MWH

June 16, 2005

Mr. Kevin Milligan
City of Riverside
3900 Main Street
Riverside, CA 92522

Subject: City of Riverside Water System Master Plan

Dear Mr. Milligan:

Enclosed are thirty five copies of the final report for the City of Riverside Water System Master Plan. In this report, the City's water system is evaluation on the ability to adequately and reliably distribute water under existing and future conditions through the year 2025. This evaluation addresses existing system deficiencies and facilities required to meet increasing demands over the next twenty years. The report summarizes a proposed Capital Improvement Program (CIP) for the water system, including the phasing of projects and the capital cost requirements.

It has been a great pleasure to serve you on this project. Our project team at MWH appreciates all your assistance, as well as the participation of Dieter Wirtzfeld and other City staff during the development of this report. We look forward to working with you again in future endeavors.

Yours truly,

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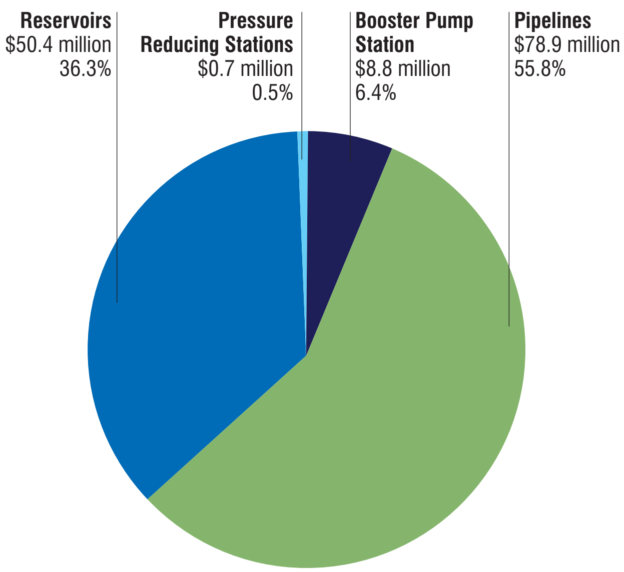
Executive Summary

The objective of this Water Master Plan is to provide the City of Riverside (City) with an evaluation of the water system's ability to adequately and reliably distribute water under existing and future conditions through the year 2025. This evaluation addresses existing system deficiencies and facilities required to meet increasing demands over the next twenty years. The report summarizes a proposed Capital Improvement Program (CIP) for the water system, including the phasing of projects and the capital cost requirements.

Figure ES-1. Capital Improvement Program



SUMMARY OF CAPITAL IMPROVEMENT PROGRAM

As recommended in this Water Master Plan, the overall Capital Improvement Program totals $138.8 million over the next twenty years in current construction dollars. As shown in ***Figure ES-1***, the City-funded portion of the CIP includes:

- $78.9 million for pipeline replacement,
- $50.4 million for reservoir rehabilitation, improvements and construction,
- $8.9 million for pumping stations and
- $0.6 million for pressure reducing stations.

The recommendations and associated CIP costs are presented in ***Table ES-1***. In addition, the Master Plan recommends increasing the pipe replacement program to 12 miles per year (approximately $8.8 million/year) and starting a booster pump replacement program of 7 pumps per year (approximately $525,000/year). The cost of these replacement programs is not included in the $138.8 million CIP.

Table ES-1. Water Distribution System Capital Improvement Program (All costs are in million $)

Ranking	Pipelines	Reservoirs	Booster Pump Stations	Pressure Reducing Stations	Total
Very High	$5.5	$11.4	$3.3	$0.0	$20.1
High	$3.6	$10.3	$2.3	$0.4	$16.6
Medium-High	$23.2	--	$1.9	$0.0	$25.1
Medium	$18.7	$14.0	-	$0.2	$32.8
Low	$9.4	$14.7	$1.1	$0.1	$25.4
Very Low	$18.4	-	$0.2	$0.1	$18.8
Total	**$78.9**	**$50.4**	**$8.8**	**$0.7**	**$138.9**

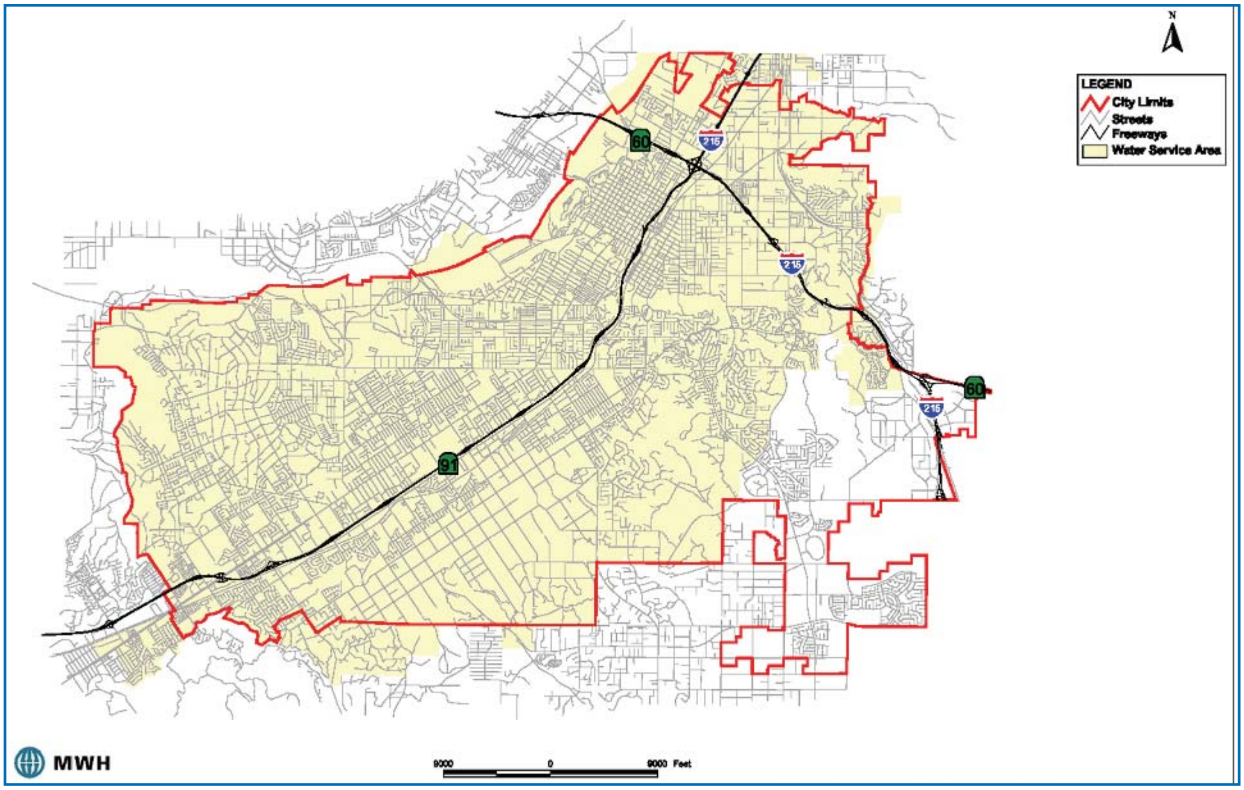
EXISTING WATER SYSTEM

The City water system serves approximately 60,000 service connections in the City of Riverside and surrounding regions as shown in ***Figure ES-2***. The water system consists of:

- approximately 890 miles of pipelines ranging from 4 to 72 inches in diameter,
- 33 pressure zones,
- 16 storage reservoirs with an approximate total volume of 100 million gallons (MG),
- 21 pressure reducing stations,
- 39 booster stations, and
- 46 groundwater wells for domestic services.

The City currently obtains water from the Bunker Hill, Colton, Riverside North and Riverside South groundwater basins and imported water from Metropolitan Water District of Southern California (MWD). The existing water system and its facilities are described in detail in **Section 4** and **Section 5**.

Figure ES-2. City of Riverside Water Service Area



WATER DEMAND PROJECTIONS

Historical and projected population within the City service boundary are evaluated and presented in Section 2. The estimated 2005 population for the entire service area is 255,346 people. Based on historic records since 1990, average annual growth has been 1.5 percent per year. ***Table ES-2*** shows the projected growth in the next 25 years.

Population projections in conjunction with land use data, aerial photography, and specific development information are used to project future water demands. Water demands are estimated to increase from 77,529 in the year 2005 to 97,410 acre-ft/yr by the year 2025. This corresponds with a total increase of 23 percent through the year 2025 or 1.0 percent compound growth per year. Maximum day demands are based on a peaking factor of 1.7 times the anticipated annual average day demands.

Table ES-2. Projected City Water Service Area Population

Year	City Population*	Water Service Area	Annual Growth Increase (percent)**
2005	286,935	255,346	2.1%
2010	307,847	271,907	1.3%
2015	323,384	287,066	1.1%
2020	338,712	301,900	1.0%
2025	353,397	315,746	0.9%
2030	367,489	329,001	0.8%

*City population based on SCAG
**Annual growth rate on a compound basis over previous 5-year period

Approximately 7,400 acres (16 percent) of the land within the water service area is currently undeveloped. Of this undeveloped land, 590 acres is designated as parks and open space, leaving 6,810 acres to be developed. ***Table ES-3*** summarizes the projected water demands based on the projected population and the development of this vacant land.

The unit water demand per capital for new development is estimated to increase from 2005 to 2010 by approximately 16 percent due to the density and type of land use currently under development or planned. However, over the following 15 years, a drop in per capita demand for new development of up to 30 percent is anticipated due to primarily higher land use densities.

Table ES-3. Projected Water Demands

Year	Projected Water Demand (acre-ft/yr)
2005	77,529
2007	80,019
2010	84,254
2015	89,494
2020	93,828
2025	97,410

WATER SUPPLY

The City obtains the majority of its water from five local groundwater basins; Bunker Hill, Colton, Riverside North and Riverside South Basins. The City also imports a portion of its water from MWD through Western Municipal Water District (WMWD). The imported water is usually used during the summer months when the groundwater supply does not meet the peak demands. The City's water supply is discussed in more detail in **Section 4**.

MODEL CREATION AND CALIBRATION

The hydraulic model for the City was created in H2OMAP Water, which operates within the GIS environment. The allocation of elevations and water demands used ArcView for automatic data processing before importing the information into the H2OMAP database. Each booster station was modeled with a multi-point curve based on the manufacturer's data and each reservoir was modeled as variable area reservoir, with the appropriate reservoir curve, to account for any reservoir that contained a hopper bottom. Water supply connections and water treatment plants were modeled as fixed head reservoirs with the hydraulic grade lines based on the surrounding topography. The calibration of the model was performed based on data collected on July 7 and July 8, 2004. These data were used for the Extended Period Simulation (EPS) calibration. EPS calibration compared the field data with the output of the model over a 24-hour period. The model creation and calibration is discussed in more detail in **Section 6**.

WATER SYSTEM EVALUATION CRITERIA

The water system was evaluated based on design criteria developed using typical criteria from similar water utilities, local codes, engineering judgement, commonly accepted industry standards and input from City staff. Criteria used to evaluate system pressures, pipeline velocities, storage volumes, booster station capacities, and pressure reducing station capacities are listed in ***Table ES-4***. These design criteria are discussed in more detail in **Section 7**.

Table ES-4. Water System Evaluation Criteria

Description	Value	Units	Evaluation Demand Conditions
System Pressure			
Maximum Pressure	125	psi [1]	MinMD [2]
Minimum Design Pressure, normal conditions	40	psi	PHD [2]
Minimum Evaluation Pressure, normal conditions	35	psi	PHD
Minimum Pressure, with fire flow	20	psi	MDD [2]
Pipeline Velocity			
Maximum Evaluation Velocity (excludes fire hydrant runs)	10	fps [1]	PHD
Maximum Design Velocity	6	fps [1]	PHD
Maximum Design Velocity (pump station suction pipelines)	4	fps [1]	MDD/PHD
Storage Volume			
Operational	25 percent of MDD	MG [1]	MDD
Fire Fighting	Highest fire flow requirement	MG	MDD
Emergency	1.5 times ADD	MG	ADD [2]
Booster Station Capacity			
Pressure Zones with Storage	Zone segment capacity of MDD with largest single pump out of service		MDD
Pressure Zones without Storage	Zone segment capacity of PHD or MDD plus Fire, whichever is larger, with largest single pump out of service		PHD
Pressure Reducing Station Capacity			
Pressure Zones with Storage	Zone segment capacity of MDD		MDD
Pressure Zones without Storage	Zone segment capacity of PHD or MDD plus Fire, whichever is larger		PHD

[1] psi = pounds per square inch, fps = feet per second, gpm = gallons per minute, MG = million gallons
[2] MinMD = minimum month demand, PHD = peak hour demand, MDD = maximum day demand, ADD = average day demand

WATER SYSTEM RECOMMENDATIONS

The water system is evaluated under existing and future demand conditions using a hydraulic model of the distribution system developed by MWH. The model is used to investigate high and low pressure locations, low pressure locations under fire flow demands, pipeline velocities, and reservoir refill. In addition, reservoir capacities, booster pump station capacities and source water capacities are evaluated for maximum day demand (MDD) conditions and emergency scenarios. Furthermore, recommendations are made to address rehabilitation needs of the existing water distribution network and facilities. Deficiencies are identified using the evaluation criteria outlined in **Section 8**.

Recommendations made to address deficiencies in the existing water system are added to the model prior to evaluating future demand conditions. The size and location of transmission pipelines, upgrades of distribution pipelines, storage reservoirs, booster pump stations and water source capacities necessary to meet existing and future demands are determined. The recommended improvement of the hydraulic analyses are divided into:

- Distribution system evaluation
- Storage evaluation
- Booster station evaluation
- Pressure reducing station evaluation

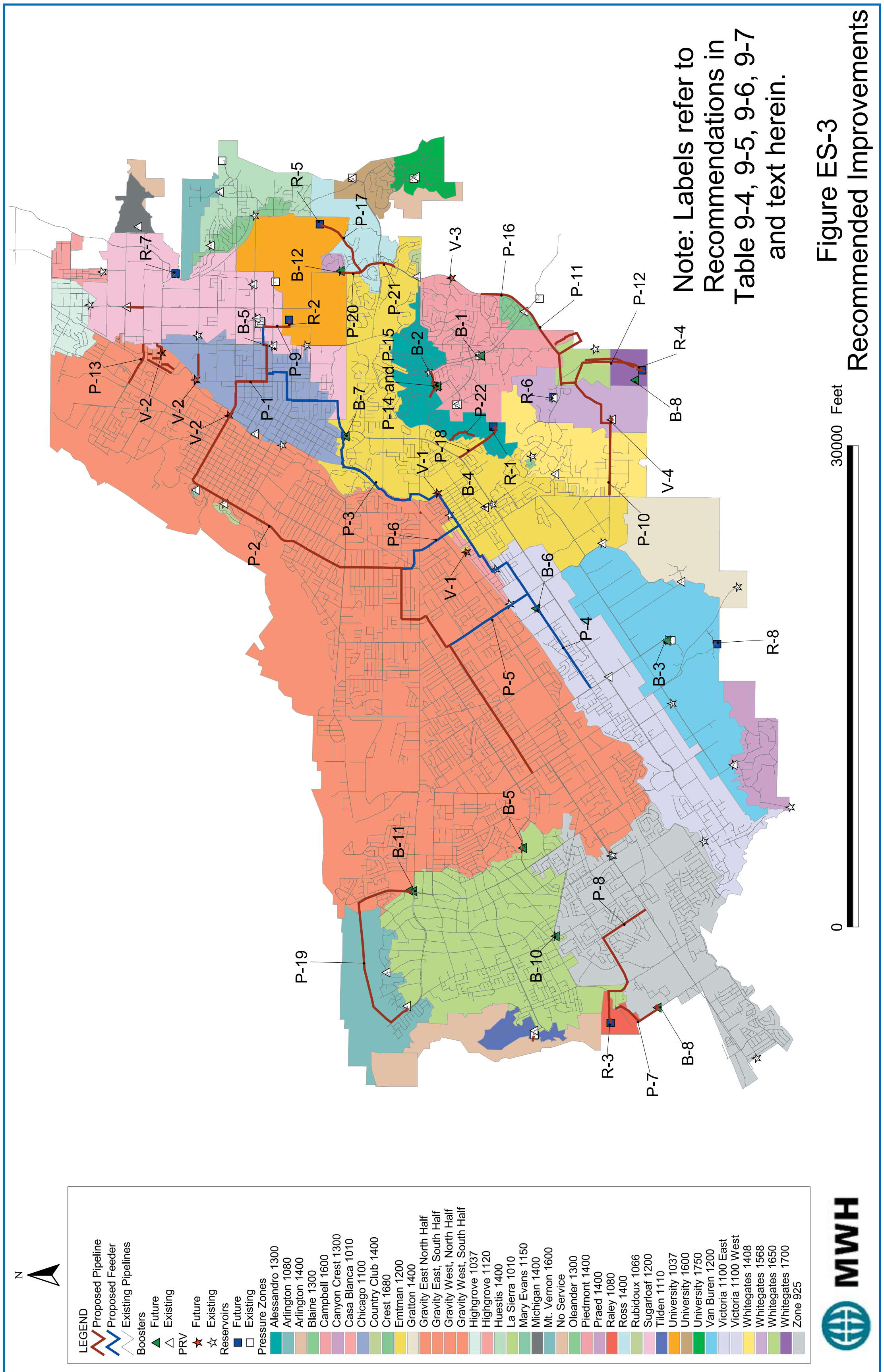
Distribution System Evaluation

Distribution system evaluation is based on pressure deficiencies under peak demand conditions, pressure deficiencies under fire flow conditions, and maximum pressure under minimum month demand conditions. Recommended improvements to address low-pressure regions include modifying pressure zone boundaries and installation of new pipelines. A total of 22 pipelines ranging from 8-inches to 54-inches in diameter for a total length of 33 miles are recommended to address low pressure and transmission requirements. These pipelines are indicated as P-1 through P-22 in ***Figure ES-3***. In addition, the distribution system evaluation identified 107 locations that cannot meet fire flow requirements at 20 psi, and a total of 18 miles of improvements are recommended to meet fire flow requirements. The fire flow pipeline improvements are assumed to be part of the annual pipeline replacement program.

Storage Evaluation

The existing water system contains approximately 100 MG of storage, while the total storage volume required is approximately 133 MG under existing conditions and 161 MG under build-out or ultimate conditions. There is a storage deficit of 33 MG under existing conditions and a deficit of 61 MG under future conditions. When the required and available storage volumes are compared for each pressure zone, ten systems of zones are identified as being deficient under existing conditions and two additional systems are identified as being deficient under future conditions. To correct such local storage deficiencies, reservoir expansion or upgrade is recommended. It is recommended that three new reservoirs be installed at existing reservoir sites (Sugarloaf Reservoir, Van Buren Reservoir and Whitegates No. 1 Reservoir) to add 12 MG of storage to the system. In addition, five new reservoirs are recommended at new sites to serve the La Sierra 925, Gravity 997, Emtman 1200, Ross 1400 and Whitegates 1600 zones, with a total capacity of 53 MG. The locations of the proposed storage improvements are shown in ***Figure ES-3***.

Figure ES-3


Note: Labels refer to Recommendations in Table 9-4, 9-5, 9-6, 9-7 and text herein.
Figure ES-3
Recommended Improvements
0
30000 Feet
N
LEGEND
Proposed Pipeline
Proposed Feeder
Existing Pipelines
Boosters
Future
Existing
PRV
Future
Existing
Reservoirs
Future
Existing
Pressure Zones
Alessandro 1300
Arlington 1080
Arlington 1400
Blaine 1300
Campbell 1600
Canyon Crest 1300
Casa Blanca 1010
Chicago 1100
Country Club 1400
Crest 1680
Emtman 1200
Gratton 1400
Gravity East North Half
Gravity East, South Half
Gravity West, North Half
Gravity West, South Half
Highgrove 1037
Highgrove 1120
Huestis 1400
La Sierra 1010
Mary Evans 1150
Michigan 1400
Mt. Vernon 1600
No Service
Oleander 1300
Piedmont 1400
Praed 1400
Raley 1080
Ross 1400
Rubidoux 1066
Sugarloaf 1200
Tilden 1110
University 1037
University 1600
University 1750
Van Buren 1200
Victoria 1100 East
Victoria 1100 West
Whitegates 1408
Whitegates 1568
Whitegates 1650
Whitegates 1700
Zone 925
MWH

Booster Station Evaluation

The majority of booster stations have insufficient capacity to meet either existing or future system demand conditions. Four new booster stations are recommended to handle the projected growth within the service area. Twelve additional booster stations need rehabilitation improvements such as replacing pumps and motors, upgrade of electrical equipment, and/or upgrading of the pump station structure. Two stations, Raley and Chase Booster Station, are recommended for abandonment or standby status due to insufficient capacity and age. Raley booster station will be replaced with Buchanan booster station, and Chase booster station which is only operated occasionally will be maintained for emergency conditions. The locations of booster station improvements are shown in ***Figure ES-3***.

Pressure Reducing Station Evaluation

The majority of pressure reducing stations have insufficient capacity to meet either existing or future system demand conditions. Two new pressure reducing stations are recommended to assist with the projected growth within the service area. Three additional pressure reducing stations need rehabilitation improvements such as replacing valves or pipelines and/or adding valves. Five new stations will be added to rezone the Casa Blanca 1010 and create the 1040 pressure zones. It is also recommended that once the Raley Reservoir is constructed, the Polk/ Magnolia reducers be operated as a flow control station to allow constant flow from the Gravity Zone to the 925 Zone. The locations of pressure reducing station improvements are shown in ***Figure ES-3***.

Pipeline Rehabilitation Recommendations

The existing distribution system consists of approximately 900 miles of pipelines. The majority of these pipelines (51 percent) are concrete or concrete lined pipe material. Because Riverside was developed in the first half of the 20th Century, many pipelines are old unlined cast iron or unlined steel and need either replacement or rehabilitation by cement mortar lining for corrosion protection. The typical expected lifetime for water pipelines is 75 years. Approximately 6 percent or 54 miles of the City's distribution pipelines exceed 75 years of age in 2005.

It is recommended that the City replace 12 miles of pipeline per year (1/75 of the system) at a cost of $8.8 million/year.

Pump Station Rehabilitation Recommendations

The City has 108 booster pumps, with 68 of the booster pumps (63 percent) older than 15 years in 2005. Many of the pumps are in very poor condition, with obsolete parts. It is recommended that the City begin a pump replacement program to address aging booster pumps throughout the City. To maintain pump efficiency and reliability, it is recommended that the City replace and/or shop-repair 7 booster pumps each year (1/15 of the booster pumps) at a cost of $525,000/year.

CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program (CIP) consists of a summary of recommended improvements, cost estimates for the improvements, and phasing of the CIP. A detailed discussion of the CIP is included in **Section 9** of this Water Master Plan.

Summary of Recommendations

The CIP includes all recommended improvements that are identified to address existing system deficiencies and improvements needed to meet future growth demand conditions. A summary of the recommended improvements is presented in ***Table ES-5***.

Table ES-5. Summary of Recommended Improvements by Facility Type

Facility Type	Existing	Recommended Improvements
Storage Reservoirs	16	Add 8 totaling about 65 MG
Booster Pump Stations	35	4 (new); 12 (upgraded)
Pressure Reducing Stations	21	8 (new); 4 (upgraded)
Pipelines (miles)	889	Add or replace 51 miles (33 miles transmission mains; 18 miles small diameter for fire flow improvements)

Costs and Phasing

Capital improvement projects are phased based on system needs. Projects addressing both existing and future deficiencies are phased over the next 20 years with a breakdown of the following prorities:

- Very High
- High
- Medium-High
- Medium
- Low
- Very Low

Improvements which will address the most severe deficiencies, affect the largest number of customers, and/or affect critical water facilities are ranked the highest. Recommended improvements by phasing period are summarized in ***Table ES-6*** on the following page. The most important projects are phased first, with lower priority projects deferred in order to even out the capital expenditure. A summary of the recommended CIP is shown in ***Table ES-1***, with a total capital cost of $138.8 million. As previously mentioned this CIP cost does not include the recommended pipeline and pump station rehabilitation programs of $8.8 million and $525,000 per year, respectively.

Table ES-6. Detailed Phasing of the Capital Improvement Program for the City of Riverside Water Distribution System

ID	Project Type	Project Description	Cost	Priority
B-1	New Booster Station	Alessandro PS (Alessandro 1300 to Campbell 1600)	$2,100,000	Very High
B-2	Booster Station Expansion	Emtman Low PS (Emtman 1200 to Alessandro 1300)	$543,000	Very High
B-9	New Booster Station	Buchanan PS (La Sierra 925 to Buchanan 1100)	$630,000	Very High
P-12	Pipeline	Connect Whitegates No. 2 Res to System	$1,450,000	Very High
P-14	Pipeline	Emtman Low Discharge to Alessandro	$350,000	Very High
P-15	Pipeline	Emtman Low Discharge to northwest	$190,000	Very High
P-18	Pipeline	Connect New 1200 Emtman Res to 30” Victoria Pipeline	$2,880,000	Very High
P-7	Pipeline	New Buchanan 1100 Zone Transmission	$629,000	Very High
R-1	Reservoir	New 1200 Zone (Central Part of System)	$5,880,000	Very High
R-4	Reservoir	Whitegates No 2 Replacement	$5,488,000	Very High
B-14	Booster Pump Replacement	Gratton PS (Van Buren 1200 to Gratton 1400)	$315,000	High
B-3	Booster Station Expansion	Mockingbird PS (Gravity 997 to Van Buren 1200)	$157,500	High
B-5	Booster Pump Replacement	Chicago PS (Gravity 997 to Chicago 1100)	$378,000	High
B-6	Booster Pump Replacement	St. Lawrence PS (Gravity 997 to Victoria 1100)	$378,000	High
B-7	Booster Pump Replacement	Victoria PS (Gravity 997 to Emtman 1200)	$472,500	High
B-8	New Booster Station	Whitegates 1700 PS (Whitegates 1600 to 1700)	$630,000	High
P-8	Pipeline	Connect Raley Reservoir to 27” Magnolia Pipeline	$3,600,000	High
R-3	Reservoir	Raley Reservoir	$7,700,000	High
R-6	Reservoir	Whitegates No 1 Replacement	$2,632,000	High
V-1	PRV Station	New 1040 Zone	$210,000	High
V-2	PRV Station	1010 Casa Blanca Zone Expansion	$140,000	High
B-13	Booster Pump Replacement	Mt. Vernon PS (Heustis 1400 to Mt. Vernon 1600)	$250,000	Medium - High
B-15	Booster Pump Replacement	Rubidoux PS (Gravity 997 to Rubidoux 1066)	$84,000	Medium - High
B-4	New Booster Station	Francis Mary PS (Gravity 997 to Emtman 1200)	$1,575,000	Medium - High
P-1	Pipeline	New Crosstown Feeder, 54-inch section	$7,110,000	Medium - High
P-10	Pipeline	Pipeline in Bradley, from Washington to Horizon View	$960,000	Medium - High
P-2	Pipeline	New Crosstown Feeder, Upper Reach, 48-inch section	$14,003,000	Medium - High
P-6	Pipeline	Connect Old Crosstown Feeder to New Crosstown Feeder at Francis Mary	$1,100,000	Medium - High
P-2	Pipeline	New Crosstown Feeder, Lower Reach, 48-inch section	$12,998,000	Medium
P-5	Pipeline	Connect Old Crosstown Feeder to New Crosstown Feeder at St Lawrence	$1,750,000	Medium
P-9	Pipeline	Connect UCR Reservoir to Evans Reservoir	$3,950,000	Medium
R-2	Reservoir	Gravity Zone at UCR	$14,000,000	Medium
V-6	PRV Station	Prospect Reducer	$50,000	Medium
V-8	PRV Station	Highgrove Reducer	$30,000	Medium
V-9	PRV	University City Reducer	$70,000	Medium
B-11	New Booster Station	Rancho La Sierra PS (Gravity 997 to Arlington 1100)	$630,000	Low
B-12	Booster Pump Replacement	Canyon Crest PS (Emtman 1200 to Ross 1400)	$472,500	Low
P-11	Pipeline	Pipeline in Overlook Pkwy, connecting Whitegates No. 2 and Campbell Zones	$2,030,000	Low
P-13	Pipeline	Reroute Industrial Booster Suction	$1,653,000	Low
P-16	Pipeline	Pipeline in Canyon Crest, from Alessandro to Via Vista	$925,000	Low

ID	Project Type	Project Description	Cost	Priority
P-17	Pipeline	Connect Proposed 1400 Zone Res to Canyon Crest & El Cerrito	$1,050,000	Low
P-19	Pipeline	Rancho La Sierra Transmission Line	$3,000,000	Low
P-20	Pipeline	Pipeline in Canyon Crest, from Canyon Crest Booster to Central	$480,000	Low
P-22	Pipeline	Pipeline in Hawarden from Anna to Rolling Ridge	$308,000	Low
R-5	Reservoir	1400 Zone Reservoir at Old Frat House Site	$4,295,200	Low
R-7	Reservoir	Sugarloaf Expansion	$4,550,000	Low
R-8	Reservoir	Van Buren Expansion	$5,880,000	Low
V-5	PRV Station	Madison Reducer	$50,000	Low
V-7	PRV Station	Westminster Reducer	$40,000	Low
B-10	Booster Station Expansion	Field PS (La Sierra 925 to La Sierra 1010)	$210,000	Very Low
P-3	Pipeline	Rehab Old Crosstown Feeder	$6,100,000	Very Low
P-4	Pipeline	Rehab Old Crosstown Feeder	$12,348,000	Very Low
V-3	PRV Station	Ransom Reducer	$70,000	Very Low
V-4	PRV Station	Horizon View Reducer	$70,000	Very Low

It should be noted that the CIP presented in this Water Master Plan includes the cost of potable water distribution system improvements only. The cost for water supply sources including groundwater wells and transmission pipelines, recycled water improvements and water conservation measures are excluded, because these programs have not yet been defined. However, future use of recycled water, as well as water conservation, will reduce the potable water demands, and could reduce or defer a portion of the drinking water system CIP presented in this report.

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APPENDICES

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Section 1
Introduction

This section provides a project overview of the Water Master Plan, including background, the scope of work and a list of abbreviations and definitions used in this report.

PROJECT BACKGROUND

The intent of this Comprehensive Water Master Plan is to provide a document that can be used as a guideline for providing water to the City of Riverside (City). This document provides a planning horizon of year 2025 and evaluates both the existing and future water systems.

This Comprehensive Water Master Plan covers the City's 74.1 square mile service area, which includes 68.5 square miles with the City limits and 5.6 square miles outside of the City limits. The service area includes approximately 59,700 service connections.

SCOPE OF WORK

The City water service objectives are to provide cost-effective and reliable water services that meet the water quantity, pressure and quality requirements. This Comprehensive Water Master Plan has been developed to assist the City in achieving these objectives.

The scope of work for this Comprehensive Water Master Plan included the following tasks:

- Meetings with City Staff
- Review of Existing Data
- Water Demand Projections
- Water Supply Analysis
- Create a Hydraulic Model
- Calibrate the Hydraulic Model
- Water System Evaluation
- Develop Recommended Improvements for Water System
- Develop a Capital Improvement Program
- Write the Comprehensive Water Master Plan Report
- Provide training to City staff to use the Hydraulic Model
- Non-Potable Water Supply Assessment

DATA SOURCES

In the preparation of this Comprehensive Water Master Plan, City staff provided many reports, maps and other sources of information. In addition to the information provided by the City Water Utility Staff, material was obtained from the City's Planning Department.

AUTHORIZATION

This Comprehensive Water Master Plan has been developed in accordance with a contract between the City of Riverside and MWH Americas, Inc. (MWH) dated March 9, 2004.

ACKNOWLEDGMENTS

MWH wishes to acknowledge and thank all of the City of Riverside staff for their support and assistance in completing this project. Special thanks go to Dieter Witrzfeld (Assistant Director-Water), Kevin Milligan (Principal Water Engineer), Owen Lu (Water Systems Operations Manager) and their staff.

PROJECT STAFF

The following MWH staff were principally involved in the preparation of this Comprehensive Water Master Plan:

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Project Engineer:	Matthew Huang, P.E.
Associate Engineers:	Sarah Munger
	Paige Igoe
	Christine Geasler
Technical Review:	Harold Glaser, P.E.
	David Bouck, P.E.
	David Ringel, P.E.

ABBREVIATIONS

To conserve space and improve readability, abbreviations have been used in this report. Each abbreviation has been spelled out in the text the first time it is used. Subsequent usage of the term is usually identified by its abbreviation. The abbreviations used are shown in **Table 1- 1**

Table 1- 1
List of Abbreviations

Abbreviation	Description
Acre-ft/yr	Acre-feet per year
ADD	Average Day Demand
ADP	Average Day Production
AWWA	American Water Works Association
CAD	Computer Aided Drafting
CDHS	California Department of Health Services
cfs	Cubic Feet per Second
CIP	Capital Improvement Program
City	City of Riverside
du	Dwelling Unit
EMWD	Eastern Municipal Water District
EPS	Extended Period Simulation

FAR	Floor Area Ratio
fps	Feet per second
Gage	Gage Canal Company
GIS	Geographical Information System
gpad	Gallon per acre per day
gpcd	Gallon per capita per day
gpd	Gallon per day
gpd/ft	Gallon per day per foot
gpm	Gallon per minute
gpm/ft	Gallon per minute per foot
MDD	Maximum Day Demand
MDP	Maximum Day Production
Mills	Mills Water Treatment Plant
MMD	Maximum Month Demand
MG	Million Gallons
mgd	Million gallons per day
MSL	Mean Sea Level
MWH	Montgomery Watson Harza
MWD	Metropolitan Water District of Southern California
OEHHA	California Office of Environmental and Health Hazard Assessment
O&M	Operation and Maintenance
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
psi	Pounds per square inch
RHNA	Regional Housing Need Assessment
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Governments
SDOF	California Department of Finance
UCR	University of California at Riverside campus
UFC	Uniform Fire Code
WMWD	Western Municipal Water District

Section 2
Land Use, Population and Development

This section describes the City's historic, current, and projected land use as well as historic and projected population. The references used in this Water System Master Plan to evaluate land use and future growth until the year 2025 are as follows:

- City population studies
- Demographic studies by California Department of Finance(SDOF)
- Population projections by Southern California Association of Governments (SCAG)
- Development projections by the City Planning Department
- General Plan and designated land use categories from the City
- United States Census Bureau
- Discussions with the City Planning Department staff

LAND USE

Existing Service Area and City Boundary

The City of Riverside is located in northwest Riverside County. The City has a water service area of 74.1 square miles, of which 68.5 square miles are within the City limits and 5.6 square miles are outside the City limits. Elevations range from less than 700 feet above mean sea level (MSL) to more than 1,700 feet above MSL.

The current service area and the City limits are presented in **Figure 2-1**. Within the City boundary, approximately 9 square miles in southeast Riverside is served by Western Municipal Water District (WMWD) and 0.9 square miles is served by Eastern Municipal Water District (EMWD). Riverside Highland Water Company serves a quarter square mile in northeast Riverside. The City serves approximately 59,700 water service connections.

Existing Development

Historically, the City of Riverside has been known for its citrus industry. The warm, dry Mediterranean climate and fertile soil were ideal for agriculture growth such as citrus crops. Since the 1940s, the City has been undergoing a transformation from agricultural to urban and economic use. The City's population tripled between the 1950s and the 1970s and the land area increased from approximately 39.2 square miles to 74.1 square miles. Although agriculture is still practiced in the underdeveloped areas, the trend to convert agricultural lands to urban uses is expected to continue. The City is moving from suburban land use to urban land use. Residential development remains the dominant land use within the City. The city's 2004 General Plan is expecting build-out by the year 2025. The 2004 General Plan is currently in the process of adoption.

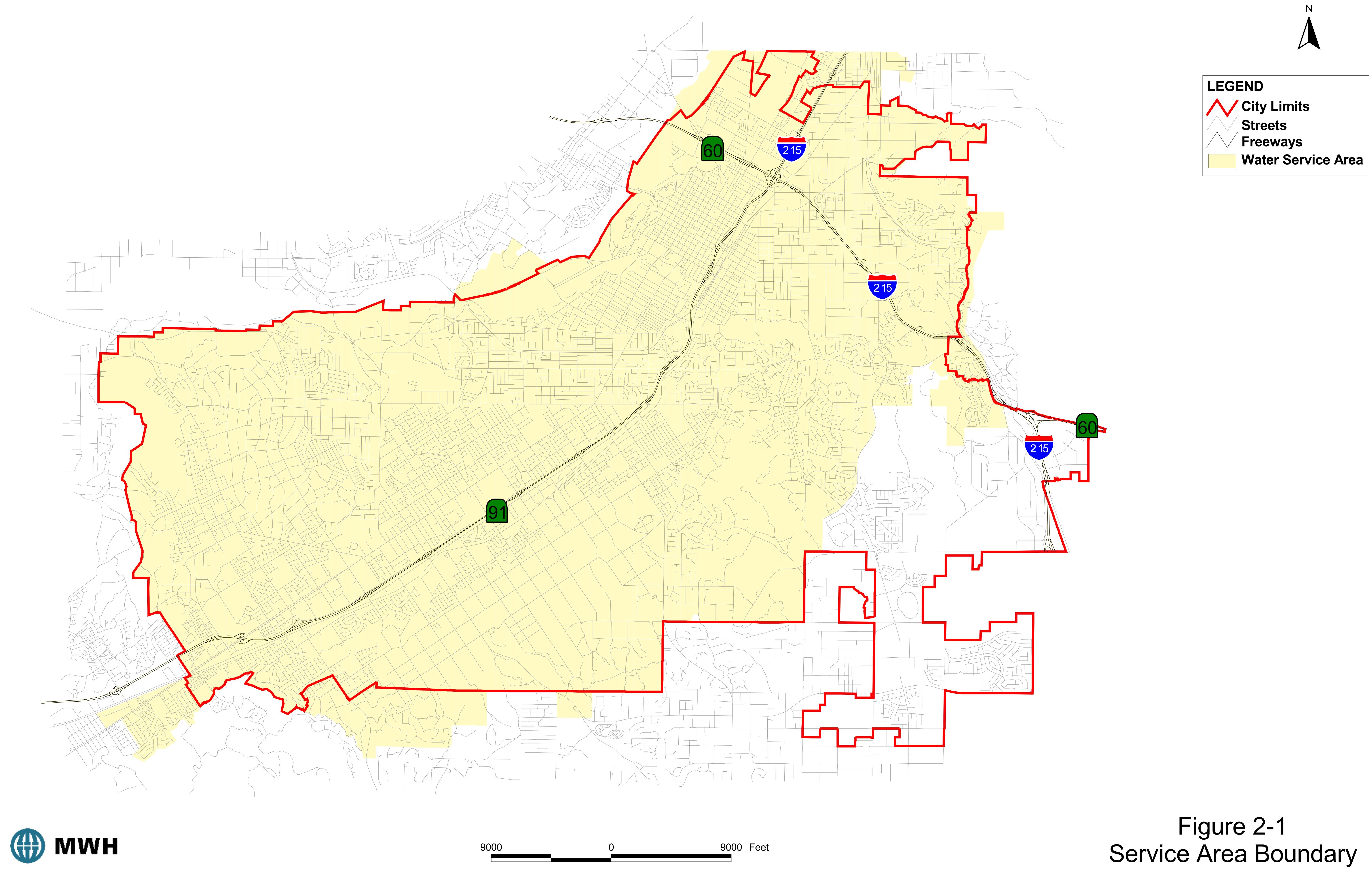


Figure 2-1
Service Area Boundary

Land Use Categories

In order to estimate future water demands, land use information for undeveloped areas within the City's water service area were compiled and evaluated. The land use categories are based on the City's parcel land use obtained from the Graphical Information System (GIS).

The City's land use is divided between residential and non-residential. Current residential land use is divided into eight sub categories: estate, hillside, low density, medium density, medium-high density, high density, semi-rural, and rural residential. Non-residential land use categories include: agriculture, commercial, downtown specific plan, industrial, office, public facilities, parks, natural open space, and mixed use. Commercial development is subdivided into automotive parks, service, center, and business and office. Industrial development is subdivided into general, light, and business park. Parks are subdivided into public and other recreation. Mixed use is divided into office emphasis and residential emphasis.

According to the 2004 General Plan, residential land use is divided into nine sub categories: hillside, very low density, low density, medium density, medium-high density, high density, very high density, semi-rural, and rural residential. The difference from the old plan being the apparent re-classification of "estate" to "very low density," and the addition of the classification of "very high density." Non-residential land use categories include: agriculture, commercial, downtown specific plan, industrial, business/office park, office, public facilities and institutions, parks, natural open space, other recreation, and mixed use. Commercial development is divided into neighborhood, regional, and general. Mixed use is divided into mixed use neighborhood, village, and urban. The mixed-use residential and very-high density residential categories were added to address future growth issues at build-out. The mixed-use and very-high density categories are discussed further in the Projected Development Section. **Table 2-1** presents the land use categories along with their typical and maximum density, in dwelling units per acre.

Table 2-1
Land Use Category Densities

Land Use Categories	Typical Density (FAR[1])	Maximum Density (FAR[1])	Typical Density (du/acre)	Maximum Density (du/acre)
Residential				
Agricultural and Rural Residential (A/RR)	NA	NA	0.2	0.2
Hillside Residential (HR)	NA	NA	0.2	0.6
Semi-Rural Residential (SRR)	NA	NA	1.5	2.5
Very Low Density Residential (VLDR)	NA	NA	1.0	2.5
Low Density Residential (LDR)	NA	NA	3.0	5.0
Medium Density (MDR)	NA	NA	4.0	6.5
Medium-High Density Residential (MHDR)	NA	NA	12.0	15.0
High Density Residential (HDR)	NA	NA	20.0	25.0
Very High Density Residential (VHDR)	NA	NA	40.0	40.0
Commercial/Industrial/Office				
Industrial (I)	0.2	0.5	NA	NA
Office (O)	0.5	1.5	NA	NA
Regional Commercial (R-C)	0.15	0.3	NA	NA
Neighborhood Commercial (N-C)	0.3	0.35	NA	NA
General - Commercial (G-C)	0.4	0.5	NA	NA
Business/Office Park (B/OP)	0.4	0.5	NA	NA
Downtown Specific Plan (DSP)	NA	NA	25.0	50.0
Non-Urban/Community Support				
Parks (P)	NA	NA	NA	NA
Other Recreation (PR)	NA	NA	NA	NA
Public Facilities and Institutions(PFI)	NA	NA	NA	NA
Open Space (OS)	NA	NA	NA	NA
Mixed Use				
Mixed Use (MU-N)	NA	NA	10.0	10.0
Mixed Use (MU-U)	NA	NA	30.0	30.0
Mixed Use (MU-V)	NA	NA	40.0	40.0

Note 1: Floor Area Ratio

Projected Development

Approximately 7,400 acres (16 percent) of the land within the water service area is currently undeveloped. Vacant land was identified through examination of the City's aerial maps along with discussions with the City Planning Department. Of this undeveloped land, 590 acres is designated as parks and open space, leaving about 6,810 acres to be developed for business, commercial, industrial, office, downtown specific, institutional, mixed-use, and residential. **Table 2-2** shows the vacant land available per land use category. **Figure 2-2** presents the vacant land available in the water service area. Future water use projections were based on the land use categories described above and from the 2004 General Plan.

It is estimated that the City of Riverside will be fully developed (reach "build-out") by the year 2025. Following a discussion with the City of Riverside's Planning Department, vacant land phasing was determined by ongoing projects and future projects in the planning stage. The development year for vacant land not yet slated for development was determined by its proximity to other projects, need for the project, and population growth estimates. **Figure 2-3** presents vacant land phasing by development year. The development years are 2005, 2007, 2010, 2015, 2020, and 2025 with 610, 689, 1273, 1969, 1941, and 906 acres by phase, respectively.

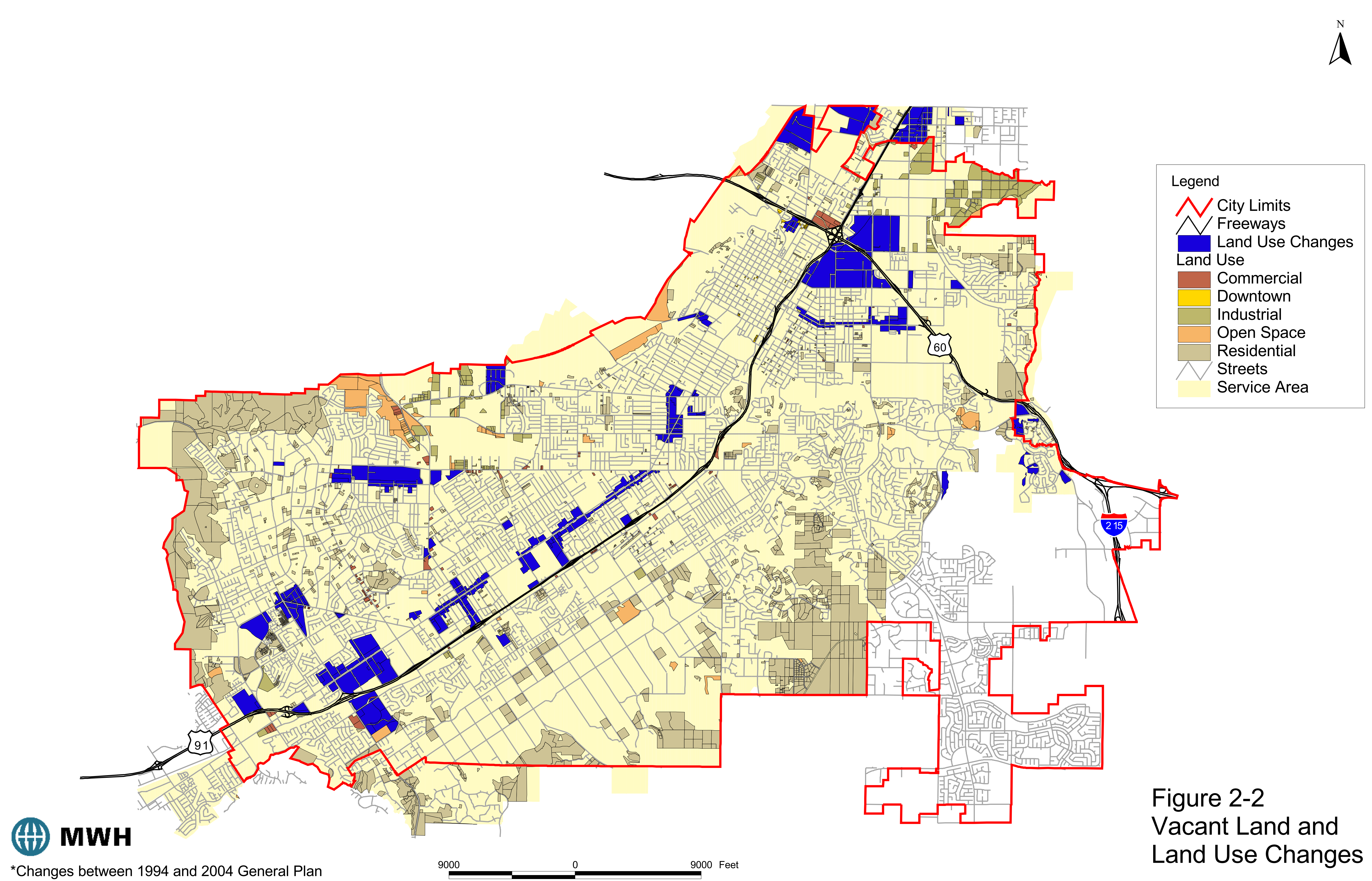
As vacant land becomes more limited, market pressure will encourage the recycling of property for higher intensity use. The 2004 General Plan re-designates land use in certain areas, especially in the Magnolia Avenue Corridor, increasing housing density. Re-designation of current land use categories will allow higher densities, and in turn match SCAG population growth estimates. **Figure 2-2** presents the land use changes under the 2004 General Plan.

The current 1994 General Plan for the City utilizes five development intensity classes: rural/non-urban, semi-rural/low intensity urban, moderate intensity urban, high intensity urban, and downtown core. In order to meet the growing population needs, additional land use categories have been added to the 2004 General Plan. The new land use categories include, very-low intensity residential, very-high intensity residential, and mixed-use residential. The mixed-use residential categories will allow horizontal low intensity mixed-use (MU-N) along with vertical building of 2 to 3 stories (MU-V) and 4 to 5 stories (MU-U). The mixed-use village (MU-V) and mixed-use urban (MU-U) categories will be predominantly residential apartments with some retail and office space. Mixed-use neighborhood (MU-N) will be predominantly office and commercial use with some residential use. The very-high density category will allow for more dwelling units per acre which should help to accommodate the larger amount of renters, college students and young adults, and alleviate some of the growing population needs.

Table 2-2
Riverside Water Service Area
Vacant Land by Land Use Categories
2004 General Plan

Land Use Categories	Total Vacant Land (acres)
Residential	
Agricultural and Rural Residential (A/RR)	1,547
Hillside Residential (HR)	3,027
Semi-Rural Residential (SRR)	119
Very Low Density Residential (VLDR)	223
Low Density Residential (LDR)	104
Medium Density (MDR)	642
Medium-High Density Residential (MHDR)	97
High Density Residential (HDR)	52
Very High Density Residential (VHDR)	7
Subtotal	**5818**
Commercial/Industrial/Office	
Industrial (I)	19
Office (O)	63
Regional Commercial (R-C)	2
Neighborhood Commercial (N-C)	13
General - Commercial (G-C)	72
Downtown Specific Plan (DSP)	11
Business/Office Park (B/OP)	745
Subtotal	**925**
Non-Urban/Community Support	
Parks (P)	103
Other Recreation (PR)	185
Public Facilities and Institutions(PFI)	107
Open Space (OS)	191
Subtotal	**586**
Mixed Use	
Mixed Use (MU-N)	2
Mixed Use (MU-U)	18
Mixed Use (MU-V)	40
Subtotal	**60**
Total	**7389**

* Categories are based on the proposed 2004 General Plan



*Changes between 1994 and 2004 General Plan

Figure 2-2
Vacant Land and
Land Use Changes

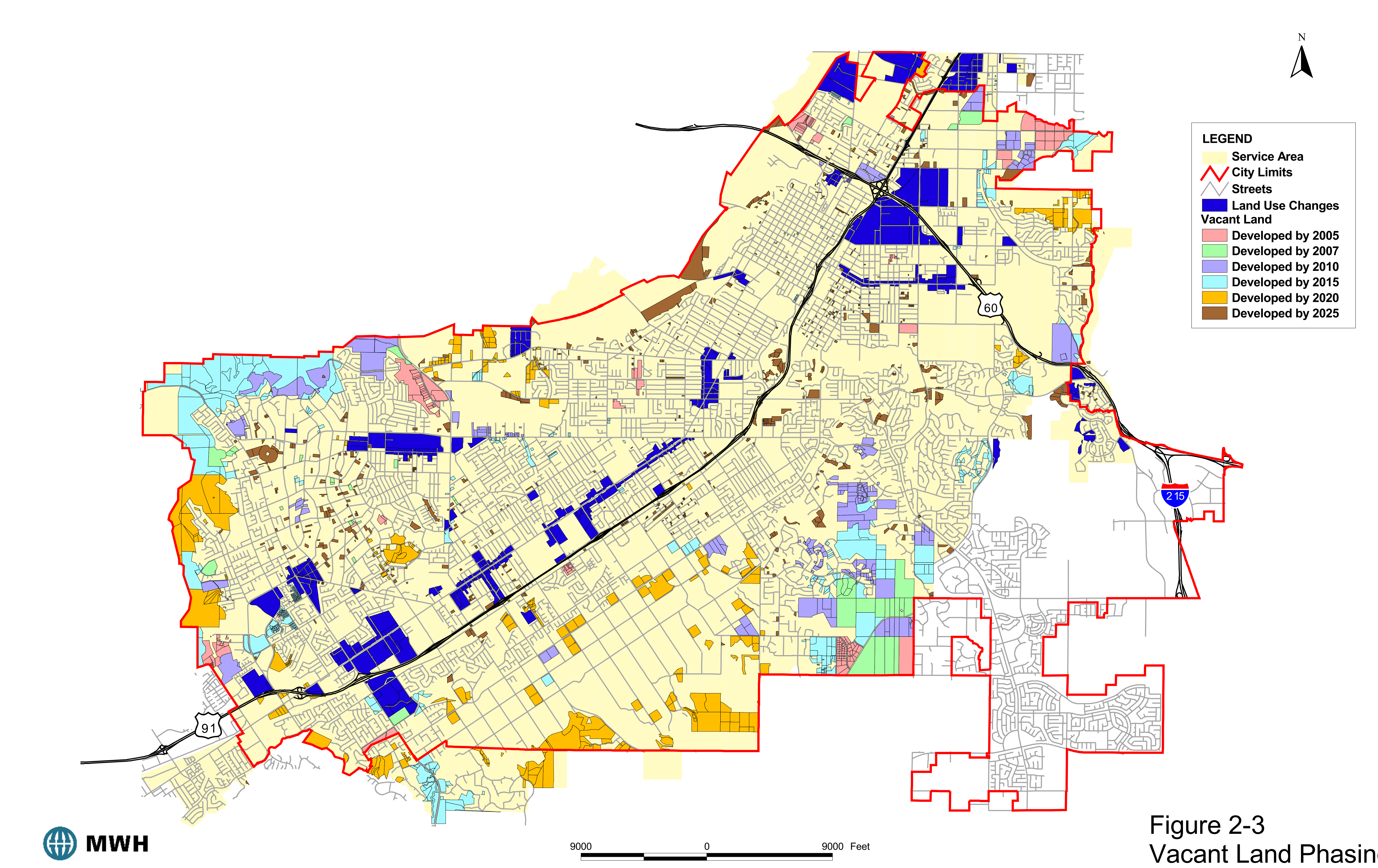


Figure 2-3
Vacant Land Phasing

POPULATION

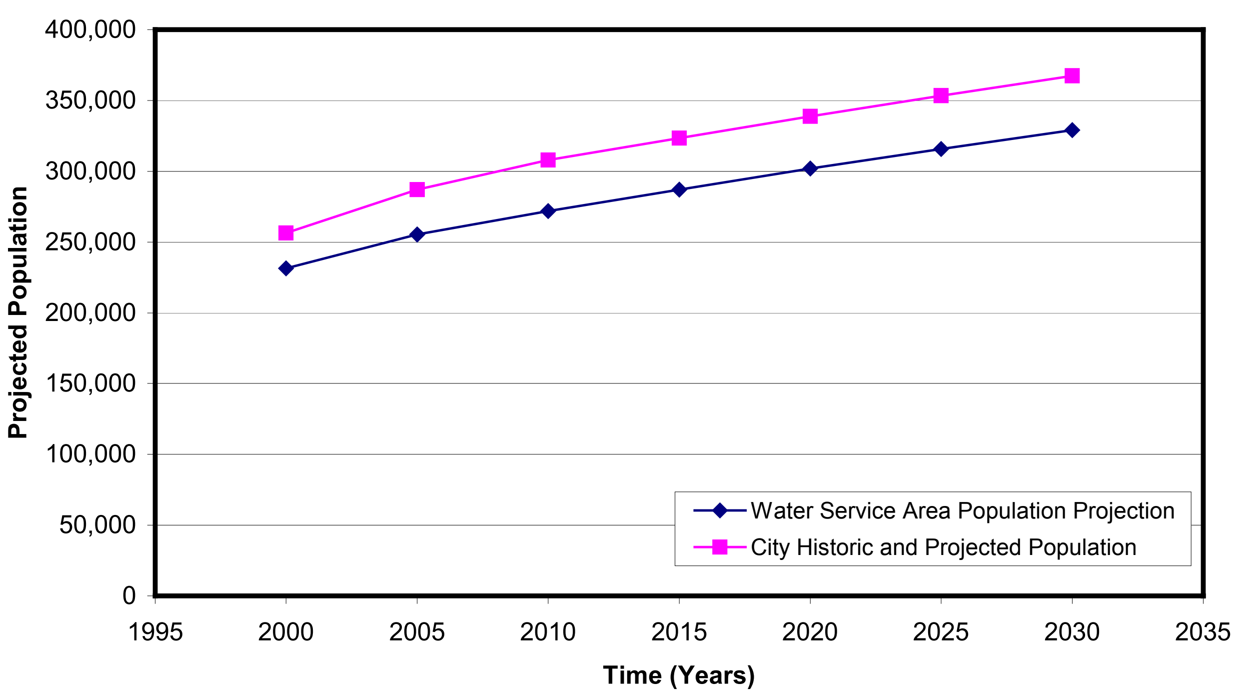
Historical Population

John North and a group of settlers from the eastern United States founded the City of Riverside in 1870. In 1873, the first navel oranges were planted. The trees thrived and the orange industry grew rapidly, along with the population. The most substantial increase in population happened between the 1950s and the 1970s. The population tripled from 46,764 to 140,089 people.

From 1970 to 1985, the City grew at a moderate rate, averaging about 2 percent per year. Between 1985 and 1990 the City's population grew by 40,000 people, approximately 4 percent per year. Since 1990, the City has continued to increase in population by roughly 1.5 percent per year. Currently the City's population is approximately 285,000 people with 9 percent preschool (ages 0-4), 20 percent school age (ages 5-17), 13 percent college age (ages 18-24), 34 percent young adults (ages 25-44), 15 percent middle age (ages 45-64), and 9 percent senior adults (age 65+).

The total population within the water service area has increased steadily, with the exception of a substantial addition of approximately 23,350 people in 1973 due to the purchase of the Southwest Water System in La Sierra. The population within the water service area emulates the population growth. **Figure 2-4** presents the recent historic and projected population growth of the City and the water service area.

Figure 2-4
City of Riverside Historic and Projected Water Service Population Growth



Projected Population

Historical population estimates in conjunction with future projections are used to evaluate population growth within the City and the Water Service area as the basis for projecting future water demands. Population growth projections were determined by using previous population studies, recent trends, regional projections, and local policy implications. The City's population projections and the water service area population projections are presented in **Figure 2-4** and **Table 2-3**. Table 2-3 illustrates the City's estimated future population growth from the years 2005 to 2030.

Table 2-3
Population and Water Service Area Projections

Year	City Population*	Water Service Area	Annual Growth Increase (percent)
2005	286,935	255,346	2.1%
2010	307,847	271,907	1.3%
2015	323,384	287,066	1.1%
2020	338,712	301,900	1.0%
2025	353,397	315,746	0.9%
2030	367,489	329,001	0.8%

*City population based on SCAG

By the year 2030, it is estimated that the City's population will have grown by approximately 81,000 people and the water service area will have increased by roughly 74,000 people. The annual growth rate in Table 2-3 is slowly decreasing over the years. It is estimated that population growth beyond the year 2030 would require significant annexations around the City.

Future development will be largely affected by the age characteristics of the community. According to data from the UCR website, the City's student population will increase 64 percent in the next two decades. Although students represent a temporary housing need, the impact upon housing demand in the area will be significant. According to the City of Riverside 2000-2005 Housing Element, the large increase in seniors (age 65+) is also expected to continue into the future. All other age groups are anticipated to increase in proportion to the general population increase.

Section 3
Water Production and Demand

This section provides a description of the City of Riverside's historic and existing water production and demand. It also presents the City's future water demands up to the build-out year 2025. Future demands were assessed by land use category and by pressure zone.

EXISTING WATER PRODUCTION AND DEMANDS

The City of Riverside and the Gage Canal Company (Gage) jointly pump, deliver, and exchange water to meet their collective water demands. The City also supplies a portion of the water to other entities.

Historical and Existing Water Production

The City obtains the majority of its water supply from the local groundwater basins in the area. The City has water rights in the Bunker Hill, Colton, Riverside North, and Riverside South Basins. In the past, the City has also produced water from Arlington Basin for irrigation. Arlington Basin has not been used since the 1970s due to poor water quality. A small portion, less than 5 percent, of treated imported water is purchased from the Western Municipal Water District of Riverside County (WMWD) during months when the groundwater supply does not meet the peak demand or when the City calculates that it will exceed its water rights from Bunker Hill Basin. This amount has increased over the past five years. The City also uses a very small amount of recycled water for irrigation (<0.5 percent). A summary of the historical combined annual production for potable and irrigation water, from 1990 through 2003, is presented in **Table 3-1**.

Table 3-1
Historical Annual Production of Potable and Irrigation Water

Year	Total Groundwater Production (acre-ft/yr)	Imported Water (acre-ft/yr)	Total (acre-ft/yr)
1990	82,559	5,423	87,982
1991	88,869	602	89,471
1992	80,986	670	81,656
1993	83,249	46	83,295
1994	90,742	179	90,921
1995	84,917	94	85,011
1996	91,721	264	91,985
1997	93,275	256	93,531
1998	83,632	272	83,904
1999	100,065	72	100,137
2000	98,184	365	98,549
2001	92,168	980	93,148
2002	94,610	654	95,264
2003	88,724	1,348	90,209

The City's total potable water supply from 1999 to 2003 is presented in **Table 3-2**. The table also presents the City's supply delivery to the WMWD. The potable water supply does not include the water used in irrigation. Based on annualized trending over the past 10 years, the

2003 existing demand is 75,369 acre-ft/yr. Annualized trending is used to estimated the average year demand for planning purposes.

Table 3-2
Historic Potable Water Production

Year	Potable Groundwater Supply (acre-ft/yr)	Imported Water (acre-ft/yr)	Total Potable Supply (acre-ft/yr)	Domestic Delivery to WMWD (acre-ft/yr)	City's Potable Use (acre-ft/yr)	Annualized Trending (acre-ft/yr)
1999	78,015	72	78,087	4,986	73,101	72,187
2000	77,261	365	77,626	3,143	74,483	72,982
2001	74,281	980	75,261	2,472	72,789	73,778
2002	79,572	654	80,226	2,509	77,717	74,574
2003	72,547	1,348	73,895	1,481	72,414	75,369

Data from City of Riverside 2004 Water Supply Plan

Historical and Existing Water Consumption

The City of Riverside provides water service to over 250,000 people through approximately 59,700 water service connections within a 74.1 square mile service area. There are approximately 9.0 square miles within the City limits in southeast Riverside that are served by Western Municipal Water District (WMWD) and 0.9 square miles served by Eastern Municipal Water District (EMWD). A small area (0.25 square mile) in northeast Riverside is served by Riverside Highland Water Company.

The City's billing data has been tabulated for the 5-year period from 1999 to 2003 and is presented in **Table 3-3**. The City serves the Home Gardens community within the City's service area. In addition, the City has the following additional wholesale service connections: Riverside Highland Water Company and the University of California Riverside.

Table 3-3
Historic Annual Consumption

Year	CIS Billing Records (acre-ft/yr)	Other Deliveries (acre-ft/yr)	Total (acre-ft/yr)
1999	64,523	382	64,905
2000	68,067	307	68,374
2001	65,164	-	65,164
2002	62,056	-	62,056
2003	63,556	-	63,556

Data from City of Riverside 2004 Water Supply Plan

Unaccounted-For Water

Unaccounted-for water is defined as the difference in volume between water produced and water consumed. It is also referred to as water losses within the system. Water loss in general may be attributed to accounting and metering errors, leaking pipes, unmetered water use, water theft, or any other events causing water to be withdrawn and not metered, such as reservoir overflow or leakage, hydrant flushing, and fire fighting. **Table 3-4** presents the City's system water loss.

Table 3-4
Unaccounted for Water

Year	City's Potable Water Use (acre-ft/yr)	Total Historic Consumption, Domestic Use (acre-ft/yr)	Water Loss (percent)
1999	73,101	64,523	12%
2000	74,483	68,067	9%
2001	72,789	65,164	10%
2002	77,717	62,056	20%
2003	72,414	63,556	12%

Data from City of Riverside 2004 Water Supply Plan

Water loss has historically been between 6 and 20 percent per year, with an average of 11 percent from 1989 to 2003. The average water loss over the past five years has been 14 percent. Water loss in most Southern California water agencies is typically 8 to 10 percent. The City's high water loss may be due to sales to other water purveyors whose sales data are not available.

Demand Peaking Factors

Daily peaking factors are typically calculated by taking the ratio of maximum day demand (MDD) and average day demand (ADD) production. The MDD is based on the day of the year with the highest demand and the ADD is based on the average day demand over a one year period. The maximum month demand (MMD) peaking factors are calculated by taking the ratio of average and maximum monthly production. **Table 3-5** presents the City's historic monthly and daily peaking factors. The historic maximum monthly peaking factor for the 5-year period 1999-2003 varies between 1.39 and 1.53. Daily water production data for 1999 was not available, and therefore was not included in **Table 3-5**.

The demand peaking factor was determined from historic peaking factors and pressure zone peaking factors. The peak demand was determined using the maximum month consumption and scaling to the maximum day demand. The total average day demand is 46,700 gpm (75,369 acre-ft/year or 67.3 mgd). Historic data shows a MDD:ADD peaking factor in the range of 1.46 to 1.60. Peaking factors were also examined zone by zone, and although the range in the peaking factor was greater, no correlation existed between the size of zone and peaking factor. Nearly half of the individual pressures zones have a MDD:ADD peaking factor higher than the highest system wide historic peaking factor of 1.60. A MDD:ADD peaking factor of 1.70 is equal to or greater than the individual MDD:ADD peaking factor for 90% of the pressure zones. Although somewhat conservative for the system as a whole, this factor is an appropriate peaking factor for all of the pressure zones. The 1.70 peaking factor results in a projected MDD of 79,400 gpm (114.4 mgd).

Table 3-5
Demand Peaking Factors

Year	Total Yearly Production (acre-ft)	Average Monthly Demand (acre-ft)	Average Day Demand (mgd)	Max Month	Maximum Monthly Demand (acre-ft)	MMD:ADD Peaking Factors	Max Day	Maximum Daily Demand (mgd)	MDD:MMD Peaking Factor	MDD:ADD Peaking Factor
1999	73,101	6,092	65.3	July	9,190	1.51	No Data	No Data	No Data	No Data
2000	74,483	6,207	66.3	July	8,903	1.43	7-Jul	99.9	1.07	1.51
2001	72,829	6,069	65.0	July	8,685	1.43	14-Jul	102.2	1.12	1.57
2002	77,717	6,476	69.4	July	9,034	1.39	2-Jul	101.5	1.07	1.46
2003	72,414	6,034	64.6	August	9,215	1.53	15-Aug	103.4	1.07	1.60

Diurnal Demand Curves

Ten different diurnal demand curves were created for Riverside's water service area to simulate the demand variations over a 24-hour period. These diurnal curves were created for areas of similar demographics and water usage. A separate diurnal curve was not created for each pressure zone due to the limited data that was collected on July 8, 2004. The diurnal demand curves were plotted using hourly field measurements from SCADA data for reservoir volumes and flows. These diurnal curves are shown in **Appendix A**.

The diurnal curves reflect the variations in demand, per pressure zone, on July 8, 2004 on an hourly basis. The diurnal curves show the highest peaking factors of 1.10 to 2.34 in the morning from 3 a.m. to 7 a.m. A second peak occurs from 7 p.m. to 11 p.m., with peaking factors between 0.87 and 1.69. The Gravity Zone is the only zone that has a larger peaking factor in the evening than in the morning.

FUTURE WATER DEMANDS

Future water demands are projected based on the estimated amount of land development or re-development that will occur in the service area – considering vacant parcels and densification due to proposed changes in land use as presented in Section 2. Demands are projected to year 2025, when the City is expected to reach build-out. Existing water users are expected to continue consuming water at their existing rates in the future, unless the land use classification is modified as part of the City's General Plan 2005.

Demands Based on Projected Development

The methodology selected to estimate future water demands is based on projected developments (known developments, specific plan areas, vacant parcels and under-utilization) and are confirmed by population projections. A water duty is the average water use of a given land use type (in gallons per day per acre or feet per year per acre).

The water duty factors are developed by taking statistical samples based on billing data of existing customers throughout the City in various land use classifications. Approximately five groups of statistical samples are taken for each land use classification; the detailed summary of the samples are shown in **Appendix B**. Based on existing demand from the statistic samples, water duty factors were developed for each land use category as presented in **Table 3-6.**

Table 3-6
Water Duty Factors per Land Use Category

Land Use Category	Total Vacant Land Acreage (acres)	Duty Factor (gpm/acre)	Density (DU/acre)
Residential			
Agricultural and Rural Residential (RAR)	1,621	0.51	0.2
Hillside Residential (RHS)	3,070	1.65	0.6
Semi-Rural Residential (RSR)	107	0.83	2.5
Very Low Density Residential (RVLD)	206	1.68	1.0
Low Density Residential (RLD)	101	1.65	5.0
Medium Density Residential (RMD)	598	1.99	6.5
Medium-High Density Residential (RMH)	97	2.61	15.0
High Density Residential (RHD)	52	2.85	25.0
Very High Density Residential (RVHD)	7	5.56	40.0
Non- Residential			
Business/Office Park (B/OP)	690	1.62	0.5
Downtown Specific Plan (DSP)	11	1.80	50.0
General – Commercial (G-C)	64	2.01	0.5
Neighborhood Commercial (N-C)	13	2.01	0.35
Regional Commercial (R-C)	2	2.01	0.3
Industrial (I)	19	0.99	0.5
Office(O)	63	1.62	1.5
Parks (P)	98	1.35	NA
Parks – Other Recreation (PR)	185	1.35	NA
Public Facilities and Institutions (PF)	107	0.94	NA
Open Space	476	0.94	NA
Mixed Use – Neighborhood (MU-N)	2	2.61	10.0
Mixed Use – Urban (MU-U)	18	4.28	30.0
Mixed Use – Village (MU-V)	40	5.56	40.0

The water duty factors shown in Table 3-6 are applied to the vacant land parcels shown in Figure 2-2. Future water demands are calculated by multiplying the total area of each land use type by its corresponding water duty factor. The estimated phasing for development for each of the vacant parcels as shown in Figure 2-3 is used to calculate the estimated demand. Projected demand through the year 2025 by land use category is shown in **Table 3-7**. This total is modified by changes in the Rancho La Sierra Specific Plan, allowing for portions of the City to be created as an environmental reserve.

Table 3-7
Additional Future Demand Based on Undeveloped Land

Land Use Category	Total Vacant Parcels (acres)	Additional Demand						
Residential		**2003 to 2005 (gpm)**	**2005 to 2007 (gpm)**	**2007 to 2010 (gpm)**	**2010 to 2015 (gpm)**	**2015 to 2020 (gpm)**	**2020 to 2025 (gpm)**	**Total (gpm)**
Agricultural & Rural (RAR)	1,621	-	-	109	279	398	3	789
Hillside (RHS)	3,070	236	758	988	1,646	1,131	203	4,962
Semi-Rural (RSR)	107	7	9	15	10	-	61	102
Very Low Density (VLDR)	206	-	50	134	99	22	73	378
Low Density (RLD)	101	-	-	12	51	5	110	178
Medium Density (RMD)	598	236	182	8	64	326	421	1,237
Medium-High Density (RMH)	97	44	-	-	156	21	32	253
High Density (RHD)	52	-	2	-	36	46	54	138
Very High Density (VHDR)	7	-	-	-	-	-	18	18
Non- Residential								
Business/Office Park (B/OP)	690	198	37	160	101	187	67	750
Downtown Specific Plan (DSP)	11	-	4	9	3	1	3	20
General – Commercial (G-C)	64	15	-	-	47	20	64	146
Neighborhood Commercial (N-C)	13	-	-	-	3	-	17	20
Regional Commercial (R-C)	2	-	-	-	-	-	3	3
Industrial (I)	19	-	-	-	5	-	22	27
Office(O)	63	-	-	71	20	14	6	111
Non-Urban/Community Support								
Parks (P)	98	28	-	88	-	4	11	131
Parks - Other Recreation (PR)	185	78	-	-	-	-	172	250
Public Facilities & Institutions (PF)	107	10	22	8	10	2	47	99
Open Space (OS)	476	27	18	99	41	72	1	258
Mixed Use								
Mixed Use (MU-N)	2	-	-	-	-	-	3	3
Mixed Use (MU-U)	18	-	-	-	9	-	31	40
Mixed Use (MU-V)	40	-	2	-	-	25	61	88
Total (gpm)		**879**	**1,084**	**1,701**	**2,580**	**2,274**	**1,483**	**10,001**
Total (acre-ft/yr)		**1,419**	**1,750**	**2,746**	**4,164**	**3,671**	**2,394**	**16,144**
Adjustments due to Rancho La Sierra (gpm)		0	0	235	(481)	(327)	(1)	10,001
Adjustments due to Rancho La Sierra (acre-ft/yr)		0	0	378	(777)	(528)	(1)	(927)
Adjusted Total (gpm)		**880**	**1,084**	**1,936**	**2,100**	**1,947**	**1,480**	**9,427**
Adjusted Total (acre-ft/yr)		**1,419**	**1,749**	**3,124**	**3,387**	**3,141**	**2,388**	**15,207**

In the General Plan 2004, the land use classification was changed for a number of parcels, increasing the population density allowable as discussed in Section 2. These new land use categories and re-designations will allow for greater development intensities and result in an increase in water demand. For parcels with a change in land use designation, the potential additional water demand is the difference between the potential demand based on the General Plan 1992 land use designation and the potential demand from the General Plan 2004 land use designation. Re-designation alone will increase demand by 4,705 acre-ft/yr.

In addition, there will be a significant increase in demands due to a substantial increase in the number of UCR students. Future demand for UC Riverside is expected to increase by 2,127 acre-ft/yr (1,319 gpm) from the year 2005 to 2025 according to the *Water Supply Assessment for the University of California Riverside (UCR) Proposed 2003 Long Range Development Plan (LRDP)*.

Future demand based on vacant land development, land use conversions, and UCR demand is presented in **Table 3-8**. Development and land use changes are expected to increase ADD within the service area by approximately 22,040 acre-ft/yr (15.8 mgd) from 2003 to 2025 to 97,410 acre-ft/yr as shown in **Table 3-9**. **Figure 3-1** presents the future demand estimates along with the estimated population growth.

Table 3-8
Additional Water Demand

Year	Additional Demand due to Vacant Land Development (acre-ft/yr)	Additional Demand due to Land Use Conversion (acre-ft/yr)	Additional UC Riverside Demand (acre-ft/yr)	Total Additional Future Demand Increase (acre-ft/yr)
2003 to 2005	1,419	428	313	2,160
2005 to 2007	1,749	428	313	2,490
2007 to 2010	3,124	642	470	4,235
2010 to 2015	3,387	1,069	783	5,240
2015 to 2020	3,141	1,069	124	4,335
2020 to 2025	2,388	1,069	124	3,581
Total Additional Demand	16,421	4,705	2,127	22,040

Table 3-9
Projected Water Demand

Year	Projected Water Demand (acre-ft/yr)
2005	77,529
2007	80,019
2010	84,254
2015	89,494
2020	93,828
2025	97,410

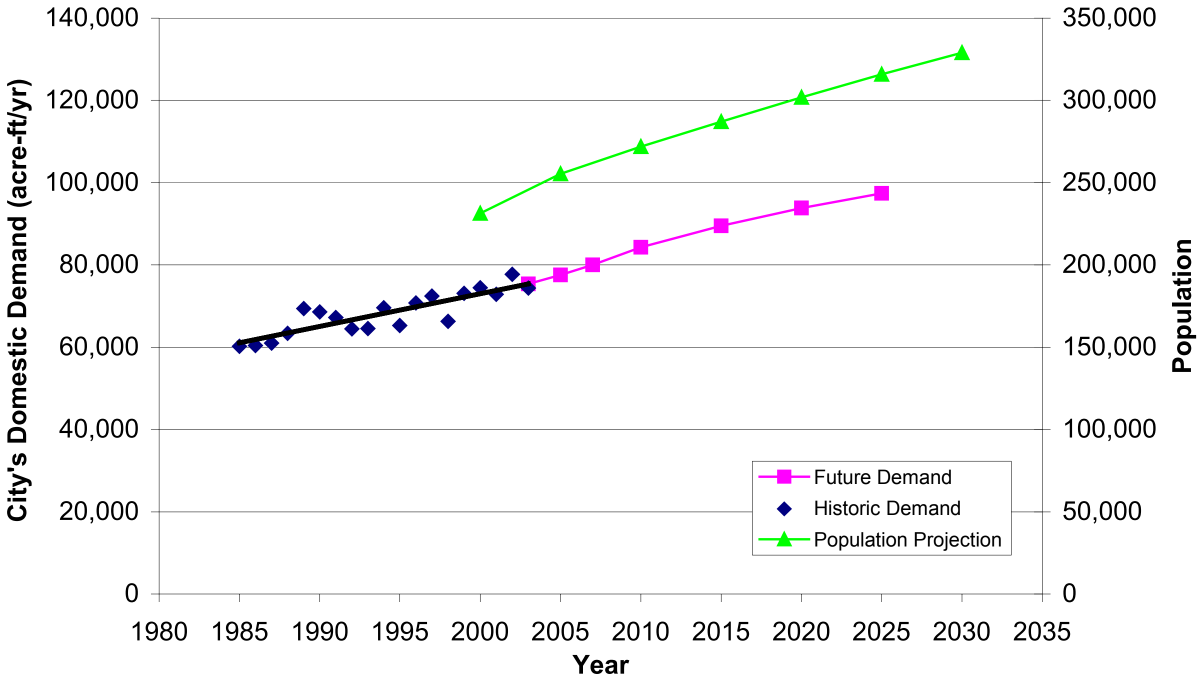


Figure 3-1
Future Demand vs. Population Growth

Section 4
Existing Water Sources and Reliability

EXISTING WATER SOURCES

The City of Riverside gets the majority of its water supply from the local groundwater basins. The City of Riverside and Gage Canal Company (Gage) jointly pump, deliver, and exchange water to meet their collective water needs. The City also supplies a small amount of water to various other entities.

The main source of water for the City of Riverside is the Bunker Hill Basin. This basin is located approximately eight miles northeast of the City of Riverside. There are a total of 44 operational production wells located in the Bunker Hill Basin delivering water to the City of Riverside. Water produced by the City (Waterman System) is conveyed through the San Bernardino Transmission System. The water produced by Gage (Gage System) is conveyed through the Gage Transmission System. The City delivers a large portion of the non-potable water it produces from the Riverside and Colton Basin to Gage in exchange for domestic water from the Gage wells in the Bunker Hill Basin.

The Riverside Basin, consisting of Riverside North and Riverside South Basins, is the second largest water source for the City and Gage. The Riverside Basin is located on the north-northwest side of the city. There are six active production wells in the Riverside North Basin and fifteen active production wells in the Riverside South Basin. For the Riverside North Basin, potable water is pumped into the Gage Pipeline and irrigation water is pumped into the Flume Pipeline and feeds the Riverside Canal. For the Riverside South Basin, potable water is transported by a 60-inch diameter pipeline to the Linden-Evans Reservoirs and irrigation water is pumped directly to the Riverside Canal.

A minimal amount of water is produced in the Colton Basin from the Mill Well. This water is also pumped to the Flume Pipeline and then transferred to the Riverside Canal for irrigation. In the past, the City also produced irrigation water from the Arlington Basin.

The City also purchases imported treated water at the Mills Filtration Plant from the Western Municipal Water District of Riverside County (WMWD). Imported water is generally only purchased during the peak demand months in the summer. A small portion of recycled water, less than 0.5 percent, is also produced for irrigation from the City's Regional Water Quality Control Plant.

Groundwater Wells

The City currently owns 131 active and inactive wells: 70 in the Bunker Hill Basin, 17 in Riverside North Basin, 25 in Riverside South Basin, 5 in Colton Basin, and 14 in Arlington Basin. The City operates 26 production wells and Gage operates 16 production wells in the basin. In addition, the Meeks & Daley 59 well, owned by Meeks and Daley Water Company, and the three Olivewood wells, owned by Gage, also contribute to the City's water supply system.

Bunker Hill Basin

Of the 70 wells in the Bunker Hill Basin, 37 are used for domestic supply and 5 for irrigation supply. The remaining wells are either inactive or used for water level monitoring. Groundwater production from the basin is delivered through the San Bernardino 42-inch transmission pipeline and the Gage 60-inch transmission pipeline to the Linden-Evans Reservoirs for blending and distribution. Each of the transmissions systems is described below with a description of wells requiring treatment as well as those used only for irrigation.

The City's wells serving the San Bernardino Transmission System are referred to as the Waterman System. Water from the Raub 5 well is treated for trichloroethylene (TCE) and tetrachloroethylene (PCE). The Thorne 10 and Thorne 11 wells are leased to the golf course for irrigation. The Thorne 3 well and the Thorne 8 well were refurbished and are now used for the Regional High Groundwater Mitigation Project. The Stewart 20 well is used for local landscape irrigation. The Meeks & Daley 59 well, owned by the Meeks and Daley Water Company, is primarily used by the City.

Gage wells, referred to as the Gage system, discharge into the Gage transmission pipeline. At the Linden Street turnout, a portion of the water from the Gage wells is transferred to the Linden-Evans Reservoirs for distribution into the City's system and the rest is directed into the Gage Canal for irrigational use. The water from Gage 29-2, Gage 29-3, and Gage 92-1 wells is treated for TCE and perchlorate at the Tippecanoe treatment facility. Water from Gage 26-1, Gage 27-1, and Gage 51-1 wells is treated for TCE and perchlorate at the Sunnyside treatment facility. A treatment facility for the removal of TCE in the Gage 31-1 well and removal of perchlorate in the Gage 46-1 well is partially constructed. The remaining wells are monitoring wells or inactive.

Riverside North Basin

There are 17 wells located in the Riverside North Basin; three wells are used for domestic supply and three for irrigation supply. Domestic wells Van Buren 1, Van Buren 2, and DeBerry discharge into the Gage transmission pipeline. Facilities exist to convey the water from the Van Buren wells into the San Bernardino pipeline when necessary. Water from the DeBerry well is shared between the City and Gage, but is operated by Gage. Water from Flume 2 and Flume 6 is delivered to Riverside Canal for irrational use. The water from the Jurupa 7 well is discharged into Jurupa ditch and delivered to Jurupa Ditch Company.

Riverside South Basin

Of the 25 wells in the Riverside South Basin, six are treated at City owned treatment facilities before the water is sent into the system for domestic use. Twin Springs, Palmyrita 2, Electric St. and Moore-Griffth wells are treated at the Palmyrita Treatment Plant. Garner B and Russell C wells are treated at the North Orange Treatment Plant. Garner C and D wells are also used for domestic use, but are not treated before entering the system. The Eleventh St., Fill, First St., and Cunningham wells are used for irrigation purposes; however, the City is considering the construction of the Downtown Treatment Plant for treating these four wells along with Mulberry well. The remaining wells are either used for monitoring or are out of service.

Colton Basin

There are five wells located in the Colton Basin; one for irrigation, one is inactive, two are monitoring wells, and one well is not equipped. Water from the Mill well is conveyed from the Flume Pipeline to the Riverside Canal for irrigation use.

Arlington Basin

There are 14 wells in the Arlington Basin; four monitoring wells, seven inactive wells, and four wells are abandoned. These wells have not been used since the late 1970's due to the poor groundwater quality of the basin. Most of the wells are on standby for emergency use situations.

Imported Water and Recycled Water

The City purchases treated imported water from the Western Municipal Water District (WMWD) during summer months when the groundwater supply does not meet the peak demand. The purchased water is supplied from the Metropolitan Water District (MWD) of Southern California's Mills Filtration Plant (Mills). Up to 60 cubic feet per second (cfs) of water can be purchased from the Mills Filtration Plant. An existing 30-inch pipeline can convey up to 30 cfs from Mills to the Campbell Reservoir. Another 30 cfs can be delivered to Van Buren and Mockingbird Reservoirs through the Van Buren connection. Up to 5 cfs can be delivered at Whitegates as part of the 60 cfs. The Campbell Reservoir is used to regulate system demands and allows for a constant flow from the Mills Filtration Plant. The Campbell Reservoir has a capacity of 4.9 million gallons and a maximum high water level of 1,600 feet in elevation. The City can increase flow capacity from Mills from 30 to 40 cfs by increasing the meter size on the existing 30-inch pipeline. If a parallel pipeline is constructed from the plant to Campbell Reservoir, an additional 30 cfs can be purchased from Mills.

Other Water System Connections

The City of Riverside maintains several interconnections with surrounding water agencies and/or development communities. The City delivers water on a continuous basis to Home Gardens through the 925 water pressure zone.

Inter-agency connections also exist with the City of San Bernardino north of Sixth Street in San Bernardino and with East Valley Water District on Sixth Street in San Bernardino for emergency use. The City has also proposed other inter-agency connections with WMWD, the City of San Bernardino, the City of Loma Linda, the City of Corona, and Rubidoux Community Service District. **Table 4-1** presents the emergency system connections to the City's water system. The table gives the capacity, location, and the agency name.

