- City Limits
- Lakes

PRELIMINARY

Figure 7.4
Peak Hour Demand
Low Pressures
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

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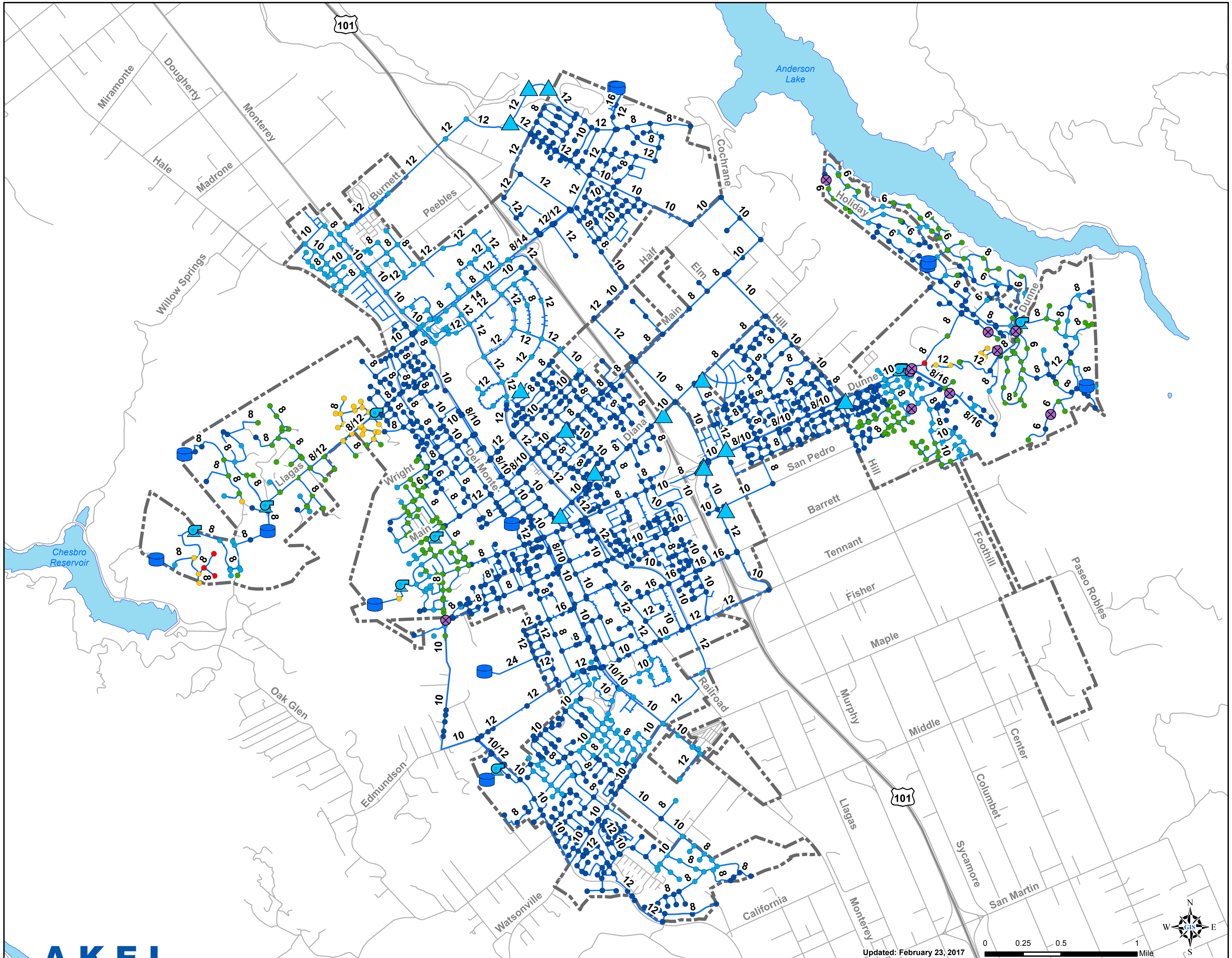

Legend

Maximum Pressures

- < 80
- 80 - 100
- 100 - 150
- 150 - 200
- 200 - 225

Existing

- Tanks
- Wells
- Booster Stations
- PRVs
- Pipes
- Roads
- City Limits
- Lakes

PRELIMINARY

Figure 7.5
Maximum Pressure

Water System Master Plan
City of Morgan Hill

AKEL ENGINEERING GROUP, INC.

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Table 7.1 Supply Capacity Analysis

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Demand and Supply	Year 2015 (MGD)	2020 (MGD)	2025 (MGD)	2030 (MGD)	2035 (MGD)
Projected Demands - Population Method					
Projected Population	42,382	48,000	51,400	54,800	58,200
Average Day Demands	7.6	7.6	8.2	8.7	9.3
Maximum Day Demands	15.2	15.3	16.3	17.4	18.5
Peak Hour Demands	22.8	22.9	24.5	26.1	27.8
Projected Demands - Land Use Method					
Average Day Demands	6.0	6.9	7.7	8.5	9.4
Maximum Day Demands	12.0	13.7	15.4	17.1	18.8
Peak Hour Demands	18.0	20.6	23.1	25.6	28.2
Supply vs. Demand Analysis					
Available Supply					
2015 Available Total Supply	19.32	-	-	-	-
2015 Available Firm Supply	17.16	-	-	-	-
Required Supply					
Meet Maximum Day Demand with Firm Supply	15.2	15.3	16.3	17.4	18.5
Surplus / Deficiency					
With Existing Firm Supply	2.0	1.9	0.8	-0.3	-1.3
With Recommended Total Supply	2.0	1.9	0.8	0.9	1.0
Recommended New Supply					
Recommended Staged Upgrade				**1 New Well**	**1 New Well**
Assumed Typ. Future Well Capacity at 1.15 MGD				1.2	1.2
Recommended Total Supply	17.2	17.2	17.2	18.3	19.5

water demand factor is approximately 15.2 mgd. The existing firm supply capacity is approximately 17.2 mgd, which results in a supply surplus of 2.0 mgd.

7.5.2 Future Supply Requirements

Future supply requirements, in 5-year increments, were identified for the City and are also summarized on Table 7.1. As shown on Table 7.1 the City's existing firm supply capacity is sufficient to meet the City's future supply requirement until the year 2030, at which point the supply requirement exceeds the City's existing firm supply capacity and a new well is required to be constructed. Following the construction of this new well the City will not need to construct a new well to meet the future supply requirement until the year 2030, when the future supply requirement will exceed the City's future firm supply capacity. The proposed groundwater wells are described as follows:

- **BR-W1:** Construct a new 800 gpm groundwater well on Burnett Avenue. This facility will be located approximately 6,000 feet northeast of Monterey Avenue.
- **NH-W1:** Construct a new 800 gpm groundwater well on Butterfield Avenue. This facility will be located approximately 400 feet northeast of the intersection of Railroad Avenue and Fisher Avenue.

7.6 WATER STORAGE REQUIREMENTS

The City's existing domestic water system storage capacity is identified in this section. Additionally, this section identifies the existing and future storage requirements to meet the storage capacity and compares it with the existing storage facilities in each zone and makes recommendations for new storage facilities.

7.6.1 Existing Storage Requirements

Existing storage requirements were identified for each pressure zone and are summarized in Table 7.2. The table lists the existing domestic water demands and identifies the operation, fire, and emergency storage for each pressure zone. This table also lists the total required storage for existing domestic water demands at 8.7 MG.

7.6.2 Future Storage Requirements

Future storage requirements were identified based on the buildout of the 2035 General Plan and summarized by pressure zone on Table 7.3. The table lists the future domestic water demands and identifies the operations, fire, and emergency storage for each pressure zones. The table also lists the total required storage for future domestic water demands at 6.0 MG.

7.6.3 Recommended New Storage Facilities

The existing and future storage requirements, shown on Tables 7.2 and Table 7.3, were compared with existing City storage facilities in each pressure zone and the required storage

Table 7.2 Existing Storage Requirements

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Pressure Zone	Existing Water Demands		Existing Water Storage Requirements				
	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Operational at 25% (MG)	Emergency at 25% (MG)	Fire Protection (MG)	Operational + Emergency (MG)	Total, By Pressure Zone (MG)
Central Zones (Nob Hill and Boys Ranch Pressure Zones)							
Nob Hill Zone[1]	4.39	8.77	2.19	2.19	0.63	4.39	5.02
Boys Ranch Zone	0.73	1.46	0.37	0.37	0.63	0.73	1.36
Subtotal	5.12	10.23	2.56	2.56	1.26	5.12	6.38
West Side Pressure Zones							
Llagas Zone	0.12	0.24	0.06	0.06	0.18	0.12	0.30
Woodland Zone	0.01	0.02	0.01	0.01	0.18	0.01	0.19
Glen Ayre Zone	0.03	0.06	0.01	0.01	0.18	0.03	0.21
El Toro Zone[2]	0.16	0.33	0.08	0.08	0.18	0.16	0.34
Encino Zone	0.07	0.14	0.04	0.04	0.18	0.07	0.25
Subtotal	0.39	0.79	0.20	0.20	0.90	0.39	1.29
East Side Pressure Zones							
Holiday Lake Zone	0.08	0.16	0.04	0.04	0.18	0.08	0.26
Holiday 1,2,3 Zones	0.16	0.33	0.08	0.08	0.18	0.16	0.34
Jackson Oaks Zone	0.23	0.45	0.11	0.11	0.18	0.23	0.41
Subtotal	0.47	0.94	0.23	0.23	0.54	0.47	1.01
Total Existing Storage Requirements							
	5.98	**11.96**	**2.99**	**2.99**	**2.70**	**5.98**	**8.68**

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Notes:

1. Nob Hill Zone includes Easy Street Zone demands.
2. El Toro Zone includes Peak and Main Zone and Spring Hill Zone demands.

Table 7.3 Future Storage Requirements

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Pressure Zone	Future Water Demands		Future Water Storage Requirements				
	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Operational at 25% (MG)	Emergency at 25% (MG)	Fire Protection (MG)	Operational + Emergency (MG)	Total, By Pressure Zone (MG)
Central Zones (Nob Hill and Boys Ranch Pressure Zones)							
Nob Hill Zone[1]	2.10	4.20	1.05	1.05	0.63	2.10	2.73
Boys Ranch Zone	0.85	1.70	0.42	0.42	0.63	0.85	1.48
Subtotal	2.95	5.90	1.48	1.48	1.26	2.95	4.21
West Side Pressure Zones							
Llagas Zone	0.10	0.21	0.05	0.05	0.18	0.10	0.28
Woodland Zone	0.004	0.008	0.002	0.002	0.18	0.004	0.18
Glen Ayre Zone	0.003	0.007	0.002	0.002	0.18	0.003	0.18
El Toro Zone[2]	0.02	0.05	0.01	0.01	0.18	0.02	0.20
Encino Zone	0.02	0.03	0.01	0.01	0.18	0.02	0.20
Subtotal	0.15	0.30	0.08	0.08	0.90	0.15	1.05
East Side Pressure Zones							
Holiday Lake Zone	0.007	0.015	0.004	0.004	0.18	0.007	0.19
Holiday 1,2,3 Zones	0.21	0.42	0.11	0.11	0.18	0.21	0.39
Jackson Oaks Zone	0.02	0.04	0.01	0.01	0.18	0.02	0.20
Subtotal	0.24	0.48	0.12	0.12	0.54	0.24	0.78
Total Future Storage Requirements							
	3.34	**6.68**	**1.67**	**1.67**	**2.70**	**3.34**	**6.04**

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Notes:

1. Nob Hill Zone includes Easy Street Zone demands.
2. El Toro Zone includes Peak and Main Zone and Spring Hill Zone demands.

facility improvements were identified and listed on **Table 7.4**. The table lists existing storage facilities for each zone, identifies existing storage capacity deficiencies, and identifies future storage capacity requirements to meet the needs from future growth.

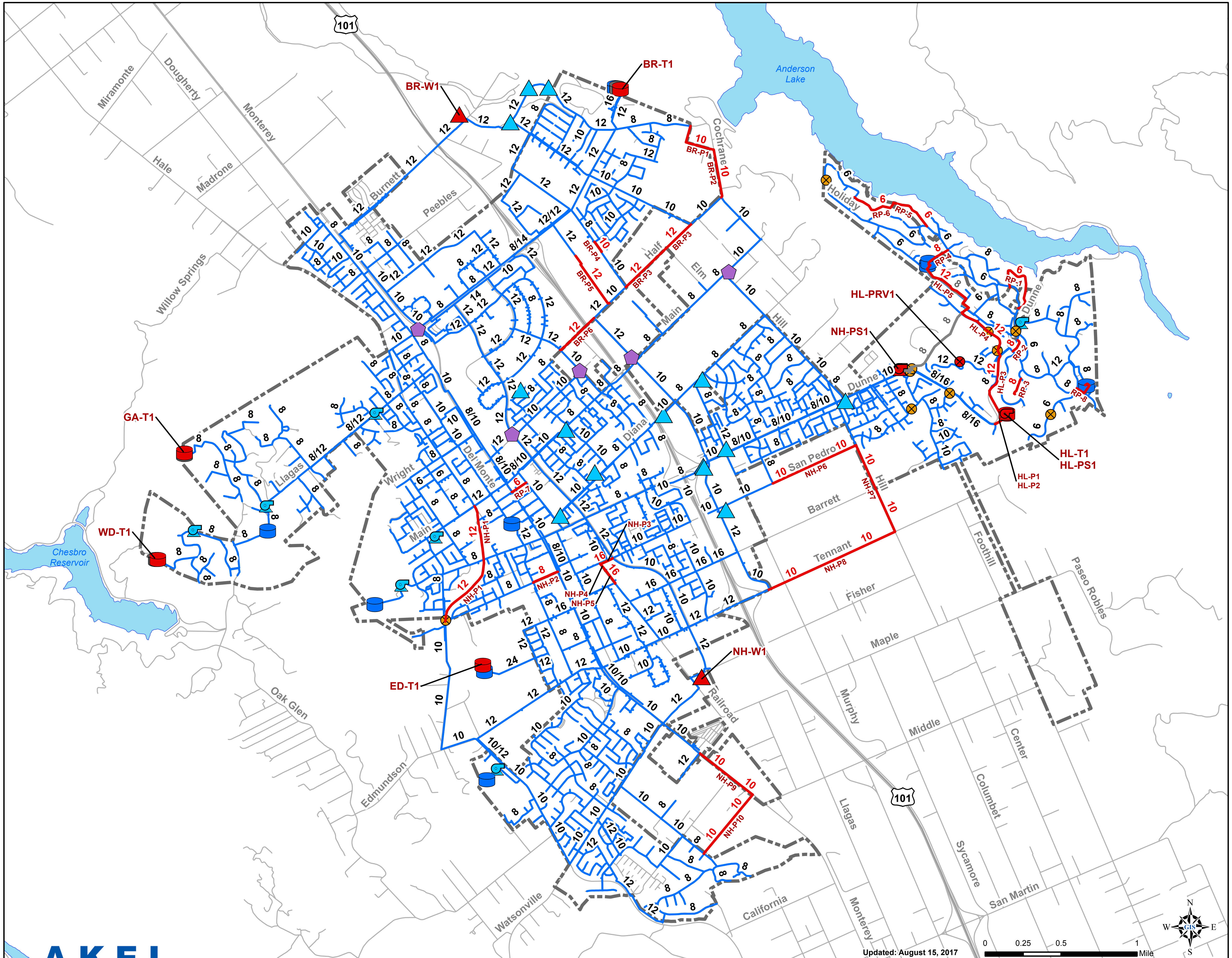
Based on the storage analysis shown on **Table 7.4**, the Woodland and Glen Ayre pressure zones are deficient under existing conditions; replacement tanks are recommended for each pressure zone that are sized to meet the storage requirements for existing and future demands. It should be noted that the storage requirements for pressure zones Holiday 1, Holiday 2, and Holiday 3 are currently met by the Holiday Lake tanks. Based on direction from City staff a new tank is to be constructed in the future to provide for the storage requirements of pressure zones Holiday 1, Holiday 2, and Holiday 3, which are approximately 0.55 MG. This future tank also includes additional 0.3 MG of storage capacity to account for the potential southeast quadrant development. Should the development not be constructed, the additional capacity may allow for operational flexibility during time of use periods.

The proposed storage reservoirs, summarized on **Table 7.5** and graphically shown on **Figure 7.6**, are described as follows:

- **BR-T1:** Construct a new 1.2 MG storage reservoir at the existing Boys Ranch Tank site. This improvement includes the demolition of the existing Boys Ranch 1 storage reservoir, which has an existing storage capacity of 0.55 MG.
- **GA-T1:** Construct a new 0.25 MG storage reservoir at the existing Glen Ayre Tank site. This improvement includes the demolition of the existing Glen Ayre Tank. This improvement is intended to mitigate an existing storage deficiency as well as provide storage for future demands.
- **ED-T1:** Construct a new 0.90 MG storage reservoir at the existing Edmundson tank site to provide additional storage for future demands.
- **WD-T1:** Construct a new 0.25 MG storage reservoir at the existing Woodland Tank site. This improvement includes the demolition of the existing Woodland Tank. This improvement is intended to mitigate an existing storage deficiency as well as provide storage for future demands.
- **HL-T1:** Construct a new 0.85 MG storage reservoir near Dunne Avenue approximately 500 feet northeast of Flaming Oak Lane. This tank is intended to provide for the storage requirements of existing pressure zones Holiday 1, Holiday 2, and Holiday 3 following the abandonment of existing booster stations East Dunne Number 2 and East Dunne Number 3.

7.7 PUMP STATION CAPACITY ANALYSIS

The City's existing pump station capacity is identified in this section. Additionally, this section identifies the existing and future pump station capacity requirements and compares it with the existing pump station facilities in each zone and makes recommendations for new pump station facilities.