Table 4-1
Water System Connections

Agency	Agency/Name	Location	Capacity (gpm)	Emergency /Imported	Direction	Riverside Pressure Zone
WMWD	Mills Connection 24-C	Cannon Rd	13,400	Imported	To Riverside	1600 Zone
WMWD	Van Buren Highline	Mockingbird Canyon Rd	13,400	Imported/ Wholesale	To/From Riverside	1200 Zone
WMWD	Warmington	Warmington St	1,000	Emergency	From Riverside	1100 Zone
Home Gardens		Harlow Av	1,500	Wholesale	From Riverside	925 Zone
Corona		Sampson Av	1,500	Emergency	To/From Riverside	925 Zone
San Bernardino		North of Sixth St	2,000	Emergency	To/From Riverside	Gravity
East Valley WD		Sixth St near Pedley	4,000	Emergency	From Riverside	Gravity
WMWD	Lusk Highland (Box Springs)	Sycamore Canyon Blvd	1,500	Emergency	To Riverside	1600 Zone
WMWD	Praed/Lake Knolls	Lake Knoll Park	1,500	Emergency	To Riverside	1400 Zone
California Filter Plant		Shelby Dr	4,000	Emergency	To Riverside	Gravity
WMWD	Whitegates	Near Whitegates 2 Res	1,100	Emergency	To Riverside	1750 Zone

WATER QUALITY

Until the 1990s, the City was able to meet the water quality standards by blending the water from most of the wells at the Linden-Evans Reservoirs. The City's groundwater supply has been subject to contamination from various natural and manmade contaminants including trichloroethylene (TCE), tetrachloroethylene (PCE), perchlorate, dibromochloropropane (DBCP), and nitrate, which were primarily introduced by past military activities, defense related industries, or past agricultural practices. Groundwater from some of the wells in the Bunker Hill Basin contains one or more of the following: arsenic, uranium, gross alpha, radon, nitrate, perchlorate, and TDS. Radon, perchlorate, and arsenic may be the major contaminants of concern in the next few years. When blending was no longer possible, due to poor water quality or lack of transmission lines, the City decommissioned or replaced some of its contaminated wells. Wellhead treatment facilities (treating one or multiple wells) were also constructed to treat some of the water from the contaminated wells. The existing and planned wellhead treatment facilities are presented in **Table 4-2**.

Table 4-2
Existing and Planned Wellhead Treatment Facilities

Treatment Facility	Chemical to Remove	Capacity (gpm)	Well Treated	Status
Raub 5	TCE, PCE	1,500	Raub 5	Existing
Sunnyside	TCE,	5,000	Gage 26-1 Gage 27-1 Gage 51-1	Existing
Gage 51-1	Perchlorate	2,000	Gage 51-1	Existing
Tippecanoe	TCE, Perchlorate	5,000	Gage 29-2 Gage 29-3 Gage 92-1	Existing
Gage 66-1	Perchlorate		Gage 66-1	Existing
Palm Meadows	TCE	5,000	Gage 31-1 Gage 46-1	Planned
Gage 46-1	Perchlorate		Gage 46-1	Planned
Downtown	DBCP, Nitrates	12,000	Cunningham Eleventh St Fill First St Mulberry	Planned
North Orange	DBCP	3,600	Garner B Russell C	Existing
Palmyrita	DBCP	10,000	Electric Street Moore-Griffith Palmyrita 2 Twin Springs	Existing

Major regulations that affect the City of Riverside include:

- The Groundwater Treatment Rule, arsenic rule, radon rule, and radionuclide (other than radon) rule by the U.S. EPA.
- Perchlorate action levels (4 ppb) and methyl tert-butyl ether (MTBE) primary (13 ppb) and secondary (5 ppb) MCLs set by California Department of Health Services (CDHS)
- Public Health Goal (PHG) for uranium (0.5 pCi/L), total chromium (2.5 ppb), DBCP (17 ppt), perchlorate (2-6 ppb, draft), and arsenic (4 ppb, draft) set by California Office of Environmental and Health Hazard Assessment (OEHHA).
- California Urban Water Management Planning Act amended by AB 901 and SB 610.
- Water Supply Assessment and Written Verification (SB 610 and SB 221).

PROJECTED WATER DEMAND AND SUPPLY

Projected Water Supply

The projected water supplies, both existing and those expected in the future, are presented in **Table 4-3**. Projected water supplies will come from the Bunker Hill Basin, the Riverside Basin, Imported Water, Recycled Water, and water from the Seven Oaks Dam Conservation Pool. Water from the Seven Oaks Dam Conservation Pool will not be available until the year 2010 upon completion of modifications to the dam.

Table 4-3
Projected Water Supply (Acre-feet/year)

Year	Bunker Hill Basin	Riverside Basin	Imported Water	Recycled Water	7 Oaks Dam	Total Supply Estimated
2004	54,763	29,500	500	-	-	84,763
2005	54,763	29,500	500	2,000	-	86,763
2006	61,358	29,500	500	2,000	-	93,358
2007	61,358	29,500	500	2,000	-	93,358
2008	61,358	29,500	500	2,000	-	93,358
2009	61,358	29,500	500	2,000	-	93,358
2010	61,358	39,500	500	5,000	2,000	108,358
2011	61,358	39,500	500	5,000	2,000	108,358
2012	61,358	39,500	500	5,000	2,000	108,358
2013	61,358	39,500	500	5,000	2,000	108,358
2014	61,358	39,500	500	5,000	2,000	108,358
2015	61,358	39,500	500	10,000	2,000	108,358
2016	61,358	39,500	500	10,000	2,000	113,358
2017	61,358	39,500	500	10,000	2,000	113,358
2018	61,358	39,500	500	10,000	2,000	113,358
2019	61,358	39,500	500	10,000	2,000	113,358
2020	61,358	39,500	500	10,000	2,000	113,358
2025	61,358	39,500	1,000	10,000	2,000	113,858

* From January 2004 Water Supply Plan

The Bunker Hill Basin supply consists of the following: City's water rights (22,299 acre-ft/yr); the City's share of Gage Canal Company stock (14,248 acre-ft/yr); stock from Meeks & Daley, Riverside Highland Water Company, and the University of California (3,816 acre-ft/yr); Gage Canal Company domestic water exchange program (6,400 acre-ft/yr); annual declared surplus (8,000 acre-ft/yr); and potential additional exchange with Gage Canal Company (6,595 acre-ft/yr). Production from Riverside Basin includes Riverside North (6,000 acre-ft/yr), Riverside South (12,000 acre-ft/yr), additional production from Riverside South (11,500 acre-ft/yr), and additional production from the downtown area (10,000 acre-ft/yr). Additional production from the Riverside South Basin will include production from Moore-Griffith, Palmyrita 2, Electric Street, and the Twin Spring wells.

The City is also planning to reduce the domestic water demand through water conservation. The water conservation programs will include water wise garden, toilet replacement program, and revised rate structure. Water conservation is anticipated to reduce water demand by up to 3,000 acre-ft/yr by the year 2015, but is not considered when sizing water system infrastructure.

ALTERNATIVES FOR ADDITIONAL WATER SUPPLY

As the City continues to grow, additional water supplies will be needed. The following is a list of potential water supply solutions that were recommended in the January 2004 Water Supply Plan.

- Continue the effort to expand the Gage Exchange Program in order to fully use Gage's water rights in the Bunker Hill Basin, in exchange for non-potable water.
- Evaluate the feasibility of participating in the regional water resources development and conjunctive use projects to secure additional sources of supply for the City.
- Evaluate the feasibility of artificial recharge of the Riverside Basin to alleviate the impact of planned additional production.
- Evaluate the feasibility of developing groundwater from the Colton and Arlington Basins.
- Evaluate the feasibility of using additional recycled water from the City's Regional Water Quality Control Plant and/or the Rapid Infiltration Extraction project.
- Consider using additional imported water.
- Continue water conservation Best Management Practices.

DISTRIBUTION SYSTEM EVALUATION ASSUMPTIONS

Based on discussions with City Staff in this Water Master Plan, the following water supply assumptions will be used for the distribution system evaluation.

- Alternative No. 1: All existing and future water supplies will be routed through the Linden-Evans Reservoirs. It is assumed that for this alternative, there will be sufficient supplies to serve the entire system.
- Alternative No. 2: Supplies serving the Gravity, 925, 1200, and La Sierra zones will be routed through the Linden-Evans Reservoirs. Higher zones in the eastern part of the City (1300 zones and higher, from Whitegates to Heustis Reservoirs) will be served by imported water purchased from WMWD at the Mills connection.

Section 5
Existing Water System

The purpose of this section is to describe the existing water system facilities and to generally describe how the system operates. The existing water system consists of 16 storage reservoirs, 21 pressure reducing stations, 46 production wells, 35 booster stations, and approximately 889 miles of pipelines, as shown in **Table 5-1** below. The locations of the existing facilities are shown in **Figure 5-1** on the following page.

Table 5- 1
Distribution Facilities Summary

Facility Type	Number
Storage Reservoirs	16
Booster Pump Stations	39
Pressure Reducing Stations	21
Production wells (active)	46
Pipeline of 4” and greater (miles)	889*
Customer Connections	59,668

*-This is the length of pipeline that was modeled.

WELLS

The City currently owns a total of 131 active and inactive wells in five different basins. These wells and other water supplies are discussed in Section 4.

Table 5- 2
Well Location Information

Basin	Production Wells	Irrigation Wells	Inactive/Monitoring Wells	Total
Bunker Hill	37	5	28	70
Colton			5	5
Riverside North	3	3	11	17
Riverside South	6	5*	17	25
Arlington			14	14

*- Two wells are used for water supply to the lake at Fairmount Park.

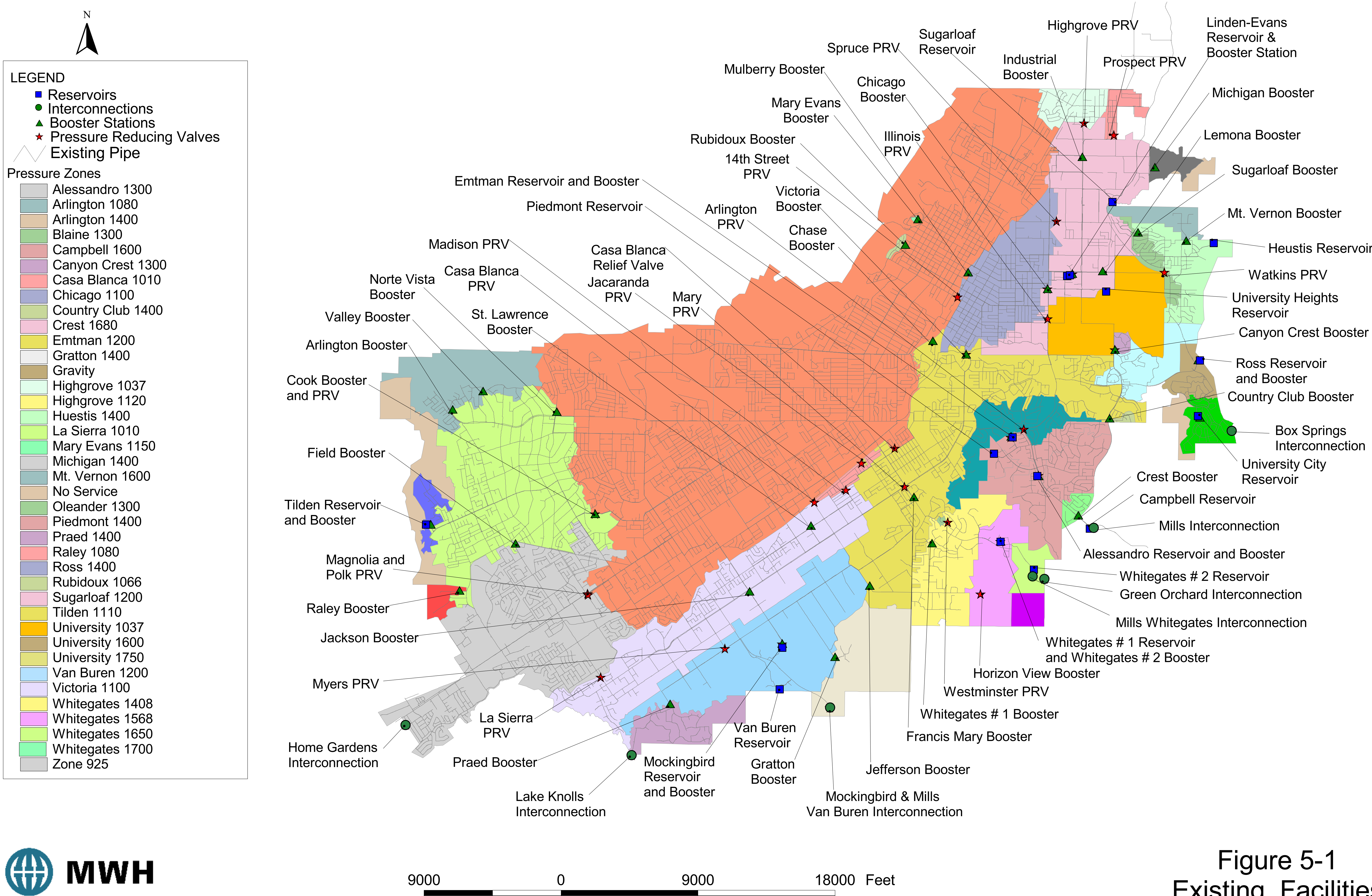


Figure 5-1
Existing Facilities

PRESSURE ZONES

Gravity Zone

The Gravity Zone is the primary pressure zone in the City's water system. All of the water supply enters the Gravity Zone with two exceptions; 1) water currently pumped directly out of the San Bernardino 42-inch Transmission Line at Industrial Booster and fed into the 1200 Zone; and 2) MWD's Mills Treatment Plant water purchased through WMWD. The Gravity Zone has a hydraulic grade line elevation (reservoir high water elevation) of 997 feet above sea level and encompasses approximately 25 square miles or 34 percent of the total 74 square mile service area. The zone serves 27,313 accounts, which is approximately 46 percent of the total number of accounts served.

A total of 12 booster stations pump water out of the Gravity Zone. These stations are Cook, Norte Vista, Mockingbird, St. Lawrence, Francis Mary, Chase, Victoria, Rubidoux, Mary Evans, Mulberry, Chicago Low and Linden Booster. These boosters all pump to higher zones including the 1010 Zone, Victoria 1100, Chicago 1100, University 1037, and two small deadend zones (Rubidoux 1066 and Mary Evans 1150). Jackson Booster moves water within the Gravity Zone. Three PRVs also remove water from the Gravity Zone. Cook, Polk and Magnolia PRVs all reduced water down from the Gravity Zone into the 925 Zone. There are three reservoirs in the Gravity Zone, Linden, Evans and Mockingbird Reservoirs. These reservoirs provide a combined storage capacity of 52 million gallons.

Rubidoux 1066 and Mary Evans 1150

The Mary Evans 1150 Zone is a small deadend zone that is approximately 0.01 square miles and serves 7 accounts. This zone is served through Mary Evans Booster which contains three pumps, and has a total capacity of 1,020 gpm (under construction at the time of this writing).

The Rubidoux 1066 Zone is another small deadend zone. This zone is approximately 0.04 square miles and serves a total of 40 accounts. This zone is served through Rubidoux Booster, another small booster station with two 7.5 hp pumps (each with a capacity of 250 gpm) for a total capacity of 500 gpm.

The fire protection for both the Rubidoux 1066 and the Mary Evans 1150 zones is considered to be substandard. In the event of a power failure a check valve will supply minimum pressure to the lower portion of the Rubidoux 1066 Zone, and the Mary Evans 1150 Zone has no backup.

925 Zone

The 925 Zone is the lowest zone in the system with a hydraulic grade line of 925 feet. Water is supplied to this zone through the Cook, Polk and Magnolia PRVs. Magnolia and Polk PRVs are the primary means of getting water into the 925 Zone; the Cook PRV, located at the Cook Booster, is used primarily as a backup. The 925 Zone encompasses approximately 5.5 square miles of the City's service area (8 percent of the total area) and serves 6,805 accounts (11 percent of the total accounts). Water can be pumped out of the zone through the Field Booster, which pumps water into the 1010 Zone. The Field Booster station has two 40 hp pumps, each with a capacity of 725 gpm or a total capacity of 1,500 gpm. Since it is more energy efficient to pump water directly from the Gravity Zone into the 1010 Zone, than from the 925 Zone to the 1010 Zone, Field Booster is operated as a backup.

1010 Zone and Associated La Sierra Zones

The 1010 Zone is normally served through Cook Booster and Norte Vista Booster pumping from the Gravity Zone, with Field Booster pumping from the 925 Zone as backup. The zone, in turn, serves three deadend zones: Raley 1080, Tilden 1100, and Arlington 1100 zones. The 1010 Zone and three deadend zones encompass a total of 7.31 square miles and serve a total of 5,793 accounts. This system has one storage reservoir, the Tilden Reservoir with a capacity of 10 million gallons.

The Raley 1080 Zone consists of 21 accounts in an area of 0.2 square miles. This zone is served through the Raley Booster station, which consists of one pump with a capacity of 250 gpm.

The Tilden 1100 Zone encompasses 0.29 square miles and serves 220 accounts. Water is pumped into this zone through the Tilden Booster. Tilden Booster station consists of four pumps in total, three are electric and one is gas-driven. The gas-driven pump is primarily used as a backup and has a design capacity of 920 gpm. The other three have design capacities of 200, 500 and 920 gpm, respectively.

The Arlington 1100 Zone encompasses 1.63 square miles and serves 507 accounts. Arlington Booster serves the Arlington 1100 Zone and is equipped with three pumps with design capacities of 200, 400, and 500 gpm. Valley Booster also serves the Arlington 1100 Zone, and consists of one pump with a design capacity of 550 gpm. In the event of a power failure a check valve will open to deliver water from the 1010 Zone, but supply under this mode of operation is limited to the lower portion of the Arlington 1100 Zone.

Victoria 1100 and Casa Blanca 1010 Zone

The Victoria 1100 Zone is served through the St. Lawrence Booster station pumping out of the Gravity Zone as well as through the Dufferin/Myers Reducer and the Mary St. Reducer from the 1200 Zone. The Victoria 1100 Zone encompasses 4.32 square miles (6 percent of the total service area) and serves 2,759 accounts. The St. Lawrence Booster has four pumps with capacities of 1,050, 1,300, 1,700, and 1,800 gpm; however, field experience has shown that the total capacity is limited to approximately 1,400 gpm due to operational problems.

The Casa Blanca 1010 Zone is served through Madison St. Reducer and the Jacaranda St. Reducer from the Victoria 1100 Zone and the 1200 Zone, respectively. This small deadend zone encompasses 0.17 square miles and serves a total of 356 accounts. These two reducers have a total capacity of 2,520 gpm.

Chicago 1100 and University 1037 Zones

The Chicago 1100 Zone encompasses 2.22 square miles or 3 percent of the total service area and serves 2,855 accounts. The zone is served primarily through the Chicago Booster. The water supply can also enter the zone through the Mulberry Booster or the Spruce and Chicago reducers.

The Chicago Booster consists of three pumps. Two of the pumps deliver water from the Gravity Zone into University 1037 and one pump delivers water from University 1037 into the Chicago 1100 Zone. The single pump that is pumping to the Chicago 1100 Zone has a capacity of 1,706 gpm and the other two pumps have a combined capacity 5,800 gpm. The Mulberry Booster station consists of three pumps with the design capacities of 650, 1,300 and 2,000 gpm. This station is operated in conjunction with the Chicago Booster.

The University 1037 Zone encompasses a total area of 1.8 square miles, but only serves the University of California at Riverside. As mentioned previously, this zone is served through the Chicago low booster. Storage is provided through the five million gallon University City Reservoir and an additional on-site storage reservoir owned and operated by UCR.

Highgrove 1037 and 1120 Zones

There are two Highgrove pressure zones, Highgrove 1037, and Highgrove 1120. These two zones serve 0.78 square miles and 876 accounts. Highgrove 1037 is served through the Highgrove reducer and Highgrove 1120 is served through Prospect reducer from the 1200 Zone. There is no backup provided for these two zones.

1200 Zone

The 1200 Zone is the second largest zone in the service area within the City's water distribution system, it contains the second largest amount of storage, and it is the third largest in number if accounts served. The 1200 Zone encompasses 12.82 square miles (17 percent of the total service area) and serves 6,057 accounts (10 percent of the total accounts). This zone is geographically divided into three smaller zones called Van Buren, Emtman, and Sugarloaf. Each of these smaller zones has its own reservoir. The Sugarloaf zone serves the northeast portion of the 1200 Zone, the Emtman zone serves the central portion and the Van Buren zone serves the southwest portion. These three subzones receive water from six booster stations. Five of the six booster stations pump water out of the Gravity Zone, these stations are Mockingbird, Frances Mary, Victoria, Chase and Linden Booster. The sixth booster, the Industrial Booster, pumps water directly out of the San Bernardino 42-inch transmission main. The storage reservoirs in this zone consist of Sugarloaf Reservoir, Van Buren Reservoir and Emtman Reservoir with capacities of 5.0, 7.5, and 5.0 MG, respectively. Water can also be brought into the 1200 Zone from three WMWD connections: Mills, Warmington and Van Buren.

Alessandro System

The Alessandro Cascade System contains four interconnected pressure zones: Alessandro 1300, Piedmont 1400, Campbell 1600 and Crest 1680 zones. Water can be pumped sequentially up from the 1200 Zone or purchased from WMWD and delivered sequentially down (the "Cascade System") from the Campbell 1600 Zone. The water purchased from WMWD is delivered from MWD Mills Filtration Plant to the City's Campbell Reservoir. Water from Campbell Reservoir can then be used to serve the Crest 1680 Zone, Campbell 1600 Zone, Piedmont 1400 Zone, and Alessandro 1300 Zone.

The Alessandro 1300 Zone serves approximately 1.13 square miles with a total of 791 accounts. This zone is served through the Emtman Low Booster and through the Alessandro Low Reducer. The Emtman Low Booster has a capacity of approximately 1,800 gpm. This zone has a storage capacity of two million gallons in Alessandro Reservoir.

Piedmont 1400 Zone serves approximately 673 accounts in a service area of 0.67 square miles. The Piedmont 1400 Zone is served from the 1200 Zone through the Emtman High Booster

Station with a capacity of approximately 2,600 gpm and through the Alessandro High Reducer. The storage in this zone is in Piedmont Reservoir, with a total volume of one million gallons.

The Campbell 1600 Zone serves approximately 1,150 accounts in a service area of approximately 1.55 square miles. This zone is served from the Alessandro 1300 Zone through the Alessandro Booster Station with a capacity of approximately 2,437 gpm. This zone also has 5.0 MG of storage in Campbell Reservoir.

Crest 1680 Zone is served through Crest Booster, which pumps water from the Campbell 1600 Zone. The small zone serves approximately 207 accounts in a service area of 0.16 square miles. The capacity of Crest Booster is approximately 1,500 gpm. This zone utilizes a check valve from the 1600 zone in case of emergencies.

Heustis/Ross 1400 Zone

The Heustis/Ross 1400 Zone consists of six separate pressure zones: Heustis 1400, Ross 1400, Country Club 1400, Canyon Crest 1300, Blaine 1300, and Mt. Vernon 1600. The Country Club and Piedmont 1400 Zone are interconnected to the Ross 1400 Zone through the 12-inch diameter pipeline.

The Heustis 1400 Zone serves 901 accounts in an area of approximately 1.0 square miles with a 2.0 million gallon reservoir. Ross 1400 Zone serves 409 accounts in a service area of approximately 0.8 square miles with its own 2.0 MG reservoir. Heustis and Ross 1400 Zones are connected through a 12-inch diameter pipeline approximately 1.0 mile in length. This connection allows this area to be served through three booster stations, Canyon Crest, Lemona, and Sugarloaf. These three booster stations have capacities of 1,700 gpm, 2,300 gpm and 4,600 gpm, respectively.

The Canyon Crest 1300 Zone serves 79 accounts in an area of approximately 0.07 square miles. This small zone is served through Canyon Crest Reducer, which reduces water from the 1400 Zone. The Canyon Crest Reducer is located at the Canyon Crest Booster Station. The capacity of the reducer is 1,260 gpm.

The Blaine 1300 Zone has a service area of approximately 0.3 square miles and 515 accounts. This zone is served from the Sugarloaf Low Booster pumping from the 1200 Zone and through the Watkins Reducer from the Heustis 1400 zone. The capacity of the booster and the reducers are 3,070 gpm and 2,260 gpm, respectively.

The Country Club 1400 Zone is a small zone, which serves 60 accounts in approximately 0.04 square miles. Water is supplied to this zone through Country Club Booster which pumps water from the 1200 Zone and has a capacity of approximately 1,533 gpm. The Country Club and Piedmont 1400 Zones are interconnected to the Ross 1400 Zone through a 12-inch diameter pipeline. The Country Club 1400 Zone is interconnected to the Ross 1400 Zone to the east and the Piedmont 1400 Zone to the west.

The Mt. Vernon 1600 Zone is another small zone. This zone serves 24 accounts in an area of 0.4 square miles. This zone is served through Mt. Vernon Booster with a capacity of 480 gpm, which pumps from the Heustis 1400 Zone.

University 1600 and University 1750 Zone

The University 1600 Zone has a service area of approximately 0.4 square miles and serves 197 accounts with 3.0 MG of storage in University City Reservoir. Ross Booster pumps from the Heustis/Ross 1400 Zone to the University 1600 Zone. Ross Booster station has a capacity of approximately 2,500 gpm.

University 1750 Zone serves 704 accounts in an area of approximately 0.45 square miles. This zone has no storage; however, there is an emergency connection with WMWD. The University City Booster delivers water from the University 1600 Zone to the University 1750 Zone. The University City Booster Station has a capacity of 3,200 gpm.

Whitegates System and Gratton 1400 Zone

The Whitegates System includes five independent pressure zones: Whitegates 1408, 1568, Oleander 1300, and Gratton 1400. The Whitegates pressure zones and Oleander 1300 Zone, together, serve 738 accounts in a 3.03 square mile area. Whitegates No. 1 and Whitegates No. 2 boosters and reservoirs are used to move water between the various Whitegates pressure zones. Water in the Whitegates system is pumped into the Whitegates 1408 Zone from the 1200 Zone using Whitegates Booster No. 1 with a capacity of 2,510 gpm and Jefferson Booster with a capacity of 4,500 gpm. Whitegates 1408 is served by Whitegates No. 1 Reservoir, which has a total storage capacity of 0.5 MG. Water is brought down to the Oleander 1300 Zone using Westminster Reducer, from the 1408 pressure zone. Water from Whitegates No. 1 Reservoir (Whitegates 1408 Zone) is pumped using Whitegates No. 2 Booster into Whitegates 1568 Zone. Whitegates No. 2 Booster and Reservoir have a capacity of 678 gpm and 0.5 MG, respectively. The Whitegates 1568 Zone is also served from 1400 Zone through the Horizon View Booster with a capacity of 2,250 gpm. Within the last five years this area has experienced tremendous growth and this growth rate is expected to continue. The City has undergone a parallel planning process in an attempt to alleviate the demand on this portion of the water distribution system.

The Gratton 1400 Zone serves a total of 31 accounts in approximately 1.6 square miles. This zone is served through Gratton Booster, with a capacity of 320 gpm, pumping from the 1200 Zone.

Praed 1400 Zone

The Praed 1400 Zone is another deadend zone without storage. This zone encompasses a total of 0.84 square miles and approximately 319 accounts. This zone is served primarily through the Praed Booster station, which has a capacity of approximately 2,400 gpm. The zone can also be served through the Lake Knolls MWD connection during an emergency or when the City's supply is deficient.

TRANSMISSION FACILITIES

Water Supply Transmission to Linden-Evans Reservoirs

The City has potable water supply facilities in the San Bernardino (Bunker Hill), Riverside North, and Riverside South groundwater basins. Water produced in the Bunker Hill and Riverside North basins is delivered through the Gage and Waterman transmission pipelines.

Water produced in the Riverside South basin is delivered through the Chicago Avenue water supply pipeline.

The San Bernardino 42-inch Transmission System delivers approximately 40 percent of the City's groundwater production. The transmission system begins below Baseline Avenue in San Bernardino and extends approximately 13 miles to the Linden-Evans Reservoir complex. The first five miles of the system consist of the Waterman Collection and Transmission system, terminating at the Stewart Intake Reservoir. The last eight miles, from the Stewart Intake Reservoir to the Linden-Evans Reservoir complex, are referred to as the San Bernardino 42-inch Transmission Pipeline. The Waterman Collection pipelines vary in size from 12 inches to 54 inches in diameter. The San Bernardino 42-inch Transmission pipeline consists of 42-inch and 48-inch pipeline segments. The majority of this reach is 42-inch concrete pipe installed in 1927. While the pipeline can flow by gravity from the Stewart Intake Reservoir to Linden-Evans Reservoirs, two in-line booster stations (Grand Terrace Booster and Iowa Booster) increase the transmission capacity of the pipeline to the limit of the pipeline pressure class.

The Gage Transmission System delivers approximately 35 percent of the City's groundwater production. The transmission system begins south of the San Bernardino Regional Airport and extends approximately 10 miles to the Linden Street Turnout. The upper reaches of the Gage Transmission system consists of 20-inch and 30-inch diameter pipelines. The balance of the transmission systems consists of 42-inch through 60-inch diameter pipelines. The Gage Transmission system terminates at the Linden Street Turnout, located north of Linden Street near the Lemona Booster Station. The turnout facility is used to deliver a portion of the groundwater production to the Gage Canal for irrigation use. The balance of water is delivered through a 36-inch diameter pipeline that terminates at the Linden-Evans Reservoir complex.

The Chicago Avenue water supply pipeline delivers approximately 25 percent of the City's groundwater production. The transmission system begins at Columbia Avenue and extends approximately two miles to the Linden-Evans Reservoir complex. Water from various wells is pumped, treated and blended in the upper reaches of the collection system. The pipelines, ranging in size from 16-inch to 30-inch diameter converge at Columbia Avenue into a 60-inch diameter transmission pipeline.

Transmission Pipelines within the Distribution System

The City's water system consists of approximately 88 miles of 24-inch and greater diameter transmission mains. These large transmission mains are described by zone in this section and are depicted in **Figure 5-2**.

Major transmission pipelines within the Gravity zone consist of approximately 67 miles of pipelines 24 inches in diameter and greater. A 72-inch diameter pipeline delivers water from Linden-Evans Reservoirs to Chicago Avenue. From Chicago Avenue the 48-inch and 42-inch diameter Crosstown Feeder delivers water to Jackson Street. A 54-inch diameter pipeline runs along Jackson Street and serves as an inlet/outlet to Mockingbird Reservoir. A separate 42-inch and 36-inch diameter transmission main parallels the Crosstown Feeder on the north side of the Riverside Freeway and delivers water to the Van Buren Boulevard and Magnolia Avenue area. The 42-inch Crosstown Feeder Extension connects these two transmission systems from Van Buren Boulevard to Jackson Street.

The Campbell 1600 Zone includes approximately 2.9 miles of pipelines 24 and 30 inches in diameter. The Campbell zone is part of the “Cascade System” which provides the ability to bring water from the Mills Filtration Plant into the City’s system. Water is delivered from the Mills Filtration Plant to the Campbell Reservoir. There is a 24/30-inch diameter pipeline that can be used to bring water from the Campbell Reservoir to the Alessandro 1300 Zone and, if necessary, to reduce the water into the 1200 Zone through the Arlington Reducer.

The La Sierra 1010 Zone transmission system includes approximately 2.75 miles of pipelines 24 and 30 inches in diameter. These pipelines serve as an inlet/outlet to Tilden Reservoir and run along Gramercy Place and Tyler Street. These pipelines connect with the transmission mains in the Gravity Zone at Cook Booster Station.

The 925 Zone is served through approximately 1.6 miles of 24-inch diameter pipeline. This pipeline connects to the Gravity Zone at the Polk and Magnolia PRV stations and runs along Magnolia Avenue, ending at Pierce St.

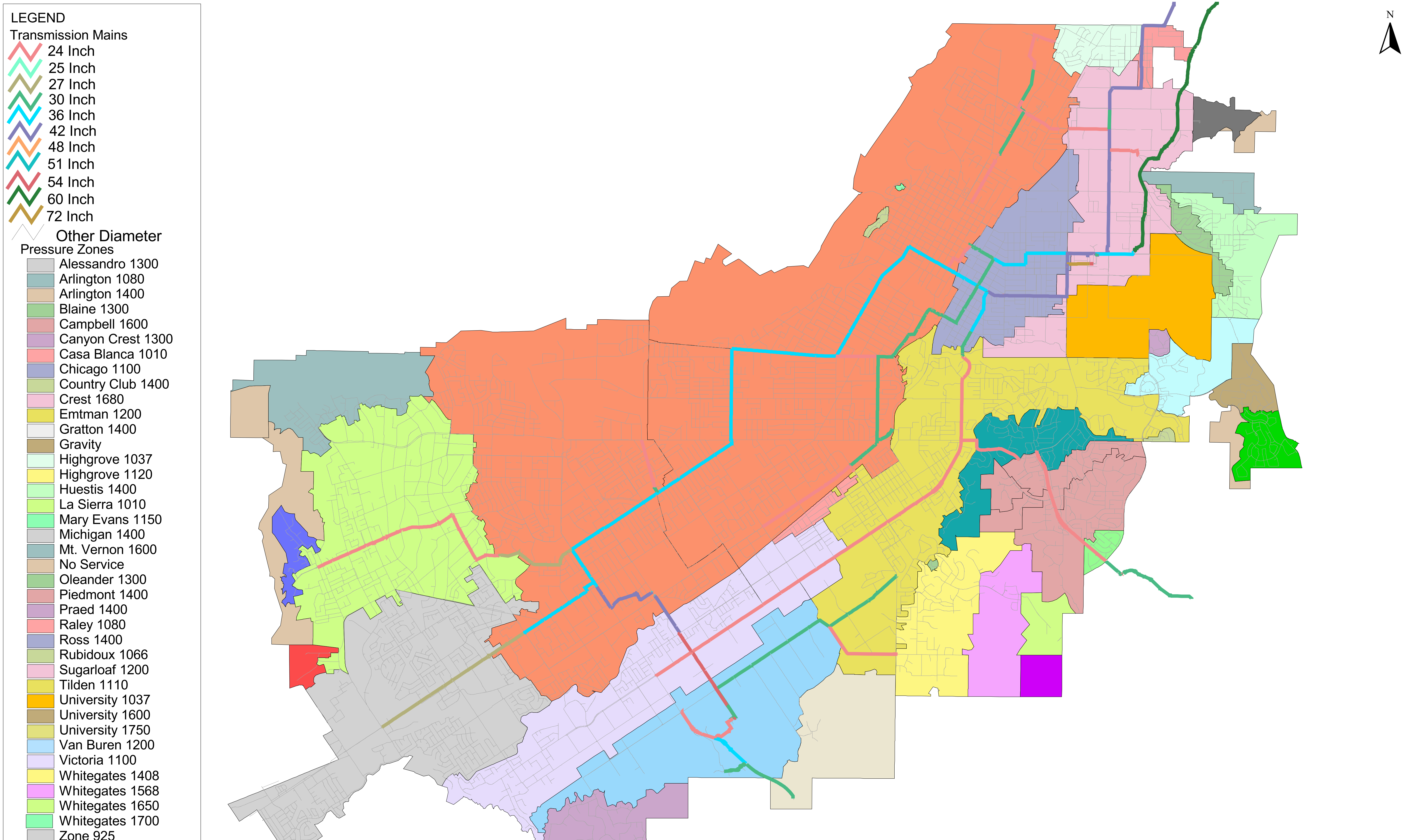
The Victoria 1100 Zone is served through 3.4 miles of 24-inch diameter pipeline. This pipeline starts at Frances Mary Booster and runs parallel to the Crosstown Feeder along Victoria Avenue, ending at Van Buren Boulevard.

The 1200 Zone is fed through a variety of transmission pipelines. Together the Van Buren 1200 Zone, Sugarloaf 1200 Zone and the Emtman 1200 Zone consist of 9.8 miles of pipelines 24 inches in diameter and greater. The Emtman 1200 Zone is served through a pipeline that runs along Arlington Avenue to Victoria Avenue, and a pipeline along Victoria Avenue between Frances Mary Booster and Victoria Booster. The majority of the pipelines that serve the Sugarloaf 1200 Zone are smaller than 24 inches in diameter. There is only 0.6 miles of pipeline with a diameter of 24-inches and greater, along Marlborough Avenue from the Sugarloaf Reservoir to Iowa Avenue. The Van Buren 1200 Zone is served through approximately 6.0 miles of pipelines 24 inches in diameter and greater. These pipelines allow water to move between Van Buren and Mockingbird Reservoirs. The majority of the transmission pipeline runs along Dufferin Avenue between Jefferson Street and Jackson Booster.

The Whitegates 1400 Zone consists of approximately 0.7 miles of 24-inch in diameter pipeline. This pipeline runs along Bradley Street and Jefferson Street, connecting with the 1200 Zone at the Jefferson Booster.

STORAGE RESERVOIRS

There are a total of 16 reservoirs within the City’s service area. These sixteen reservoirs vary in size from 0.5 MG to 20 MG, providing a total storage capacity of approximately 100.4 MG. Table 5-3 provides details of the reservoirs including the capacity and year installed. These reservoirs are shown on **Figure 5-1**.



MWH

10000 0 10000 20000 Feet

Figure 5-2
Transmission Mains

BOOSTER PUMPING STATIONS

The City of Riverside operates two booster stations on the San Bernardino 42-inch transmission system, and 35 booster stations (counting Low and High stations separately) to move water throughout the service area. Each booster station varies in the number of pumps (from one to four pumps) as well as the size of pumps. The majority of the booster stations within the City's service area are electric-driven, constant speed pumps. A few booster stations are equipped with variable frequency drives and others use gas-driven motors. More frequently, the gas-driven motors are used as backup. The details of each booster station, including the number of pumps, capacity, age and the zones that each are pumping to and from are included in **Table 5-4** below. The location of these booster stations is also shown in **Figure 5-1**. The majority of these booster stations are operated on the level of the controlling reservoir for that zone. There are a few boosters that are turned on by low pressure, flow settings, time clocks, or manually. The controls for the boosters are presented in more detail in **Section 8** of this report.

Table 5- 3
Existing Reservoirs*

Reservoir	Capacity (MG)	Primary Zone Served	Total Capacity Per Zone (MG)	Date of Construction
Mockingbird	20.0	Gravity		1981
Linden	16.0	Gravity		1927**
Evans	16.0	Gravity	52.0	1968
Tilden	10.0	1010	10.0	1995
University Heights	5.0	1010	5.0	1936
Sugarloaf	5.0	1200		1963
Emtman	5.0	1200		1968
Van Buren	7.5	1200	17.5	1992
Alessandro	2.0	1300	2.0	1961
Heustis	2.0	1400		1978
Ross	2.0	1400		1978
Piedmont	1.0	1400		1979
Whitegates No.1	0.5	1400	5.5	1960
Whitegates No. 2	0.5	1600		1960
University City	3.0	1600		1992
Campbell	4.9	1600	8.4	1979
Total System Capacity		**100.4 MG**		

*Information from the City of Riverside Water Supply Plan 2004
**Major structural renovation in 1985

PRESSURE REDUCING STATIONS

There are 21 pressure reducing stations throughout the City of Riverside's service area. The majority of these stations have more than one valve with the second valve acting as a backup or emergency supply. Table 5-5 provides the details of these pressure reducing stations including size, capacity and the zones between which the valve is operating. **Figure 5-1** shows the geographical locations of these stations.

Table 5- 4
Existing Pump Stations

Location or Name	Pump Unit	Pumps Water From Zone	Pumps Water To Zone	Horsepower & Energy*	Pump Design Capacity (gpm)	Total Station Capacity (gpm)	Efficiency** (Percent)
Grand Terrace	1	42" Line	Gravity	250G	13,500		N.A.
	2	42" Line	Gravity	250G	13,500	**27,000**	N.A.
Iowa	1	42" Line	Gravity	300E, 400G	25,000	**27,000**	80.8, 78.2
Norte Vista	1	Gravity	1010	50E	1,500		68, 72
	2	Gravity	1010	40E	1,000	**2,645**	N.A.
Cook Booster	1	Gravity	1010	100E	2,600		N.A.
	2	Gravity	1010	100E	2,600		67.6, 76
	3	Gravity	1010	50E	1,300	**5,749**	52.2, 47
Field Booster	1	925	1010	40E	725		N.A.
	2	925	1010	40E	725	**1,516**	N.A.
Rubidoux	1	Gravity	1066	7.5E	250		N.A.
	2	Gravity	1066	7.5E	250	**500**	N.A.
Chicago	1	Gravity	1037	60E	3,000		N.A.
	2	Gravity	1037	50E	3,200	**5,762**	N.A.
	3	1037	1100	75E	3,000	**1,706**	N.A.
Mulberry	1	Gravity	1100	100E	2,000		N.A.
	2	Gravity	1100	60E	1,300		N.A.
	3	Gravity	1100	30E	650	**3,950**	N.A.

		Pumps Water					
Location or Name	**Pump Unit**	**From Zone**	**To Zone**	**Horsepower & Energy***	**Pump Design Capacity (gpm)**	**Total Station Capacity (gpm)**	**Efficiency** (Percent)**
St. Lawrence	1	Gravity	1100	50E	1,050		62.9, 59.3
	2	Gravity	1100	75E	1,300		59.8. 58.4
	3	Gravity	1100	100E	1,700		66.6, 66.7
	4	Gravity	1100	125E	1,800	**6,355**	N.A.
Tilden	1	1010	1150	20E	200		21
	2	1010	1150	30E	500		31.2
	3	1010	1150	50E	920		N.A.
	4	1010	1150	95(G)	920	**2,540**	N.A.
Raley	1	1010	1080	3E	250	**250**	N.A.
Arlington	1	1010	1080	7.5E	200		57.4, 83.2
	2	1010	1080	15E	400		56.2
	3	1010	1080	40E	500	**1,100**	29.3
Valley	1	1010	1080	20E	550	**550**	N.A.
Chase	1	Gravity	1200	40E	500	**500**	N.A.
Mary Evans	1	Gravity	1150	10E	110		N.A.
	2	Gravity	1150	10E	110		N.A.
	3	Gravity	1150	50E	800	**1,020**	N.A.
Frances Mary	1	Gravity	1200	100E	900		N.A.
	2	Gravity	1200	75E	940	**1,055**	N.A.
Victoria	1	Gravity	1200	200E	3,000		N.A.

	Pumps Water						
Location or Name	**Pump Unit**	**From Zone**	**To Zone**	**Horsepower & Energy***	**Pump Design Capacity (gpm)**	**Total Station Capacity* (gpm)**	**Efficiency** (Percent)**
Victoria, Continued	2	Gravity	1200	150E	1,750		N.A.
	3	Gravity	1200	200E	2,500		N.A.
	4	Gravity	1200	198G	2,800	**9,352**	N.A.
Linden	1	Gravity	1200	270G	1,500***		N.A.
	2	Gravity	1200	300E	3,000		80
	3	Gravity	1200	280G	1,500***		N.A.
	4	Gravity	1200	280G	1,500***	**7,131**	N.A.
Industrial	1	42" Line	1200	75E	1,000		85.5
	2	42" Line	1200	125E	1,600		77.5
	3	42" Line	1200	200E	2,500	**4,525**	63.6
Jackson	1	Gravity	Gravity	50E	4,500		
	2	Gravity	Gravity	50E	4,500	**9,754**	
Mockingbird	1	Gravity	1200	200E	2,800		70.4
	2	Gravity	1200	75E	1,000		70.3
	3	Gravity	1200	200E	2,800	**6,144**	73
Sugarloaf Low	4	1200	1300	25E	1,100		N.A.
	5	1200	1300	50E	1,400		N.A.
	6	1200	1300	15E	280	**2,377**	N.A.
Emtman Low	2	1200	1300	25E	600		N.A.
	3	1200	1300	25E	600		62.8, 41.8
	4	1200	1300	60E	1,200	**1,787**	46.5, 28.8

	Pumps Water						
Location or Name	**Pump Unit**	**From Zone**	**To Zone**	**Horsepower & Energy***	**Pump Design Capacity (gpm)**	**Total Station Capacity (gpm)**	**Efficiency** (Percent)**
Sugarloaf High	1	1300	1400	50E	1,040		N.A.
	2	1300	1400	30E	555		N.A.
	3	1300	1400	15E	260	**2,313**	N.A.
Lemona	1	1200	1400	75E	1,100		59.2
	2	1200	1400	75E	1,100		64.9
	3	1200	1400	75E	1,100	**2,305**	22.3
Praed	1	1200	1400	50E	600		N.A.
	2	1200	1400	50E	600		N.A.
	3	1200	1400	100E	1200	**2,400**	N.A.
Canyon Crest	1	1200	1400	10E	130		N.A.
	2	1200	1400	15E	150		N.A.
	3	1200	1400	40E	475		N.A.
	4	1200	1400	75E	950	**1,710**	N.A.
Country Club	1	1200	1400	75E	800		N.A.
	2	1200	1400	75E	800	**1,533**	N.A.
Emtman High	6	1200	1400	50E	700		67
	7	1200	1400	75E	1,100	**1,800**	N.A.
Gratton	1	1200	1400	10E	120		N.A.
	2	1200	1400	20E	200	**320**	N.A.
Jefferson	1	1200	1400	100E	1,125		N.A.
	2	1200	1400	100E	1,125		N.A.

	Pumps Water						
Location or Name	**Pump Unit**	**From Zone**	**To Zone**	**Horsepower & Energy***	**Pump Design Capacity (gpm)**	**Total Station Capacity (gpm)**	**Efficiency** (Percent)**
Jefferson Continued	3	1200	1400	100E	1,125		N.A.
	4	1200	1400	100E	1,125	**4,500**	N.A.
Whitegates No. 1	1	1200	1408	75E	800		N.A.
	2	1200	1408	75E	950		N.A.
	3	1200	1408	100E	1,000	**2,510**	N.A.
Whitegates No. 2	1	1408	1568	25E	375		N.A.
	2	1408	1568	25E	375	**678**	N.A.
Alessandro	1	1300	1600	30E	275		N.A.
	2	1300	1600	30E	275		N.A.
	3	1300	1600	125E	1,000		N.A.
	4	1300	1600	75E	800	**2,437**	N.A.
Horizon View	1	1400	1568	75E	241		N.A.
	2	1400	1568	75E	241		N.A.
	3	1400	1568	75E	241	**2,250**	N.A.
Mt. Vernon	1	1400	1600	10E	80		N.A.
	2	1400	1600	30E	400	**480**	N.A.
Ross	1	1400	1600	50E	500		77.4
	2	1400	1600	75E	850		89.2, 75.7
	3	1400	1600	40E	500	**500**	75.4
Crest	1	1600	1680	20E	500		46.2
	2	1600	1680	20E	500		73.3

	Pumps Water						
Location or Name	**Pump Unit**	**From Zone**	**To Zone**	**Horsepower & Energy***	**Pump Design Capacity (gpm)**	**Total Station Capacity (gpm)**	**Efficiency** (Percent)**
Crest Continued	3	1600	1680	20E	500	**1,500**	70.4
University City	1	1600	1750	50E	800		81.2, 61.3
	2	1600	1750	50E	800		70.7, 52.0
	3	1600	1750	50E	800		N.A.
	4	1600	1750	50E	800	**3,200**	N.A.

*Total Station Capacities were determined using H2OMAP Version 4.5 Software
**Efficiencies for Booster Stations are from the City's efficiency tests or from the Water Master Plan July1988; listed oldest to newest where two points are shown
***Actual design is 3,000 gpm, but practical limit due to suction is 1,500 gpm
N.A. – No Current test data available

Table 5- 5
Existing Pressure Reducing Stations*

	Transfer Water			Capacity (gpm)	
Name	**From Zone**	**To Zone**	**Number**	**Maximum**	**Continuous**
Alessandro	1600	1400	1-3” 1-6”	3,070	2,260
Canyon Crest	1400	1300	1-2” 1-4”	1,260	1,000
Chicago	1200	1100	2-8”	6,200	
Cook	997	925	3-12”	8,600	7,000
Highgrove	1200	1050	1-3” 2-6”	5,570	4,060
Magnolia	997	925	2-12” 1-6”	19,700	15,800
Polk	997	925	1-12”, 1-4”, 1-3”	10,170	8,260
Prospect	1200	1120	1-3” 1-6”	3,070	2,260
Spruce	1200	1100	1-6”	2,500	1,800
Mary St	1200	1100	1-6” 1-10”	8,500	6,700
Watkins	1400	1300	1-3” 1-6”	3,070	2,260
Westminster	1400	1300	1-2”	260	200
Green Orchard	WMWD	1670	1-2”	260	200
Myers/Dufferin	1200	1100	1-12”	8,600	7,000
14th Street	1100	997	1-6”	2,500	1,800
Jacaranda	1200	1010	1-2” 1-4”	1,260	1,000
Madison	1100	1010	1-2” 1-4”	1,260	1,000
La Sierra	1100	925	1-8”	3,900	3,100
Lake Knoll	WMWD	1400	1-12”	8,600	7,000
Mockingbird Canyon	WMWD	1200	3-12”	25,800	21,000
Arlington	1600	1200	3-10”	12,000	11,000

*Information for PRV Stations are from Water Master Plan July1988

Section 6
Model Development and Calibration

MODEL CREATION

This section describes the process utilized to develop and calibrate the hydraulic model of the City's water distribution system. The hydraulic model is used to identify deficiencies with the existing system in meeting the City's current and future water demands. It is also used to develop and/or confirm the sizing of capital improvements for pipelines, pumping stations, PRVs, and reservoirs, as well as to provide recommendations to increase the efficiency of the whole system.

Computer Program

The hydraulic model for the City was created in *H_2OMAP* Version 4.5, which operates within the GIS environment. The allocation of elevations and water demands used *ArcView 3.2* for automatic data processing before importing the information into the *H_2OMAP* database.

Data Acquisition

The City of Riverside provided detailed information that was required for the development of the hydraulic model for this master planning effort. Key information included:

- Electronic aerial photography coverage
- General Plan and land use information
- Pump curves and performance tests for booster pumps
- GIS
- Depth-volume curves for all reservoirs
- Customer billing and consumption records
- Water system schematic
- Pump controls and settings of pressure regulating valves
- Facility addresses and their corresponding circuit and substation electrical sources
- Paper charts from pressure recorders around the City
- SCADA data for stations connected to the system

Model Construction

The model for the City is based on the City's GIS information. First, the pipes that were brought into the model database were designated as Facility, Transmission, Distribution or Supply. The pipes that had the designation of Abandoned or Irrigation were not included in the model. Other information that was included in the *H_2OMAP* database was pipe diameter, year installed, zone, and zone code. This started the model with approximately 40,000 pipes. Some of these pipes consisted of similar diameters and short lengths, other pipes were dead-end segments. To reduce the model to a more manageable size, the model was skeletonized, then trimmed and re-skeletonized. The skeletonization process reduced the number of junctions by combining pipes of identical diameter and similar material. The pipes that were trimmed first, were those that were less than 50 feet in length. Next, any pipe that was less than six inches in diameter and less than 250 feet long that did not create a loop was also trimmed. Finally, all pipes that had a zone designation of "Not Applicable" in the databases were deleted from the model. The model was then re-skeletonized bringing the total number of pipes to approximately 14,000.

Booster Pumping Stations

Thirty-six of the existing booster pump stations (excluding Grand Terrace, but including Iowa) were included in the model, as well as three new stations that have not yet been constructed: Horizon View, Jefferson and New Mary Evans Booster Station. Each booster station pumping station is modeled with a multi-point curve based on the manufacturer's data that was obtained from the City's operations staff. If an efficiency test had been performed on a pump, the curve was adjusted to indicate how the pump has aged and possibly lost capacity.

Reservoirs

All of the 16 existing reservoirs were included in the model. The reservoirs in the system were each modeled as a variable area reservoir, with the appropriate reservoir curve, to account for any reservoir that contained a hopper bottom. For calibration, the initial water level represents the water level at the beginning of the hydraulic simulation. The hydraulic simulation represents the day that data was collected for the model calibration, which was July 8, 2004.

Water Supply Connections

The supply sources or inter-connects with other agencies were modeled as a fixed head reservoir with a flow control valve. The hydraulic grade lines of the fixed head reservoirs were based on the estimated hydraulic grade line of the source. These water supply connections are summarized in **Section 4.**

Wells

Eight existing water supply wells are included in the hydraulic model. These wells are Electric St., Garner B, Garner C, Garner D, Moore-Griffth, Palmyrita 2, Russell C and Twin-Springs. Four of the existing wells; Palmyrita 2, Moore-Griffth, Electric St., and Twin Springs, are treated in the Palmyrita Treatment Plant and two wells; Garner B and Russel C, are treated in the North Orange Treatment Plant. These plants are modeled as fixed head reservoirs with a flow control valve. The hydraulic grade lines of the fixed head reservoirs are based on the surrounding topography and the capacities of the flow control valves are set at the capacity of the wells.

Pressure Regulating Stations

All Pressure Regulating Stations within the water system are modeled. Pressure relief valves are not modeled because they are primarily used in emergency situations and most vent to the atmosphere. The status of the PRV's as well as the settings were provided by the City. A total of 21 stations and 41 PRV's are modeled.

Pressure Zones

There are a total of 23 pressure zones within the City of Riverside's water distribution system. The pressure zone boundaries were defined in the GIS information that was provided by the

City. This information was used to assign pressure zones to pipes and junctions in the model. Pipes connecting two pressure zones are closed at locations of closed valves.

Elevation Allocation

The elevations of all model nodes and facilities were established using the GIS information provided by the City. The GIS information is used to create a 3-dimensional elevation grid using *ArcView Spatial Analyst* software. The model junctions are then exported from *H_2OMAP* into *ArcView* and are overlaid with the created grid to generate ground elevations for each model node. The junction elevations are then imported back into *H_2OMAP*. The elevations in the model range from 660 feet in the 925 Zone to 1,633 feet in the University 1750 Zone.

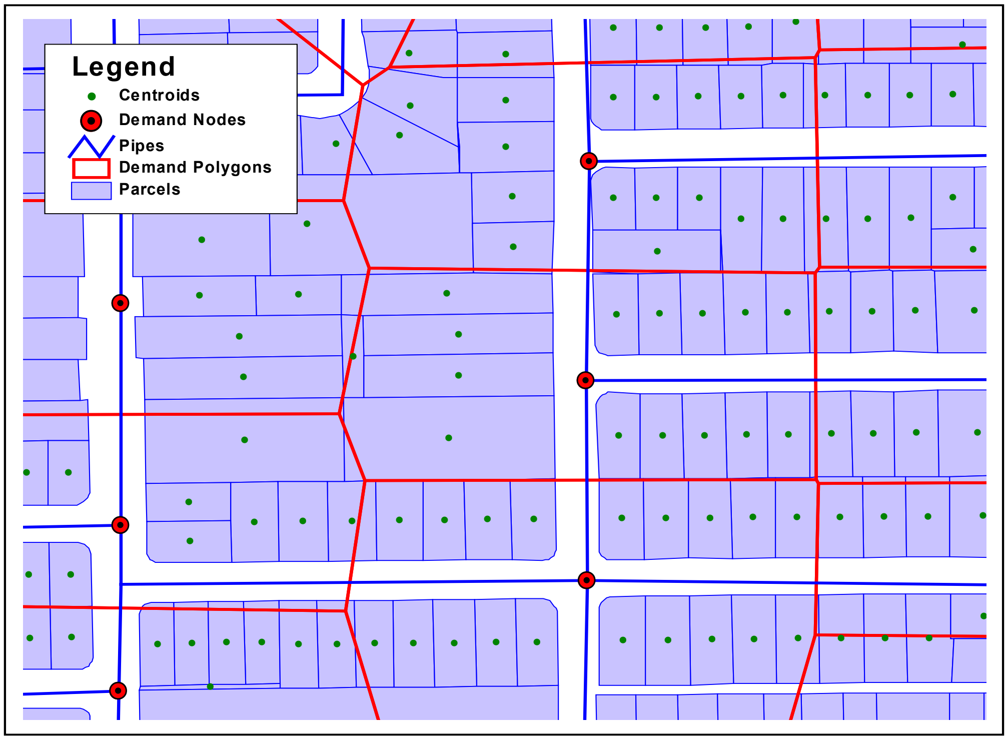
DEMAND ALLOCATION

Allocation of Existing Demands

The water demands for existing conditions are based on customer usage information (billing data) provide by the City. The billing data covers the water usage of 59,882 accounts for the period of January 2003 to December 2003. The average water usage for each account for the calendar year 2003 was calculated and scaled to the water production of 2003 to include all unaccounted-for-water in the model. Using the addresses in the usage information and the street centerline information each billing record was located geographically.

The process of geographically locating the customer demands, based on the physical address from the billing records is called “geocoding.” With this process, centroids for the 59,882 billing records were created. These centroids contain the average demands of the account scaled to production and their geographical locations. To incorporate the demands into the hydraulic model, the demands were allocated by zone and then within each zone demand nodes were selected that represent a small area of multiple accounts. To aid with selection of demand nodes, all junctions associated with water facilities or transmission pipes were excluded from the selection. A total of 8,094 demand nodes were used to create demand polygons, using the Theissen polygon tool in *Arcview*. The demands of all centroids that were located within one demand polygon were totaled and allocated to the appropriate demand node. **Figure 6- 1**, below, is a representation of the “geocoding” process.

Figure 6- 1
Demand Allocation "Geocoding" Process



The total Average Day Demand (ADD) allocated within the model is 46,110 gpm (74,400 Acre-ft/year or 66.4 mgd). For current Maximum Day Demand (MDD), all ADDs are multiplied by a peaking factor of 1.70, allocating a total of 78,370 gpm (112.9 mgd).

Allocation of Future Demands

The same demand nodes and demand polygons used for allocating existing demands were used for allocating future demands. New centroids were created for areas identified for future growth. The projected water demand of these new centroids was calculated using the area and water duty factor per land use type, as discussed in Section 3.

Diurnal Curve

Ten different diurnal demand curves were created based on data collected from the SCADA system over a 24-hour period. Diurnal curves were not created for each zone, due to the limited data collected on July 8, 2004. For some of the smaller zones the data were either insufficient or not representative of the zone. To remedy this, diurnal curves of zones with similar demographics were used as a substitute. July 8, 2004 was considered a typical summer day. The diurnal curves by pressure zone are presented in **Appendix A**.

MODEL CALIBRATION

The calibration of the hydraulic model was performed based on data collected on July 7 and July 8, 2004. Field data collected from midnight to midnight on July 8, 2004 were used for the Extended Period Simulation (EPS) calibration. EPS calibration compared the field data with the output of the model over a 24-hour period.

For both July 7th and July 8th, the SCADA system was used to collect the following information:

- Hourly reservoir levels for all storage tanks.
- Hourly well production flows of wells serving the Palmyrita and North Orange Treatment plants with the exception of Palmyrita 2. During calibration day the operating wells were Electric St., Garner B, Garner C, Garner D, Moore-Griffth, Russell C and Twin-Springs.
- Hourly flows of imported water at the Mills connection.
- Hourly flows of all booster stations connected to the SCADA system.
- Hourly pressures of all booster stations and PRV's connected to the SCADA system.
- 24-hour event log for all stations connected to the SCADA system.

Some adjustments were necessary to correctly calibrate the field data with the output of the model. One of the adjustments made was the C-factors of the pipes in the hydraulic model. The C-factors used in the model are categorized based on pipe material, diameter and year of installation. The C-factors used in the hydraulic model are summarized in **Table 6- 1** below.

Table 6- 1
C-Factors Used in Model

Pipe Diameter (inches)	Smooth Pipe	Year 1973-Present	Year 1963-72	Year 1953-62	Year 1943-52	Year 1933-42	Year 1923-32	Year 1922 and earlier
4	110	110	110/100	100/90	100/80	95/75	90/70	90/65
6 to 10	120	120	120/110	110/100	110/90	105/85	100/75	100/70
12 to 20	130	130	130/100	120/110	120/100	115/90	110/80	110/75
24 to 30	135	135	135/125	125/115	125/105	120/95	115/85	115/80
36 to 48	140	140	140/130	130/120	130/110	125/100	120/90	120/85
54	145	145	---	---	---	---	---	---
60-72	150	150	---	---	---	---	---	---

1 All Concrete pipe is smooth regardless of age
2 The numbers presented in the table are Cast Iron/Steel
3 All pipe that was installed after 1973 has a C-value of smooth pipe.

Extended Period Simulation (EPS) Calibration

Ideally, model calibration is performed during the summer months of July and August to represent the maximum demand that the water system will incur during operation under regular conditions. As mentioned previously, the EPS calibration testing was conducted from midnight to midnight on July 8, 2004. The total water production on this day was 89.9 mgd, which equals

1.4 times the ADD of the 2003 calendar year. Therefore, it was determined that the calibrated model accurately reflects system operation under maximum day demand conditions.

Diurnal curves discussed in Section 2 were developed for groups of pressure zones based on data collected on July 8, 2004. **Table 6-2** presents the diurnal curves and the pressure zones associated with each curve along with the MDD, ADD, and the peaking factor. The total production for July 8, 2004 was 64,748 gpm, with an average peaking factor of 1.4 for the entire water service area for calibration day.

Table 6- 2
Diurnal Demand Curve - Peaking Factors per Pressure Zone

Diurnal Curve Zone Grouping	Pressure Zones	Demands on July 8, 2004 (gpm)	Average Day Demand (gpm)	Calibration Day Peaking Factor
1010	1010, 1080 Raley	5,406	3,065	1.76
1200	1200, 1100 Victoria, Highgrove, Casa Blanca 1010, Gratton 1400	13,473	9,709	1.39
1400	1400, Canyon Crest, Blaine, University City 1600, Mt. Vernon	2,469	2,336	1.06
Arlington	Arlington 1160	558	358	1.56
Alessandro	Alessandro 1300	568	868	0.65
Campbell	Campbell, Crest	1,863	1,339	1.39
Gravity	Gravity, 925, Rubidoux, Mary Evans, Chicago 1100	35,773	24,807	1.44
Tilden	Tilden 1160	252	151	1.67
University 1037	University 1037	793	1,360	0.58
Praed	Praed 1400	776	414	1.87
Whitegates #1	Whitegates 1400, Oleander	1,730	991	1.75
Whitegates #2	Whitegates 1568	256	163	1.63
University 1750	University City 1750	831	550	1.51
Total/Average	**All Zones**	**64,748**	**46,111**	**1.40**

Several indicators can be used to determine how closely the model resembles the field data collected during the 24-hour test period. These indicators consist of water level in storage tanks/reservoirs, flows of pump stations, pressure of pump stations and flows and pressures into the water system, such as the MWD connection. Some adjustments and assumptions were made to obtain a model that closely resembled the field data. Some of the assumptions and adjustments are:

- Open or closed valves
- Adjustment of pump curves
- Adjustment of pump controls
- Adjustment of pressure settings at PRV stations

The calibration process also acted as a "debugging" phase for the model. During this phase of the calibration, the apparent model discrepancies or data input errors were discovered and corrected. One error corrected was the ground elevations of Tilden Booster, Canyon Crest Booster and University City Booster. These elevations were adjusted to match the topographical information that was provided by the City.

Some of the possible causes for the discrepancies between the model data and the field data include:

- Pump curves for some of the booster may no longer represent the actual pump operation due to the age and "wear and tear" on the pump. Booster stations that were not tested on calibration day could not be adjusted. Therefore, it is possible that these boosters are running off of old pump curves, which may not represent the actual operating point.
- Some level of inaccuracy exists in the measuring and in the manual positioning of the pressure meters and flow meters used during calibration day as well as"human error" in reading such meters.
- Spatial variance in demand between different times. The demand allocation is spatially distributed using the averaged billing data. All the demand nodes are then assigned diurnal curves of a combination of pressure zones. In reality these demands vary spatially from day to day.
- There are possible inaccuracies in the elevation data.

In conclusion, the EPS calibration results for the entire water system, especially for the system pressure, are good. The simulated system pressure points are on average one percent lower than the field data. The storage reservoir levels are on average four percent lower and the booster station flow data points are on average one percent lower than the field data. The detailed results of the model versus field data can be found in **Appendix C** of this report.

Section 7
Design Criteria and Evaluation Methodology

This section presents the design criteria and methodologies for analysis used to evaluate both the existing system and the future system facilities. For most of the analyses, the hydraulic model runs (discussed in Section 6) were used for system evaluation.

DESIGN CRITERIA

Design criteria are developed using typical criteria from similar water utilities, local codes, engineering judgement, commonly accepted industry standards and input from City staff. The "industry standards" typically represent ranges of values acceptable for the criteria in question and are used as a check to confirm that the values being developed are reasonable. A summary of the developed system evaluation criteria used in this Water Master Plan is shown below in **Table 7-1**.

System Pressures

Minimum system pressures are evaluated under two different scenarios: Peak Hour Demand (PHD) and Maximum Day Demand (MDD) plus fire flow. The minimum pressure criterion under peak hour demand is 40 psi under normal conditions with 35 psi as the absolute minimum service pressure. Under maximum day demand plus fire flow conditions, the minimum pressure is 20 psi.

The model is run for a 24-hour simulation and the minimum pressure evaluated for all demands nodes in the model. Transmission and water facility junctions not directly serving customers are excluded from the low pressure evaluation. All demand nodes with minimum pressure less than 40 psi under peak hour conditions or less than 20 psi for maximum day conditions plus fire flow, are presented as part of the analysis of both existing and future scenarios and are discussed in a later section of this report.

Pipeline Velocities

Pipeline velocities are evaluated using three different maximum velocity criteria for selected flow conditions under both existing and future demand scenarios. For transmission and distribution pipelines, a maximum velocity during peak hour demand of 10 fps was used for existing pipelines and 6 fps as the design criteria for new pipelines. Fire hydrant laterals are excluded from these criteria, as higher velocities are acceptable. Ideally, all transmission and distribution pipelines should have maximum velocities less than 6 fps in order to minimize headloss; however, higher velocities in existing pipelines is not, by itself sufficient justification for pipeline replacement. The third maximum velocity criteria of 4 fps applies to pump station suction pipelines operating at the maximum station capacity; MDD for pressure zones with storage or PHD for zones without storage.

Supply Storage

The total storage required for a water system is evaluated in three components: 1) storage for operational use, 2) storage for fire fighting, and 3) storage for emergencies. These three components are determined for each pressure zone in order to evaluate the ability of the water system to meet the storage criteria on both a zone by zone basis as well as a system wide basis. These three storage requirements are discussed in more detail below.

Operational Storage

Operational storage is defined as the quantity of water that is required to meet daily fluctuations in demand beyond the quantity of water that is produced on a daily basis. It is necessary to coordinate the production rates of water sources and the available storage capacity in a water system to ensure that a continuous treated water supply is provided to the system. Water systems are often designed to produce the average flow on the day of maximum demand. Water storage is then used to supply water for peak flows that may occur throughout the day. This operational storage is replenished during off peak hours when the demand is less.

The majority of pressure zones within the City of Riverside's water system are fed by gravity reservoirs. AWWA recommends an operational supply volume ranging from one-quarter to one-third of the demand experienced during one maximum day. It is recommended that each zone in the City's water system have operational storage of 25 percent of the maximum day demand fed by that reservoir.

Fire Flow Storage and Criteria

The fire flow requirements used for the City of Riverside's water system are based on the Uniform Fire Code (UFC), and conversations with the City of Riverside Fire Department and City staff. The fire flow requirements used are listed in Table 7-1. The duration increases with flow rate based on the UFC requirements. For flows between 0 and 2,500 gpm the duration is 2 hours; for flow between 3,000 and 3,500 gpm the duration is 3 hours; and for flows greater than or equal to 4,000 gpm the duration is 4 hours.

In addition to these general fire flow requirements, the downtown Specific Plan has more specific requirements as outlined in Table 7-1.

Fire flow storage is determined based on the single greatest fire flow requirement (flow and duration) within each zone. For example, if the highest fire flow of a zone is 3,000 gpm for a duration of 3 hours, the required storage for that zone is 0.54 MG. When multiple zones are fed by the same reservoir, these zones are combined and the highest fire flow among them is used to determine the necessary storage requirement. This calculation assumes that there will be only one fire in a zone or group of zones served by a single reservoir at any one time.

Emergency Storage

The volume of water that is needed during an emergency is usually based on past experience and on the estimated time expected to lapse before the emergency is corrected. Possible emergencies include earthquakes, water contamination, several simultaneous fires, unplanned electrical outages, pipeline ruptures, or other unplanned events. The occurrence and magnitude of emergencies is difficult to predict, therefore the emergency storage criteria is based on past experience and engineering judgement.

Typically, emergency storage is set as a percentage of either average day demand or maximum day demand. For the City, a criteria of 150 percent of average day demand is recommended. Given the MDD to ADD peaking factor of 1.70, the emergency storage criteria of 1.50 times ADD is equivalent to 0.88 times the MDD.

Table 7-1
Water System Evaluation Criteria

Description	Value	Units	Evaluation Demand Conditions
System Pressure			
Maximum Pressure	125	psi [1]	ADD [2]
Minimum Design Pressure, normal conditions	40	psi	PHD [2]
Minimum Evaluation Pressure, normal conditions	35	psi	PHD
Minimum Pressure, with fire flow	20	psi	MDD [2]
Pipeline Velocity			
Maximum Evaluation Velocity (excludes fire hydrant runs)	10	fps [1]	PHD
Maximum Design Velocity (network)	6	fps [1]	PHD
Maximum Design Velocity (pump station suction pipelines)	4	fps [1]	MDD/PHD
Storage Volume			
Operational	25 percent of MDD	MG [1]	MDD
Fire Fighting	Highest fire flow requirement	MG	MDD
Emergency	1.5 times ADD	MG	ADD [2]
Booster Station Capacity			
Pressure Zones with Storage	Zone segment capacity of MDD with largest single pump out of service		MDD
Pressure Zones without Storage	Zone segment capacity of PHD or MDD plus Fire, whichever is larger, with largest single pump out of service		PHD
Pressure Reducing Station Capacity			
Pressure Zones with Storage	Zone segment capacity of MDD		MDD
Pressure Zones without Storage	Zone segment capacity of PHD or MDD plus Fire, whichever is larger		PHD
Fire Flow Requirements [3]			
Agricultural and Rural Residential 0.2 Du/Acre	1000	gpm for 2 hours	MDD
Hillside Residential 0.2 DU/Acre	1000	gpm for 2 hours	MDD
Very Low Density Residential 1 DU/Acre	1000	gpm for 2 hours	MDD
Semi-Rural Residential 1.5 DU/Acre	1000	gpm for 2 hours	MDD
Low Density Residential 3 DU/Acre	1000	gpm for 2 hours	MDD
Medium Density Residential 4 DU/Acre	1000	gpm for 2 hours	MDD
Medium High Density Residential 12 DU/Acre	1750	gpm for 2 hours	MDD
High Density Residential 20 DU/Acre	2500	gpm for 2 hours	MDD
Very High Density Residential 40 DU/Acre	3500	gpm for 3 hours	MDD
Business Office Park	3000	gpm for 3 hours	MDD

Neighborhood Commercial	1500	gpm for 2 hours	MDD
General Commercial	3000	gpm for 3 hours	MDD
Regional Commercial	4000	gpm for 4 hours	MDD
Industrial	3000	gpm for 3 hours	MDD
Mixed Use Horizontal Building	2000	gpm for 2 hours	MDD
Mixed Use Vertical 2-3 Stories	4000	gpm for 4 hours	MDD
Mixed Use Vertical 4-5 Stories	4000	gpm for 4 hours	MDD
Public Facilities and Institutions	3500	gpm for 3 hours	MDD
Office	2000	gpm for 2 hours	MDD
Downtown Specific Plan:			
Almond Street	2,000	gpm for 2 hours	MDD
Health Center	3,500	gpm for 3 hours	MDD
Health Center (Community Hospital Campus)	5,000	gpm for 4 hours	MDD
Justice Center	6,000	gpm for 4 hours	MDD
Justice Center (Market St Corridor)	6,000	gpm for 4 hours	MDD
Market St Gateway	3,500	gpm for 3 hours	MDD
Market St Gateway (adjacent to Freeway)	3,000	gpm for 3 hours	MDD
Mission Inn Historic District	4,000	gpm for 4 hours	MDD
Neighborhood Commercial	3,000	gpm for 3 hours	MDD
North Main St Specialty Services	3,000	gpm for 3 hours	MDD
Prospect Place Office	3,000	gpm for 3 hours	MDD
Prospect Place Office (14th St Corridor)	5,000	gpm for 4 hours	MDD
Raincross	4,500	gpm for 4 hours	MDD
Residential	1,500	gpm for 2 hours	MDD
System Reliability			
Pipe Breaks	Maintain service with a single supply/transmission pipeline out of service		MDD
Single Source Out of Service	Maintain service for 7 days with a single source out of service		ADD
Electric Power Out of Service	Maintain service at 20 psi with power failure during 6 hours of highest MDD period		MDD
No Natural Gas Supplies	Maintain service without natural gas supplies during 24-hour period		MDD
Emergency	Maintain service for 3 days with a single source out of service and no electrical power		MinMD

[1] psi = pounds per square inch, fps = feet per second, gpm = gallons per minute, MG = million gallons
[2] PHD = peak hour demand, MDD = maximum day demand, ADD = average day demand
[3] Based on the 1997 Uniform Fire Code (UFC) and Riverside County Fire Department requirements.

Booster Pumping Stations

Booster pumping station capacity is evaluated under two scenarios:

- The largest single pump out of service for pressure zones with storage under maximum day demand conditions
- The largest single pump out of service for pressure zones without storage under peak hour demand conditions or maximum day demand plus fire flow conditions, whichever is larger.

The hydraulic model will be used to evaluate the booster station capacity with the largest single pump serving each zone out of service.

Pressure Reducing Stations

There are a few zones within the City's water system that are either served solely through a pressure reducing station or are served through a pressure reducing station in addition to a booster station. In the latter case, the pressure reducing station may serve the zone in conjunction with the booster station or may act as an emergency supply. For the zones where it is necessary to rely on a pressure reducing station to meet demands, the capacity is evaluated under two different scenarios:

- Capacity of pressure reducing stations at maximum day demand for pressure zones with storage
- Capacity of pressure reducing stations at peak hour demand or maximum day demand plus fire flow, whichever is larger, for pressure zones without storage

Again, the hydraulic model will be used to evaluate the ability of the pressure reducing stations to satisfy the demands within each zone with the largest single pressure reducing valve out of service.

EVALUATION METHODOLOGY

Analyses for water supplies, storage quantities and inter-zone transfer capabilities are conducted outside of the hydraulic model. Water supply requirements are determined based on projected maximum day demand for the years 2005, 2007, 2010, 2015, 2020 and 2025. The maximum day demand (MDD) projections are evaluated based on existing capacity and supplemented by additional supply as needed. Hydraulic evaluations are performed for both the existing system and build-out (assumed to be 2025) conditions.

Requirements for reservoir storage are evaluated both on a system wide basis and on a zone by zone basis. Criteria discussed previously in this section are used to identify deficiencies within the existing system as well as to project the future system storage needs. Recommendations for additional reservoir facilities are based on the comparison of the existing and anticipated storage volume requirements.

Pumping station capacities are evaluated on a zone by zone basis. Maximum day demands are compared to capacities of the pumping stations with the largest unit out of service. This comparison will identify the necessary upgrades to deficient pumping stations.

The existing system and the projected future system configurations are evaluated with respect to the optimum locations for the recommended improvements in storage facilities and booster pumps. Each zone is analyzed to determine how water will be supplied in the appropriate quantities and pressures from the available water sources and storage facilities.

Hydraulic model runs are made for the existing and future systems after the completion of the analyses described above. The model runs include recommended facilities such as additional storage reservoirs, booster pumps and PRV's. Model runs are made using steady state and 24-hour EPS runs to evaluate anticipated system pressures and pipeline velocities.

Recommendations are made for any additional pipelines necessary due to system hydraulics and the adequacy of pipelines with respect to system redundancy.

Model runs have been completed using the following three conditions:

- Average day demands (ADD) conditions, 24-hour EPS simulation
- Maximum day demand (MDD) conditions, 24-hour EPS simulation
- Maximum day demand conditions with fire flow demands, steady state simulation

Maximum day plus fire flow situations are evaluated at every demand node in the existing and future system having fire hydrants. Each demand node is given fire flow criterion based on the maximum fire flow requirement for the services that the node represents. Using the model, each node is then evaluated to determine if the fire flow requirements can be met while maintaining a pressure of 20 psi at all demand nodes in that pressure zone. Where fire flow cannot be met using a single node and the fire flow demand is 1,250 gpm or more, then the fire flow analysis is performed using two adjacent nodes. Nodes with fire flow requirements that could not be brought within acceptable parameters are identified and are presented as part of the analyses of both the existing and future scenarios in later sections of the report.

Section 8
Water System Evaluation

INTRODUCTION

This section describes the evaluation of the water distribution system under existing and future conditions, identifies the deficiencies, and recommends improvements to address these deficiencies. The system evaluation is based on the criteria described in Section 7. The system evaluation consists of the following three components:

- An evaluation of the distribution system
- An evaluation of the water system facilities, consisting of a facility assessment and a capacity analysis for storage, booster stations, and pressure reducing stations
- A discussion of deficiencies and recommendations by pressure zone

DISTRIBUTION SYSTEM EVALUATION

The distribution system network is evaluated for system pressures using the H_2OMAP Water model.

System Pressure Evaluation

The hydraulic model is used to evaluate the system pressures for the following three scenarios:

1. Meet peak hour demand (PHD) while maintaining a minimum pressure of 40 psi
2. Meet average day demand (ADD) while not exceeding the maximum pressure of 125 psi (if possible)
3. Meet maximum day demand (MDD) and fire flow while maintaining a minimum pressure of 20 psi

The results of these analyses are discussed below:

Minimum Pressure with PHD

For the first criterion, the model is run for 24 hours with existing MDD. Using the 24-hour model simulation. The lowest pressures in the simulation of operating conditions are selected as PHD. The pressures are evaluated only for demand nodes, because the pressure criteria do not apply to transmission mains or at water facility locations, provided that the minimum pressure exceeds 5 psi. The model contains 8,094 demand nodes. The model run identifies 301 demand nodes (2.4 percent of the system) with pressures below 40 psi and 118 demand nodes (0.9 percent of the system) with pressures below 35 psi. Low pressures vary between 10 and 40 psi. All low-pressure areas are shown on **Figure 8-1**.

Maximum Pressure with ADD

The model is also used to identify areas where the maximum pressure exceeds 125 psi. This evaluation is conducted for ADD conditions. There are 719 demand nodes or approximately 5.7

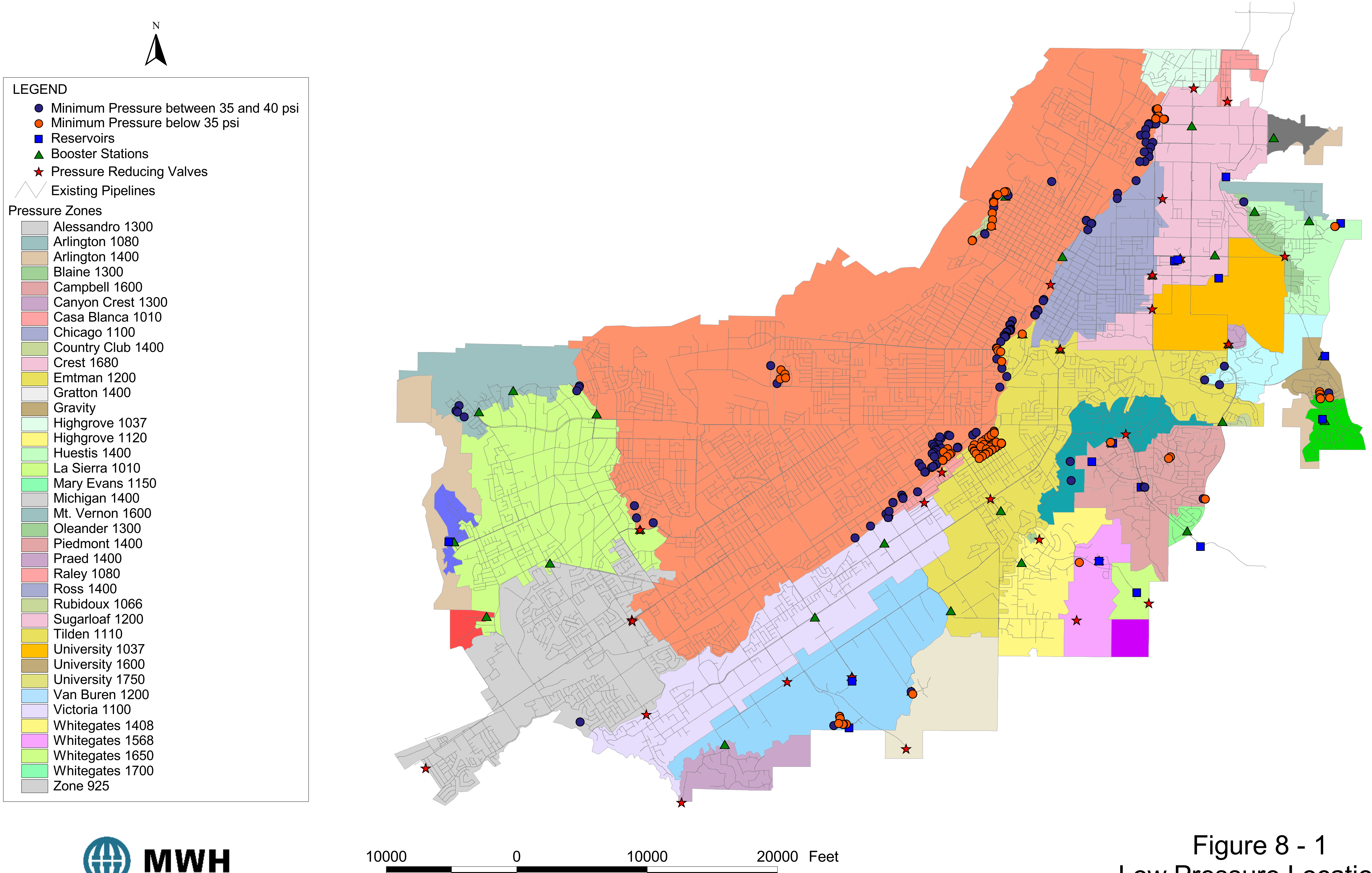


Figure 8 - 1
Low Pressure Locations

percent of the system with maximum pressures in excess of 125 psi. High pressures varied between 120 psi and 180 psi. For the high-pressure areas indicated on **Figure 8-2**, no recommendations have been made to modify (lower) the operating pressures. This is because City staff does not have a history of receiving high-pressure complaints from customers.

Minimum Pressure with MDD plus Fire Flow

The hydraulic model is used to evaluate the impact of fire flows on the distribution system. Fire flows ranging from 1,000 to 6,000 gpm are applied to the model to evaluate if the system could meet the fire flow demand under MDD conditions, while maintaining a minimum pressure of 20 psi. For this analysis, the H_2OMAP Water Fireflow Simulation is used. It should be noted that the fire flow runs are based on the future land use according to the City's General Plan.

Based on the model runs, 570 out of 9,100 fire flow locations are identified as failing due to insufficient pressures, this equates to 6 percent of model junctions not meeting assigned fire flows. Where fire flows are not met, the system is checked to see if a hydrant is present at the model node, if the fire flows are allocated correctly in the model, and if the fire flow can be met through multiple hydrants (for fire flows greater than 2,000 gpm). For locations that still have deficiencies, recommendations are made for improvements to approximately 15 miles of pipeline. These recommended improvements (water main replacements) are shown in **Figure 8-3**. The junctions with residual pressures below 20 psi and their respective recommended improvements are summarized in the discussion of each of the pressure zones.

STORAGE EVALUATION

The storage and emergency supply analyses are performed for each pressure zone. According to the planning criteria discussed in Section 7, the total storage requirement is the sum of operational, fire and emergency storage. The operational storage requirement is defined as 25 percent of MDD. Fire flow storage is defined as sufficient water for the highest fire flow requirement of the zone evaluated. Emergency storage is defined as 150 percent of ADD.

A summary of the required and available storage volumes by pressure zone is presented in **Table 8-1** for existing conditions and **Table 8-2** for future conditions. Under existing conditions the system has a deficit of 32.82 MG storage capacity for the system as a whole. It has a deficit of 61.37 MG under future conditions. When the required and available storage volumes are compared on a zone-by-zone basis, there are nine zones with a storage deficit under existing conditions. These zones are 925, Gravity, La Sierra 1010, Victoria 1100, Chicago 1100, 1200, Heustis/Ross 1400, Whitegates 1400, and Whitegates 1568. When the required and available storage volumes are compared on a zone-by-zone basis under future conditions, there are two additional zones with a storage deficit. These zones are Alessandro 1300 and Piedmont 1400. Recommendations to address these deficiencies are shown on **Figure 8-4**. Identification numbers shown on the figure correspond to recommended improvements noted throughout this section.

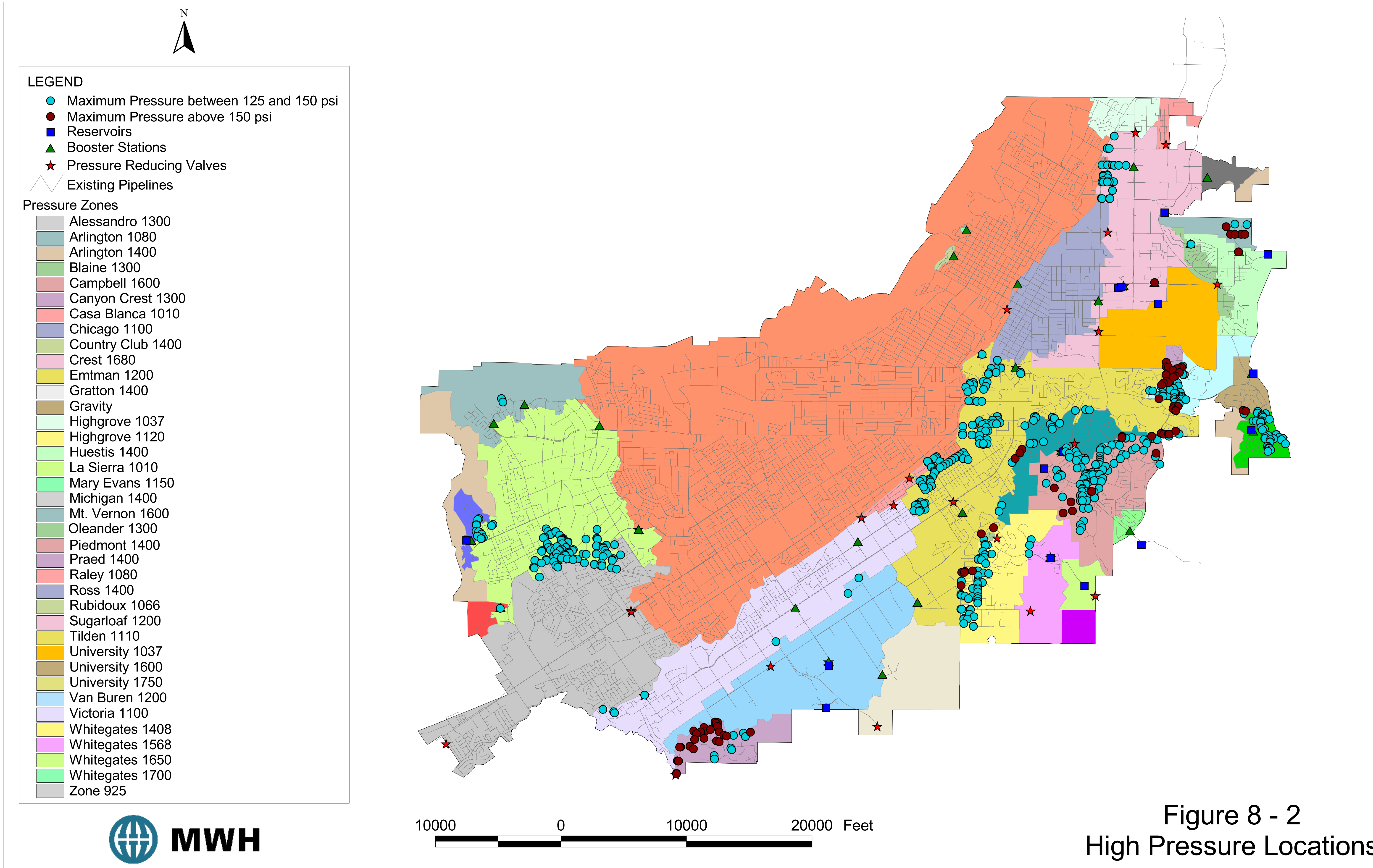


Figure 8 - 2
High Pressure Locations

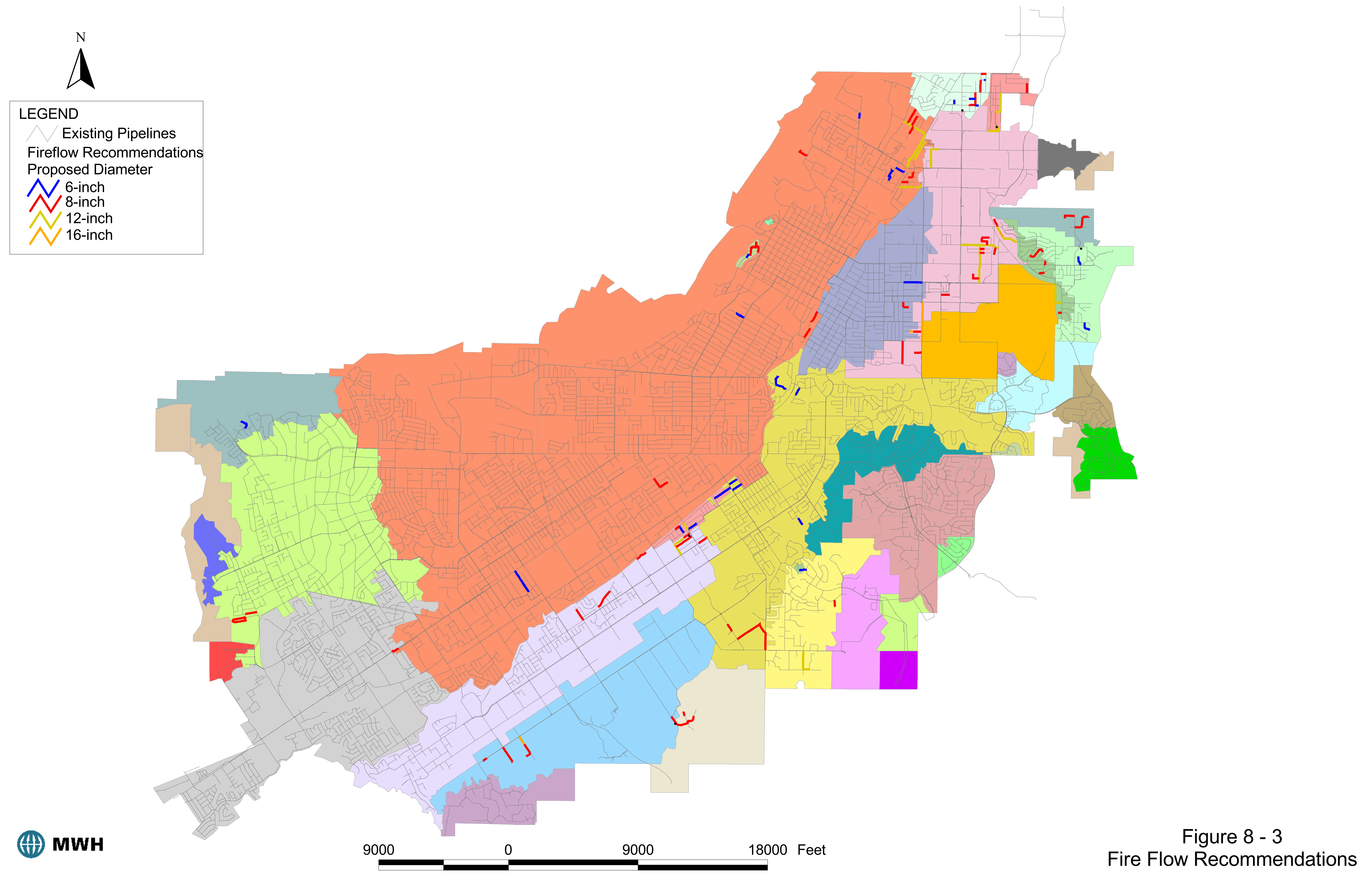


Figure 8 - 3
Fire Flow Recommendations

Table 8-1
Existing System Storage Evaluation

Pressure Zone	Demands					Storage Required				Evaluation	
Description	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs)	Fire Flow (MG) [3]	Operational (MG) [1]	Emergency (MG) [2]	Required (MG)	Storage Available (MG)	Surplus or (Deficit) (MG)
Zone 925	***6.72***	***1.7***	***11.43***	***4,000***	***4***	***0.96***	***2.86***	***10.08***	***13.90***	***0***	***(13.90)***
Gravity (997)	25.98	1.7	44.17	6,000	4	1.44	11.04	38.98	51.46	52	0.54
Rubidoux 1066	0.05	1.7	0.09	1,000	2	0.12	0.02	0.08	0.22	0	(0.22)
Mary Evans 1150	0.01	1.7	0.02	1,000	2	0.12	0.005	0.02	0.14	0	(0.14)
Gravity Total	***26.05***	***1.7***	***44.28***	***6,000***	***4***	***1.44***	***11.07***	***39.07***	***51.58***	***52***	***0.42***
La Sierra 1010	4.39	1.7	7.46	4,000	4	0.96	1.86	6.58	9.40	10	0.60
Raley 1080	0.03	1.7	0.05	1,750	2	0.21	0.01	0.04	0.26	0	(0.26)
Tilden 1110	0.22	1.7	0.37	1,000	2	0.12	0.09	0.33	0.54	0	(0.54)
Arlington 1080	0.51	1.7	0.88	1,000	2	0.12	0.22	0.77	1.11	0	(1.11)
1010 Zone Total	***5.15***	***1.7***	***8.75***	***4,000***	***4***	***0.96***	***2.19***	***7.72***	***10.87***	***10***	***(0.87)***
Casa Blanca 1010	0.22	1.7	0.38	3,000	3	0.54	0.09	0.33	0.97	0	(0.97)
Victoria 1100	2.89	1.7	4.91	4,000	4	0.96	1.23	4.33	6.52	0	(6.52)
Casa Blanca & Victoria Total	***3.11***	***1.7***	***5.29***	***4,000***	***4***	***0.96***	***1.32***	***4.66***	***6.95***	***0***	***(6.95)***
University 1037	1.96	1.7	3.33	3,500	3	0.63	0.83	0.00	1.46	5	3.54
Chicago 1100	2.95	1.7	5.02	4,000	4	0.96	1.26	4.43	6.65	0	(6.65)
University & Chicago Total	***4.91***	***1.7***	***8.35***	***4,000***	***4***	***0.96***	***2.09***	***4.43***	***7.48***	***5***	***(2.48)***
Highgrove 1037	0.38	1.7	0.64	4,000	4	0.96	0.16	0.57	1.69	0	(1.69)
Highgrove 1120	0.17	1.7	0.29	4,000	4	0.96	0.07	0.26	1.29	0	(1.29)
Emtman 1200	5.99	1.7	10.18	4,000	4	0.96	2.54	8.98	12.49	5	(7.49)
Sugarloaf 1200	3.45	1.7	5.87	4,000	4	0.96	1.47	5.18	7.61	5	(2.61)
Van Buren 1200	0.77	1.7	1.31	1,000	2	0.12	0.33	1.16	1.61	7.5	5.89
Praed 1400	0.60	1.7	1.01	1,000	2	0.12	0.25	0.51	0.88	0	(0.88)
Gratton 1400	0.51	1.7	0.88	1,000	2	0.12	0.22	0.77	1.11	0	(1.11)
1200 Zone Total	***11.87***	***1.7***	***20.19***	***4,000***	***4***	***0.96***	***5.05***	***17.42***	***23.43***	***17.5***	***(5.93)***
Alessandro 1300	***1.25***	***1.7***	***2.13***	***1,000***	***2***	***0.12***	***0.53***	***1.88***	***2.53***	***2***	***(0.53)***
Piedmont 1400	***0.89***	***1.7***	***1.52***	***1,000***	***2***	***0.12***	***0.38***	***1.34***	***1.84***	***1***	***(0.84)***

1) MDD x 0.25, 2) ADD x1.50, 3) FF x Duration

Table 8-1 (continued)
Existing System Storage Evaluation

Pressure Zone	Demands					Storage Required				Evaluation	
Description	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs)	Fire Flow (MG) [3]	Operational (MG) [1]	Emergency (MG) [2]	Required (MG)	Storage Available (MG)	Surplus/ Deficit (MG)
Heustis 1400	0.68	1.7	1.16	1,000	2	0.12	0.29	1.02	1.43	2	0.57
Ross 1400	1.01	1.7	1.71	4,000	4	0.96	0.43	1.51	2.90	2	(0.90)
Country Club 1400	0.06	1.7	0.10	1,000	2	0.12	0.03	0.09	0.24	0	(0.24)
Blaine 1300	0.40	1.7	0.68	3,000	3	0.54	0.17	0.60	1.31	0	(1.31)
Canyon Crest 1300	0.10	1.7	0.16	1,000	2	0.12	0.04	0.15	0.31	0	(0.31)
Mt. Vernon 1600	0.05	1.7	0.09	1,000	2	0.12	0.02	0.08	0.22	0	(0.22)
Heustis/Ross System	***2.30***	***1.7***	***3.90***	***4,000***	***4***	***0.96***	***0.98***	***3.44***	***5.38***	***4***	***(1.38)***
Whitegates 1408	1.41	1.7	2.39	1,000	2	0.12	0.60	2.11	2.83	0.5	(2.33)
Oleander 1300	0.02	1.7	0.03	1,000	2	0.12	0.01	0.03	0.15	0	(0.15)
Whitegates 1400 System	***1.43***	***1.7***	***2.43***	***1,000***	***2***	***0.12***	***0.61***	***2.14***	***2.87***	***0.5***	***(2.37)***
Whitegates 1568	0.23	1.7	0.39	1,000	2	0.12	0.10	0.35	0.57	0.5	(0.07)
Whitegates 1650	0.003	1.7	0.01	1,000	2	0.12	0.001	0.005	0.13	0	(0.13)
Whitegates 1568 System	***0.23***	***1.7***	***0.40***	***1,000***	***2***	***0.12***	***0.10***	***0.35***	***0.57***	***0.5***	***(0.07)***
Campbell 1600	1.67	1.7	2.83	3,000	3	0.54	0.71	2.50	3.75	5	1.25
Crest 1680	0.26	1.7	0.44	1,000	2	0.12	0.11	0.39	0.62	0	(0.62)
Campbell System	***1.93***	***1.7***	***3.28***	***3,000***	***3***	***0.54***	***0.82***	***2.89***	***4.25***	***5***	***0.75***
University 1600	0.18	1.7	0.30	1,000	2	0.12	0.08	0.27	0.46	3	2.54
University 1750	0.79	1.7	1.35	2,500	2	0.3	0.34	1.19	1.83	0	(1.83)
University System	***0.97***	***1.7***	***1.65***	***2,500***	***2***	***0.3***	***0.41***	***1.45***	***2.17***	***3***	***0.83***

1) MDD x 0.25, 2) ADD x1.50, 3) FF x Duration

Table 8-2
Future System Storage Evaluation

Pressure Zone	Demands					Storage Required				Evaluation	
Description	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs)	Fire Flow (MG)	Operational (MG)	Emergency (MG)	Required (MG)	Available Storage (MG)	Surplus/ Deficit (MG)
Zone 925	***7.77***	***1.7***	***13.21***	***4,000***	***4***	***0.96***	***3.30***	***11.66***	***15.92***	***0.0***	***(15.92)***
Gravity (997)	30.11	1.7	51.18	6,000	4	1.44	12.80	45.16	59.40	52.0	(7.40)
Rubidoux 1066	0.05	1.7	0.09	1,000	2	0.12	0.02	0.08	0.22	0.0	(0.22)
Mary Evans 1150	0.02	1.7	0.03	1,000	2	0.12	0.01	0.02	0.15	0.0	(0.15)
Gravity Total	***30.18***	***1.7***	***51.30***	***6,000***	***4***	***1.44***	***12.82***	***45.26***	***59.53***	***52.0***	***(7.53)***
La Sierra 1010	5.38	1.7	9.14	4,000	4	0.96	2.29	8.07	11.32	10.0	(1.32)
Raley 1080	0.20	1.7	0.34	1,750	2	0.21	0.08	0.30	0.59	0.0	(0.59)
Tilden 1110	0.33	1.7	0.56	1,000	2	0.12	0.14	0.50	0.76	0.0	(0.76)
Arlington 1080	1.86	1.7	3.17	1,000	2	0.12	0.79	2.79	3.70	0.0	(3.70)
1010 Zone Total	***7.77***	***1.7***	***13.22***	***4,000***	***4***	***0.96***	***3.30***	***11.66***	***15.93***	***10.0***	***(5.93)***
Casa Blanca 1010	0.23	1.7	0.39	3,000	3	0.54	0.10	0.35	0.99	0.0	(0.99)
Victoria 1100	3.44	1.7	5.85	4,000	4	0.96	1.46	5.16	7.58	0.0	(7.58)
Casa Blanca & Victoria Total	***3.67***	***1.7***	***6.24***	***4,000***	***4***	***0.96***	***1.56***	***5.51***	***8.03***	***0.0***	***(8.03)***
University 1037	3.86	1.7	6.56	3,500	3	0.63	1.64	0.00	1.94	5.0	2.73
Chicago 1100	3.40	1.7	5.78	4,000	4	0.96	1.45	5.10	7.51	0.0	(7.51)
University & Chicago Total	***7.26***	***1.7***	***12.34***	***4,000***	***4***	***0.96***	***3.09***	***5.10***	***9.15***	***5.0***	***(4.15)***
Highgrove 1037	0.48	1.7	0.82	4,000	4	0.96	0.21	0.73	1.89	0.0	(1.89)
Highgrove 1120	0.20	1.7	0.34	4,000	4	0.96	0.08	0.30	1.34	0.0	(1.34)
Emtman 1200	6.40	1.7	10.88	4,000	4	0.96	2.72	9.60	13.28	5.0	(8.28)
Sugarloaf 1200	3.97	1.7	6.74	4,000	4	0.96	1.69	5.95	8.59	5.0	(3.59)
Van Buren 1200	1.04	1.7	1.78	1,000	2	0.12	0.44	1.57	2.13	7.5	5.37
Michigan 1400	0.20	1.7	0.34	3,000	2	0.36	0.09	0.30	0.75	0.0	(0.75)
Praed 1400	0.94	1.7	1.60	1,000	2	0.12	0.40	1.41	1.93	0.0	(1.93)
Gratton 1400	0.31	1.7	0.52	1,000	2	0.12	0.13	0.46	0.71	0.0	(0.71)
1200 Zone Total	***13.54***	***1.7***	***23.02***	***4,000***	***4***	***0.96***	***5.76***	***20.31***	***27.03***	***17.5***	***(9.53)***
Alessandro 1300	***1.45***	***1.7***	***2.47***	***1,000***	***2***	***0.12***	***0.62***	***2.18***	***2.91***	***2.0***	***(0.91)***

Table 8-2 (continued)
Future System Storage Evaluation

Pressure Zone	Demands					Storage Required				Evaluation	
Description	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs)	Fire Flow (MG)	Operational (MG)	Emergency (MG)	Required (MG)	Available Storage (MG)	Surplus/ Deficit (MG)
Piedmont 1400	***1.15***	***1.7***	***1.95***	***1,000***	***2***	***0.12***	***0.49***	***1.72***	***2.33***	***1.0***	***(1.33)***
Heustis 1400	0.88	1.7	1.50	1,000	2	0.12	0.37	1.32	1.81	2.0	0.19
Ross 1400	1.40	1.7	2.37	4,000	4	0.96	0.59	2.09	3.65	2.0	(1.65)
Country Club 1400	0.06	1.7	0.10	1,000	2	0.12	0.03	0.09	0.24	0.0	(0.24)
Blaine 1300	0.41	1.7	0.69	3,000	3	0.54	0.17	0.61	1.33	0.0	(1.33)
Canyon Crest 1300	0.11	1.7	0.18	1,000	2	0.12	0.04	0.16	0.32	0.0	(0.32)
Mt. Vernon 1600	0.23	1.7	0.39	1,000	2	0.12	0.10	0.35	0.57	0.0	(0.57)
Heustis/Ross System	***3.08***	***1.7***	***5.24***	***4,000***	***4***	***0.96***	***1.31***	***4.62***	***6.89***	***4.0***	***(2.89)***
Whitegates 1408	2.18	1.7	3.71	1,000	2	0.12	0.93	3.28	4.32	0.5	(3.82)
Oleander 1300	0.02	1.7	0.03	1,000	2	0.12	0.01	0.03	0.15	0.0	(0.15)
Whitegates 1400 System	***2.20***	***1.7***	***3.74***	***1,000***	***2***	***0.12***	***0.94***	***3.30***	***4.36***	***0.5***	***(3.86)***
Whitegates 1600	1.45	1.7	2.47	1,000	2	0.12	0.62	2.18	2.92	0.5	(2.42)
Whitegates 1700	0.79	1.7	1.35	1,000	2	0.12	0.34	1.19	1.65	0.0	(1.65)
Crest 1680	0.27	1.7	0.46	1,000	2	0.12	0.12	0.41	0.65	0.0	(0.65)
Campbell 1600	2.33	1.7	3.96	3,000	3	0.54	0.99	3.50	5.03	5.0	(0.03)
Campbell/Whitegates 1600 System	***4.85***	***1.7***	***8.25***	***3,000***	***3***	***0.54***	***2.06***	***7.28***	***9.88***	***5.0***	***(4.88)***
University 1600	0.28	1.7	0.48	1,000	2	0.12	0.12	0.42	0.66	3.0	2.34
University 1750	0.82	1.7	1.40	2,500	2	0.30	0.35	1.24	1.89	0.0	(1.89)
University System	***1.11***	***1.7***	***1.88***	***2,500***	***2***	***0.30***	***0.47***	***1.66***	***2.43***	***3.0***	***0.57***

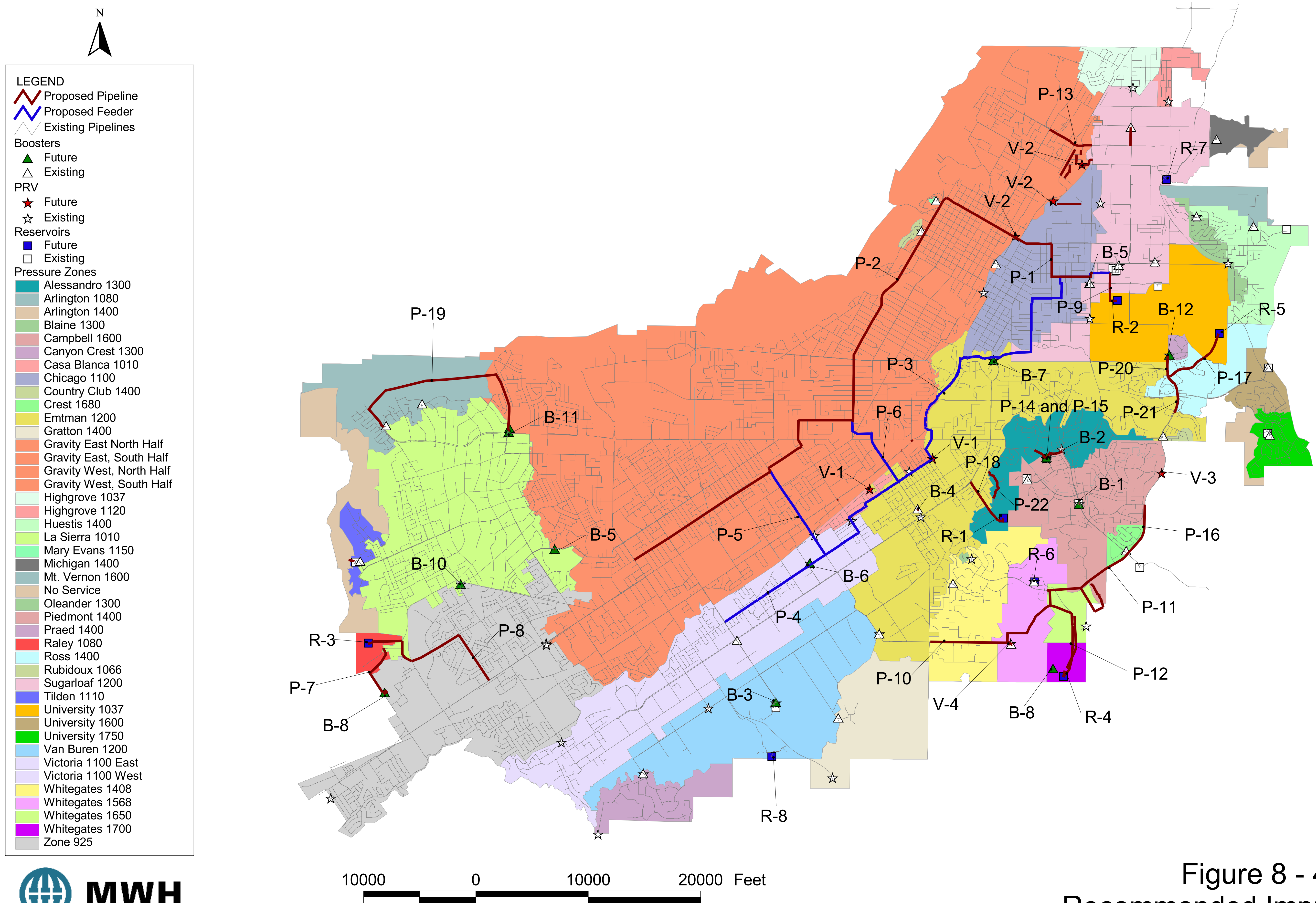


Figure 8 - 4
Recommended Improvements

BOOSTER STATION EVALUATION

In this analysis, the MDD of each pressure zone is compared with the pumping capacity of all booster stations feeding the evaluated pressure zone with the largest unit being out of service. If a zone is fed by multiple booster stations, only the largest unit of all pumps is considered to be out of service, rather than the largest unit of each station feeding the zone. If a zone does not have storage within the zone, the booster stations are evaluated using the greater of MDD plus fire flow (MDD+FF) or peak hour conditions with all pumps being operable.

The results of the analysis are presented in **Table 8-3** for existing conditions and **Table 8-4** for future conditions. As shown in Table 8-4, fifteen zones are identified to have booster station capacity deficiencies based on future demand. These zones are Rubidoux 1066, La Sierra 1010, Raley 1080, Arlington 1080, Victoria 1100, University 1037, Chicago 1100, Gratton 1400, Michigan 1400, 1200 Zone, Alessandro 1300, Mt. Vernon 1600, Whitegates 1700, Campbell 1600, and University City 1750. Recommendations to address these deficiencies are shown on Figure 8-4.

PRESSURE REDUCING STATION EVALUATION

In this analysis, the maximum flow of MDD+FF and PHD of each reduced zone is compared with the valve capacity of all PRVs feeding a pressure zone with the largest unit being out of service. If a zone is fed by multiple PRVs, only the largest unit of all PRVs is considered to be out of service, rather than the largest unit of each station feeding the zone.

The results of the analysis are presented in **Table 8-5** for existing conditions and **Table 8-6** for future conditions. As shown in Table 8-6, there are eight zones which will have pressure reducing station capacity deficiencies based on future demand. These zones are Casa Blanca 1010, Highgrove 1037, Highgrove 1120, Chicago 1100, Oleander 1300, 1400 Zone, Blaine 1300, and Canyon Crest 1300. Recommendations to address these deficiencies are shown on Figure 8-4.

GRAVITY ZONE

The Gravity Zone service area is the largest within the City and is located in the northern central portion of the City. The majority of the land use designation within this area is commercial, but there are also many residential areas. The demands in this zone are expected to increase significantly due to the addition of a "very high" density land use category, as well as new classifications in the downtown Specific Plan.

Table 8-3
Existing System Booster Station Evaluation

Pressure Zone	Demands							Available Capacity		Pump Station Evaluation		
Description	ADD (gpm)	Higher Zones ADD (gpm)	Total ADD (gpm)	Peaking Factor	MDD (gpm)	MDD + FF* (gpm)	PHD (gpm)	Total Capacity (gpm)	Largest Pump Out of Service (gpm)	Total Required Capacity (gpm)	Surplus (gpm)	(Deficit) (gpm)
Gravity+ Zone 925	22,712	28,067	50,779	1.70	86,324			N/A**	N/A**	N/A**	N/A**	N/A**
Rubidoux 1066	36		36	1.70	61	1,061	73	500	250	1,061		(561)
Mary Evans 1150	8		8	1.70	13	1,013	15	220	110	1,013		(793)
La Sierra 1010	3,046	528	3,574	1.70	6,075			9,910	7,733	6,075	1,658	
Raley 1080	19		19	1.70	32	1,782	42	250	0	1,782		(1,532)
Tilden 1110	151		151	1.70	257	1,257	338	2,540	1,620	1,257	1,283	
Arlington 1080	358		358	1.70	608	1,608	799	1,650	1,150	1,608	42	
Casa Blanca & Victoria Total	2,159		2,159	1.70	3,671	7,409	4,711	3,871	3,170	7,409		(3,537)
University 1037	1,360	2,051	3,411	1.70	5,799			5,762	3,004	5,799		(2,795)
Chicago 1100	2,051		2,051	1.70	3,486	7,486	4,149	7,468	4,710	7,486		(19)
Praed 1400	414		414	1.70	703	1,703	1,167	2,400	1,200	1,703	697	
Gratton 1400	75		75	1.70	127	1,127	154	320	120	1,127		(807)
1200 Zone Total	7,475	6,736	14,211	1.70	24,159			28,707	26,634	24,159	2,475	
Alessandro 1300	868	1,339	2,208	1.70	3,753			1,787	1,007	3,753		(2,745)
Heustis/Ross/ Piedmont 1400	2,178	708	2,886	1.70	4,907			12,839	10,139	4,907	5,232	
Mt. Vernon 1600	35		35	1.70	59	1,059	125	480	80	1,059		(579)
Whitegates 1408 + Oleander	991	163	1,154	1.70	1,961			2,510	1,905	1,961		(56)
Whitegates 1568	161	2	163	1.70	277			678	283	277	6	
Whitegates 1700	2		2	1.70	4				0	4		(4)
Campbell 1600	1,158	181	1,339	1.70	2,277			2,437	1,427	2,277		(850)
Crest 1680	181		181	1.70	308		694	1,500	1,000	694	306	
University 1600	123	550	673	1.70	1,144			2,546	1,837	1,144	693	
University 1750	550		550	1.70	936	3,436	1,975	3,200	2,400	3,436		(236)

* Zones without storage are evaluated using MDD plus Fire Flow and all pumps are operable
** Gravity Zone is fed through wells, therefore booster pumping capacity is not required for this zone

Table 8-4
Future System Booster Station Evaluation

Pressure Zone	Demands							Available Capacity		Pump Station Evaluation		
Description	ADD (gpm)	Higher Zones ADD (gpm)	Total ADD (gpm)	Peaking Factor	MDD (gpm)	MDD + FF* (gpm)	PHD (gpm)	Total Capacity (gpm)	Largest Pump Out of Service (gpm)	Total Required Capacity (gpm)	Surplus (gpm)	Deficit (gpm)
Gravity + Zone 925	26,304	31,509	57,813	1.7	98,281			N/A**	N/A**	N/A**	N/A**	N/A**
Rubidoux 1066	37	0	37	1.7	64	1,064	76	500	250	1,064		(564)
Mary Evans 1150	11	0	11	1.7	18	1,018	21	1,020	220	1,018	2	
La Sierra 1010	3,736	1,663	5,399	1.7	9,178			9,910	7,733	9,178		(1,445)
Raley 1080	137	0	137	1.7	233	1,983	307	250	0	1,983		(1,733)
Tilden 1110	229	0	229	1.7	390	1,390	512	2,540	1,620	1,390	1,150	
Arlington 1080	1,293	0	1,293	1.7	2,198	3,198	2,889	1,650	1,150	3,198		(1,548)
Casa Blanca & Victoria Total	2,550	0	2,550	1.7	4,335	8,061	5,241	3,871	3,170	8,061		(4,190)
University 1037	2,679	2,363	5,042	1.7	8,572			5,762	3,004	8,572		(5,568)
Chicago 1100	2,363	0	2,363	1.7	4,017	8,017	4,780	7,468	4,710	8,017		(549)
Praed 1400	653	0	653	1.7	1,111	2,111	1,844	2,400	1,200	2,111	289	
Gratton 1400	213	0	213	1.7	362	1,362	438	320	120	1,362		(1,042)
Michigan 1400	140	0	140	1.7	238	4,238		3,800	2,400	4,238		(438)
1200 Zone Total	8,398	9,778	18,176	1.7	30,899			28,707	26,634	30,899		(4,265)
Alessandro 1300	1,007	1,809	2,816	1.7	4,787			1,787	1,007	4,787		(3,780)
Heustis/Ross/Piedmont 1400 System	2,777	928	3,705	1.7	6,298			10,526	9,386	6,298	3,087	
Mt. Vernon 1600	161	0	161	1.7	273	1,273	577	480	80	1,273		(793)
Whitegates 1408 + Oleander	1,529	1,561	3,090	1.7	5,253			7,010	5,885	5,253		632
Whitegates 1700	551	0	551	1.7	937	1,937	1,593	0	0	1,937		(1,937)
Whitegates 1600	1,010	551	1,561	1.7	2,654			2,928	2,928	2,654	274	
Campbell 1600	1,619	189	1,809	1.7	3,075			2,437	1,427	3,075		(1,648)
Crest 1680	189	0	189	1.7	322		725	1,500	1,000	725	275	
University 1600	195	572	768	1.7	1,305			2,546	1,837	1,305	532	
University 1750	572	0	572	1.7	973	3,473	2,054	3,200	2,400	3,473		(273)

* Zones without storage are evaluated using MDD plus Fire Flow and all pumps are operable
** Gravity Zone is fed through wells, therefore booster pumping capacity is not required for this zone

Table 8-5
Existing System Pressure Reducing Station Evaluation

Pressure Zone	Demands							Available Capacity		Evaluation	
Description	ADD (gpm)	Additional Zones ADD (gpm)	Total ADD (gpm)	Peaking Factor	MDD (gpm)	MDD + FF* (gpm)	PHD (gpm)	Total Capacity (gpm)	Largest Valve Out of Service (gpm)	Total Require d Capacity (gpm)	Surplus/ Deficit (gpm)
Zone 925	4,668	0	4,668	1.7	7,935	11,935	9,443	38,470	30,570	11,935	18,635
Casa Blanca 1010	154	0	154	1.7	262	3,262	317	2,520	1,520	3,262	(742)
Victoria 1100	2,005	154	2,159	1.7	3,671	7,409	4,121	17,100	8,500	7,409	9,691
Chicago 1100	2,051	0	2,051	1.7	3,486	7,486	4,149	8,700	5,600	7,486	(1,886)
Highgrove 1120	120	0	120	1.7	203	4,203	246	3,070	1,270	4,203	(2,933)
Highgrove 1037	263	0	263	1.7	447	4,447	540	5,570	3,700	4,447	(747)
Oleander 1300	12	0	12	1.7	21	1,021	45	260	0	1,021	(1,021)
Alessandro 1300	868	0	868	1.7	1,476			1,800	0	1,476	324
Heustis/Ross/Piedmont 1400	1,791	1,019	2,810	1.7	4,777			1,270	0	4,777	(3,507)
Canyon Crest 1300	67	0	67	1.7	114	1,114	257	1,260	260	1,114	(854)
Blaine 1300	278	0	278	1.7	473	3,473	999	3,070	1,270	3,473	(403)

*Zones without storage are evaluated using MDD plus Fire Flow

Table 8-6
Future System Pressure Reducing Station Evaluation

Pressure Zone	Demands							Available Capacity		Evaluation	
Description	ADD (gpm)	Additional Zones ADD (gpm)	Total ADD (gpm)	Peaking Factor	MDD (gpm)	MDD + FF* (gpm)	PHD (gpm)	Total Capacity (gpm)	Largest Valve Out of Service (gpm)	Total Required Capacity (gpm)	Surplus/ Deficit (gpm)
Zone 925	5,396	0	5,396	1.7	9,173	13,173	10,916	38,470	30,570	13,173	17,397
Casa Blanca 1010	161	0	161	1.7	274	3,274	331	2,520	1,520	3,274	(1,754)
Victoria 1100	2,389	161	2,550	1.7	4,335	8,061	4,910	17,100	8,500	8,061	9,039
Chicago 1100	2,363	0	2,363	1.7	4,017	8,017	4,780	8,700	5,600	8,017	(2,417)
Highgrove 1120	139	0	139	1.7	236	4,236	285	3,070	1,270	4,236	(2,966)
Highgrove 1037	336	0	336	1.7	571	4,571	690	5,570	3,700	4,571	(871)
Oleander 1300	12	0	12	1.7	21	1,021	45	260	0	1,021	(1,021)
Alessandro 1300	1,007	0	1,007	1.7	1,712			1,800	0	1,712	88
Heustis/Ross/Piedmont 1400	2,378	357	2,735	1.7	4,649			1,270	0	4,649	(3,379)
Canyon Crest 1300	73	0	73	1.7	124	1,124	279	1,260	260	1,124	(864)
Blaine 1300	284	0	284	1.7	483	3,483	1,019	3,070	0	3,483	(413)

*Zones without storage are evaluated using MDD plus Fire Flow

Table 8-7
Projected ADD in the Gravity Zone System (gpm)

Year	Gravity Zone
Existing (2003)	14,472
2005	14,947
2007	15,103
2010	15,584
2015	15,983
2020	16,510
2025	17,360

Water Supply for the Gravity Zone is groundwater from the San Bernardino and the Gage Transmission systems and the North Orange well field. The water is all fed directly to Linden-Evans Reservoirs where the water is blended and distributed. Water is distributed to the Gravity Zone from the Linden-Evans Reservoirs through a 72-inch diameter pipeline which feeds from multiple transmission pipelines, the largest of which is the 48-and 42-inch diameter Crosstown Feeder. Water is currently pumped through 12 booster stations into the higher zones. These higher zones are 1010 Zone, 1200 zone, Victoria 1100, Rubidoux 1066, Mary Evans 1150, Chicago 1100 and University 1037. Two pressure reducing stations provide water to the La Sierra 925 Zone from the Gravity Zone (Polk and Magnolia pressure reducing stations), and a third station (Cook) can provide water to the 925 Zone after it is pumped into the 1010 Zone from the Gravity, thus all the water to the 925 Zone is delivered from the Gravity Zone.

In the future, it is assumed that the Gravity Zone will continue to be fed through groundwater from the Bunker Hill and Riverside North groundwater basins. It is assumed that all flow entering the system will be delivered through the Linden-Evans Reservoirs.

Storage Evaluation

As presented in **Table 8-1** and **Table 8-2**, the total storage required for the Gravity Zone is 51.0 MG under existing conditions and 58.9 MG under future conditions. The reservoirs in the Gravity Zone also feed the Rubidoux 1066, Mary Evans 1150, and La Sierra 925 Zones, and provide operational and fire storage for the Chicago 1100 Zone. As discussed in the La Sierra 1010 Zone section, storage in the 925 or Gravity Zone can serve as emergency for the La Sierra 1010 Zone if a gas-engine booster is installed at Field Booster. Including these associated zones, the storage required under future conditions in the Gravity, associated zones, and the 925 Zone is 83.0 MG as shown in **Table 8-8**.

The Linden-Evans Reservoirs have a capacity of 16 MG each for a total of 32 MG at the site. Mockingbird Reservoir has a total capacity of 20 MG. However, there are operational problems with the reservoirs – primarily the water level at Linden-Evans Reservoirs can not be allowed to drop below about half full without low pressure in the distribution system, which, for example, sets off pressure alarms on commercial sprinkler systems in the downtown area. Based on the system configuration, Mockingbird Reservoir can only serve the system in case of emergency. For these reasons, the practical operational and fire storage available in the Gravity Zone should be evaluated separately from the total storage volume that is only available under true emergency circumstances. Assuming the system is allowed to operate with pressure deficiencies during emergencies, the total nominal storage deficiency in the Gravity Zone and 925 Zone is 31.0 MG.

Table 8-8
Storage Evaluation of the Gravity and Associated Zones

Storage Required (Future Demands):	**Storage (MG)**
Gravity, Mary Evans, and Rubidoux Zones	59.4
La Sierra 925	15.9
Deficiency in 1010 Zone	5.9
Operational and Fire Deficiency in Chicago 1100 Zone	1.7
Total Required	**83.0**
Storage Available:	
Linden Reservoir	16.0
Evans Reservoir	16.0
Mockingbird Reservoir	20.0
Total Available	**52.0**
Total Deficiency	**31.0**
Recommended:	
New UCR/Gravity Zone Reservoir	20.0
New Raley/925 Zone Reservoir	11.0

The La Sierra 925 Zone (discussed later) recommends an 11.0 MG Raley Reservoir to serve the 925 Zone. The remaining 18.9 MG deficiency needs to be supplied as part of the Gravity Zone. Therefore, an additional 20 MG of storage is recommended for this zone. An investigation of potential reservoir sites, including a property owned by University of California Riverside (UCR) and a site next to the existing Mockingbird Reservoir, has been performed as part of this study.

The City currently owns the property north of the existing Mockingbird Reservoir, though the California Department of Parks and Recreation would like to trade this property for the property east of the reservoir across Jackson Street. Due to the headlosses in the Gravity Zone from north to south, the HGL drops to approximately 930 feet near the reservoir and water must be pumped into the reservoir via Jackson Booster Station. To expand storage at Mockingbird Reservoir, system operation must be modified to fill water (up to 40,000 gpm) during off-peak hours and allow the reservoir to drain during peak hours. Even with a future parallel large-diameter Crosstown Feeder, this reservoir filling process will depress the system pressures to unacceptable levels. Therefore, the proposed fill and draw system with an expanded Mockingbird Reservoir is not feasible.

For this reason, a reservoir site location near the existing Linden-Evans Reservoirs is preferred. The City owns a parcel for a reservoir site in the middle of the UCR agricultural operation; it is proposed that the City offer the State of California a trade for a parcel at the edge of the agricultural parcels as shown on Figure 8-5. This reservoir (R-2) would have a capacity of 20 MG and a high water level of 997 feet. It is recommended that the reservoir be constructed as a relatively shallow reservoir (approximately 20 feet in depth), to maximize volume fluctuations without depressing the hydraulic grade. An additional 5,000 linear feet of 54-inch diameter pipeline (P-9) would be required to connect this reservoir to Linden-Evans Reservoir and the future water system.

Booster Station and Pressure Regulator Evaluation

With the exception of supply facilities, there are no booster stations or pressure regulating stations that serve the Gravity Zone.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are a number of locations in the Gravity Zone with low pressures below 40 psi, as seen in **Figure 8-1**. Most of these locations are at higher elevations than other areas within the zone, but some are also due to pressure drop (caused by friction losses) across the Gravity Zone. The location with the lowest pressures at the west end of the Gravity Zone is southwest of Van Buren Blvd and Wells Avenue. Under existing MDD, the pressures range from 37.5 to 43.4 psi, with pressures dropping to a low of 30 psi under future MDD if no improvements are made. The City also needs to fill the proposed Raley Reservoir (serving the La Sierra 925 Zone) by gravity flow. Therefore, a minimum HGL of 930 feet is required at the Polk and Magnolia Reducers to refill the reservoir on a continuous basis. The model runs show a minimum HGL of 919.8 ft under existing MDD and a minimum HGL of 908 ft under future MDD, if no improvements are made. Therefore, additional transmission capacity, such as a parallel Crosstown Feeder, is needed across the Gravity Zone to meet service criteria.

Since the existing Crosstown Feeder is located along the foothills in the eastern and southern portion of the Gravity Zone south of the 91 Freeway, it is recommended that the new Parallel Feeder be located on the western and northern portions of the Gravity Zone north of the 91 Freeway. A proposed alignment is shown on **Figure 8-4**, but other alignments are possible. **Table 8-9** shows model results for various diameters for the new Parallel Feeder under various demand and diameter scenarios. The results show that the Parallel Feeder should be 54-inch diameter in the northern section (close to Linden-Evans Reservoir) and 48-inch diameter in the remaining section to meet adequate pressures in the southern portion of the system and for sufficient HGL to fill the proposed Raley Reservoir. The proposed alignment begins at the 72-inch diameter pipeline at the intersection of Chicago Avenue and Seventh Street, with the 54-inch diameter pipeline traveling west on Seventh Street, north on Kansas Avenue and west on Third Street (P-1). The pipeline diameter would change to 48-inch diameter at Orange Street, with the pipeline continuing west on Third Street, south on Redwood Drive and Palm Avenue, west on Sierra Avenue, south on Palomar Way and Madison Avenue, and west on Garfield Avenue to Van Buren Blvd (P-2). A series of analyses were performed with 48-inch diameter being the minimum pipe size to maintain an adequate HGL at the Polk and Magnolia Reducers. These improvements are shown on **Figure 8-6.**

The City has the option to phase the construction of the new Parallel Feeder. Constructing only the northern 30,000 ft of the pipeline will meet approximately half of the potential demand increase, and projected construction of the southern 20,000 ft of the pipeline would be required to meet water demand projections in 2015.

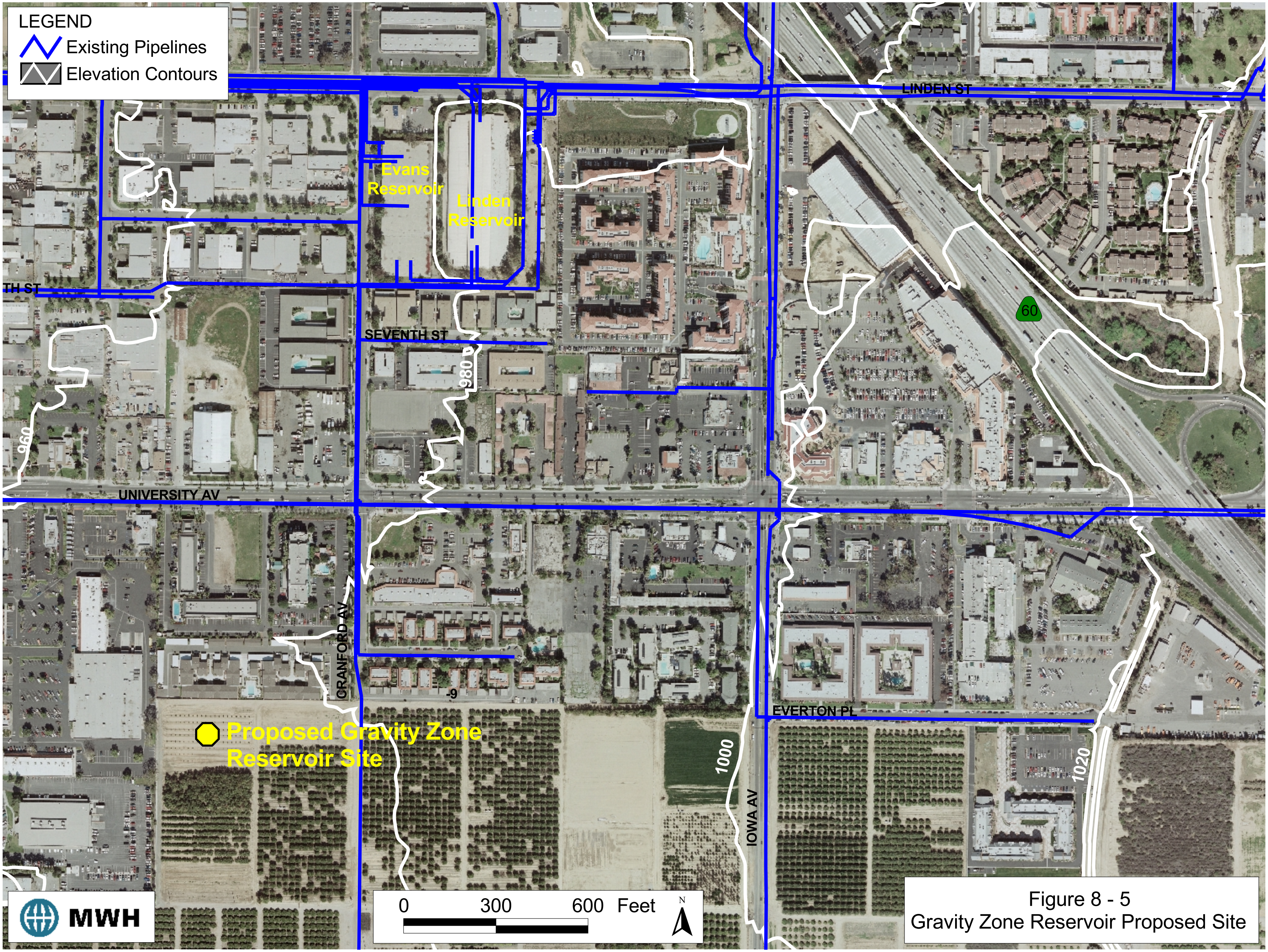


Figure 8 - 5
Gravity Zone Reservoir Proposed Site

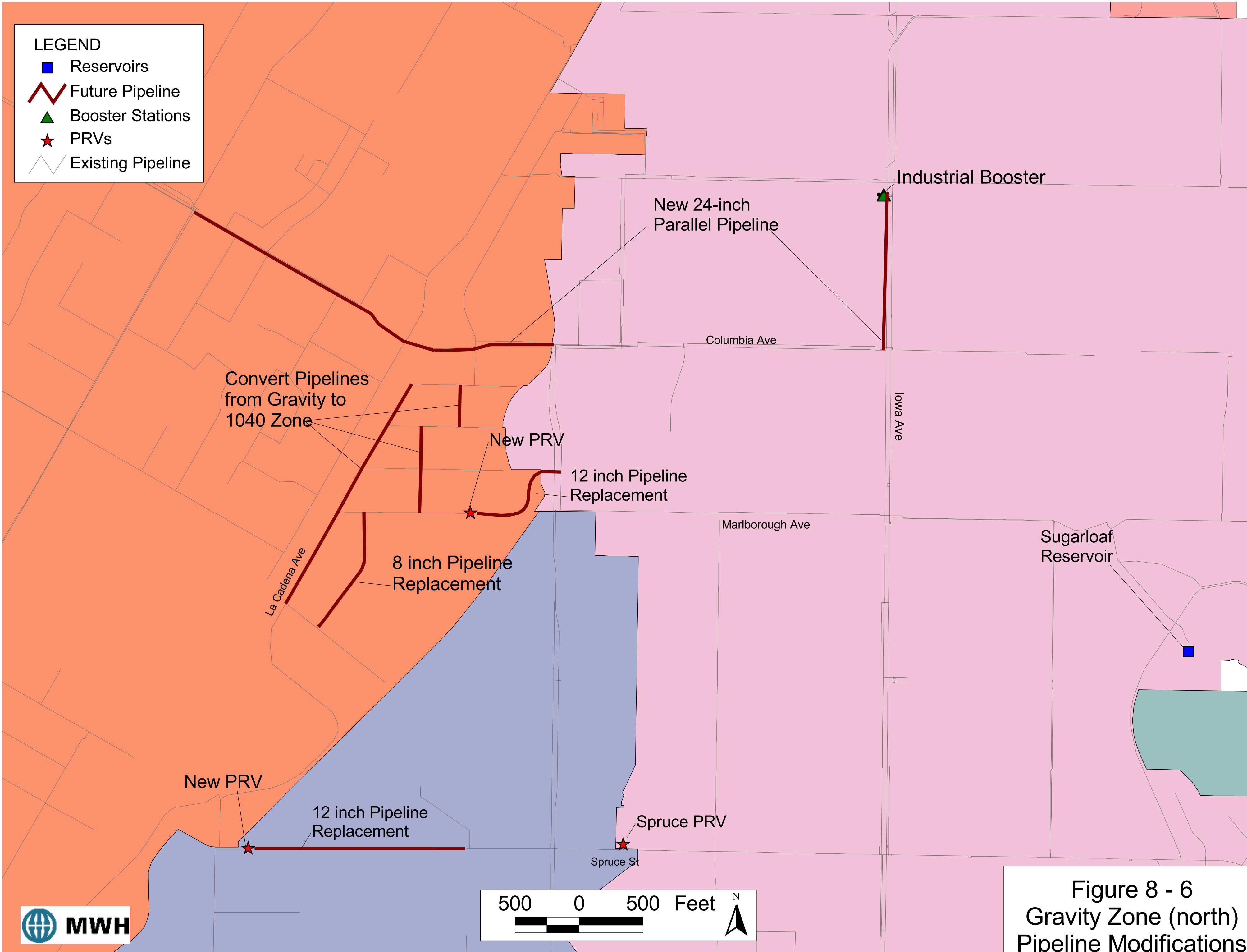


Figure 8 - 6
Gravity Zone (north)
Pipeline Modifications

Table 8-9
Crosstown Feeder Model Results

Scenario	1	2	2a	3	3a	3b	4	4a	5	6	7
Demand Condition	Existing MDD	Future MDD	Future MDD	Future MDD	Future MDD	Future MDD	Future MDD	Half Future MDD	Future MDD	Future MDD	Half Future MDD
Old Crosstown Feeder	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y
Slipline Old Crosstown Feeder	N	N	Y	Y	Y	N	Y	Y	Y	N	Y
New Parallel Feeder Length (ft)	--	--	--	50,000	50,000	50,000	30,000	30,000	50,000	50,000	30,000
New Parallel Feeder Size	--	--	--	54/48	54	54/48	54/48	54/48	48/42	48/42	48/42
Max HGL at West End (ft)	941.6	930.7	931.9	946.8	951.4	939.2	938.7	942.7	942.3	931.1	940.1
Min HGL at West End (ft)	928.0	911.3	912.8	937.7	942.0	924.5	927.2	934.0	932.6	912.7	932.6
Avg HGL at West End (ft)	936.3	921.6	923.3	942.7	947.2	932.2	933.3	938.0	937.3	922.7	937.0
Max Pressure at West End (psi)	43.4	38.7	39.2	45.7	47.7	42.4	42.2	43.9	43.7	38.9	42.8
Min Pressure at West End (psi)	37.5	30.3	30.9	41.7	43.6	36.0	37.2	40.1	39.5	30.9	39.5
Avg Pressure at West End (psi)	41.1	34.8	35.5	43.9	45.9	39.3	39.8	42.1	41.6	35.2	41.4
Max HGL At Polk/Magnolia (ft)	936.3	924.9	925.6	937.8	942.5	929.6	929.6	932.2	933.5	924.7	930.5
Min HGL at Polk/Magnolia (ft)	919.8	908.3	909.4	930.3	934.8	917.9	920.0	926.2	924.9	909.4	925.3
Avg HGL at Polk/Magnolia (ft)	930.3	916.8	918.0	934.4	939.0	923.7	925.1	929.3	929.1	916.8	928.1

Explanation of Scenarios:

Scenario 1	The Old Crosstown Feeder without sliplining, without new Parallel Feeder (CTF) under Existing MDD conditions
Scenario 2	The Old Crosstown Feeder without sliplining, without new CTF under Future MDD conditions
Scenario 2a	The Old Crosstown Feeder with sliplining, without new CTF under Future MDD conditions
Scenario 3	Sliplining OCTF and installing the new CTF (54"/48"), under Future MDD conditions
Scenario 3a	Sliplining OCTF and installing the new CTF (54"), under Future MDD conditions
Scenario 3b	Installing the new CTF (54"/48") and removal of the OCTF, under Future MDD conditions
Scenario 4	Sliplining OCTF and installing the new CTF up to Frances Mary Booster, under Future MDD conditions
Scenario 4a	Sliplining OCTF and installing the new CTF up to Frances Mary Booster, under Future MDD (2015) conditions
Scenario 5	Sliplining OCTF and installing the new CTF (48"/42"), under Future MDD conditions
Scenario 6	Installing the new CTF (48"/42") without OCTF, under Future MDD conditions
Scenario 7	Installing the north half of the new CTF (48"/42") with sliplining the OCTF, under Future MDD (2015) conditions

Note: The pressure readings are taken at a pressure point in the south end of the Gravity Zone, near Drayton Place and Eddystone St. This point was shown during model runs to have a problem with low pressure.

It is recommended that the existing Crosstown Feeder and the Parallel Feeder be connected through two additional pipelines. These pipelines are required to feed the Frances Mary and St. Lawrence Booster Stations – in case the existing Crosstown Feeder is out of service, the booster stations would each require a 20-inch diameter pipeline connection to the new Crosstown Feeder to receive suction. The pipeline to Frances Mary Booster would connect from the intersection of Palm Avenue and Sierra Street to the intersection of Washington Street and Marguerita Avenue (P-6). The pipeline to St. Lawrence Booster Station would be along Jefferson Street from Garfield Street to Lincoln Avenue (P-5) as shown on Figure 8-4.

The existing Crosstown Feeder is constructed of Techite II, a fiberglass composite pipe that replaced the original Techite pipe following numerous pipe and joint failures in many installations in the western U.S. The longevity of the current Techite II pipe is unknown. In the long-term, it is recommended that the City slip-line the pipeline with the largest possible diameter at a time when the condition of the existing pipeline deteriorates and causes reliability and/or maintenance problems. The model results show that slip-lining of the existing Crosstown Feeder with one pipeline diameter size smaller has a negligible result on system pressures assuming the new crosstown feeder is constructed as recommended herein.

There are several other locations with low pressures below 35 psi in the Gravity Zone that will not be resolved from the construction of a parallel Crosstown Feeder. One area containing several blocks is the region surrounded by Maude Street, Marguerita Avenue, Ronald Street, and Indiana Avenue. It is recommended that this region be converted to the Casa Blanca 1010 Zone and is discussed further in the section on that pressure zone.

Another region with low pressures below 35 psi is the region in the Gravity Zone east of the 91 Freeway around Columbia Avenue. The City has proposed converting this region to a new 1040 Zone, fed by PRV from the Sugarloaf 1200 Zone. This recommendation will require three PRVs to meet system pressures in this region (V-2).

Another region with low pressures below 35 psi is the region at the intersection of Olivewood Avenue and Jurupa Avenue. With the addition of the parallel Crosstown Feeder, pressures in the region are raised to a minimum of 38 psi, so no further recommendations are required. Similarly, pressure below 35 psi at the intersection of Vickers Drive and Shannon Road north of the airport are increased above 35 psi with the implementation of the parallel Crosstown Feeder.

There are no known portions of the Gravity Zone with high pressures above 125 psi.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. The model identified distribution system locations that cannot meet the minimum 20 psi with fire flow demands, as presented in **Table 8-10**. To address the fire flow deficiencies in the Gravity 997 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-11**.

Table 8-10
Fire Flow Deficiencies in the Gravity Zone System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
Main St & Alamo St	Gravity 997	3,500	3,214
1008 Main St	Gravity 997	3,500	2,020
875 Clark St	Gravity 997	3,500	953
649 Kemp St	Gravity 997	3,500	831
680 Forest Park Dr	Gravity 997	3,500	906
Blake Rd & Chase Rd	Gravity 997	3,500	1,453
Chase Rd & La Cadena Dr West	Gravity 997	3,500	1,311
1919 Atlas Dr	Gravity 997	3,500	857
La Cadena Dr West & Interchange St	Gravity 997	3,500	2,306
91 Freeway north of Oxford St	Gravity 997	3,500	1,104
La Cadena Dr East & Oxford St	Gravity 997	3,500	1,188
1624 Oxford St	Gravity 997	3,000	997
La Cadena Dr East & Palmyrita Av	Gravity 997	3,500	1,474
1698 Palmyrita Av	Gravity 997	3,000	1,265
997 La Cadena Dr West	Gravity 997	3,500	1,524
1168 La Cadena Dr East	Gravity 997	3,000	647
4250 Ramona Dr	Gravity 997	3,500	1,274
Fifteenth St & Vine St	Gravity 997	3,000	1,001
3194 Prospect Av	Gravity 997	3,000	922
7415 Mt. Vernon St	Gravity 997	3,500	1,761
Milton St & La Cadena Dr East	Gravity 997 (planned conversion to 1040)	3,500	2,565
Blenheim St & La Cadena Dr East	Gravity 997 (planned conversion to 1040)	3,500	2,762
Blenheim St & Laurel Av	Gravity 997 (planned conversion to 1040)	3,500	1,664
Columbia Av & La Cadena Dr East	Gravity 997 (planned conversion to 1040)	3,000	1,928
1792 Columbia Av	Gravity 997 (planned conversion to 1040)	3,500	1,766
Marlborough Av & Mathews St	Gravity 997 (planned conversion to 1040)	3,500	2,932
1659 Mathews St	Gravity 997 (planned conversion to 1040)	3,500	3,192
Thornton St & La Cadena Dr East	Gravity 997 (planned conversion to 1040)	3,500	3,368
1951 Thornton St	Gravity 997 (planned conversion to 1040)	3,500	2,745
Kansas Av & La Cadena Dr East	Gravity 997 (planned conversion to 1040)	3,500	3,307

Table 8-11
Fire Flow Recommendations in the Gravity System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Allstate Dr	End of Street	Rivera St	Gravity 997	6	8	727
Vine St	Cridge St	Prospect Av	Gravity 997	6	8	875
Vine St	Fourteenth St	Fifteenth St	Gravity 997	6	8	780
Chase Rd	Orange St	Kemp St	Gravity 997	6	12	316
Kemp St	Chase Rd	End of Kemp St	Gravity 997	6	8	1,138
Spring Garden St	Laurel Av	End of Spring Garden St	Gravity 997	6	8	113
Milton St	Laurel Av	300 ft west of Laurel Av	Gravity 997	4	8	303
La Cadena Dr	Interchange St	Chase Rd	Gravity 997	8	12	2,097
Chase Rd	Kemp St	Forest St	Gravity 997	6	12	460
Forest St	Chase Rd	End of Forest	Gravity 997	6	8	779
Chase Rd	Clark St	La Cadena Dr	Gravity 997	12	12	1,073
Clark St	Chase Rd	End of Clark St	Gravity 997	6	8	570
Main St	Alamo St	Carter Av	Gravity 997	4	6	408
Spring Garden St	Mulberry St	La Cadena Dr	Gravity 997	4	6	655
Mulberry	Marsh Wy	Knoll Wy	Gravity 997	4	6	932
Romona Dr	Brockton Av	End of Romona Dr	Gravity 997	4	6	652
Mt Vernon St	Madison St	End of Mt Vernon	Gravity 997	4	8	651
Madison St	Mt Vernon St	Magnolia Av	Gravity 997	6	8	747
Donald Av	Magnolia Av	Andrew St	Gravity 997	4	6	1,764
La Cadena Dr	Interchange St	Columbia Av	Gravity 997	8	12	557
La Cadena Dr	Oxford Dr	Palmyrita WTP site	Gravity 997	8	12	1,598
Marlborough Av	La Cadena Dr	End of Marlborough Av	Gravity (converted to 1040)	4	12	1,001
Blenheim St	La Cadena Dr	Laurel Av	Gravity (converted to 1040)	4	8	460

Summary of Recommendations for the Gravity Zone System

Based on the evaluation described above, the following improvements are recommended for the Gravity Zone:

- New Parallel Crosstown Feeder – construct approximately 10 miles of 54- and 48-inch pipeline as a second parallel transmission main. The feeder will extend from the Linden-Evans Reservoirs, North of the 91 Freeway, to the 42-inch Mockingbird Feeder Extension (P-1 and P-2).

- Construct two 20-inch diameter connection pipelines between the two crosstown feeders near Frances Mary Booster Station (7,700 ft, P-6) and St. Lawrence Booster Station (4,000 ft, P-5).
- Slip-line the existing Crosstown Feeder to help with the reliability of the pipeline (41,600 ft, P-3 and P-4).
- Additional Storage – add 20 MG of storage with a high water level (HWL) of 997 feet at UCR agricultural property, as an extension of Linden-Evans Reservoirs approximately one mile south of the existing Linden-Evans Reservoirs site. Approximately 5,000 linear feet of 54-inch diameter pipeline will be needed to connect this new reservoir to the existing water system (R-2).
- Create a new 1040 Zone, including three pressure reducing stations.

RUBIDOUX 1066 AND MARY EVANS 1150

Rubidoux 1066 and Mary Evans 1150 are two small dead-end zones (pumped zones with no storage within zone) that are fed by the Gravity Zone. Rubidoux 1066 Zone is fed through Rubidoux Booster and Mary Evans 1150 is fed through Mary Evans Booster. Both of these zones are primarily residential and the demands are not expected to increase significantly in the future.

The projected ADD for Rubidoux 1066 and Mary Evans 1150 Zones is presented in **Table 8-12** below.

Table 8-12
Projected ADD in the Rubidoux 1066 and Mary Evans 1150 Zones (gpm)

Year	Rubidoux 1066	Mary Evans 1150
Existing (2003)	36	8
2005	36	8
2007	36	8
2010	36	8
2015	36	8
2020	36	8
2025	37	11

Storage Evaluation

Storage for the Rubidoux 1066 and Mary Evans 1150 Zones are included as part of the Gravity Zone evaluation.

Booster Station Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-13**, listing the future booster pumping requirements and existing booster pump capacities.

Table 8-13
Booster Pump Capacity Evaluation – Rubidoux and Mary Evans Zones

Criteria	Rubidoux 1066 Future	Mary Evans 1150 Future
Booster Pumping Required (MDD+FF)	1,060	1,020
Booster Pumping Required (PHD)	80	20
Existing Booster Station Capacity	500	1,020
Capacity with Largest Pump Out of Service	250	220
Total (Deficiency)	(560)	0

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

The existing Rubidoux Booster Station has a total capacity of 500 gpm. Since there is no storage in the Rubidoux 1066 Zone, the total required capacity of the station is the greater of MDD+FF with all pumps operating or PHD demands with the largest pump out of service. Under MDD+FF conditions, the demand in the Rubidoux Zone is 1,064 gpm. Therefore, there is insufficient capacity at Rubidoux Booster Station and an additional fire pump is necessary (600 gpm at 100 ft TDH).

The existing Mary Evans Booster Station has a total capacity of 1,020 gpm. Since there is no storage in the Mary Evans 1150 Zone, the total required capacity of the station is the greater of MDD+FF and PHD demands. Under MDD+FF conditions, the demand in the Mary Evans Zone is 1,018 gpm. Therefore, there is sufficient capacity at Mary Evans Booster Station and no modifications are necessary.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within the Rubidoux and Mary Evans Zones with low pressures below 40 psi, nor are there any locations with high pressures above 125 psi.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. All junctions in the Mary Evans 1150 Zone can meet the fire flow requirement while maintaining 20 psi pressure. Locations in the Rubidoux 1066 that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-14**. To address the fire flow deficiencies in the Rubidoux 1066 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-15**.

Table 8-14
Fire Flow Deficiencies in the Rubidoux System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
3849 Loring Dr	Rubidoux 1066	1,000	349
Ninth St & Mt Rubidoux Dr	Rubidoux 1066	1,000	411
Ninth St & Loring Dr	Rubidoux 1066	1,000	376
4705 9th St	Rubidoux 1066	1,000	323
4545 10th St	Rubidoux 1066	1,000	412
4804 Miramonte Pl	Rubidoux 1066	1,000	365
Allis Pl & Miramonte Pl	Rubidoux 1066	1,000	356

Table 8-15
Fire Flow Recommendations in the Rubidoux System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Mt Rubidoux Dr	Ninth St	Tenth St	Rubidoux 1066	6	8	441
Ninth St, and Miramont Pl	Mt Rubidoux Dr	Allis St	Rubidoux 1066	6	8	1460

Summary of Recommendations for the Rubidoux and Mary Evans System

Based on the evaluation described above, there are no recommended improvements for the Mary Evans 1150 Zone. Recommended improvements for the Rubidoux 1066 Zone are limited to modifications for fire flow:

- Add a third pump at Rubidoux Booster Station (600 gpm at 100 ft TDH).
- Replace pipelines for fire flow: about 1,900 ft of 8-inch diameter pipeline.

LA SIERRA 925 ZONE

The La Sierra 925 Zone is in the southwest portion of the City, also serving some areas in unincorporated Riverside County (Home Gardens). The existing La Sierra 925 Zone is fed by the Gravity Zone by three PRV stations, Polk Reducer, Magnolia Reducer, and Cook Reducer. The La Sierra 1010 Zone is fed from this zone via the Field Booster. In the future, the Buchanan 1100 Zone will also be fed from this zone. The projected ADD for the zone is presented below in **Table 8-16**.

Table 8-16
Projected ADD in the La Sierra 925 Zone (gpm)

Year	La Sierra 925 Zone
Existing (2003)	4,130
2005	4,164
2007	4,334
2010	4,381
2015	4,473
2020	4,570
2025	4,859

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-8**, in the discussion of the Gravity Zone, the total storage required for the La Sierra 925 Zone is 13.9 MG under existing conditions and 15.9 MG under future conditions. Storage for the 925 Zone can be located in the Gravity Zone; however, storage is recommended in the 925 Zone for operational purposes to minimize peaking off the Gravity Zone and Crosstown Feeder(s). The City has a reservoir site at the west end of Raley Drive for the 925 Zone that can accommodate an 11 MG reservoir (R-3). The remaining storage will be included as part of the Gravity Zone. The Raley Reservoir will also require approximately 10,000 linear-ft of 30-inch diameter pipeline to connect the reservoir to the 27-inch diameter pipeline in Magnolia Avenue (P-8). A potential alignment for the pipeline is east along Raley Drive, south along Ambs Drive, east along Collett Avenue, and south along Golden Avenue as shown in Figure 8-4.

Booster Station and Pressure Regulator Evaluation

There are no booster stations feeding the La Sierra 925 Zone. The existing pressure reducing stations have sufficient capacity to meet existing and future demands, and station expansions are not necessary. However, with the completion of the Raley Reservoir, flow through Magnolia and Polk Reducers should be operated based on flow control rather than pressure control. Constant flow through the Polk and Magnolia Reducers will allow the City to minimize pressure fluctuations in the Gravity Zone.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within La Sierra 925 Zone with low pressures below 40 psi nor any locations with high pressures above 125 psi.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the La Sierra 925 Zone that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-17**. To address the fire flow deficiencies in the La Sierra 925 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-18**.

Table 8-17
Fire Flow Deficiencies in the La Sierra 925 Zone

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
Magnolia Av & Nye Av	La Sierra 925	4,000	2,463

Table 8-18
Fire Flow Recommendations in the La Sierra 925 Zone

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Magnolia Av	Polk St	Nye Av	La Sierra 925	6	8	625

Summary of Recommendations for the La Sierra 925 Zone

Based on the evaluation described above, the following improvements are recommended for the La Sierra 925 Zone:

- Add 11 MG reservoir at the end of Raley Drive with a HWL of 930'. Add approximately 10,000 LF of a 30" inlet/outlet pipeline from the new reservoir to connect with the 27" pipeline in Magnolia Avenue (R-3 and P-8).
- Polk/Magnolia Reducers – when Raley Reservoir is operational, operate reducers as flow control station to allow constant flow from Gravity to 925 Zone.
- Replace pipelines for fire flow: 600 ft of 8-inch diameter pipeline.

LA SIERRA 1010 ZONE AND ASSOCIATED ZONES (1080, 1160)

The La Sierra service area in the central southern portion of the City includes four independent pressure zones: La Sierra 1010, Raley 1080, Arlington 1080, and Tilden 1160. In the future, the Raley 1080 Zone will be converted to the Buchanan 1100 Zone. There is a significant new development in the northern half of the Arlington 1080 Zone, the Rancho La Sierra development. In the past, there was a proposed Arlington 1400 Zone; however, with the implementation of the Rancho La Sierra specific plan, the area for the proposed Arlington 1400 Zone will become an open space preserve with no potable or irrigation water demands. The La Sierra 1010 Zone is fed by three booster stations – Field, Cook, and Norte Vista, and has one reservoir – Tilden with a capacity of 10 MG. The three smaller zones, Raley 1080, Arlington 1080, and Tilden 1160, each are pumped from the La Sierra 1010 Zone and do not have any storage. In the future, the Raley 1080 Zone will be converted to the Buchanan 1100 Zone and be fed from the La Sierra 925 Zone.

The projected ADD for each of the zones is presented below in **Table 8-19**.

Table 8-19
Projected ADD in the La Sierra System (gpm)

Year	La Sierra 1010	Raley 1080/Buchanan 1100	Arlington 1080	Tilden 1160
Existing (2003)	2,695	17	316	134
2005	2,711	101	316	134
2007	2,825	101	316	134
2010	2,943	101	621	134
2015	3,025	132	949	141
2020	3,310	132	1,252	210
2025	3,519	135	1,252	212

Storage Evaluation

As presented in **Table 8-1** and **Table 8-2** and summarized in **Table 8-20**, the total storage required for the La Sierra 1010 system is 10.9 MG under existing conditions and increases to 15.9 MG under future conditions. The existing Tilden Reservoir has a capacity of 10.0 MG, leaving the zone with a deficiency of 0.9 MG under existing conditions and 5.9 MG under future conditions. However, there is no space for additional storage at the existing Tilden Reservoir site. Therefore, rather than building increased storage for the La Sierra 1010 system, it is recommended that La Sierra system obtain some of their emergency storage from the Gravity and 925 Zones. This can be accomplished by installing a gas-driven booster pump at Field Booster (or converting one of the existing booster pumps to gas-power) to supply the La Sierra 1010 Zone in case of emergency (B-10).

Table 8-20
Storage Evaluation of the La Sierra 1010 and Associated Zones

Storage Required (Future):	Storage (MG)
Operational Storage	3.3
Fire Flow Storage	1.0
Emergency Storage	11.7
Total Required	**15.9**
Storage Available:	
La Sierra 1010	10.0
Total Available	**10.0**
Total Deficiency	**5.9**
Recommended:	
Storage Provided from Gravity 997 Zone	5.9

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in **Table 8-3** and **Table 8-4**. A summary of booster pumping requirements is shown in **Table 8-21** and **Table 8-22**, listing the future pumping requirements and existing booster pump capacities.

Table 8-21
Booster Pump Capacity Evaluation – La Sierra Zone

Total Pumping Required	Future
1010 Zone	6,400
Higher Zones	2,800
Total Required	**9,200**
Booster Station	**Existing Capacity**
Cook	3,600
Norte Vista	2,600
Field	1,400
Total Capacity	**8,600**
Total (Deficiency)	**(600)**

Note: Capacities are based on the largest pump feeding the zone out of service, Cook Booster Pump No. 2.

Table 8-22
Booster Pump Capacity Evaluation – Higher Zones in La Sierra System

Criteria	Buchanan 1100 Future	Tilden 1100 Future	Arlington 1080 Future
Booster Pumping Required (MDD+FF)	2,000	1,400	3,200
Booster Pumping Required (PHD)	300	500	2,900
Existing Booster Station Capacity	300	2,500	1,700
Capacity with Largest Pump Out of Service	0	1,600	1,400
Total Surplus (Deficiency)	(1,700)	1,100	(1,500)

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

The existing Field, Cook, and Norte Vista Booster Stations that feed the La Sierra 1010 Zone have a total firm capacity of 7,700 gpm. The total required booster pumping capacity for these three stations are 6,100 gpm under existing demands and 9,200 gpm to meet future MDD demands to serve the La Sierra 1010 system. Thus, there is sufficient capacity in the booster stations to meet existing demands, but insufficient capacity to meet future demands. To meet the deficiency in the La Sierra system, the proposed Rancho La Sierra Booster Station feeding the Arlington 1080 Zone will take suction from the Gravity Zone rather than the La Sierra 1010 Zone.

The existing Raley Booster Station has a total capacity of 250 gpm. With growth in this region, the future total required capacity is 2,000 gpm. With this large amount of growth, it is recommended that the Raley Booster Station be replaced with a new station – the Buchanan Booster Station (B-8). The total required firm capacity of the Buchanan Booster Station is 2,000 gpm at 200 ft TDH. A 12-inch diameter transmission pipeline (3,700 ft) is also required to connect the existing Raley Zone pipelines with the proposed Buchanan Booster Station (P-7).

The existing Tilden Booster Station has a firm capacity of 1,620 gpm. The total required capacity of the booster station is 1,390 gpm; therefore, no upgrades are necessary.

The existing Arlington and Valley Booster Stations have a firm capacity of 1,150 gpm. Existing MDD in the Arlington 1080 Zone is 1,600 gpm, but the future MDD in the Arlington 1080 Zone is 3,200 gpm with the addition of the Rancho La Sierra development. Rather than serving the Rancho La Sierra development from the La Sierra 1010 Zone, it is recommended that the Rancho La Sierra Booster Station pump directly to the Arlington 1080 Zone from the Gravity Zone. The Rancho La Sierra Booster Station has a recommended firm capacity (with the largest unit out of service) of 1,600 gpm at 150 ft TDH (B-11). The proposed site for the Rancho La Sierra Booster Station is at or near the Norte Vista Booster Station. In addition, a 16-inch diameter transmission pipeline (15,000 ft) is necessary across the Rancho La Sierra Zone to serve customers, from the discharge of Arlington Booster Station to the discharge of Rancho La Sierra Booster Station (P-19).

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There is one region within the Arlington 1080 Zone with low pressures below 40 psi as seen in Figure 8-1. The region in the foothills west of Arlington Avenue, around Cadbury Drive and Yearling Street has nominally low pressures as low as 37 psi during MDD conditions. There are significant portions of the La Sierra 1010 and Tilden 1160 Zones with high pressures between 125 and 150 psi during ADD conditions as seen in Figure 8-2.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the model that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-23**. To address the fire flow deficiencies in the La Sierra 1010 system, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-24**.

Table 8-23
Fire Flow Deficiencies in the La Sierra 1010 System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
6792 Rolling Hills Dr	Arlington 1080	1,000	381
Ambs Dr & Knoefler Dr	Buchanan 1100	1,750	757
12016 Herman Dr	La Sierra 1010	1,750	385
Ambs Dr & Herman Dr	La Sierra 1010	1,750	570
Hazeldell Dr & Blehm St	La Sierra 1010	3,500	1724
11784 Carmine St	La Sierra 1010	1,000	718
11791 Hazeldell Dr	La Sierra 1010	3,500	805

Table 8-24
Fire Flow Recommendations in the La Sierra 1010 System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Rolling Hills Dr	Western Hills Dr	End of Rolling Hills Dr	Arlington 1080	4	6	774
Hazeldell Dr	Blehm St	End of Hazeldell Dr	La Sierra 1010	6	8	2,127
Carmine St	Sierra Vista Av	Blehm St	La Sierra 1010	2	8	833

Summary of Recommendations for the La Sierra 1010 Zone and Associated Zones (1080, 1160)

Based on the evaluation described above, the following improvements are recommended for the La Sierra 1010 system:

- Field Booster - Add a new gas-driven pump with a capacity of 1,500 gpm (B-10).
- Raley Booster – Abandon Raley Booster.
- Buchanan Booster – Add a new booster station on Buchanan Street north of Madera Way, with three 650 gpm pumps (B-8).
- Construct approximately 3,700 LF of 12" pipeline to connect Buchanan Booster to the new Buchanan 1100 Zone (P-7).
- Rancho La Sierra Booster – Construct this new booster station to help supply the demand in the Arlington 1080 Zone. This new station will consist of 3 pumps (2+1) each with a capacity 800 gpm (B-11).
- Rancho La Sierra Transmission – Construct 15,000 LF of new 16-inch diameter pipeline to serve water from the new Rancho La Sierra Booster to the Arlington 1080 Zone (P-19).
- Replace pipelines for fire flow: approximately 800 ft of 6-inch diameter pipeline and 3,000 ft of 8-inch diameter pipeline.

VICTORIA 1100 AND CASA BLANCA 1010 ZONES

The Victoria 1100 Zone is in the southwestern portion of the City and serves portions of the City's agricultural region along Victoria Avenue. A small residential area is served by the Casa Blanca 1010 Zone. The Victoria 1100 Zone is fed by the St. Lawrence Booster Station, pumped from the Gravity Zone, and by two PRV stations from the 1200 Zone, Dufferin & Myers and Mary Street. The Casa Blanca 1010 Zone is served by the Madison Reducer from the Victoria 1100 Zone and the Jacaranda Reducer from the 1200 Zone. In the future, the Casa Blanca 1010 Zone will be expanded to address some of the low pressure deficiencies in the Gravity Zone as discussed earlier.

The projected ADD for each of the zones is presented below in **Table 8-25**.

Table 8-25
Projected ADD in the Victoria System (gpm)

Year	Casa Blanca 1010	Victoria 1100
Existing (2003)	136	1,774
2005	136	1,774
2007	136	1,774
2010	136	1,784
2015	136	1,889
2020	136	2,154
2025	143	2,158

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-26**, the total storage required for the Victoria 1100 and Casa Blanca 1010 Zones is 7.0 MG under existing conditions and 8.0 MG under future conditions. However, there is no existing storage in either zone under existing conditions. Therefore, operational storage for this zone needs to be included in the Gravity or 1200 Zones, since these zones can be served by pumping or by PRV, and fire and emergency storage is available from the 1200 Zone. Calculations for storage capacities for the Gravity and 1200 Zones includes the storage for the Victoria 1100 and Casa Blanca 1010 Zones. Therefore, storage deficiencies in the Victoria 1100 and Casa Blanca 1010 Zones are addressed with recommendations made for the Gravity and 1200 Zones.

Table 8-26
Storage Evaluation of the Victoria 1100 and Casa Blanca 1010 Zones

Storage Required (Future):	**Storage (MG)**
Operational Storage	1.5
Fire Flow Storage	1.0
Emergency Storage	5.5
Total Required	**8.0**
Storage Available:	
Total Available	**0.0**
Total Deficiency	**8.0**
Recommended:	
Storage Provided from 1200 Zone	8.0

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-27**, listing the future booster pumping requirements and capacities.

Table 8-27
Booster Pump Capacity Evaluation – Victoria 1100 Zone

Criteria	Casa Blanca 1010 and Victoria 1100 Future
Booster Pumping Required (MDD+FF)	8,000
Booster Pumping Required (PHD)	4,300
Existing Booster Station Capacity	3,900
Capacity with Largest Pump Out of Service	3,200
Total Surplus (Deficiency)	(4,200)

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

The existing St. Lawrence Booster Station has a firm capacity of 1,400 gpm. Since fire flow and emergency storage for the Victoria system is located in the 1200 Zone and served by PRVs, St. Lawrence Booster Station only needs to serve operational demands. The required capacity of the St. Lawrence Booster Station to meet existing PHD is 4,300 gpm (3,700 gpm for MDD) and to meet future PHD is 5,000 gpm (4,300 gpm for MDD).

Since operational storage for the Victoria system is also located in the 1200 Zone, some of the booster capacity for peaking can be transferred to the 1200 Zone, as necessary. In addition, there are limitations in the 18-inch diameter suction and discharge pipelines. Therefore, it is recommended that capacity upgrades to St. Lawrence Booster Station be limited. St. Lawrence Booster Station Pump No. 1 often cannot deliver flow due to the low shut-off head of the pump; it is recommended that the pump be replaced with an 1,800 gpm to match the largest pump, Pump No. 4 (B-6). No recommendations are made for the other pumps at St. Lawrence Booster Station, due to the limited capacity of the existing pipelines. This improvement will increase the firm capacity of St. Lawrence Booster Station to 3,900 gpm; however, the booster pump deficiency is still 400 gpm when compared to future PHD. This deficiency will be addressed as part of the 1200 Zone improvements. The existing PRVs have sufficient capacity to serve this zone for operational and fire supplies.

To address low pressures in a portion of the Gravity Zone, a section of the existing Gravity Zone should be converted to the Casa Blanca 1010 Zone. The region to be converted to the Casa Blanca Zone is bounded by Maude Street to the east, Marguerita Avenue to the south, Ronald Street to the west, and Indiana Avenue to the north, converting all Gravity Zone pipelines in this region. Portions of Indiana Avenue between Mary Street and Madison Street should also be converted to the Casa Blanca 1010 Zone. Two new PRV stations will be necessary to serve the new portion of the Casa Blanca Zone, with the recommended locations at Maude Street and Marguerita Avenue, and at Ronald Street and Marguerita Avenue (V-1). The details for this conversion are shown on **Figure 8-7**.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within the Victoria 1100 and Casa Blanca 1010 Zones with low pressures below 40 psi or high pressures above 125 psi.