Legend

Proposed Improvements

- Tanks
- Wells
- Booster Stations
- Valves
- Pipes

To be Abandoned

- Tanks
- Booster Stations
- Pipes

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs
- Pipes
- Roads
- City Limits
- Lakes

PRELIMINARY

Figure 7.6
Schedule of Improvements

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Morgan_Hill\Water\WSMP\MH_Fig7-6_ScheduleCIP_081517.mxd

Table 7.4 Storage Capacity Analysis by Pressure Zone

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Pressure Zone	Existing Water Storage Requirements					Future Water Storage Requirements					Total Existing and Future Storage Requirement	Existing Storage Reservoirs													Storage Balance for Existing Demands	Proposed New Storage Reservoirs						Total Storage	Existing and Future Storage Balance
	Existing Average Day Demand (MGD)	Existing Maximum Day Demand (MGD)	Operational + Emergency (MG)	Fire Protection (MG)	Total (MG)	Future Average Day Demand (MGD)	Future Maximum Day Demand (MGD)	Operational + Emergency (MG)	Fire Protection (MG)	Total (MG)	(MG)	Nob Hill (MG)	Edmunson (MG)	Boys Ranch 1 (MG)	Boys Ranch 2 (MG)	Llagas (MG)	Woodland (MG)	Glen Ayre (MG)	El Toro (MG)	Encino (MG)	Holiday Lake 1 (MG)	Holiday Lake 2 (MG)	Jackson Oaks (MG)	Total (MG)	(MG)	Edmundson 2 ED-T1 (MG)	Boys Ranch 3 BR-T1 (MG)	Woodland 2 WD-T1 (MG)	Glen Ayre 2 GA-T1 (MG)	E Dunne HL-T1 (MG)	Total (MG)	(MG)	(MG)
Central Zones (Nob Hill and Boys Ranch Pressure Zones)																																	
Nob Hill Zone[1]	4.39	8.77	4.39	0.63	5.02	2.10	4.20	2.10	0.63	2.73	7.12	2.00	4.25											6.25	1.23	0.90					0.90	7.15	0.03
Boys Ranch Zone	0.73	1.46	0.73	0.63	1.36	0.85	1.70	0.85	0.63	1.48	2.21			0.55	1.03									1.58	0.22		1.20				1.20	2.23	0.02
Subtotal	5.12	10.23	5.12	1.26	6.38	2.95	5.90	2.95	1.26	4.21	9.33													7.83	1.45						2.10	9.38	0.05
West Side Pressure Zones																																	
Llagas Zone	0.12	0.24	0.12	0.18	0.30	0.10	0.21	0.10	0.18	0.28	0.40					0.35								0.35	0.05						0.00	0.35	-0.05
Woodland Zone	0.01	0.02	0.01	0.18	0.19	0.004	0.008	0.004	0.18	0.18	0.19						0.03							0.03	-0.16			0.25			0.25	0.25	0.06
Glen Ayre Zone	0.03	0.06	0.03	0.18	0.21	0.003	0.007	0.003	0.18	0.18	0.21							0.10						0.10	-0.11				0.25		0.25	0.25	0.04
El Toro Zone[2]	0.16	0.33	0.16	0.18	0.34	0.02	0.05	0.02	0.18	0.20	0.37								0.50					0.50	0.16						0.00	0.50	0.13
Encino Zone	0.07	0.14	0.07	0.18	0.25	0.02	0.03	0.02	0.18	0.20	0.27									0.60				0.60	0.35						0.00	0.60	0.33
Subtotal	0.39	0.79	0.39	0.90	1.29	0.15	0.30	0.15	0.90	1.05	1.44													1.58	0.29						0.50	1.95	0.51
East Side Pressure Zones																																	
Holiday Lake Zone	0.08	0.16	0.08	0.18	0.26	0.01	0.01	0.01	0.18	0.19	0.27										0.50	0.20		0.70	0.44						0.00	0.70	0.43
Holiday 1,2,3 Zones	0.16	0.33	0.16	0.18	0.34	0.21	0.42	0.21	0.18	0.39	0.55													0.00	-0.34					0.85	0.85	0.85	0.30
Jackson Oaks Zone[3]	0.23	0.45	0.23	0.18	0.41	0.02	0.04	0.02	0.18	0.20	0.43												0.35	0.35	-0.06						0.00	0.35	-0.08
Subtotal	0.47	0.94	0.47	0.54	1.01	0.24	0.48	0.24	0.54	0.78	1.25													1.05	0.04						0.85	1.90	0.65
Total	**5.98**	**11.96**			**8.68**	**3.34**	**6.68**			**6.04**	**12.02**													**10.46**	**1.78**						**3.45**	**13.23**	1.21

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Notes:

1. Nob Hill Zone includes East Street Zone demands.
2. El Toro Zone includes Peak and Main Zone and Spring Hill Zone demands.
3. Jackson Oaks Zone includes Hydropneumatic Zone demands.

Table 7.5 Proposed Storage Reservoirs

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Reservoir	Pressure Zone	Volume (MG)	Height (ft)	Diameter (ft)	Bottom Elevation (ft)	Overflow Height (ft)	Overflow Elevation (ft)
Boys Ranch 3	Boys Ranch	**1.20**	32	80	533	30	563
Edmundson 2	Nob Hill	**0.90**	32	70	473	30	503
East Dunne	Holiday 1, 2, and 3	**0.85**	24	80	780	23	803
Glen Ayre 2	Glen Ayre Zone	**0.25**	15	50	900	14	914
Woodland 2	Woodland Zone	**0.25**	15	50	1,079	14	1,093
Total		**3.45**					

7.7.1 Existing Pump Station Capacity Requirements

Existing pump station requirements were identified for each existing pump station and are summarized on **Table 7.6**. The table lists the existing pump station capacities and identifies the required capacity, based on the City criteria. The existing pump station capacity analysis indicates the City's current pump stations have adequate capacity to meet existing requirements.

7.7.2 Future Pump Station Capacity Requirements

Future pump station requirements were identified for each existing pump station and are summarized on **Table 7.7**. This table identifies the future pump station capacity requirements based on the buildout demands. At the buildout of the master plan the existing pump stations East Dunne Number 1, East Dunne Number 2, and East Dunne Number 3 are going to be abandoned and replaced with a new pump station; this proposed pump station will serve a proposed Holiday tank. Additionally, a new pump station is recommended at the proposed Holiday Lake tank site to serve the existing Holiday Lake tanks. The proposed pump stations, summarized on **Table 7.8** and shown graphically on **Figure 7.6**, are described as follows:

- **NH-PS1:** Replace existing pump stations East Dunne Number 1, East Dunne Number 2, and East Dunne Number 3 with one new pump station. This pump station is planned to have three 900 gpm pumps for a total pump station capacity of 2,700 gpm. It should be noted that the construction of this pump station will require trigger the construction of a PRV on Thomas Grade Lane, approximately 1,100 feet west of Gnarled Oak Lane. This PRV improvement is listed as HL-PRV1 in **Table 7.9**.

- **HL-PS1:** Construct a new pump station at the proposed Holiday tank site. This pump station is planned to have four 550 gpm pumps for a total pump station capacity of 2,200 gpm.

7.8 PIPELINE IMPROVEMENTS TO SERVE FUTURE GROWTH

The buildout of the 2035 General Plan includes development outside of the extents of the existing domestic water distribution system. Distribution pipelines are recommended to serve future growth as well as increase the hydraulic reliability of the domestic water distribution system. Each pipeline improvement is assigned a uniquely coded identifier, which is intended to aid in defining the location of the improvement for mapping purposes. These identifiers reflect the pressure zone, improvement type, and sequence in the improvement schedule. The pipeline improvements are summarized on **Table 7.9** and described in detail on the following pages.

7.8.1 Boys Ranch Pressure Zone

This section documents pipeline improvements within the Boys Ranch Pressure Zone.

- **BR-P1:** Construct a new 10-inch pipeline in future right-of-way between Cochrane Road and Coyote Road.

Table 7.6 Existing Pump Station Capacity Analysis

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Name	Elevation (ft)	Source Pressure Zone	Destination Pressure Zone	Pump Station Capacity		Pump Station Capacity Analysis	
				Total (gpm)	Firm (gpm)	Required Capacity[1] (gpm)	Deficiency (gpm)
Existing Pump Stations							
East Dunne # 1	430	Nob Hill	Holiday Lake	1,800	1,200	446	-
East Dunne # 2	430	Nob Hill	Holiday Zone No. 1	400	200	135	-
East Dunne # 3	430	Nob Hill	Holiday Zone No. 2	925	425	73	-
El Toro	520	Peak and Main	El Toro Tank	380	190	2	-
Encino Booster	415	Nob Hill	Encino Tank	900	450	100	-
Glen Ayre Booster	660	Llagas	Glen Ayre Zone	330	165	41	-
Hydropneumatic Booster	1170	Jackson Oaks	Hydropneumatic Zone	1,710	1,640	1,538	-
Jackson Oaks Booster	830	Holiday Lake	Jackson Oaks Zone	970	620	315	-
Llagas Booster	365	Nob Hill	Llagas Zone	750	300	221	-
Peak and Main Booster	370	Nob Hill	Peak and Main Zone	2,050	1,350	226	-
Woodland Booster	620	Llagas	Woodland Zone	430	140	14	-

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2/15/2017

Note:

1. Required firm pump station capacity equal to Maximum Day Demand. Required firm hydropneumatic pump station capacity also required to include 1,500 gpm fire flow.

Table 7.7 Future Pump Station Capacity Analysis
Water System Master Plan
City of Morgan Hill

PRELIMINARY

Name	Elevation (ft)	Source Pressure Zone	Destination Pressure Zone	Pump Station Capacity Total (gpm)	Pump Station Capacity Firm (gpm)	Pump Station Capacity Analysis Required Capacity[1] (gpm)	Pump Station Capacity Analysis Deficiency (gpm)
Existing Pump Stations							
East Dunne # 1	430	Nob Hill	Holiday Lake	*Pump Station to be Abandoned*			
East Dunne # 2	430	Nob Hill	Holiday Zone No. 1	*Pump Station to be Abandoned*			
East Dunne # 3	430	Nob Hill	Holiday Zone No. 2	*Pump Station to be Abandoned*			
El Toro	520	Peak and Main	El Toro Tank	380	190	2	-
Encino Booster	415	Nob Hill	Encino Tank	900	450	123	-
Glen Ayre Booster	660	Llagas	Glen Ayre Zone	330	165	46	-
Hydropneumatic Booster	1170	Jackson Oaks	Hydropneumatic Zone	1,710	1,640	1,549	-
Jackson Oaks Booster	830	Holiday Lake	Jackson Oaks Zone	970	620	346	-
Llagas Booster	365	Nob Hill	Llagas Zone	750	300	376	75
Peak and Main Booster	370	Nob Hill	Peak and Main Zone	2,050	1,350	258	-
Woodland Booster	620	Llagas	Woodland Zone	430	140	19	-
Future Pump Stations							
East Dunne[2]	430	Nob Hill	Holiday Zone No. 1	2,700	1,800	984	-
Holiday Lake[2]	780	Holida Zone No. 1	Holiday Lake	2,200	1,650	842	-

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2/15/2017

Notes:

1. Required firm pump station capacity equal to Maximum Day Demand. Required firm hydropneumatic pump station capacity to also include fire flow.
2. Future capacity of East Dunne and Holiday Lake pump stations consistent with "Holiday Lake Zone Improvements" prepared by Akel Engineering Group July 2015.

Table 7.8 Proposed Pump Stations

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Name	Elevation (ft)	Source Pressure Zone	Destination Pressure Zone	Pump Station Capacity Total (gpm)	Pump Station Capacity Firm (gpm)	No. of Pumps (gpm)	Pump Status (gpm)	Design Capacity (gpm)
New Pump Stations								
East Dunne[1,2]	430	Nob Hill	Holiday Zone No. 1	2,700	1,800	3	Duty	900
							Duty	900
							Standby	900
Holiday Lake[2]	780	Holiday Zone No. 1	Holiday Lake	2,200	1,650	4	Duty	550
							Duty	550
							Duty	550
							Standby	550

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2/15/2017

Notes:

1. East Dunne Pump Station to replace existing East Dunne Pump Stations 1, 2, and 3.
2. Future capacity of East Dunne and Holiday Lake pump stations consistent with "Holiday Lake Zone Improvements" prepared by Akel Engineering Group July 2015.

Table 7.9 Schedule of Improvements

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel /Replace	Diam. (in)	Length (ft)
Pipeline Improvements							
Boys Ranch Pressure Zone							
BR-P1	Boys Ranch	ROW	Cochrane Rd to Coyote Rd	-	New	10	1,600
BR-P2	Boys Ranch	Cochrane Rd	Half Rd to approx 1,700' n/o Half Rd	-	New	10	1,700
BR-P3	Boys Ranch	Half Rd	Mission View Dr to Peet Rd	-	New	12	3,150
BR-P4	Boys Ranch	Mission View Dr	Between Cochrane Rd and 2,100' nw/o Cochrane Rd	-	Replace	10	450
BR-P5	Boys Ranch	Mission View Dr	Half Rd to 2,100' nw/o Half Rd	-	New	12	2,100
BR-P6	Boys Ranch	Half Rd	Serene Dr to Conduit Rd	-	New	12	1,650
Nob Hill Pressure Zone							
NH-P1	Nob Hill	Hale Ave Extension	Spring Ave to Main Ave	-	New	12	4,550
NH-P2	Nob Hill	Spring Ave	Del Monte Ave to Monterey Rd	4	Replace	8	950
NH-P3	Nob Hill	San Pedro Ave	Butterfield Blvd to Railroad Ave	10	Replace	16	550
NH-P4	Nob Hill	Railroad Ave	San Pedro Ave to approx 600' n/o Mast St	10	Replace	16	350
NH-P5	Nob Hill	Railroad Ave	Approx 600' n/o Mast St to Mast St	6	Replace	16	600
NH-P6	Nob Hill	San Pedro Ave	Peppertree Dr to Hill Rd	-	New	10	3,200
NH-P7	Nob Hill	Hill Rd	San Pedro Ave to Tennant Ave	-	New	10	3,300
NH-P8	Nob Hill	Tennant Ave	Hill Rd to Conduit Rd	-	New	10	4,850
NH-P9	Nob Hill	Monterey Rd	John Wilson Way to Middle Ave	-	New	10	2,350
NH-P10	Nob Hill	ROW	Monterey Rd to Olive Ave	-	New	10	2,700
Holiday Pressure Zones							
HL-P1	Holiday 1	Dunne Ave	Flaming Oak Ln to Proposed E Dunne Tank	-	New	16	550
HL-P2	Holiday 1	Dunne Ave	Proposed E Dunne Tank to Flaming Oak Ln	-	New	12	550
HL-P3	Holiday Lake	Dunne Ave	Proposed E Dunne Tank to Flaming Oak Ln	-	New	12	2,450
HL-P4	Holiday Lake	Oak Leaf Dr	Dunne Ave to 650' w/o Lori Dr	-	New	12	2,300
HL-P5	Holiday Lake	Lake View Dr	Oak Leaf Dr to Holiday Lake Tanks	8	Replace	12	2,850

Improv. No.	Pressure Zone	Description		Proposed Storage Capacity (MG)
Storage Reservoir Improvements				
BR-T1	Boys Ranch	Demolish existing 0.55 MG Boys Ranch tank and replace with 1.20 MG tank	Replace	1.20
GA-T1	Glen Ayre	Demolish existing 0.10 MG Glen Ayre tank and replace with 0.25 MG tank	New	0.25
ED-T1	Nob Hill	Existing Edmundson tank site	New	0.90

Table 7.9 Schedule of Improvements

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel /Replace	Diam. (in)	Length (ft)
WD-T1	Woodland	Demolish existing 0.03 MG Woodland tank and replace with 0.25 MG tank			New	0.25	
HL-T1	Holiday 1	Dunne Ave approx 500' ne/o Flaming Oak Ln			New	0.85	
Groundwater Well Improvements						**Proposed Pumping Capacity** (gpm)	
BR-W1	Boys Ranch	Burnett Ave	Approx 6,000' ne/o Monterey Ave		New	800	
NH-W2	Nob Hill	Butterfield Blvd	400' E of Railroad Ave and Fisher Ave		New	800	
Pump Station Improvements						**Proposed Capacity** (gpm)	
NH-PS1	Nob Hill	Dunne Ave and Magnolia Wy			New	3 @ 900 gpm	
HL-PS1	Holiday 1	Dunne Ave approx 500' ne/o Flaming Oak Ln			New	4 @ 550 gpm	
Pressure Reducing Valve Improvements						**Proposed Size** (in)	
HL-PRV1	Holiday 1	Thomas Gr approx 1,100' w/o Gnarled Oak Ln			New	3	

- **BR-P2:** Construct a new 10-inch pipeline in Cochrane Road between Half Road and approximately 1,700 feet north of Half Road.
- **BR-P3:** Construct a new 12-inch pipeline in Half Road between Avenida de los Padres and approximately 450 feet south of Avenida de los Padres.
- **BR-P4:** Replace existing 8-inch pipeline with a new 10-inch pipeline in Mission View Drive between Cochrane Road and 2,100 feet northwest of Cochrane Road.
- **BR-P5:** Construct a new 12-inch pipeline in De Paul Road between Half Road and 2,100 feet northwest of Half Road.
- **BR-P6:** Construct a new 12-inch pipeline in Half Road between Serene Road and Condit Road.

7.8.2 Nob Hill Pressure Zone

This section documents pipeline improvements within the Nob Hill Pressure Zone.

- **NH-P1:** Construct a new 12-inch pipeline in Hale Avenue Extension between Spring Avenue and Main Avenue.
- **NH-P2:** Replace existing 4-inch pipeline with a new 8-inch pipeline in Spring Avenue between Del Monte Avenue and Monterey Road.
- **NH-P3:** Replace existing 10-inch pipeline with a new 16-inch pipeline in San Pedro Avenue between Butterfield Boulevard and Railroad Avenue.
- **NH-P4:** Replace existing 10-inch pipeline with a new 16-inch pipeline in Railroad Avenue between San Pedro Avenue and approximately 600 feet north of Mast Street.
- **NH-P5:** Replace existing 6-inch pipeline with a new 16-inch pipeline in Railroad Avenue between S600 feet north of Mast Street and Mast Street.
- **NH-P6:** Construct a new 10-inch pipeline in San Pedro Avenue between Peppertree Drive and Hill Road.
- **NH-P7:** Construct a new 10-inch pipeline in Hill Road between San Pedro Avenue and Tennant Avenue.
- **NH-P8:** Construct a new 10-inch pipeline in Tennant Avenue between Hill Road and Condit Road.
- **NH-P9:** Construct a new 10-inch pipeline in Monterey Road between John Wilson way and Middle Avenue.
- **NH-P10:** Construct a new 10-inch pipeline in right of way between Monterey Road and Olive Avenue.

7.8.3 Holiday Pressure Zones

This section documents pipeline improvements within the Holiday Pressure Zone.

- **HL-P1:** Construct a new 16-inch pipeline in Dunne Avenue between Flaming Oak Lane and Proposed East Dunne Tank.
- **HL-P2:** Construct a new 12-inch pipeline in Dunne Avenue between Proposed East Dunne Tank and Flaming Oak Lane.
- **HL-P3:** Construct a new 12-inch pipeline in Dunne Avenue between Proposed Holiday 1 Pressure Zone and Oak Leaf Drive.
- **HL-P4:** Construct a new 12-inch pipeline in Oak Leaf Drive between Dunne Avenue and 650 feet west of Lori Drive.
- **HL-P5:** Replace existing 8-inch pipeline with a new 12-inch pipeline in Lake View Drive between Oak Leaf Drive and Holiday Lake Tanks.

7.9 PIPELINE REPAIR AND REPLACEMENT

During the preparation of this master plan, City staff identified sections of pipeline intended to be replaced due to either deteriorated condition or for operational considerations (**Table 7.10**). It should be noted that, for planning purposes, the operational improvements generally involve replacing deficient pipes in kind. However, if feasible and based on site-specific constraints, it is recommended that 6-inch pipes be upsized to 8-inches. The operational improvements are summarized below:

- **RP-1:** Replace existing 6-inch pipeline with a new 6-inch pipeline in Shady Lane between Holiday Drive and Holiday Drive.
- **RP-2**: Replace existing 8-inch pipeline with a new 8-inch pipeline in Hill Top Court between Jackson Oaks Drive and approximately 550 feet northeast of Jackson Oaks Drive.
- **RP-3:** Replace existing 8-inch pipeline with a new 8-inch pipeline in Oak View Court between Jackson Oaks Drive and approximately 700 feet northeast of Jackson Oaks Drive.
- **RP-4:** Replace existing 8-inch pipeline with a new 8-inch pipeline on the Holiday Tank site between the existing Holiday Lake tanks and Manzanita Drive.
- **RP-5:** Replace existing 6-inch pipeline with a new 6-inch pipeline in Manzanita Drive between Holiday Drive and the end of Manzanita Drive.
- **RP-6:** Replace the existing 6-inch pipeline with a new 6-inch pipeline in Raccoon Court between Holiday Court and the end of Raccoon Court.

Table 7.10 Pipeline Repair and Replacement

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel/ Replace	Pipeline Improvements Diam.[2] (in)	Pipeline Improvements Length (ft)
RP-1	Holiday Lake	Shady Ln	From Holiday Dr to Holiday Dr	6	Replace	6	2,550
RP-2	Jackson Oaks	Hill Top Ct	From Jackson Oaks Dr to approx 550' ne/o Jackson Oaks Dr	8	Replace	8	550
RP-3	Jackson Oaks	Oak View Ct	From Jackson Oaks Dr to approx 700' s/o Jackson Oaks Dr	8	Replace	8	700
RP-4	Holiday Lake	Holiday Tank Site	From Holiday Lake Tanks to Manzanita Dr	8	Replace	8	800
RP-5	Holiday Lake	Manzanita Dr	From Holiday Dr to end of Manzanita Dr	6	Replace	6	1,650
RP-6	Holiday Lake	Raccoon Ct	From Holiday Ct to end of Manzanita Dr	6	Replace	6	1,700
RP-7	Nob Hill	First St	From Monterey Rd to Depot St	6	Replace	6	600
RP-8	Hydropneumatic Zone	Oak Canyon Dr	From Jackson Oaks Hydropneumatic tank to Jackson Oaks Dr	8	Replace	8	600

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Note:

1. Planned operational improvements include pipelines requiring replacement due to deteriorated condition or other operational issue, as identified by City staff.
2. Where feasible, it is recommended that 6-inch pipelines be upsized to 8-inch pipelines.

- **RP-7:** Replace the existing 6-inch pipeline with a new 6-inch pipeline in First Street between Monterey Road and Depot Street.
- **RP-8:** Replace the existing 8-inch pipeline with a new 8-inch pipeline from the Jackson Oaks hydropneumatic tank and Jackson Oaks Drive.

CHAPTER 8 – CAPITAL IMPROVEMENT PROGRAM

This chapter provides a summary of the recommended domestic water system improvements to mitigate existing capacity deficiencies and to accommodate anticipated future growth. The chapter also presents the cost criteria and methodologies for developing the capital improvement program. Finally, a capacity allocation analysis, usually used for cost sharing purposes, is also included.

8.1 COST ESTIMATE ACCURACY

Cost estimates presented in the CIP were prepared for general master planning purposes and, where relevant, for further project evaluation. Final costs of a project will depend on several factors including the final project scope, costs of labor and material, and market conditions during construction.

The Association for the Advancement of Cost Engineering (AACE International), formerly known as the American Association of Cost Engineers has defined three classifications of assessing project costs. These classifications are presented in order of increasing accuracy: Order of Magnitude, Budget, and Definitive.

- **Order of Magnitude Estimate.** This classification is also known as an "original estimate", "study estimate", or "preliminary estimate", and is generally intended for master plans and studies.

  This estimate is not supported with detailed engineering data about the specific project, and its accuracy is dependent on historical data and cost indexes. It is generally expected that this estimate would be accurate within -30 percent to +50 percent.

- **Budget Estimate.** This classification is also known as an "official estimate" and generally intended for predesign studies. This estimate is prepared to include flow sheets and equipment layouts and details. It is generally expected that this estimate would be accurate within -15 percent to +30 percent.

- **Definitive Estimate.** This classification is also known as a "final estimate" and prepared during the time of contract bidding. The data includes complete plot plans and elevations, equipment data sheets, and complete specifications. It is generally expected that this estimate would be accurate within -5 percent to + 15 percent.

Costs developed in this study should be considered "Order of Magnitude" and have an expected accuracy range of **-30 percent** and **+50 percent**.

8.2 COST ESTIMATE METHODOLOGY

Cost estimates presented in this chapter are opinions of probable construction and other relevant costs developed from several sources including cost curves, Akel experience on other master planning projects, and input from City staff on the development of public and private cost sharing. Where appropriate, costs were escalated to reflect the more current Engineering News Records (ENR) Construction Cost Index (CCI).

This section documents the unit costs used in developing the opinion of probable construction costs, the Construction Cost Index, the land acquisition costs, and markups to account for construction contingency and other project related costs.

8.2.1 Unit Costs

The unit cost estimates used in developing the Capital Improvement Program are summarized on **Table 8.1**. Domestic water pipeline unit costs are based on length of pipes, in feet. Storage reservoir unit costs are based on capacity, per million gallons (MG). Pump Station costs are based on an equation that replaces the pump curve.

The unit costs are intended for developing the Order of Magnitude estimate and do not account for site specific conditions, labor and material costs during the time of construction, final project scope, implementation schedule, detailed utility and topography surveys for reservoir sites, investigation of alternative routings for pipes, and other various factors. The capital improvement program included in this report accounts for construction and project-related contingencies as described in this chapter.

8.2.2 Construction Cost Index

Costs estimated in this study are adjusted utilizing the Engineering News Record (ENR) Construction Cost Index (CCI), which is widely used in the engineering and construction industries.

The costs in this Water System Master Plan were benchmarked using a 20-City national average ENR CCI of 10,532, reflecting a date of January 2017.

8.2.3 Construction Contingency Allowance

Knowledge about site-specific conditions for each proposed project is limited at the master planning stage; therefore, construction contingencies were used. The estimated construction costs in this master plan include a **30 percent** contingency allowance to account for unforeseen events and unknown field conditions.

8.2.4 Project Related Costs

The capital improvement costs also account for project-related costs, comprising of engineering design, project administration (developer and City staff), construction management and

Table 8.1 Unit Costs

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Pipelines	
Pipe Size (in)	**Cost**[2] ($/lineal foot)
6	$160
8	$180
10	$207
12	$229
16	$276
18	$297
20	$340
24	$372
30	$412
36	$485
Pump Stations	
Estimated Pumping Station Project Cost = $2.075*10^{(0.7583*\log(Q)+3.1951)}$ where Q is in gpm	
Pressure Reducing Stations	
Size (in)	**Cost** ($)
3" valve	$47,300
6" valve	$77,400
Storage Reservoirs ($/gallon)	
≤1.0 MG	$2.15
1.1 MG-3.0 MG	$1.72
3.1 MG - 5.0 MG	$1.24
> 5 MG	$0.92
Groundwater Wells	
800 gpm Capacity	$2,340,000

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Notes:

1. Construction costs estimated using January 2017 ENR CCI of 10,532.
2. Pipeline unit costs based on water main construction estimates provided by City staff.

inspection, and legal costs. The project related costs in this master plan were estimated by applying an additional **30 percent** to the estimated construction costs.

8.3 CAPITAL IMPROVEMENT PROGRAM

This section documents the capital improvement program, contingencies included in the costs, and the allocation of costs to meet the requirements of AB1600.

8.3.1 Capital Improvement Costs

The Capital Improvement Program costs for the projects identified in this master plan for mitigating existing system deficiencies and for serving anticipated future growth throughout the City are summarized on **Table 8.2**.

Each improvement was assigned a unique coded identifier associated with the improvement type and is summarized graphically on **Figure 8.1**. The estimated construction costs include the baseline costs plus **30 percent** contingency allowance to account for unforeseen events and unknown field conditions, as described in a previous section. Capital improvement costs include the estimated construction costs plus **30 percent** project-related costs (engineering design, project administration, construction management and inspection, and legal costs).

8.3.2 Recommended Cost Allocation Analysis

Cost allocation analysis is needed to identify improvement funding sources, and to establish a nexus between development impact fees and improvements needed to service growth. In compliance with the provisions of Assembly Bill AB 1600, the analysis differentiates between the project needs of servicing existing users and for those required to service anticipated future developments. The cost responsibility is based on model parameters for existing and future land use, and may change depending on the nature of development. **Table 8.2** lists each improvement, and separates the cost by responsibility between existing and future users.

8.4 SUGGESTED EXPENDITURE BUDGET

This section discusses the suggested expenditure budget for the capital improvement plan horizon as well as the recommended sequence of construction for capital improvement planning.

8.4.1 5-Year Capital Improvement Costs and Phasing

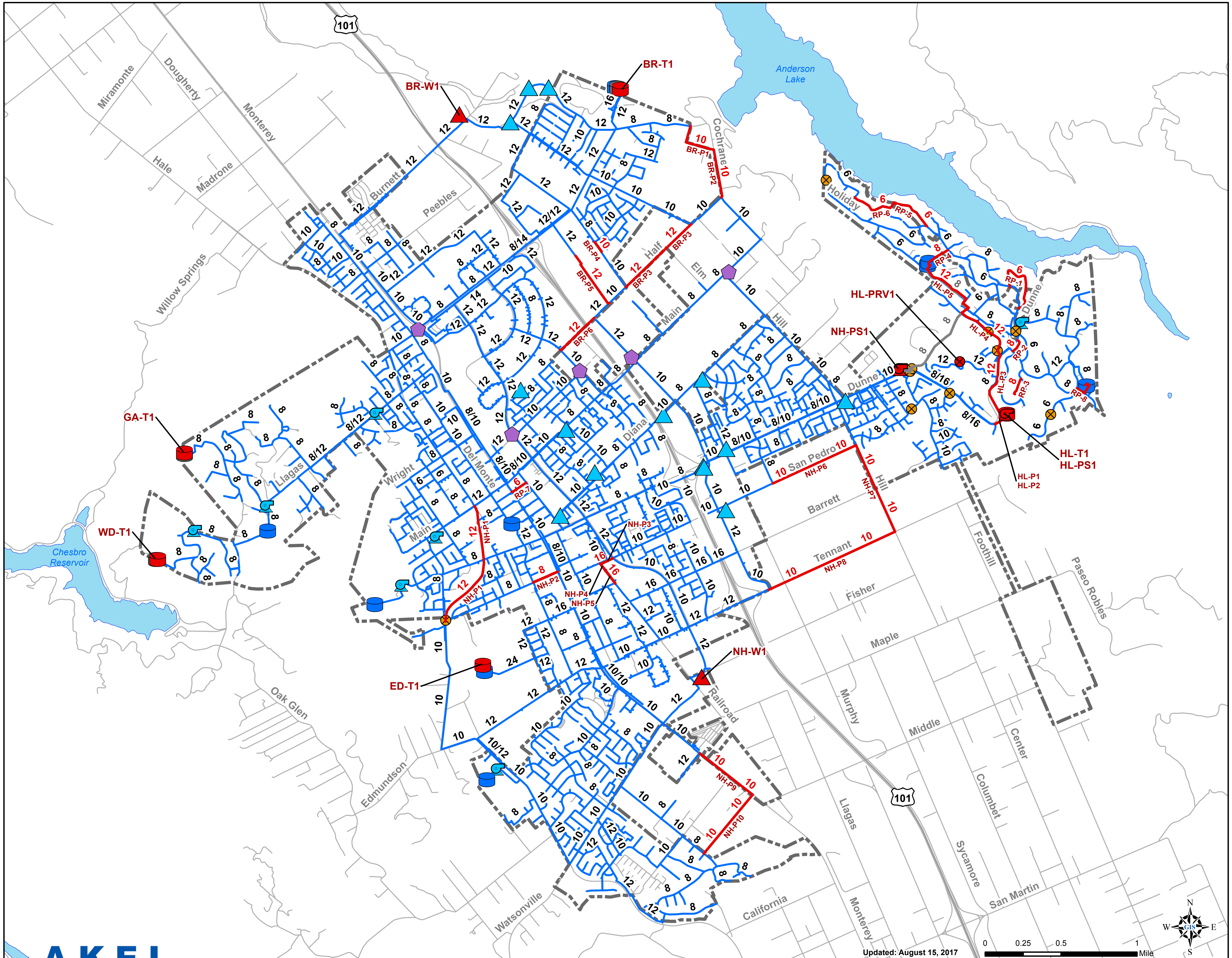
The capital improvement program costs and phasing for the next five fiscal years (FY) are summarized on **Table 8.3**; this plan includes the total costs for pipelines, tanks, booster stations, and valves to be constructed. The improvements listed are also categorized by improvement classification, indicating whether the improvement is intended to expand or replace the existing water distribution system infrastructure.

8.4.2 Suggested Expenditure Budget

The suggested expenditure budget is shown on **Table 8.4**, and includes the total costs for pipelines, tanks, pump stations, valves, and wells phased by 5-year fiscal periods through the year 2035. Costs are categorized through the General Plan horizon of 2035 for near-term, intermediate term, and long-term planning.

8.4.3 Sequence of Construction

Suggested expenditure budget phasing is intended to provide general guidance for implementing the capital improvement projects listed in this master plan. The sequence of construction on **Table 8.4** for the near term and intermediate term improvements accounts for projects that City staff have identified as having immediate benefit. Additional improvements may be constructed as development occurs and the phasing and implementation of a sequence of construction is subject to the approval of the City Engineer.



Legend

Proposed Improvements

- Tanks
- Wells
- Booster Stations
- Valves
- Pipes

To be Abandoned

- Tanks
- Booster Stations
- Pipes

Existing

- Tanks
- Zone Interties (Closed)
- Wells
- Booster Stations
- PRVs
- Pipes
- Roads
- City Limits
- Lakes

PRELIMINARY

Figure 8.1
Capital Improvement Program
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\Morgan_Hill\Water\WSMP\MH_Fig8-1_FutureImprovements_081517.mxd

Table 8.2 Capital Improvement Program

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Pipeline Improvements		Infrastructure Costs				Baseline Constr. Costs	Estimated Const. Costs[1]	Capital Improv. Costs[2]	Suggested Expenditure Budget	Construction Trigger	Suggested Cost Allocation		Cost Sharing	
				Existing Diameter (in)	New/Parallel/Replace	Diameter (in)	Length (ft)	Unit Cost ($)	Infr. Cost ($)	($)	($)	($)			Existing Users	Future Users	Existing Users	Future Users
Pipeline Improvements																		
Boys Ranch Pressure Zone																		
BR-P1	Boys Ranch	ROW	Cochrane Rd to Coyote Rd	-	New	10	1,600	207	331,932	331,932	431,512	560,965	2026-2030	As development occurs	0%	100%	0	560,965
BR-P2	Boys Ranch	Cochrane Rd	Half Rd to approx 1,700' n/o Half Rd	-	New	10	1,700	207	352,678	352,678	458,481	596,026	2026-2030	As development occurs	0%	100%	0	596,026
BR-P3	Boys Ranch	Half Rd	Mission View Dr to Peet Rd	-	New	12	3,150	229	720,763	720,763	936,992	1,218,089	2026-2030	As development occurs	0%	100%	0	1,218,089
BR-P4	Boys Ranch	Mission View Dr	Between Cochrane Rd and 2,100' nw/o Cochrane Rd	-	Replace	10	450	207	93,356	93,356	121,363	157,772	2018-2020	Immediate	100%	0%	157,772	0
BR-P5	Boys Ranch	Mission View Dr	Half Rd to 2,100' nw/o Half Rd	-	New	12	2,100	229	480,508	480,508	624,661	812,059	2026-2030	As development occurs	0%	100%	0	812,059
BR-P6	Boys Ranch	Half Rd	Serene Dr to Conduit Rd	-	New	12	1,650	229	377,542	377,542	490,805	638,047	2026-2030	As development occurs	0%	100%	0	638,047
						Subtotal - Boys Ranch Pressure Zone				**2,356,780**	**3,063,814**	**3,982,958**					**157,772**	**3,825,186**
Nob Hill Pressure Zone																		
NH-P1	Nob Hill	Hale Ave Extension	Spring Ave to Main Ave	-	New	12	4,550	229	1,041,102	1,041,102	1,353,432	1,759,462	2021-2025	As development occurs	100%	0%	1,759,462	0
NH-P2	Nob Hill	Spring Ave	Del Monte Ave to Monterey Rd	4	Replace	8	950	180	171,000	171,000	222,300	288,990	2018-2020	As development occurs	100%	0%	288,990	0
NH-P3	Nob Hill	San Pedro Ave	Butterfield Blvd to Railroad Ave	10	Replace	16	550	276	151,856	151,856	197,413	256,637	2021-2025	As development occurs	100%	0%	256,637	0
NH-P4	Nob Hill	Railroad Ave	San Pedro Ave to approx 600' n/o Mast St	10	Replace	16	350	276	96,636	96,636	125,626	163,314	2021-2025	As development occurs	0%	100%	0	163,314
NH-P5	Nob Hill	Railroad Ave	Approx 600' n/o Mast St to Mast St	6	Replace	16	600	276	165,661	165,661	215,359	279,967	2021-2025	As development occurs	0%	100%	0	279,967
NH-P6	Nob Hill	San Pedro Ave	Peppertree Dr to Hill Rd	-	New	10	3,200	207	663,864	663,864	863,024	1,121,931	2031-2035	As development occurs	0%	100%	0	1,121,931
NH-P7	Nob Hill	Hill Rd	San Pedro Ave to Tennant Ave	-	New	10	3,300	207	684,610	684,610	889,993	1,156,991	2031-2035	As development occurs	0%	100%	0	1,156,991
NH-P8	Nob Hill	Tennant Ave	Hill Rd to Conduit Rd	-	New	10	4,850	207	1,006,169	1,006,169	1,308,020	1,700,426	2031-2035	As development occurs	0%	100%	0	1,700,426
NH-P9	Nob Hill	Monterey Rd	John Wilson Way to Middle Ave	-	New	10	2,350	207	487,525	487,525	633,783	823,918	2031-2035	As development occurs	0%	100%	0	823,918
NH-P10	Nob Hill	ROW	Monterey Rd to Olive Ave	-	New	10	2,700	207	560,136	560,136	728,176	946,629	2031-2035	As development occurs	0%	100%	0	946,629
RP-7	Nob Hill	First St	From Monterey Rd to Depot St	6	Replace	6	600	160	96,000	96,000	124,800	162,240	2018-2020	Immediate	100%	0%	162,240	0
						Subtotal - Nob Hill Pressure Zone				**5,124,559**	**6,661,927**	**8,660,505**					**2,467,328**	**6,193,177**
Holiday Pressure Zones																		
HL-P1	Holiday 1	Dunne Ave	Flaming Oak Ln to Proposed E Dunne Tank	-	New	16	550	276	151,856	151,856	197,413	256,637	2018-2020	E. Dunne Pump Station 2 and 3 Abandonement	40%	60%	102,655	153,982
HL-P2	Holiday 1	Dunne Ave	Proposed E Dunne Tank to Flaming Oak Ln	-	New	12	550	229	125,847	125,847	163,602	212,682	2018-2020	E. Dunne Pump Station 2 and 3 Abandonement	40%	60%	85,073	127,609
HL-P3	Holiday Lake	Dunne Ave	Proposed E Dunne Tank to Flaming Oak Ln	-	New	12	2,450	229	560,593	560,593	728,771	947,403	2018-2020	Holiday Pump Station Construction	0%	100%	0	947,403
HL-P4	Holiday Lake	Oak Leaf Dr	Dunne Ave to 650' w/o Lori Dr	-	New	12	2,300	229	526,271	526,271	684,153	889,398	2021-2025	Holiday Pump Station Construction	0%	100%	0	889,398
HL-P5	Holiday Lake	Lake View Dr	Oak Leaf Dr to Holiday Lake Tanks	8	Replace	12	2,850	229	652,119	652,119	847,754	1,102,081	2021-2025	Holiday Pump Station Construction	0%	100%	0	1,102,081
RP-1	Holiday Lake	Shady Ln	From Holiday Dr to Holiday Dr	6	Replace	6	2,550	160	408,000	408,000	530,400	689,520	2018-2020	Immediate	100%	0%	689,520	0
RP-4	Holiday Lake	Holiday Tank Site	From Holiday Lake Tanks to Manzanita Dr	8	Replace	8	800	180	144,000	144,000	187,200	243,360	2018-2020	Immediate	100%	0%	243,360	0
RP-5	Holiday Lake	Manzanita Dr	From Holiday Dr to end of Manzanita Dr	6	Replace	6	1,650	160	264,000	264,000	343,200	446,160	2018-2020	Immediate	100%	0%	446,160	0
RP-6	Holiday Lake	Raccoon Ct	From Holiday Ct to end of Manzanita Dr	6	Replace	6	1,700	160	272,000	272,000	353,600	459,680	2018-2020	Immediate	100%	0%	459,680	0
						Subtotal - Holiday Pressure Zones				**3,104,686**	**4,036,092**	**5,246,920**					**2,026,447**	**3,220,473**