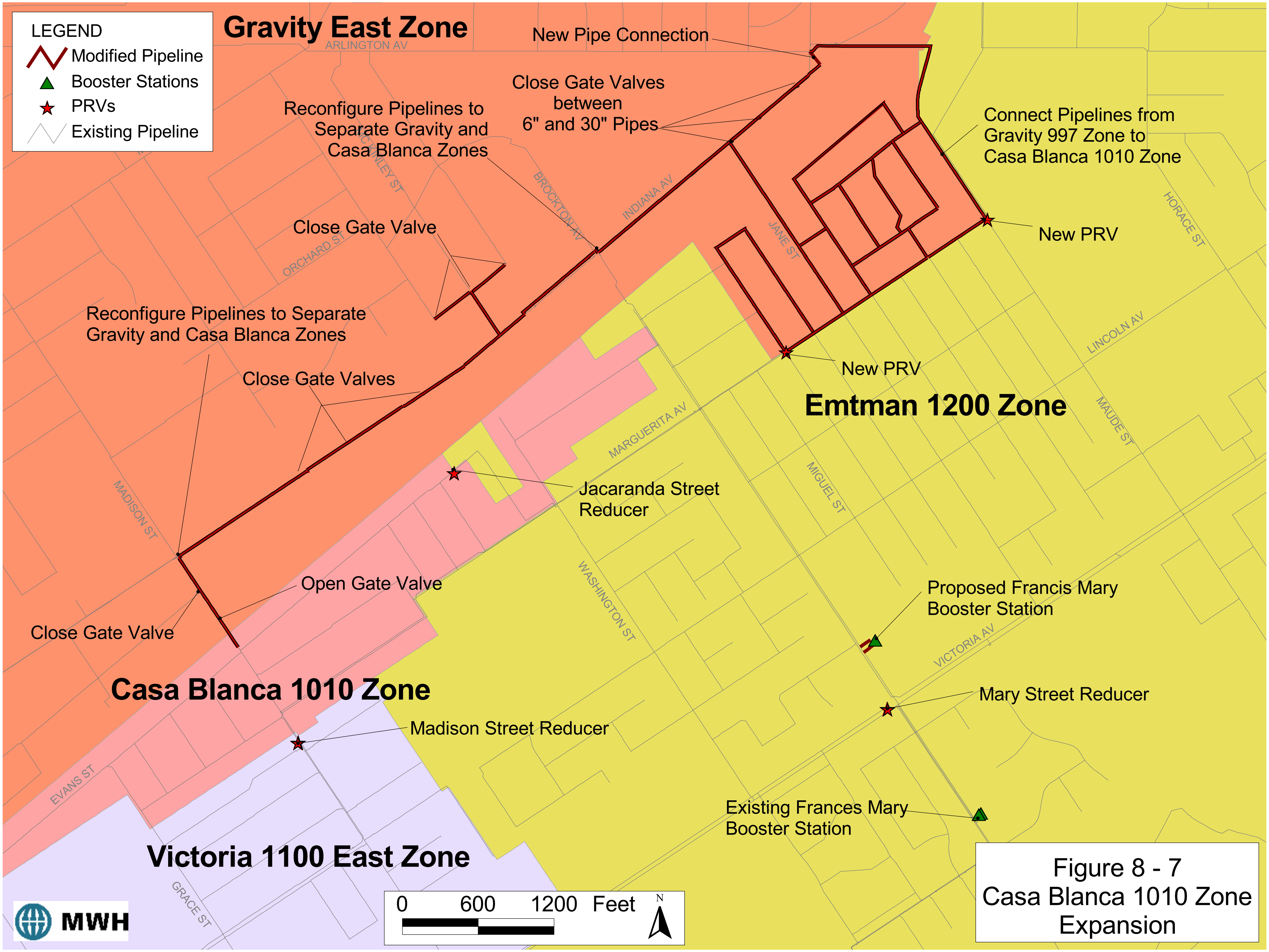


Figure 8 - 7
Casa Blanca 1010 Zone Expansion

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the model that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-28**. To address the fire flow deficiencies in the Victoria system, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-29**. In addition, the Madison Reducer needs to be upgraded to deliver sufficient fire flow to the Casa Blanca 1010 Zone – this upgrade should include a new 8-inch PRV and upgrading the suction and discharge piping to 12-inch diameter.

Summary of Recommendations for the Victoria System

Based on the evaluation described above, the following improvements are recommended for the Victoria system:

- St. Lawrence Booster – replace the existing Pump No. 1 with an 1,800 gpm pump; use existing suction and discharge piping (B-6)
- Casa Blanca 1010 – Expand the existing zone by adding two new PRV stations to bring water down from the Emtman 1200 Zone. This is to address existing low pressure issues (V-1)
- Replace pipelines for fire flow: 2,600 ft of 6-inch diameter pipeline, 5,200 ft of 8-inch diameter pipeline, and 3,100 ft of 12-inch diameter pipeline
- For fire flow, at Madison Reducer, install additional 8-inch diameter PRV and upgrade suction and discharge piping to 12-inch diameter

Table 8-28
Fire Flow Deficiencies in the Victoria System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
7594 Emerald St	Victoria 1100	3,500	2,470
City Yard	Victoria 1100	3,500	2,029
City Yard	Victoria 1100	3,500	1,796
City Yard	Victoria 1100	3,500	2,271
Emerald St & Grace St	Victoria 1100	3,500	2,222
Fern Av & Cary St	Victoria 1100	3,500	1,493
Fern Av & Grace St	Victoria 1100	3,500	2,505
Freda Av & Grace St	Victoria 1100	3,500	2,743
Irving St & Cherbourg Dr	Victoria 1100	3,500	3,148
Limestone Dr & Shorepine Ct	Victoria 1100	4,000	3,154
Lincoln Av & Bunker St	Victoria 1100	1,000	528
Lincoln Av & Sonora Pl	Victoria 1100	1,000	522
1659 Mathews St	Casa Blanca 1010	3,500	3,192
1792 Columbia Av	Casa Blanca 1010	3,500	1,766
1951 Thornton St	Casa Blanca 1010	3,500	2,745
Blenheim St & La Cadena Dr East	Casa Blanca 1010	3,500	2,762
Blenheim St & Laurel Av	Casa Blanca 1010	3,500	1,664
Columbia Av & La Cadena Dr East	Casa Blanca 1010	3,000	1,928
Kansas Av & La Cadena Dr East	Casa Blanca 1010	3,500	3,307
Marlborough Av & Mathews St	Casa Blanca 1010	3,500	2,932
Milton St & La Cadena Dr East	Casa Blanca 1010	3,500	2,565
Thornton St & La Cadena Dr East	Casa Blanca 1010	3,500	3,368
Madison St & Diamond St	Casa Blanca 1010	3,000	2,284
Washington St & Coolidge Av	Casa Blanca 1010	1,000	904
Peters St & Bunker St	Casa Blanca 1010	1,000	725
Evans St & Cary St	Casa Blanca 1010	3,000	1,685
Evans St & Samuel St	Casa Blanca 1010	3,000	1,809
Madison St & Evans St	Casa Blanca 1010	3,000	1,823
Madison St & Peters St	Casa Blanca 1010	3,000	2,244

Table 8-29
Fire Flow Recommendations in the Victoria System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Peters St	Madison St	Esperanza St	Casa Blanca 1010	4	6	722
Madison St	Peters St	Evans St	Casa Blanca 1010	8	12	624
Samuel St	Peters St	Evans St	Casa Blanca 1010	4	6	559
Evans St	Samuel St	Cary St	Casa Blanca 1010	6	8	351
Coolidge Av	Mary St	Washington St	Casa Blanca 1010	4	6	1,325
Irving St	Lincoln Av	Cherbourg Dr	Victoria 1100 West	6	8	902
Lincoln Dr	Monroe St	Gratton St	Victoria 1100 West	6	8	1,395
Grace St	Lincoln Av	Emerald St	Victoria 1100 East	6	12	876
Emerald St	7578 Emerald St	Madison St	Victoria 1100 East	6	8	495
Emerald St	Grace St	7578 Emerald St	Victoria 1100 East	6	12	810
Fern Av	Grace St	Madison St	Victoria 1100 East	6	8	1,327
Lincoln Dr	Madison St	Sonora Pl	Victoria 1100 East	4	8	714
City Yard	Adams St	St Lawrence St	Victoria 1100 East	6	12	796

CHICAGO 1100 AND UNIVERSITY 1037 ZONES

The Chicago 1100 and University 1037 Zones are located in the north central portion of the City, serving the region east of downtown and the University of California Riverside (UCR) campus. UCR is expecting a large increase in the student population in the next ten years. The University 1037 Zone only serves the UCR campus – UCR pumps from the University 1037 reservoir into their own storage reservoirs at higher elevations. The University 1037 Zone is fed from two booster pumps at the Chicago Low Booster Station. The Chicago 1100 Zone is fed from one booster pump in the Chicago High Booster Station (from the University 1037 Zone) and three pumps at the Mulberry Booster Station (from the Gravity Zone). In an emergency, the Chicago 1100 Zone can also be fed by two PRVs (Spruce Reducer and Chicago Reducer) from the 1200 Zone, but these are not normally used.

The projected ADD for each of the zones is presented below in **Table 8-30**.

Table 8-30
Projected ADD in the Chicago System (gpm)

Year	Chicago 1100	University 1037
Existing (2003)	1,815	1,204
2005	1,843	1,398
2007	1,862	1,592
2010	1,896	1,883
2015	1,945	2,369
2020	2,005	2,446
2025	2,127	2,523

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-31**, the total storage required for the University 1037 and Chicago 1100 Zones is 7.5 MG under existing conditions and 9.2 MG under future conditions. The existing University Heights Reservoir has a capacity of 5.1 MG. The Chicago 1100 Zone does not have any storage. However, since there is no space at the site for additional storage and the Chicago 1100 Zone is a pumped zone, operational and fire storage for this zone needs to be included in the Gravity Zone. Emergency storage can be supplied for the Chicago 1100 Zone from the 1200 Zone. Calculations for storage capacities for the Gravity and 1200 Zones includes the storage deficiency in the Chicago 1100 and University 1037 Zones, and therefore no storage recommendations are made for these zones.

Table 8-31
Storage Evaluation of the University 1037 and Chicago 1100 Zones

Storage Required (Future):	**Storage (MG)**
Operational Storage	3.4
Fire Flow Storage	1.0
Emergency Storage	5.1
Total Required	**9.2**
Storage Available:	
University Heights 1037	5.0
Total Available	**5.0**
Total Deficiency	**4.2**
Recommended:	
Operational Storage Provided in Gravity 997 Zone	1.7
Emergency Storage Provided in 1200 Zone	2.5

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-32** and **Table 8-33**, listing the existing and future booster pumping requirements, and existing and proposed booster pump capacities.

Table 8-32
Booster Pump Capacity Evaluation – Chicago 1100 Zone

Criteria	Chicago 1100 Future
Booster Pumping Required (MDD+FF)	8,000
Booster Pumping Required (PHD)	4,800
Existing Booster Station Capacity	7,500
Capacity with Largest Pump Out of Service	4,700
Total Surplus (Deficiency)	(500)

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

Table 8-33
Booster Pump Capacity Evaluation – University 1037 Zone

Total Pumping Required	Existing	Future
University 1037 Zone	2,300	4,600
Higher Zone (Chicago 1100)	3,500	0
Total Required	**5,800**	**8,600**
Booster Station	**Existing Capacity**	**Proposed Capacity**
Chicago	4,600	4,600
Total Capacity	**4,600**	**4,600**

Notes: Capacities are based the largest pump out of service at Chicago Booster Station to the University 1037 zone. Recommended modifications to Chicago Booster Station will allow the Chicago 1100 zone to be pumped directly from the Gravity Zone.

The booster station calculations show that there is a booster pump capacity deficiency in both the Chicago 1100 and University 1037 Zones. The Chicago 1100 Zone has a MDD+FF demand of 8,000 gpm and a PHD of 4,800 gpm. The total combined capacity at Mulberry Booster and Chicago Booster Pump No. 3 is 7,500 gpm with firm capacity of 4,700 gpm. Since the Chicago 1100 Zone is also served by the Spruce and Chicago Reducers, which can deliver fire flow and emergency flow, there is sufficient capacity in the existing booster pumps to meet operational demands.

The University 1037 Zone has a future MDD of 4,600 gpm. The University 1037 Zone also feeds the Chicago Booster Pump No. 3, which has a capacity of 3,000 gpm; therefore, the University 1037 Zone has a booster pumping requirement of 7,500 gpm. The existing Chicago Booster Pump Nos. 1 and 2, which feed the University 1037 Zone have a total capacity of 5,800 gpm and firm capacity of 3,000 gpm, which is insufficient to meet the needs of the University 1037 Zone and the Chicago Booster Pump No. 3. Therefore, it is recommended that Chicago Booster Pump No. 3 be replaced with a pump receiving suction from the Gravity Zone, bypassing the University 1037 Zone (B-5). This new pump should have a similar capacity to the existing pump (3,000 gpm), but the TDH needs to be higher (130 ft) and the pump station piping needs to be reconfigured. Thus, the capacity remaining in Chicago Booster Pump Nos. 1 and 2 will be sufficient to feed the University 1037 Zone (the capacity is not sufficient to meet demands with the largest unit out of service, but is acceptable since this reservoir is only used as a wetwell for UCR and UCR has additional storage)

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within the University 1037 and Chicago 1100 Zones with low pressures below 40 psi or high pressures above 125 psi for MDD and ADD conditions, respectively.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the model that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-34**. To address the fire flow deficiencies in the Chicago 1100 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-35**.

Table 8-34
Fire Flow Deficiencies in the Chicago Zone

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
Ottawa Av & Ninth St	Chicago 1100	4,000	2,146
Keith St & Anderson Av	Chicago 1100	2,500	1,954
1806 Loma Vista Av	Chicago 1100	2,500	2,194
Ottawa Av & Eleventh St	Chicago 1100	1,750	1,735
Seventh St & Mesa St	Chicago 1100	4,000	892
Linden St & Anderson Av	Chicago 1100	2,500	1,918
1842 9th St	Chicago 1100	4,000	637

Table 8-35
Fire Flow Recommendations in the Chicago Zone

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Ottawa Av	Ninth St	University Av	Chicago 1100	6	8	358
Ninth St	Ottawa Av.	End of Ninth St	Chicago 1100	4	8	402
Linden St	Ottawa Av.	Chicago Av	Chicago 1100	4	6	1,304

Summary of Recommendations for the Chicago System

Based on the evaluation described above, the following improvements are recommended for the University 1037 and Chicago 1100 system:

- Replace Chicago Booster Pump No. 3 with a new pump (3,000 gpm at 130 ft TDH) from the Gravity Zone; reconfiguring piping as appropriate (B-5).
- Replace pipelines for fire flow: approximately 1,300 ft of 6-inch diameter pipeline and 800 ft of 8-inch diameter pipeline.

HIGHGROVE 1037 AND 1120 ZONES

The Highgrove 1037 and 1120 Zones are two small zones located in the northeast portion of the City and in unincorporated Riverside County. The zones are served by PRV from the 1200 Zone, with the Highgrove Reducer serving the Highgrove 1037 Zone and the Prospect Reducer serving the Highgrove 1120 Zone.

The projected ADD for each of the zones is presented below in **Table 8-36**.

Table 8-36
Projected ADD in the Highgrove System (gpm)

Year	Highgrove 1037	Highgrove 1120
Existing (2003)	233	106
2005	234	106
2007	235	106
2010	236	106
2015	238	108
2020	273	108
2025	306	125

Storage Evaluation

Storage for the Highgrove Zones are included in the evaluation for the 1200 Zone.

Booster Station and Pressure Regulator Evaluation

There are no booster stations serving either Highgrove Zone. The two PRV stations serving the Highgrove Zones are undersized to meet fire flows as shown in Table 8-5 and Table 8-6**.** It is recommended that one of the 6-inch diameter PRV at Highgrove Reducer be replaced with an 8-inch diameter PRV. An additional 8-inch diameter PRV is necessary at Prospect Reducer.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within the Highgrove Zones with low pressures below 40 psi or high pressures above 125 psi, for MDD and ADD conditions, respectively.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the Highgrove Zones that cannot meet the minimum 20 psi according to the model with fire flow demands are described in **Table 8-37**. To address the fire flow deficiencies in the Highgrove Zones, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-38**.

Table 8-37
Fire Flow Deficiencies in the Highgrove Zones

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
1202 Fountain St	Highgrove 1037	3,000	446
407 Devener St	Highgrove 1037	3,000	593
1124 Villa St	Highgrove 1037	3,000	893
679 Center St	Highgrove 1120	3,000	1,235
1027 Citrus St	Highgrove 1120	3,500	1,876
Center St & Walker Av	Highgrove 1120	3,500	1,463
696 Arliss St	Highgrove 1120	3,000	1,498
Flynn St & Sanrive Av	Highgrove 1120	3,000	1,626
Main St & Sanrive Av	Highgrove 1120	3,000	1,686
Center St & California Av	Highgrove 1120	3,000	1,755
Center St & Prospect Av	Highgrove 1120	3,000	1,777
Church St & California Av	Highgrove 1120	3,000	1,765
Transit Av & Church St	Highgrove 1120	3,000	1,812
Transit Av & Villa St	Highgrove 1120	3,000	1,779
Transit Av & Fountain St	Highgrove 1120	3,000	1,816
Main St & Commercial Av	Highgrove 1037	3,000	1,296
621 Prospect Av	Highgrove 1120	3,000	1,848
Center St & Garfield Av	Highgrove 1120	3,500	1,574

Table 8-38
Fire Flow Recommendations to Address Deficiencies in the Highgrove Zone

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Villa St	Pacific Av	Glen Av	Highgrove 1037	4	8	453
Pacific Av	Villa St	Center St	Highgrove 1037	4	8	867
Fountain St	Pacific Av	End of Fountain St	Highgrove 1037	4	6	436
Devener St	Villa St	End of Devener St	Highgrove 1037	4	6	306
Villa St	Pacific Av	Highland Av	Highgrove 1037	4	6	269
Prospect Av	Citrus Av	Spring St	Sugarloaf 1200	8	12	408
Highland Av	Center St	Mound St	Highgrove 1037	4	8	898
Mound St	Commercial Av	Highland Av	Highgrove 1037	4	6	131
Main St	Commercial Av	Highland Av	Highgrove 1037	None	8	380
Citrus St	Prospect Av	1027 Citrus St	Sugarloaf 1200	None	12	776
Walker Av	Center St	Flynn St	Highgrove 1120	6	8	674
Spring St	California Av	Prospect Av	Highgrove 1120	8	12	360
California Av	Center St	Prospect Av	Highgrove 1120	8	12	1,324

Summary of Recommendations for the Highgrove System

Based on the evaluation described above, the following improvements are recommended for the University 1037 and Chicago 1100 system:

- Replace 6-inch PRV with 8-inch PRV at Highgrove Reducer.

- Add 8-inch PRV at Prospect Reducer.
- Replace pipelines for fire flow: 1,100 ft of 6-inch diameter pipeline, 3,300 ft of 8-inch diameter pipeline, and 2,900 ft of 12-inch diameter pipeline.

1200 ZONE

The 1200 Zone runs along the City's eastern foothills from the northern portion of the City to the southern portion. The zone is divided into three sections – Sugarloaf, Emtman, and Van Buren. The 1200 Zone is fed from the Gravity Zone by six booster stations: Industrial, Linden, Victoria, Chase, Frances Mary, and Mockingbird. All of the higher zones are fed through the 1200 Zone via pumping. The 1200 Zone feeds the Highgrove 1037, Highgrove 1120, and Victoria 1100 Zones via PRVs. The 1200 Zone has three existing reservoirs within the zone, Sugarloaf, in the northeast portion of the City, Emtman, in the southeastern portion of the City, and Van Buren in the southern portion of the City. The projected ADD for each of the zones is presented below in **Table 8-39**.

Table 8-39
Projected ADD in the 1200 Zone (gpm)

Year	Sugarloaf 1200	Emtman 1200	Van Buren 1200
Existing (2003)	2,121	3,680	475
2005	2,203	3,680	475
2007	2,240	3,680	475
2010	2,359	3,717	475
2015	2,422	3,717	525
2020	2,422	3,774	664
2025	2,478	3,965	664

Storage Evaluation

As presented in Table 8-1 and Table 8-2, the total storage required for the 1200, Highgrove, Praed 1400, Gratton 1400, and Michigan 1400 Zones is 23.4 MG under existing conditions and 27.0 MG under future conditions. However, since there is no storage in the Victoria 1100 and Casa Blanca 1010 Zones, sufficient supply capacity is also needed to serve these zones. Emergency storage deficiencies in the Chicago 1100 Zone will also be included in the 1200 Zone. A summary of storage needs for the 1200 Zone is shown in **Table 8-40**.

Table 8-40
Storage Evaluation – 1200 and Associated Zones

Storage Required (Future Demands):	**Storage Capacity (MG)**
1200 and Pumped/Reduced Zones (Highgrove, Praed, Gratton, Michigan)	27.0
Victoria 1100 and Casa Blanca 1010	8.0
Emergency Deficiency in Chicago 1100 Zone	2.5
Total Required	**37.5**
Storage Available:	
Sugarloaf Reservoir	5.0
Emtman Reservoir	5.0
Van Buren Reservoir	7.5
Total Available	**17.5**
Total Deficiency	**20.0**
Recommended:	
Sugarloaf Expansion	5.0
Emtman Expansion	7.5
Van Buren Expansion	7.5
Total Recommended	**20.0**

Since the 1200 Zone covers such a large area, storage must be appropriately located to serve customers. The Sugarloaf Reservoir serves the northern portion of the 1200 Zone, but also serve as emergency storage for the Chicago 1100 Zones. The Emtman Reservoir serves the central portion of the 1200 Zone; model results and storage calculations show that this area has the greatest deficiency in storage. The Van Buren Reservoir serves the southern portion of the 1200 Zone, which has minimal demand, and also the Praed 1400 Zone, Gratton 1400 Zone, Victoria 1100 Zone, and Casa Blanca 1010 Zone.

The total required storage for the 1200 and associated Zones is 37.5 MG, compared to a total existing storage of 17.5 MG, for a storage deficiency of 20.0 MG. Therefore, 20 MG of storage is recommended for the 1200 Zone. There is space next to the existing Sugarloaf Reservoir for an additional 5 MG Reservoir (R-7). There is space next to the existing Van Buren Reservoir for an additional 7.5 MG Reservoir (R-8). There is space near the existing Emtman Reservoir for additional storage; however, property acquisition and construction issues are expected to be significant. One potential site for a new 7.5 MG in the Emtman 1200 Zone is at the end of Horace Street, south of Hawarden Drive; however, other sites are possible (R-6). There is not sufficient transmission capacity to locate the needed Emtman Reservoir storage at Sugarloaf or Van Buren and to serve the Emtman portion of the 1200 Zone.

Booster Station and Pressure Regulator Evaluation

Booster stations to the 1200 Zone provide water to the 1200 Zone, as well as all higher zones (via additional pumping) as well as some lower zones via a PRV. A summary of booster pumping requirements is shown in **Table 8-41**, listing the existing and future booster pumping requirements, and existing and proposed booster pump capacities.

Table 8-41
Booster Pump Capacity Evaluation – 1200 Zone

Total Pumping Required	Existing	Future
1200 Zone	12,700	14,300
Higher Zones	11,500	16,600
Victoria 1100 Deficiency	500	400
Total Required	**24,700**	**31,300**
Booster Station	**Existing Capacity**	**Proposed Capacity**
Industrial	4,500	4,500
Linden	3,400	7,100
Victoria	7,300	8,200
Chase	500	0
Frances Mary	1,100	5,200
Mockingbird	3,700	6,600
Total Capacity	**20,500**	**31,600**

Note: Capacities are based on one gas and one electric pump out of service at Linden, the gas pump out of service at Victoria, and one pump out of service at Mockingbird.

The total required booster pump capacity for the 1200 Zone is 24,700 gpm with existing MDD and 31,300 with future MDD. The total firm capacity of the existing booster stations serving the 1200 Zone is 20,500 gpm, with a 4,200 gpm deficit with existing MDD and 10,800 gpm deficit with future MDD. Each of the booster pump stations feeding the 1200 Zone are discussed individually below, including recommended improvements.

Industrial Booster Station is located in the northern portion of the City, and currently feeds the Sugarloaf portion of the 1200 Zone directly from the 42-inch San Bernardino Transmission Pipeline, a supply transmission pipeline from the Bunker Hill Groundwater Basin. Supply issues in the Bunker Hill Basin are likely to require that all the water supplies be fed first to Linden-Evans Reservoir before distribution in the system. Therefore, the Industrial Booster suction needs to be rerouted to feed from the Gravity Zone, rather than directly from the San Bernardino Transmission Pipeline. There is a section of 24-inch diameter pipeline in Columbia Avenue from Chicago Avenue to Iowa Avenue that is unused and can be used as suction piping to Industrial Booster. There is a 30-inch diameter transmission pipeline in Orange Street(s) with minimal demands; Industrial Booster can be served from this pipeline with minimal effect on system pressures. To tie the booster suction to these pipelines, the following pipelines are necessary: 3,200 ft of 24-inch diameter pipeline in Columbia Avenue from Orange Street to Chicago Avenue, and 1,500 ft of 24-inch diameter pipeline in Iowa Avenue from Columbia Avenue to the booster station as shown on Figure 8-4 (P-13). The suction heads before and after are essentially equal, and no capacity improvements are recommended for this station.

Linden Booster Station is located at the Linden-Evans Reservoir and serves the Emtman and Sugarloaf portions of the 1200 Zone. The booster station has three gas engine-driven pump and one electric pump. The gas-engine driven pumps cavitate when all three gas engine-driven pumps are operated simultaneously; the gas-engine driven pumps also can only operate at approximately 1,500 gpm each because the pumps cavitate when the setpoints are increased (the pumps have a design flow of 3,000 gpm). This may be due to undersized suction pipelines, but additional studies are recommended to increase Linden Booster Station to its design capacity. A future firm capacity of 7,100 gpm has been assumed for planning purposes.

Victoria Booster Station serves the Emtman 1200 Zone, and contains three electric pumps and one gas engine-driven pump. The gas engine-driven pump is used only in case of emergency. City staff have considered replacing this gas engine-driven pump with an electric pump, but this is not recommended, as the gas engine-driven pump provides additional reliability since it has a different power source. Victoria Booster Pump No. 2 capacity is 1,800 gpm, while the other booster pumps have a larger nameplate capacity. Therefore, it is recommended that the pump be replaced by a 2,500 gpm pump to increase the capacity of Victoria Booster Station (B-7). Additional expansion of Victoria Booster Station is not recommended as the existing suction and discharge transmission pipelines are close to capacity.

Chase Booster Station is a small booster station with a single 500 gpm pump. No modifications are recommended for this facility. Given the old age and limited reliability of this single pump, its capacity is not included to meet future demands.

Frances Mary Booster Station is located in a historic building; only one of the two pumps inside the building is operational and produces a total of 1,100 gpm. To help address booster station capacity deficiencies in the 1200 Zone, a new Frances Mary Booster Station is recommended at Washington Park. This booster station should have three pumps, each sized at 2,600 gpm and 250 ft TDH (B-4). At the time this is completed, the existing Frances Mary Booster Station should be abandoned, and a portion of the existing 20-inch booster station suction will become the discharge pipeline from the new booster station.

Mockingbird Booster, located in the southern portion of the City, contains three pumps, with an existing pump can for a fourth pump. It is recommended that the City add a fourth pump with a capacity of 2,800 gpm in the existing spare pump can (B-3).

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are four locations within the 1200 Zone with low pressures below 40 psi (under MDD conditions) as shown in **Figure 8-1**. The region along Equestrian Drive behind Van Buren Reservoir has pressures as low as 17 psi. Each of the homes in this region has an individual booster pump, but the pressures are too low to meet fire flow requirements. The low pressure is due to static elevation, and is a concern when the level in Van Buren Reservoir drops. However, there is sufficient water available due to close proximity to the reservoir. The second location is near the suction of Gratton Booster Station, where the pressure drops to 36 psi during MDD. There are also two locations in the Emtman 1200 Zone with pressures that drop to 39 psi during MDD – at the intersection of La Mart Drive and El Cerrito Drive, near the Canyon Crest Town Center, and at the end of Blazewood Street in the same vicinity. No improvements are recommended.

There are several locations with high pressures between 125 and 150 psi in both the Emtman 1200 and Sugarloaf 1200 Zones as shown in **Figure 8-2**. No modifications are recommended to address the high pressures, as lowering the region to another zone would result in additional zone configuration problems.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the 1200 Zone that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-42**. To address the fire flow deficiencies in the 1200 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-43**.

Table 8-42
Fire Flow Deficiencies in the 1200 Zone

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
2266 Kentwood Dr	Sugarloaf 1200	3,500	1,989
Monterey Rd & Berkeley Rd	Emtman 1200	3,500	873
6806 Leland Av	Emtman 1200	3,000	694
Monterey Rd & Robin Rd	Emtman 1200	3,000	871
3170 Pachappa Hill	Emtman 1200	1,000	493
5185 Monterey Rd	Emtman 1200	1,000	891
Coolidge Av & Ronald St	Emtman 1200	1,000	686
2520 Raeburn Dr	Emtman 1200	1,000	517
9501 Equestrian Dr	Van Buren 1200	1,000	0 (pressure < 20 psi)
9600 Equestrian Dr	Van Buren 1200	1,000	964
10510 Dufferin Av	Van Buren 1200	1,000	887
2110 McAllister St	Van Buren 1200	1,000	334
John St & Trails End	Van Buren 1200	1,000	284
7820 Summit St	Van Buren 1200	1,000	985
Washington St & Bradley St	Van Buren 1200	1,000	690
10150 Trails End	Van Buren 1200	1,000	258

Summary of Recommendations for the 1200 Zone

Based on the evaluation described above, the following improvements are recommended for the 1200 Zone:

- Emtman Reservoir - add a new 7.5 MG reservoir at the end of Horace St. and add approximately 8,000 LF of 30” pipeline to connect the new reservoir with the 24” Emtman 1200 pipeline in Victoria Ave (R-1 and P-18).
- Sugarloaf Reservoir - add a second 5 MG reservoir at the existing Sugarloaf Reservoir site; use the existing inlet/outlet pipeline (R-7).
- Van Buren Reservoir - add 7.5 MG of storage at the existing Van Buren Reservoir site; use the existing inlet/outlet pipeline (R-8).
- Mockingbird Booster - add a fourth pump with a capacity of 2,800 gpm; use existing spare pump can (B-3).
- Frances Mary Booster - construct a new booster pump station at Washington Park with three 2,600 gpm pumps. Decomission existing Frances Mary booster pump station. (B-4).

Table 8-43
Fire Flow Recommendations in the 1200 Zone

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Leland Av	Mary St	Roland St	Emtman 1200	4	6	630
Monterey Rd	Robin Rd	Ivy St	Emtman 1200	4	6	558
	End of Gibraltar Dr	Across from Pachappa Dr	Emtman 1200	4	6	1,479
Maude St	Marlo Way	End of Maude St	Emtman 1200	4	6	551
Coolidge Av	Mary St	Roland St	Emtman 1200	4	6	794
McAllister St	Dufferin Av	City Boundary	Van Buren 1200	4	8	1,213
John St	Dufferin Av	Trails End	Van Buren 1200	4	8	1,415
Trails End	John St	End of Trails End	Van Buren 1200	4	8	368
Grace St	Broadacre Pl	2090 Grace St	Van Buren 1200	6	8	605
Summit St	Grace St	Huntington St	Van Buren 1200	6	8	1,829
Huntington St	Summit St	Washington St	Van Buren 1200	6	8	314
Washington St	Huntington St	Bradley St	Van Buren 1200	6	8	1,245
Kentwood Dr/Glenhill Dr	Spruce St	Sugarloaf Dr	Sugarloaf 1200	6	12	1,891
Kentwood Dr	Spruce St	End of Kentwood Dr	Sugarloaf 1200	6	8	593
Elgin Dr	Canyon Crest Dr	2929 Elgin Dr	Sugarloaf 1200	6	12	198
Gage Canal crossing	2929 Elgin Dr	Intersection of Massachusetts Av & Don Goodwin Dr	Sugarloaf 1200	6	12	405
Massachusetts Av	Iowa Av	Don Goodwin Dr	Sugarloaf 1200	6	12	2,099
Rustin Av	Massachusetts Av	Linden St	Sugarloaf 1200	6	12	2,640
Tripoli St/Edinburgh Av	Rustin Av	End of Edinburgh Av	Sugarloaf 1200	6	8	751
Ohio St	Chicago Av	1834 Ohio St	Sugarloaf 1200	6	8	588
Vassar Dr	Chicago Av (20-inch pipe)	Wellesley Wy	Sugarloaf 1200	6	8	260
Palmyrita Av	Ardmore St	1540 Palmyrita Av	Sugarloaf 1200	4	12	508
Ardmore St	Palmyrita Av	Columbia Av	Sugarloaf 1200	4	12	1,305
Elgin Dr	2929 Elgin Dr	End of Elgin Dr	Sugarloaf 1200	6	8	8,680
New Kirk Dr/Altura Dr/Baltic Av	Massachusetts Av	Bascomb Dr	Sugarloaf 1200	6	8	881
Bascomb Dr	Baltic Av	1009 Bascomb Dr	Sugarloaf 1200	6	8	528
Minerva Ct	Rustin Av	1051 Minerva Ct	Sugarloaf 1200	6	8	316
Athena Ct	Rustin Av	1051 Athena Ct	Sugarloaf 1200	6	8	293
Seventh St	Crawford Av	End of 7th St	Sugarloaf 1200	6	8	618
Ottawa Av	Martin Luther King Blvd	Prince Albert Dr	Sugarloaf 1200	6	8	1,608
Chicago Av	University Av	Martin Luther King Blvd	Sugarloaf 1200	Construct Parallel	16	2,542

- Victoria Booster – replace existing Pump No 2 with a 2,500 gpm pump; enlarge Pump No. 2 suction and discharge piping, valves, and electrical; no change in the 30” suction and 24” discharge to and from the pump station (B-7).
- Linden Booster – modify booster station to produce the design capacity.
- Industrial Booster – rerouted suction piping to use existing piping in Orange St, construct approximately 3,200 LF of 24” piping in Columbia Av and construct approximately 1,500 LF of 24” pipeline between Columbia and the suction of Industrial Booster (P-13).
- Replace pipelines for fire flow: 4,000 ft of 6-inch diameter pipeline, 22,100 ft of 8-inch diameter pipeline, 9,000 ft of 12-inch diameter pipeline, and 2,500 ft of 16-inch diameter pipeline.

MICHIGAN 1400 ZONE

The Michigan 1400 Zone is located in the northeastern portion of the City. The projected ADD for the Michigan 1400 is presented in **Table 8-44** below.

Table 8-44
Projected ADD in the Michigan 1400 Zone (gpm)

Year	Michigan 1400
Existing (2003)	0
2005	88
2007	88
2010	88
2015	140
2020	140
2025	140

Storage Evaluation

Storage for the Michigan 1400 Zone is included as part of the 1200 Zone evaluation.

Booster Station Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. The Michigan Booster Station currently under construction is sized to meet future projected demands.

Summary of Recommendations for the Michigan 1400 Zone

There are no recommended improvements for the Michigan 1400 Zone.

HEUSTIS/ROSS SYSTEM (HEUSTIS 1400, ROSS 1400, COUNTRY CLUB 1400, CANYON CREST 1300, BLAINE 1300, MT. VERNON 1600)

The Heustis/Ross service area is in the eastern portion of the City and includes six pressure zones: Heustis 1400, Ross 1400, Country Club 1400, Canyon Crest 1300, Blaine 1300 and Mt. Vernon 1600. The three 1400 Zone sections (Heustis, Ross, and Country Club) are hydraulically connected to each other as well as the Piedmont 1400 Zone in the Alessandro system. The Blaine 1300 and Canyon Crest 1300 Zone are served by PRV from the 1400 Zone (Blaine 1300 can also be pumped from the 1200 Zone). The Mt. Vernon 1600 is pumped from the 1400 Zone. The Heustis/Ross/Country Club 1400 Zone is served by four booster stations: Country Club, Canyon Crest, Lemona, and Sugarloaf Boosters, each pumping from the 1200 Zone. The Sugarloaf Booster has two booster systems: the Sugarloaf Low Boosters pump from the 1200 Zone to the Blaine 1300 Zone, and the Sugarloaf High Boosters pump from the Blaine 1300 Zone to the Heustis 1400 Zone. The 1400 Zone is also served by two existing reservoirs: Ross Reservoir and Heustis Reservoir. The Blaine 1300 Zone is served by the Watkins Reducer as well as the Sugarloaf Low Booster. The Canyon Crest 1300 Zone is served by the Canyon Crest Reducer. The Mt. Vernon 1600 Zone is pumped from the 1400 Zone via the Mt. Vernon Booster.

The projected ADD for each of the zones in the Heustis/Ross system is presented below in **Table 8-45**.

Table 8-45
Projected ADD in the Heustis/Ross System (gpm)

Year	Blaine 1300	Canyon Crest 1300	Country Club 1400	Heustis 1400	Ross 1400	Mt. Vernon 1600
Existing (2003)	246	59	37	419	618	31
2005	246	59	37	419	618	31
2007	246	59	37	419	618	31
2010	246	59	37	419	771	31
2015	246	59	37	423	857	48
2020	246	65	37	516	888	157
2025	252	65	37	556	888	157

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-46**, the total storage required for the Heustis/Ross system is 5.4 MG under existing conditions and 6.9 MG under future conditions. Considering the existing reservoir sizes of 2 MG at Heustis Reservoir and 2 MG at Ross Reservoir, there is a total of 4 MG existing reservoir storage. Therefore, there is a 2.9 MG storage deficiency in the Heustis/Ross system. Adding the 0.9 MG storage deficiency in the Alessandro 1300 Zone and 1.3 MG storage deficiency in the Piedmont 1400 Zone brings the total storage deficiency in the Heustis, Ross, and Piedmont 1400 Zones to 5.1 MG. Therefore, a 5.2 MG storage reservoir is recommended for the 1400 Zone.

A potential site for this reservoir is located north of the 60 freeway and west of Watkins Dr, but other sites are possible as well (R-5). Since this reservoir serves both the Piedmont and the Heustis/Ross systems, it is recommended that the reservoir be connected to the existing 16-inch diameter pipeline on Canyon Crest Drive. To connect the proposed reservoir to the system at Canyon Crest Drive and El Cerrito Drive, about 4,200 feet of 20-inch diameter pipeline is necessary (P-17).

Table 8-46
Storage Evaluation of the Heustis/Ross System

Storage Required:	**Operational Storage (MG)**	**Emergency Storage (MG)**
Heustis 1400	0.4	1.3
Ross 1400	0.6	2.1
Country Club 1400	0.03	0.1
Blaine 1300	0.2	0.6
Canyon Crest 1300	0.04	0.2
Mt. Vernon 1600	0.1	0.4
Total Operational and Emergency	1.3	4.6
		Storage (MG)
Fire Flow		1.0
Total Required		**6.9**
Storage Available:		
Heustis 1400		2.0
Ross 1400		2.0
Total Available		**4.0**
Deficiency in Heustis/Ross System		2.9
Deficiency in Alessandro 1300 Zone		0.9
Deficiency in Piedmont 1400 Zone		1.3
Total Deficiency		**5.1**
Recommended:		
Additional Storage Reservoir Required		5.2

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-47** and **Table 8-48**, listing the existing and future booster pumping requirements, and existing and proposed booster pump capacities. The four existing booster pump stations have a firm capacity of 9,400 gpm, and at future MDD, the total required capacity is 6,300 gpm. Using just total capacity, the existing stations would appear to have ample capacity; however, system deficiencies exist for both the 1400 and 1600 zones.

Table 8-47
Booster Pump Capacity Evaluation – Heustis/Ross/Piedmont 1400 System

Total Pumping Required	**Existing**	**Future**
Heustis/Ross/Piedmont 1400 Zone and PRV Zones	3,700	4,700
Higher Zones (Mt. Vernon 1600, Campbell 1600, Crest 1680)	1,200	1,600
Total Required	**4,900**	**6,300**
Booster Station	**Existing Capacity**	**Proposed Capacity**
Canyon Crest	1,700	2,900
Country Club	1,500	1,500
Emtman High	2,600	2,600
Lemona	2,000	2,000
Sugarloaf	2,300	2,300
Total Capacity	**10,100**	**11,300**

Notes: Capacities are based the largest single pump out of service out of all the booster stations.

Table 8-48
Booster Pump Capacity Evaluation – Mt. Vernon 1600 Zone

Criteria	Mt. Vernon 1600 Future
Booster Pumping Required (MDD+FF)	1,300
Booster Pumping Required (PHD)	300
Existing Booster Station Capacity	500
Capacity with Largest Pump Out of Service	80
Total Surplus (Deficiency)	(800)

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

As a whole, there is sufficient booster pumping capacity to serve the 1400 Zone. However, due to the size of transmission mains' capacity in the 1400 Zone, based on results from model runs, there is not sufficient booster pumping capacity to maintain the level in the proposed 1400 Zone reservoir. Therefore, an expansion is recommended at Canyon Crest Booster Station to provide sufficient capacity to fill the proposed reservoir. Pump Nos. 1, 2 and 3 should be replaced with 75 hp pumps at 950 gpm and 250 ft TDH (same size as the existing pump No. 4), with suction and discharge piping upgraded equivalently (B-12). To deliver water from the upgraded Canyon Crest Booster Station to the system, several transmission pipelines are recommended – a 16-inch diameter pipeline along Canyon Crest Drive from Canyon Crest Booster Station to Central Avenue (2,400 ft) and a 12-inch diameter pipeline along Canyon Crest Drive from Central Avenue to Via Zapata (1,000 ft), (P-20 and P-21).

The existing Mt. Vernon Booster Station has a total capacity of 480 gpm. Since there is no storage in the Mt. Vernon 1600 Zone, the total required capacity of the station is the greater of MDD+FF and PHD demands. Under MDD+FF conditions, the demand in the Mt. Vernon 1600 Zone is 1,300 gpm. Therefore, there is insufficient capacity at Mt. Vernon Booster Station and a fire pump is necessary (800 gpm at 215 ft TDH).

Pressure reducing station calculations for existing and future conditions are presented in Table 8-5 and Table 8-6. These tables show that the Heustis/Ross 1400 Zone, Canyon Crest 1300, and Blaine 1300 Zones have deficient PRV capacity.

The Heustis/Ross system shows a PRV capacity deficiency because the City would like the ability to deliver water to this service zone from an existing connection to MWD from it Mills Treatment Plant. The recommendation addressing this deficiency is included in the Alessandro system discussion, and includes the recommendation for a new PRV station, Ransom Reducer, located at Canyon Crest Drive and Ransom Road. These improvements, plus the transmission pipelines described with the booster pump station, will allow Mills water to be delivered to the Heustis/Ross system.

The Canyon Crest PRV has insufficient capacity to meet MDD plus FF demands with the largest valve out of service. However, this deficiency is disregarded since nearby gate valves can be throttled to deliver the flow to the Canyon Crest 1300 Zone in case of the largest valve is out of service.

The Watkins PRV has insufficient capacity to meet MDD plus FF demands in the Blaine 1300 Zone. However, no improvements are recommended, because the Blaine 1300 Zone is also fed by the Sugarloaf Low Booster Station. This station has sufficient capacity to meet the deficiency in the undersized Watkins PRV, even with the largest booster pump out of service.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There is one location within the Heustis/Ross system with low pressures below 40 psi (under MDD conditions) as seen in Figure 8-1. There are a group of homes below Heustis Reservoir with pressures as low as 26 psi, due to the elevation of the homes below the reservoir. These homes have individual booster pumps so improvements are not necessary. Sections of the Canyon Crest 1300 and Ross 1400 Zones as shown in Figure 8-2, with pressures reaching as high as 155 psi (under ADD conditions) at the intersection of Canyon Crest Drive and Via Zapata. No modifications are recommended to address the high pressures.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the Huestis/Ross System that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-49**. To address the fire flow deficiencies in the Heustis/Ross system, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-50**.

Table 8-49
Fire Flow Deficiencies in the Heustis/Ross System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
500 Alta Mesa Dr	Blaine 1300	1,000	436
Blaine St & Celeste Dr	Blaine 1300	1,000	721
430 Maravilla Dr	Blaine 1300	1,000	631
Big Springs Rd & Valencia Hill Dr	Blaine 1300	3,500	1,410
Watkins Dr & Big Springs Rd	Blaine 1300	2,500	1,301
Mt Vernon Av & Big Springs Rd	Blaine 1300	3,500	1,248
273 W Broadbent Dr	Blaine 1300	3,500	454
End of Quail Rd	Heustis 1400	1,000	587
End of Maricopa Dr	Heustis 1400	1,000	370
2270 Mt Vernon Av	Mt Vernon 1600	1,000	361
2190 Mt Vernon Av	Mt Vernon 1600	1,000	411
2005 Mt Vernon Av	Mt Vernon 1600	1,000	311
2173 Mt Vernon Av	Mt Vernon 1600	1,000	372
2866 Mt Vernon Av	Mt Vernon 1600	1,000	292

Table 8-50
Fire Flow Recommendations in the Heustis/Ross System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Broadbent Dr	Watkins Dr	End of Broadbent Rd	Blaine 1300	4	8	267
Discharge of Watkins PRV			Blaine 1300	8	12	22
Valencia Hill Dr	Watkins PRV	Watkins Dr	Blaine 1300	8	12	72
Valencia Hill Dr	Watkins Dr	Big Springs Rd	Blaine 1300	6	12	1,302
Big Springs Rd	Valencia Hill Dr	Watkins Dr	Blaine 1300	8	12	546
Celeste Dr	Highlander Dr	Blaine St	Blaine 1300	6	8	258
Alta Mesa Dr	Flanders Rd	Waldorf Dr	Blaine 1300	6	8	1,235
Maravilla Dr	Campus View Dr	Maraville Dr	Blaine 1300	6	8	388
Quail Rd	Broadbent Rd	End of Quail Rd	Heustis 1400	4	6	767
Maricopa Dr	Blaine St	End of Maricopa Dr	Heustis 1400	4	6	628
Dirt Road	Mt. Vernon Av	End of Dirt Road	Mt. Vernon 1600	6	8	2,457

Summary of Recommendations for the Heustis/Ross System

Based on the evaluation described above, the following improvements are recommended for the Heustis/Ross system:

- Canyon Crest Booster - Replace pumps 1, 2, and 3 with 75 hp pumps (existing size of pump 4) at 950 gpm and 250 ft head. Upgrade suction and discharge piping and the electrical motor control appropriately (B-12).
- Add about 2,400 ft of 16-inch diameter pipeline from Canyon Crest Booster Station, south along Canyon Crest Drive to intersection of Central Avenue, and add about 1,000 LF of 12 inch diameter pipeline along Canyon Crest Drive from Central Avenue to Via Zapata (P-20 and P-21).
- 1400 Zone Reservoir - New 5.2 MG Reservoir for storage in the 1400 Zone. Approximately 4,200 LF of 20 inch piping including a freeway crossing to connect the reservoir to the system at Canyon Crest & El Cerrito (R-5 and P-17).
- Add a third pump at Mt. Vernon Booster Station (800 gpm at 215 ft TDH).
- Replace pipelines to improve fire flow: approximately 1,400 ft of 6-inch diameter pipeline, approximately 2,100 ft of 8-inch diameter pipeline and approximately 1,900 ft of 12-inch diameter pipeline.

UNIVERSITY CITY SYSTEM

The University City service area in the eastern portion of the City includes two independent pressure zones: University City 1600 and University City 1750. The University City 1600 Zone is fed by Ross Booster Station, and has one reservoir – University City Reservoir. University City 1750 Zone is fed by University City Booster Station, and does not have any storage. The projected ADD for each of the zones is presented below in **Table 8-51**.

Table 8-51
Projected ADD in the University City System (gpm)

Year	University City 1600	University City 1750
Existing (2003)	109	486
2005	109	486
2007	109	486
2010	109	486
2015	112	486
2020	112	486
2025	181	508

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-52**, the total storage required for the University City system is 2.2 MG under existing conditions and increases to 2.4 MG under future conditions. The existing University City Reservoir, with a capacity of 3.0 MG, has sufficient capacity to meet existing and future demands.

Table 8-52
Storage Evaluation of the University City System

Storage Required:	**Operational Storage (MG)**	**Emergency Storage (MG)**
University City 1600	0.1	0.4
University City 1750	0.4	1.2
Total Operational and Emergency	0.5	1.7
		Storage (MG)
Fire Flow		0.3
Total Required		**2.4**
Storage Available:		
University City 1600		3.0
Total Available		**3.0**
Total Surplus		**0.6**

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. The existing Ross Booster Station has a total firm capacity of 1,800 gpm. A summary of booster pumping requirements is shown in **Table 8-53** and **Table 8-54**, listing the existing and future booster pumping requirements, and existing and proposed booster pump capacities. The total required booster pumping capacity for University City 1600 is 1,300 gpm under future demands, and therefore, the Ross Booster Station has sufficient capacity to meet future demands.

Table 8-53
Booster Pump Capacity Evaluation – University City 1600 Zone

Total Pumping Required	Existing	Future
University City 1600 Zone	200	300
Higher Zone (University City 1750)	900	1,000
Total Required	**1,100**	**1,300**
Booster Station	**Existing Capacity**	**Proposed Capacity**
Ross	1,800	1,800
Total Capacity	**1,800**	**1,800**
Total Surplus	**700**	**500**

Notes: Capacities are based the largest pump out of service at Ross Booster Station.

Table 8-54
Booster Pump Capacity Evaluation – University City 1750 Zone

Criteria	Future
Booster Pumping Required (MDD+FF)	3,500
Booster Pumping Required (PHD)	2,000
Existing Booster Station Capacity	3,200
Capacity with Largest Pump Out of Service	2,400
Total Surplus (Deficiency)	(300)

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

The existing University City Booster Station has a total capacity of 3,200 gpm. Since there is no storage in the University City 1750 Zone, the total required capacity of the station is the greater of MDD+FF and PHD demands. Under MDD+FF conditions, the demand in the University City 1750 Zone is 3,500 gpm. Based on the capacity analysis, the booster station capacity appears to be insufficient. However, based on the model runs during conditions with high fire flow demands, pressures are slightly depressed in the system, and the booster station provides sufficient fire flow. In addition, there is a metered emergency interconnection with WMWD that will open in the event of low pressure. Therefore, no improvements are recommended.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There is one service area within the University City 1600 Zone with low pressures below 40 psi under MDD conditions as seen in Figure 8-1. The region around Tulane Avenue and Cornell Avenue has nominally low pressures as low as 32 psi during MDD conditions due to high elevations. To address the low pressures, the distribution pipelines should be converted from the University City 1600 to University City 1750 Zone: 6-inch diameter pipe in College Blvd from Kirkmichael Drive to Stanford Ave, 4- and 8-inch diameter pipes in Stanford Ave from Eton Lane to College Blvd, 4- and 8-inch diameter pipes in Tulane Ave, and 8-inch diameter pipe in Cornell Ave. Converting these pipelines to the University 1750 Zone will address the low pressures in the zone; however, it will raise pressures in the region to as high as 150 psi. Thus, a PRV at College Blvd. north of Kirkmichael Drive is necessary to regulate pressures (V-9), and a check valve at Princeton Avenue east of Lehigh Lane for emergencies. The detail of this conversion is shown on **Figure 8-8**.

There are significant portions of the University City 1750 Zone with high pressures between 125 and 150 psi during ADD conditions as seen in Figure 8-2. No improvements are recommended.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. There are no locations in the University City system that cannot meet the minimum 20 psi with fire flow demands.

Summary of Recommendations for the University City System

Based on the evaluation described above, the only recommended improvement is to convert a portion of the system from the University 1600 to the University 1750 Zone. This will require a PRV (V-9) at College Blvd. north of Kirkmichael Drive and a check valve at Princeton Avenue east of Lehigh Lane.

ALESSANDRO SYSTEM (ALESSANDRO 1300, PIEDMONT 1400, CAMPBELL 1600, AND CREST 1680 ZONES)

The Alessandro system in the central southern portion of the City includes four pressure zones: Alessandro 1300, Piedmont 1400, Campbell 1600 and Crest 1680. In the future, Campbell 1600 may be combined with the Whitegates 1568 Zone in the Whitegates system.

The projected ADD for each of the zones is presented below in **Table 8-55**.

Table 8-55
Projected ADD in the Alessandro System (gpm)

Year	Alessandro 1300	Piedmont 1400	Campbell 1600	Crest 1680
Existing (2003)	768	548	1,025	160
2005	768	548	1,025	160
2007	768	548	1,124	160
2010	848	650	1,288	160
2015	848	697	1,470	160
2020	848	697	1,470	160
2025	907	727	1,486	169

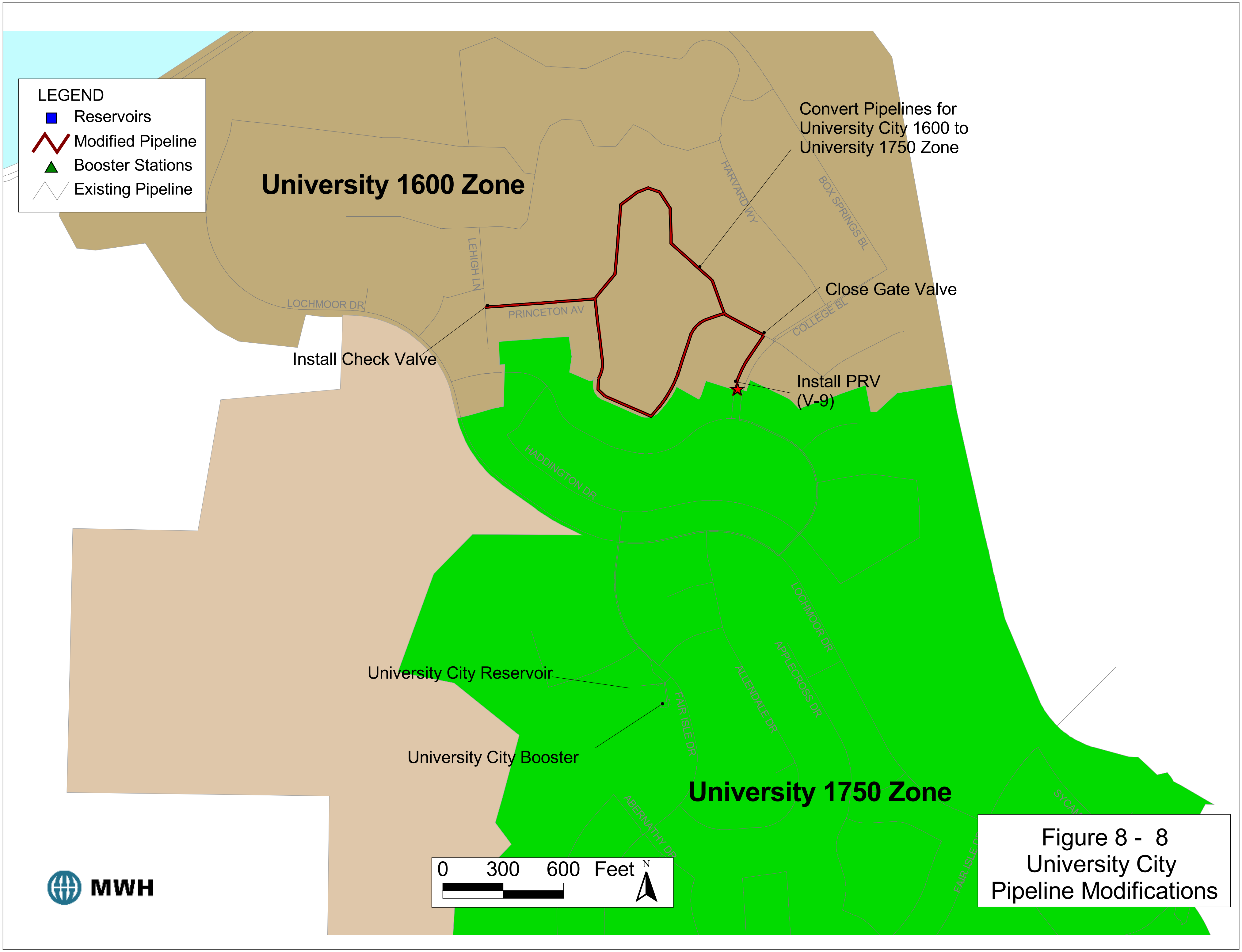


Figure 8 - 8
University City
Pipeline Modifications

System Configuration

The Alessandro 1300 Zone is fed by the Emtman Low Booster from the Emtman 1200 Zone and served by the Alessandro Reservoir. The Piedmont 1400 Zone is fed by the Emtman High Booster from the Emtman 1200 Zone and served by Piedmont Reservoir; the Piedmont 1400 Zone is also connected to the Heustis, Ross, and Country Club 1400 Zones. The Campbell 1600 Zone is fed by the Alessandro Booster from the Alessandro 1300 Zone and served by the Campbell Reservoir. The Crest 1680 Zone is fed by pumping from the Campbell 1600 Zone. Alternatively, the Campbell 1600 Zone can be served by the Mills connection providing imported water treated at the MWD's Mills Water Treatment Plant (WTP). Water from the Mills connection has chloramine as the disinfectant and should not be combined with groundwater from the wells, pumped from the lower zones which are disinfected with free chlorine.

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-56**, the total storage required for the Alessandro 1300 Zone is 2.5 MG under existing conditions and 2.9 MG under future conditions. This is greater than the existing Alessandro Reservoir, with a capacity of 2 MG. However, since there is not a location for additional storage in this region, it will be combined with storage for the 1400 Zone discussed in the section on the Country Club 1400 Zone.

Table 8-56
Storage Evaluation of the Alessandro Cascade System

Pressure Zone	Alessandro 1300	Piedmont 1400	Campbell and Crest 1600
Operational Storage (MG)	0.6	0.5	1.1
Emergency Storage (MG)	2.2	1.7	3.9
Fire Flow Storage (MG)	0.1	0.1	0.5
Total Storage Required:	**2.9**	**2.3**	**5.5**
Storage Available:			
Total Available (MG)	**2.0**	**1.0**	**5.0**
Total Deficiency (MG)	**0.9**	**1.3**	**0.5**
Recommended:			
Storage Provided from Heustis/Ross 1400 System (MG)	0.9	1.3	0.0
Storage Provided from Whitegates 1600 System (MG)	0.0	0.0	0.5

The total storage required for the Piedmont 1400 Zone is 1.8 MG under existing conditions and 2.3 MG under future conditions. This is greater than the existing Piedmont Reservoir, with a capacity of 1 MG. However, since there is not a location for additional storage in this region, it will be combined with storage for the rest of the 1400 Zone discussed in the section on the Heustis/Ross system.

The total storage required for the Campbell 1600 and Crest 1680 Zone is 4.3 MG under existing conditions and 5.5 MG under future conditions. The existing 5 MG Campbell Reservoir is nominally sufficient to serve the Campbell 1600 and Crest 1680 Zones; fire flow storage can be shared between the Campbell 1600 and the Whitegates 1600 zones in the future.

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-57** and **Table 8-58**, listing the future booster pumping requirements and booster pump capacities. Note that the Piedmont 1400 booster pump capacity is summarized in Table 8-47 and discussed in the Heustis/Ross system section.

Table 8-57
Booster Pump Capacity Evaluation – Alessandro Cascade System

Total Pumping Required	Alessandro 1300 Future	Campbell 1600 Future
Zone Considered	1,700	2,700
Higher Zones	3,100	300
Total Required	**4,800**	**3,000**
Existing Capacity (Emtman Low for Alessandro 1300 and Alessandro for Campbell 1600)	1,000	1,400
Capacity Deficiency	**3,800**	**1,600**

Notes: Capacities are based the largest pump out of service at each booster station.

Table 8-58
Booster Pump Capacity Evaluation – Crest 1680 Zone

Criteria	Crest 1680 Future
Booster Pumping Required (PHD)	700
Capacity with Largest Pump Out of Service	1,000
Total Surplus	300

The existing Emtman Low Booster Station has a firm capacity of 1,000 gpm. The total required booster pumping capacity for this station is 4,800 gpm to meet future MDD demands to serve the Alessandro 1300 and higher zones. Therefore, there is significantly insufficient capacity at Emtman Low Booster Station to serve the Alessandro 1300 Zone. It is recommended that the existing pump Nos. 1 and 2 be replaced with 2,500 gpm pumps and a fourth 2,500 gpm pump be added at this station (B-2).

The transmission pipelines in the Alessandro 1300 Zone are significantly undersized and cannot handle the required flows through the zone. Therefore, it is recommended that the City replace the existing 14-inch diameter Emtman Low Booster discharge pipeline to the intersection of Alessandro Blvd and Arlington Avenue with a new 20-inch diameter pipeline (1,400 ft, P-14). The 10-inch diameter discharge pipeline to the northwest to Arlington Avenue should also be replaced with a 16-inch diameter discharge pipeline (950 ft, P-15). The 14-inch transmission pipeline along Alessandro Blvd to the Alessandro Reservoir is also undersized with high velocities. There is currently a 24-inch diameter transmission pipeline in Alessandro Blvd. in the Campbell 1600 Zone which was designed to bring Mills water to the 1200 Zone. This pipeline is only used for emergencies; it is recommended that the portion from Arlington Avenue to Alessandro Reservoir be converted to the Alessandro 1300 Zone for use as a transmission pipeline with the capability for emergency delivery of Mills water to the 1200 Zone retained. These modifications are shown in **Figure 8-9**.

There is sufficient capacity in the Emtman High Booster Station to serve the Piedmont 1400 Zone as discussed earlier in the evaluation of the Heustis/Ross system.

The existing Alessandro Booster Station has a firm capacity of 1,400 gpm. The total required capacity of the booster station is 3,100 gpm, for a deficiency of 1,700 gpm. Since the Alessandro Reservoir site has space for an additional booster station, and the existing booster station has undersized suction and discharge pipelines, it is recommended that the existing booster station be replaced by a new station (total firm capacity of 4,800 gpm and 300 ft TDH, B-1).

The Crest Booster Station is sufficiently sized to serve the Crest 1680 Zone. Fire flow for the Crest 1680 Zone is served via a check valve from the Campbell 1600 Zone.

Alternatively, water can be served from the Mills connection to the Campbell 1600 Zone. Water from the Mills connection has chloramine as a disinfectant, and therefore should be isolated from water delivered from the City's wells. The City would like to have the capability to deliver Mills water to all zones above the 1200 Zone, which includes the entire Alessandro system, as well as the Heustis/Ross and Whitegates systems. There is a single existing Alessandro Reducer to deliver water from the Campbell 1600 Zone to the Alessandro 1300 Zone, if water is taken from the Mills connection.

This valve has nominally sufficient capacity to deliver water to the Alessandro 1300 Zone. With the conversion of the 24-inch diameter Alessandro pipeline to the 1300 Zone, the City needs to install a larger reducer to the Alessandro 1300 Zone to retain the ability to deliver emergency water to the 1200 Zone.

To serve the 1400 Zone (Piedmont, Country Club, Ross and Heustis) with Mills water, a Reducer is necessary from the Campbell 1600 to the Piedmont 1400 Zone. There is a PRV at Alessandro Reducer to the Piedmont 1400 Zone, but it is insufficiently sized to serve the entire 1400 Zone. The Ransom Reducer, with a capacity of 4,400 gpm, is recommended at the intersection of Canyon Crest Drive and Ransom Drive to deliver water to the 1400 Zone (V-3). The transmission pipelines in the Campbell 1600 Zone are undersized to deliver this amount of water to the 1400 Zone; a 20-inch transmission pipeline is recommended along Canyon Crest Drive from Alessandro Blvd to Via Vista Dr to allow Mills water to be delivered to the 1400 Zone (P-16).

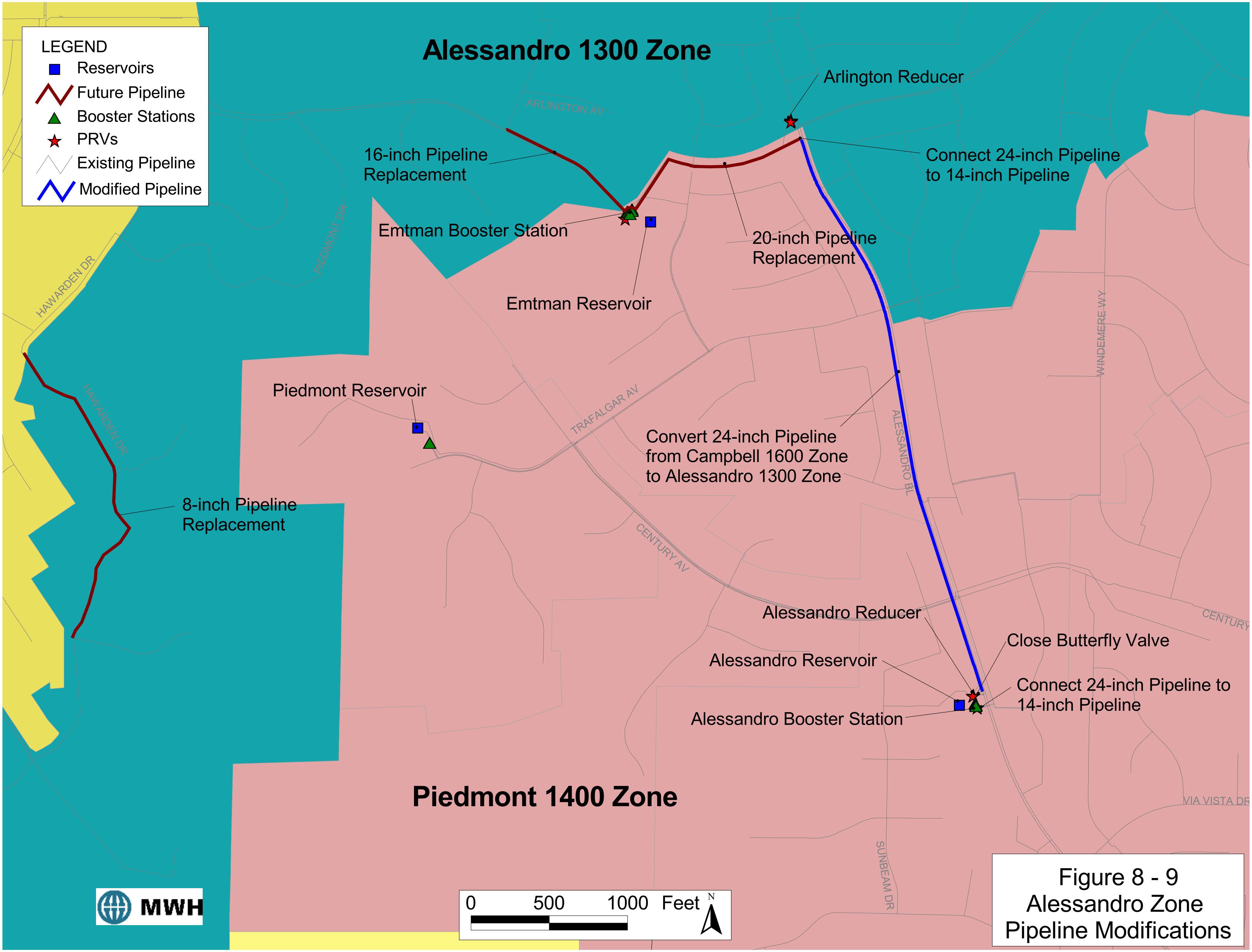


Figure 8 - 9
Alessandro Zone
Pipeline Modifications

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are three locations within Alessandro system with low pressures below 40 psi (under MDD conditions) as seen in Figure 8-1. In the Campbell 1600 Zone, the intersection of Canyon Crest Drive and Chekhov Drive has low pressures as low as 32 psi. Once the 20-inch transmission pipeline in Canyon Crest Drive is installed, the pressures only drop to 37 psi. In the Alessandro 1300 Zone, pressures at the end of Tiburon Drive and Rolling Ridge Road drop to 36 psi under existing MDD but as low as 13 psi under future MDD. This is due to large head losses (and velocities as high as 7 fps) in the 6-inch diameter pipeline in Hawarden Drive. It is recommended that the 6-inch diameter pipeline in Hawarden Drive from Anna Street to Rolling Ridge Road be replaced with an 8-inch diameter pipeline (2,200 ft) to address the pressure deficiency.

There are large sections on the Campbell 1600, Piedmont 1400, and Alessandro 1300 Zones with pressures above 125 psi, with a few locations with pressures above 150 psi as shown in Figure 8-2. These are due to regions with rapidly changing elevations, and no modifications are recommended to address the high pressures.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. There are no locations in the Alessandro system that cannot meet the minimum 20 psi with fire flow demands.

Summary of Recommendations for the Alessandro System

Based on the evaluation described above, the following improvements are recommended for the Alessandro system:

- Alessandro Booster – replace entire booster station with a larger station at the existing site. Include 4 pumps each with a capacity of 1,600 gpm (B-1).
- Convert 24-inch pipe in Alessandro, from Chicago Avenue to Alessandro Reservoir, to 1300 Alessandro Zone.
- Emtman Low Booster – replace pump No 1 and 2 and add a fourth, all with a capacity of 2,500 gpm. Increase size of pump discharge (12 inch) and discharge header (20 inch) to accommodate new flows (B-2).
- New 20 inch Emtman Low Booster discharge to the northeast, from Emtman Low Booster Station to the intersection of Alessandro Boulevard and Chicago Avenue (1,400 ft); new 16-inch Emtman Low discharge to the northwest (950 ft) (P-14 and P-15).
- Replace 6-inch pipeline in Hawarden Drive from Anna Street to Rolling Ridge Drive with 8-inch pipeline (2,200 ft) (P-22).
- Installation of Ransom Reducer at 4,400 gpm capacity to allow flow from Campbell 1600 to Country Club 1400 Zones when Mills water is used (V-3).
- Construct a new 20-inch pipeline on Canyon Crest from Alessandro Boulevard to Via Vista, 1600 Campbell Zone, 3,700 ft (P-16).

WHITEGATES SYSTEM

The Whitegates service area in the central southern portion of the City includes four independent pressure zones: Whitegates 1400, Whitegates 1568, Whitegates 1650 and Oleander 1300. In the future, Whitegates 1568 will be combined with the Campbell 1600 Zone in the Alessandro Cascade system. Also, in the future, there will be an additional zone in this region, Whitegates 1700. This area has had significant development within the last ten years and is expected to have continuing rapid development.

The projected ADD for each of the zones is presented below in **Table 8-59**.

Table 8-59
Projected ADD in the Whitegates System (gpm)

Year	Oleander 1300	Whitegates 1408	Whitegates 1568	Whitegates 1700
Existing (2003)	11	866	142	2
2005	11	866	250	2
2007	11	866	609	266
2010	11	972	669	378
2015	11	1,174	840	378
2020	11	1,186	840	378
2025	11	1,404	991	551

System Configuration

The existing Whitegates 1400 Zone is fed by the existing Whitegates No. 1 Booster station and served by the Whitegates No. 1 Reservoir. The Whitegates 1568 Zone is pumped from the Whitegates 1400 Zone via the Whitegates No. 2 and Horizon View Booster stations and is served by the Whitegates No. 2 Reservoir. Alternatively, Whitegates 1568 Zone can be served from a connection with Western Municipal Water District (WMWD) located near the Whitegates No. 2 Reservoir, receiving water treated by MWD at the Mills Filtration Plant with a maximum capacity of 1,000 gpm. The Oleander 1300 Zone is fed by PRV from the Whitegates 1400 Zone.

Current plans call for the Whitegates 1568 Zone to be changed to the Whitegates 1600 Zone and connected with the Campbell 1600 Zone. Pipelines will be constructed to connect the portions served by the Whitegates No. 2 Booster and Horizon View Booster together. The Whitegates 1600 Zone will continue to be served by pumping from the Whitegates 1400 Zone under normal conditions. However, water will flow to and from the Campbell 1600 Zone as necessary. A secondary water source for the Whitegates system in the future are two WMWD connections – the Mills connection located at Campbell Reservoir, and the existing connection located near the existing Whitegates No. 2 Reservoir. When water is delivered from the Mills connection, water will flow through the Campbell 1600 Zone to the Whitegates 1600 Zone and serve the Whitegates 1400 Zone by PRV. The City has proposed two 12-inch diameter transmission pipelines throughout the Whitegates region, connecting the Horizon View Booster with the existing Whitegates No. 2 system.

The Whitegates 1650 Zone is currently fed by PRV from WMWD via the Green Orchard Reducer. In the future, the Whitegates 1650 Zone will be converted to the Whitegates 1700

Zone, a small zone in the southeast corner of the Whitegates service area, serving less than 50 homes. The zone will be pumped from the Whitegates 1600 Zone. Storage is not proposed for the Whitegates 1700 Zone.

Storage Evaluation

As presented in Table 8-1 and Table 8-2 and summarized in **Table 8-60**, the total storage required for the Whitegates 1400 Zone is 2.4 MG under existing conditions and 3.9 MG under future conditions. The total storage required for the Whitegates 1568/1600 Zone is 0.6 MG under existing conditions and 4.5 MG under future conditions. In the future, storage can be shared between the Whitegates 1600 and Campbell 1600 Zones since the zones will be combined. The capacity of the existing Whitegates No.1 Reservoir is 0.5 MG and the existing Whitegates No. 2 Reservoir is 0.5 MG. The City has experienced significant operational storage deficiencies in the Whitegates 1408 Zone due to the insufficient size of the existing Whitegates No.1 Reservoir. The need for an expanded Whitegates No. 2 Reservoir is determined by growth requirements, not by existing deficiencies.

Table 8-60
Storage Evaluation of the Whitegates System

Pressure Zone	Whitegates 1400 & Oleander 1300	Whitegates 1600 & 1700
Operational Storage (MG)	0.9	1.0
Emergency Storage (MG)	3.3	3.4
Fire Flow Storage (MG)	0.1	0.1
Total Storage Required:	**4.4**	**4.5**
Storage Available:		
Total Available (MG)	**0.5**	**0.5**
Total Deficiency (MG)	**3.9**	**4.0**
Recommended:		
Recommended Storage (MG)	2.0	7.0

To address the storage deficiencies in the Whitegates system, expanded Whitegates No. 1 and Whitegates No. 2 Reservoirs are recommended. Surplus storage can be located at Whitegates No. 2 to serve the Whitegates 1400 Zone for emergencies, since Whitegates 1400 can be served from Whitegates 1600 by gravity, but not vice-versa. Since land acquistion is expensive in the Whitegates region, the City prefers to acquire one parcel for additional reservoir storage in this region rather than two parcels. Therefore, expansion of the Whitegates No. 1 Reservoir at the current parcel to the maximum size possible is recommended, with the remainder of storage recommended at the new Whitegates No. 2 Reservoir. Based on the maximum reservoir size possible at the existing parcel, the Whitegates No. 1 Reservoir replacement is recommended at a minimum of 2.0 MG (R-6), a gain of 1.5 MG. The remaining storage deficit in the Whitegates system, a total of 7.0 MG, should be placed in a new Whitegates No. 2 Reservoir, with high water level of 1,600 feet (R-4). A potential location for a new larger Whitegates No. 2 replacement is shown in **Figure 8-10**. Alternatively, the reservoir could be sited farther south in the unincorporated area of Riverside County. The Whitegates No. 2 Reservoir replacement is also expected to require approximately 5,000 linear-ft of 24-inch diameter pipeline to connect the reservoir to the future water system (P-12).

Booster Station and Pressure Regulator Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-47** and **Table 8-48**, listing the future booster pumping requirements and existing booster pump capacities.

Table 8-61
Booster Pump Capacity Evaluation – Whitegates System

Total Pumping Required	Whitegates 1400	Whitegates 1600	Whitegates 1700
Zone Concerned	2,600	1,600	2,000
Higher Zones	2,700	1,000	0
Total Required	**5,300**	**2,600**	**2,000**
Existing Booster Pumping Capacity	5,900	2,900	2,000
Capacity Surplus (Deficiency)	**600**	**300**	**(2,000)**

Notes: Capacities are based the largest pump out of service out of all the booster stations.

The existing Whitegates No. 1 and Jefferson Booster Stations have a total firm capacity of 5,900 gpm. The total required booster pumping capacity for these two stations is 5,300 gpm to meet future MDD demands to serve the Whitegates 1400 and higher zones. Thus, there is sufficient capacity in the existing Whitegates No. 1 and Jefferson Booster Stations to meet future demands, and station expansions are not necessary.

The existing Whitegates No. 2 and Horizon View Booster Stations have a total capacity of 2,900 gpm. The total required booster pumping capacity for these two stations are 2,700 gpm to meet future MDD demands to serve the Whitegates 1600 and higher zones. Since there is additional reliable supply in the Campbell 1600 Zone, expansion of the Whitegates No. 2 Booster station is not required. However, due to its proximity adjacent to the existing Whitegates No. 1 Reservoir, the Whitegates No. 2 Booster Station will need to be replaced as part of the Whitegates No.1 Reservoir Expansion.

The Whitegates 1700 Zone has a future MDD of 940 gpm and PHD of 1,600 gpm. Since there will be no reservoir storage in the Whitegates 1700 Zone, the Whitegates 1700 Booster Station needs to have a firm capacity to meet the greater of PHD or MDD plus fire flow. With a fire flow requirement of 1,000 gpm, MDD+FF dictates that the proposed Whitegates 1700 booster station should have a firm capacity of 2,000 gpm at 100 ft TDH (B-8).

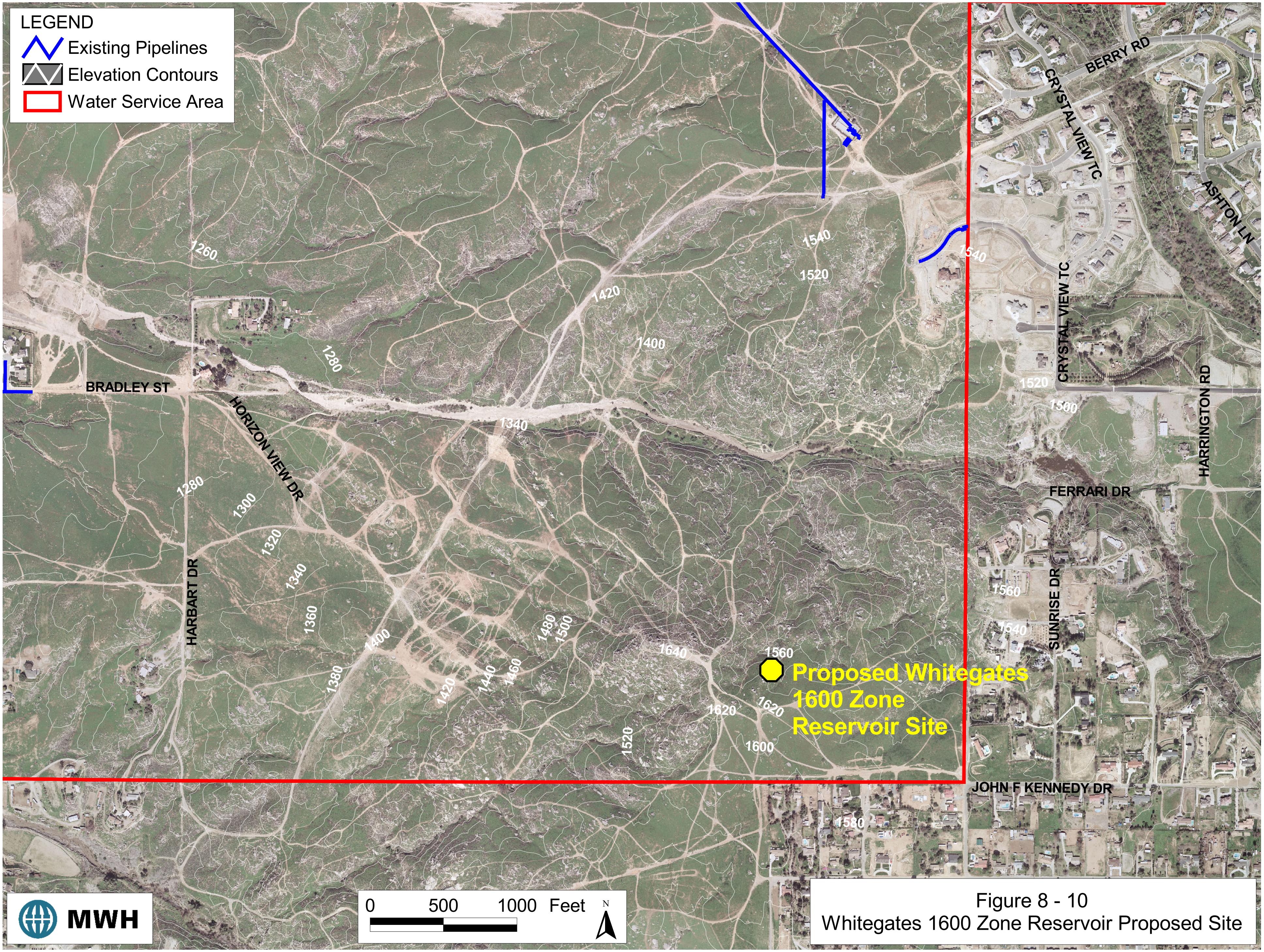


Figure 8 - 10
Whitegates 1600 Zone Reservoir Proposed Site

In addition to booster pumping, the Whitegates system requires infrastructure to allow for imported water purchased at the Mills connection to be served to the Whitegates system. To deliver water from the Campbell 1600 Zone to the Whitegates 1600 Zone, a 24-inch diameter transmission pipeline is needed along Overlook Parkway from Alessandro Blvd to Chateau Ridge Lane (7,000 ft, P-10). In addition, a PRV station with firm capacity of 2,600 gpm is needed at Horizon View Booster Station to deliver Mills water from the Whitegates 1600 to the Whitegates 1400 Zone (V-4).

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There is one location within the Whitegates system with low pressures below 40 psi under MDD conditions as seen in Figure 8-1. In the Whitegates 1400 Zone, the east end of Talcey Terrace has pressures ranging from 33 to 37 psi under existing MDD conditions. This pipeline serves two homes at the end of the cul-de-sac and has low pressures due to high elevations. The service to these homes could be moved to the 12-inch Whitegates 1568 Zone pipeline on Overlook Parkway, which is located behind the homes. However, this would require rerouting the customer piping and should only be considered if requested by the customers. Sections of both the Whitegates 1400 and 1568 have high pressures above 125 psi due to elevation as shown in Figure 8-2. Pressures are as high as 165 psi at the intersection of Hawarden Dr and Rockwell Rd. No modifications are recommended to address the high pressures, as rezoning the distribution system to the adjacent Emtman 1200 Zone would result in marginal pressures.

The model is also used to identify pipelines with high velocities under MDD and PHD conditions. When two of the three pumps are operating at Horizon View Booster Station, the velocities in the existing 12-inch diameter transmission pipeline serving as suction to the booster station are above 6 fps. Therefore, a parallel 16-inch diameter transmission pipeline is recommended in Bradley Street from Washington Street to Horizon View Booster Station (4,800 ft, P-10). No other pipelines with high velocities requiring replacement are identified in the Whitegates system. These improvements are shown on **Figure 8-11**.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the model that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-62**. To address the fire flow deficiencies in the Whitegates 1408 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-63**.

Table 8-62
Fire Flow Deficiencies in the Whitegates System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
6736 Oleander Dr	Oleander 1300	1,000	464
Highridge St & Gopher Gulch	Whitegates 1408	1,000	897

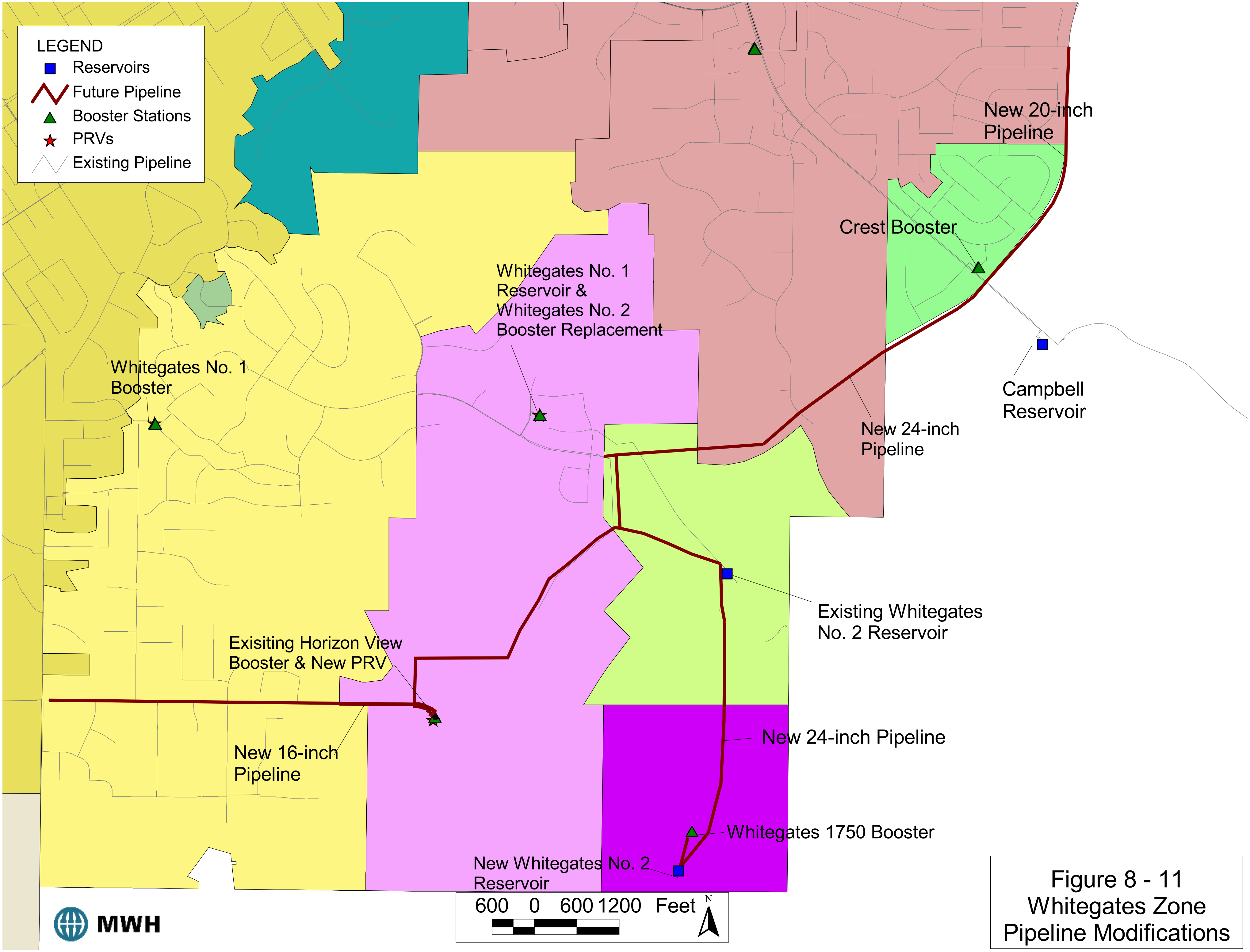


Figure 8 - 11
Whitegates Zone
Pipeline Modifications

Table 8-63
Fire Flow Recommendations in the Whitegates System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Easement	2114 Westminster Dr	End of Oleander Dr	Oleander 1300	2.5	6	512
Golden Star Av	Bradley St	Highridge St	Whitegates 1408	6	12	1286
Highridge St	Golden Star Av	Milligan Dr	Whitegates 1408	6	12	440

Summary of Recommendations for the Whitegates System

Based on the evaluation described above, the following improvements are recommended for the Whitegates system:

- Whitegates 1408 Reservoir – replace existing 0.5 MG reservoir with a 2 MG reservoir at the existing site and install the associated piping (R-6).
- Reconstruct the Whitegates No. 2 Booster when the 1408 Reservoir is replaced.
- Install new 16-inch parallel pipeline in Bradley Street from Washington Street to Horizon View Booster Station (P-10).
- Replace pipelines for fire flow: 1,700 ft of 12-inch diameter pipeline.
- Install PRV station from Whitegates 1600 Zone to Whitegates 1408 Zone at Horizon View Booster Station, sized for 2,600 gpm capacity (V-4).
- Whitegates 1600 Reservoir – replace existing 0.5 MG reservoir with a 7 MG Reservoir south of existing site and install 5,000 LF of 24-inch diameter pipeline (R-4 and P-12).
- Install 12-inch diameter transmission piping for Whitegates 1600 Zone.
- Install 24-inch diameter pipeline in Overlook Parkway from Alessandro to Chateau Ridge (7,000 ft) (P-11).
- Add Whitegates 1700 Booster and 3,800 LF of 12-inch diameter transmission piping for 1700 Zone (B-8 and P-13).