Table 8.2 Capital Improvement Program

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Pipeline Improvements: Existing Diameter (in)	Pipeline Improvements: New/Parallel/ Replace	Infrastructure Costs: Diameter (in)	Infrastructure Costs: Length (ft)	Infrastructure Costs: Unit Cost ($)	Infrastructure Costs: Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Const. Costs[1] ($)	Capital Improv. Costs[2] ($)	Suggested Expenditure Budget	Construction Trigger	Suggested Cost Allocation: Existing Users	Suggested Cost Allocation: Future Users	Cost Sharing: Existing Users	Cost Sharing: Future Users
Jackson Oaks Pressure Zones																		
RP-2	Jackson Oaks	Hill Top Ct	From Jackson Oaks Dr to approx 550' ne/o Jackson Oaks Dr	8	Replace	8	550	180	99,000	99,000	128,700	167,310	2018-2020	Immediate	100%	0%	167,310	0
RP-3	Jackson Oaks	Oak View Ct	From Jackson Oaks Dr to approx 700' s/o Jackson Oaks Dr	8	Replace	8	700	180	126,000	126,000	163,800	212,940	2018-2020	Immediate	100%	0%	212,940	0
RP-8	Hydropneumatic Zone	Oak Canyon Dr	From Jackson Oaks Hydropneumatic tank to Jackson Oaks Dr	8	Replace	8	600	180	108,000	108,000	140,400	182,520	2018-2020	Immediate	100%	0%	182,520	0
						Subtotal - Jackson Oaks Pressure Zones				**333,000**	**432,900**	**562,770**					**562,770**	**0**
						Subtotal - Pipeline Improvements				**10,919,025**	**14,194,733**	**18,453,153**					**5,214,317**	**13,238,836**
Storage Reservoir Improvements						**Proposed Storage Capacity (MG)**												
BR-T1	Boys Ranch	Demolish existing 0.55 MG Boys Ranch tank and replace with 1.20 MG tank			Replace		1.20		2,063,412	2,063,412	2,682,436	3,487,167	2026-2030	420 EDUs	30%	70%	1,046,150	2,441,017
GA-T1	Glen Ayre	Demolish existing 0.10 MG Glen Ayre tank and replace with 0.25 MG tank			Replace		0.25		537,347	537,347	698,551	908,116	2021-2025	Immediate	80%	20%	726,493	181,623
ED-T1	Nob Hill	Existing Edmundson tank site			New		0.90		1,934,449	1,934,449	2,514,784	3,269,219	2026-2030	2,350 EDUs	0%	100%	0	3,269,219
WD-T1	Woodland	Demolish existing 0.03 MG Woodland tank and replace with 0.25 MG tank			Replace		0.25		537,347	537,347	698,551	908,116	2021-2025	Immediate	70%	30%	635,681	272,435
HL-T1	Holiday 1	Dunne Ave approx 500' ne/o Flaming Oak Ln			New		0.85		1,826,980	1,826,980	2,375,073	3,087,596	2018-2020	E. Dunne Pump Station 1, 2, and 3 Abandonement	40%	60%	1,235,038	1,852,557
						Subtotal - Storage Reservoir Improvements				**6,899,535**	**8,969,395**	**11,660,214**					**3,643,363**	**8,016,851**
Groundwater Well Improvements						**Proposed Pumping Capacity (gpm)**												
BR-W1	Boys Ranch	Burnett Ave	Approx 6,000' ne/o Monterey Ave		New		800		2,340,000	2,340,000	3,042,000	3,954,600	2031-2035	As development occurs	0%	100%	0	3,954,600
NH-W2	Nob Hill	Butterfield Blvd	400' E of Railroad Ave and Fisher Ave		New		800		2,340,000	2,340,000	3,042,000	3,954,600	2031-2035	As development occurs	0%	100%	0	3,954,600
						Subtotal - Groundwater Well Improvements				**4,680,000**	**6,084,000**	**7,909,200**					**0**	**7,909,200**
Pump Station Improvements						**Proposed Capacity (gpm)**												
NH-PS1	Nob Hill	Dunne Ave and Magnolia Wy			New		3 @ 900 gpm		1,300,533	1,300,533	1,690,692	2,197,900	2018-2020	E. Dunne Pump Station 1, 2, and 3 Abandonement	40%	60%	879,160	1,318,740
HL-PS1	Holiday 1	Dunne Ave approx 500' ne/o Flaming Oak Ln			New		4 @ 550 gpm		1,113,467	1,113,467	1,447,507	1,881,759	2021-2025	Holiday Tank Construction	90%	10%	1,693,583	188,176
						Subtotal - Pump Station Improvements				**2,413,999**	**3,138,199**	**4,079,659**					**2,572,743**	**1,506,916**
Pressure Reducing Valve Improvements						**Proposed Size (in)**												
HL-PRV1	Holiday 1	Thomas Gr approx 1,100' w/o Gnarled Oak Ln			New		3		47,300	47,300	61,490	79,937	2018-2020	Holiday Tank Construction	40%	60%	31,975	47,962
						Subtotal - Pressure Reducing Valve Improvements				**47,300**	**61,490**	**79,937**					**31,975**	**47,962**
Comprehensive Plan Updates																		
Water System Master Plan Updates (Years 2021, 2026, 2031, 2036)									200,000	-	-	800,000	2021, 2026, 2031, 2036		65%	35%	520,000	280,000
Urban Water Management Plan Updates (Years 2021, 2026, 2031, 2036)									100,000	-	-	400,000	2021, 2026, 2031, 2036		65%	35%	260,000	140,000
Water Rate Study Updates (Years 2021, 2026, 2031, 2036)									100,000	-	-	400,000	2021, 2026, 2031, 2036		65%	35%	260,000	140,000
						Subtotal - Comprehensive Plan Updates						**1,600,000**					**1,040,000**	**560,000**

Table 8.2 Capital Improvement Program

Water System Master Plan
City of Morgan Hill

PRELIMINARY

Improv. No.	Pressure Zone	Alignment	Limits	Pipeline Improvements: Existing Diameter (in)	Pipeline Improvements: New/Parallel/ Replace	Infrastructure Costs: Diameter (in)	Infrastructure Costs: Length (ft)	Infrastructure Costs: Unit Cost ($)	Infrastructure Costs: Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Const. Costs[1] ($)	Capital Improv. Costs[2] ($)	Suggested Expenditure Budget	Construction Trigger	Suggested Cost Allocation: Existing Users	Suggested Cost Allocation: Future Users	Cost Sharing: Existing Users	Cost Sharing: Future Users
Currently Planned Projects																		
El Toro Tank Improvements										-	-	300,000	2018-2020		100%	0%	300,000	0
Water Supply Planning										-	-	1,000,000	2018-2020		65%	35%	650,000	350,000
Water Supply Facility Improvements										-	-	1,650,000	2018-2020		100%	0%	1,650,000	0
Well Demolition and Abandonment										-	-	400,000	2018-2020		100%	0%	400,000	0
Reservoir Recoating										-	-	200,000	2021-2025		100%	0%	200,000	0
Generator Replacement										-	-	1,000,000	2018-2020		100%	0%	1,000,000	0
Holiday Tank #2 Repair										-	-	90,000	2018-2020		100%	0%	90,000	0
									Subtotal - Currently Planned Projects			**4,640,000**					**4,290,000**	**350,000**
Total Improvement Cost																		
									Pipeline Improvements	**10,919,025**	**14,194,733**	**18,453,153**					**5,214,317**	**13,238,836**
									Storage Reservoirs	**6,899,535**	**8,969,395**	**11,660,214**					**3,643,363**	**8,016,851**
									Groundwater Wells	**4,680,000**	**6,084,000**	**7,909,200**					**0**	**7,909,200**
									Pump Stations	**2,413,999**	**3,138,199**	**4,079,659**					**2,572,743**	**1,506,916**
									Pressure Reducing Valves	**47,300**	**61,490**	**79,937**					**31,975**	**47,962**
									Comprehensive Plan Updates	**-**	**-**	**1,600,000**					**1,040,000**	**560,000**
									Currently Planned Projects	**-**	**-**	**4,640,000**					**4,290,000**	**350,000**
									Total Improvement Costs	**24,959,859**	**32,447,817**	**48,422,162**					**16,792,398**	**31,629,765**

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8/15/2017

Notes:

1. Baseline construction costs plus 30% to account for unforeseen events and unknown conditions.
2. Estimated construction costs plus 30% to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.

Table 8.3 5-year Improvement Phasing

Water System Master Plan
City of Morgan Hill

PRELIMINARY

CIP ID	Project Description	Year Range	Expansion	Repair & Replacement	Fiscal Year Improvement Phasing FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2017-2022 Total
Pipeline Improvements											
Capacity Improvements											
NH-P1	Hale Avenue Extension	2021	100%	0%					1,759,462		1,759,462
NH-P2	Fire Flow Improvement	2017	0%	100%	288,990						288,990
HL-P1	Holiday Tank Inflow	2019	100%	0%			256,637				256,637
HL-P2	Holiday Tank Outflow	2019	100%	0%			212,682				212,682
HL-P3	Holiday Lake Boosting Pipeline	2020	100%	0%				947,403			947,403
HL-P4	Holiday Lake Boosting Pipeline	2021	100%	0%					889,398		889,398
HL-P5	Holiday Lake Boosting Pipeline	2022	100%	0%						1,102,081	1,102,081
BR-P4	Fire Flow Improvement	2018	0%	100%		157,772					157,772
	Subtotal - Pipeline Capacity Improvements				288,990	157,772	469,319	947,403	2,648,860	1,102,081	5,614,423
Repair and Replacement											
RP-1	Holiday Lake Improvement	2019	0%	100%			689,520				689,520
RP-2	Jackson Oaks Improvement	2019	0%	100%			167,310				167,310
RP-3	Jackson Oaks Improvement	2019	0%	100%			212,940				212,940
RP-4	Holiday Lake Improvement	2019	0%	100%			243,360				243,360
RP-5	Holiday Lake Improvement	2019	0%	100%			446,160				446,160
RP-6	Holiday Lake Improvement	2019	0%	100%			459,680				459,680
RP-7	Nob Hill Improvement	2017	0%	100%	162,240						162,240
RP-8	Hydropneumatic Improvement	2017	0%	100%	182,520						182,520
	Subtotal - Pipeline Operational Improvements				344,760	0	2,218,970	0	0	0	2,563,730
	Subtotal - Pipeline Improvements				**633,750**	**157,772**	**2,688,289**	**947,403**	**2,648,860**	**1,102,081**	**8,178,153**
Tanks											
HL-T1	Holiday Tank	2018	100%	0%		3,087,596					3,087,596
GA-T1	Glen Ayre Tank	2022	0%	100%						908,116	908,116
WD-T1	Woodland Tank	2022	0%	100%						908,116	908,116
	Subtotal - Storage Tank Improvements				**0**	**3,087,596**	**0**	**0**	**0**	**1,816,233**	**4,903,828**
Pump Stations											
NH-PS1	Nob Hill to Holiday 1	2017	100%	0%	2,197,900						2,197,900
HL-PS1	Holiday 1 to Holiday Lake	2020	100%	0%				1,881,759			1,881,759
	Subtotal - Pump Station Improvements				**2,197,900**	**0**	**0**	**1,881,759**	**0**	**0**	**4,079,659**
Pressure Reducing Valves											
HL-PRV1	Thomas Grade PRV	2019	100%	0%			79,937				79,937
	Subtotal - Pressure Reducing Valve Improvements				**0**	**0**	**79,937**	**0**	**0**	**0**	**79,937**
Comprehensive Plan Updates											
	Water System Master Plan Updates	2021							200,000		200,000
	Urban Water Management Plan Updates	2021							100,000		100,000
	Water Rate Study Updates	2021							100,000		100,000
	Subtotal - Comprehensive Plan Updates				**0**	**0**	**0**	**0**	**400,000**	**0**	**400,000**
Currently Planned Projects											
	El Toro Tank Improvements	2018	0%	100%		300,000					300,000
	Water Supply Planning	2017-2021	100%	0%	100,000	100,000	300,000	250,000	250,000		1,000,000
	Water Supply Facility Improvements	2017-2018	0%	100%	500,000	500,000		650,000			1,650,000
	Well Demolition and Abandonment	2018	0%	100%		400,000					400,000
	Reservoir Recoating	2021	0%	100%					200,000		200,000
	Generators Replacement	2017-2019	0%	100%	500,000	250,000	250,000				1,000,000
	Holiday Tank #2 Repair	2018	0%	100%		90,000					90,000
	Subtotal - Currently Planned Projects				**1,100,000**	**1,640,000**	**550,000**	**900,000**	**450,000**	**0**	**4,640,000**
Total Improvement Costs											
	Fiscal Year Total				$3,931,650	$4,885,367	$3,318,226	$3,729,161	$3,498,860	$2,918,313	$22,281,577
	Cumulative Total				$3,931,650	$8,817,017	$12,135,243	$15,864,404	$19,363,264	$22,281,577	**$22,281,577**

AKEL ENGINEERING GROUP, INC.

7/26/2017

Table 8.4 Suggested Expenditure Budget

Water System Master Plan

City of Morgan Hill

PRELIMINARY

Project Type	Suggested Expenditure Budget[1]			
	General Plan Horizon			
	Near-Term	Intermediate Term	Long-Term	
	2018-2020	2021-2025	2026-2030	2031-2035
Pipe	$4,427,213	$4,450,858	$3,825,186	$5,749,896
Tank	$3,087,596	$1,816,233	$6,756,385	
Well				$7,909,200
Pump Station	$2,197,900	$1,881,759		
Valve	$79,937			
Comprehensive Plan Updates	$400,000	$400,000	$400,000	$400,000
Currently Planned Projects	$4,190,000	$450,000		
Total	**$14,382,645**	**$8,998,850**	**$10,981,572**	**$14,059,096**
Cumulative Cost	$14,382,645	$23,381,495	$34,363,067	$48,422,162

AKEL ENGINEERING GROUP, INC.

7/2/2017

Note:

1. This expenditure budget is suggested, and is dependent on the City's rate of growth. The City is not bound by this budget and may implement capital improvement projects as funding is available.

APPENDICES

APPENDIX A

Existing Water System Schematic

WATER SYSTEM SCHEMATIC

NOTES:
1. P.R.V = PRESSURE REDUCING VALVE SETTING SHOWN IS THAT OF ELEVATION OF STATIC HYDRAULIC GRADE LINE (SHGL)
2. AT CAPRI VALVE TWO PRV'S INSTALLED. NORMAL FLOW IS FROM BOY'S RANCH ZONE TO NOB HILL ZONE: HOWEVER ON LOW PRESSURE (I.E FIRE FLOW) SECOND VALVE ALLOWS FLOW FROM NOB HILL TO BOY'S RANCH.
3. DUE TO HIGH NITRATES DIANA WELL NO. 1 DOES NOT PUMP DIRECTLY INTO DISTRIBUTION SYSTEM BUT RATHER DIRECTLY TO NOB HILL RESERVOIR. MAIN WELL PUMPS INTO BOTH DISTRIBUTION SYSTEM AND NOB HILL LINE. DUE TO PIPE SIZES FLOW GOES PRIMARILY TO NOB HILL LINE. MAIN WELL STARTS, PRIOR TO DIANA 1 TO PREVENT FLOW FROM DIANA NO.1 TO SYSTEM. IF MAIN WELL IS DOWN, VALVE BETWEEN MAIN AND DIANNA CLOSED.
4. HOLIDAY LAKE RESERVOIR CONTROLS JACKSON WELL NO. 1. PRIOR TO START OF E.DUNNE BOOSTER, JACKSON WELL STARTS PUMP INTO BOTH NOB HILL ZONE AND HOLIDAY LAKE ZONE. FLOW GOES PRIMARILY TO HOLIDAY LAKE.

NO.	DESCRIPTION	DATE	BY

WORK ACCEPTED: INSPECTOR:
AS-BUILT CORRECTIONS
BY: DATE:

G:\R-14\PROJ\util\schemtic\schemtic.dwg
Revisions

DRAWN: MARK
DESIGN:
CHECKED: RAY
APPROVED: DATE:
HOR: NONE
VERT: NONE
JOB NUMBER:
JAMES M. ASHCRAFT- CITY ENGINEER
R.C.E. #28921 EXP. 3/31/07

City of Morgan Hill
Public Works Department
100 Edes Ct. Morgan Hill, CA 95037 (408)776-7337, Fax (408)779-6282

LAST UPDATE APRIL 2003

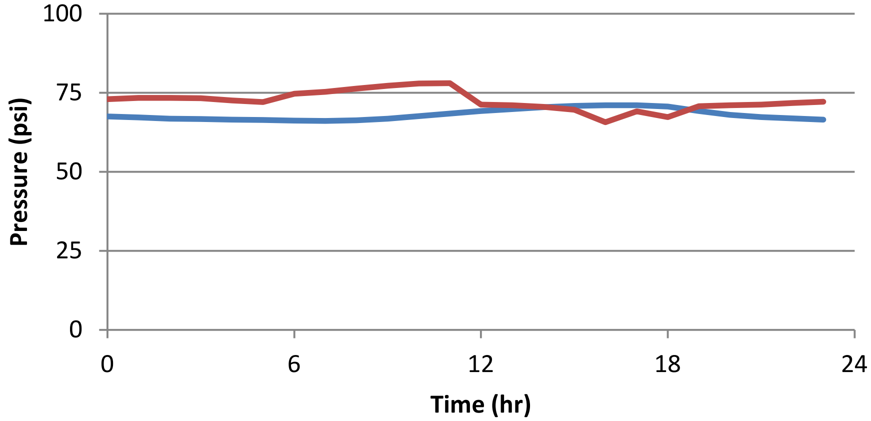
WATER SYSTEM SCHEMATIC

FILE NUMBER:
PRINT DATE: 3/19/08
SHEET NUMBER: 1 OF 1

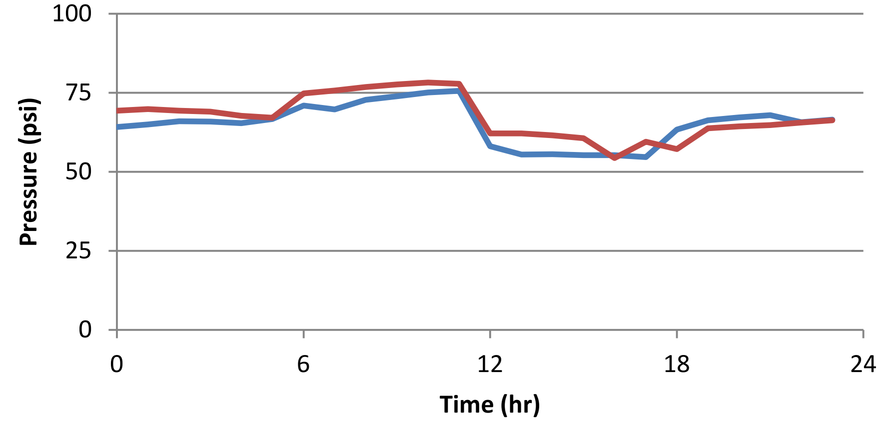
APPENDIX B

Hydraulic Model Calibration

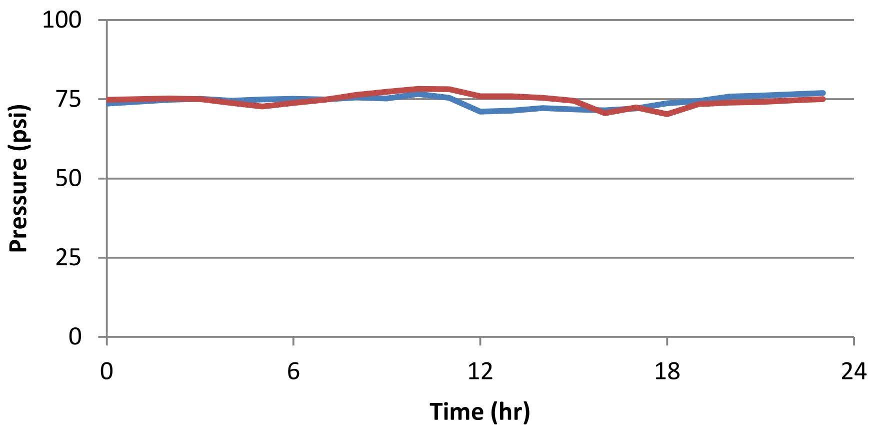
San Pedro Ave and Butterfield Blvd
Pressure Logger NH1



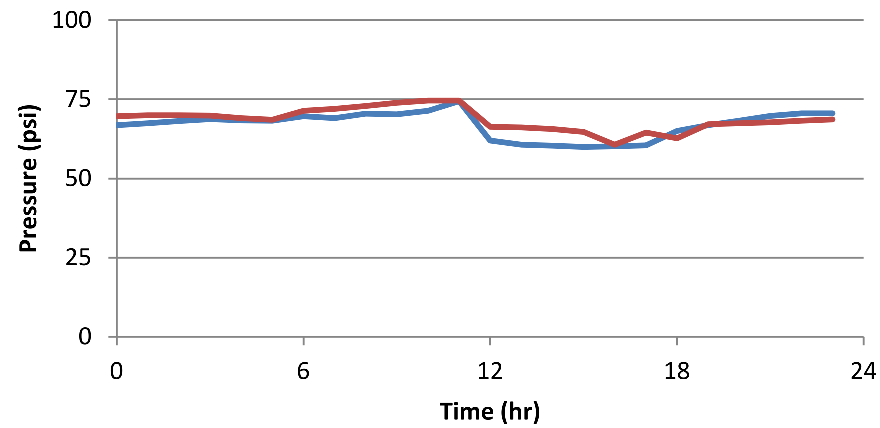
Dunne Ave and Pine Wy
Pressure Logger NH2



Watsonville Rd and Olive Ave
Pressure Logger NH3



Main Ave and Butterfield Blvd
Pressure Logger NH4



LEGEND

Telemetry Data
Model Data

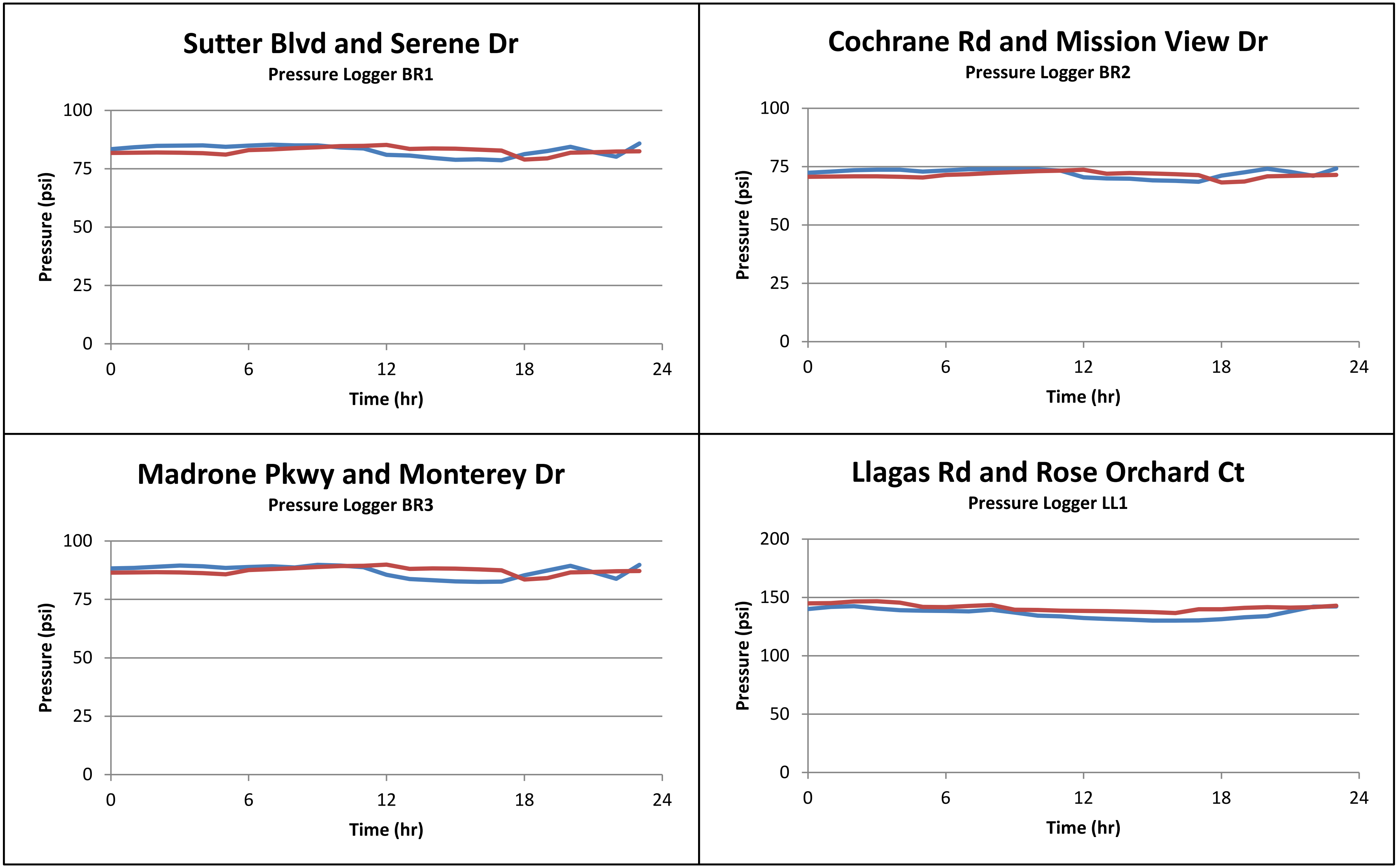
PRELIMINARY

February 23, 2016

Figure 1
Pressure Logger Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.



LEGEND

- Telemetry Data
- Model Data

PRELIMINARY

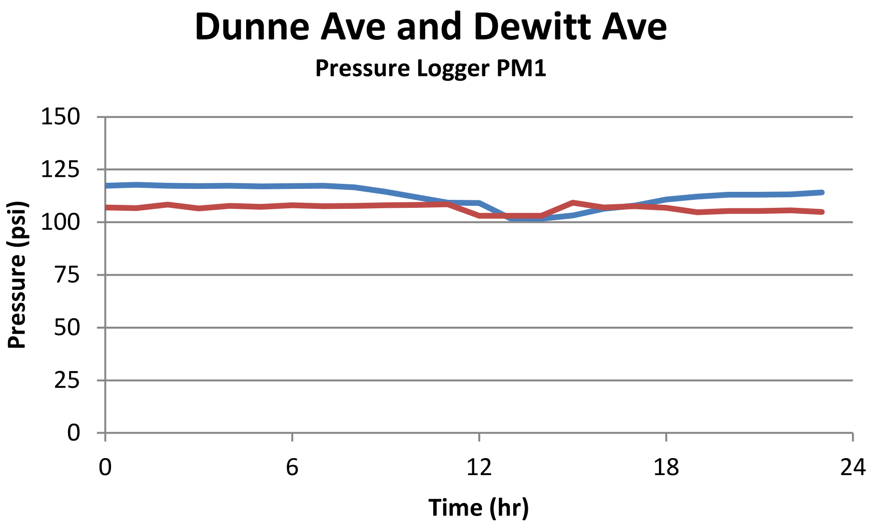
February 23, 2016

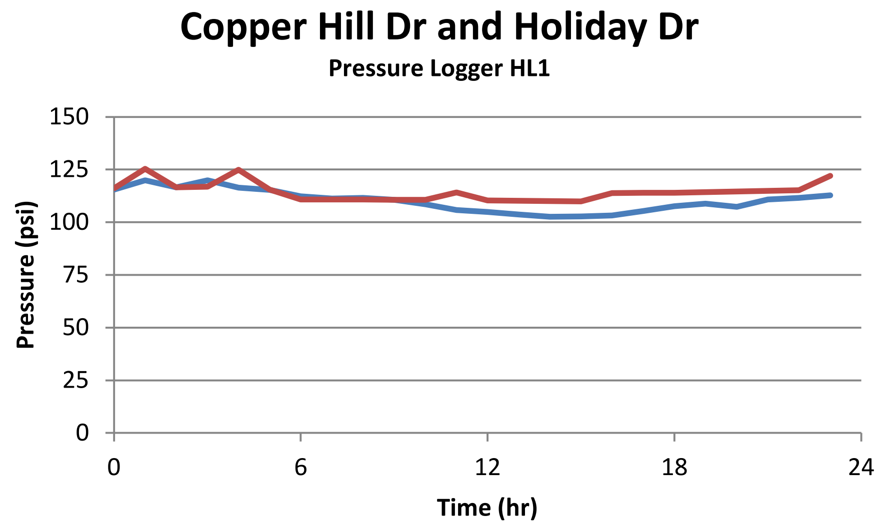
AKEL ENGINEERING GROUP, INC.

Figure 2
Pressure Logger Calibration

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL





LEGEND

Telemetry Data

Model Data

PRELIMINARY

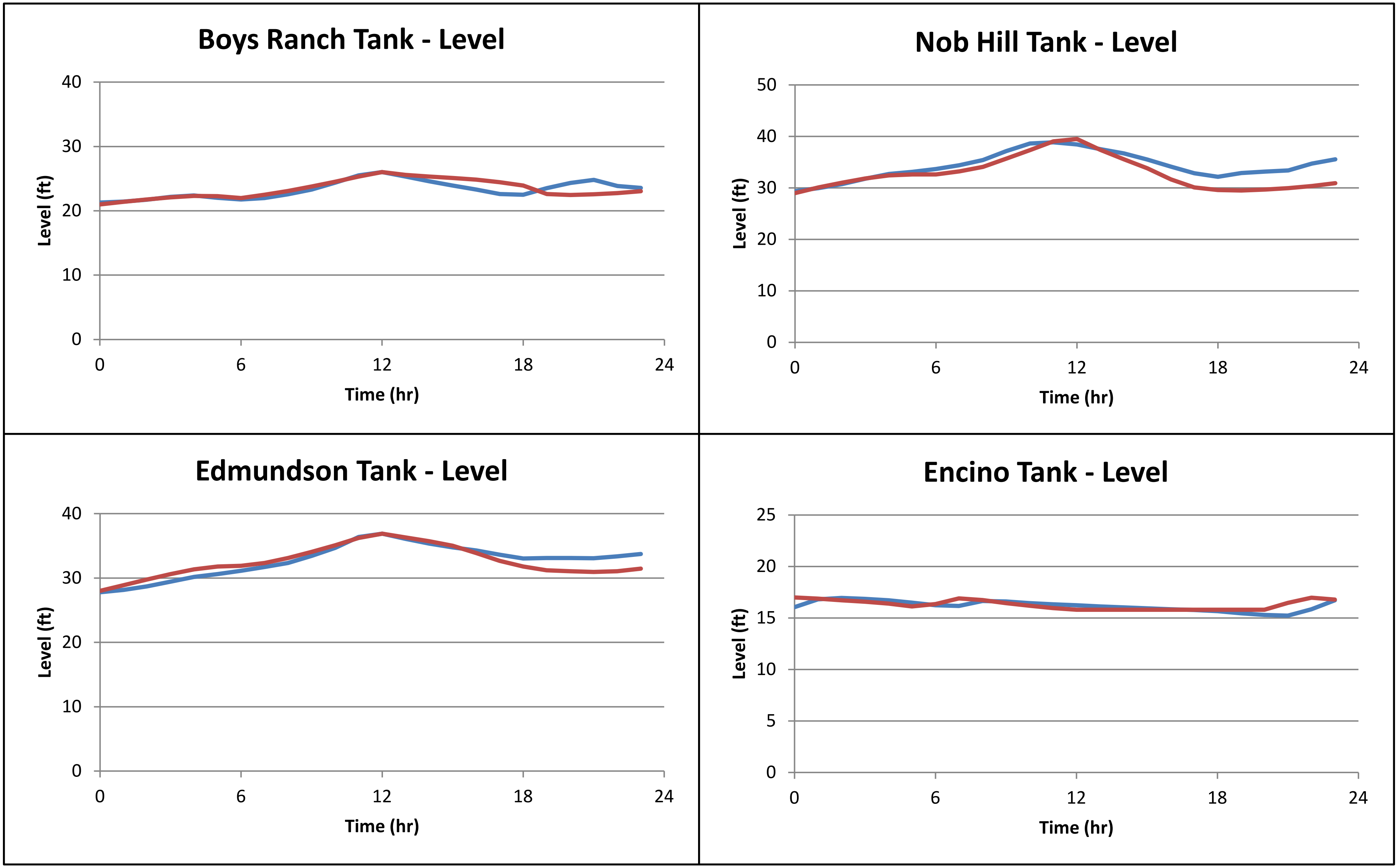
February 23, 2016

Figure 3
Pressure Logger Calibration

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.



LEGEND

Telemetry Data

Model Data

PRELIMINARY

February 23, 2016

Figure 4

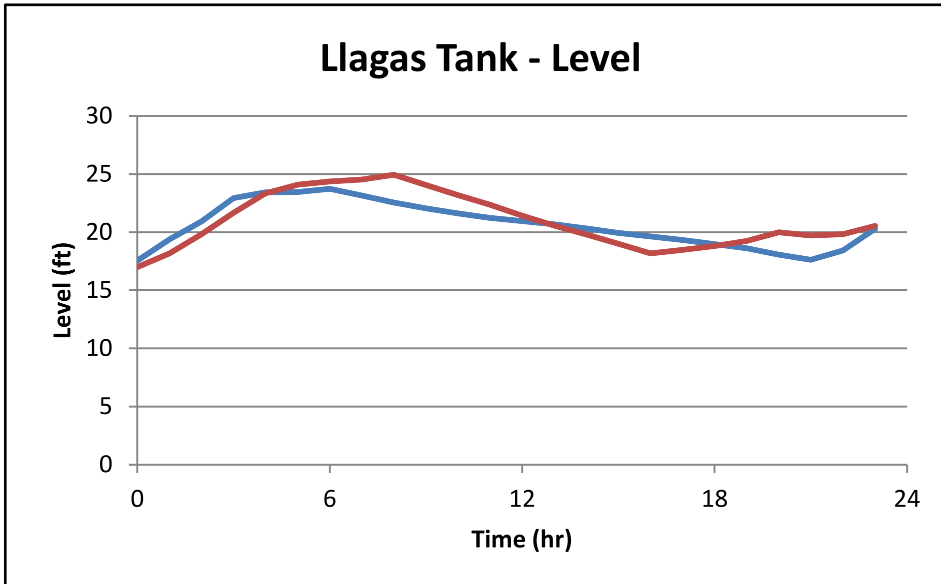
Tank Calibration

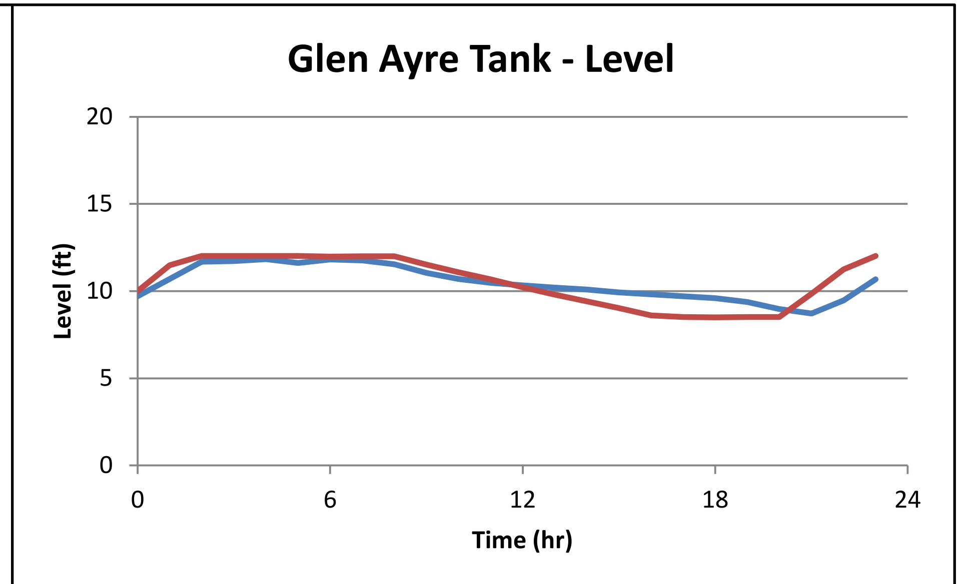
Water System Master Plan

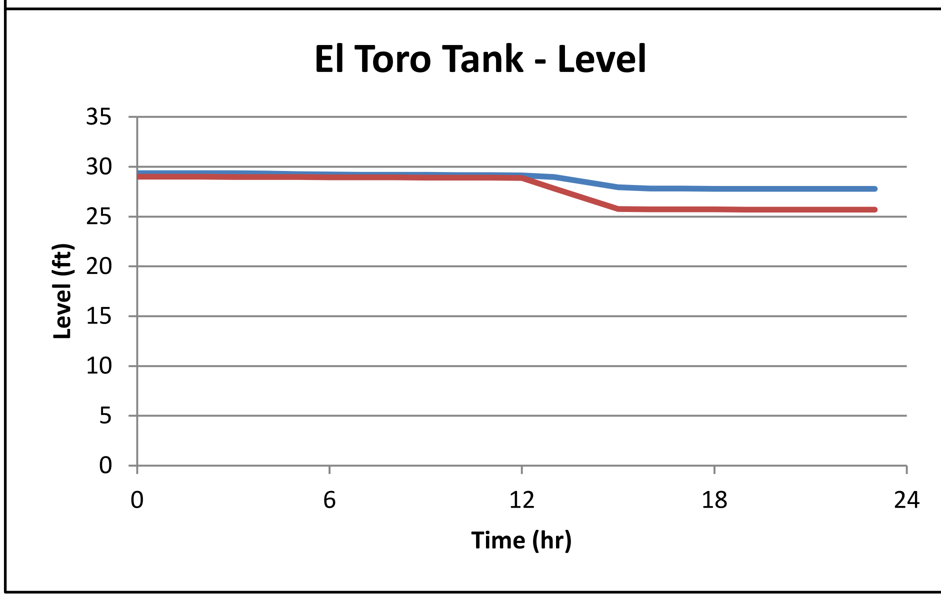
City of Morgan Hill

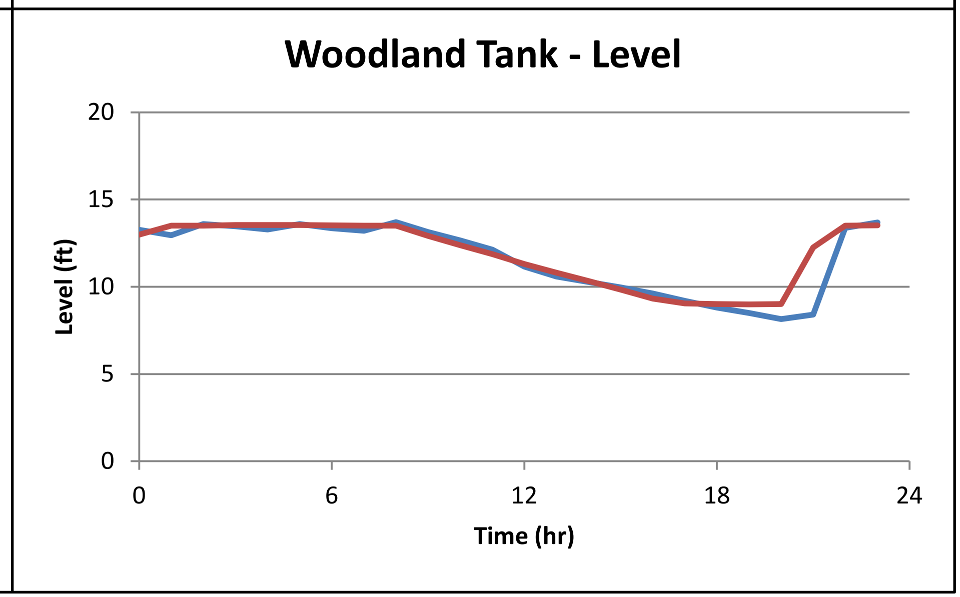
CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.