GRATTON 1400 ZONE

Gratton 1400 Zone is a small dead-end zone that is fed by the 1200 Zone in the southern portion of the City.

The projected ADD for the Gratton 1400 is presented in **Table 8-64** below.

Table 8-64
Projected ADD in the Gratton 1400 Zone (gpm)

Year	Gratton 1400
Existing (2003)	142
2005	142
2007	142
2010	142
2015	142
2020	281
2025	281

Storage Evaluation

Storage for the Gratton 1400 Zone is included as part of the 1200 Zone evaluation.

Booster Station Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-65**, listing the future booster pumping requirements and existing booster pump capacities.

Table 8-65
Booster Pump Capacity Evaluation – Gratton 1400 Zone

Criteria	Future
Booster Pumping Required (MDD+FF)	1,400
Booster Pumping Required (PHD)	400
Existing Booster Station Capacity	300
Capacity with Largest Pump Out of Service	100
Total (Deficiency)	(1,100)

Note: Deficiency is based on the larger of PHD and largest pump out of service or MDD+FF and all pumps operational.

The existing Gratton Booster Station has a total capacity of 320 gpm. Since there is no storage in the Gratton 1400 Zone, the total required capacity of the station is the greater of MDD+FF and PHD demands. Under MDD+FF conditions, the demand in the Gratton Zone is 1,100 gpm. Therefore, there is insufficient capacity at Gratton Booster Station and a fire pump is necessary (1, 00 gpm at 210 ft TDH).

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within the Gratton Zone with low pressures below 40 psi nor any locations with high pressures above 125 psi, for MDD and ADD conditions, respectively.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. Locations in the Gratton 1400 Zone that cannot meet the minimum 20 psi with fire flow demands are described in **Table 8-66** due to both pipeline and booster deficiencies. To address the fire flow deficiencies in the Gratton 1400 Zone, pipeline replacements are recommended as part of the pipeline replacement program as shown in **Table 8-67**.

Table 8-66
Fire Flow Deficiencies in the Gratton System

Location	Zone	Required Fire Flow (gpm)	Available Fire Flow at 20 psi (gpm)
1549 Heather Ln	Gratton 1400	1,000	88
1555 Gratton St	Gratton 1400	1,000	151
1525 Heather Ln	Gratton 1400	1,000	93
Gratton St & Heather Ln	Gratton 1400	1,000	86

Table 8-67
Fire Flow Recommendations in the Gratton System

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)
Monroe St	Frontier Av	Gratton BS	Gratton 1400	6	8	770
Gratton St	Gratton BS	Heather Lane	Gratton 1400	6	8	901
Heather Lane	Gratton St	Last fire hydrant	Gratton 1400	6	8	707
Gratton St	Heather Lane	Frontier Av	Gratton 1400	6	8	321

Summary of Recommendations for the Gratton 1400 Zone

Recommended improvements for the Gratton 1400 Zone are limited to modifications for fire flow:

- Add third pump at Gratton Booster Station (1,100 gpm at 210 ft TDH)
- Replace pipelines for fire flow: 2,700 ft of 8-inch diameter pipeline

PRAED 1400 ZONE

The Praed 1400 Zone is a small dead-end residential zone that is fed by the 1200 Zone in unincorporated Riverside County south of the City's boundary. The region is east of La Sierra Avenue.

The projected ADD for the Praed 1400 is presented in **Table 8-68** below.

Table 8-68
Projected ADD in the Praed 1400 Zone (gpm)

Year	Praed 1400
Existing (2003)	366
2005	366
2007	366
2010	366
2015	506
2020	606
2025	606

Storage Evaluation

Storage for the Praed 1400 Zone is included as part of the 1200 Zone evaluation.

Booster Station Evaluation

Booster station calculations for existing and future conditions are presented in Table 8-3 and Table 8-4. A summary of booster pumping requirements is shown in **Table 8-13**, listing the future booster pumping requirements and existing booster pump capacities.

Table 8-69
Booster Pump Capacity Evaluation – Praed 1400 Zone

Criteria	Future
Booster Pumping Required (MDD+FF)	2,100
Booster Pumping Required (PHD)	1,800
Existing Booster Station Capacity	2,400
Capacity with Largest Pump Out of Service	1,200
Total Surplus	(600)

The existing Praed Booster Station has a total capacity of 1,800 gpm with the largest pump out of service. Since there is no storage in the Praed 1400 Zone, the total required capacity of the station is the greater of MDD+FF or PHD demands. Under MDD+FF conditions, the demand in the Praed Zone is 2,100 gpm. Therefore, there is a 600 gpm capacity deficiency in the Praed Booster Station. However, since the Praed 1400 Zone can be served by Western MWD via the Lake Knolls PRV in case of emergency, there are no recommended improvements for Praed Booster Station.

Distribution System Evaluation

The H_2OMAP Water model is used to evaluate existing and future system pressures under ADD and MDD conditions. There are no locations within the Praed Zone with low pressures below 40 psi under MDD conditions. There are a number of locations with high pressures above 125 psi under ADD conditions as shown in Figure 8-2, with some pressures as high as 180 psi. It would be impractical to convert these locations to a lower pressure zone.

The model is also used to evaluate the distribution system for the ability to pass fire flow under future MDD while maintaining 20 psi pressure. There are no locations in the Praed Zone that cannot meet the minimum 20 psi with fire flow demands.

Summary of Recommendations for the Praed 1400 Zone

There are no recommended improvements for the Praed 1400 Zone.

Section 9
Capital Improvement Program

This section describes the recommended Capital Improvement Program (CIP) for the City's potable water distribution system with respect to the existing system deficiencies and the anticipated growth-related future expansions. This CIP addresses improvements necessary to meet current deficiencies as well as improvements necessary to provide continued reliable water service through the year 2025. The section includes a discussion of the basis for the Opinion of Probable Cost. Following is a discussion of the recommended improvements and facility replacement programs. The last portion of the section discusses the phasing of improvements and capital costs.

OPINION OF PROBABLE COST ASSUMPTIONS

Capital cost estimates are developed based on costs obtained from industry manufacturers, MWH's experience on similar water system master planning projects, and data provided by the City. All estimates have been adjusted to an Engineering News Record (ENR) Construction Cost Index of 8,168 (Los Angeles, September 2004) and reflect 2004 dollars. This ENR index is used to adjust construction costs for inflation and current business conditions. For example, if a reservoir in this CIP will be constructed in five years, its cost should be adjusted for inflation by the ratio of the anticipated ENR index in 2010 to the current ENR index. Assuming a year 2010 ENR index of 9,200 and a current cost of $1 million, the future cost of the reservoir will be $1,130,000 ($1,000,000 x 9,200/8,168). The ENR Cost Index is calculated periodically based on various industry factors that adjust cost and include factors such as inflation for material and labor costs. The cost estimates which range between 50 percent above and 30 percent below actual capital expenditures are consistent with the American Association of Cost Engineers guidelines for developing reconnaissance-level estimates.

Pipeline cost estimates are based on recent cost data for work completed by MWH and recent City experience. The unit cost per inch-diameter is estimated to decrease with increasing diameter. Costs for new reservoirs are based on partially buried reinforced concrete reservoirs rather than steel tanks. Although steel tanks have lower initial costs, they have higher routine maintenance costs mostly for corrosion protection and coatings. Buried or partially buried reservoirs are often preferred for aesthetic reasons and concrete reservoirs are more appropriate than steel tanks for such installations. Costs for pump and motor replacements, pump upsizing, and new booster stations are based on the required replacement HP per station. New and upgraded pressure reducing stations are based on the number and diameter of the valves. Unit costs used in this Master Plan are listed in **Appendix D**.

Based on the level of detail that a Water Master Plan provides, cost estimates require that a 20 percent contingency be applied to the construction cost estimates. This contingency factor is used for both existing and future system recommendations. The environmental, engineering, administration, and legal costs are estimated to be 20 percent of construction costs plus contingency. Hence, the total capital costs are estimated to be 144 percent of the construction cost. The contractor's overhead and profit are included in the cost estimates. Costs for acquisition of land, rights-of-way and easements are not included. As more details regarding construction issues become apparent and the recommended projects proceed through the design process, many of the unknown issues will be resolved, construction cost estimates will be more accurate, and the contingency may be lowered.

FACILITY REPLACEMENT PROGRAMS

The system evaluation discussed in **Section 8** only includes discussion on the hydraulic deficiencies of the water system. Water system infrastructure also has a limited life span due to age and wear and tear. Pipeline and pump station replacement programs are discussed further.

Pipeline Replacement Program

The City began a pipeline replacement program in 2001, replacing approximately 3 miles of pipeline each year. The purpose of the pipeline replacement program is to replace older pipelines, focusing first on small diameter (less than 6-inch) and leaking pipelines.

The typical expected lifetime for water pipelines is 75 years. The City has a total of 889 miles of pipelines. As noted in **Table 9-1** and shown in **Figure 9-1,** about 6 percent or 55 miles of the City's pipelines exceed 75 years old in 2005.

Table 9-1
Age of Existing Pipelines

Year Installed	Total Length (miles)	Percent of Total
Pre-1910	0.3	0.04%
1911-1920	11.5	1.3%
1921-1930	43.0	4.8%
1931-1940	65.1	7.3%
1941-1950	44.9	5.0%
1951-1960	197.9	22.2%
1961-1970	126.6	14.2%
1971-1980	175.2	19.7%
1981-1990	122.9	13.8%
1991-2000	64.8	7.3%
Post-2001	34.1	3.8%
Unknown	3.1	0.4%

It is recommended that the City replace about 12 miles of pipeline per year (1/75 or 1.3 percent of the system) based on the expected average pipeline life of 75 years. Based on an average pipeline replacement diameter of 8-inch, at a total cost of $140/linear-ft (with contingencies), the cost to replace 11.9 miles of pipeline is $8.8 million. Therefore, it is recommended that the City budget $8.8 million each year to fund the pipeline replacement program.

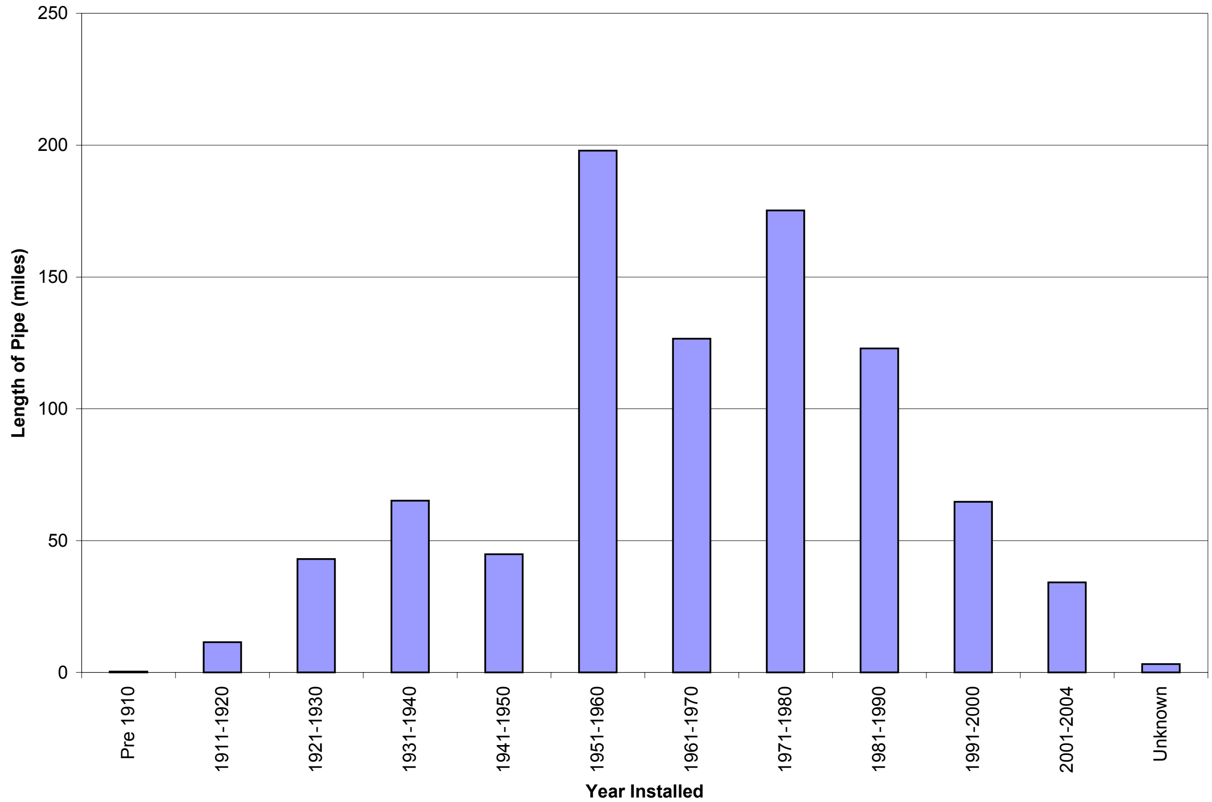


Figure 9-1
Development of Riverside's Water Distribution System

The following criteria should be used to rank which pipelines should be replaced first, in the following order of importance:

1. Leak history (greater than 5 leaks in 5 years)
2. Pipelines less than 6-inch diameter connected to fire hydrants
3. Pipelines addressing fire flow deficiencies
4. Street repavement programs (assuming the pipes in that region are old enough to warrant replacement)
5. Age versus average expected service life

Replacement of groups of pipelines within communities is recommended rather than single pipelines on individual streets, where feasible.

The following criteria are not included in the pipelines ranking criteria for the following reasons:

- Lining status (lined/unlined) – It is assumed that the lining status is determined by the age of the pipeline. This is explained in more detail in Section 6.
- Material – There is no conclusive data to recommend that a particular pipeline material has a shorter life expectancy than other material.

Pump Replacement Program

It is recommended that the City begin a pump replacement program to address aging booster pumps throughout the City. Many of the pumps are in very poor condition, with obsolete parts. The typical expected lifetime for booster pumps is 15 years. The City has 108 booster pumps, with 68 of the booster pumps (63 percent) older than 15 years in 2005.

To maintain pump efficiency and reliability, the City should replace and/or shop-repair 1/15 or 7 of 108 booster pumps each year. Estimated cost for pump replacement is an average of $75,000 per pump, including engineering and contingency. Therefore, it is recommended the City budget $525,000 for booster pump replacements each year.

A ranking system is listed in **Table 9-2** to determine which booster pumps should be replaced first. The points associated with each criterion are summed in total; pumps with the highest number are recommended to be replaced first. The ranking system is applied to each of the booster pumps; these data are listed in **Appendix E**.

Table 9-2
Pump Station Replacement Program Ranking Criteria

Criteria	Range of Value of Points Assigned
Obsolete Manufacturer	Yes (5), No (0)
Gross Age	If no major retrofit, pump age = years since installation If major retrofit, pump age = 0.5 x years since installation + 0.5 x years since retrofit
Hydraulic Efficiency	No data (0), Greater than 70% (0), 65-70% (1), 60-65% (2), Less than 60% (3)
Operational Deficiencies (such as cavitation, cannot deliver flow, or excessive wear)	Yes (5), No (0)
Critical Facility	Continuous/Regular Operation (4), Seasonal/Intermittent Use (2), Emergency (0)

Other Replacement Programs

Other renewal/replacement/improvement programs are not discussed as part of this Master Plan. However, additional replacement programs should be considered by the City, including, but not limited to, well pumps, wells, reservoirs, customer meters, and hydrants.

Well pumps can be evaluated using the same criteria as set for booster pumps.

RECOMMENDED IMPROVEMENTS

As discussed in **Section 8**, the water distribution system is evaluated under existing and projected water demands. Recommendations are made to the water system in the following areas:

- Pipelines
- Reservoirs
- Booster Pump Stations
- Pressure Reducing Stations

Table 9-3 lists a summary of each of the proposed system improvements by facility type.

Table 9-3
Summary of Recommended Improvements

Facility Type	Existing	Recommended Improvements
Storage Reservoirs	16	Add 8 totaling about 65 MG
Booster Pump Stations	39	5 (new); 10 (upgraded)
Pressure Reducing Stations	21	8 (new); 4 (upgraded)
Pipelines (miles)	889	Add 52 miles (34 miles transmission mains; 18 miles small diameter for fire flow improvements)

Each of the recommended improvements is assigned one of six rankings: Very High, High, Medium-High, Medium, Low, and Very Low. These rankings indicate the priority for the City to complete the project, based on the severity or critical nature of the deficiency addressed. Thus, the City should address the recommendations with the Very High and High rankings first, addressing the lower ranked deficiencies afterward. No dates have been included for addressing the deficiencies; however, based on the planning period of this Master Plan, it is expected that the City will need to perform all improvements within 20 years. Recommended pipeline improvements addressing transmission or operational deficiencies are listed on **Table 9-4**. Reservoir improvements are listed on **Table 9-5**, pressure reducing station improvements on **Table 9-6**, and pump station improvements on **Table 9-7**.

Pipeline replacements addressing insufficient fire flow are listed on **Table 9-8** and have not been phased; it is expected that the City will install these larger diameter pipelines as part of the ongoing pipeline replacement program. As such, the cost of this program is not included in the total cost of recommended improvements.

CAPITAL IMPROVEMENT PROGRAM

The summary of the CIP by phasing and facility type is summarized in **Table 9-9**. **Figure 9-2** shows the CIP by phasing, and **Figure 9-3** illustrates the CIP by facility type. There is a total of \$138.8 million of recommended improvements, (excluding pipeline and pump replacements) with 57 percent of the cost for pipelines, 36 percent for reservoirs, 6 percent for pumping stations, and less than 1 percent for PRV stations. In addition to the capital projects, it is recommended that the City increase funding of the pipeline replacement program to \$8.8 million/year and the booster pump replacement program to \$525,000/year.

Table 9-4
Recommended Pipeline Improvements

ID (on Figure 8-4)	Description	Pressure Zone	Length (feet)	Diameter (inches)	Estimated Total Cost ($)	Ranking
P-1	New Crosstown Feeder, 54-inch section	Gravity 997	9,000	54	$7,100,000	Medium - High
P-2	New Crosstown Feeder, Upper Reach, 48-inch section	Gravity 997	20,900	48	$14,000,000	Medium - High
P-2	New Crosstown Feeder, Lower Reach, 48-inch section	Gravity 997	19,400	48	$13,000,000	Medium
P-3	Rehab Old Crosstown Feeder	Gravity 997	12,200	48	$6,100,000	Very Low
P-4	Rehab Old Crosstown Feeder	Gravity 997	29,400	42	$12,300,000	Very Low
P-5	Connect Old Crosstown Feeder to New Crosstown Feeder at St Lawrence	Gravity 997	7,000	20	$1,800,000	Medium
P-6	Connect Old Crosstown Feeder to New Crosstown Feeder at Francis Mary	Gravity 997	4,400	20	$1,100,000	Medium - High
P-7	New Buchanan 1100 Zone Transmission	Buchanan 1100	3,700	12	$600,000	Very High
P-8	Connect Raley Reservoir to 27" Magnolia Pipeline	La Sierra 925	10,000	30	$3,600,000	High
P-9	Connect UCR Reservoir to Evans Reservoir	Gravity 997	5,000	54	$4,000,000	Medium
P-10	Pipeline in Bradley, from Washington to Horizon View	Whitegates No. 1 1400	4,800	16	$1,000,000	Medium - High
P-11	Pipeline in Overlook Pkwy, connecting Whitegates No. 2 and Campbell Zones	Whitegates No. 2/ Campbell 1600	7,000	24	$2,000,000	Low
P-12	Connect Whitegates No. 2 Res to System	Whitegates No. 2 1600	5,000	24	$1,500,000	Very High
P-13	Reroute Industrial Booster Suction	Gravity 997	5,700	24	$1,700,000	Low
P-14	Emtman Low Discharge to Alessandro	Alessandro 1300	1,400	20	$400,000	Very High
P-15	Emtman Low Discharge to northwest	Alessandro 1300	950	16	$200,000	Very High
P-16	Pipeline in Canyon Crest, from Alessandro to Via Vista	Campbell 1600	3,700	20	$900,000	Low
P-17	Connect Proposed 1400 Zone Res to Canyon Crest & El Cerrito	Ross 1400	4,200	20	$1,100,000	Low
P-18	Connect New 1200 Emtman Res to 30" Victoria Pipeline	Emtman 1200	8,000	30	$2,900,000	Very High
P-19	Rancho La Sierra Transmission Line	Arlington 1100	15,000	16	$3,000,000	Low
P-20	Pipeline in Canyon Crest, from Canyon Crest Booster to Central	Ross 1400	2,400	16	$500,000	Low
P-21	Pipeline in Canyon Crest from Central to Via Zapata	Ross 1400	1,000	12	$200,000	Low
P-22	Pipeline in Hawarden from Anna to Rolling Ridge	Alessandro 1300	2,200	8	$300,000	Low
Total			**176,750**		**$79,300,000**	

Table 9-5
Recommended Reservoir Improvements

ID (on Figure 8-4)	Reservoir Description	Pressure Zone	Future Capacity (MG)	Estimated Total Cost ($)	Ranking
R-1	New 1200 Zone (Central Part of System)	Emtman 1200	7.5	$5,900,000	Very High
R-2	Gravity Zone at UCR	Gravity 997	20.0	$14,000,000	Medium
R-3	Raley Reservoir	La Sierra 925	11.0	$7,700,000	High
R-4	Whitegates No 2 Replacement	Whitegates No. 2 1600	7.0	$5,500,000	Very High
R-5	1400 Zone Reservoir	Ross 1400	5.2	$4,300,000	Low
R-6	Whitegates No 1 Replacement	Whitegates No. 1 1400	2.0	$2,600,000	High
R-7	Sugarloaf Expansion	Sugarloaf 1200	5.0	$4,600,000	Low
R-8	Van Buren Expansion	Van Buren 1200	7.5	$5,900,000	Low
Total			**65.2**	**$50,500,000**	

Table 9-6
Recommended Pressure Reducing Station Improvements

ID (on Figure 8-4)	PRV Station Description	Number of New PRV Stations	Number of Additional PRVs	Number of Upsized PRVs	Estimated Total Cost ($)	Ranking
V-1	New 1040 Zone	3			$210,000	High
V-2	1010 Casa Blanca Zone Expansion	2			$140,000	High
V-3	Ransom Reducer	1			$70,000	Very Low
V-4	Horizon View Reducer	1			$70,000	Very Low
V-5	Madison Reducer		1		$50,000	Low
V-6	Prospect Reducer		1		$50,000	Medium
V-7	Westminster Reducer		1		$40,000	Low
V-8	Highgrove Reducer			1	$30,000	Medium
V-9	University City Reducer	1			$70,000	Medium
Total		**8**	**3**	**1**	**$730,000**	

Table 9-7
Recommended Booster Station Improvements

ID (on Figure 8-4)	Booster Station Description	New Pump Stations		Pump Station Expansions		Upsize Pumps		Estimated Total Cost ($)	Ranking
		No. of Pumps	Combined HP	No. of New Pumps	Combined HP	Unit No.	HP		
B-1	Alessandro PS (Alessandro 1300 to Campbell 1600)	4	1,000			-	-	$2,100,000	Very High
B-2	Emtman Low PS (Emtman 1200 to Alessandro 1300)			3	300	-	-	$540,000	Very High
B-3	Mockingbird PS (Gravity 997 to Van Buren 1200)			1	250	-	-	$160,000	High
B-4	Francis Mary PS (Gravity 997 to Emtman 1200)	3	750			-	-	$1,580,000	Medium-High
B-5	Chicago PS (Gravity 997 to Chicago 1100)					1	150	$380,000	High
B-6	St. Lawrence PS (Gravity 997 to Victoria 1100)			-	-	1	150	$380,000	High
B-7	Victoria PS (Gravity 997 to Emtman 1200)			-	-	2	250	$470,000	High
B-8	Whitegates 1700 PS (Whitegates 1600 to 1700)	2	150			-	-	$630,000	High
B-9	Buchanan PS (La Sierra 925 to Buchanan 1100)	3	150			-	-	$630,000	Very High
B-10	Field PS (La Sierra 925 to La Sierra 1010)			1	50	-	-	$210,000	Very Low
B-11	Rancho La Sierra PS (Gravity 997 to Arlington 1100)	3	150			-	-	$630,000	Low
B-12	Canyon Crest PS (Emtman 1200 to Ross 1400)			-	-	3	250	$470,000	Low
B-13	Mt. Vernon PS (Heustis 1400 to Mt. Vernon 1600)			1	75			$250,000	Medium-High
B-14	Gratton PS (Van Buren 1200 to Gratton 1400)			1	100			$320,000	High
B-15	Rubidoux PS (Gravity 997 to Rubidoux 1066)			1	20			$80,000	Medium-High
Total			**2,200**		**820**		**800**	**$8,800,000**	

Table 9-8
Fire Flow Pipeline Recommendations

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)	Comment	Total Cost
Allstate Dr	End of Street	Rivera St	Gravity 997	6	8	727	Replace	$102,000
Vine St	Cridge St	Prospect Av	Gravity 997	6	8	875	Replace	$123,000
Vine St	Fourteenth St	Fifteenth St	Gravity 997	6	8	780	Replace	$110,000
Chase Rd	Orange St	Kemp St	Gravity 997	6	12	316	Replace	$54,000
Kemp St	Chase Rd	End of Kemp St	Gravity 997	6	8	1,138	Replace	$160,000
Spring Garden St	Laurel Av	End of Spring Garden St	Gravity 997	6	8	113	Replace	$16,000
Milton St	Laurel Av	300 ft west of Laurel Av	Gravity 997	4	8	303	Replace	$43,000
La Cadena Dr	Interchange St	Chase Rd	Gravity 997	8	12	2,097	Replace	$357,000
Chase Rd	Kemp St	Forest St	Gravity 997	6	12	460	Replace	$79,000
Forest St	Chase Rd	End of Forest	Gravity 997	6	8	779	Replace	$110,000
Chase Rd	Clark St	La Cadena Dr	Gravity 997	12	12	1,073	Replace	$183,000
Clark St	Chase Rd	End of Clark St	Gravity 997	6	8	570	Replace	$80,000
Main St	Alamo St	Carter Av	Gravity 997	4	6	408	Replace	$49,000
Spring Garden St	Mulberry St	La Cadena Dr	Gravity 997	4	6	655	Replace	$79,000
Mulberry	Marsh Wy	Knoll Wy	Gravity 997	4	6	932	Replace	$112,000
Romona Dr	Brockton Av	End of Romona Dr	Gravity 997	4	6	652	Replace	$79,000
Mt Vernon St	Madison St	End of Mt Vernon	Gravity 997	4	8	651	Replace	$92,000
Madison St	Mt Vernon St	Magnolia Av	Gravity 997	6	8	747	Replace	$105,000
Donald Av	Magnolia Av	Andrew St	Gravity 997	4	6	1,764	Replace	$212,000
La Cadena Dr	Interchange St	Columbia Av	Gravity 997	8	12	557	Replace	$95,000
La Cadena Dr	Oxford Dr	Palmyrita WTP site	Gravity 997	8	12	1,598	Replace	$272,000
Marlborough Av	La Cadena Dr	End of Marlborough Av	1040 Zone	4	12	1,001	Replace	$171,000
Blenheim St	La Cadena Dr	Laurel Av	1040 Zone	4	8	460	Replace	$65,000
Mt Rubidoux Dr	Ninth St	Tenth St	Rubidoux 1066	6	8	441	Replace	$62,000
Ninth St, and Miramonte Pl	Mt Rubidoux Dr	Allis St	Rubidoux 1066	6	8	1,460	Replace	$205,000
Magnolia Av	Polk St	Nye Av	Zone 925	6	8	625	Replace	$88,000
Rolling Hills Dr	Western Hills Dr	End of Rolling Hills Dr	Arlington 1080	4	6	774	Replace	$93,000
Hazeldell Dr	Blehm St	End of Hazeldell Dr	La Sierra 1010	6	8	2,127	Replace	$298,000
Carmine St	Sierra Vista Av	Blehm St	La Sierra 1010	2	8	833	Replace	$117,000
Peters St	Madison St	Esperanza St	Casa Blanca 1010	4	6	722	Replace	$87,000
Madison St	Peters St	Evans St	Casa Blanca 1010	8	12	624	Replace	$107,000
Samuel St	Peters St	Evans St	Casa Blanca 1010	4	6	559	Replace	$68,000
Evans St	Samuel St	Cary St	Casa Blanca 1010	6	8	351	Replace	$50,000

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)	Comment	Total Cost
Coolidge Av	Mary St	Washington St	Casa Blanca 1010	4	6	1,325	Replace	$159,000
Irving St	Lincoln Av	Cherbourg Dr	Victoria 1100 West	6	8	902	Replace	$127,000
Lincoln Dr	Monroe St	Gratton St	Victoria 1100 West	6	8	1,395	Replace	$196,000
Grace St	Lincoln Av	Emerald St	Victoria 1100 East	6	12	876	Replace	$149,000
Emerald St	7578 Emerald St	Madison St	Victoria 1100 East	6	8	495	Replace	$70,000
Emerald St	Grace St	7578 Emerald St	Victoria 1100 East	6	12	810	Replace	$138,000
Fern Av	Grace St	Madison St	Victoria 1100 East	6	8	1,327	Replace	$186,000
Lincoln Dr	Madison St	Sonora Pl	Victoria 1100 East	4	8	714	Replace	$100,000
City Yard	Adams St	St. Lawrence St	Victoria 1100 East	6	12	796	Replace	$136,000
Ottawa Av	Ninth St	University Av	Chicago 1100	6	8	358	Replace	$51,000
Ninth St	Ottawa Av	End of Ninth St	Chicago 1100	4	8	402	Replace	$57,000
Linden St	Ottawa Av	Chicago Av	Chicago 1100	4	6	1,304	Replace	$157,000
Villa St	Pacific Av	Glen Av	Highgrove 1037	4	8	453	Replace	$64,000
Pacific Av	Villa St	Center St	Highgrove 1037	4	8	867	Replace	$122,000
Fountain St	Pacific Av	End of Fountain St	Highgrove 1037	4	6	436	Replace	$53,000
Devener St	Villa St	End of Devener St	Highgrove 1037	4	6	306	Replace	$37,000
Villa St	Pacific Av	Highland Av	Highgrove 1037	4	6	269	Replace	$33,000
Prospect Av	Citrus Av	Spring St	Sugarloaf 1200	8	12	408	Replace	$70,000
Highland Av	Center St	Mound St	Highgrove 1037	4	8	898	Replace	$126,000
Mound St	Commercial Av	Highland Av	Highgrove 1037	4	6	131	Replace	$16,000
Main St	Commercial Av	Highland Av	Highgrove 1037		8	380	New	$54,000
Citrus St	Prospect Av	1027 Citrus St	Sugarloaf 1200		12	776	Parallel	$132,000
Walker Av	Center St	Flynn St	Highgrove 1120	6	8	674	Replace	$95,000
Spring St	California Av	Prospect Av	Highgrove 1120	8	12	360	Replace	$62,000
California Av	Center St	Prospect Av	Highgrove 1120	8	12	1,324	Replace	$226,000
Leland Av	Mary St	Ronald St	Emtman 1200	4	6	630	Replace	$76,000
Monterey Rd	Robin Rd	Ivy St	Emtman 1200	4	6	558	Replace	$67,000
	End of Gibraltar Dr	Across from Pachappa Dr	Emtman 1200	4	6	1,479	Replace	$178,000
Maude St	Marlo Way	End of Maude St	Emtman 1200	4	6	551	Replace	$67,000
Coolidge Av	Mary St	Roland St	Emtman 1200	4	6	794	Replace	$96,000
McAllister St	Dufferin Av	City Boundary	Van Buren 1200	4	8	1,213	Replace	$170,000
John St	Dufferin Av	Trails End	Van Buren 1200	4	8	1,415	Replace	$199,000
Trails End	John St	End of Trails End	Van Buren 1200	4	8	368	Replace	$52,000
Grace St	Broadacre Pl	2090 Grace St	Van Buren 1200	6	8	605	Replace	$85,000
Summit St	Grace St	Huntington St	Van Buren 1200	6	8	1,829	Replace	$257,000
Huntington St	Summit St	Washington St	Van Buren 1200	6	8	314	Replace	$44,000
Washington St	Huntington St	Bradley St	Van Buren 1200	6	8	1,245	Replace	$175,000
Kentwood Dr/Glenhill Dr	Spruce St	Sugarloaf Dr	Sugarloaf 1200	6	12	1,891	Replace	$322,000
Kentwood Dr	Spruce St	End of Kentwood Dr	Sugarloaf 1200	6	8	593	Replace	$84,000

Street Name	From	To	Zone	Existing Diameter (in)	New Diameter (in)	Length (ft)	Comment	Total Cost
Elgin Dr	Canyon Crest Dr	2929 Elgin Dr	Sugarloaf 1200	6	12	198	Replace	$34,000
Gage Canal crossing	2929 Elgin Dr	Intersection of Massachusetts Av & Don Goodwin Dr	Sugarloaf 1200	6	12	405	Replace	$69,000
Massachusetts Av	Iowa Av	Don Goodwin Dr	Sugarloaf 1200	6	12	2,099	Replace	$357,000
Rustin Av	Massachusetts Av	Linden St	Sugarloaf 1200	6	12	2,640	Replace	$449,000
Tripoli St/Edinburgh Av	Rustin Av	End of Edinburgh Av	Sugarloaf 1200	6	8	751	Replace	$106,000
Ohio St	Chicago Av	1834 Ohio St	Sugarloaf 1200	6	8	588	Replace	$83,000
Vassar Dr	Chicago Av (20-inch pipe)	Wellesley Wy	Sugarloaf 1200	6	8	260	Replace	$37,000
Palmyrita Av	Ardmore St	1540 Palmyrita Av	Sugarloaf 1200	4	12	508	Replace	$87,000
Ardmore St	Palmyrita Av	Columbia Av	Sugarloaf 1200	4	12	1,305	Replace	$222,000
Elgin Dr	2929 Elgin Dr	End of Elgin Dr	Sugarloaf 1200	6	8	8,680	Replace	$1,216,000
New Kirk Dr/Altura Dr/Baltic Av	Massachusetts Av	Bascomb Dr	Sugarloaf 1200	6	8	881	Replace	$124,000
Bascomb Dr	Baltic Av	1009 Bascomb Dr	Sugarloaf 1200	6	8	528	Replace	$74,000
Minerva Ct	Rustin Av	1051 Minerva Ct	Sugarloaf 1200	6	8	316	Replace	$45,000
Athena Ct	Rustin Av	1051 Athena Ct	Sugarloaf 1200	6	8	293	Replace	$42,000
Seventh St	Crawford Av	End of 7th St	Sugarloaf 1200	6	8	618	Replace	$87,000
Ottawa Av	Martin Luther King Bl	Prince Albert Dr	Sugarloaf 1200	6	8	1,608	Replace	$226,000
Chicago Av	University Av	Martin Luther King Bl	Sugarloaf 1200		16	2,542	Parallel	$509,000
Broadbent Dr	Watkins Dr	End of Broadbent Rd	Blaine 1300	4	8	267	Replace	$38,000
Discharge of Watkins PRV			Blaine 1300	8	12	22	Replace	$4,000
Valencia Hill Dr	Watkins PRV	Watkins Dr	Blaine 1300	8	12	72	Replace	$13,000
Valencia Hill Dr	Watkins Dr	Big Springs Rd	Blaine 1300	6	12	1,302	Replace	$222,000
Big Springs Rd	Valencia Hill Dr	Watkins Dr	Blaine 1300	8	12	546	Replace	$93,000
Celeste Dr	Highlander Dr	Blaine St	Blaine 1300	6	8	258	Replace	$37,000
Alta Mesa Dr	Flanders Rd	Waldrof Dr	Blaine 1300	6	8	1,235	Replace	$173,000
Maravilla Dr	Campus View Dr	Maraville Dr	Blaine 1300	6	8	388	Replace	$55,000
Quail Rd	Broadbent Rd	End of Quail Rd	Heustis 1400	4	6	767	Replace	$70,000
Maricopa Dr	Blaine St	End of Maricopa Dr	Heustis 1400	4	6	628	Replace	$57,000
Easement	6736 Oleander Ct	2114 Westminster Dr	Oleander 1300	2.5	6	512	Replace	$62,000
Easement	2114 Westminster Dr	End of Oleander Dr	Oleander 1300	2.5	6	512	Replace	$62,000
Golden Star Av	Bradley St	Highridge St	Whitegates 1408	6	12	1,286	Replace	$219,000
Highridge St	Golden Star Av	Milligan Av	Whitegates 1408	6	12	440	Replace	$75,000
Dirt Road	Mt. Vernon Av	End of Dirt Road	Mt Vernon 1600	6	8	2,457	Replace	$295,000
Monroe St	Frontier Av	Gratton BS	Gratton 1400	6	8	770	Parallel	$108,000
Gratton St	Gratton BS	Heather Lane	Gratton 1400	6	8	901	Replace	$127,000
Heather Lane	Gratton St	Last fire hydrant	Gratton 1400	6	8	707	Replace	$99,000
Gratton St	Heather Lane	Frontier Av (6-inch only)	Gratton 1400	6	8	321	Replace	$45,000

Table 9-9
Water Distribution System Capital Improvement Program

All costs are in million $

Ranking	Pipelines	Reservoirs	Booster Pump Stations	Pressure Reducing Stations	Total
Very High	$5.5	$11.4	$3.3	$0.0	$20.1
High	$3.6	$10.3	$2.3	$0.4	$16.6
Medium-High	$23.2	--	$1.9	$0.0	$25.1
Medium	$18.7	$14.0	-	$0.2	$32.8
Low	$9.4	$14.7	$1.1	$0.1	$25.4
Very Low	$18.4	-	$0.2	$0.1	$18.8
Total	**$78.9**	**$50.4**	**$8.8**	**$0.7**	**$138.9**

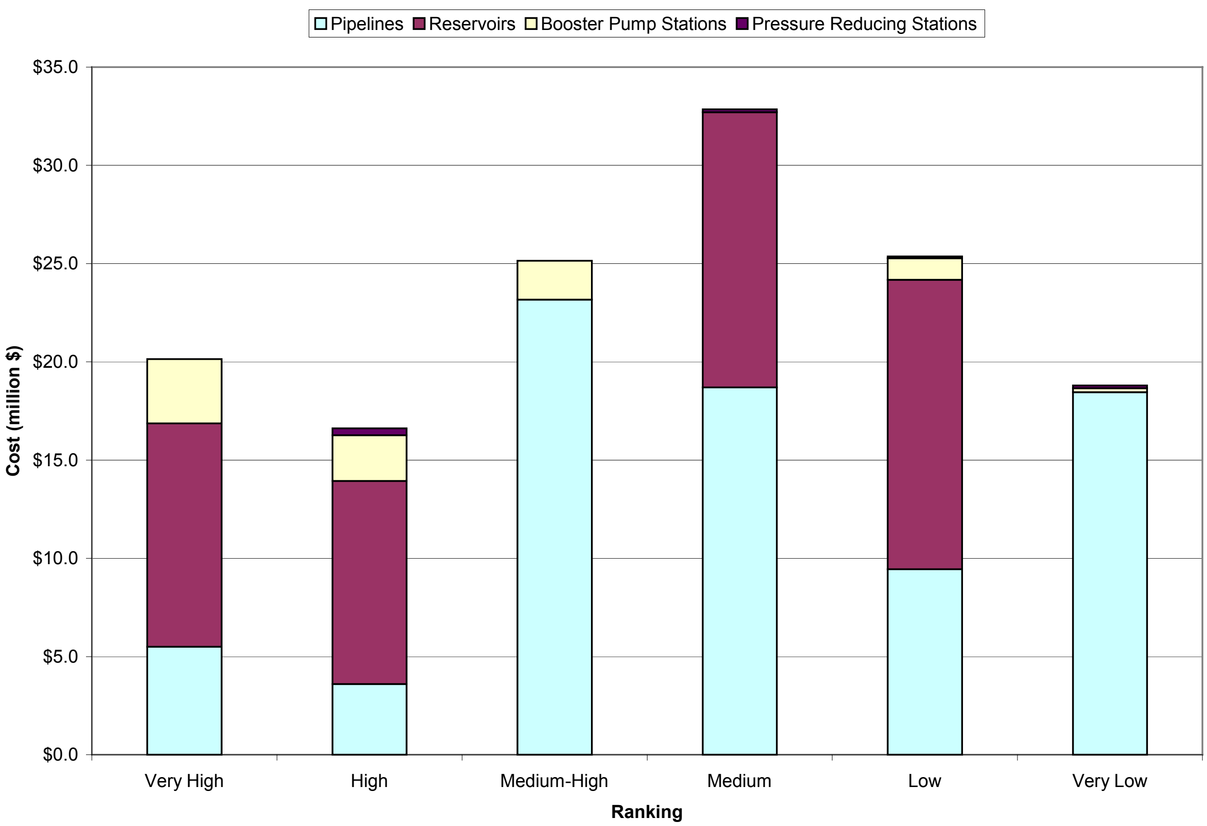


Figure 9-2
Water System CIP by Phasing

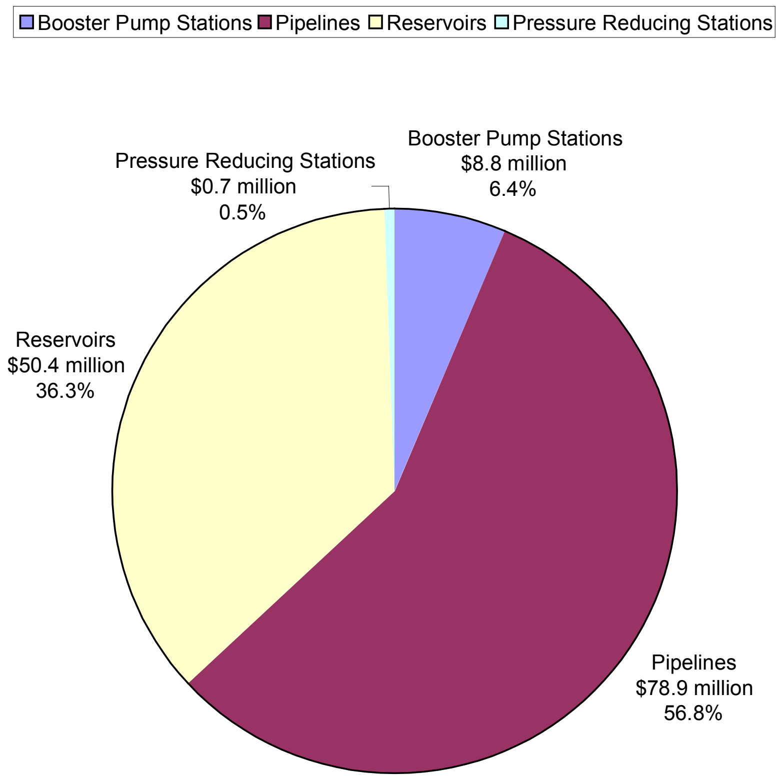
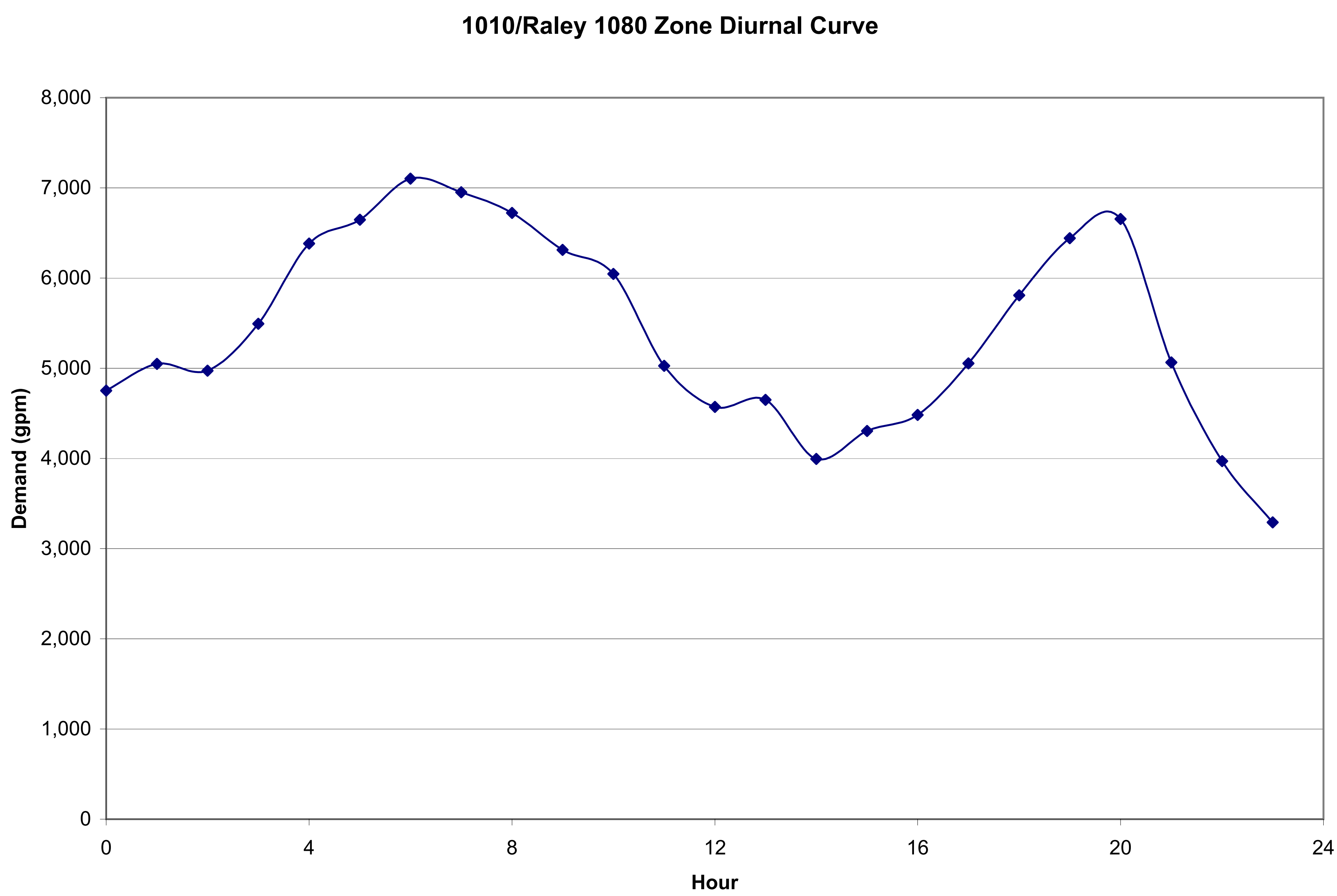


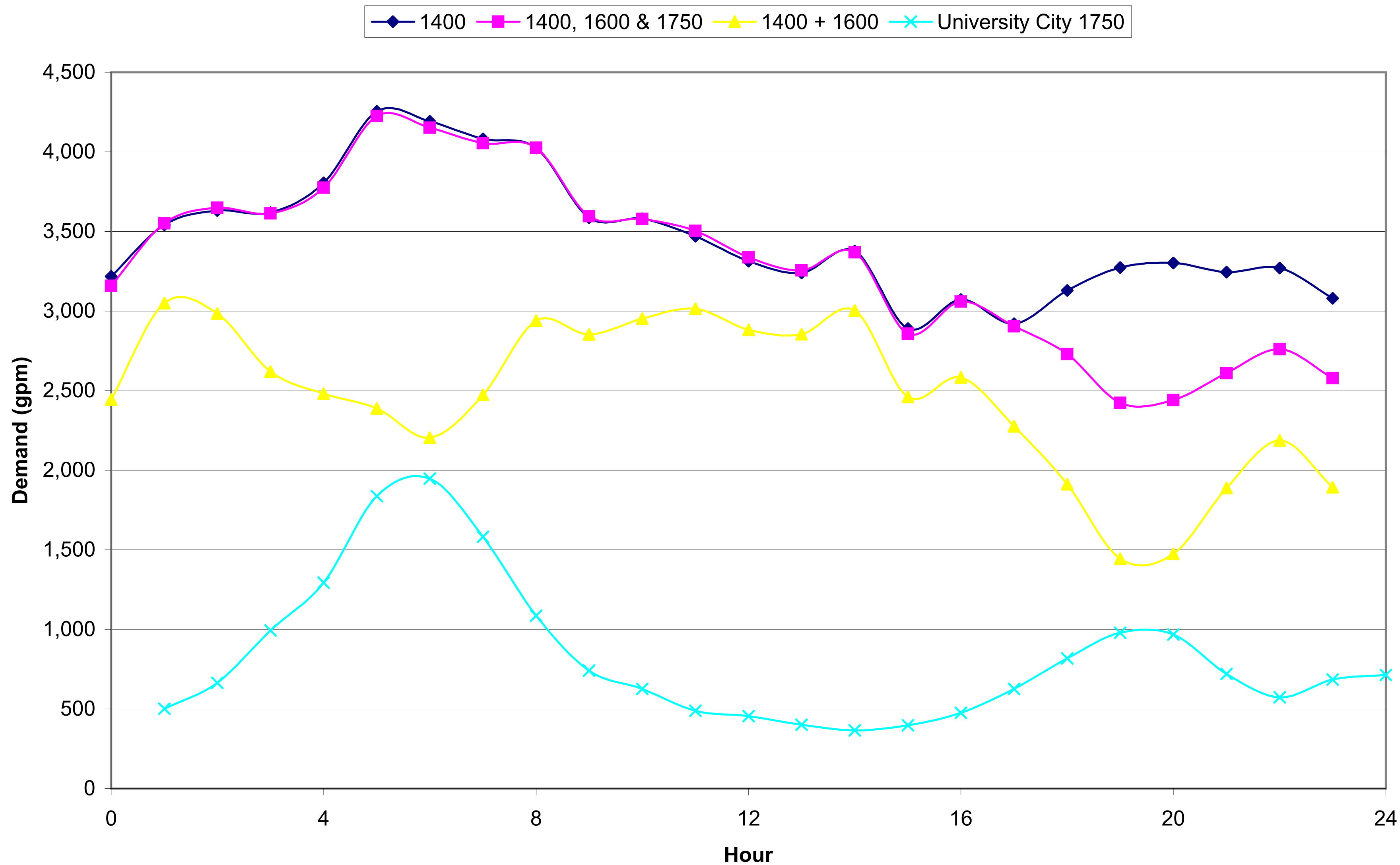
Figure 9-3
Water System CIP by Facility Type

Appendix A
Diurnal Curves

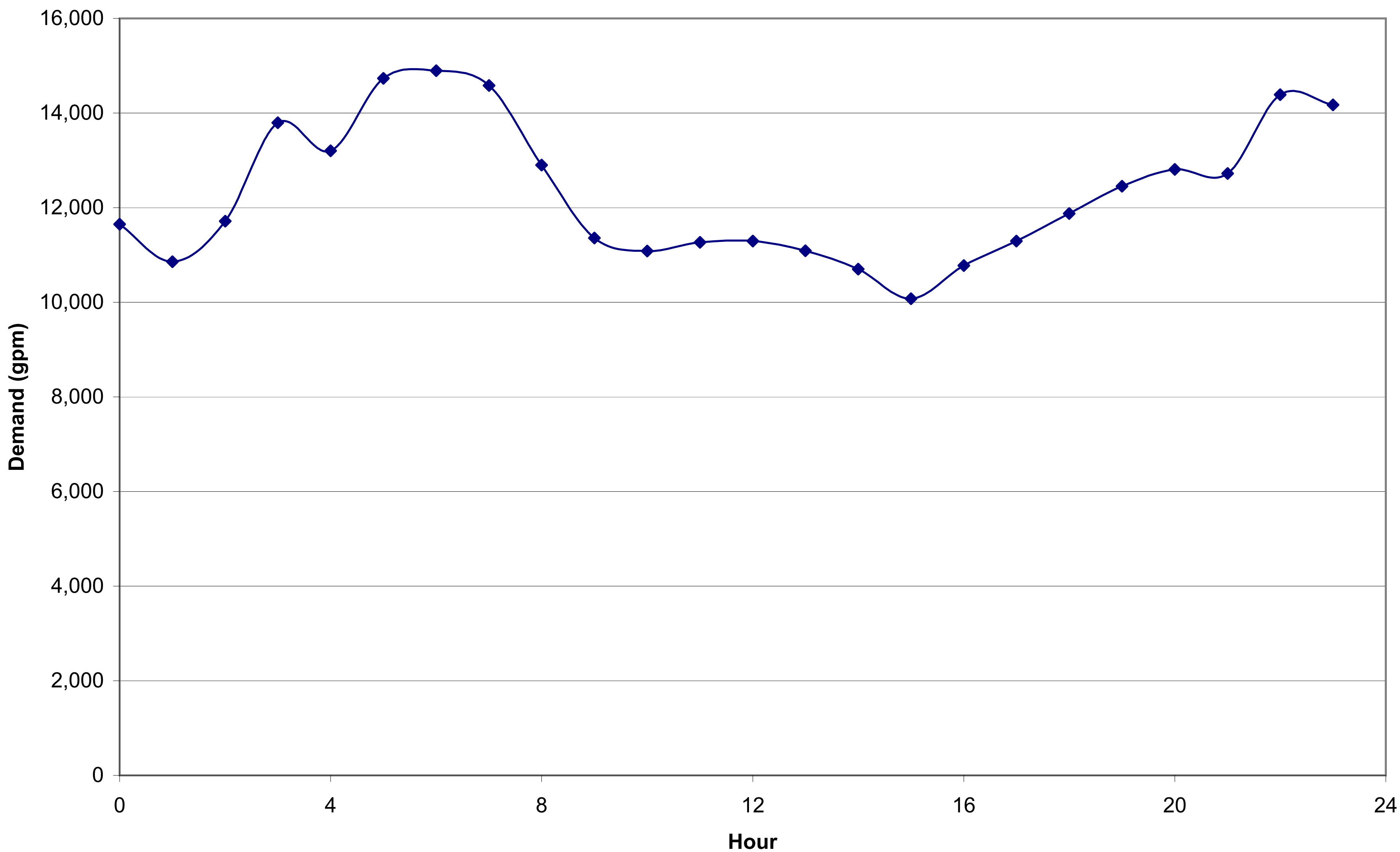
Diurnal curves were created for areas of similar demographics and water usage. A separate diurnal curve was not created for each pressure zone due to the limited data that was collected on July 8, 2004. The diurnal demand curves were plotted using hourly field measurements from SCADA data for reservoir volumes and flows.

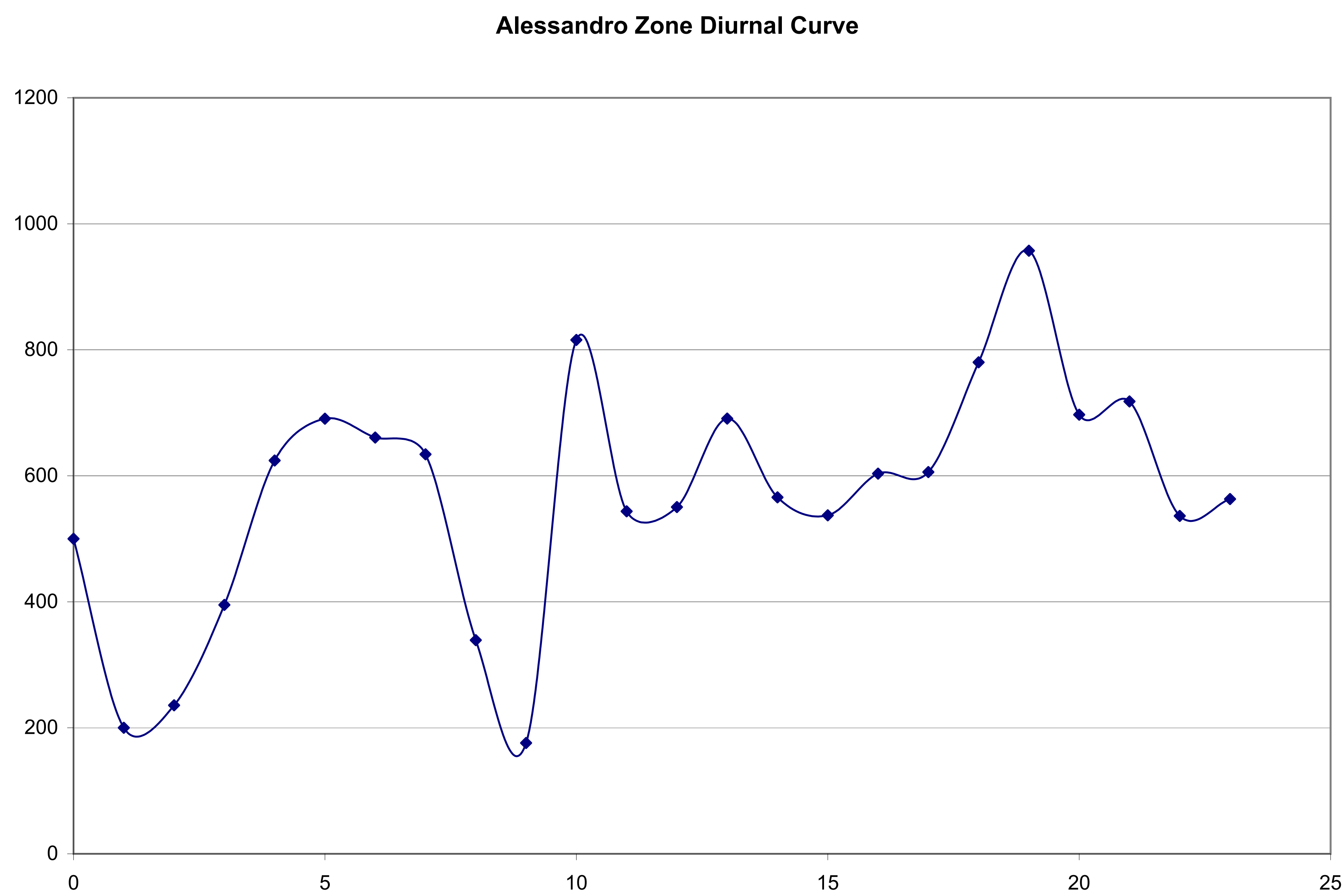

1010/Raley 1080 Zone Diurnal Curve
Demand (gpm)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
4
8
12
16
20
24
Hour

Piedmont/Heustis/Ross/Libby/Mt Vernon/Canyon Crest/Blaine Zone Diurnal Curve

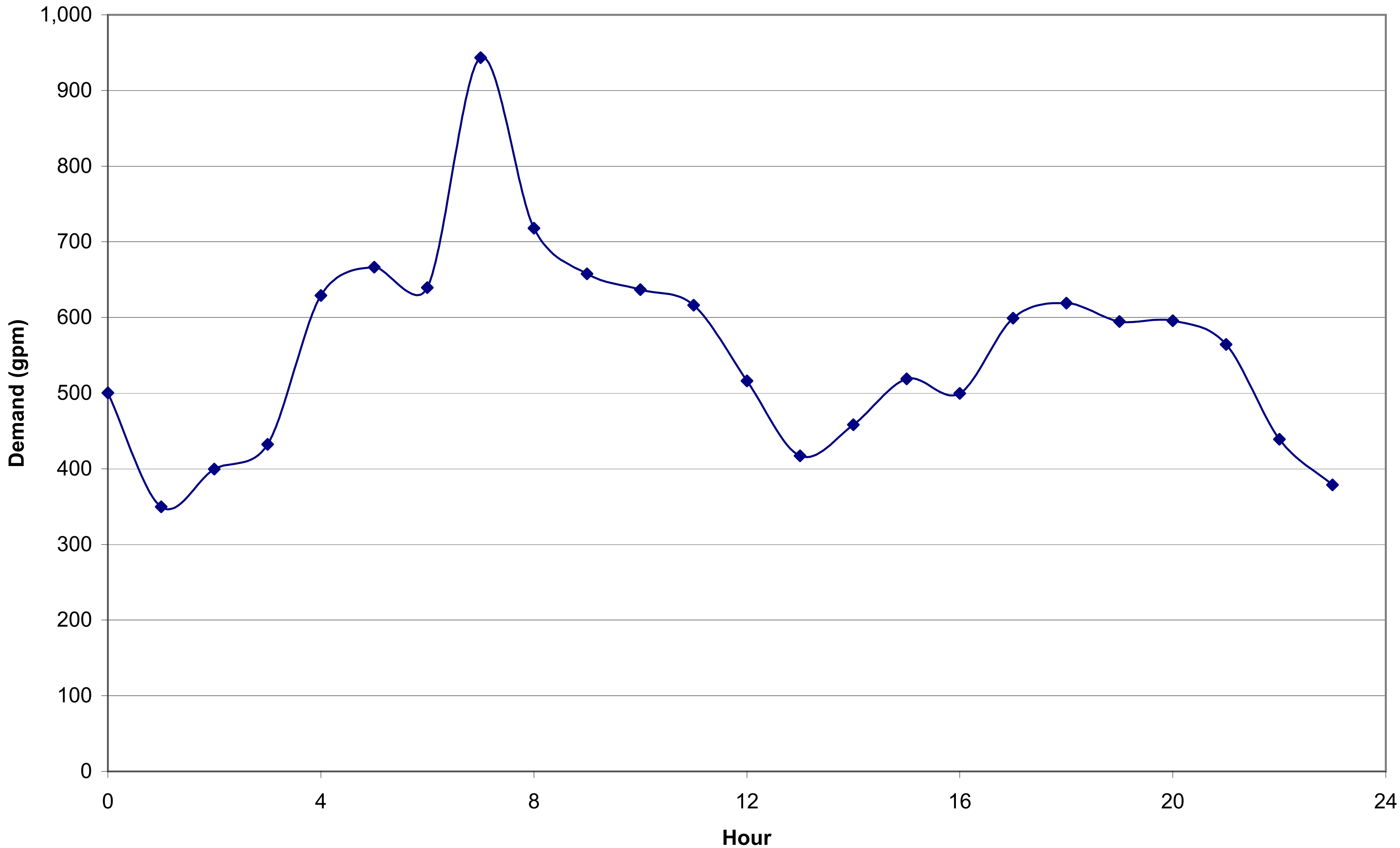


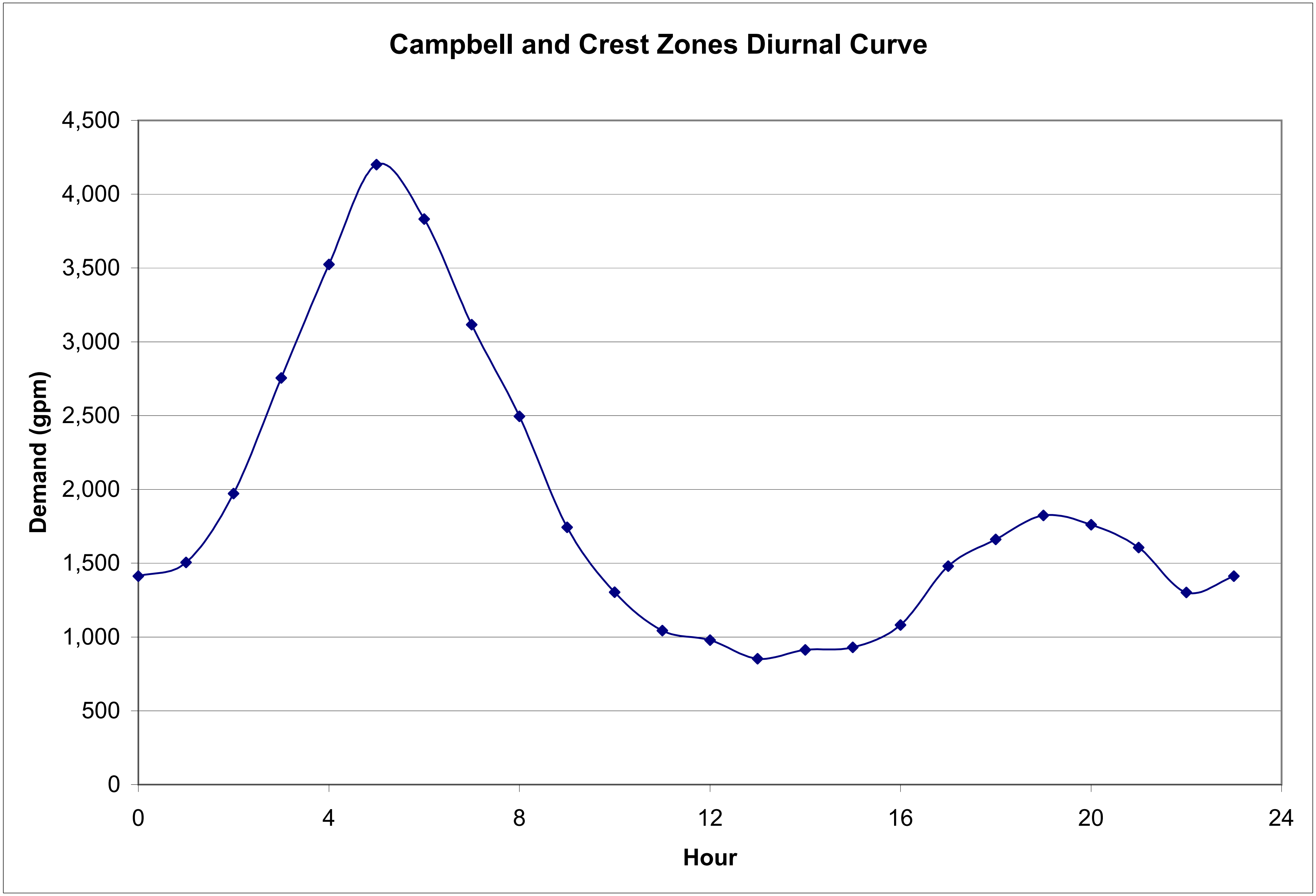
1200 Zone & Gratton 1400 Diurnal Curve



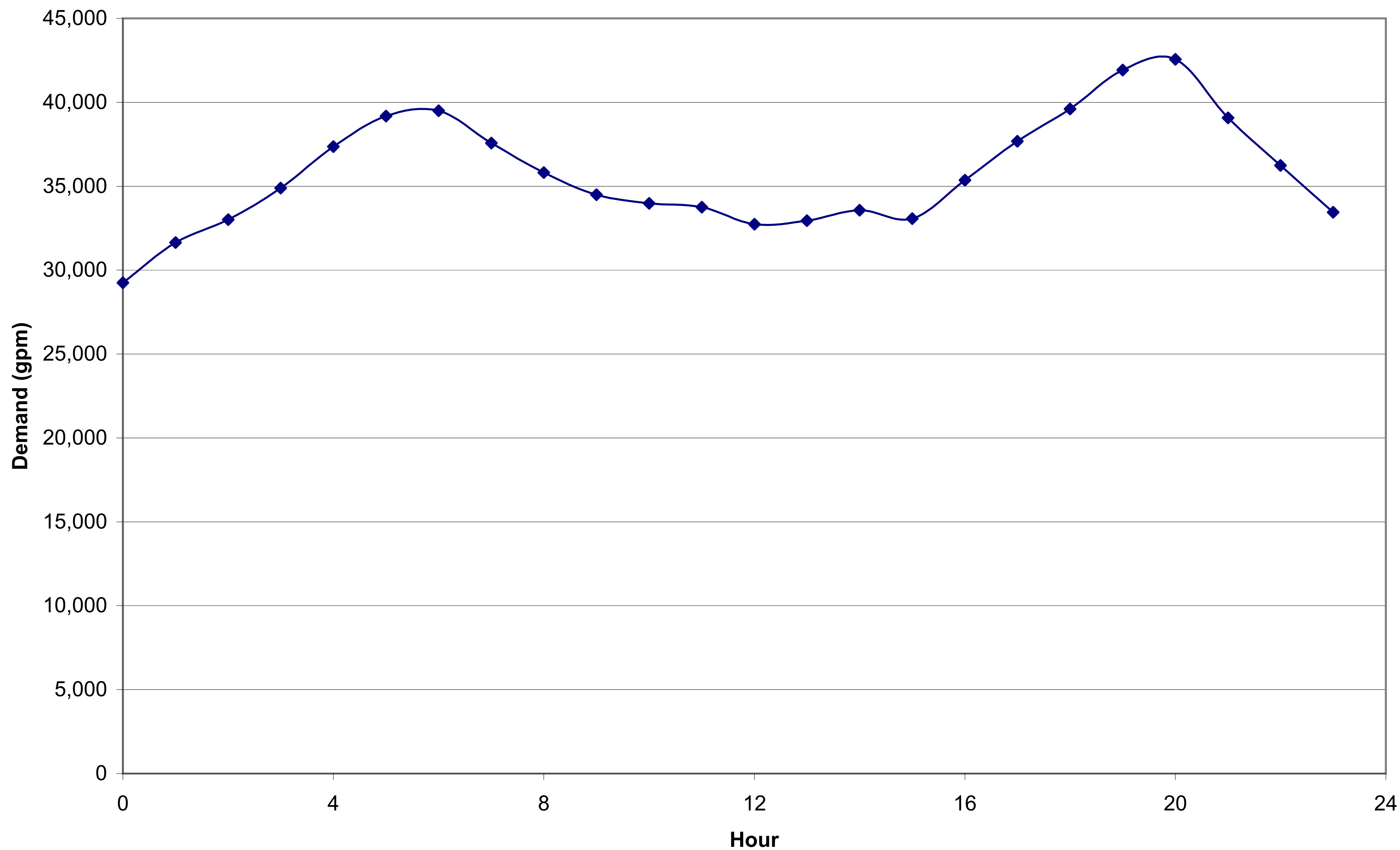

Alessandro Zone Diurnal Curve
1200
1000
800
600
400
200
0
0
5
10
15
20
25

Arlington 1160 Zone Diurnal Curve

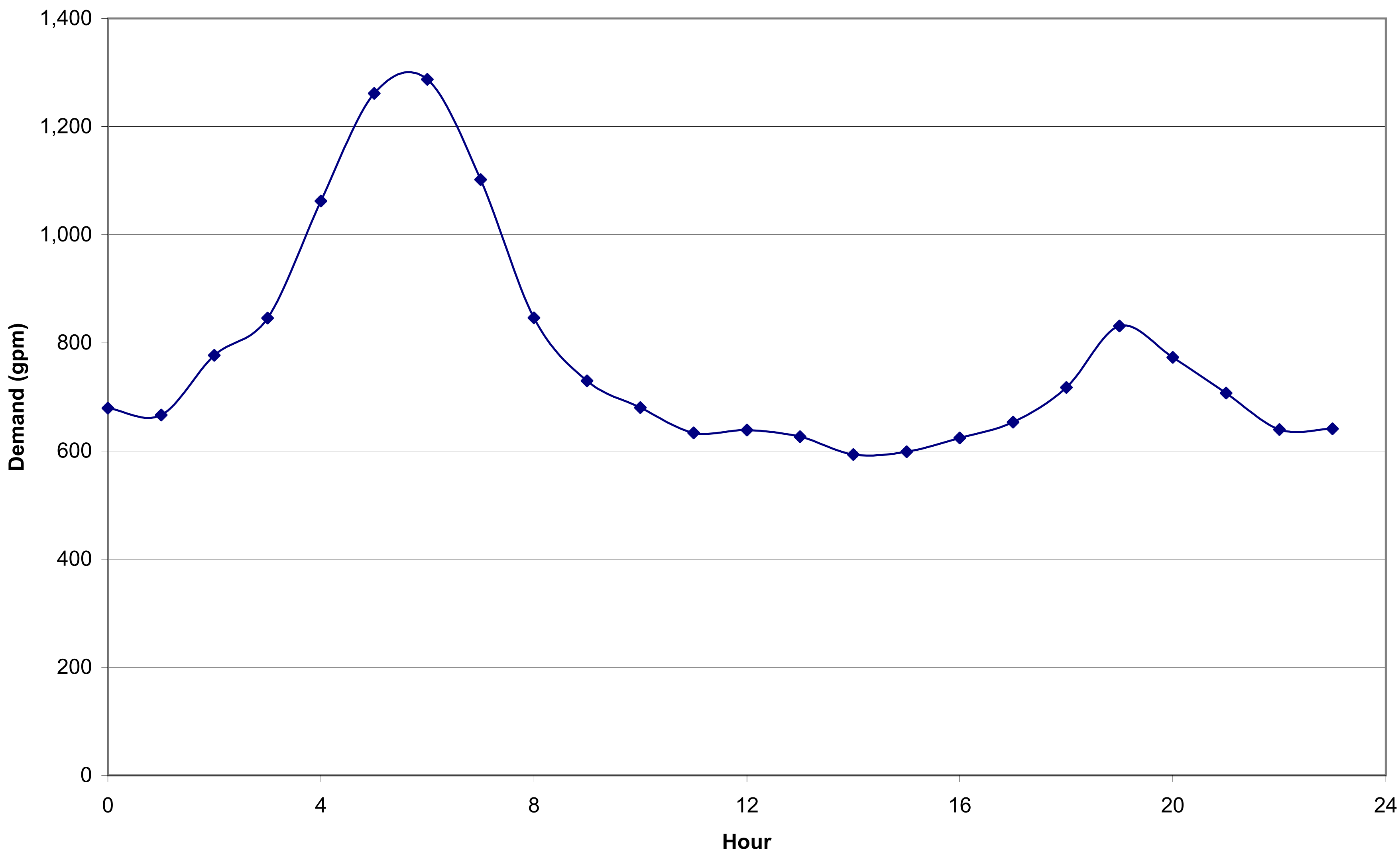



Campbell and Crest Zones Diurnal Curve
Demand (gpm)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
4
8
12
16
20
24
Hour

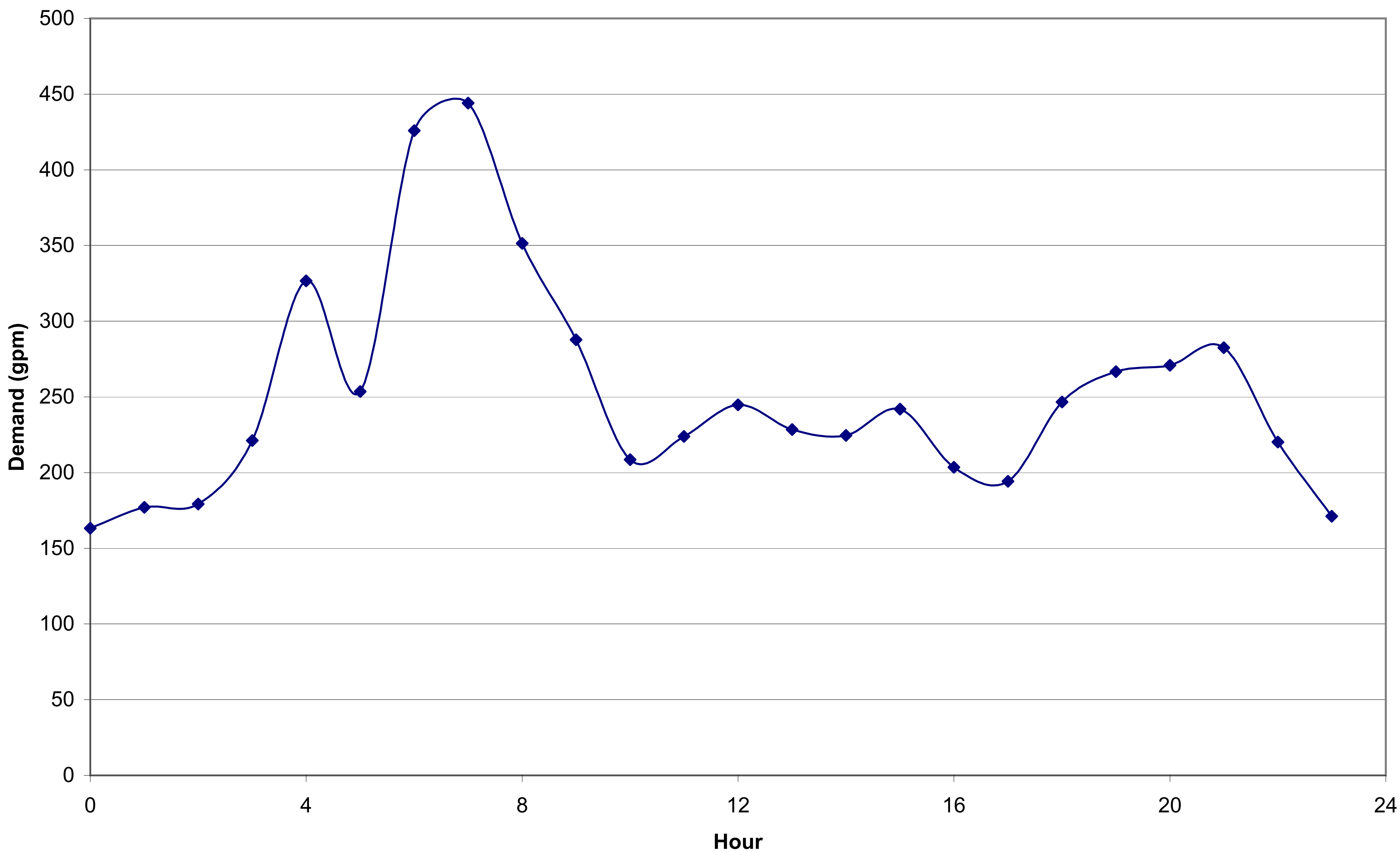
Gravity and 925 Zones Diurnal Curve

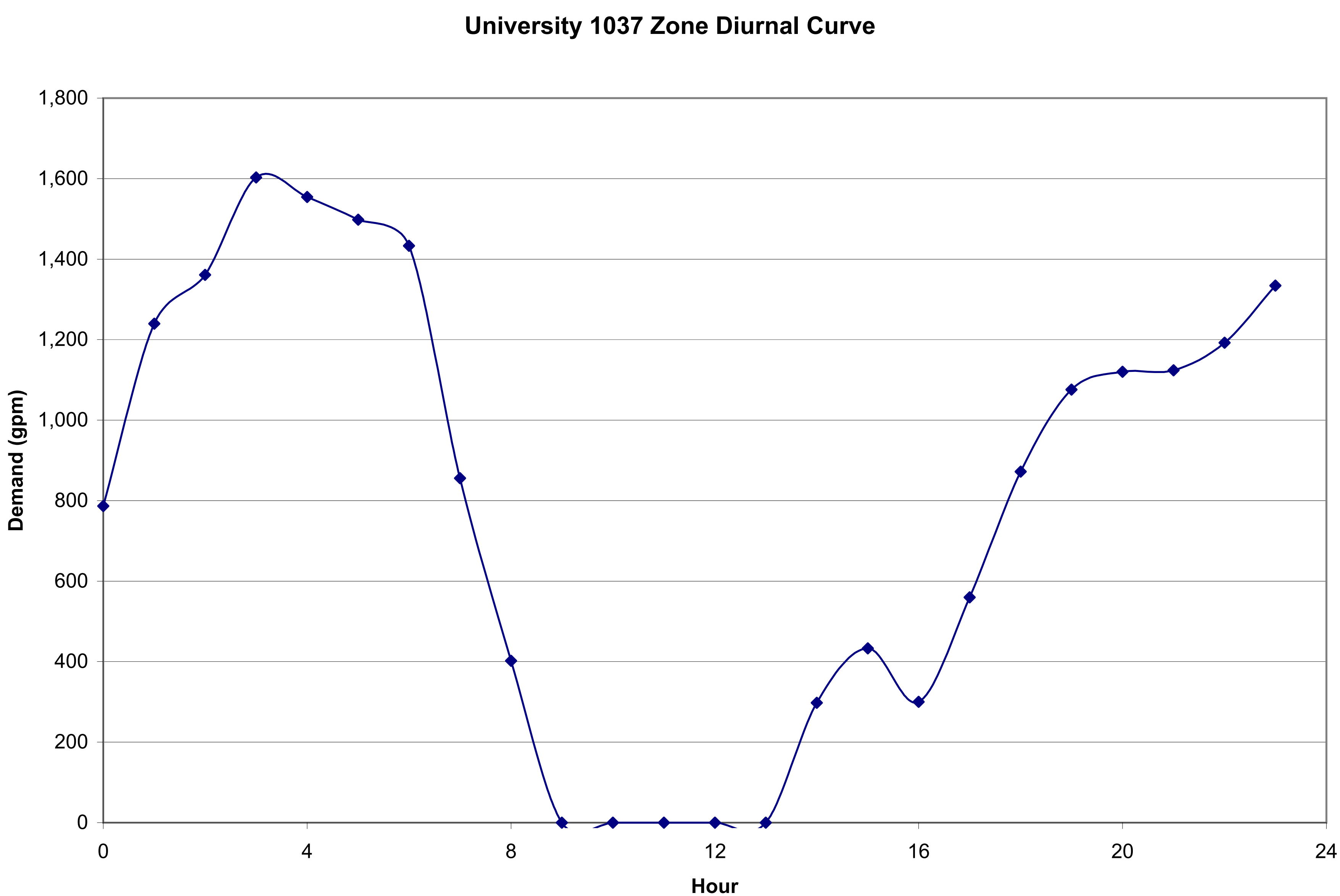


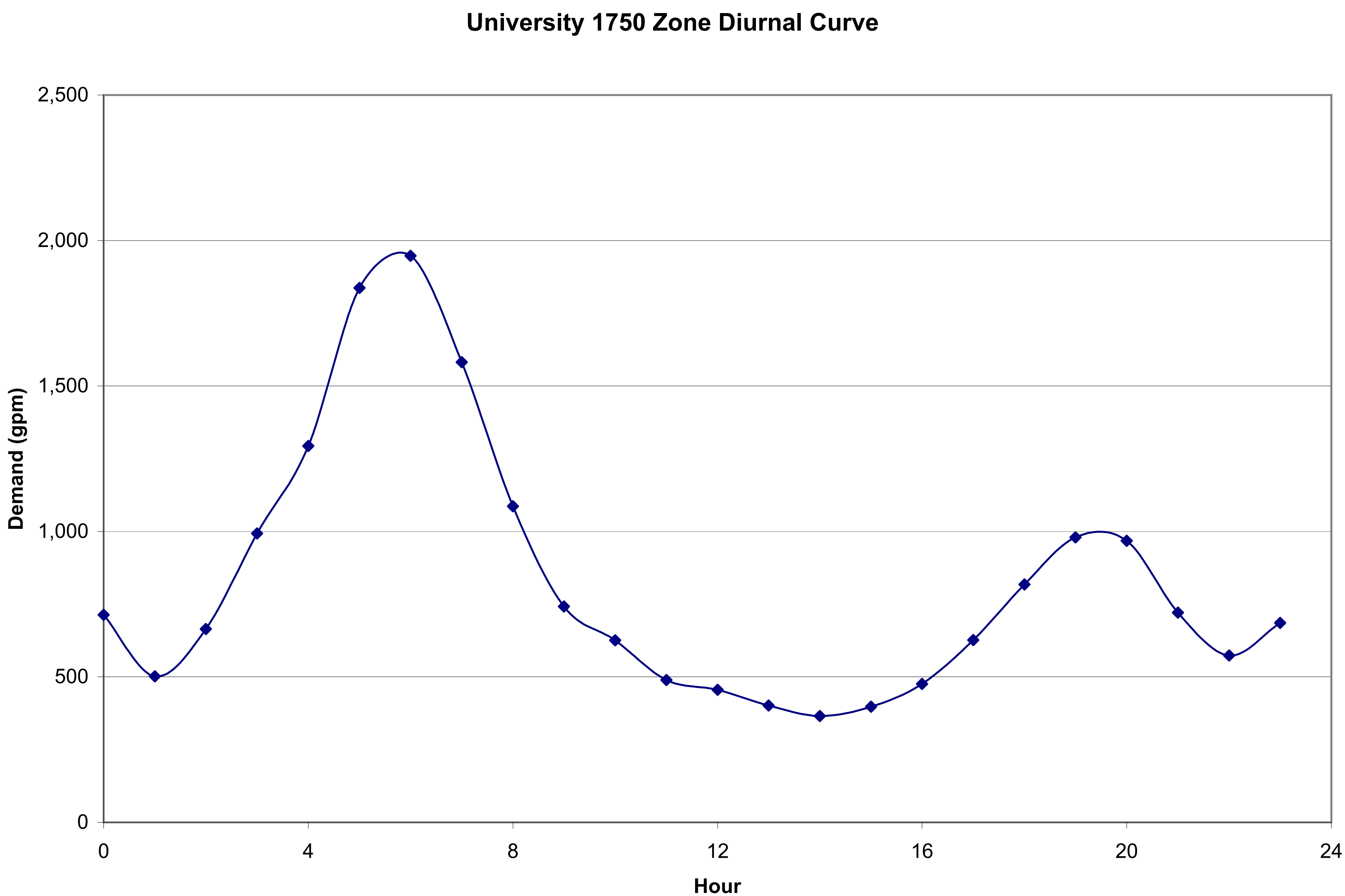
Praed 1400 Zone Diurnal Curve

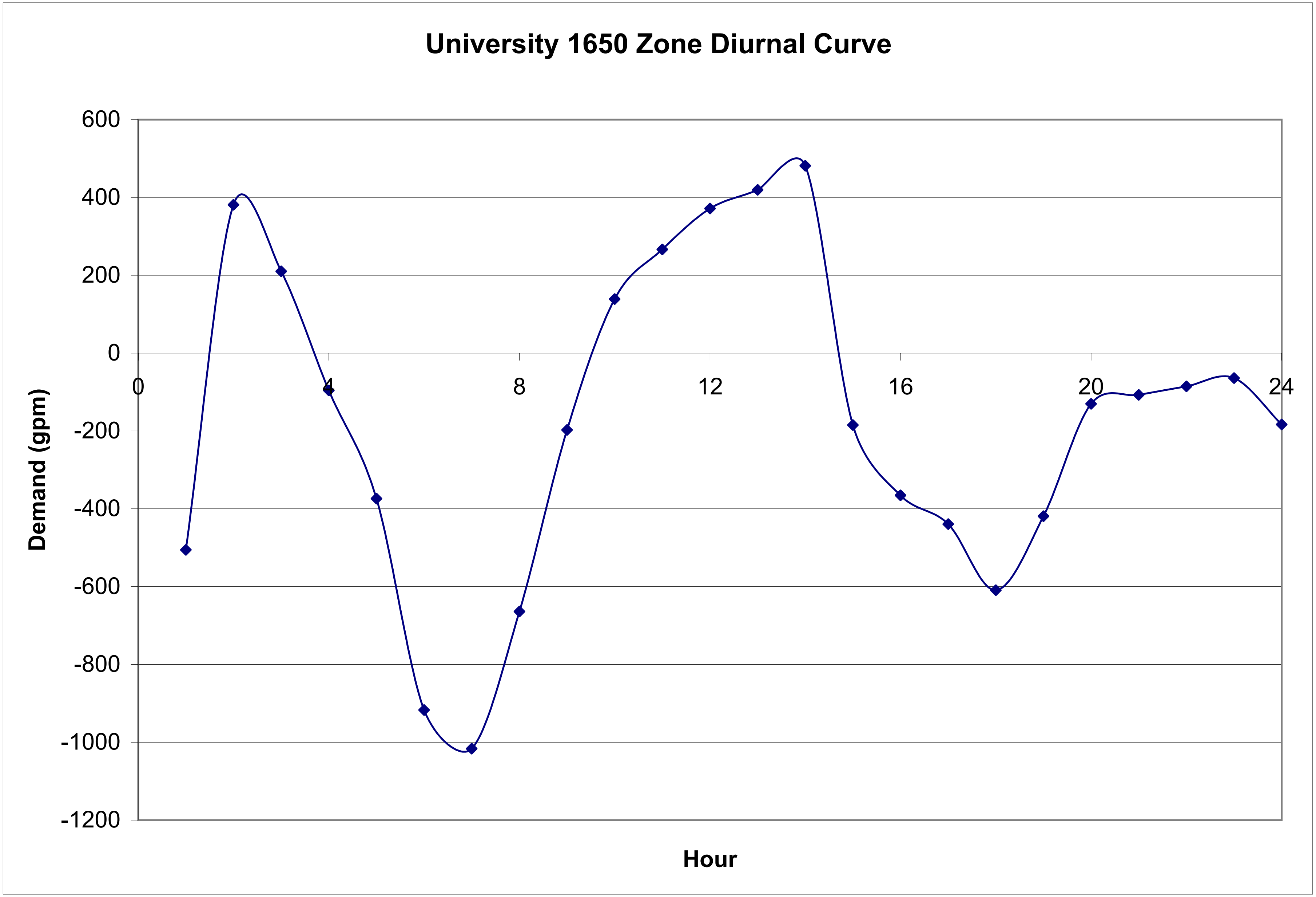


Tilden 1160 Zone Diurnal Curve

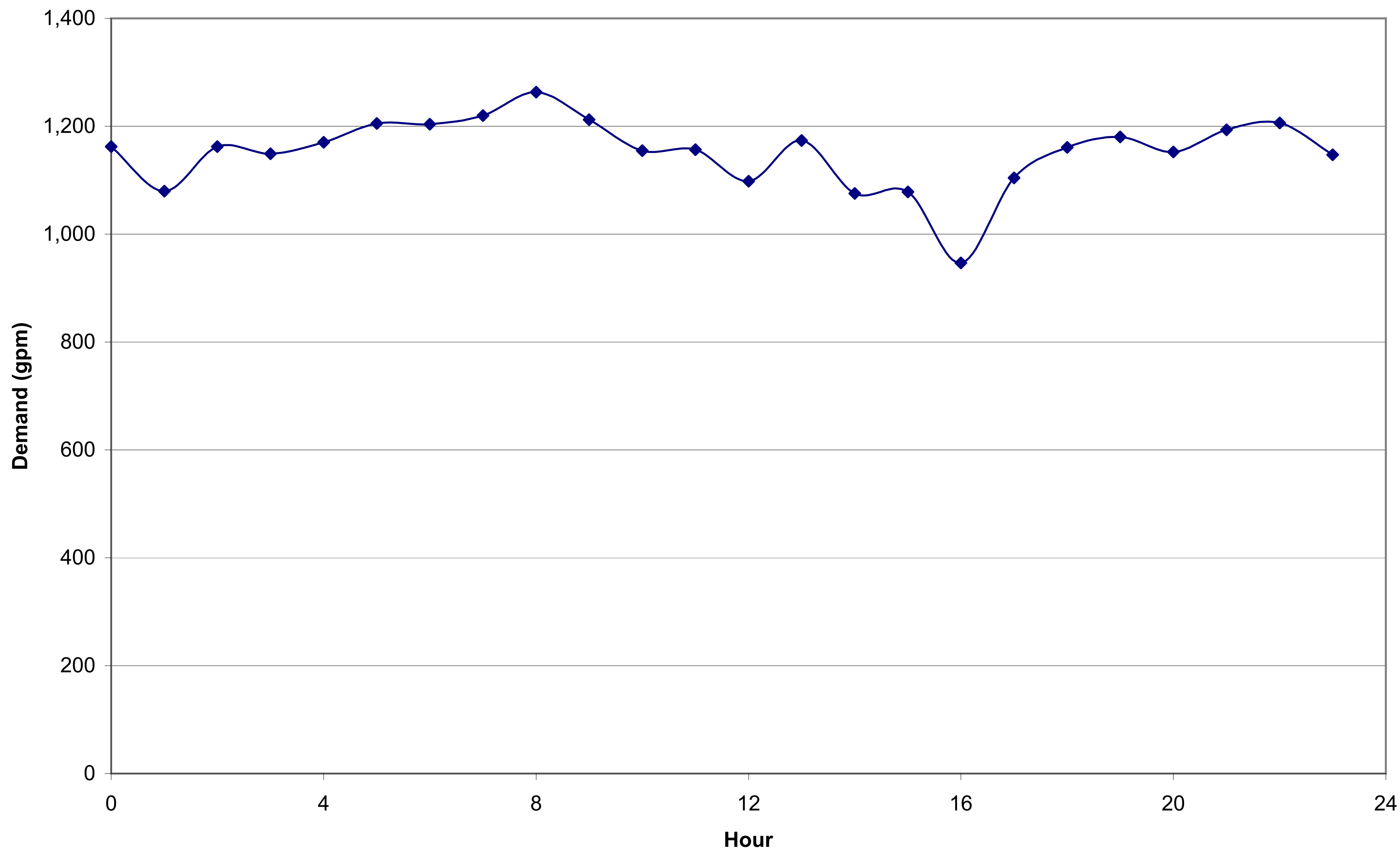



University 1037 Zone Diurnal Curve
Demand (gpm)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
4
8
12
16
20
24
Hour