LEGEND

- Telemetry Data
- Model Data

PRELIMINARY

February 23, 2016

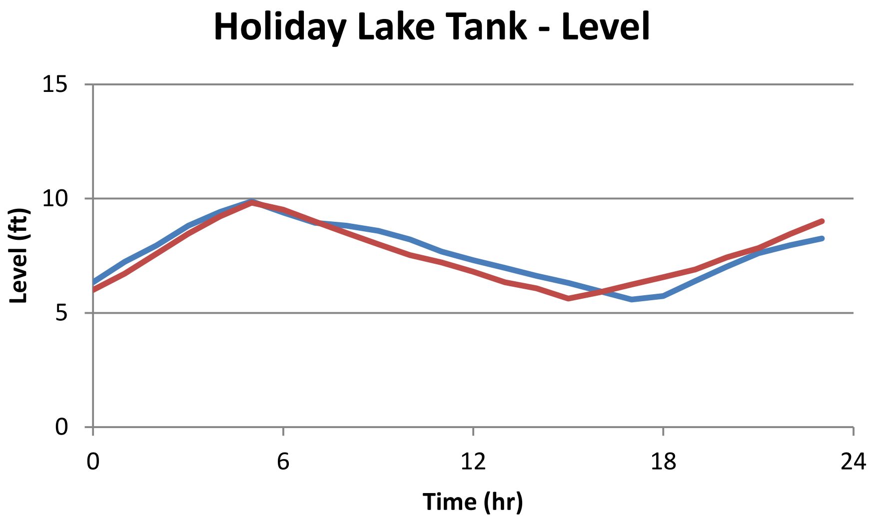
Figure 5

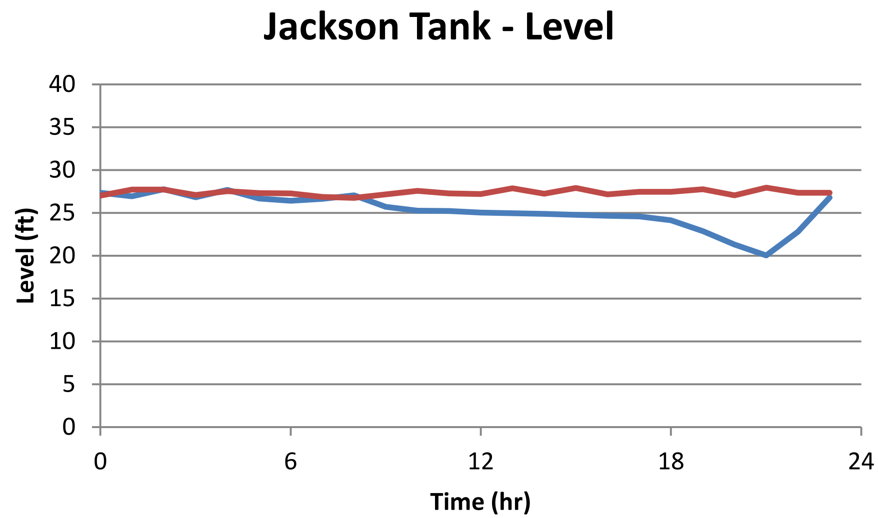
Tank Calibration

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.





LEGEND

Telemetry Data
Model Data

PRELIMINARY

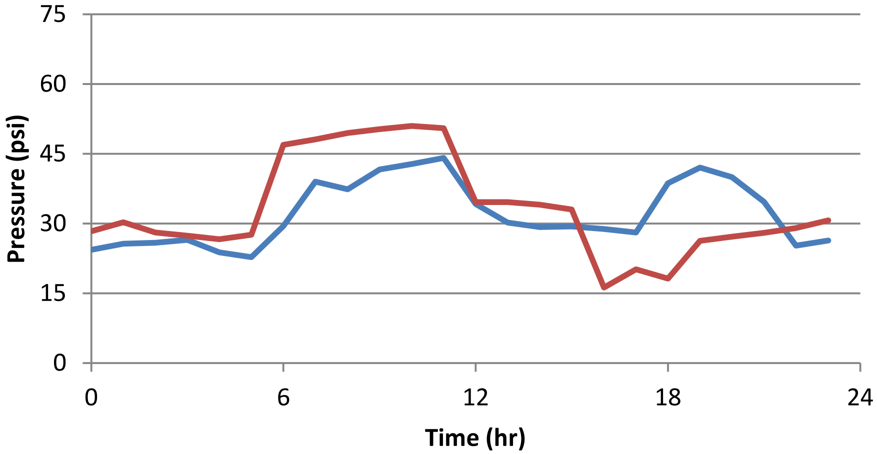
February 23, 2016

AKEL ENGINEERING GROUP, INC.

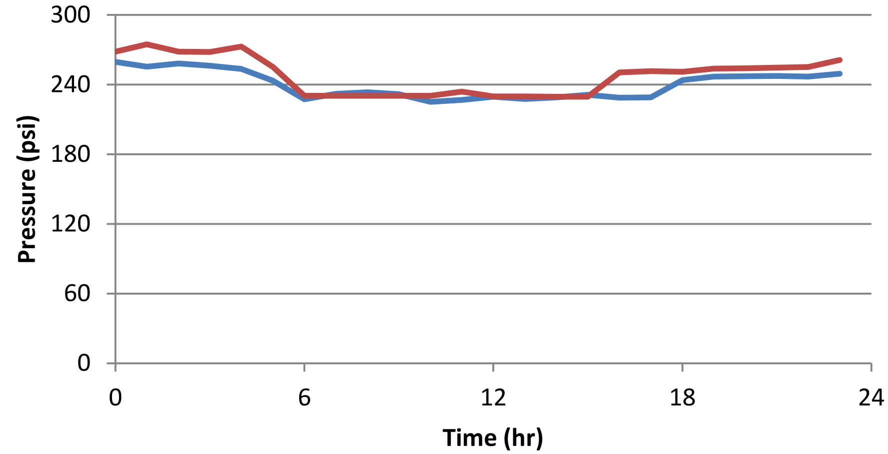
Figure 6
Tank Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

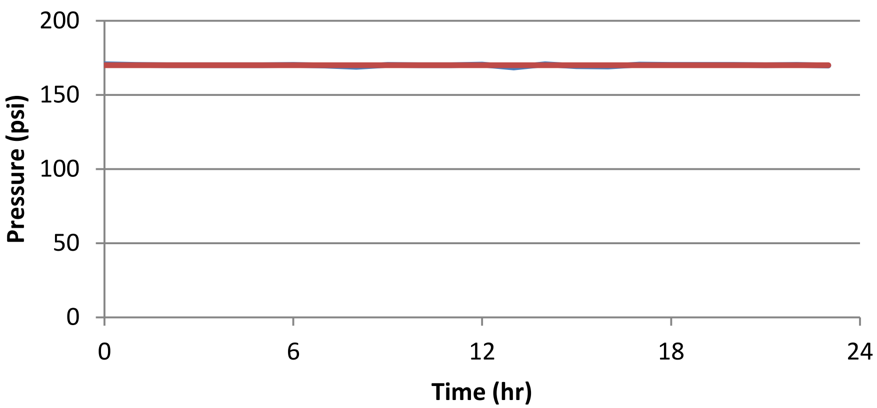
E. Dunne Booster - Suction Pressure



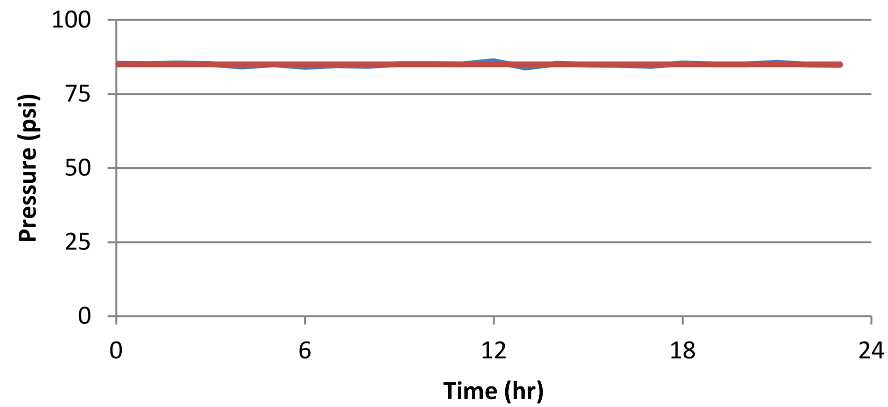
E. Dunne Booster - Discharge Pressure



E. Dunne Booster High Zone 1 No. 1 - Discharge Pressure



E. Dunne Booster High Zone 2 No. 1 - Discharge Pressure



LEGEND

Telemetry Data
Model Data

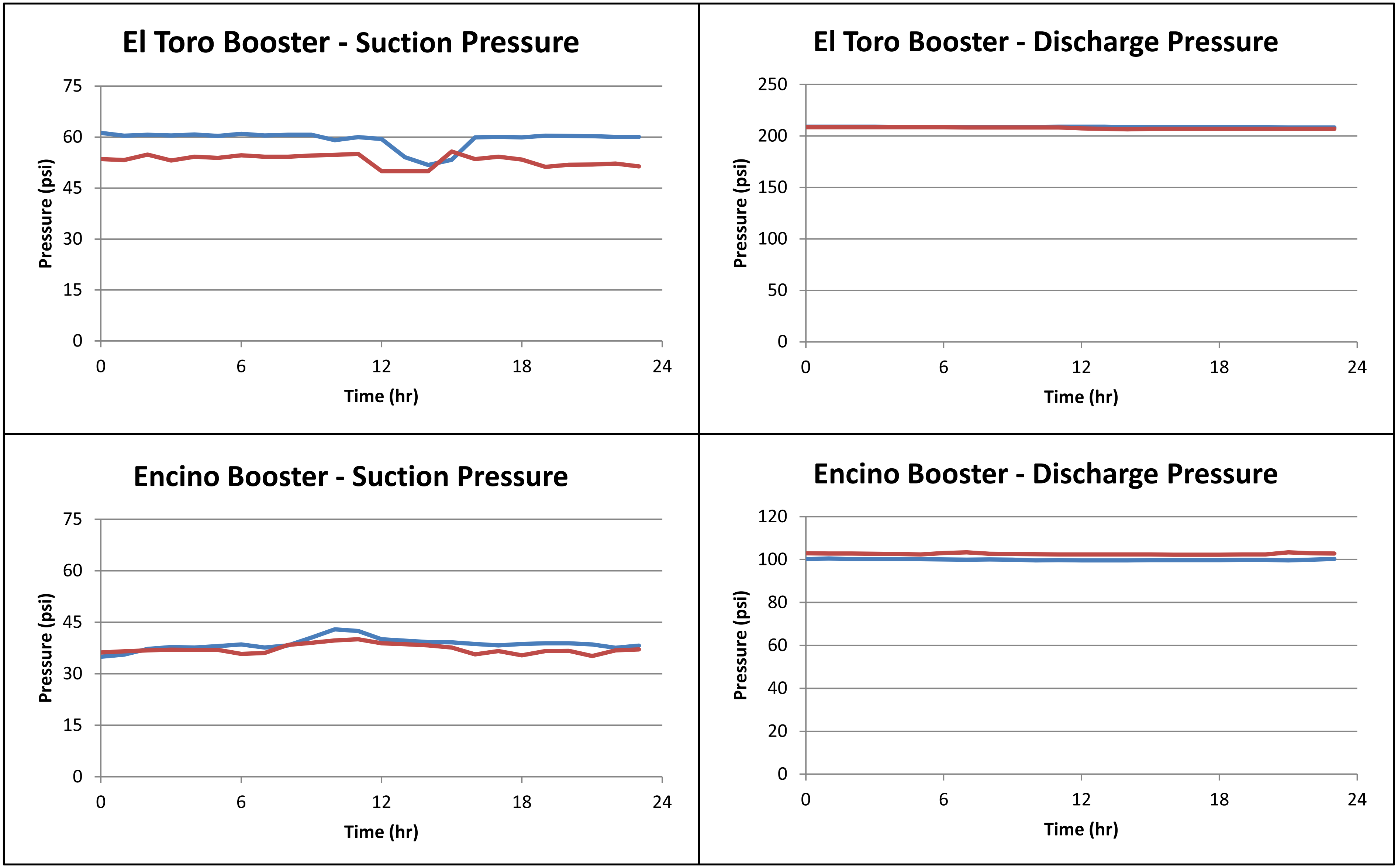
Note: Results shown with Holiday Lake Tank at 960'

PRELIMINARY

February 23, 2016

Figure 7
Booster Calibration
Water System Master Plan
City of Morgan Hill

AKEL ENGINEERING GROUP, INC.



LEGEND

Telemetry Data
Model Data

PRELIMINARY

February 23, 2016

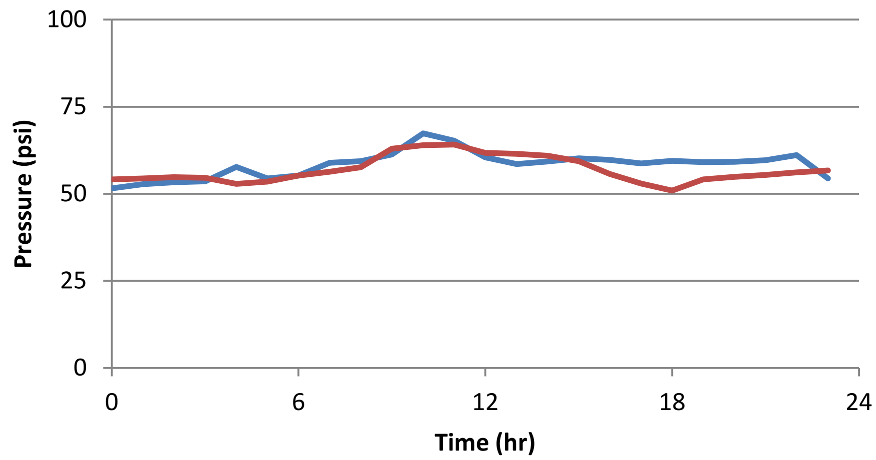
AKEL ENGINEERING GROUP, INC.

Figure 8

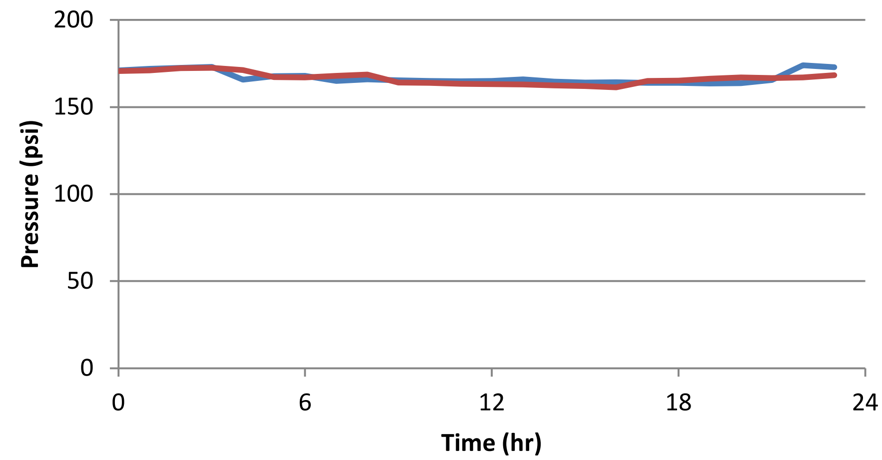
Booster Calibration

Water System Master Plan
City of Morgan Hill

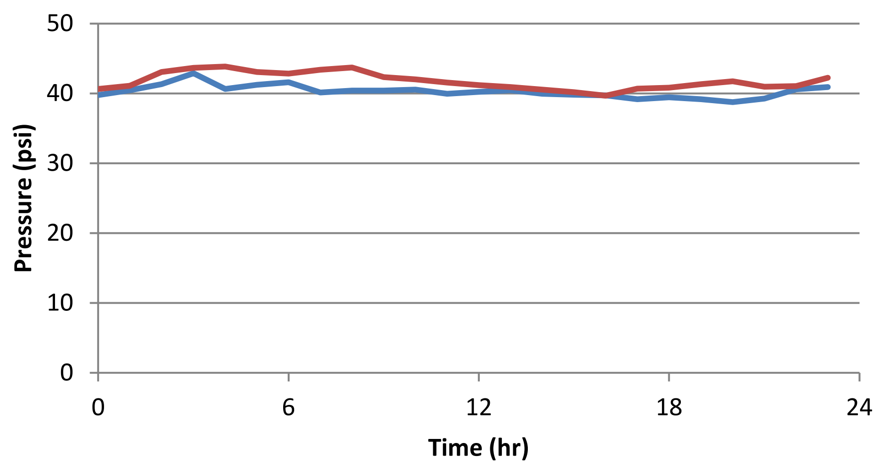
Llagas Booster - Suction Pressure



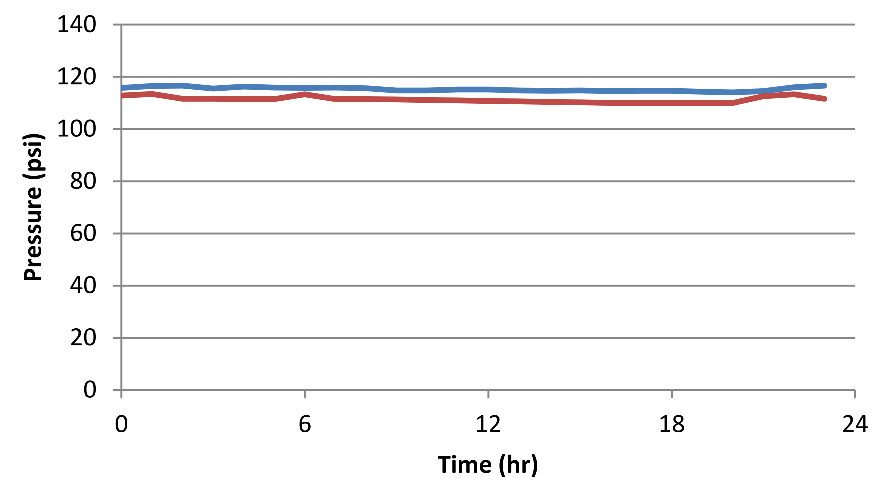
Llagas Booster - Discharge Pressure



Glen Ayre Booster - Suction Pressure



Glen Ayre Booster - Discharge Pressure



LEGEND

- Telemetry Data (blue line)
- Model Data (red line)

Note: Results shown with Llagas Tank at 723'

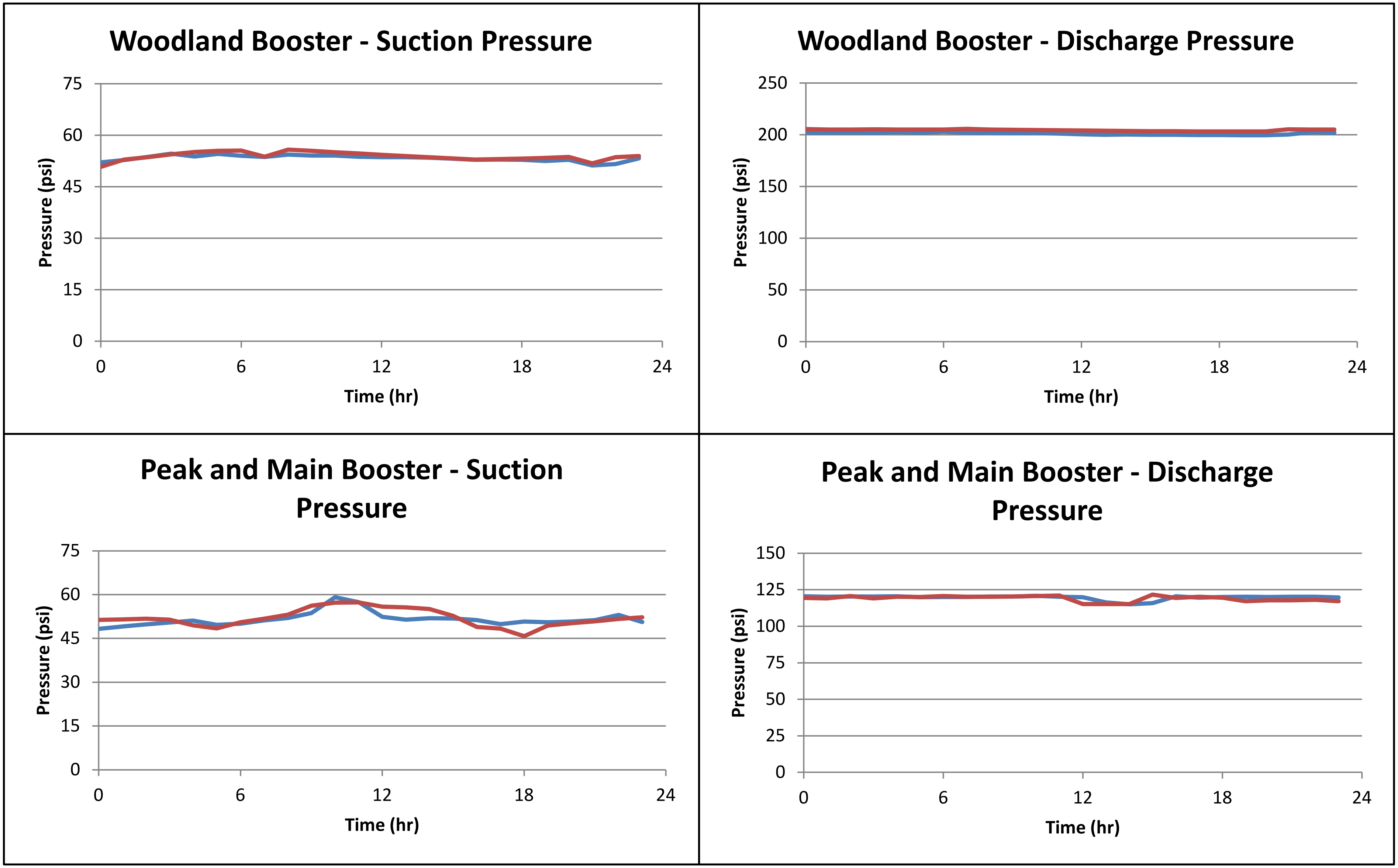
PRELIMINARY

February 23, 2016

AKEL ENGINEERING GROUP, INC.

Figure 9
Booster Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL



LEGEND

Telemetry Data

Model Data

PRELIMINARY

February 23, 2016

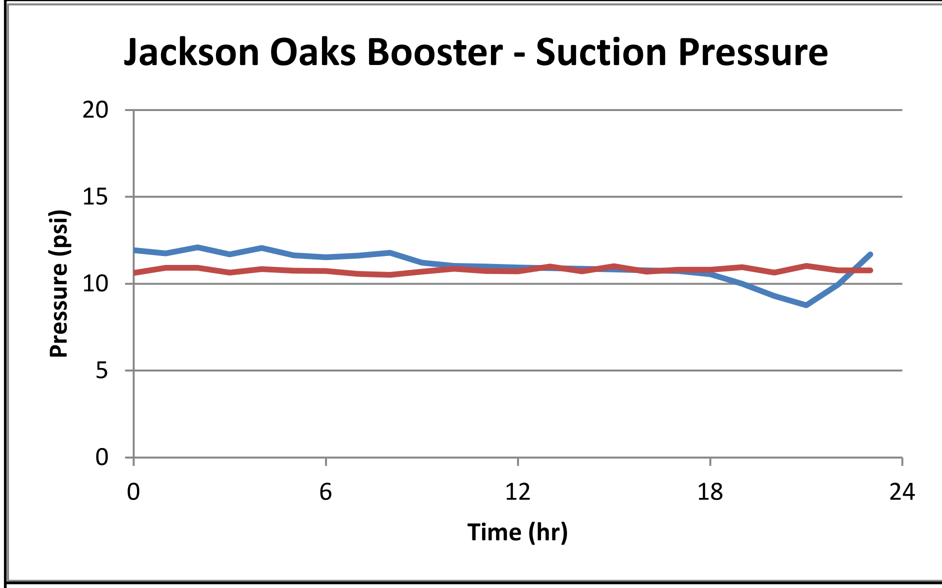
Figure 10

Booster Calibration

Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.



LEGEND

Telemetry Data
Model Data

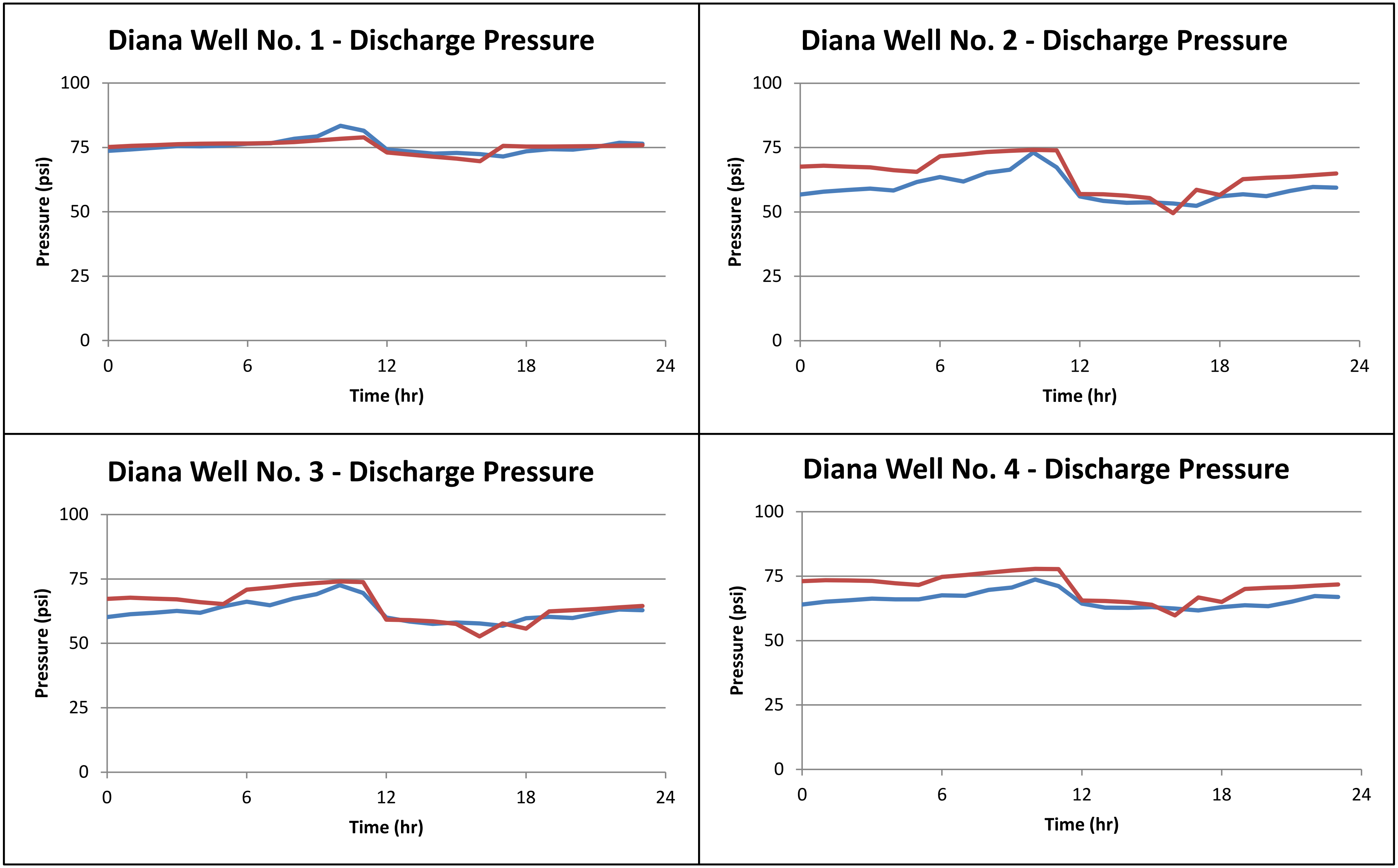
PRELIMINARY

February 23, 2016

Figure 11
Booster Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.



LEGEND

Telemetry Data
Model Data

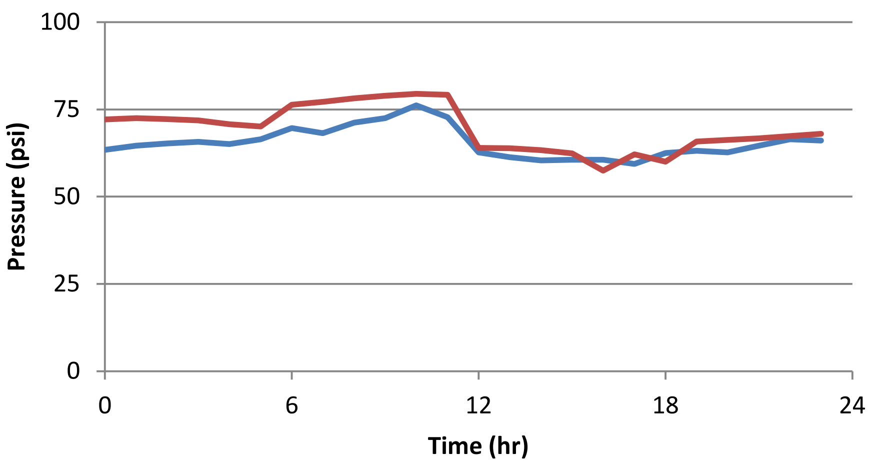
PRELIMINARY

February 23, 2016

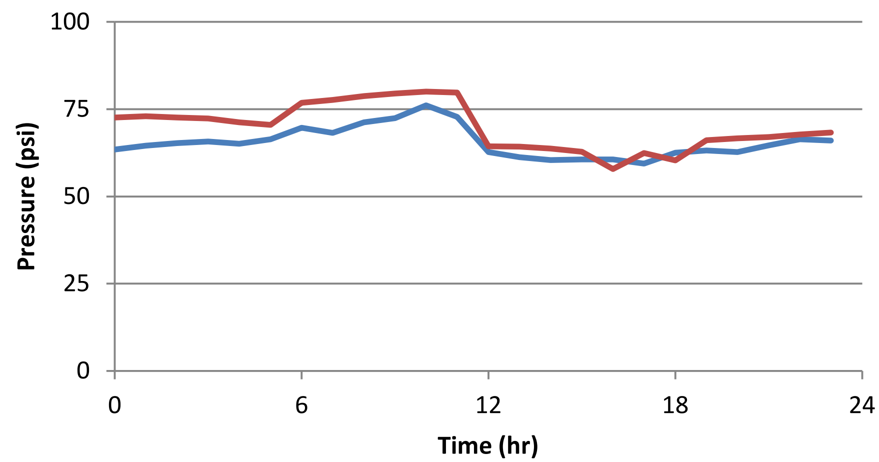
Figure 12
Well Calibration
Water System Master Plan
City of Morgan Hill

AKEL ENGINEERING GROUP, INC.

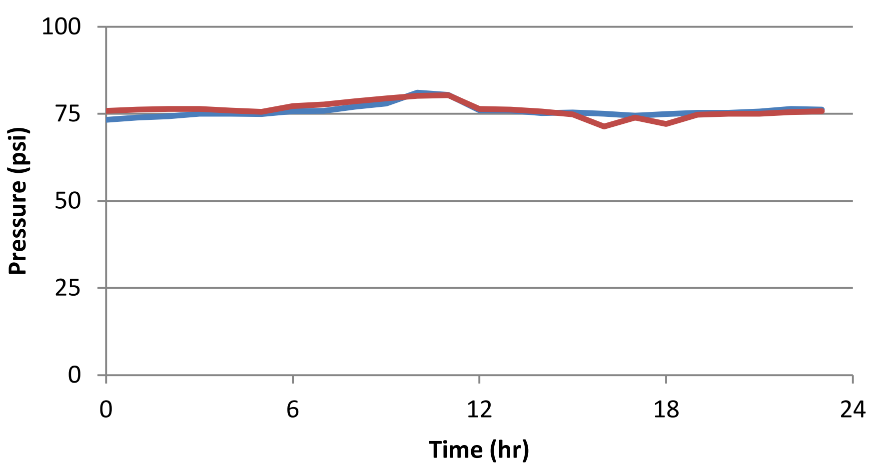
Dunne Well No. 1 - Discharge Pressure



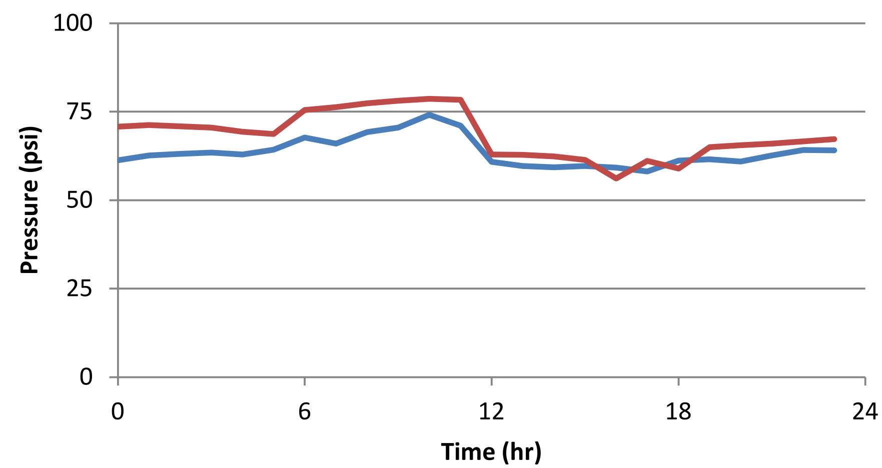
Dunne Well No. 2 - Discharge Pressure



Tennant Well - Discharge Pressure



Nordstrom Park Well - Discharge Pressure



LEGEND

- Telemetry Data (blue line)
- Model Data (red line)

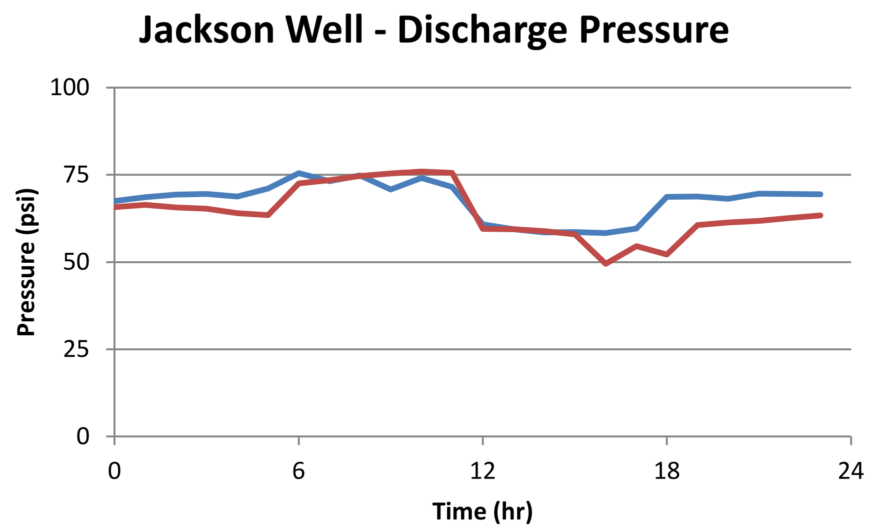
PRELIMINARY

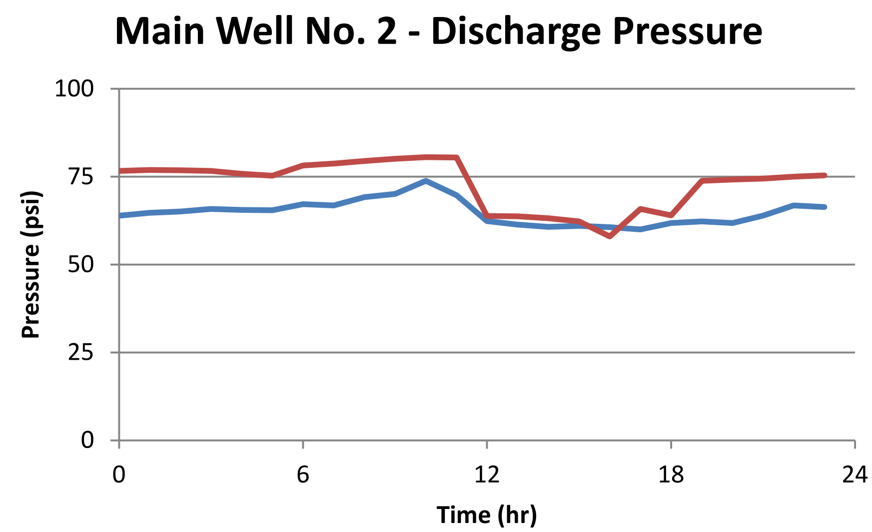
February 23, 2016

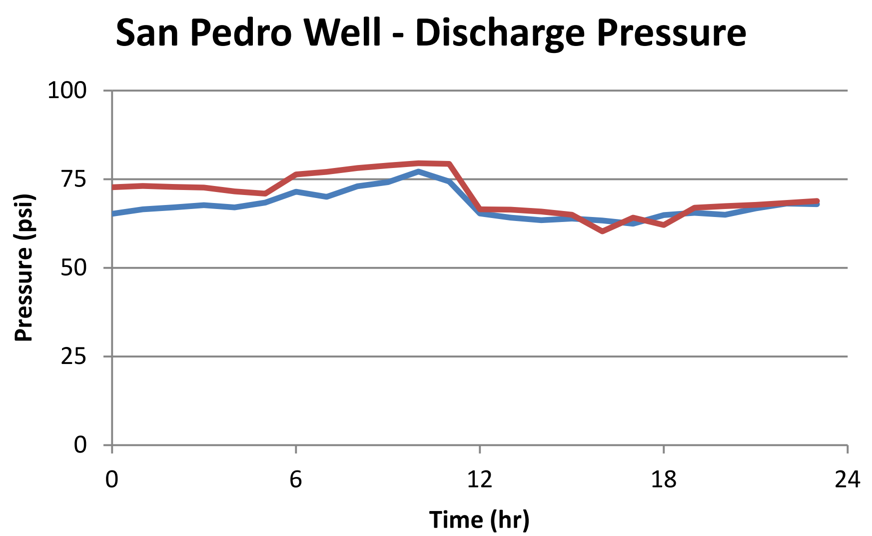
AKEL ENGINEERING GROUP, INC.