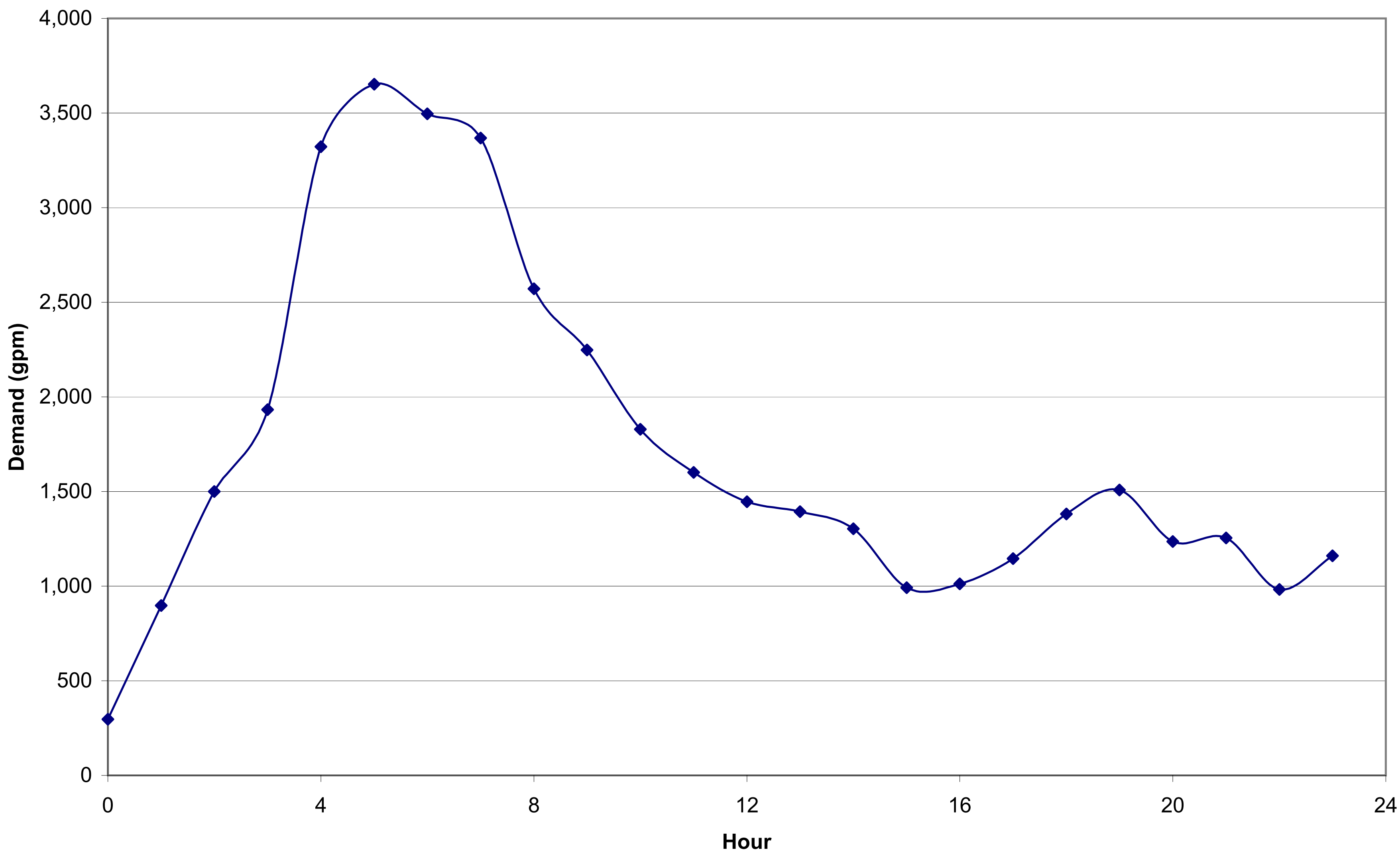

University 1750 Zone Diurnal Curve
Demand (gpm)
2,500
2,000
1,500
1,000
500
0
0
4
8
12
16
20
24
Hour


University 1650 Zone Diurnal Curve
Demand (gpm)
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
4
8
12
16
20
24
Hour

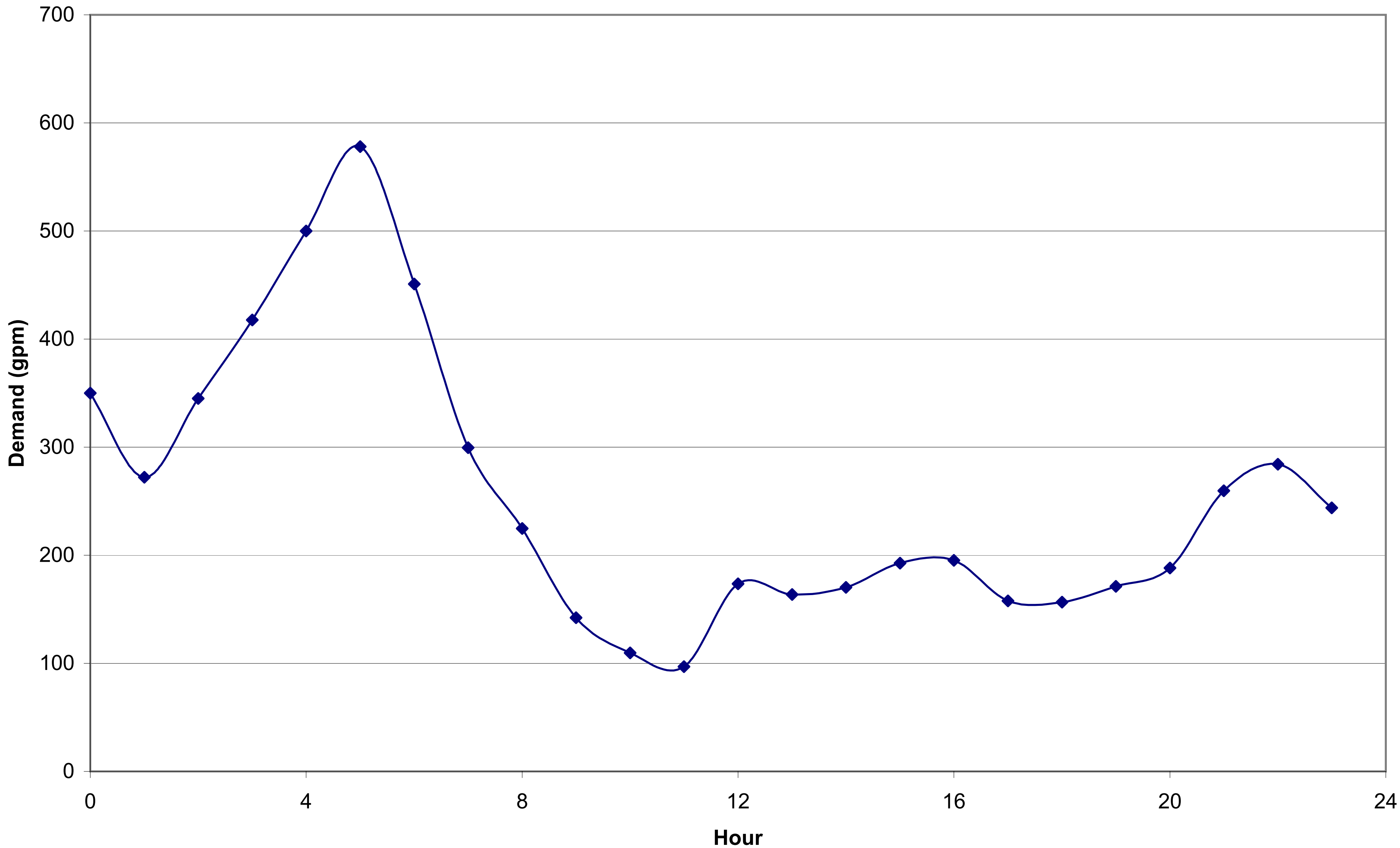
Victoria 1100 & Casa Blanca 1010 Zones Diurnal Curve



Whitegates 1400 Zone Diurnal Curve



Whitegates 1568/1750 Zone Diurnal Curve



Appendix B
Land Use Sampling

The following table is the Land Use Sampling that was used to determine the duty factors.

Sample	**Land Use Type**	**Water Consumption from Billing Data (gpm)**	**Area (acres)**	**No. of Accounts**	**Duty Factor (gal/acre/day)**	**Duty Factor (gal/DU/day)**
Low_Den_Sample1	Residential - Low Density	69	48	148	2,065	669
Low_Den_Sample2	Residential - Low Density	204	119	354	2,461	829
Low_Den_Sample3	Residential - Low Density	106	70	138	2,204	1,111
Low_Den_Sample4	Residential - Low Density	126	84	227	2,152	797
Low_Den_Sample5	Residential - Low Density	279	153	366	2,615	1,097
	Total - Average	**783**	**474**	**1,233**	**2,378**	**915**
Med_Den_Sample1	Residential - Medium Density	101	63	231	2,324	631
Med_Den_Sample2	Residential - Medium Density	154	99	308	2,233	721
Med_Den_Sample3	Residential - Medium Density	194	99	522	2,825	537
Med_Den_Sample4	Residential - Medium Density	277	106	669	3,763	596
Med_Den_Sample5	Residential - Medium Density	209	103	386	2,919	780
	Total - Average	**936**	**471**	**2,116**	**2,865**	**637**
High_Den_Sample1	Residential - High Density	232	59	97	5,664	
High_Den_Sample2	Residential - High Density	174	72	48	3,467	
High_Den_Sample3	Residential - High Density	98	58	36	2,411	
High_Den_Sample4	Residential - High Density	57	20	51	4,059	
High_Den_Sample5	Residential - High Density	188	52	77	5,162	
	Total - Average	**748**	**262**	**309**	**4,111**	
Med_High_Den_Sample1	Residential - Medium to High Density	78	32	148	3,555	761
Med_High_Den_Sample2	Residential - Medium to High Density	269	101	104	3,819	
	Total - Average	**347**	**133**	**252**	**3,756**	
Commercial_Sample1	Commercial	371	198	142	2,699	
Commercial_Sample2	Commercial	198	68	86	4,186	
Commercial_Sample3	Commercial	61	57	109	1,541	
Commercial_Sample4	Commercial	13	8	26	2,257	
Commercial_Sample5	Commercial	212	94	83	3,230	
	Total - Average	**855**	**426**	**446**	**2,891**	
Industrial_Sample1	Industrial	123	100	17	1,765	
Industrial_Sample2	Industrial	178	218	179	1,178	
Industrial_Sample3	Industrial	124	111	114	1,612	
Industrial_Sample4	Industrial	310	238	88	1,875	
Industrial_Sample5	Industrial	107	184	33	838	
	Total - Average	**843**	**852**	**431**	**1,425**	
Semi_Rural_Res_Sample1	Residential - Semi Rural	26	49	52	772	725
Semi_Rural_Res_Sample2	Residential - Semi Rural	148	138	230	1,541	926
Semi_Rural_Res_Sample3	Residential - Semi Rural	125	168	276	1,075	655
Semi_Rural_Res_Sample4	Residential - Semi Rural	63	86	109	1,050	827
Semi_Rural_Res_Sample5	Residential - Semi Rural	56	63	98	1,289	828
	Total - Average	**418**	**504**	**765**	**1,196**	**788**
Hillside_Res_Sample1	Residential - Hillside	46	28	50	2,331	1,315
Hillside_Res_Sample2	Residential - Hillside	31	37	31	1,220	1,461
Hillside_Res_Sample3	Residential - Hillside	173	89	104	2,793	2,397
Hillside_Res_Sample4	Residential - Hillside	263	152	94	2,495	4,023
Hillside_Res_Sample5	Residential - Hillside	36	27	36	1,917	1,432
	Total - Average	**549**	**333**	**315**	**2,372**	**2,508**
Rural_and_Res_Sample3	Residential - Rural and Residential	14	122	9	169	2,290
Rural_and_Res_Sample4	Residential - Rural and Residential	21	136	24	219	1,245
Rural_and_Res_Sample5	Residential - Rural and Residential	41	84	25	699	2,358
Rural_and_Res_Sample6	Residential - Rural and Residential	72	67	14	1,562	7,455
Rural_and_Res_Sample8	Residential - Rural and Residential	64	86	17	1,071	5,406
Rural_and_Res_Sample9	Residential - Rural and Residential	44	55	27	1,166	2,360
Rural_and_Res_Sample10	Residential - Rural and Residential	20	128	21	229	1,400
	Total - Average	**277**	**678**	**137**	**731**	**3,216**
Estate_Res_Sample1	Residential - Estate	56	28	48	2,905	1,666
Estate_Res_Sample3	Residential - Estate	86	49	59	2,516	2,090
Estate_Res_Sample4	Residential - Estate	79	49	64	2,330	1,772
Estate_Res_Sample5	Residential - Estate	300	184	282	2,348	1,530
	Total - Average	**519**	**309**	**453**	**2,422**	**1,651**
Office_Sample1	Office	7	8	5	1,191	

Office_Sample2	Office	61	40	119	2,209	
Office_Sample3	Office	18	19	34	1,354	
Office_Sample4	Office	28	17	47	2,421	
Office_Sample5	Office	49	17	67	4,181	
	Total - Average	**162**	**100**	**272**	**2,332**	
Parks_Sample1	Parks	25	67	2	546	
Parks_Sample2	Parks	49	226	9	310	
Parks_Sample 3	Parks	10	3	4	4,644	
Parks_Sample 4	Parks	22	23	2	1,357	
Parks_Sample5	Parks	11	6	2	2487	
Parks_Sample6	Parks	34	37	1	1320	
Parks_Sample7	Parks	18	9	14	2848	
Parks_Sample8	Parks	59	32	2	2646	
Parks_Sample9	Parks	24	34	4	1025	
Parks_Sample10	Parks	35	22	3	2289	
	Total - Average	**448**	**559**	**315**	**1,947**	
Open_Sample3	Public Facilities and Open Space	178	318	17	807	
Open_Sample4	Public Facilities and Open Space	174	155	29	1,620	
Open_Sample5	Public Facilities and Open Space	321	246	29	1,877	
	Total - Average	**673**	**719**	**75**	**1,348**	

Appendix C
Model Calibration Data

The following is the summary of the calibration of the model against the data that was collected on July 8, 2004. Figure C-1, is a summary of all of the calibration points that were collected, including reservoir levels, booster stations, and pressure reducing stations.

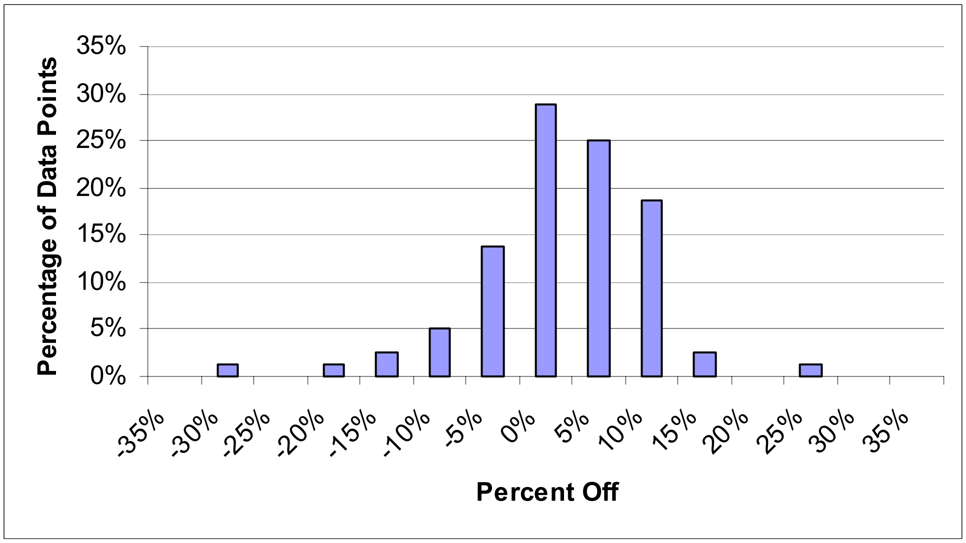


Figure C- 1
Summary of Calibration Points

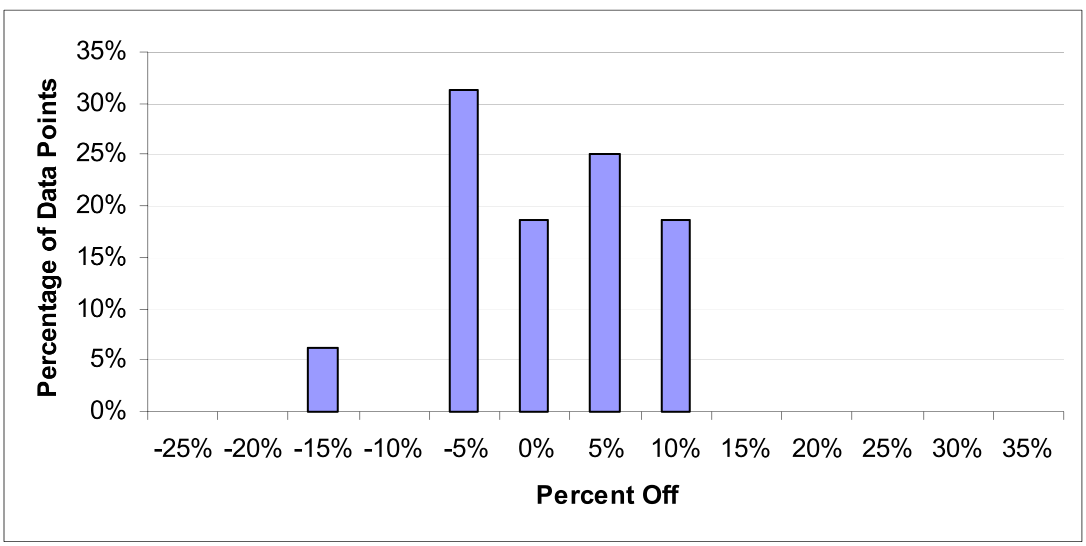


Figure C- 2
Summary of Reservoir Calibration Points

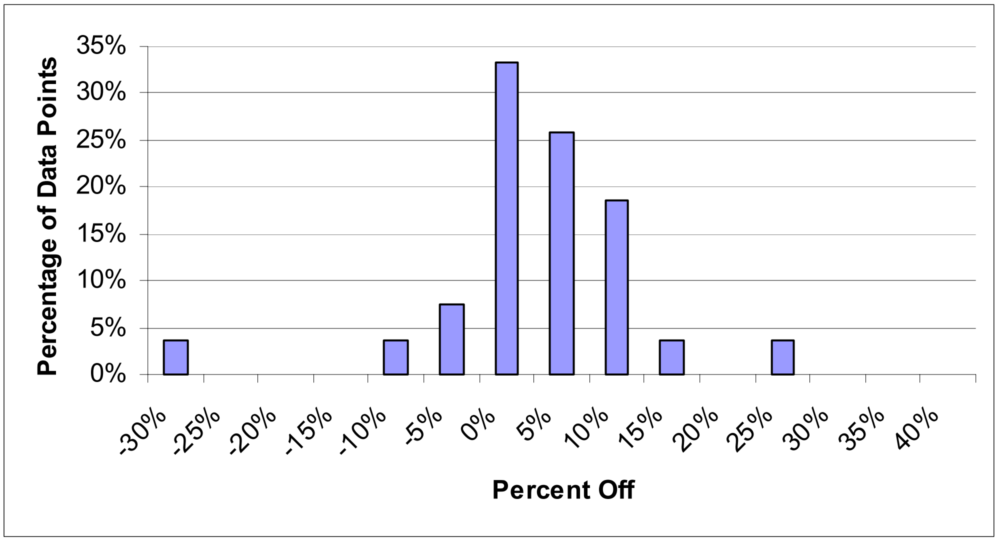


Figure C- 3
Summary of Booster Station Calibration Points

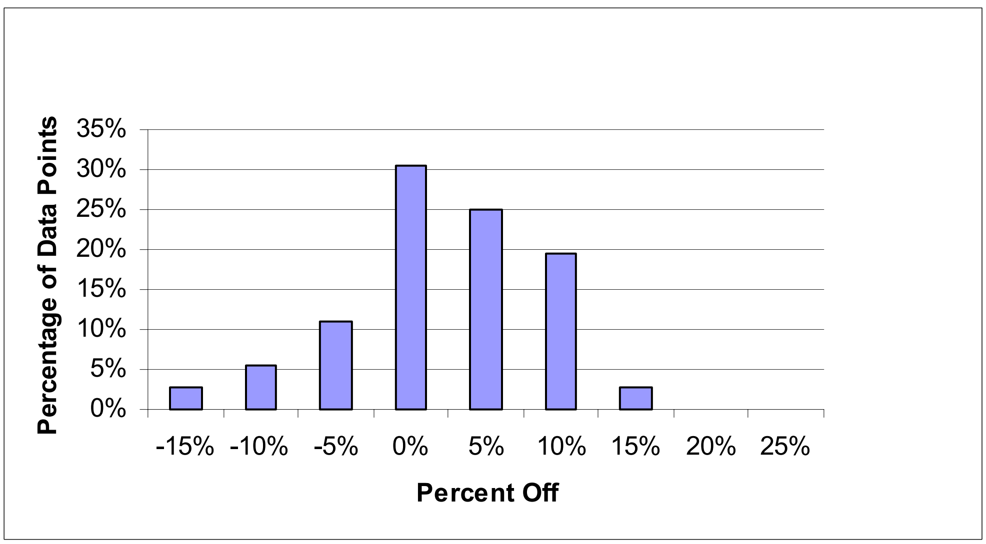
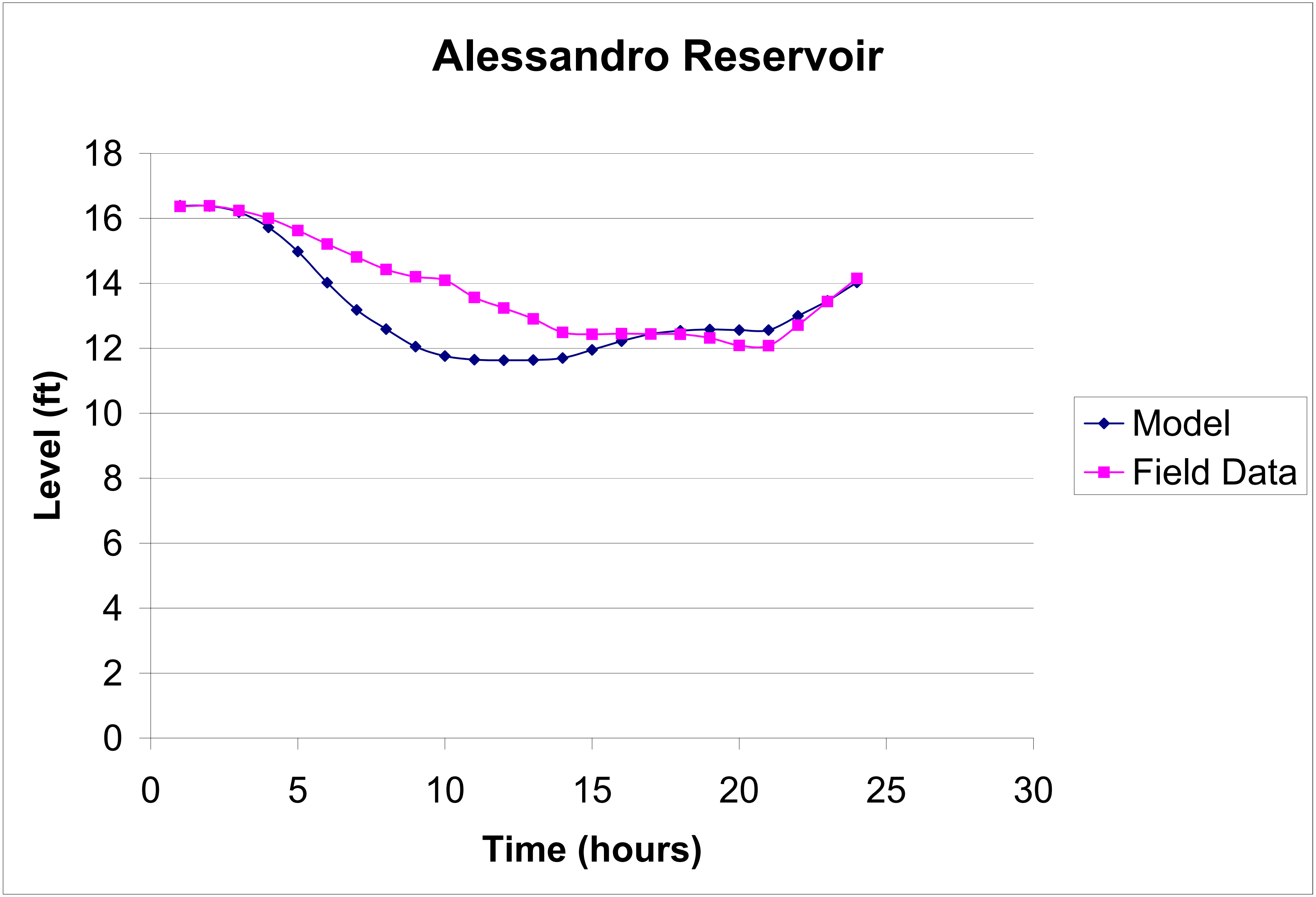
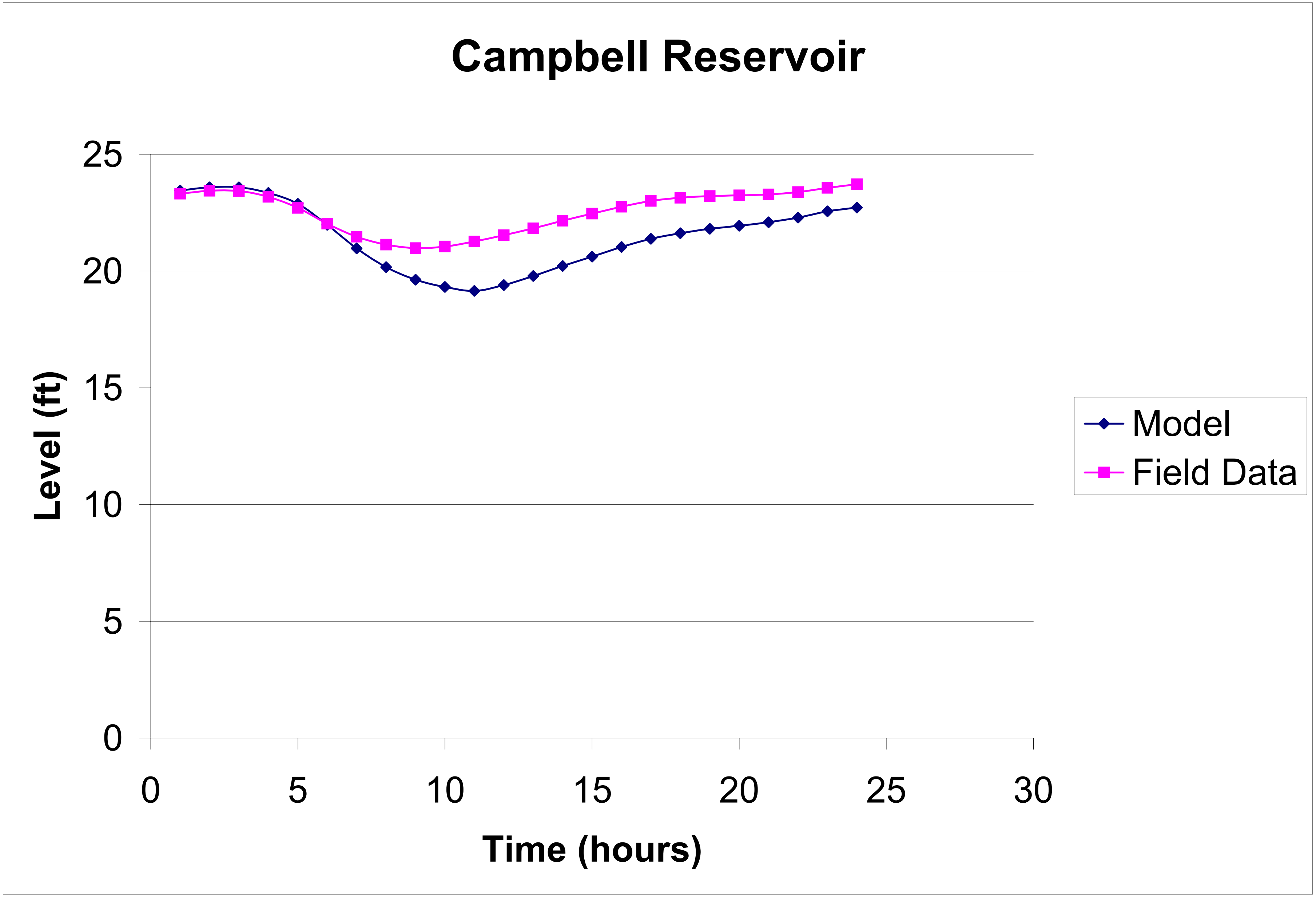
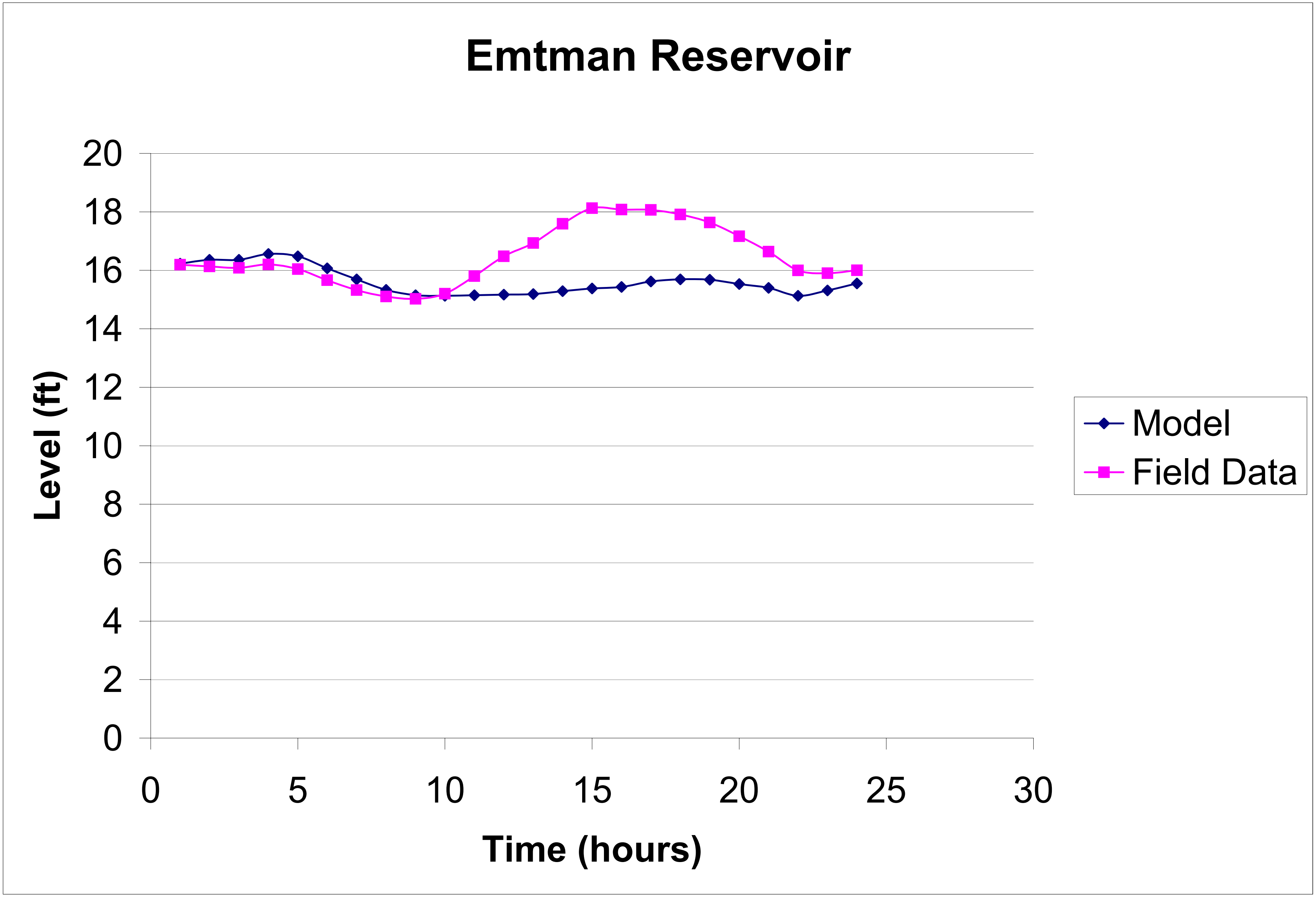


Figure C- 4
Summary of Pressure Reducing Station Calibration Points

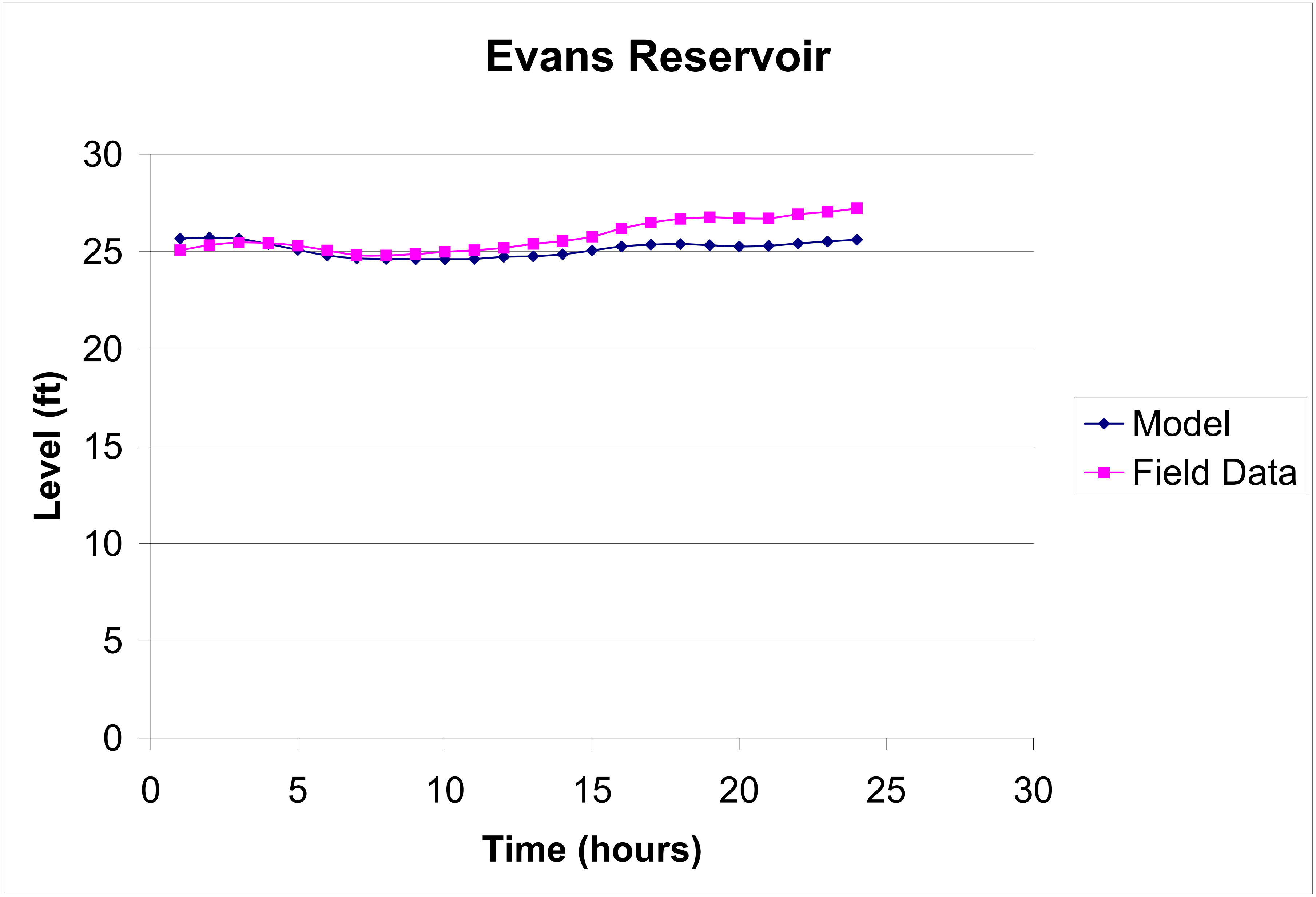

Alessandro Reservoir
Level (ft)
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

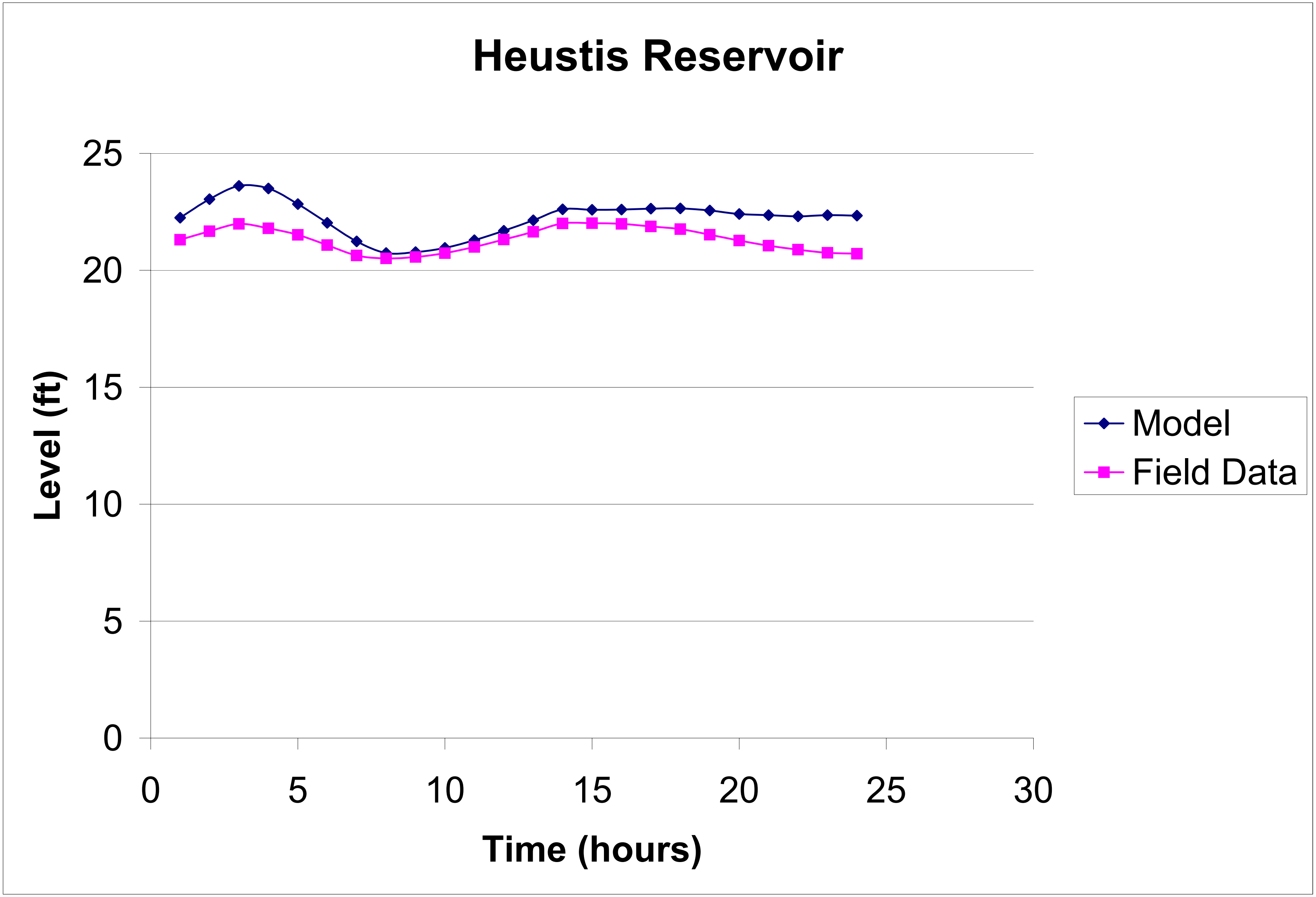


Campbell Reservoir
Level (ft)
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

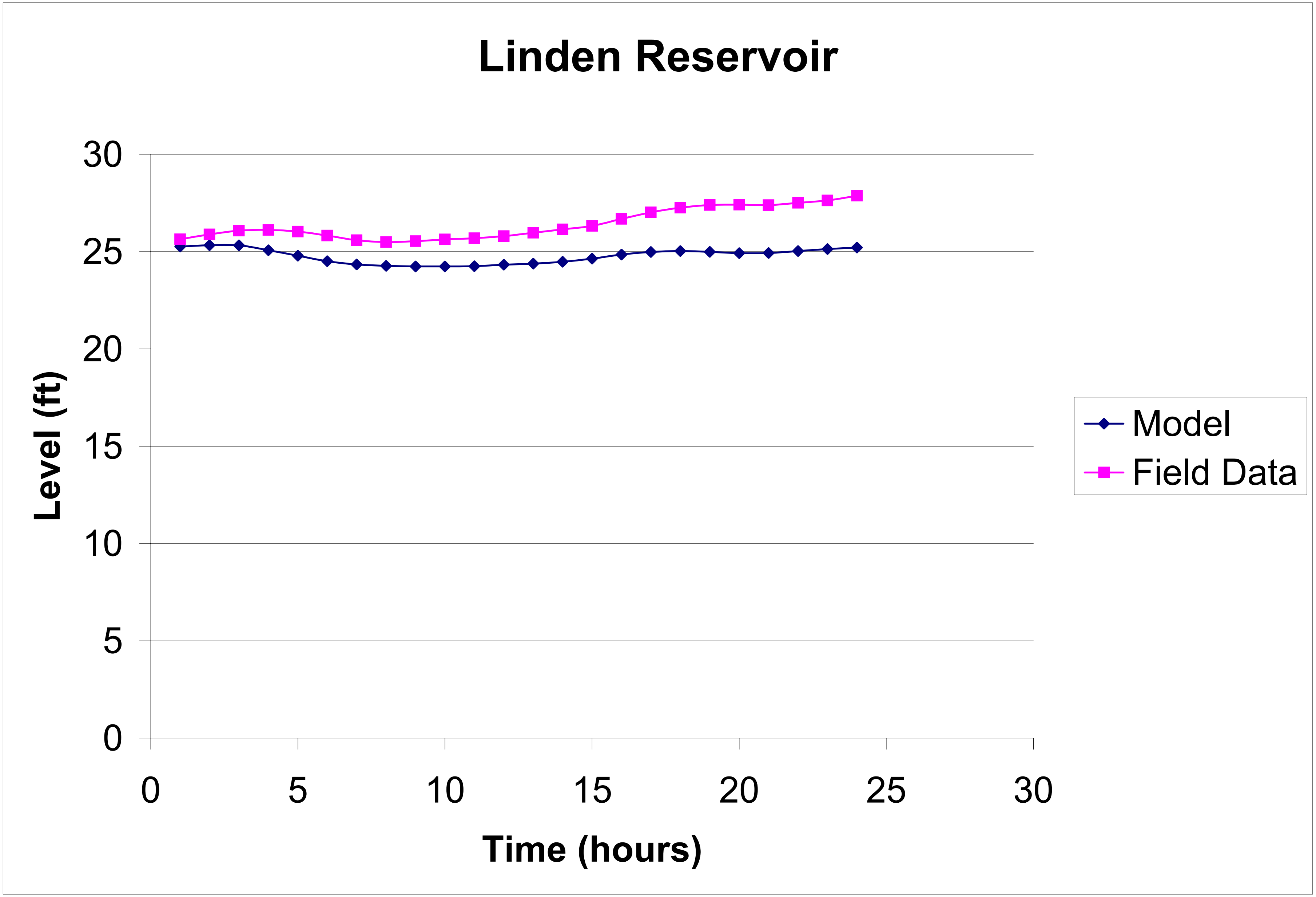


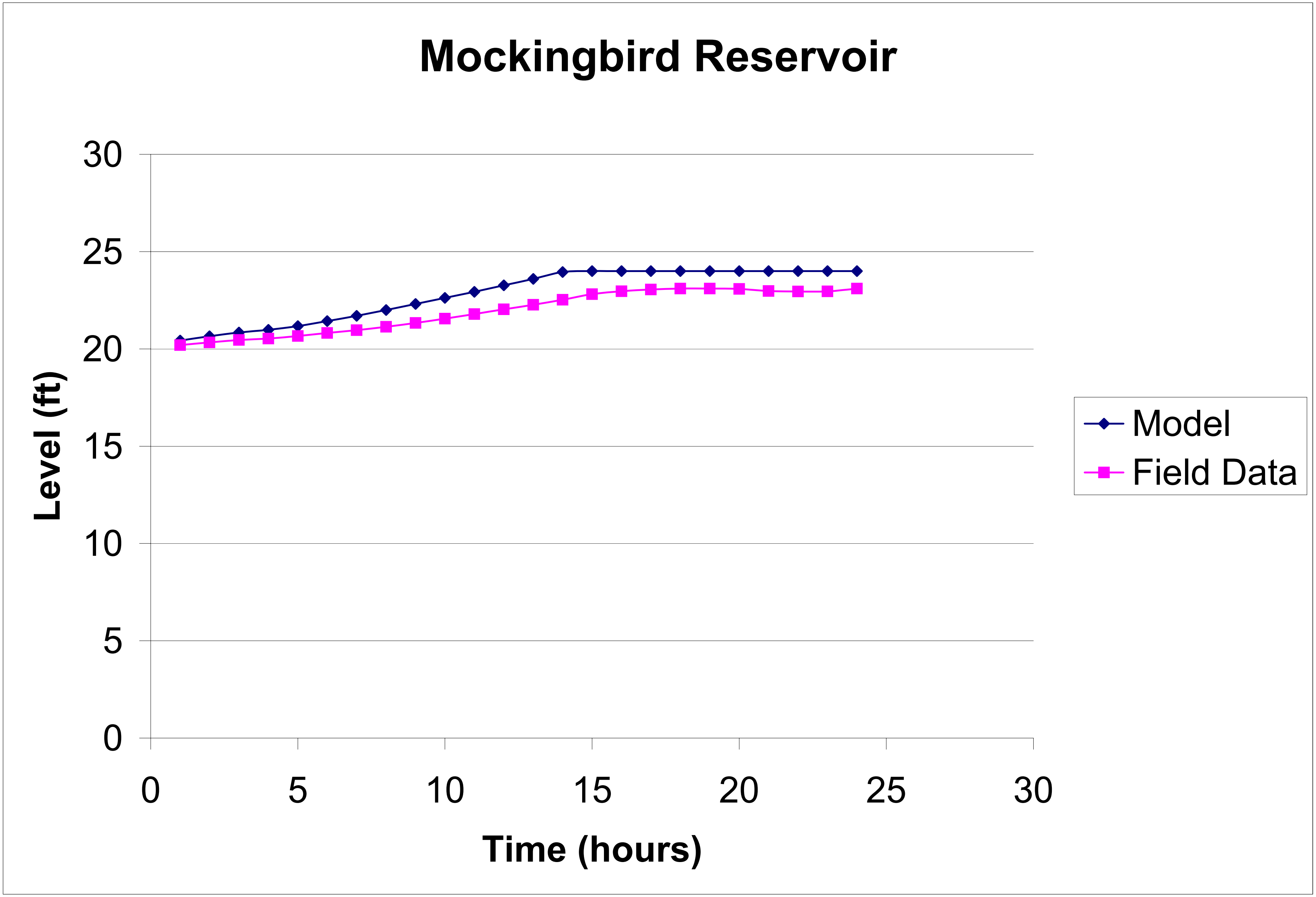
Emtman Reservoir
Level (ft)
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

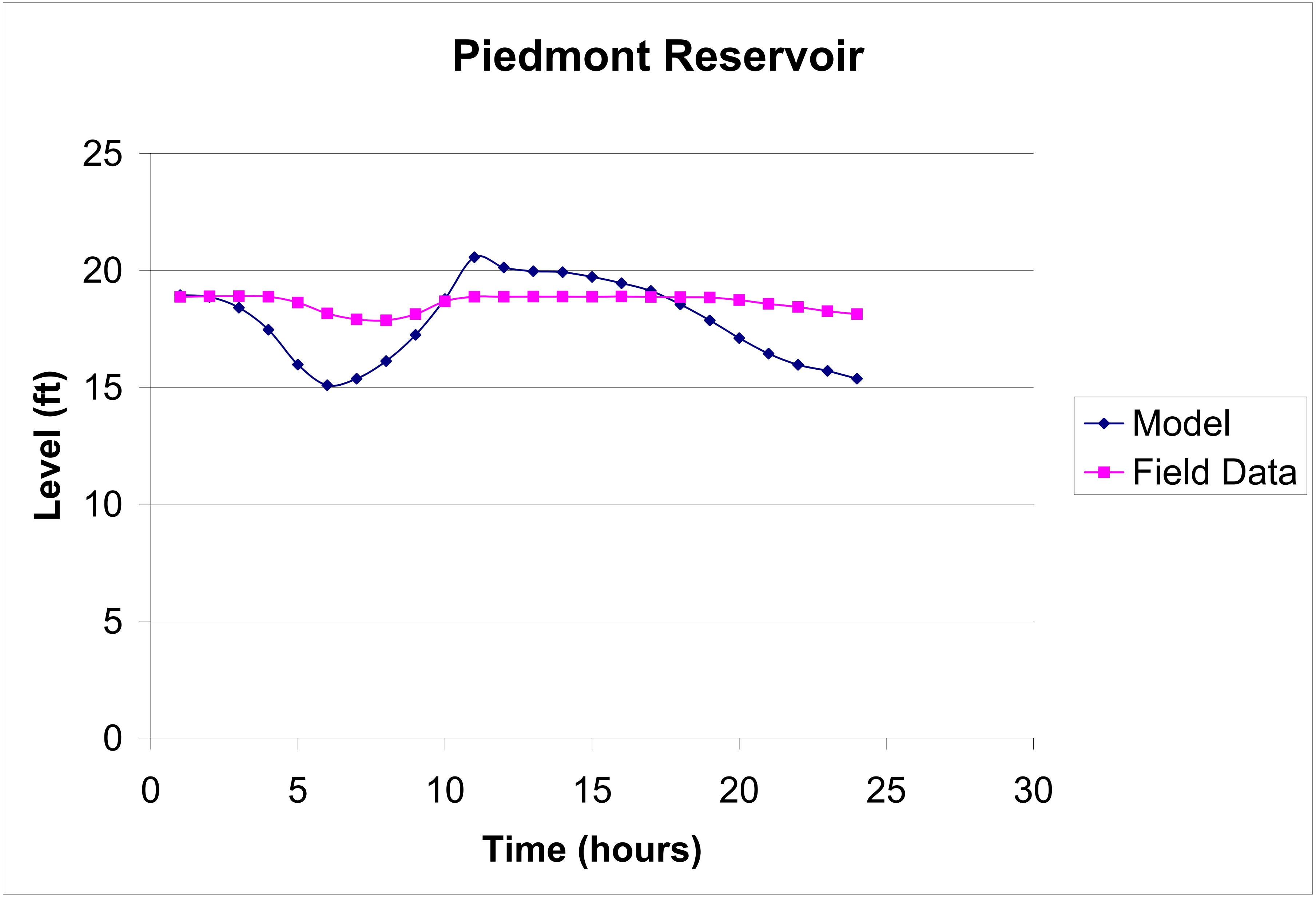

Evans Reservoir
Level (ft)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



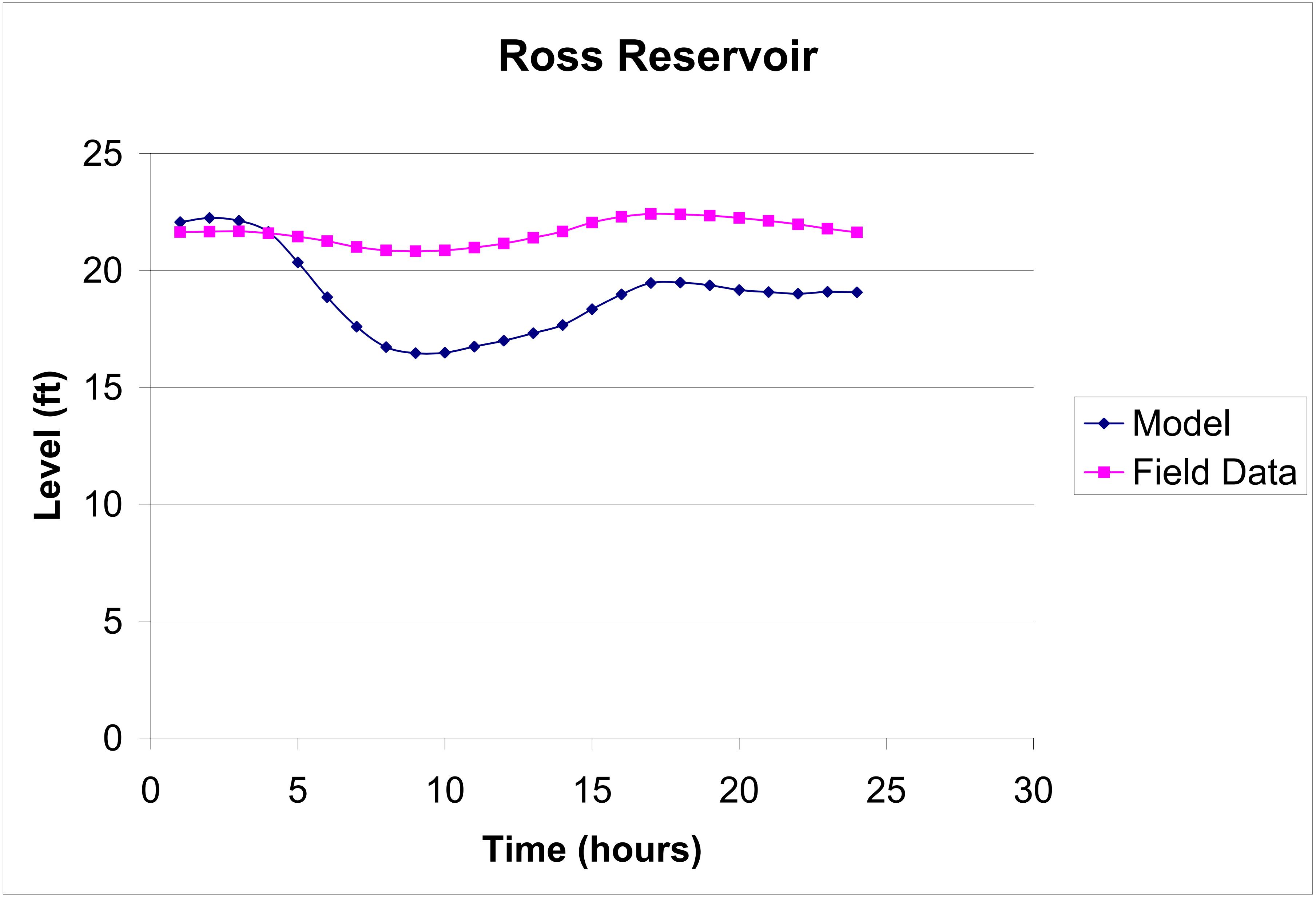
Heustis Reservoir
Level (ft)
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

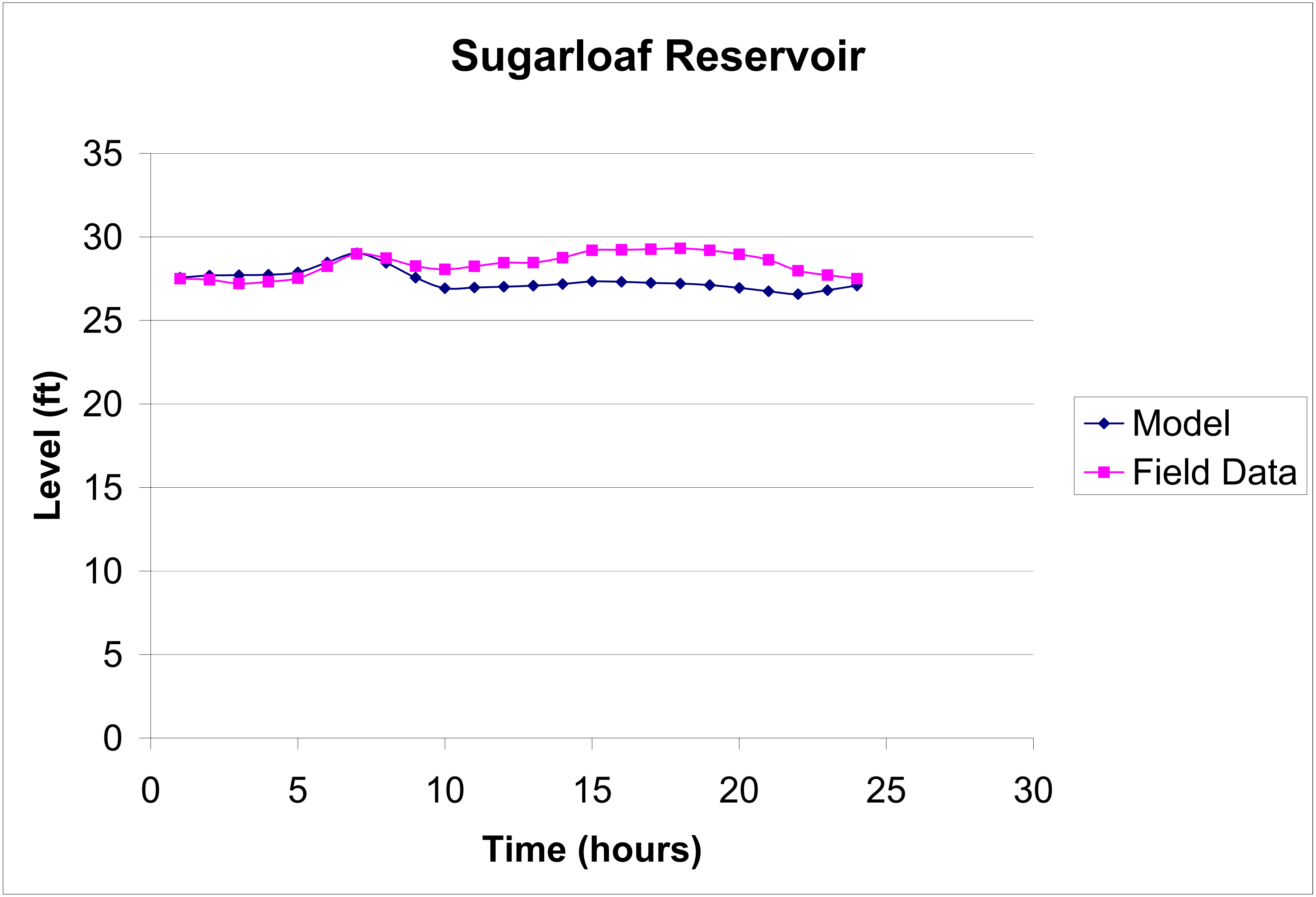

Linden Reservoir
30
25
20
15
10
5
0
Level (ft)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

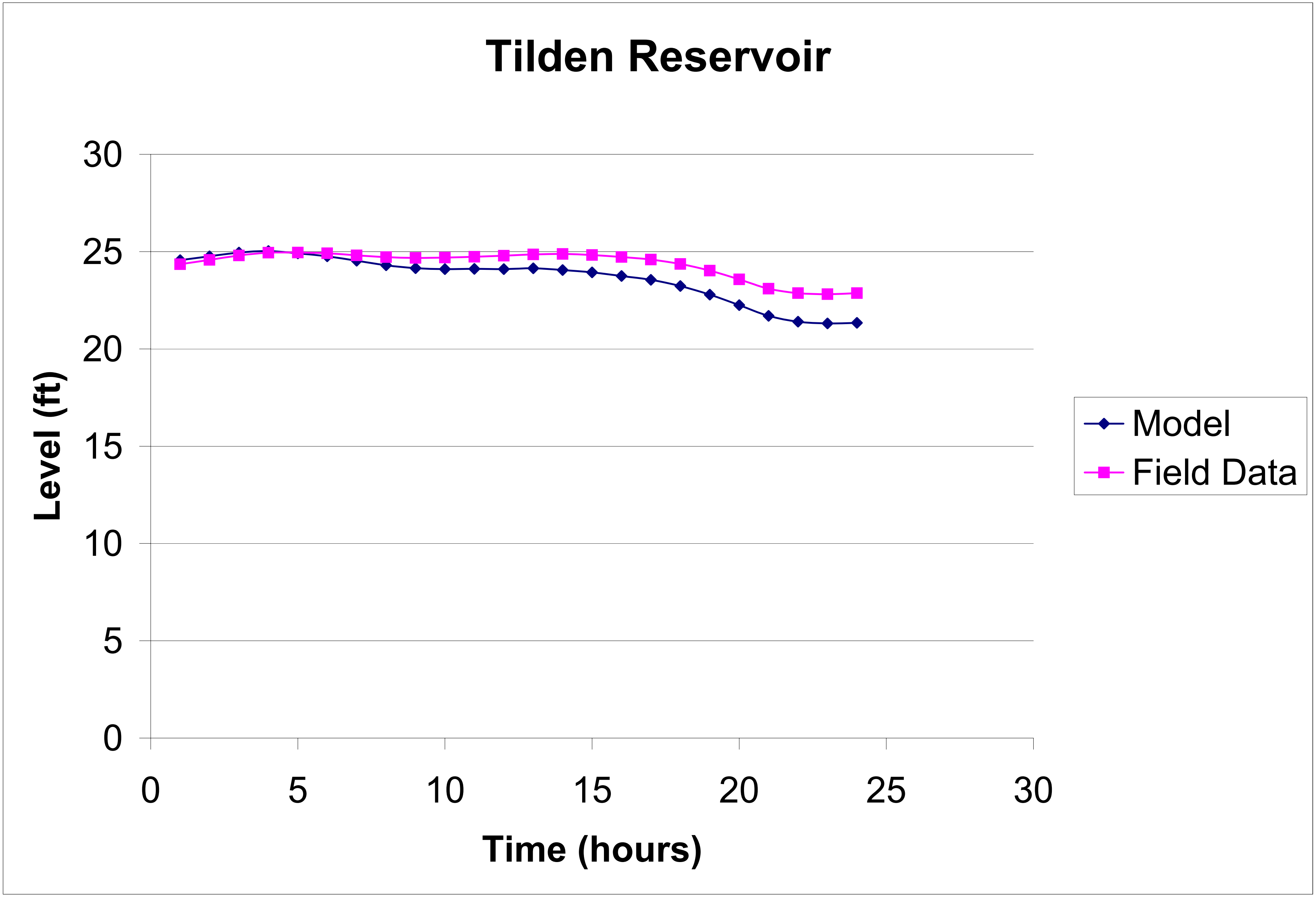

Mockingbird Reservoir
Level (ft)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



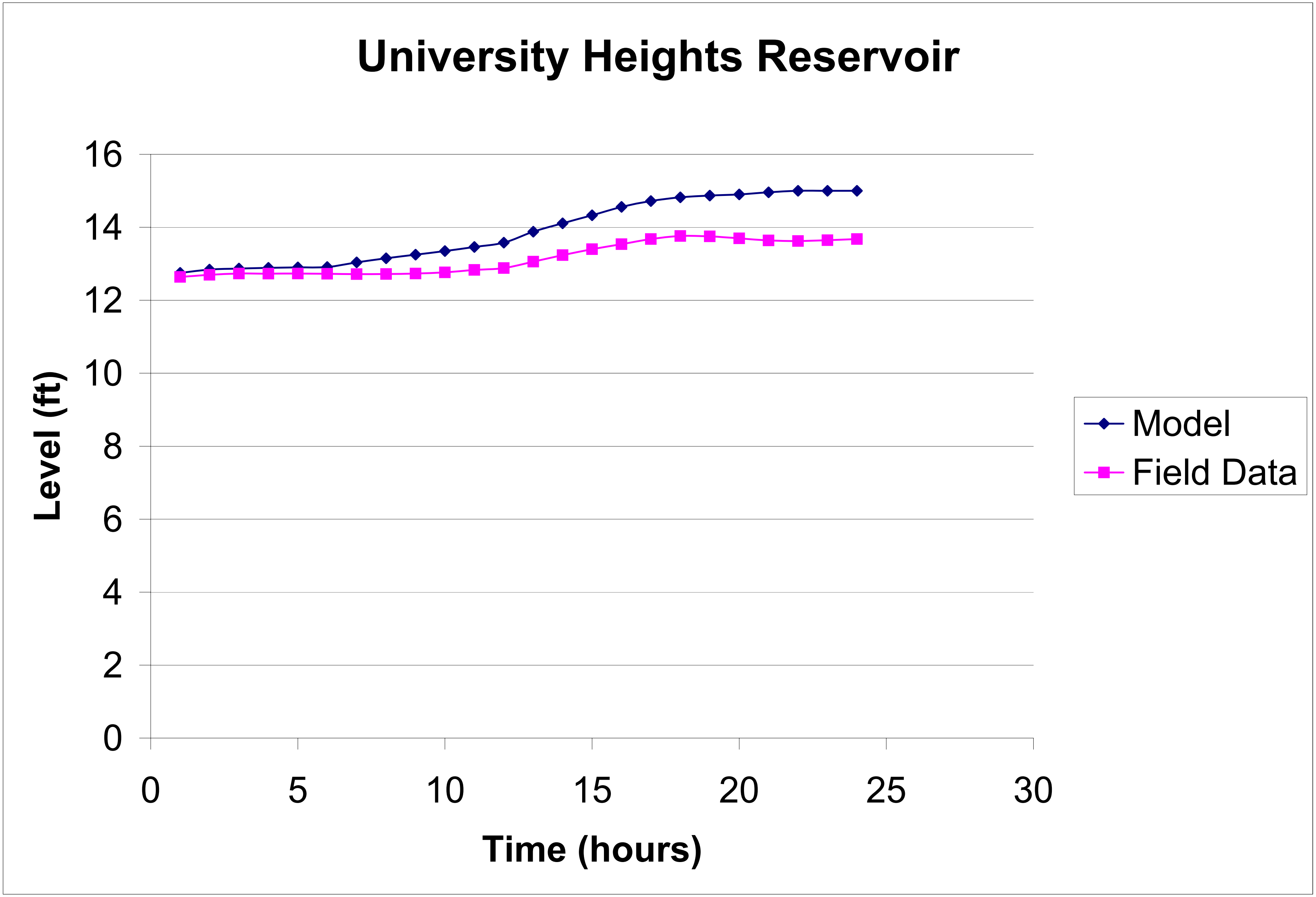
Piedmont Reservoir
Level (ft)
Time (hours)
Model
Field Data
25
20
15
10
5
0
0
5
10
15
20
25
30

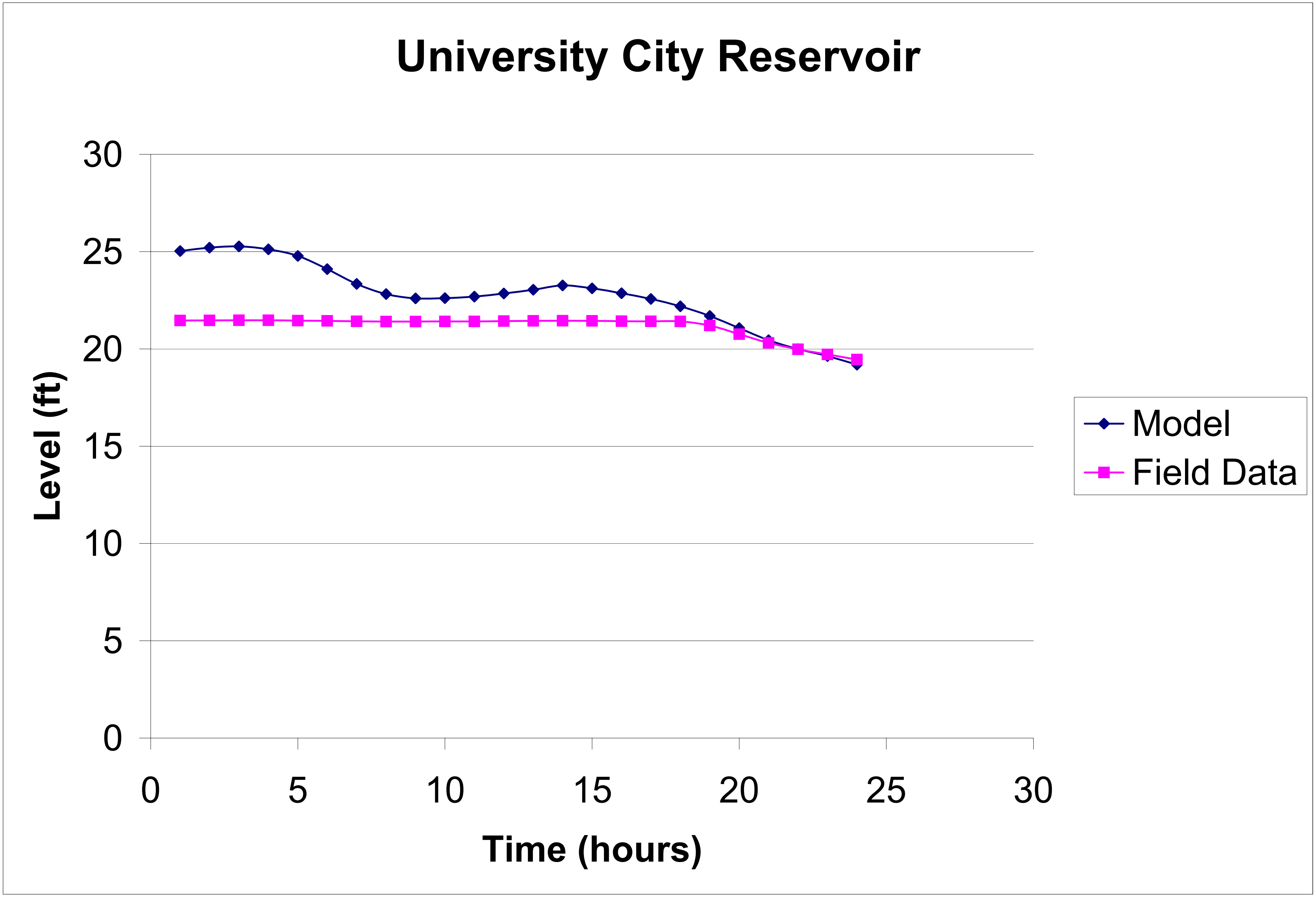

Ross Reservoir
Level (ft)
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Sugarloaf Reservoir
Level (ft)
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

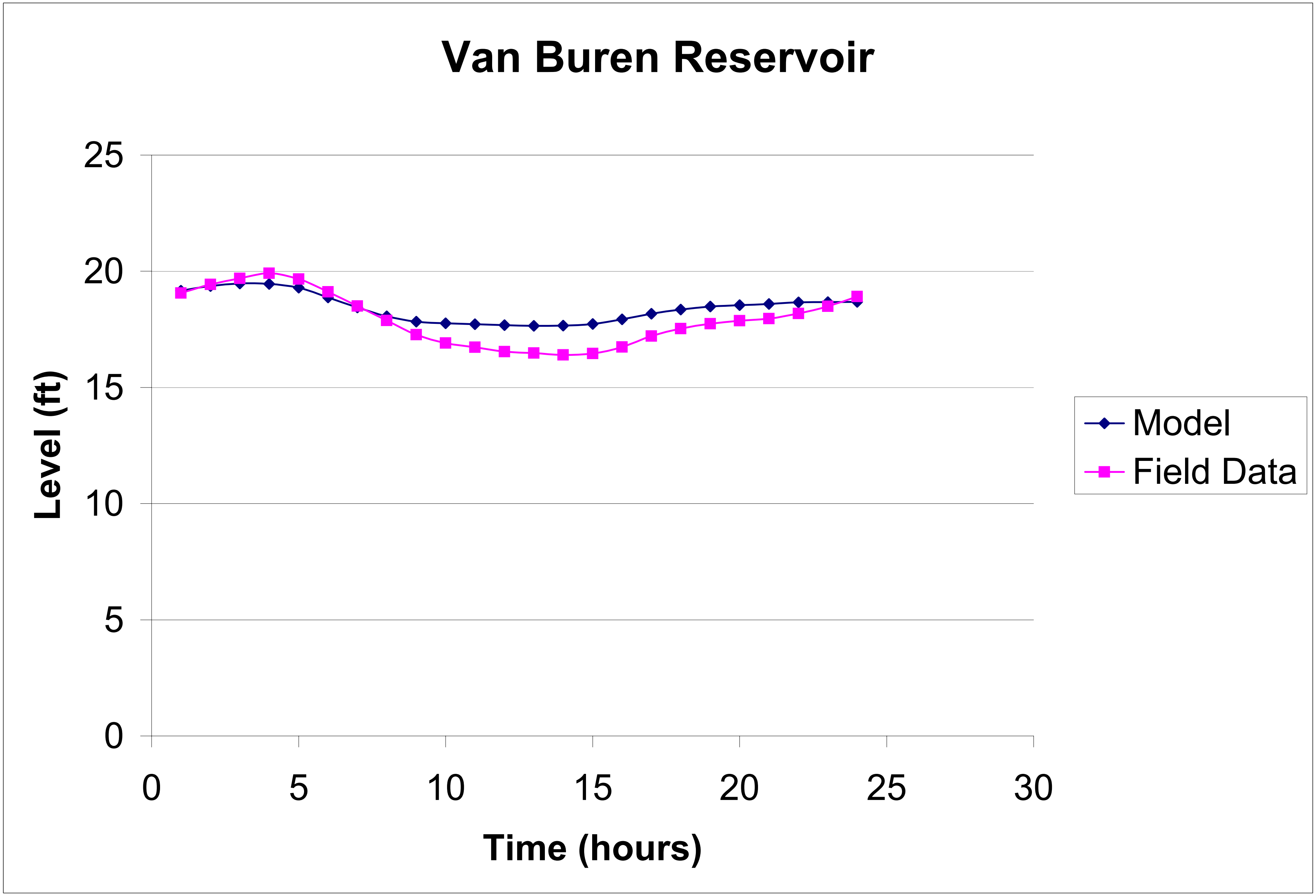


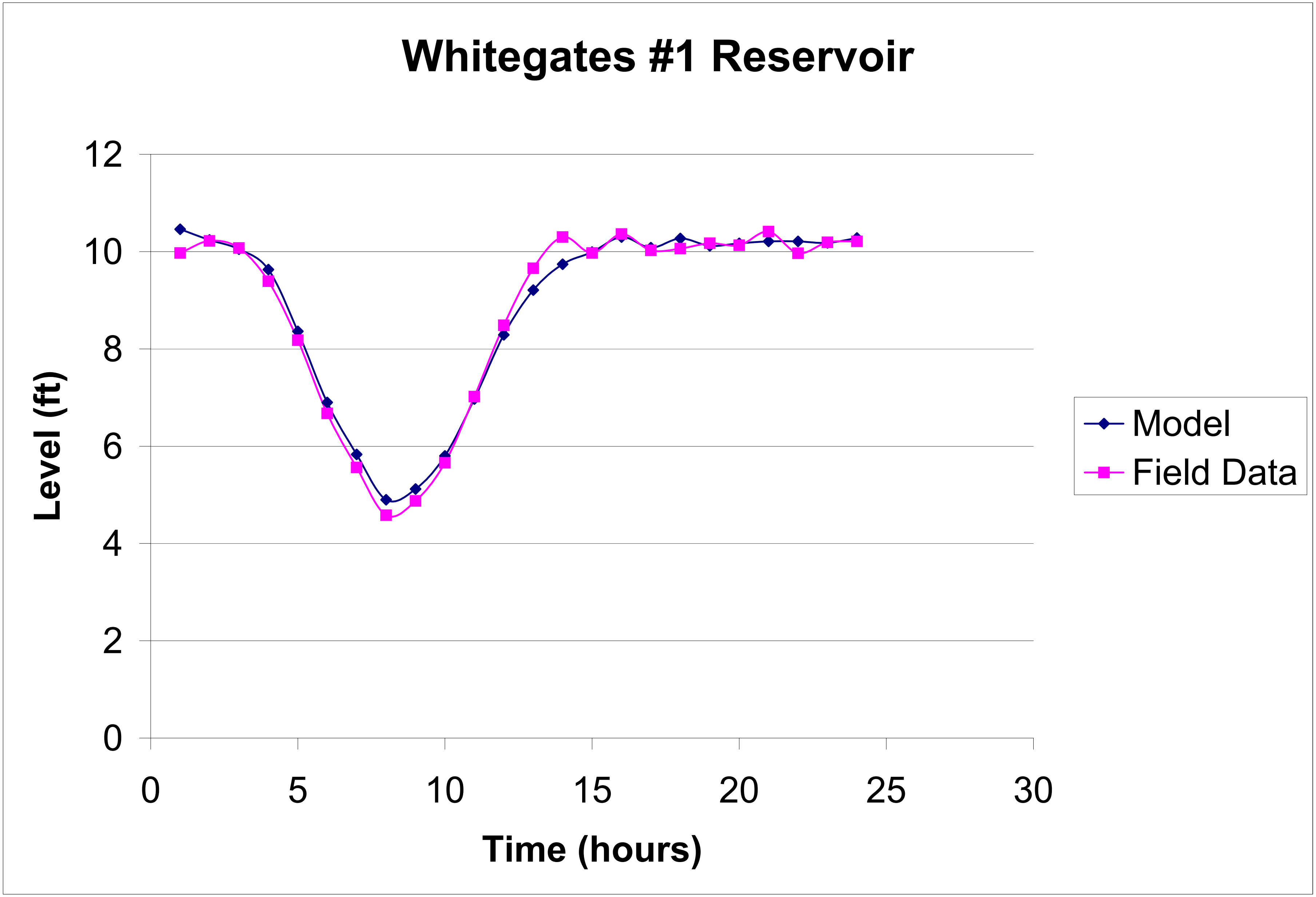
Tilden Reservoir
Level (ft)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