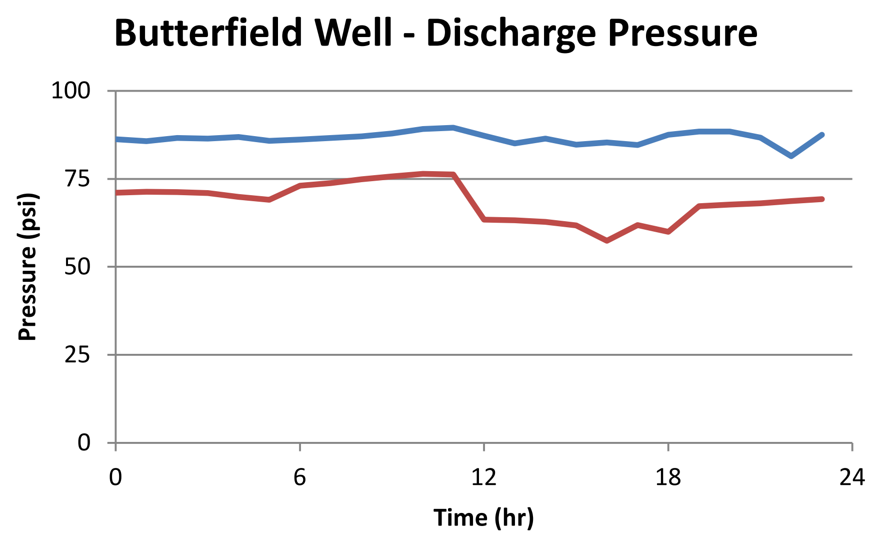
Figure 13
Well Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL









LEGEND

Telemetry Data

Model Data

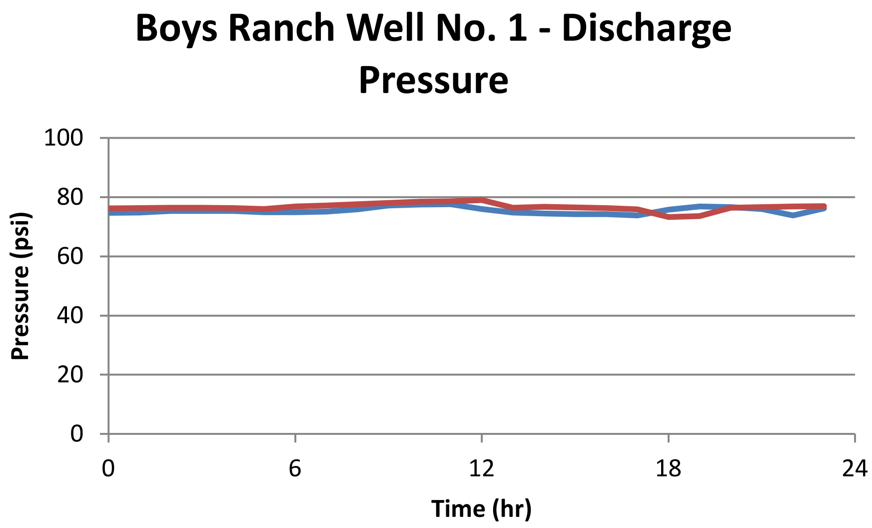
PRELIMINARY

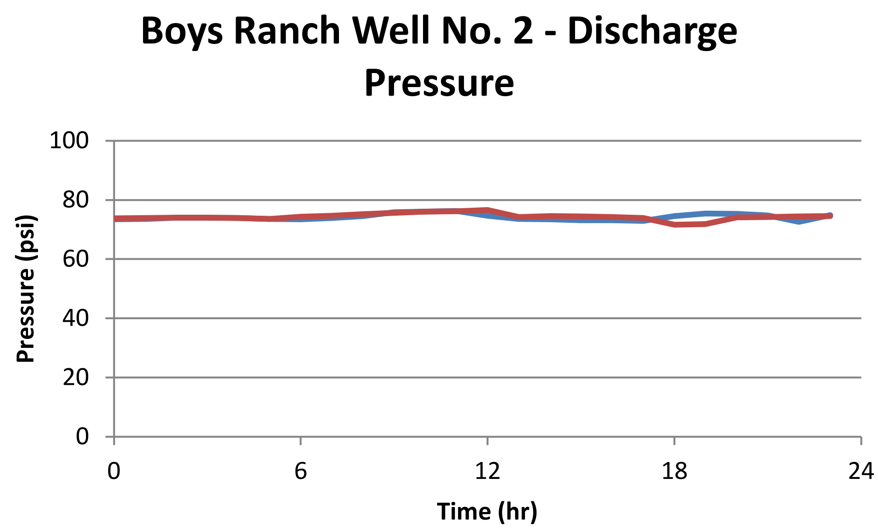
February 23, 2016

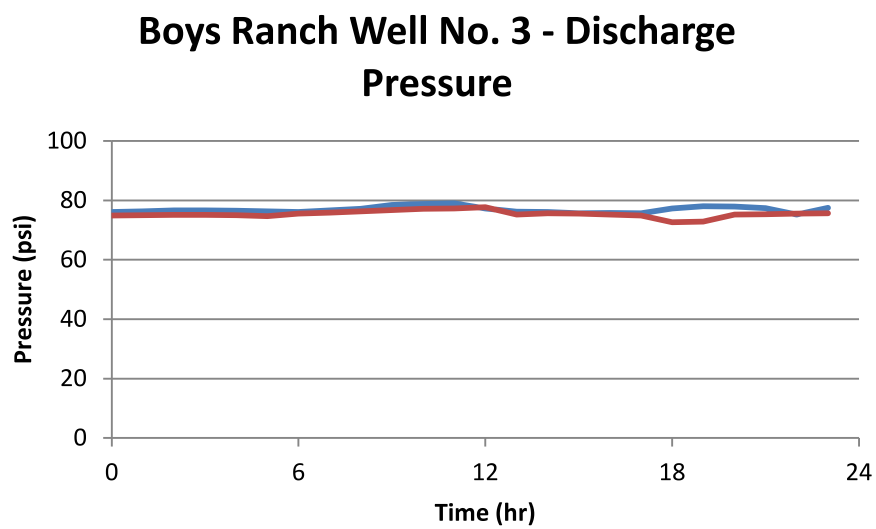
Figure 14
Well Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.







LEGEND

Telemetry Data
Model Data

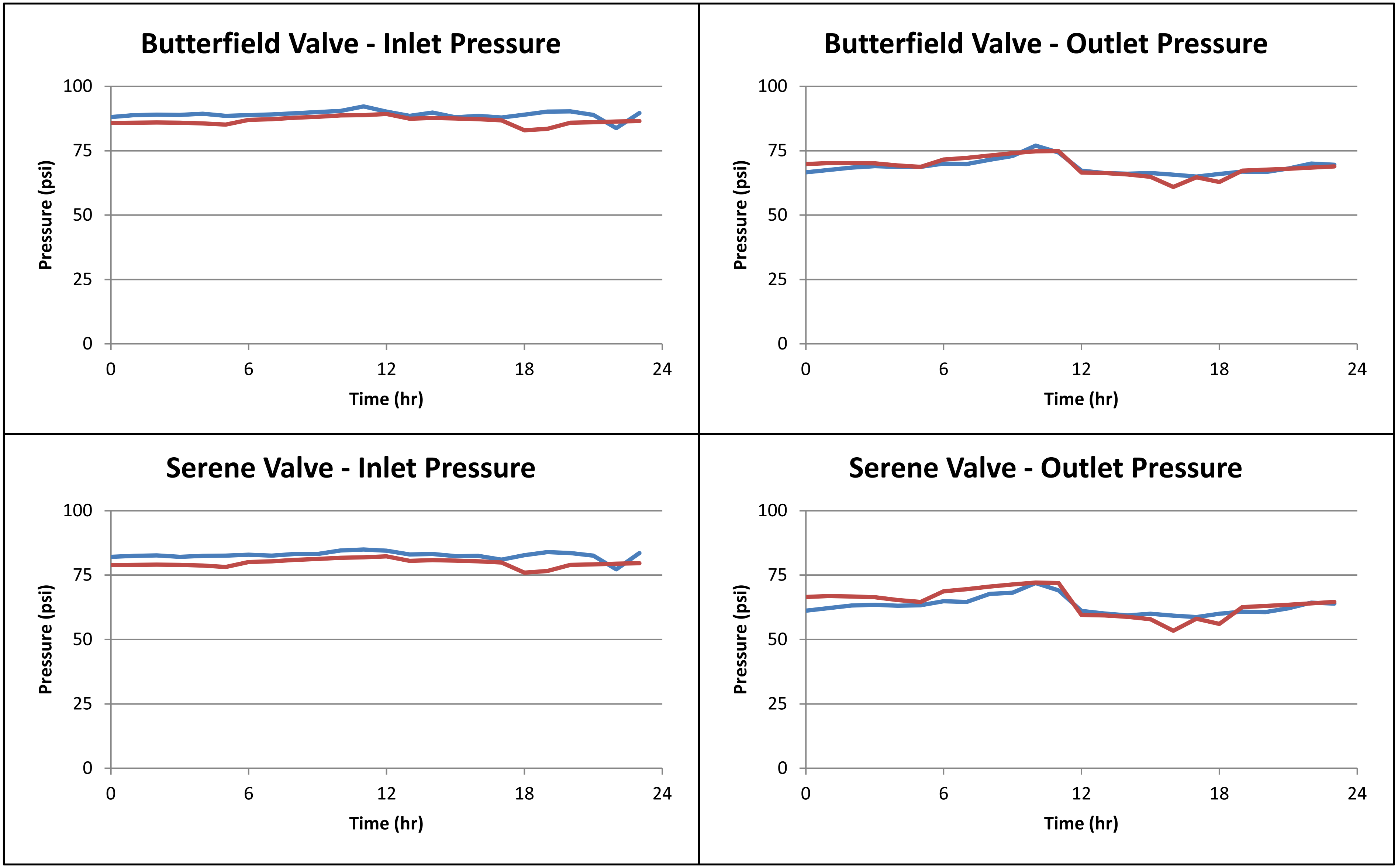
PRELIMINARY

February 23, 2016

Figure 15
Well Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.



LEGEND

Telemetry Data
Model Data

PRELIMINARY

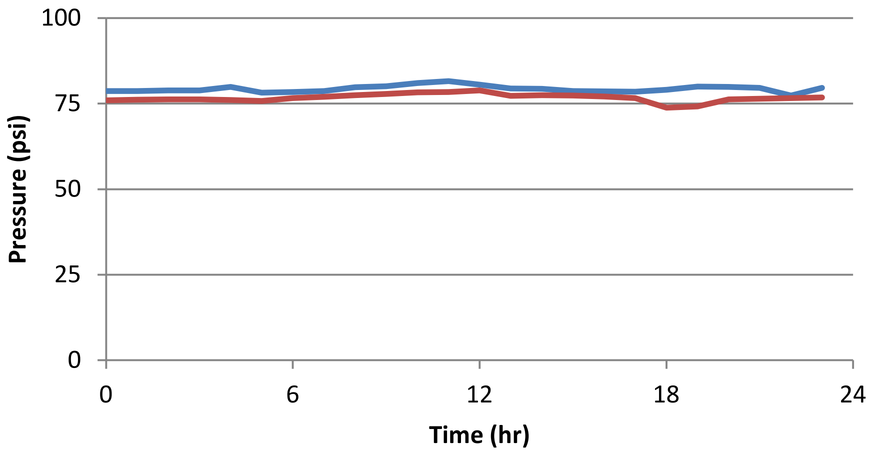
February 23, 2016

Figure 16
Valve Calibration
Water System Master Plan
City of Morgan Hill

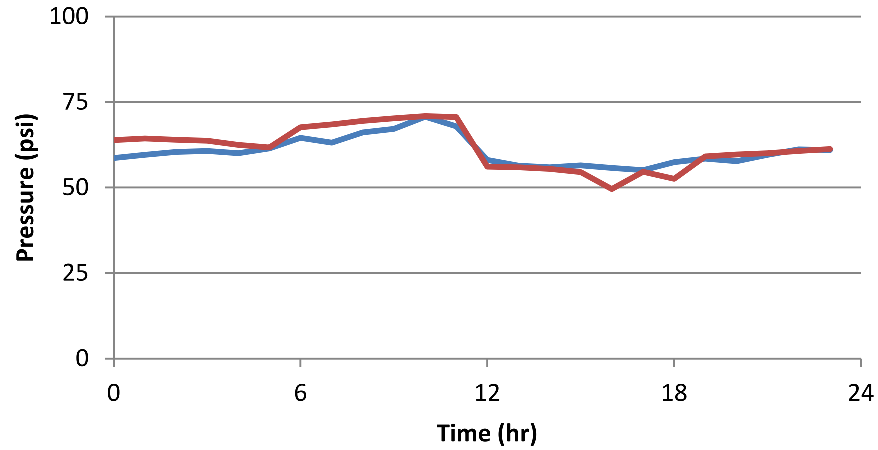
CITY OF MORGAN HILL

AKEL
ENGINEERING GROUP, INC.

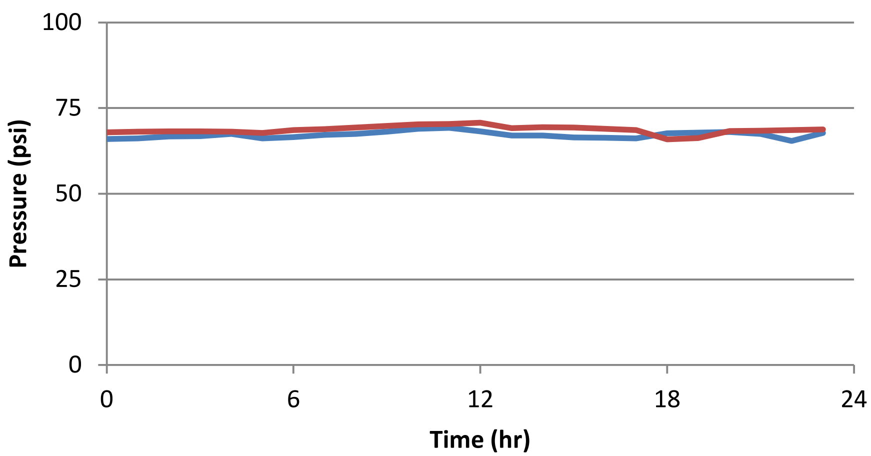
Condit Valve - Inlet Pressure



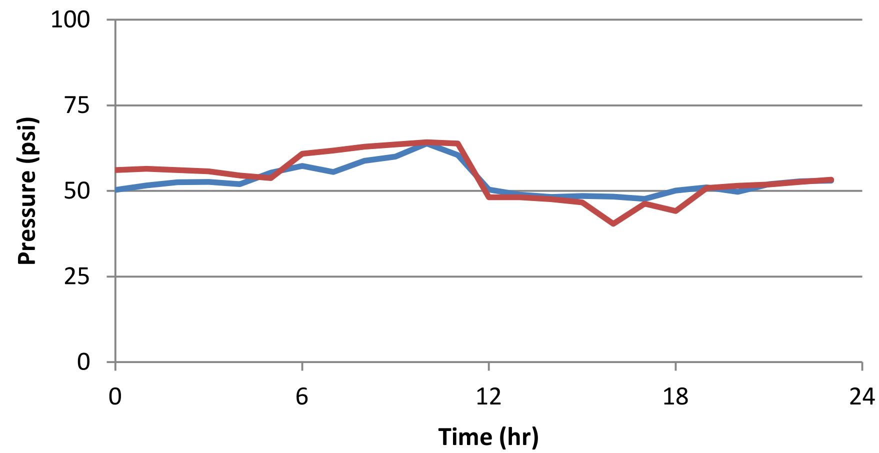
Condit Valve - Outlet Pressure



Main Ave Valve - Inlet Pressure



Main Ave Valve - Outlet Pressure



LEGEND

Telemetry Data
Model Data

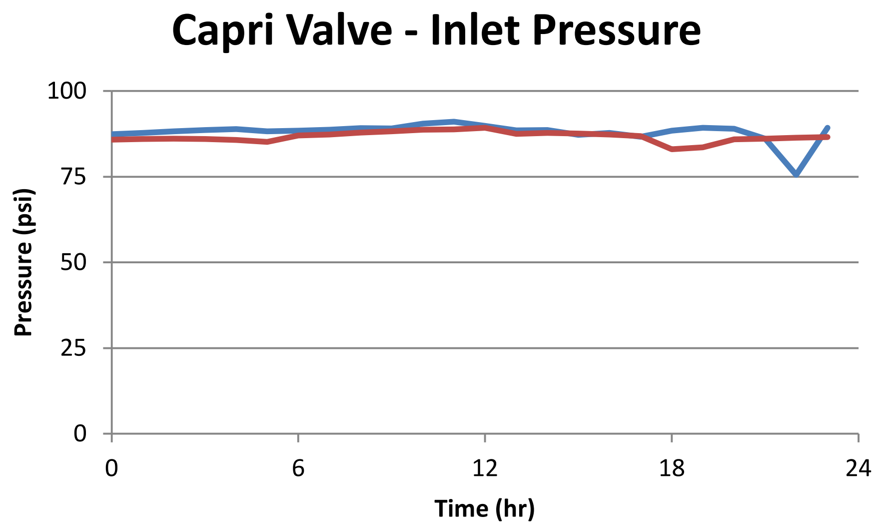
PRELIMINARY

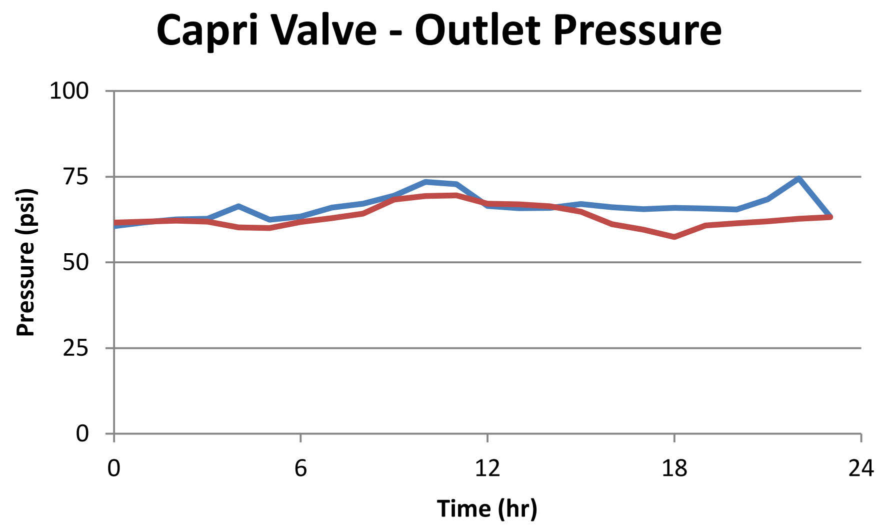
February 23, 2016

Figure 17
Valve Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL

AKEL ENGINEERING GROUP, INC.





LEGEND

Telemetry Data
Model Data

PRELIMINARY

February 23, 2016

AKEL ENGINEERING GROUP, INC.

Figure 18
Valve Calibration
Water System Master Plan
City of Morgan Hill

CITY OF MORGAN HILL