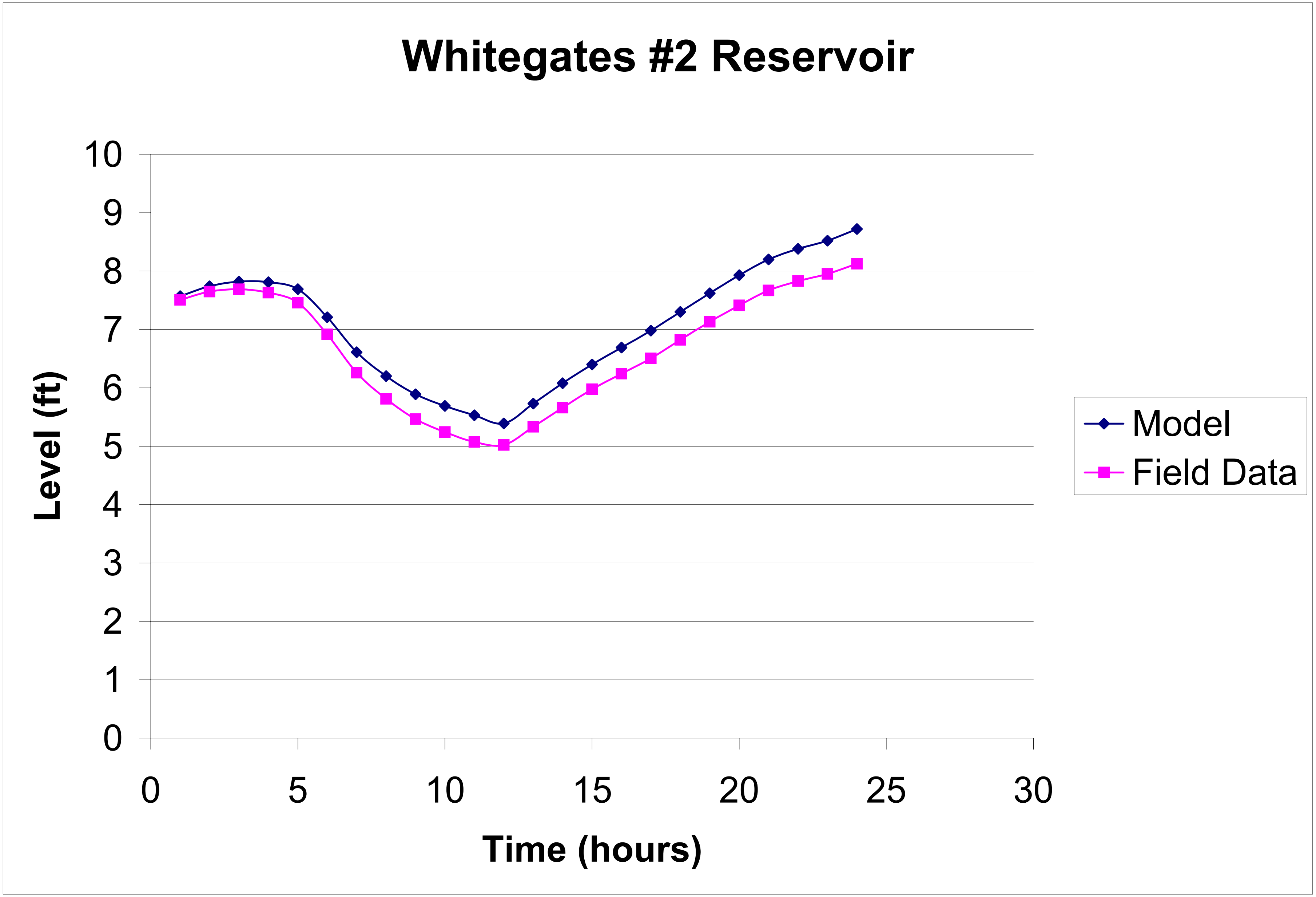

University Heights Reservoir
Level (ft)
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

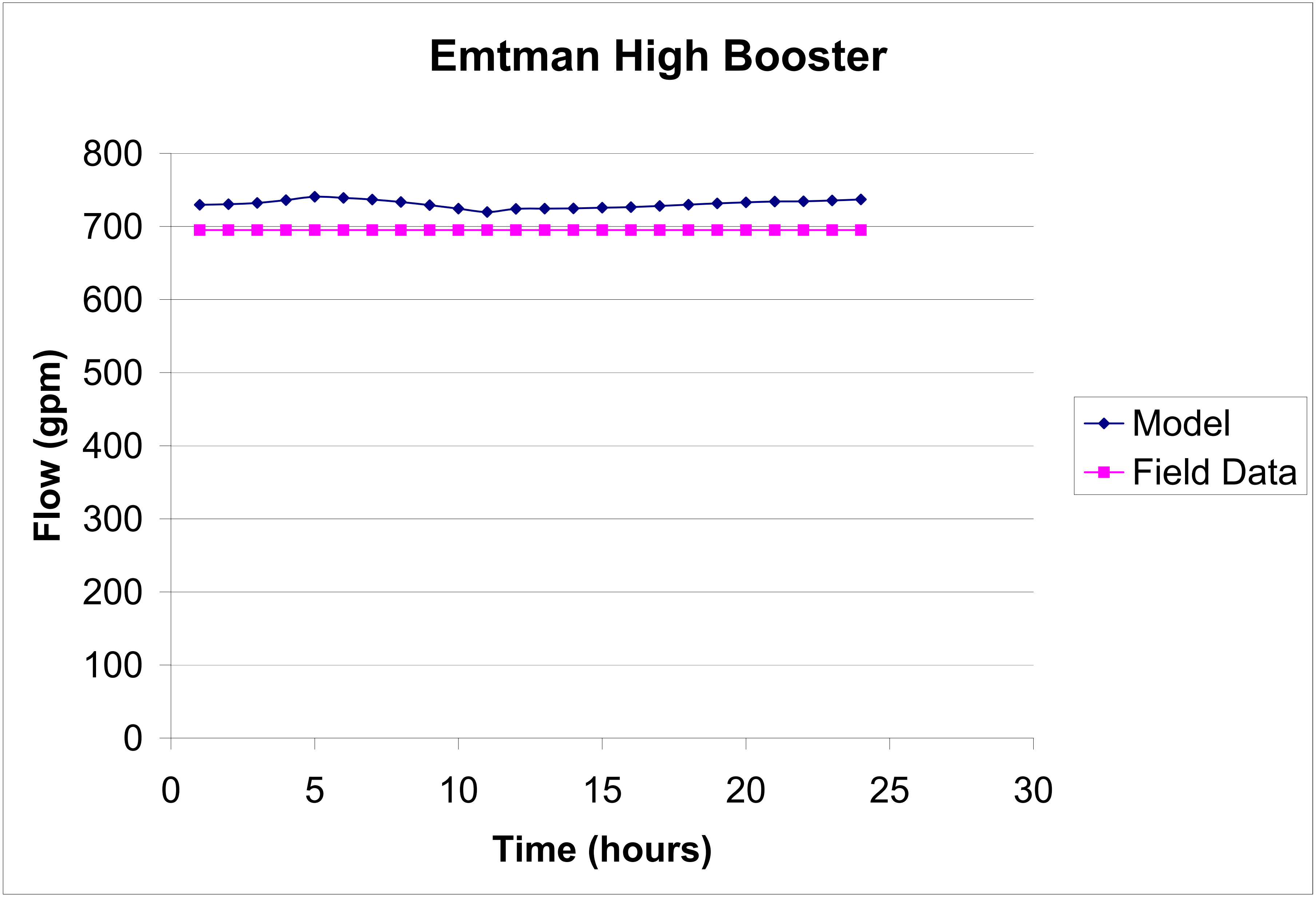


University City Reservoir
Level (ft)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

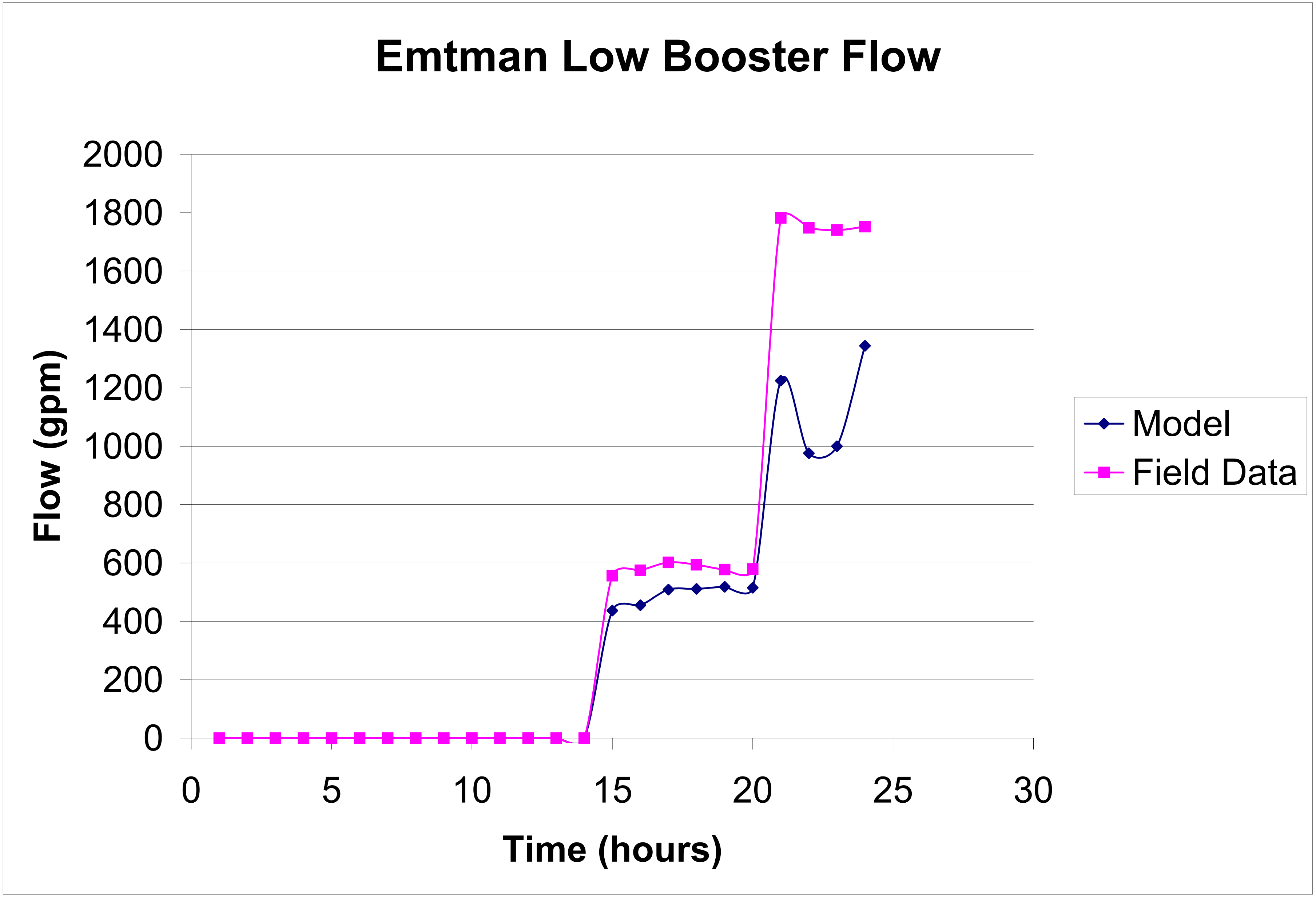

Van Buren Reservoir
Level (ft)
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

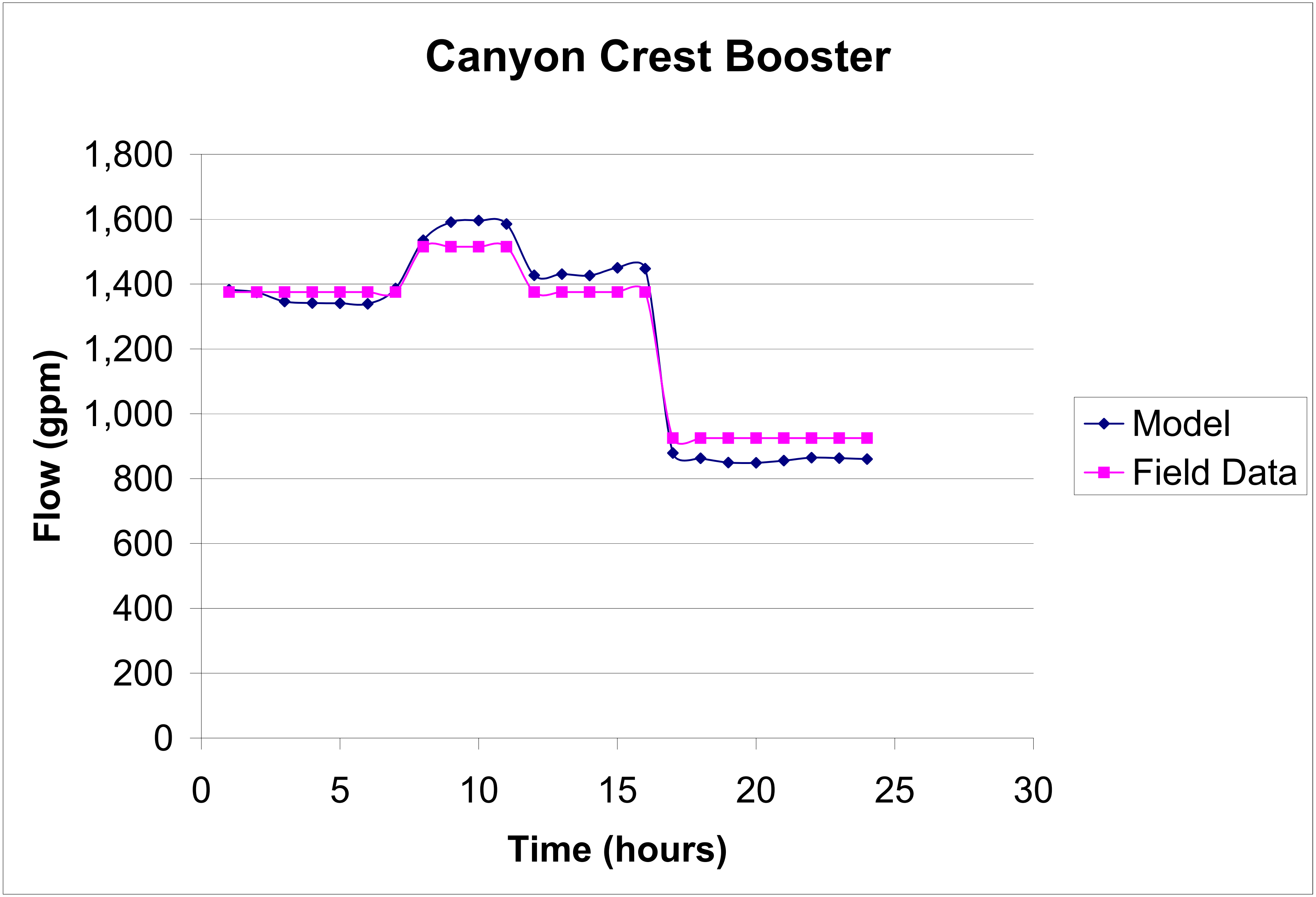

Whitegates #1 Reservoir
Level (ft)
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

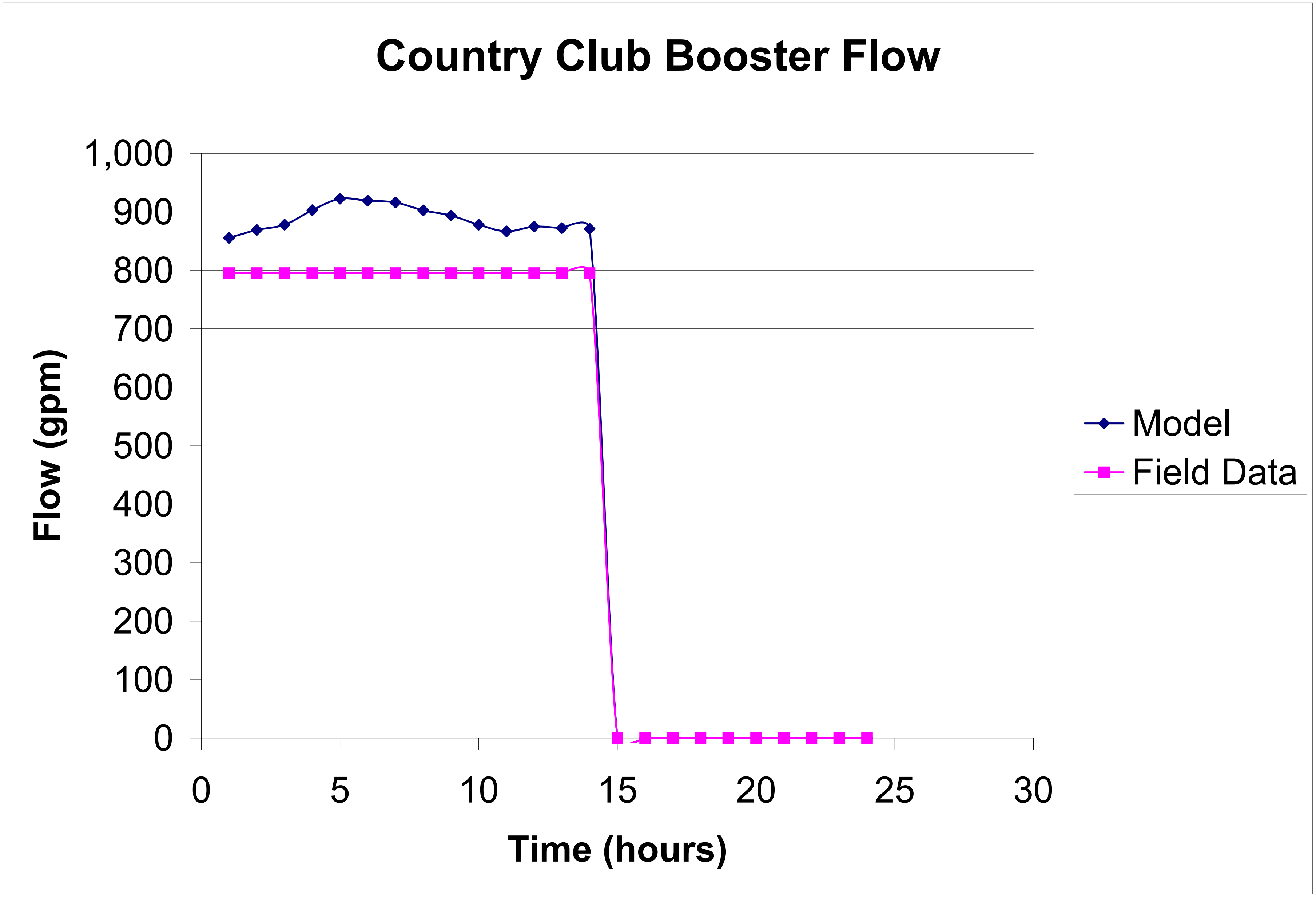

Whitegates #2 Reservoir
Level (ft)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

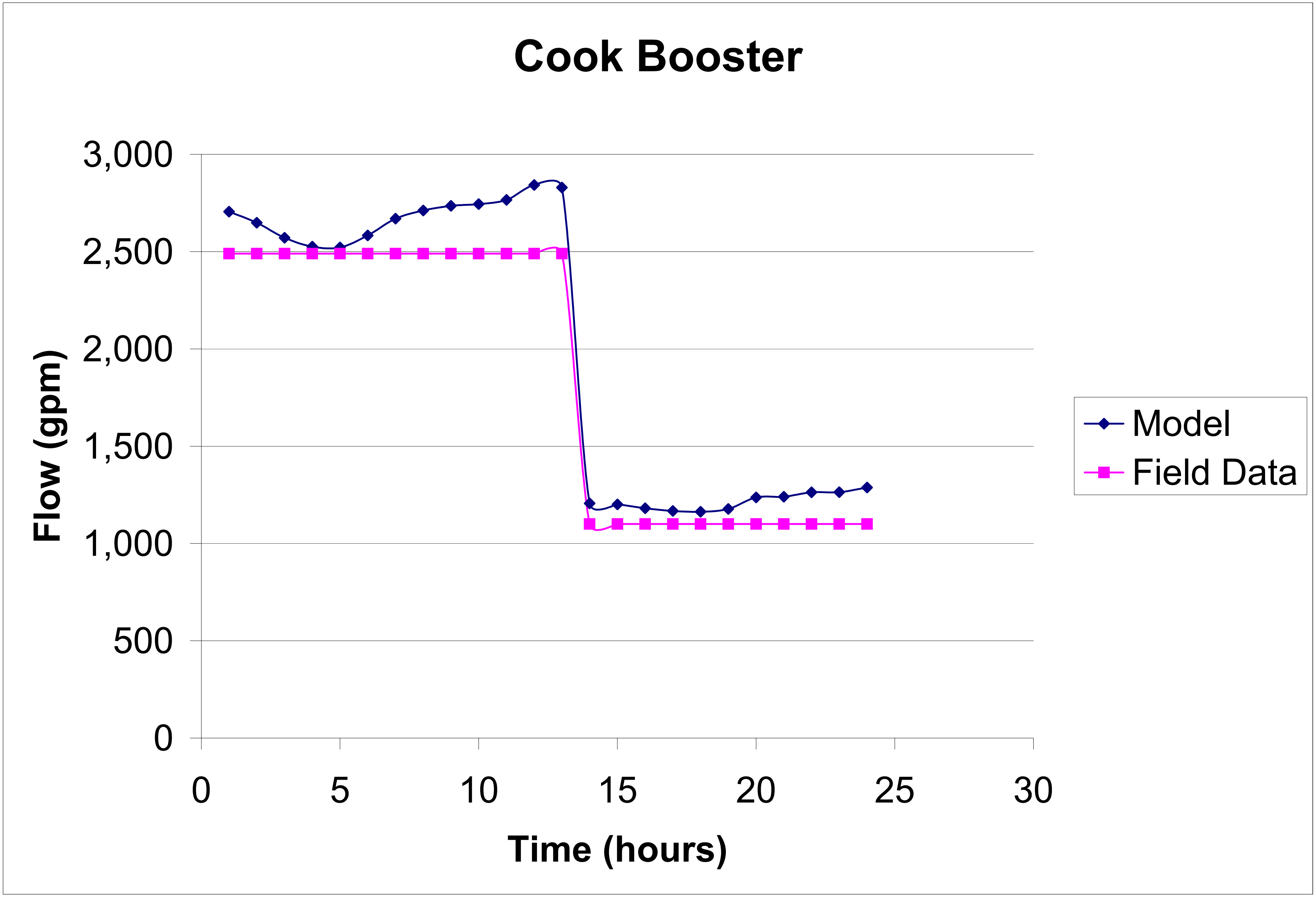


Emtman High Booster
800
700
600
500
400
300
200
100
0
Flow (gpm)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

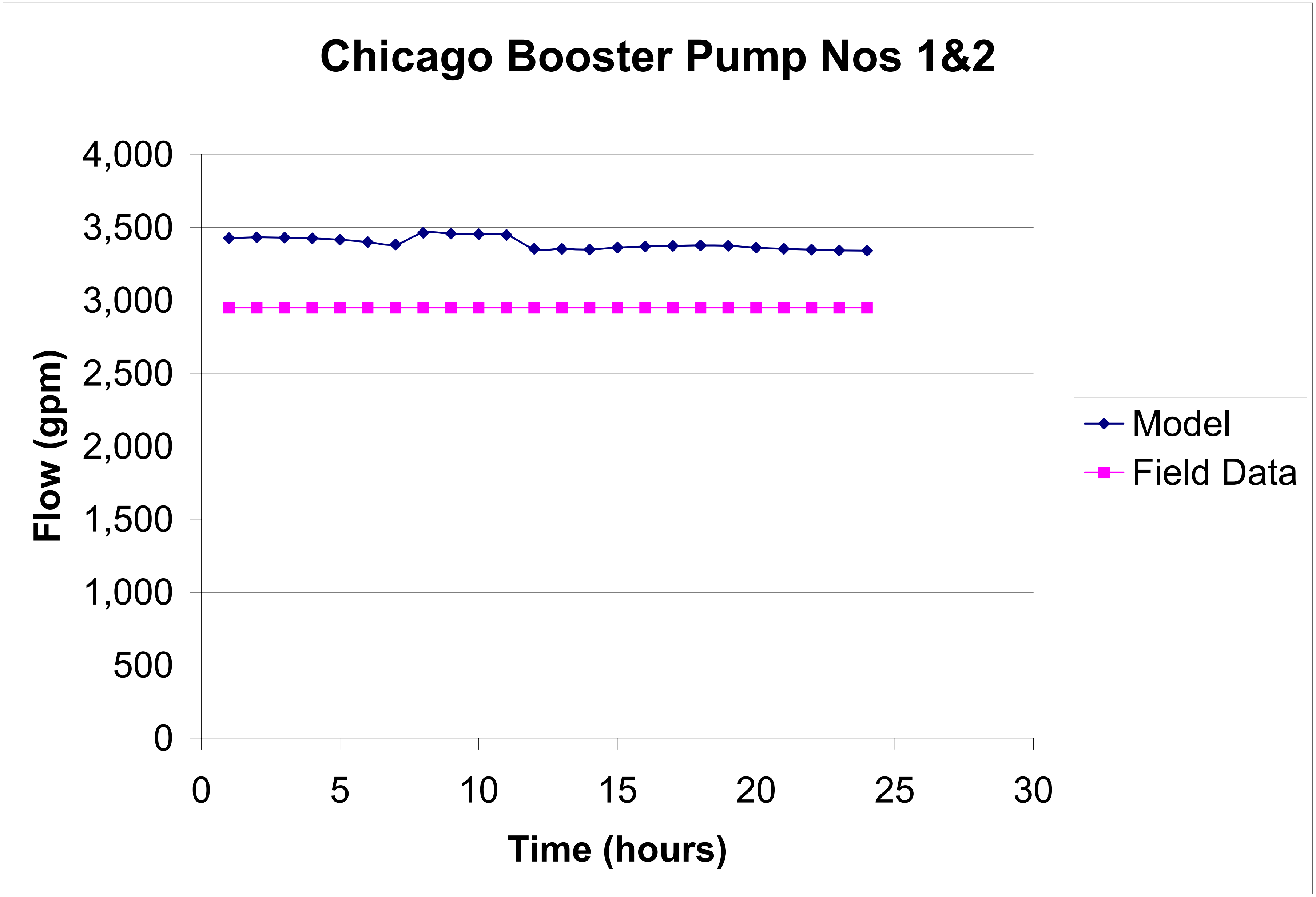

Emtman Low Booster Flow
Flow (gpm)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Canyon Crest Booster
Flow (gpm)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

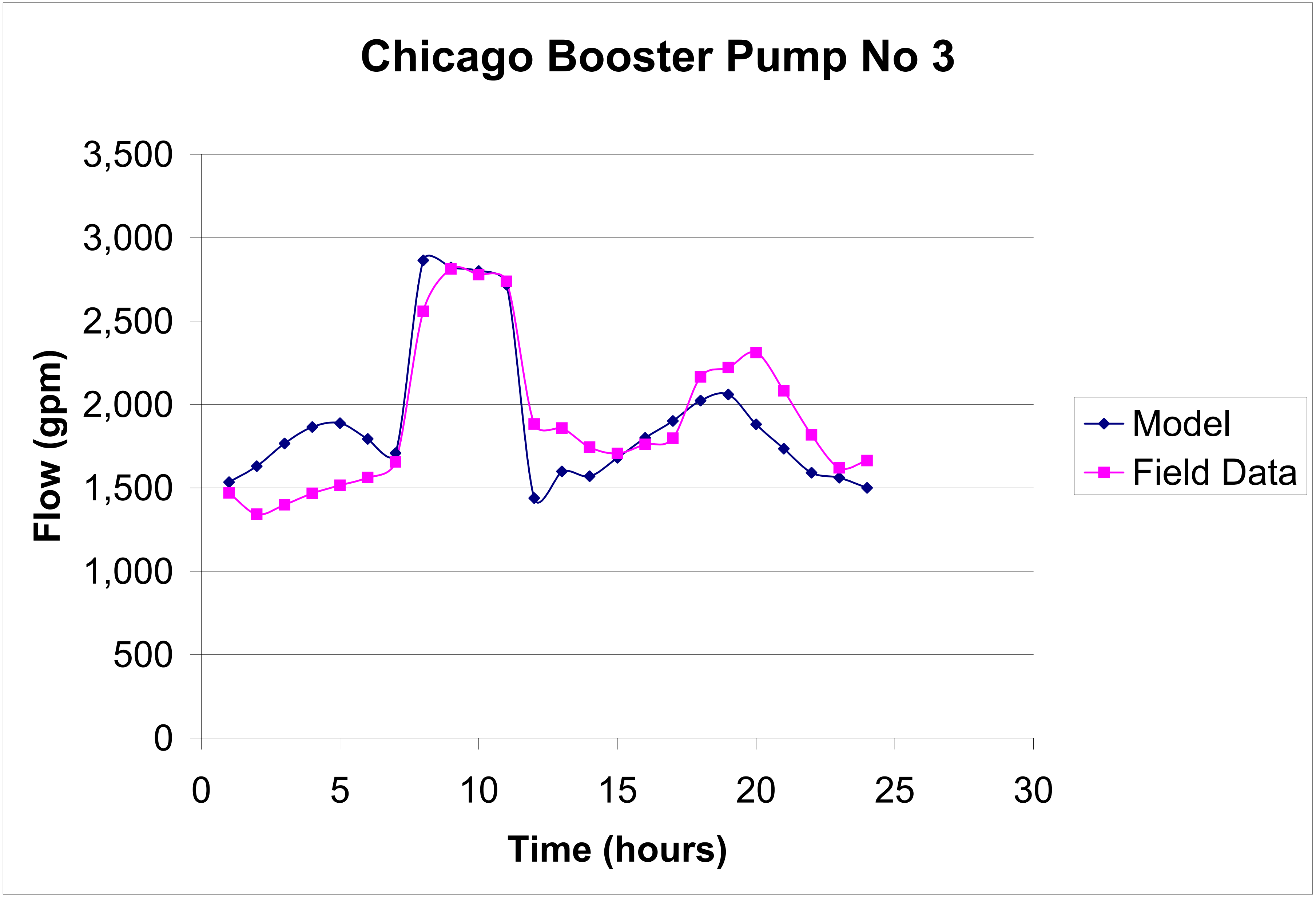

Country Club Booster Flow
Flow (gpm)
1,000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



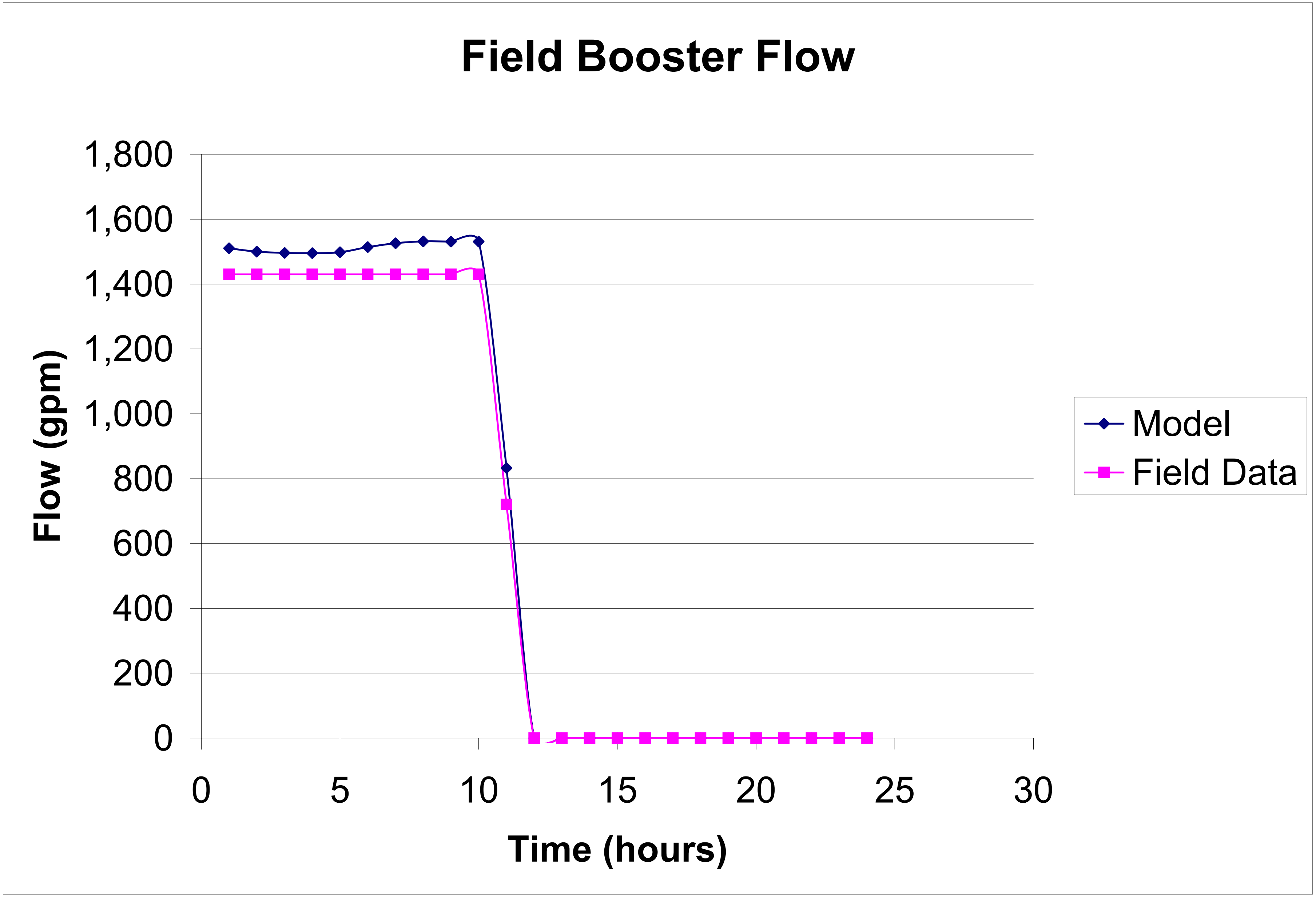
Cook Booster
Flow (gpm)
3,000
2,500
2,000
1,500
1,000
500
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



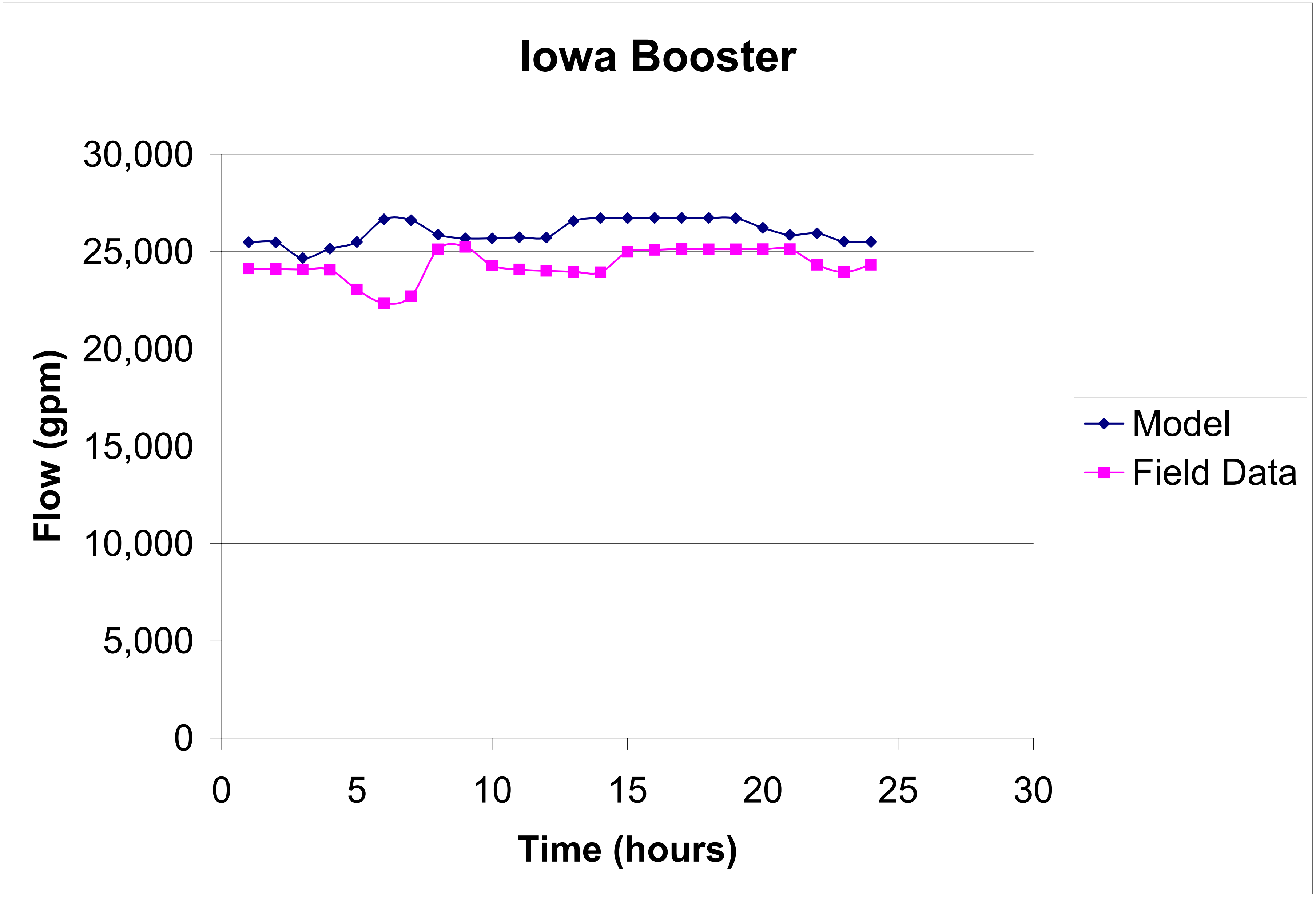
Chicago Booster Pump Nos 1&2
Flow (gpm)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

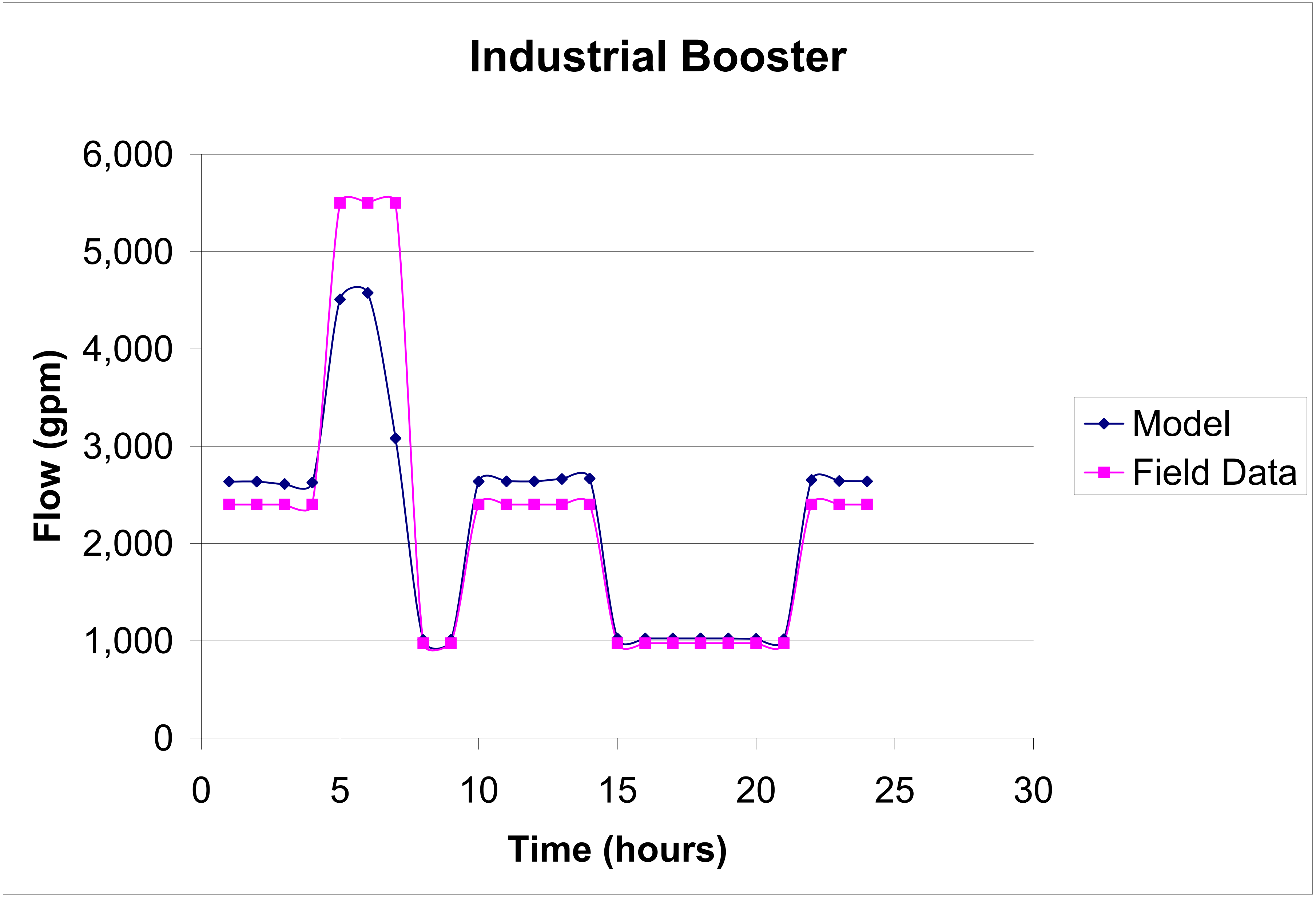


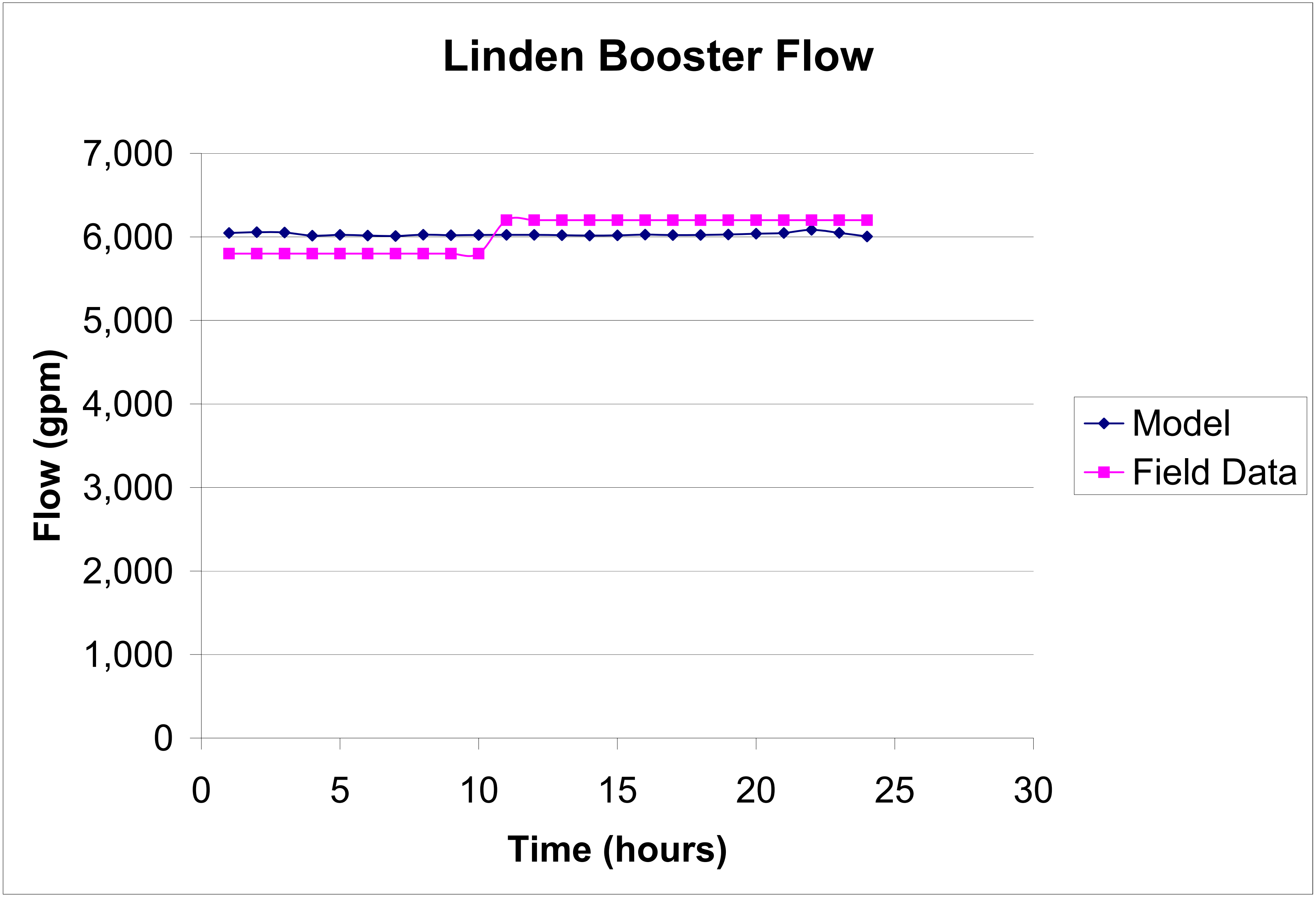
Chicago Booster Pump No 3
Flow (gpm)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

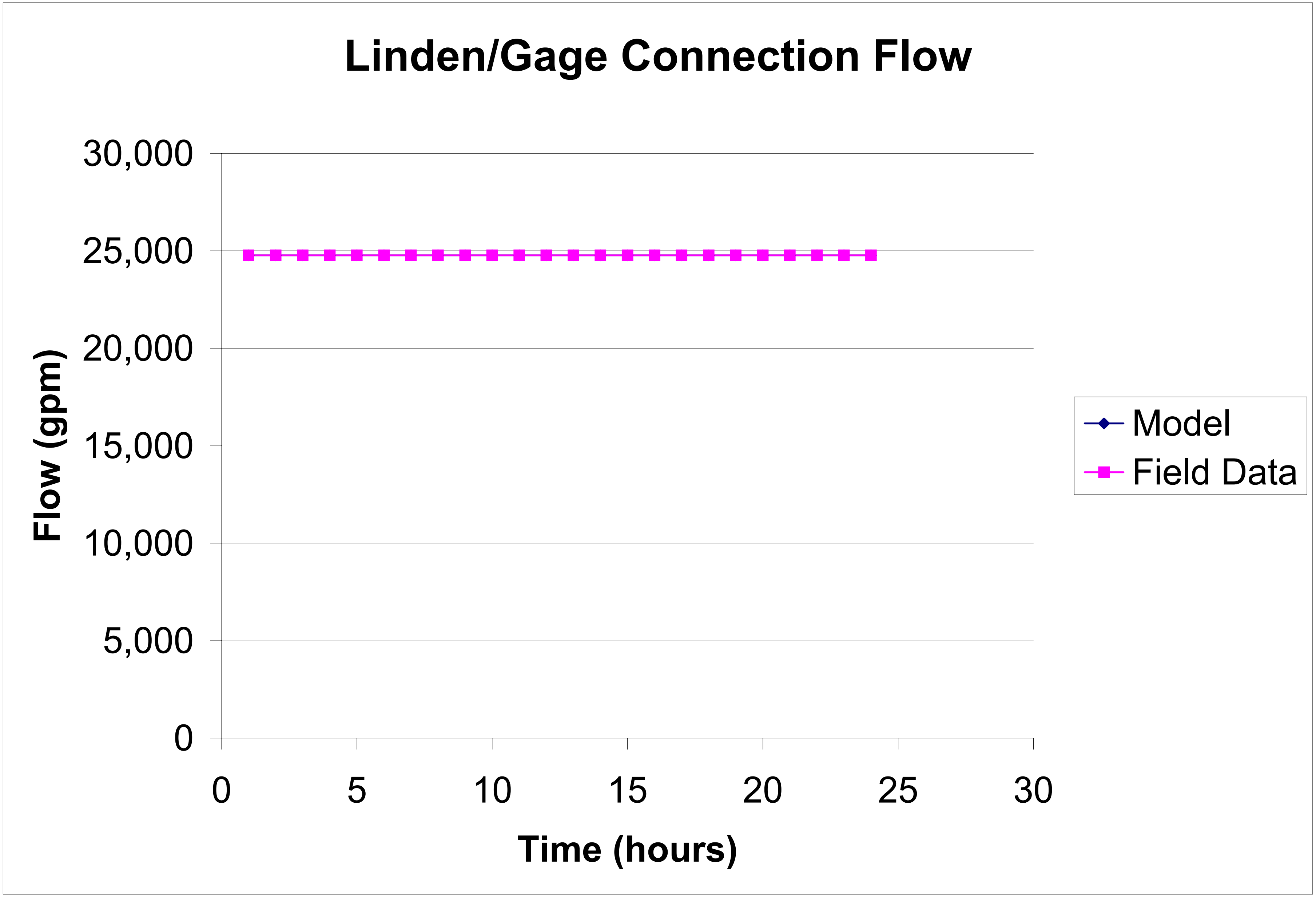


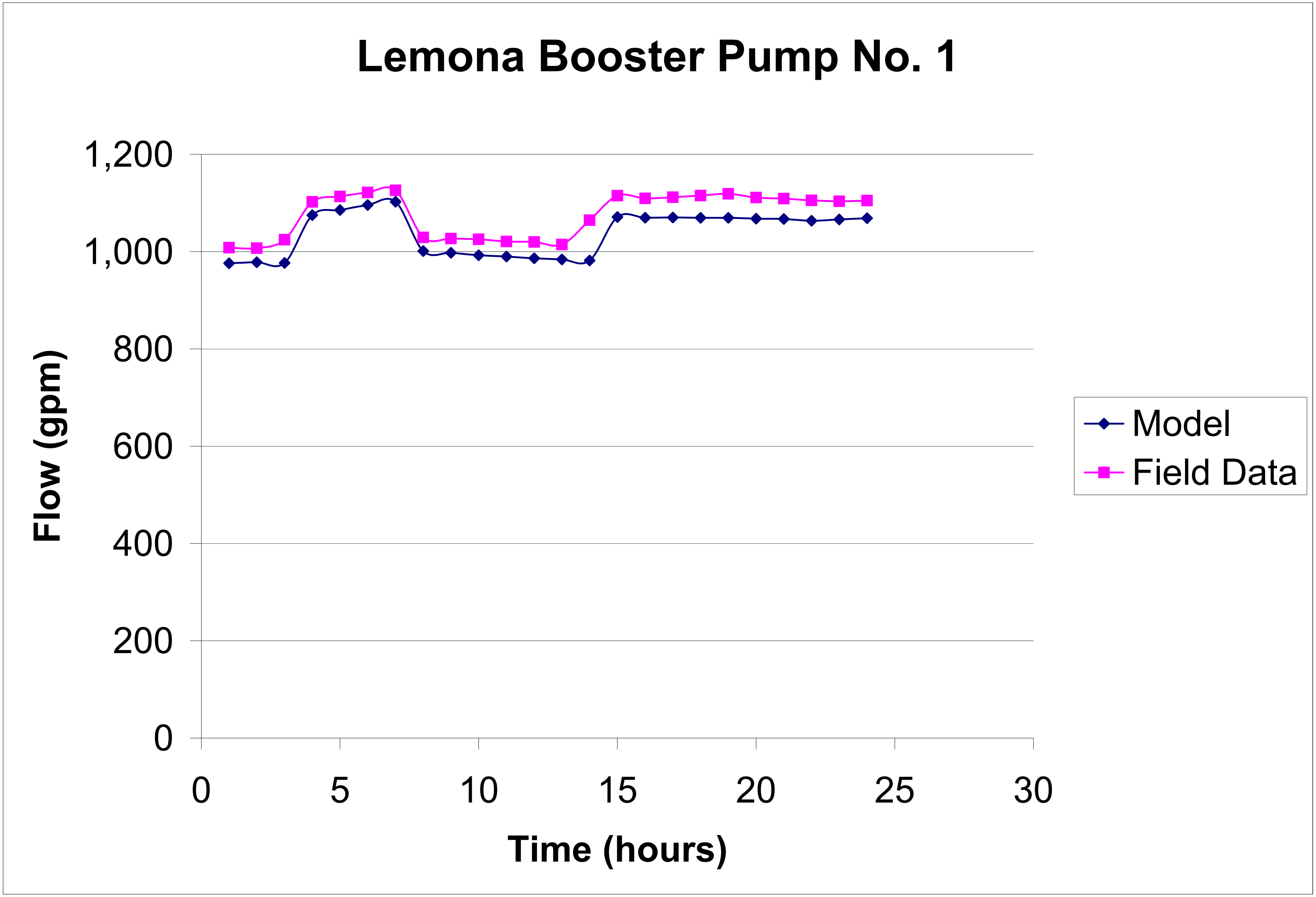
Field Booster Flow
Flow (gpm)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

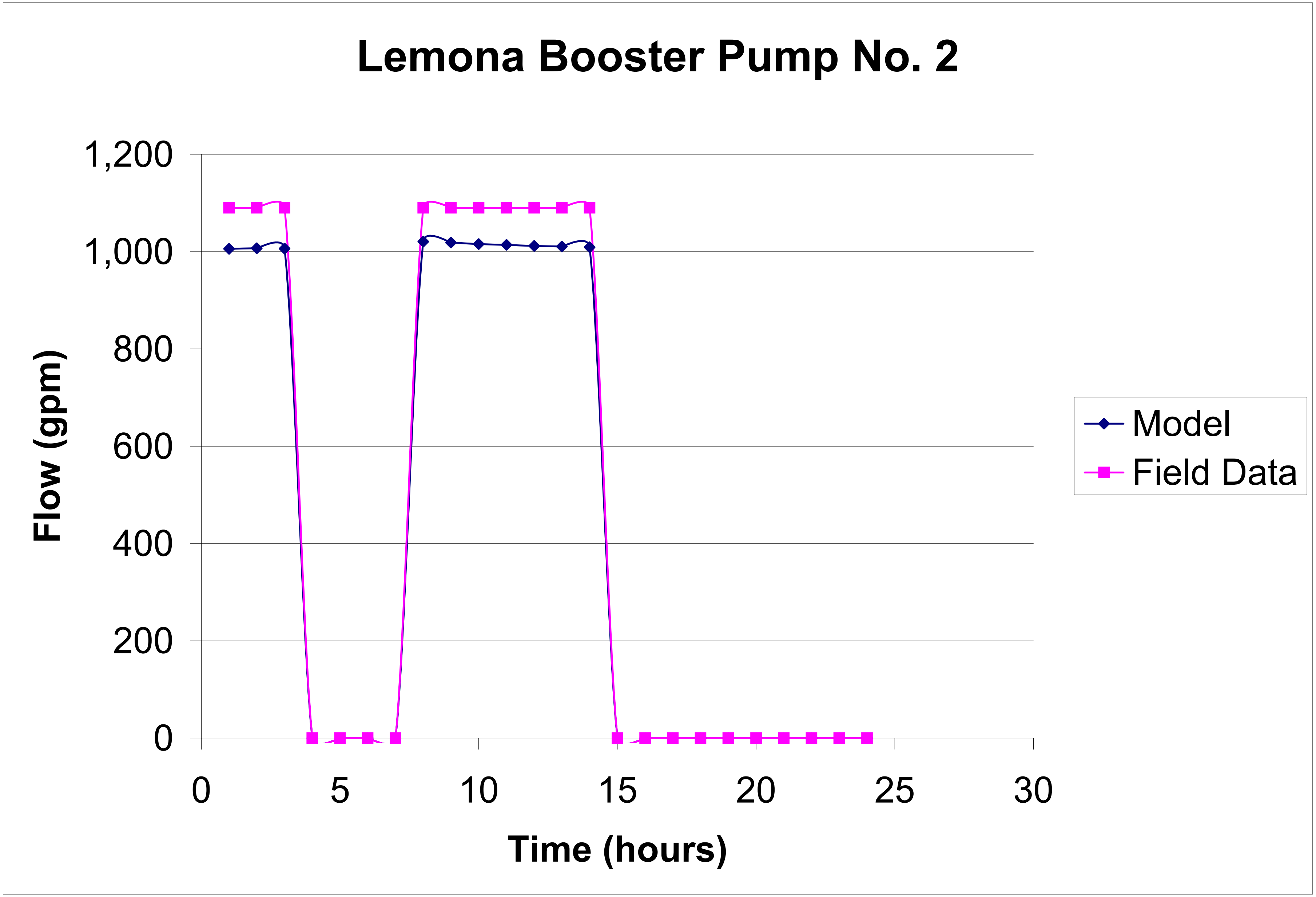

Iowa Booster
Flow (gpm)
30,000
25,000
20,000
15,000
10,000
5,000
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Industrial Booster
Flow (gpm)
6,000
5,000
4,000
3,000
2,000
1,000
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

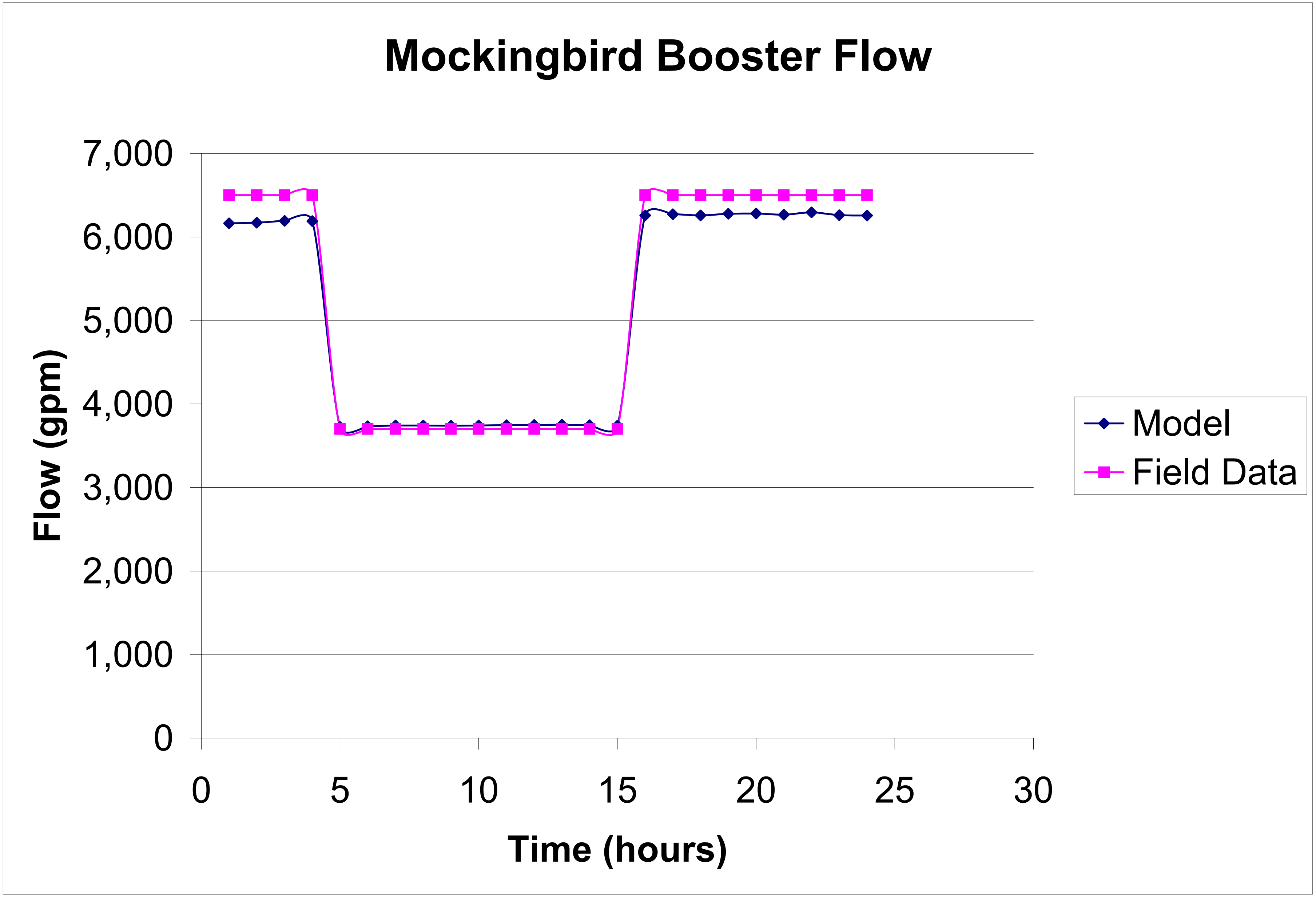

Linden Booster Flow
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (gpm)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

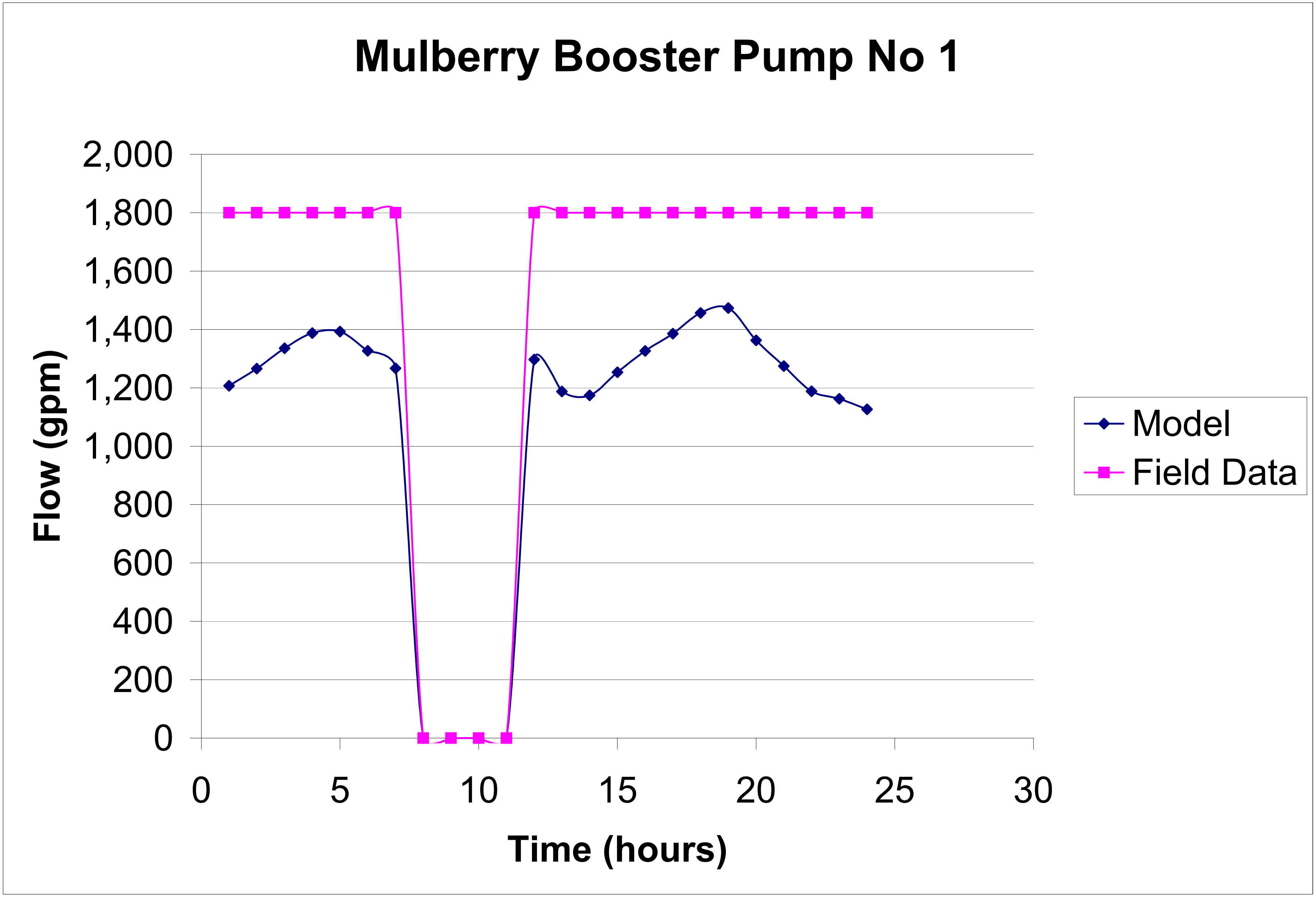

Linden/Gage Connection Flow
30,000
25,000
20,000
15,000
10,000
5,000
0
Flow (gpm)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

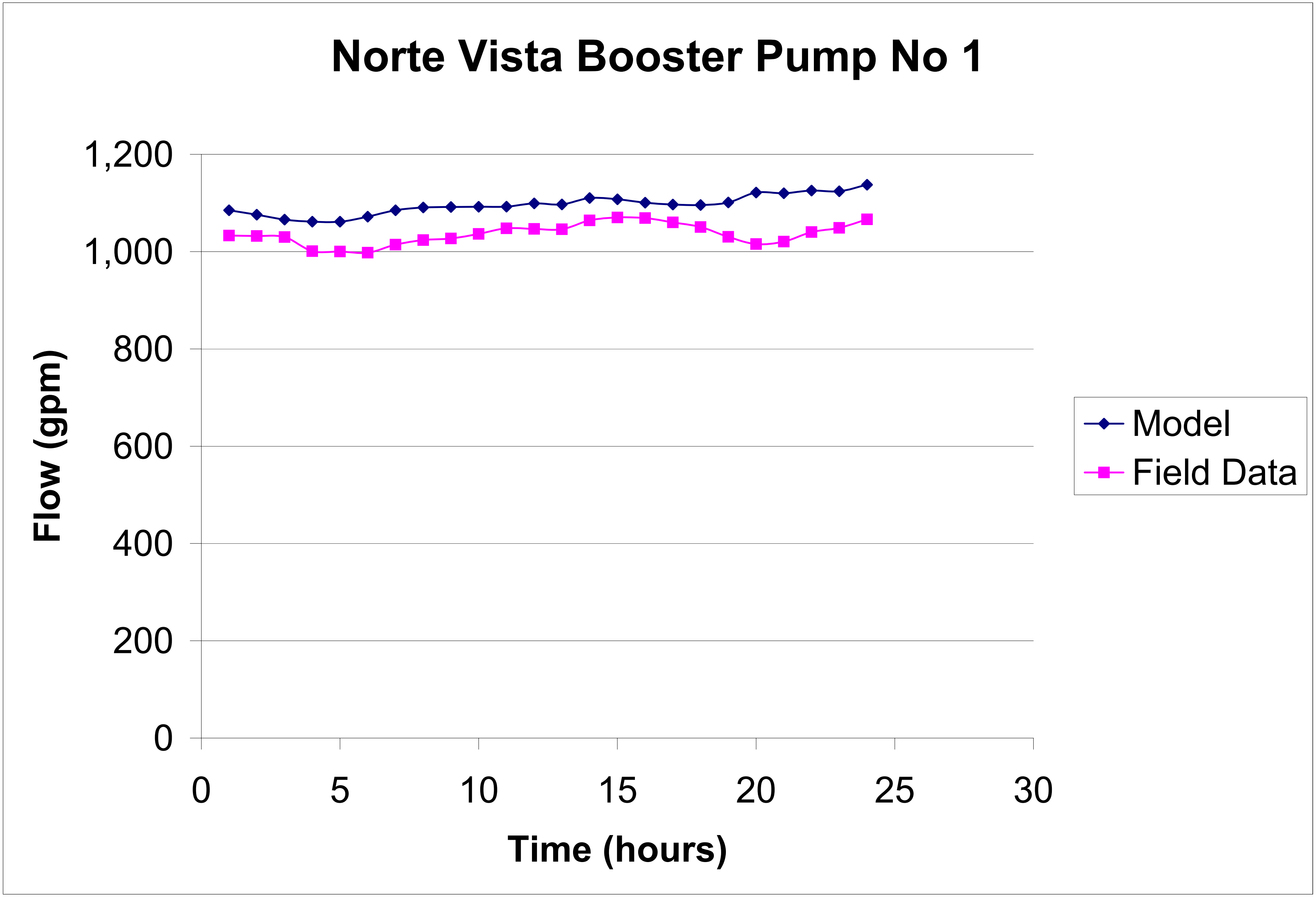

Lemona Booster Pump No. 1
Flow (gpm)
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

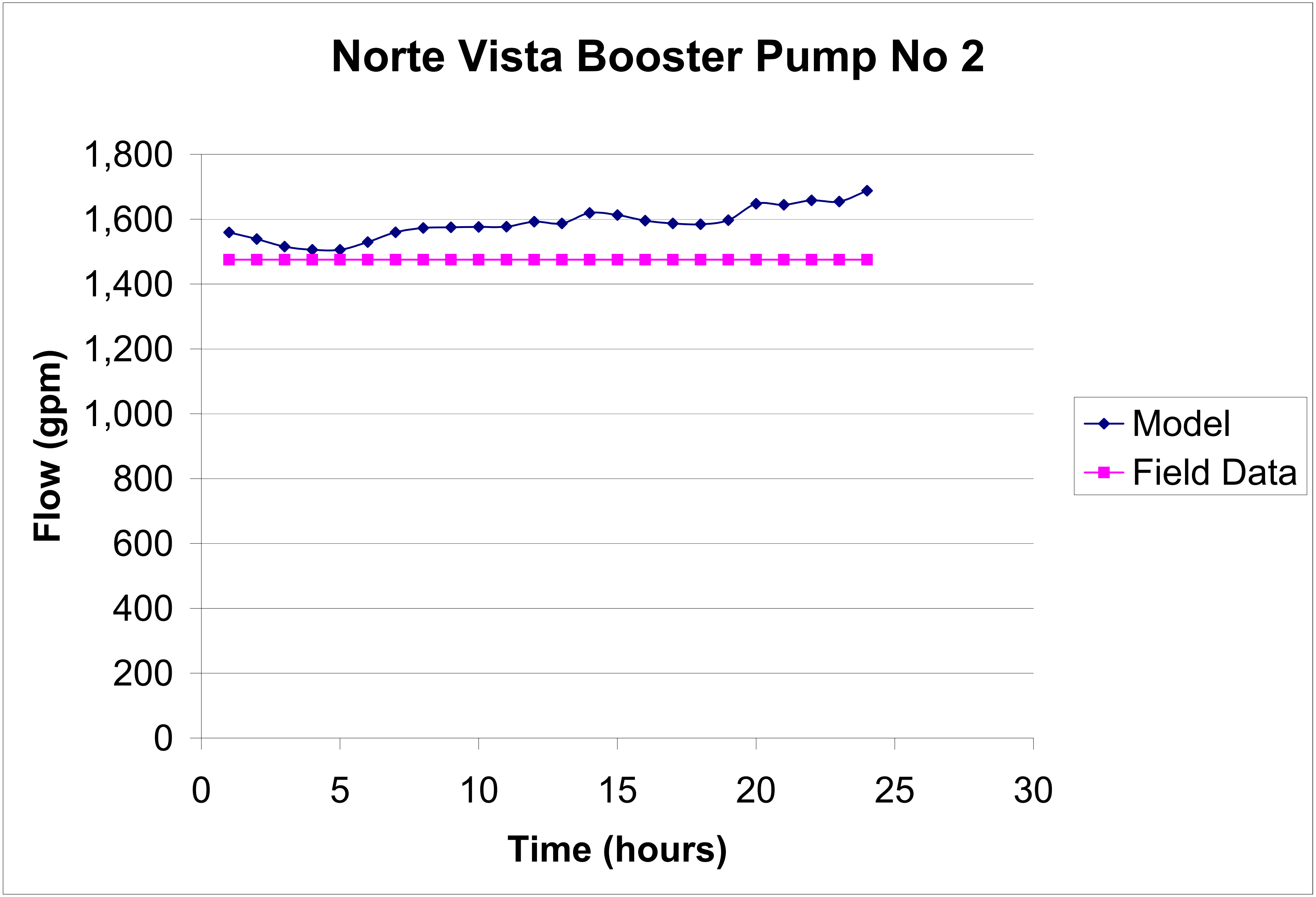


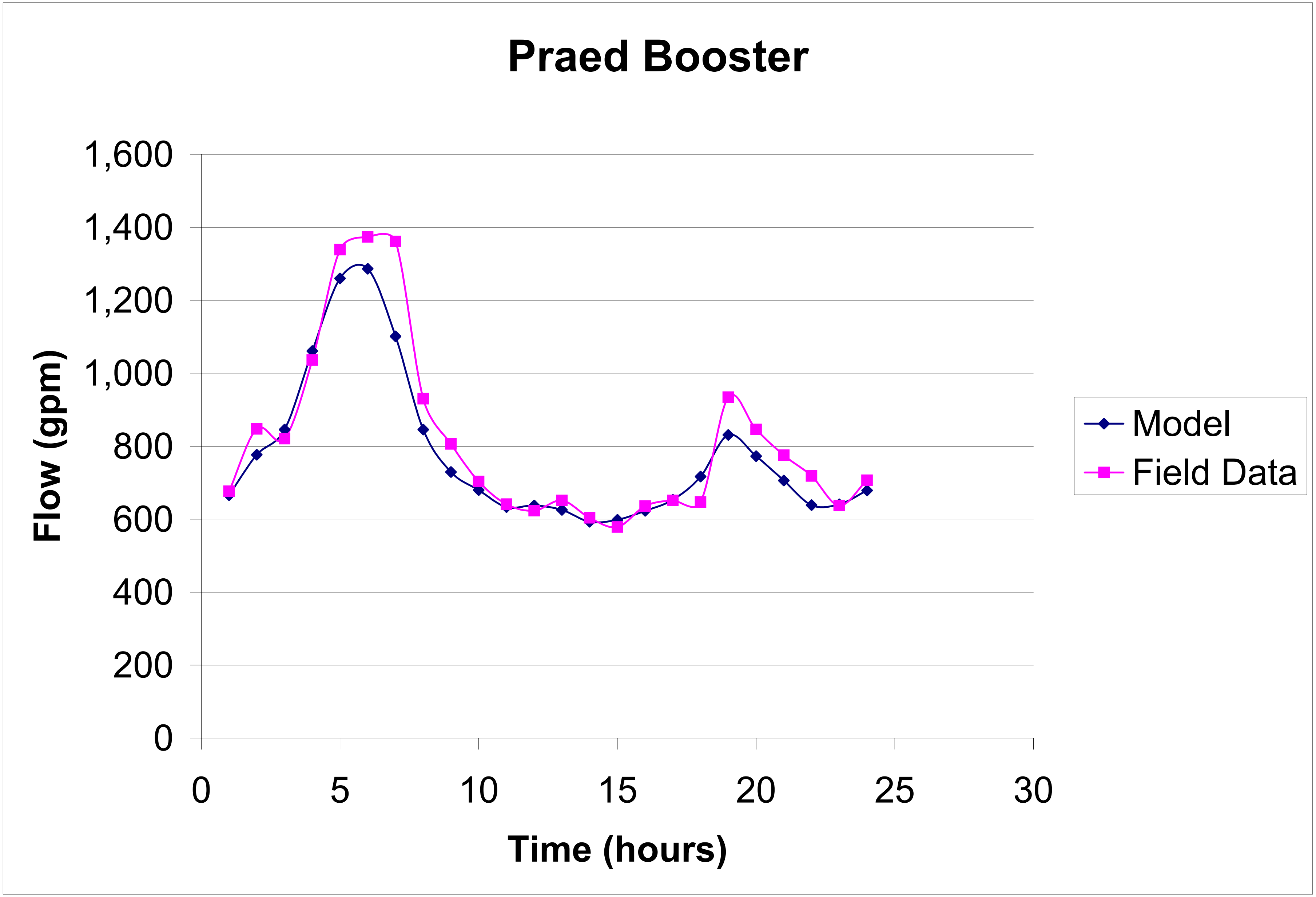
Lemona Booster Pump No. 2
Flow (gpm)
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

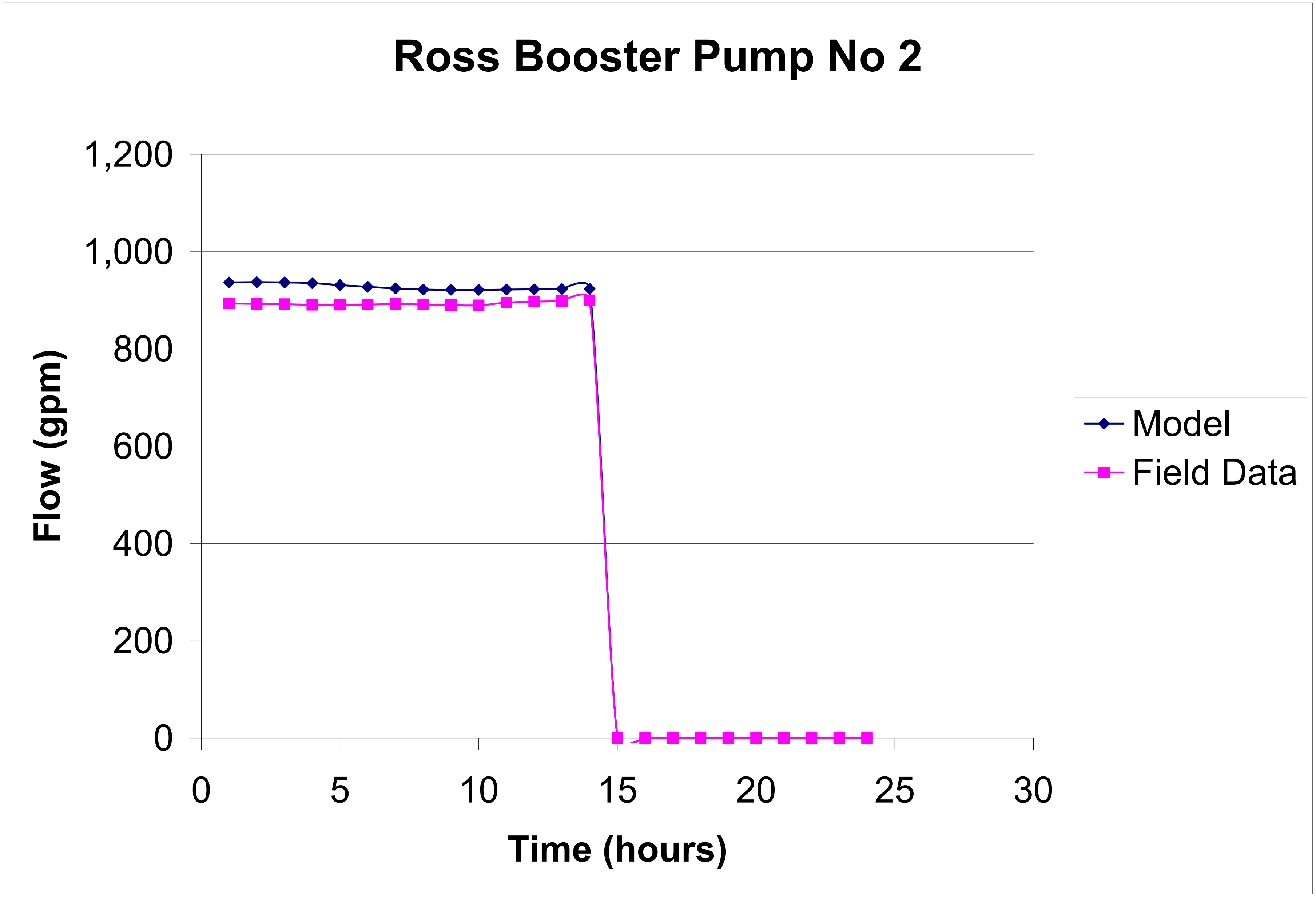

Mockingbird Booster Flow
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (gpm)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Mulberry Booster Pump No 1
Flow (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

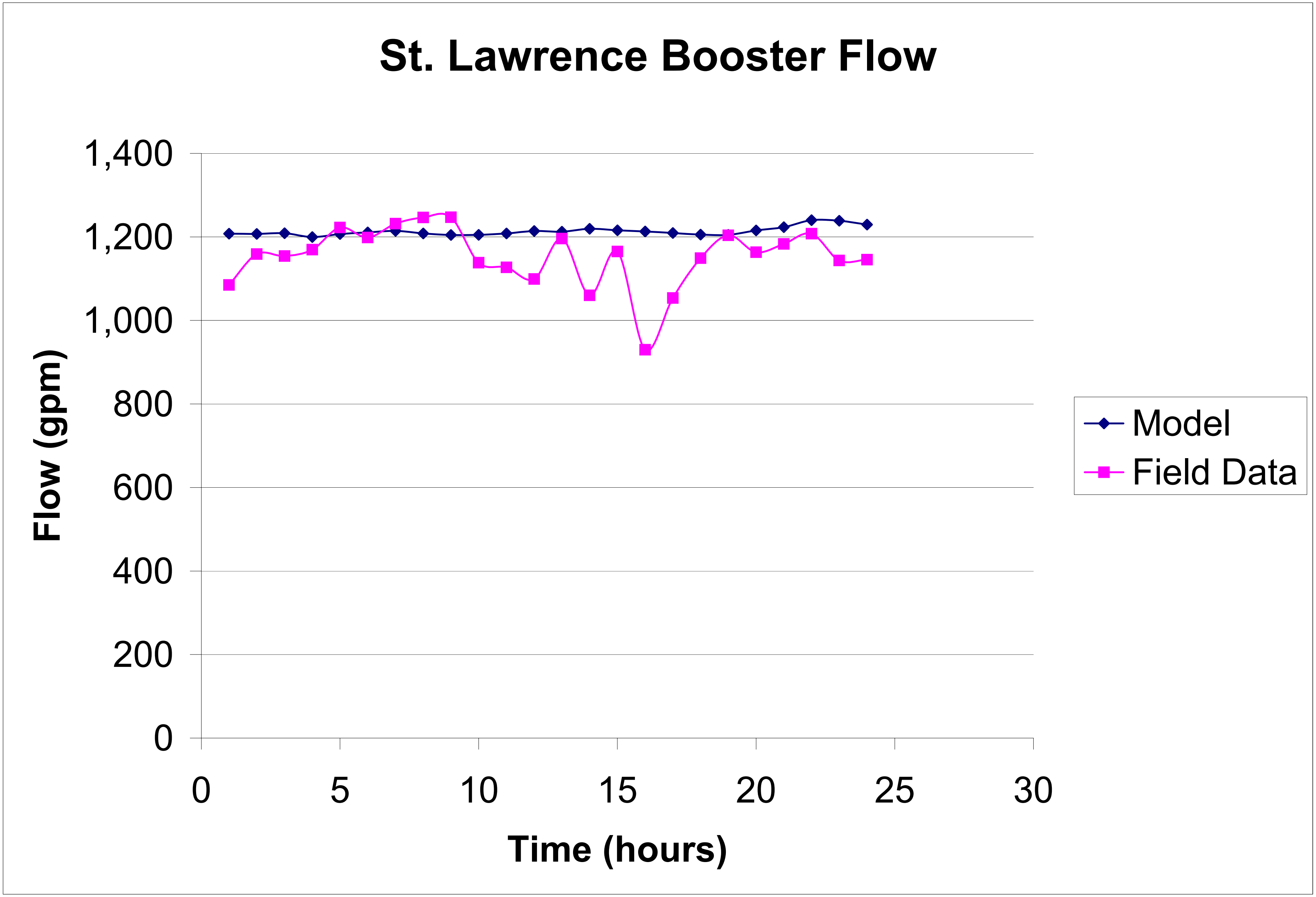

Norte Vista Booster Pump No 1
Flow (gpm)
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

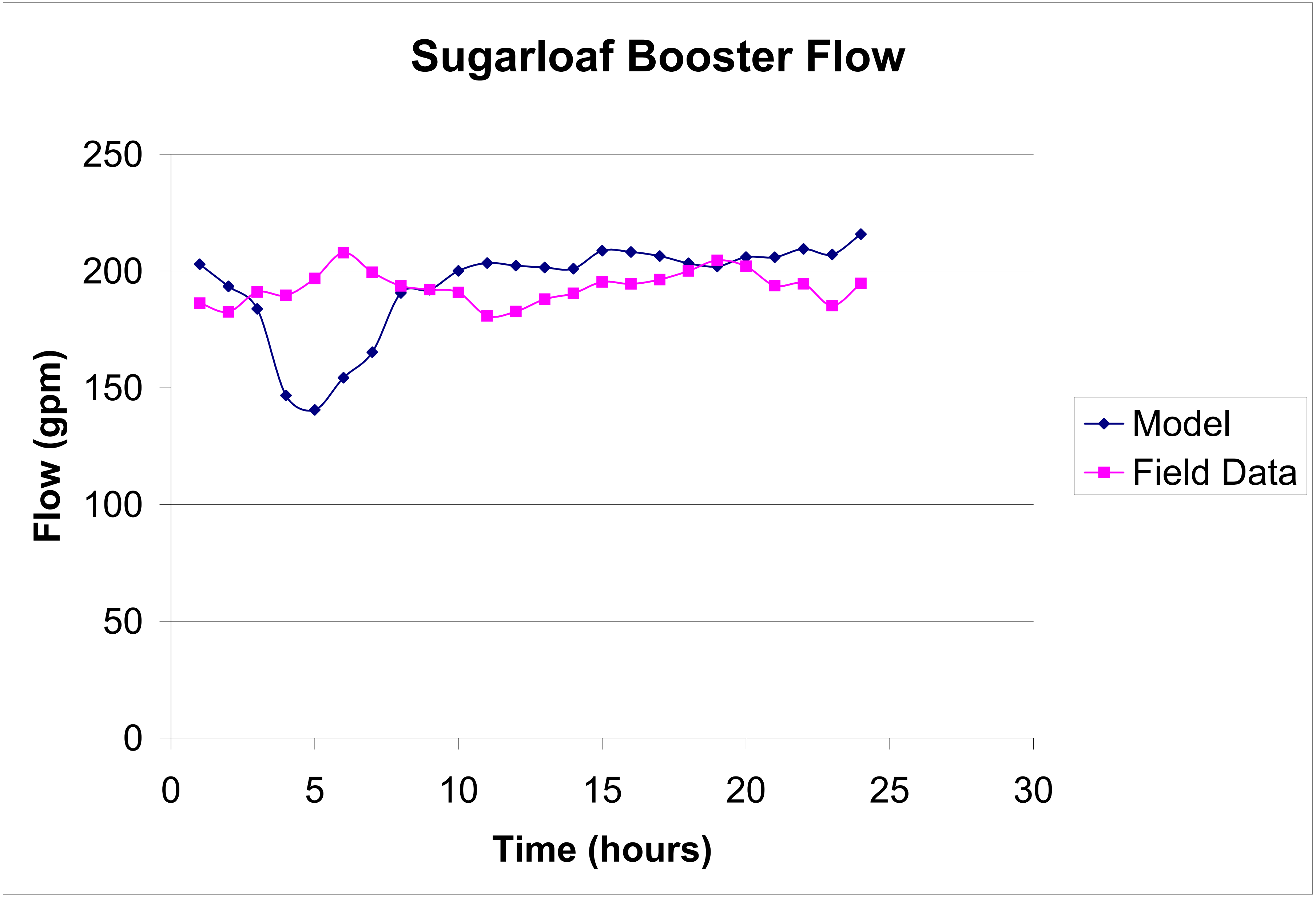

Norte Vista Booster Pump No 2
Flow (gpm)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

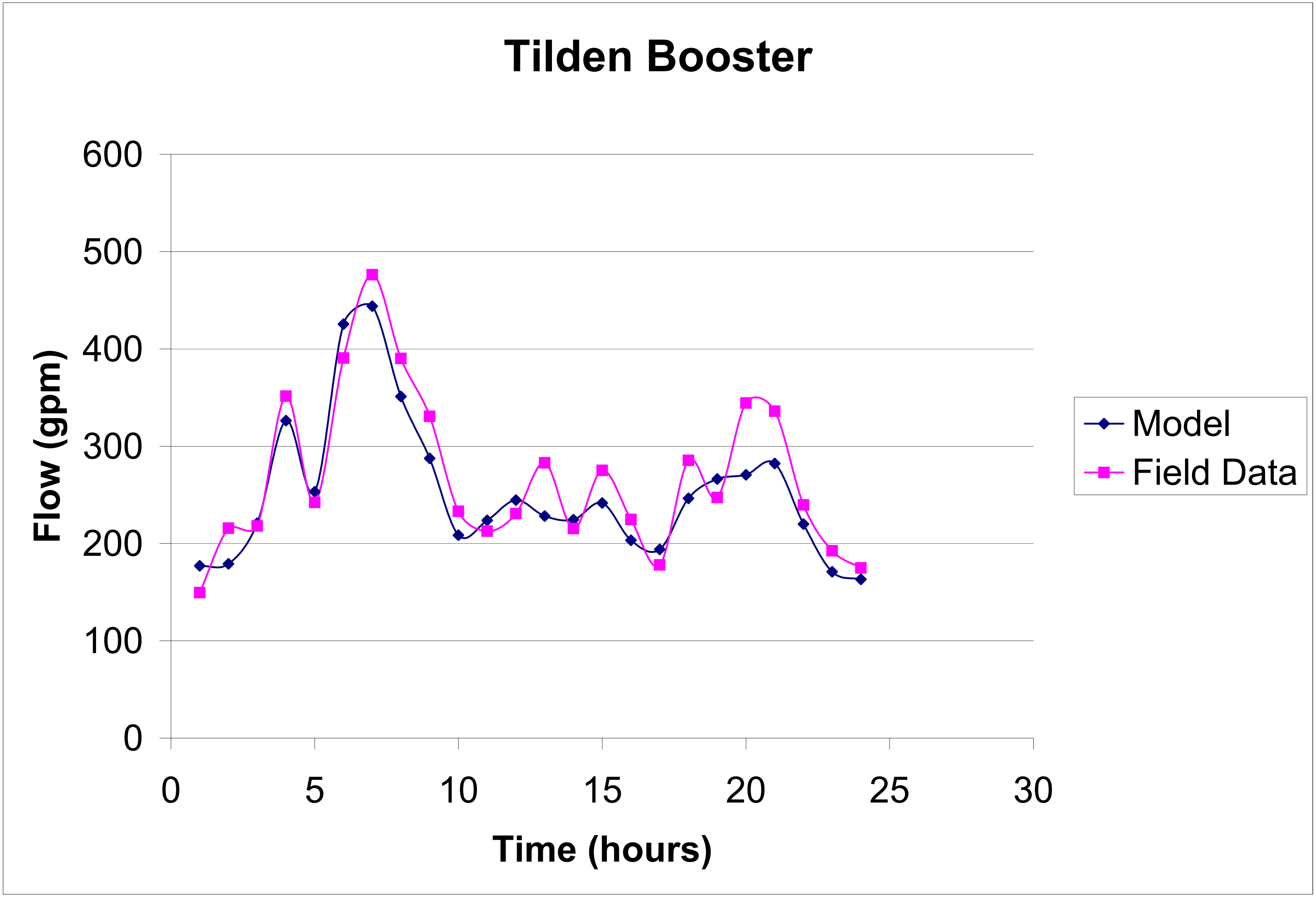

Praed Booster
Flow (gpm)
1,600
1,400
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

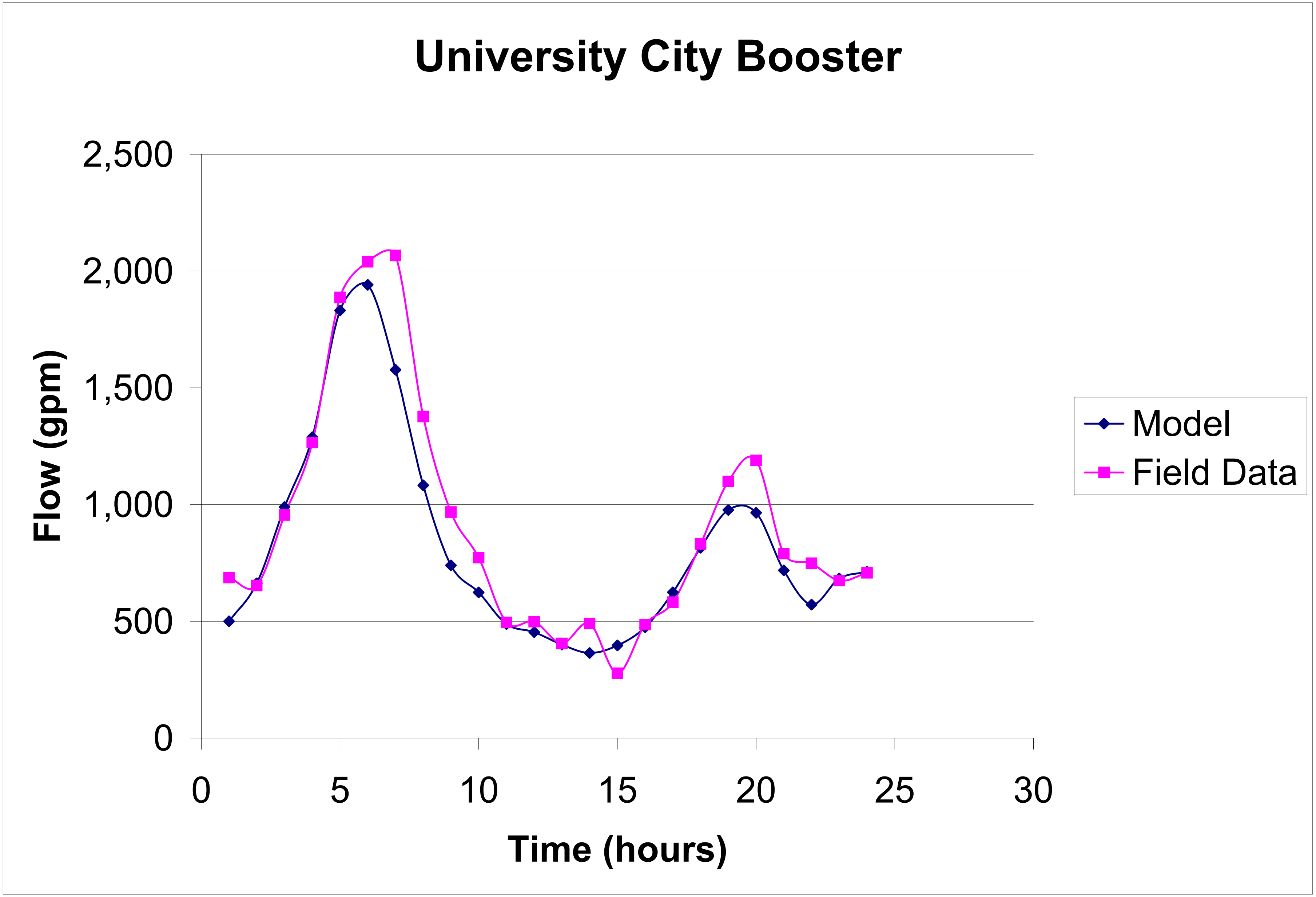


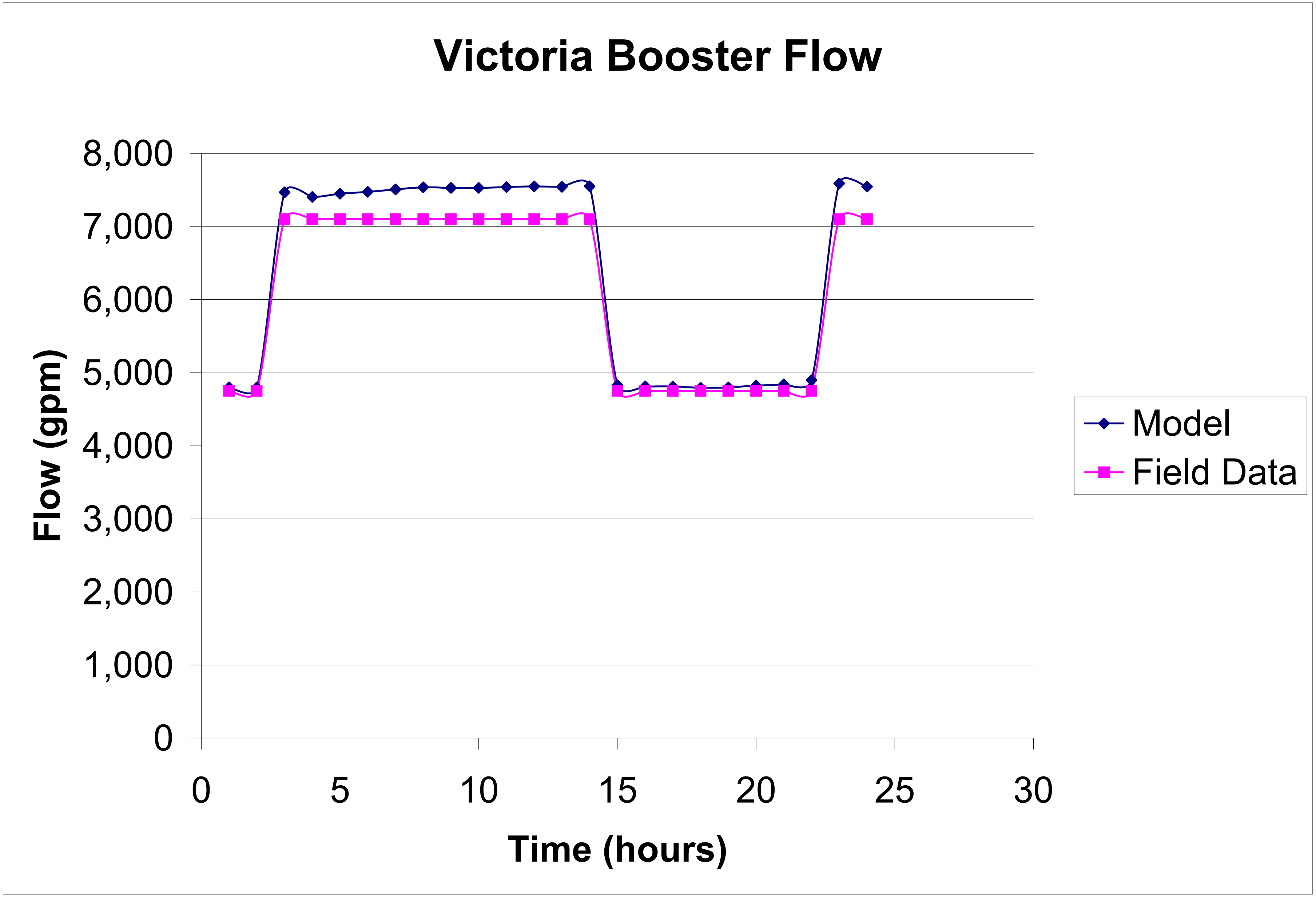
Ross Booster Pump No 2
1,200
1,000
800
600
400
200
0
Flow (gpm)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

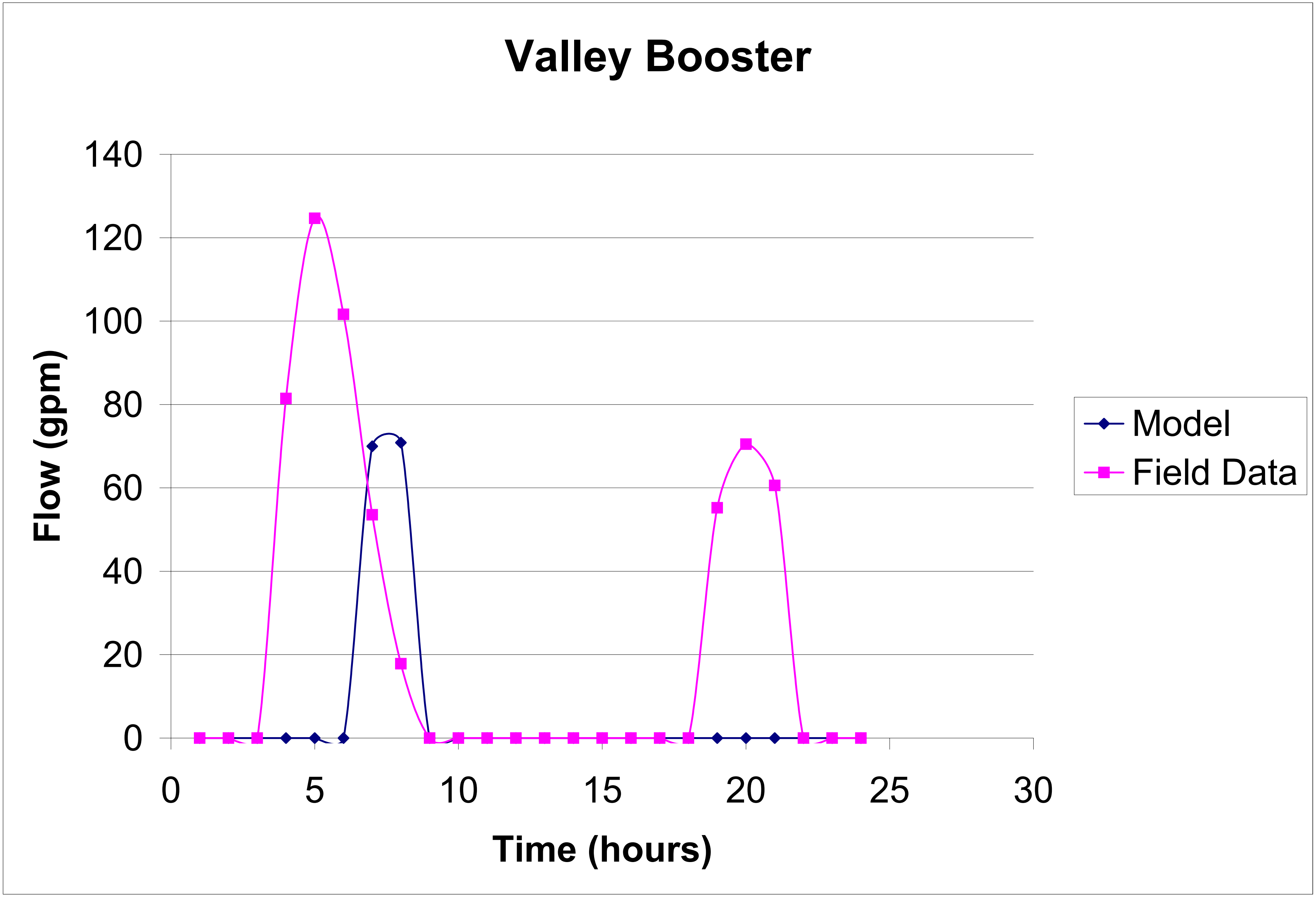

St. Lawrence Booster Flow
Flow (gpm)
1,400
1,200
1,000
800
600
400
200
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

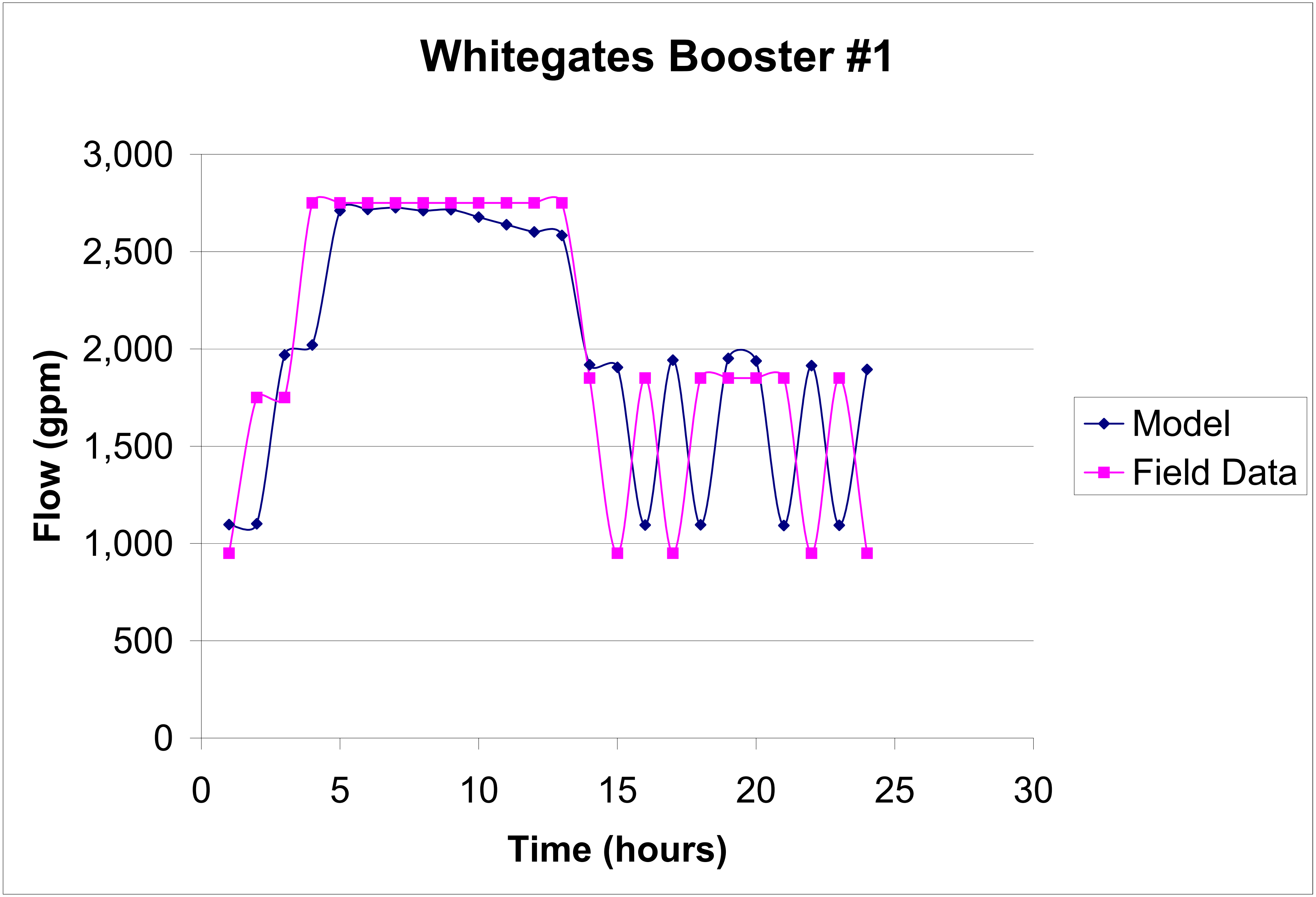

Sugarloaf Booster Flow
Flow (gpm)
250
200
150
100
50
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Tilden Booster
600
500
400
300
200
100
0
Flow (gpm)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

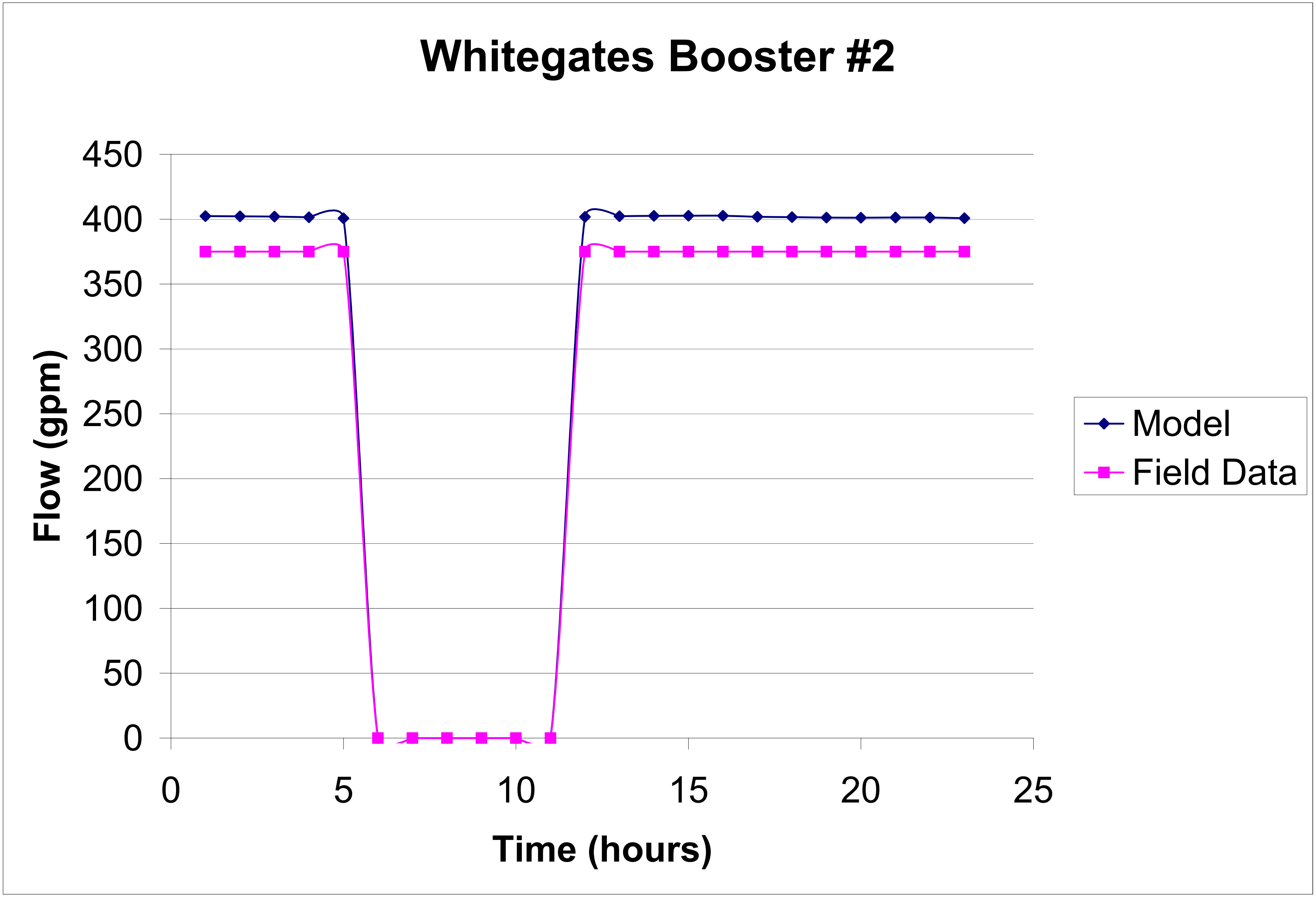

University City Booster
Flow (gpm)
2,500
2,000
1,500
1,000
500
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

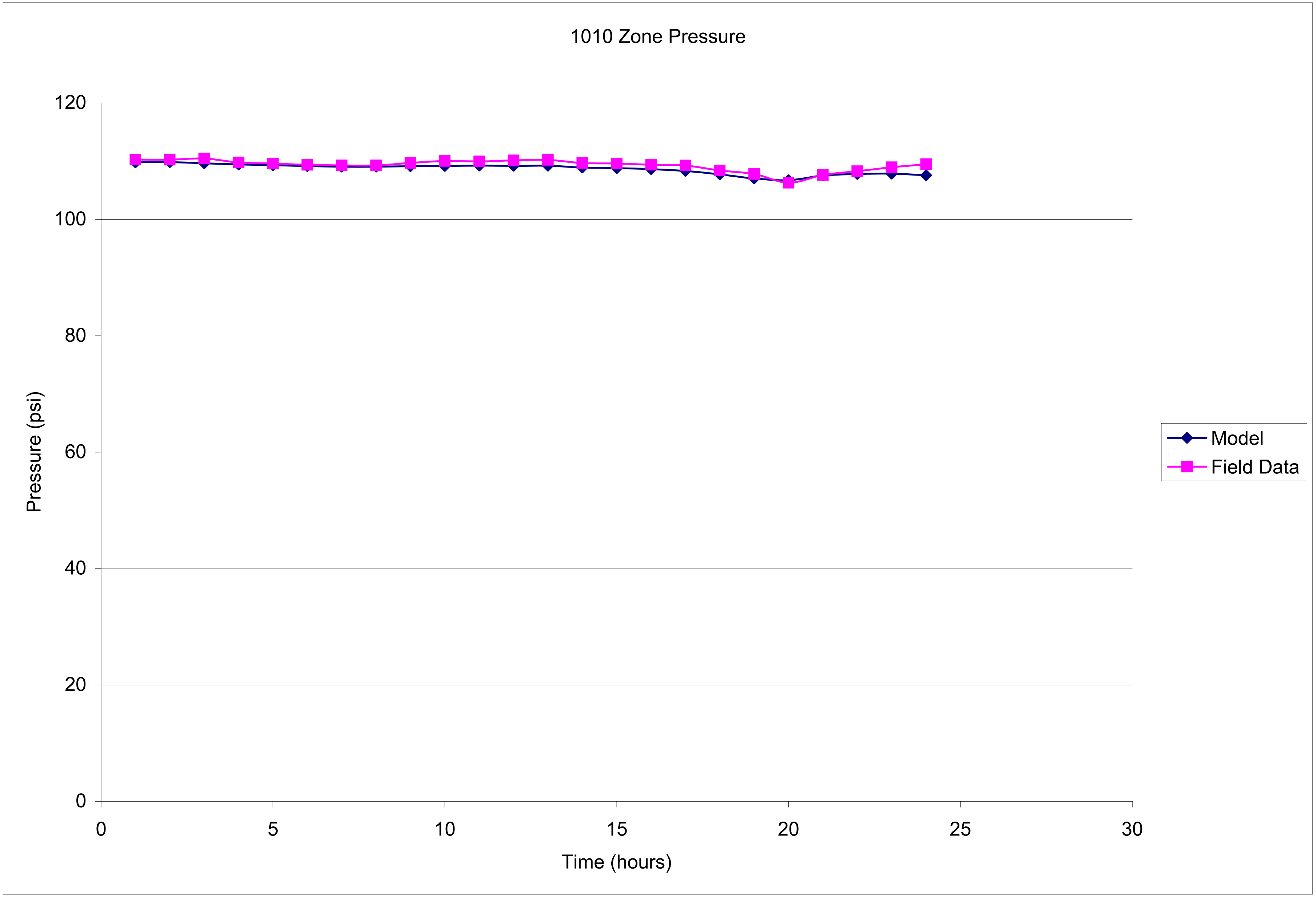

Victoria Booster Flow
Flow (gpm)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

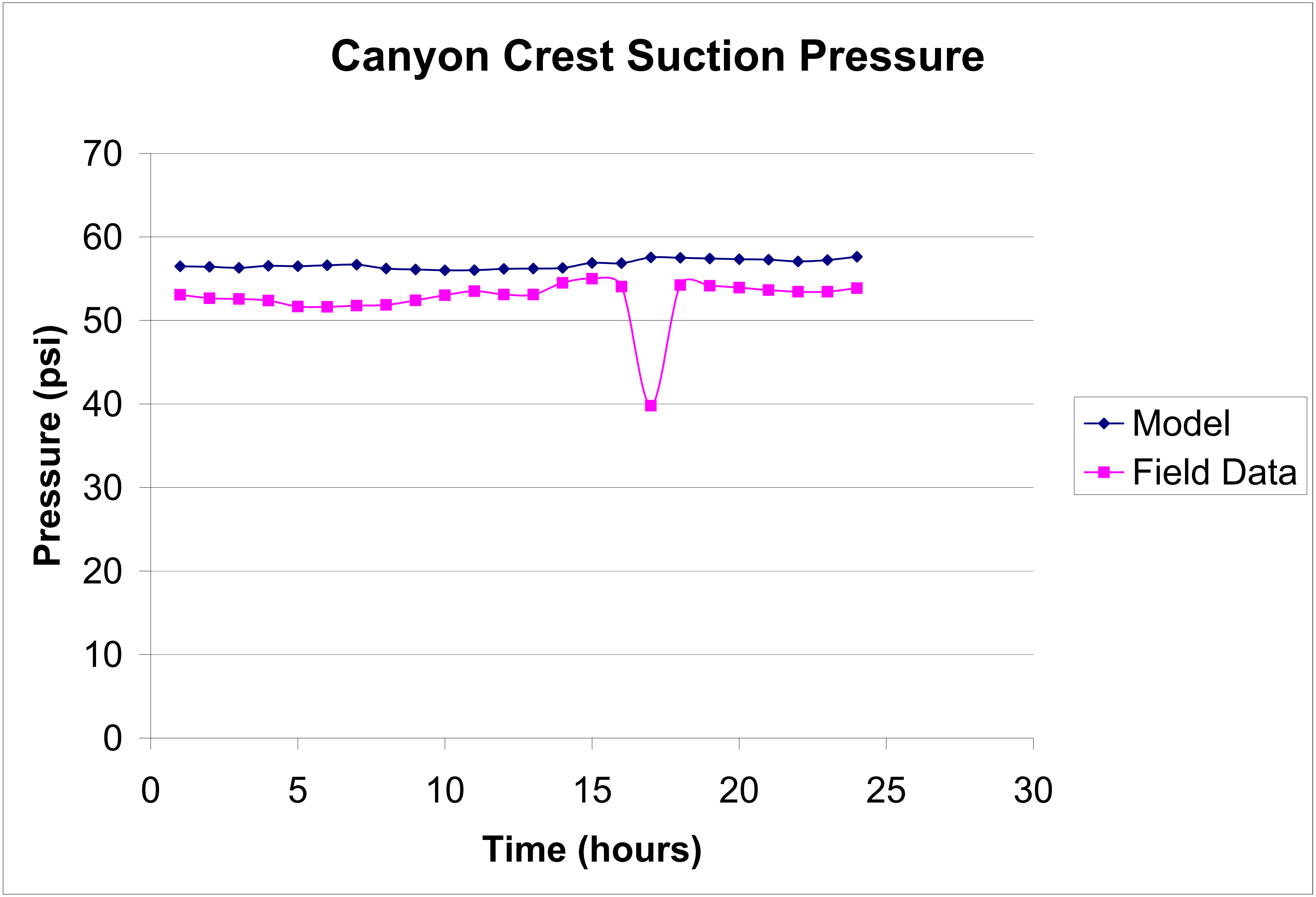

Valley Booster
Flow (gpm)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

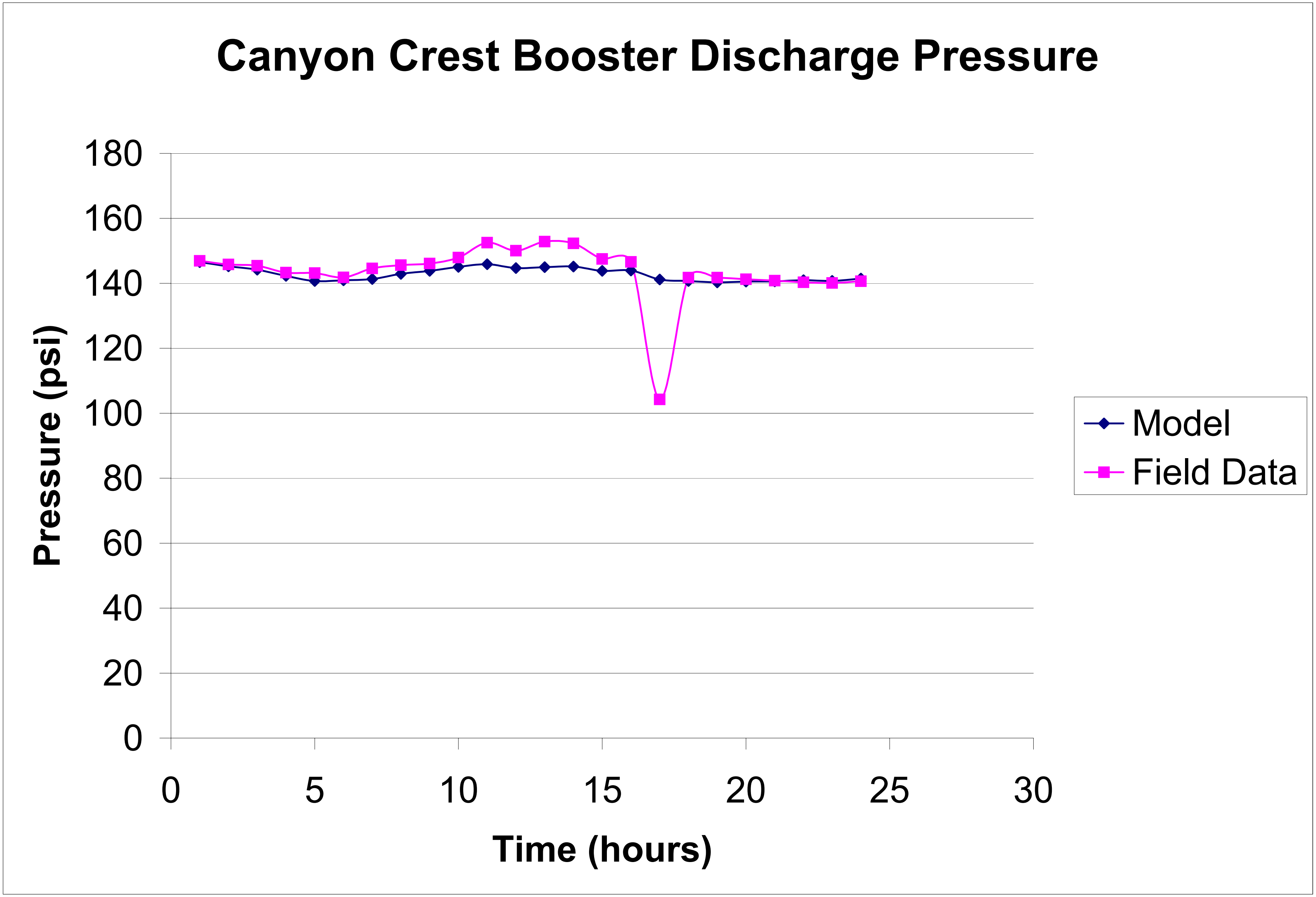


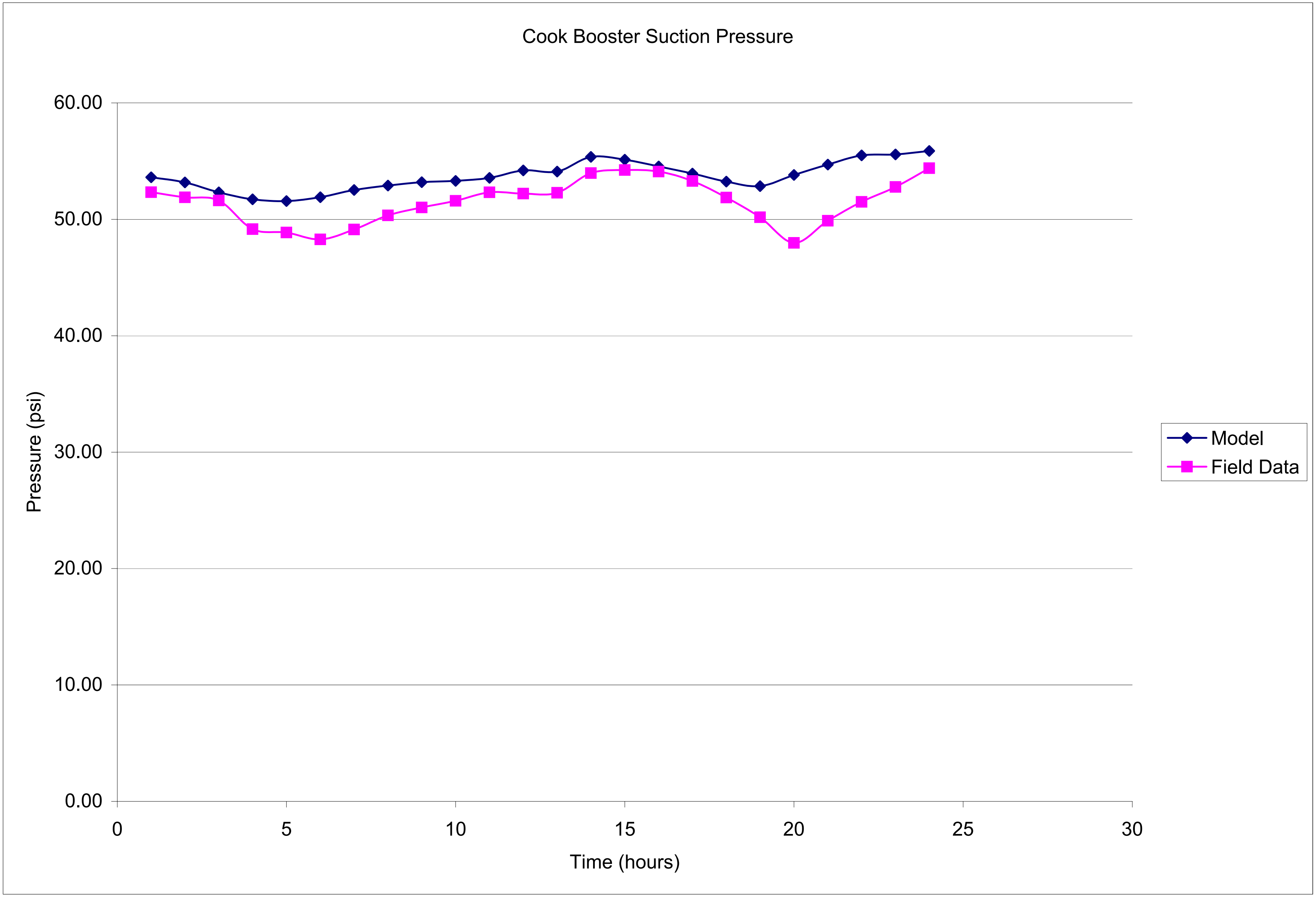
Whitegates Booster #1
Flow (gpm)
3,000
2,500
2,000
1,500
1,000
500
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Whitegates Booster #2
Flow (gpm)
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
Time (hours)
Model
Field Data

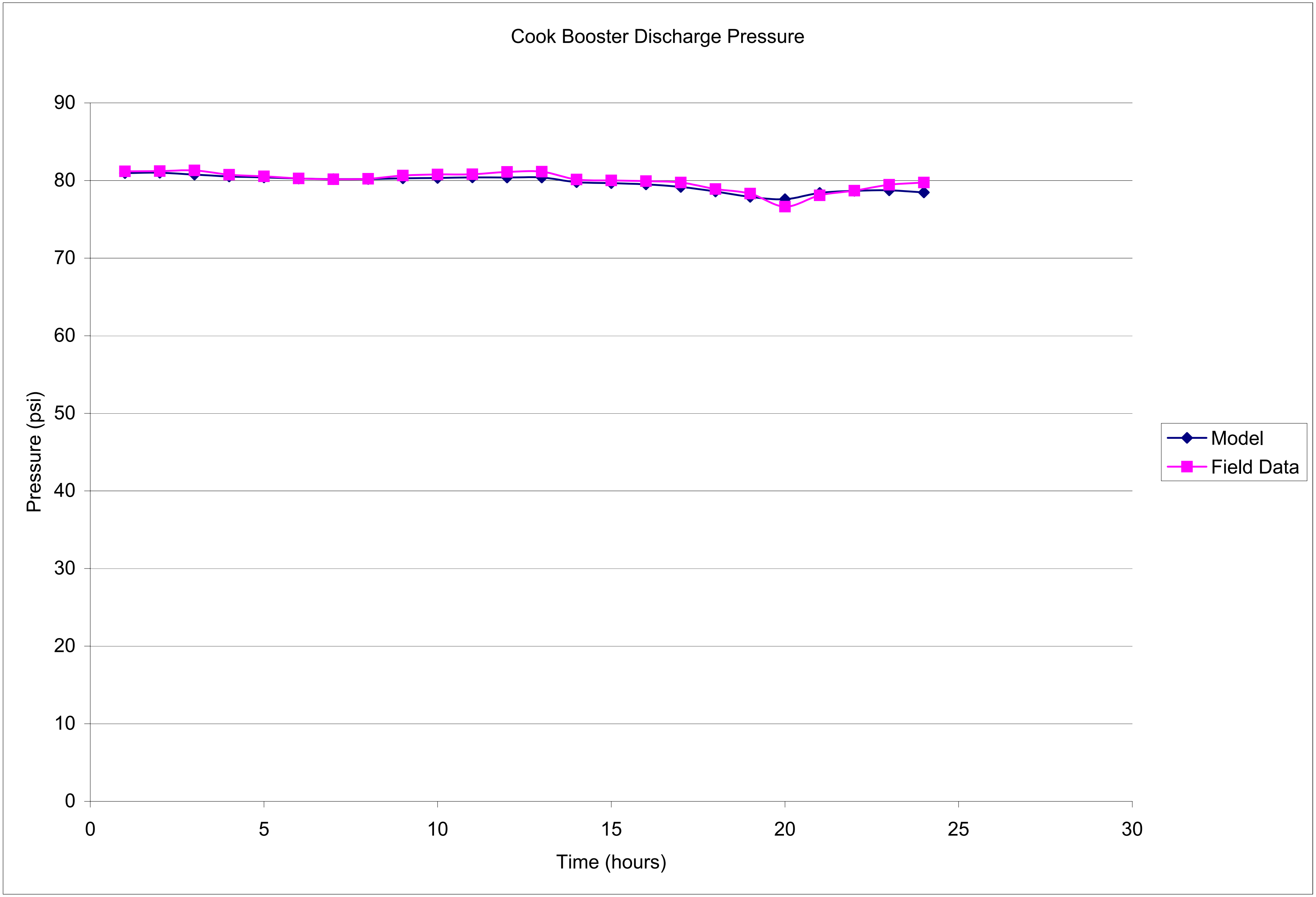

1010 Zone Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

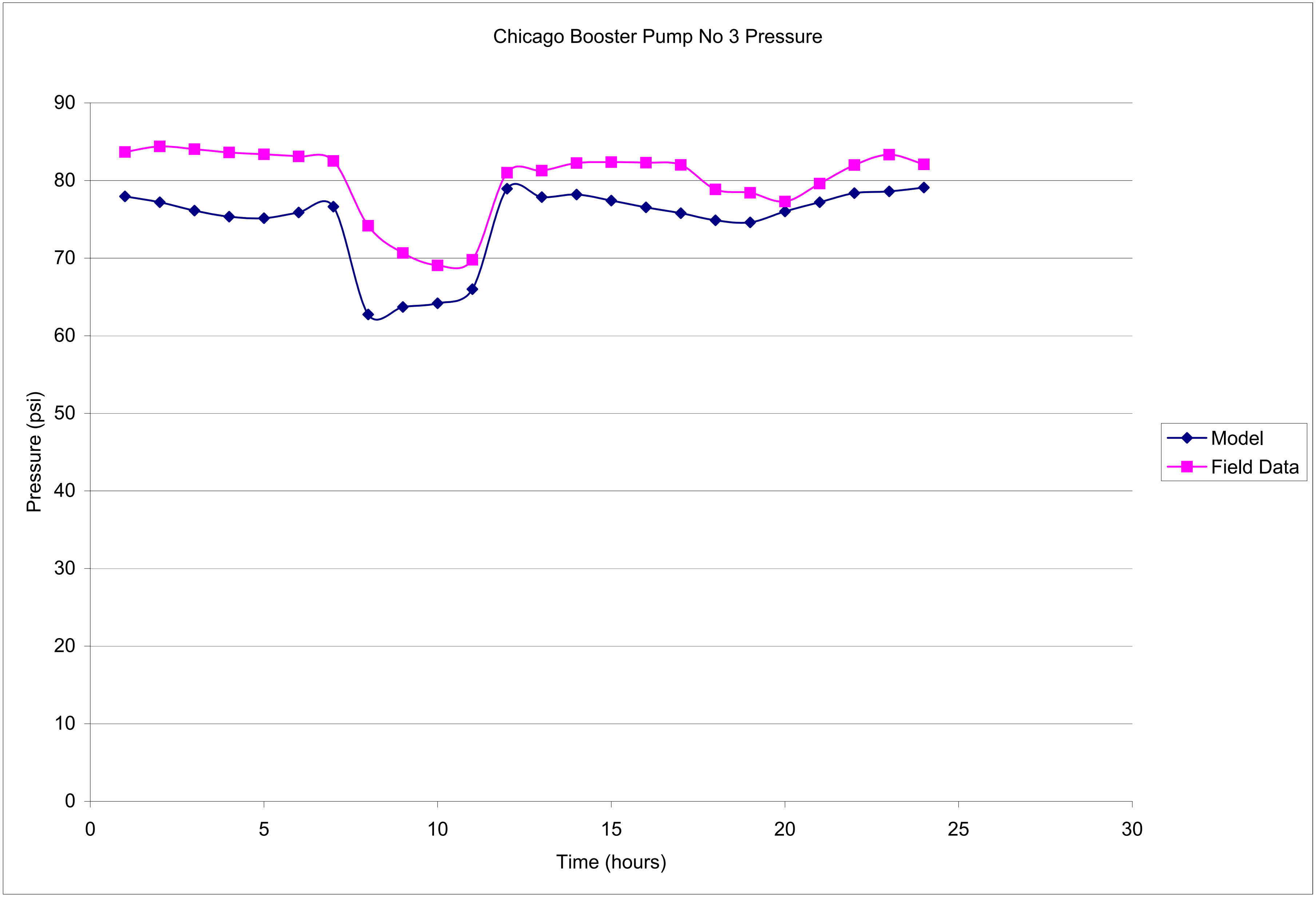

Canyon Crest Suction Pressure
Pressure (psi)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Canyon Crest Booster Discharge Pressure
Pressure (psi)
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

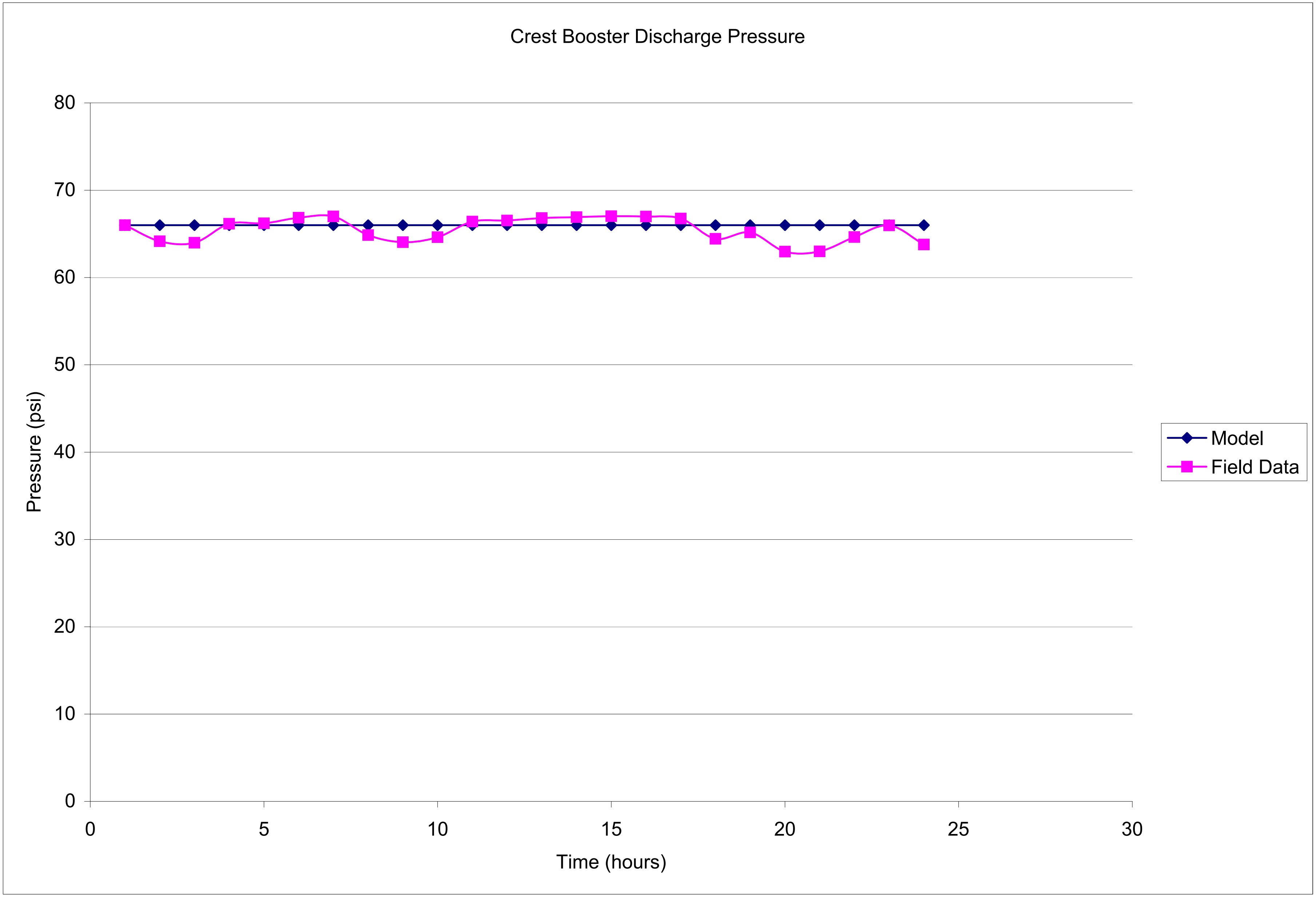


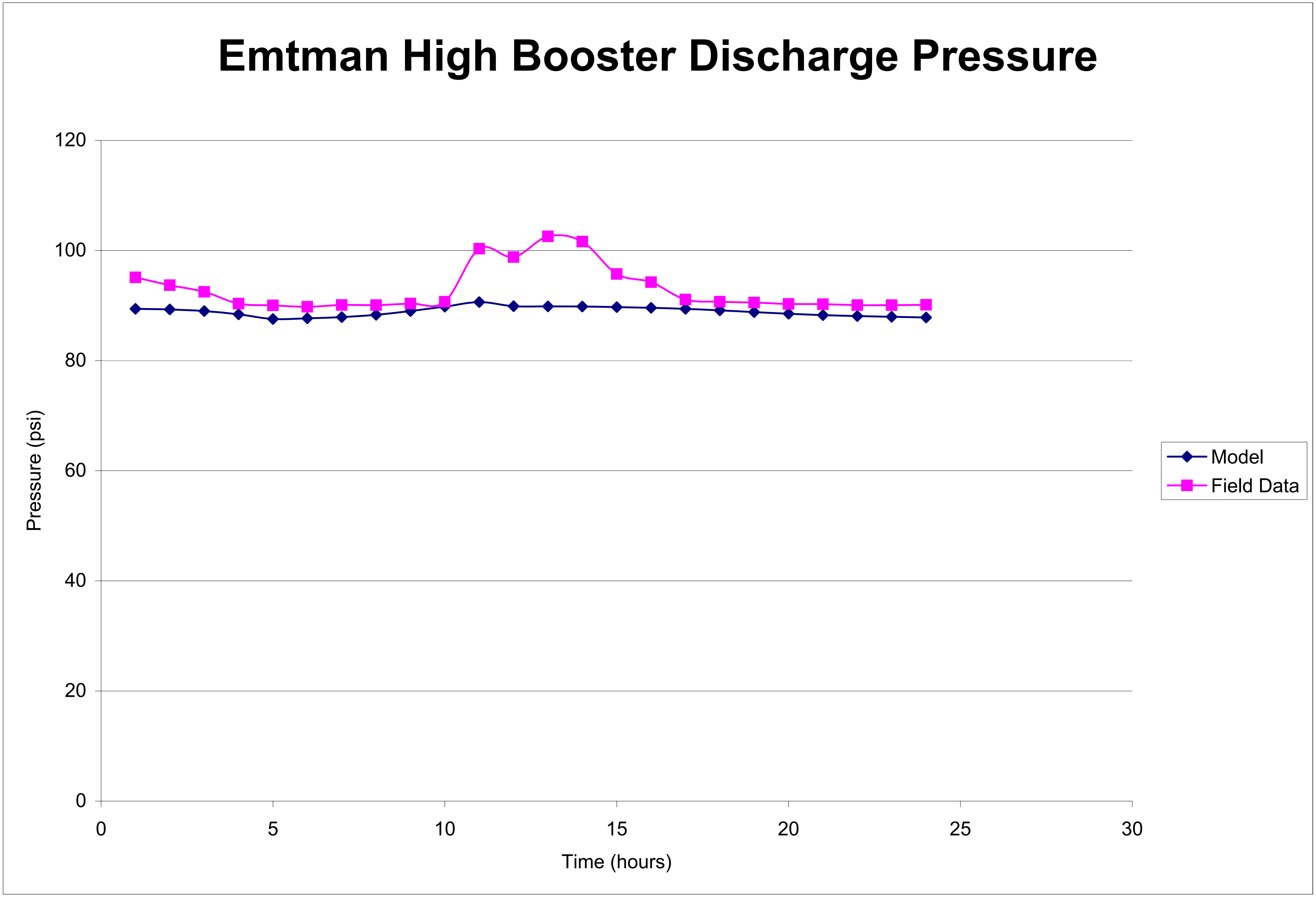
Cook Booster Suction Pressure
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Pressure (psi)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

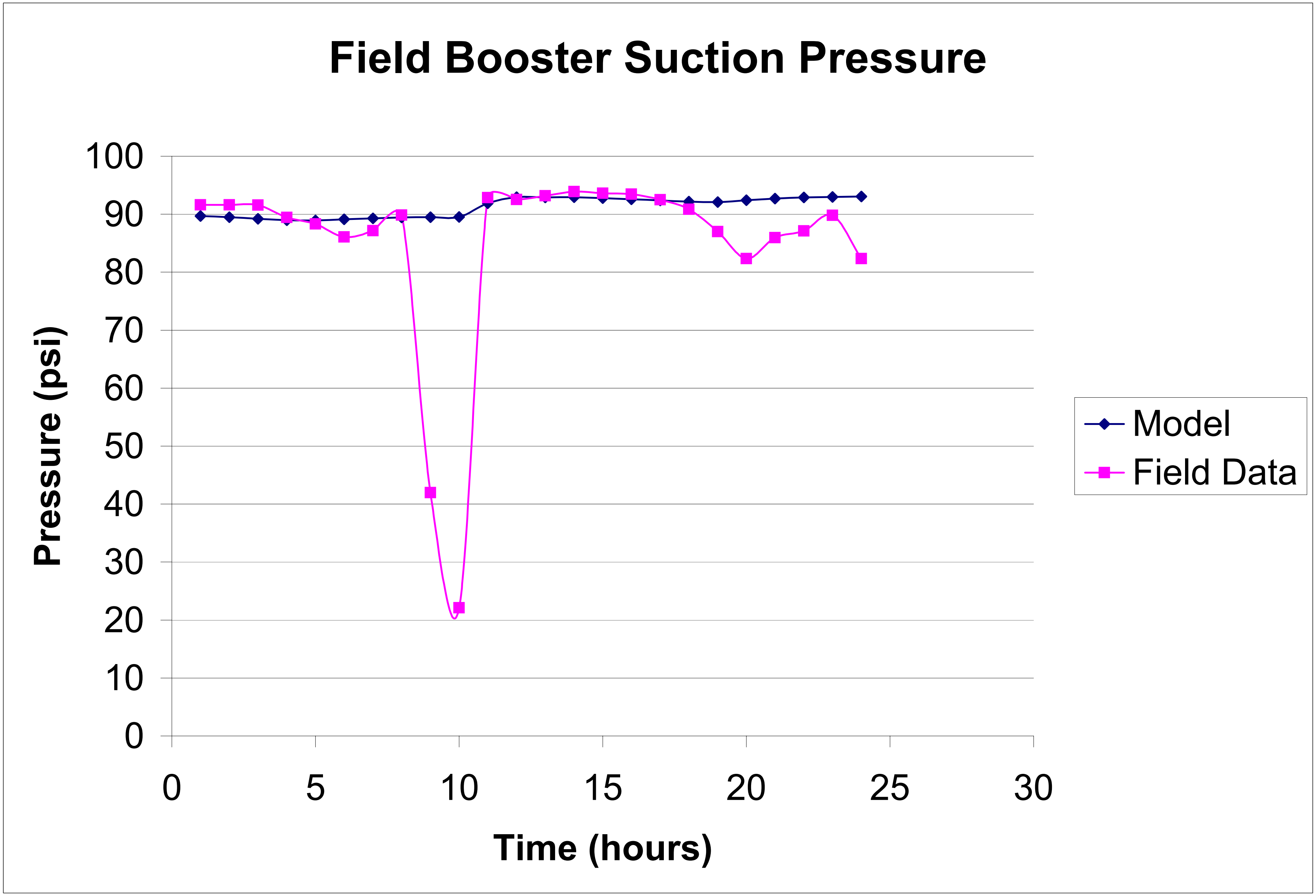

Cook Booster Discharge Pressure
Pressure (psi)
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

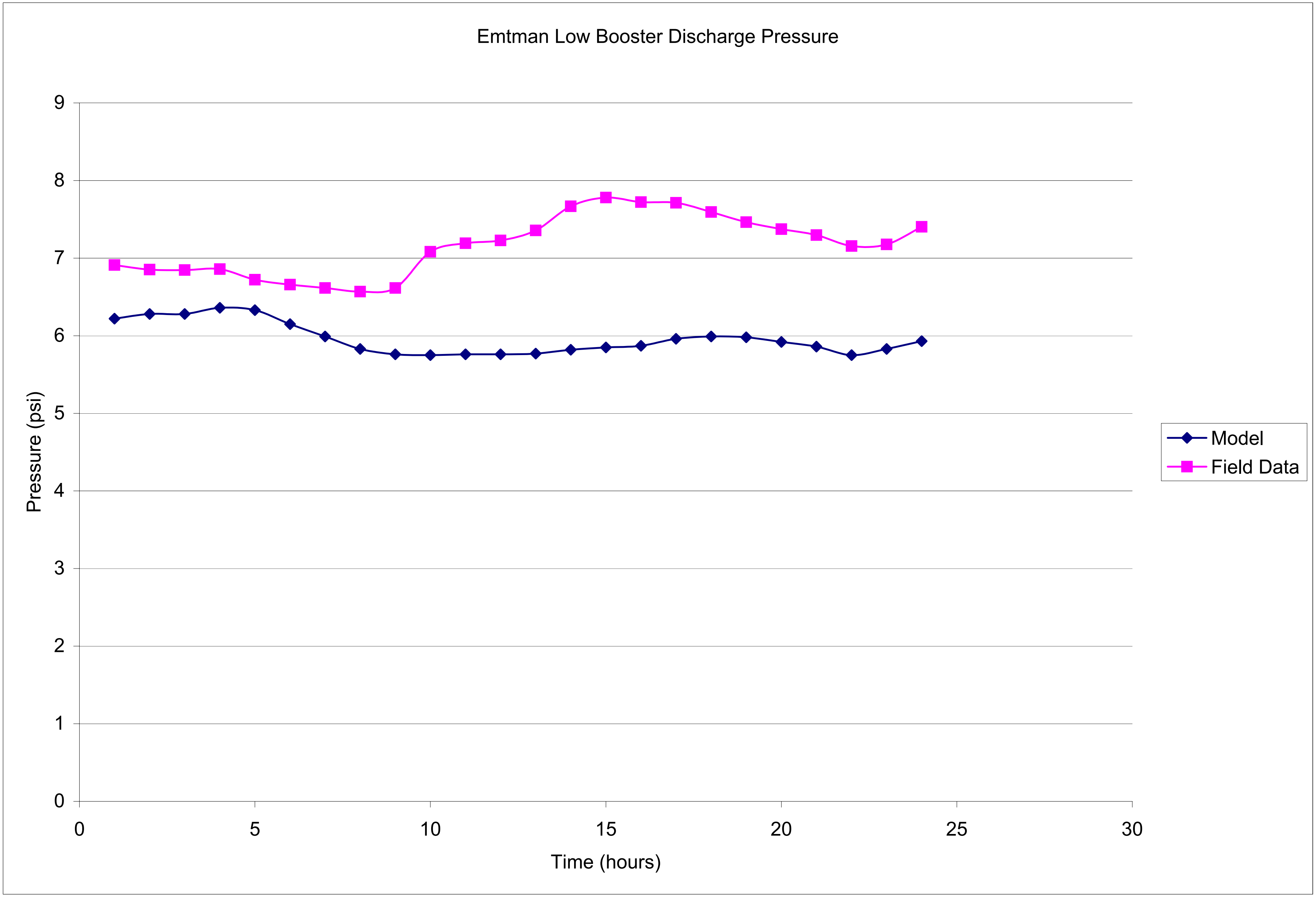


Chicago Booster Pump No 3 Pressure
Pressure (psi)
0
10
20
30
40
50
60
70
80
90
Time (hours)
0
5
10
15
20
25
30
Model
Field Data

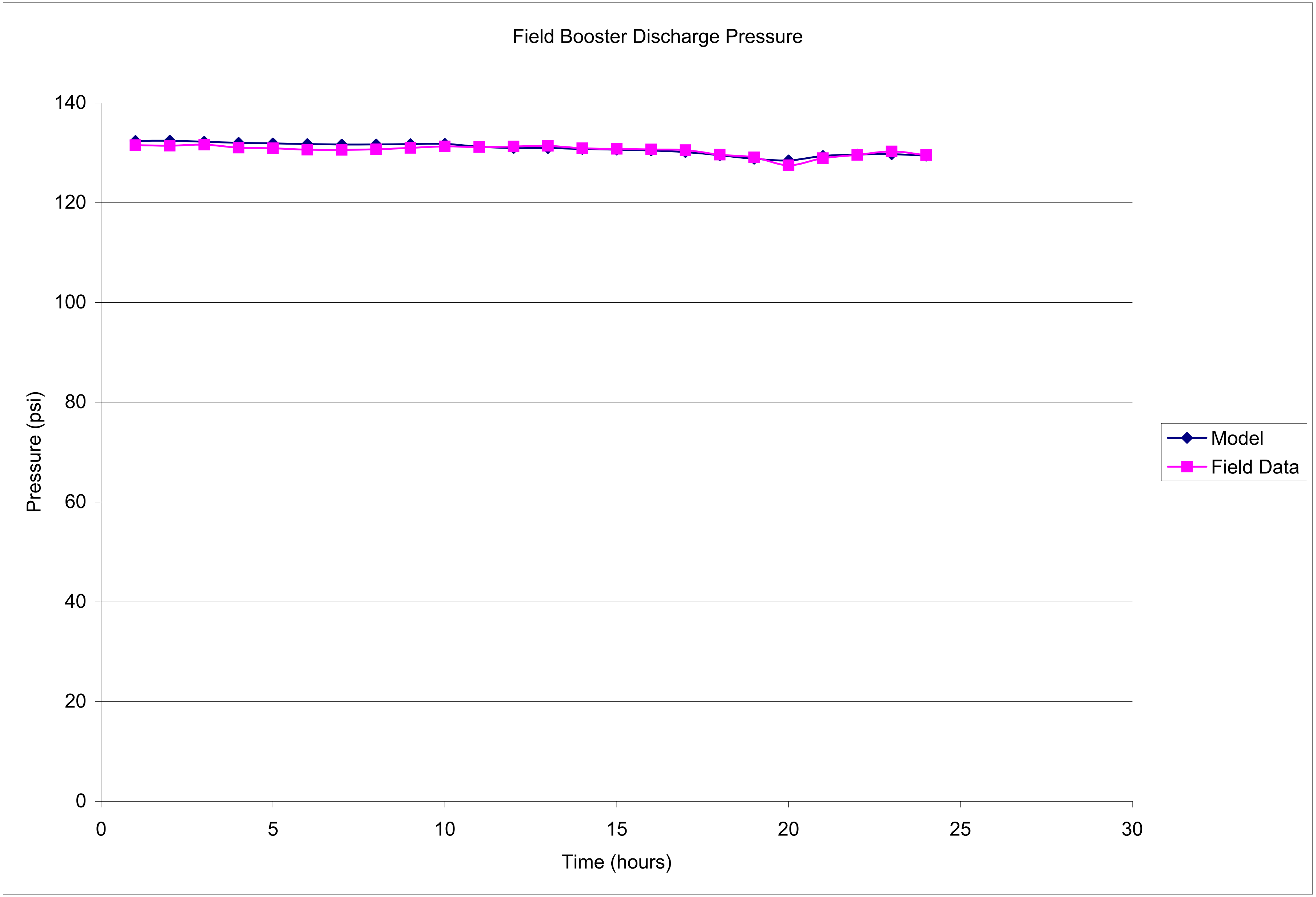

Crest Booster Discharge Pressure
Pressure (psi)
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

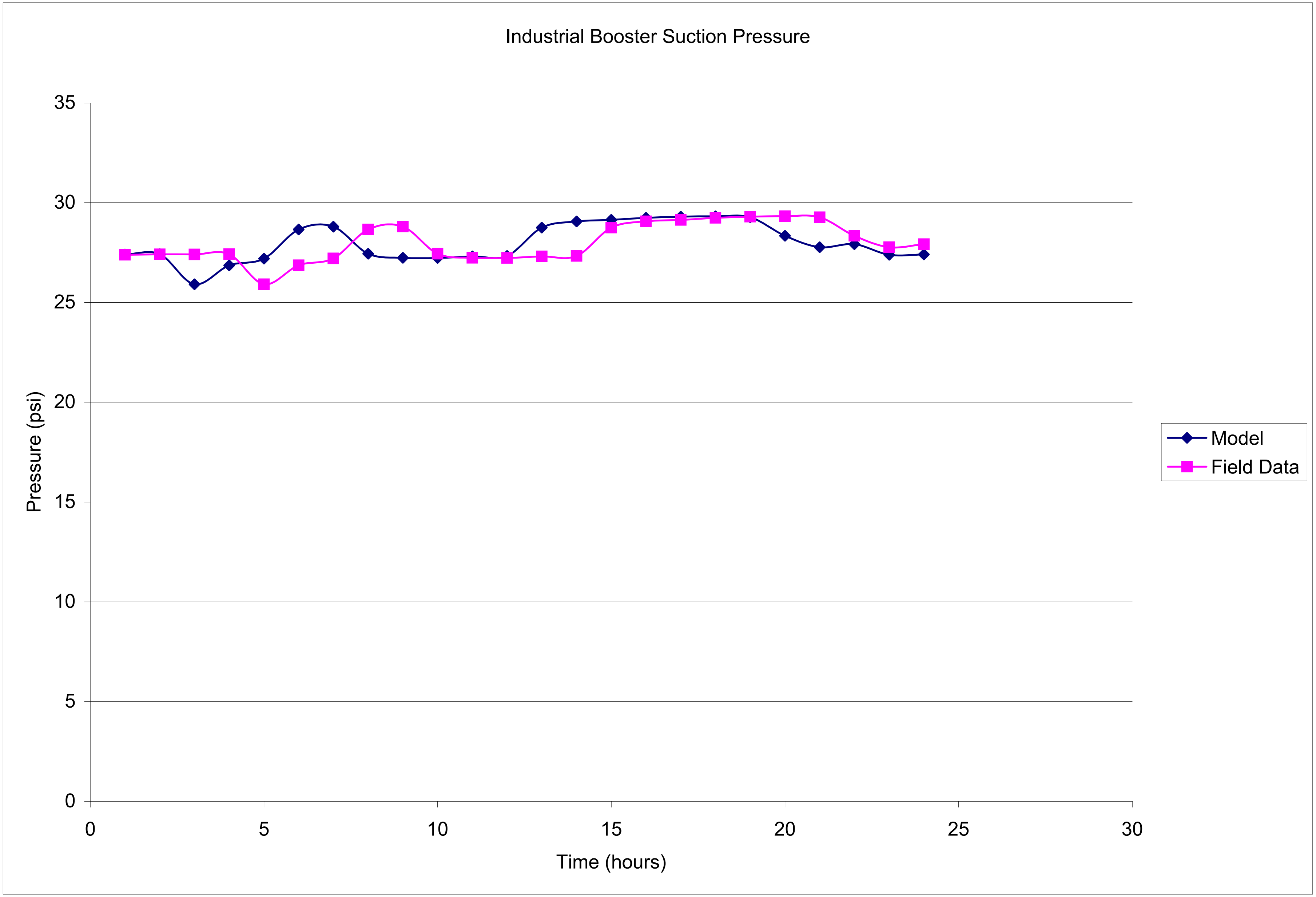

Emtman High Booster Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

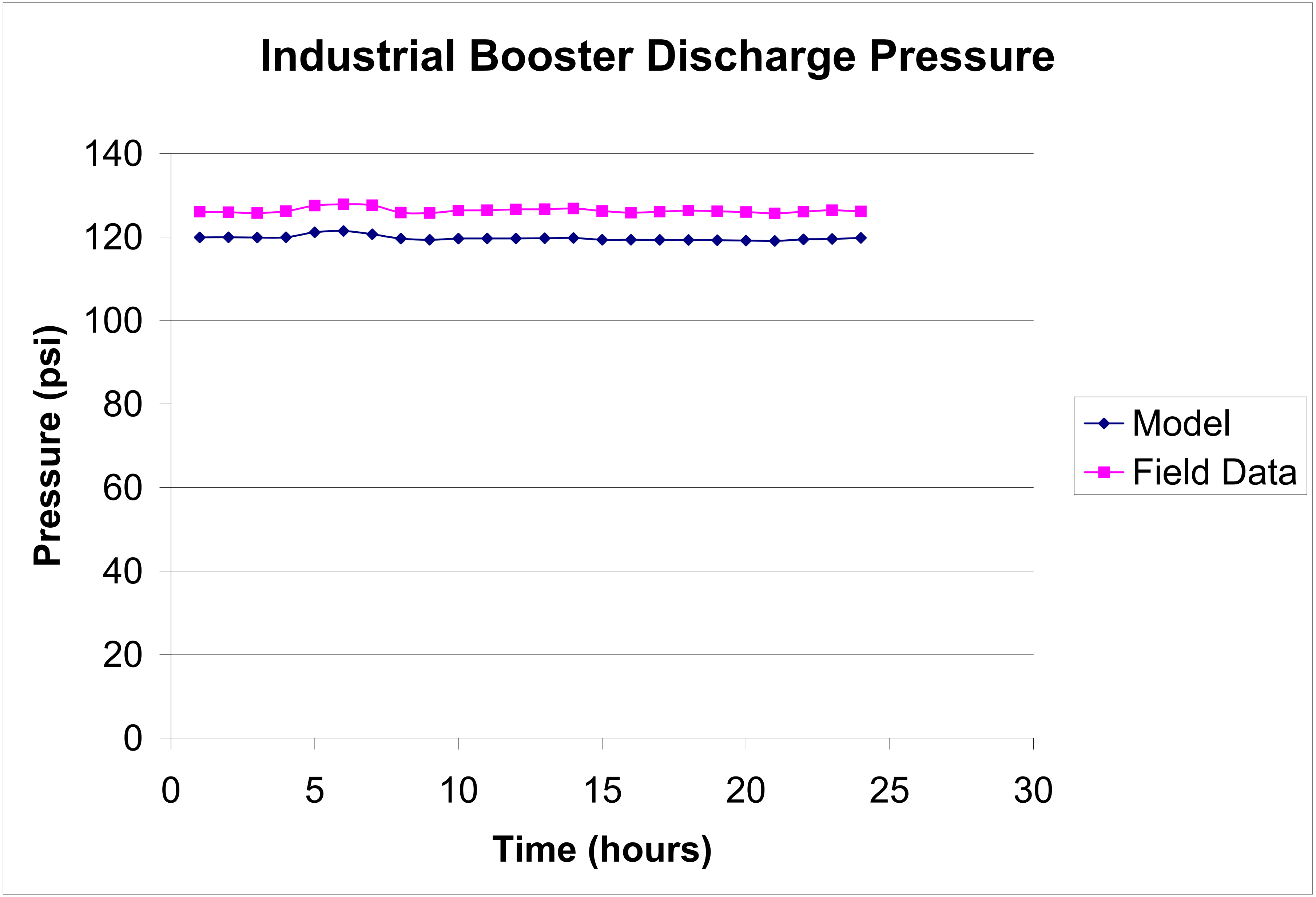

Field Booster Suction Pressure
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

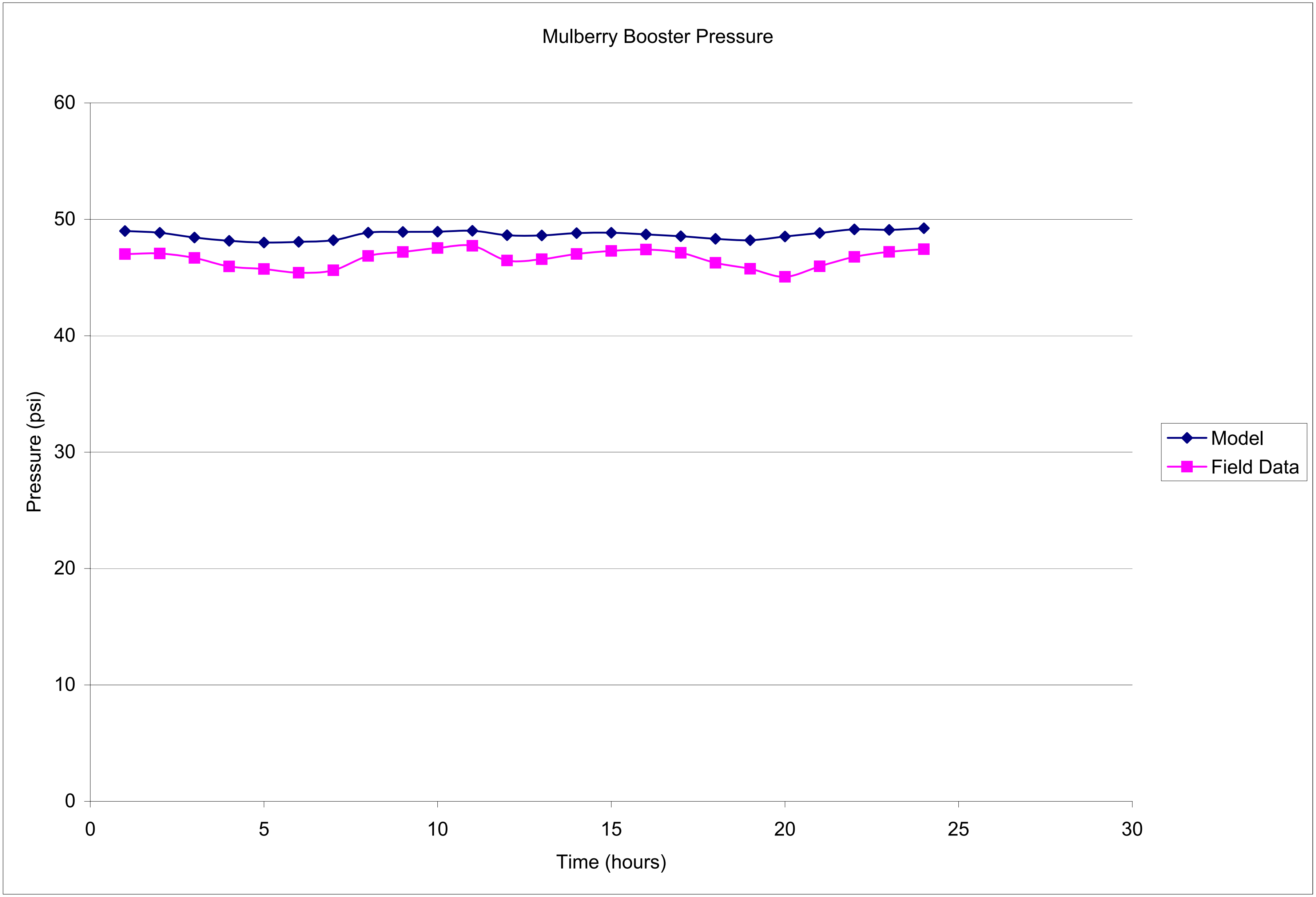


Emtman Low Booster Discharge Pressure
Pressure (psi)
9
8
7
6
5
4
3
2
1
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

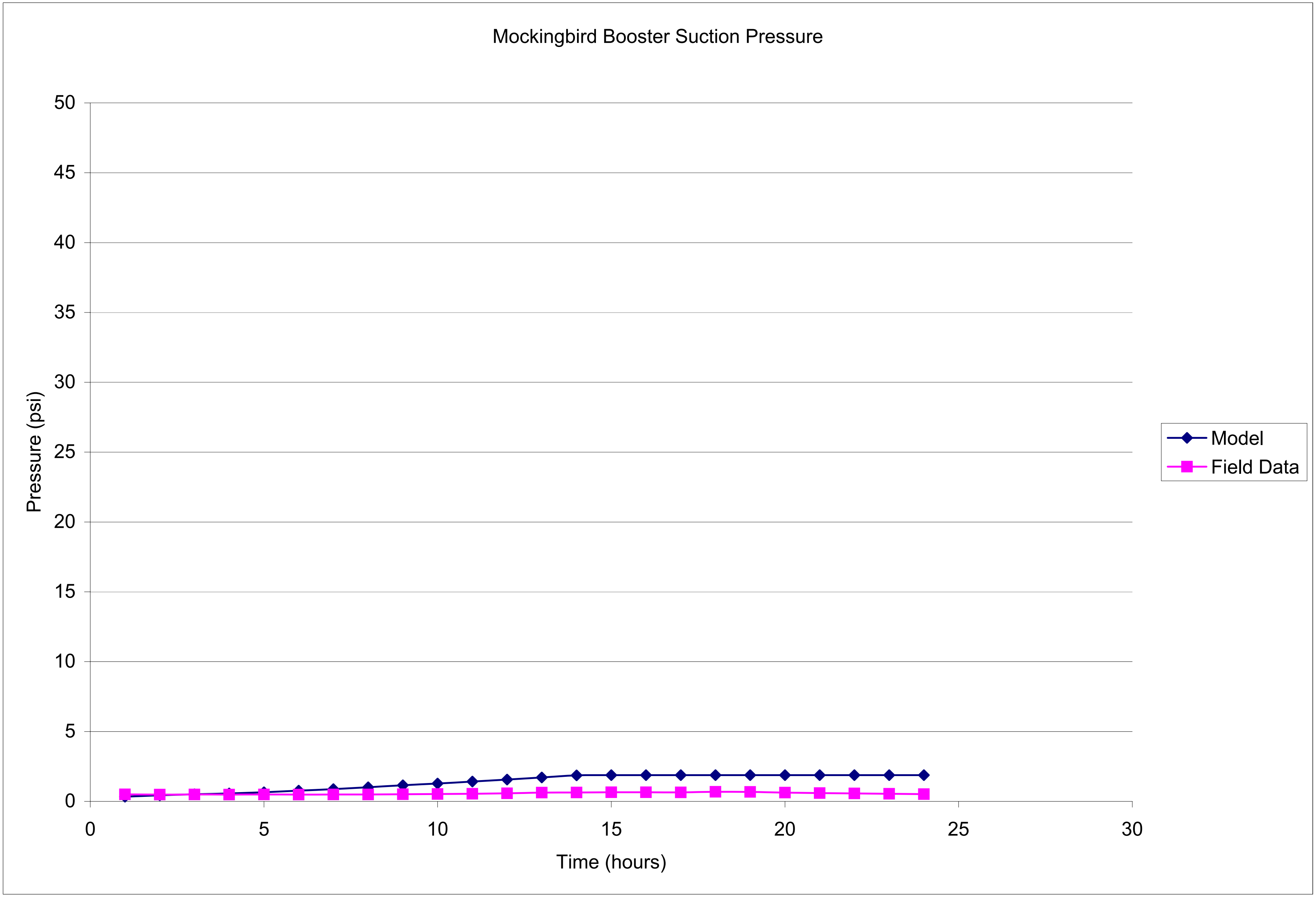

Field Booster Discharge Pressure
Pressure (psi)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Industrial Booster Suction Pressure
Pressure (psi)
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

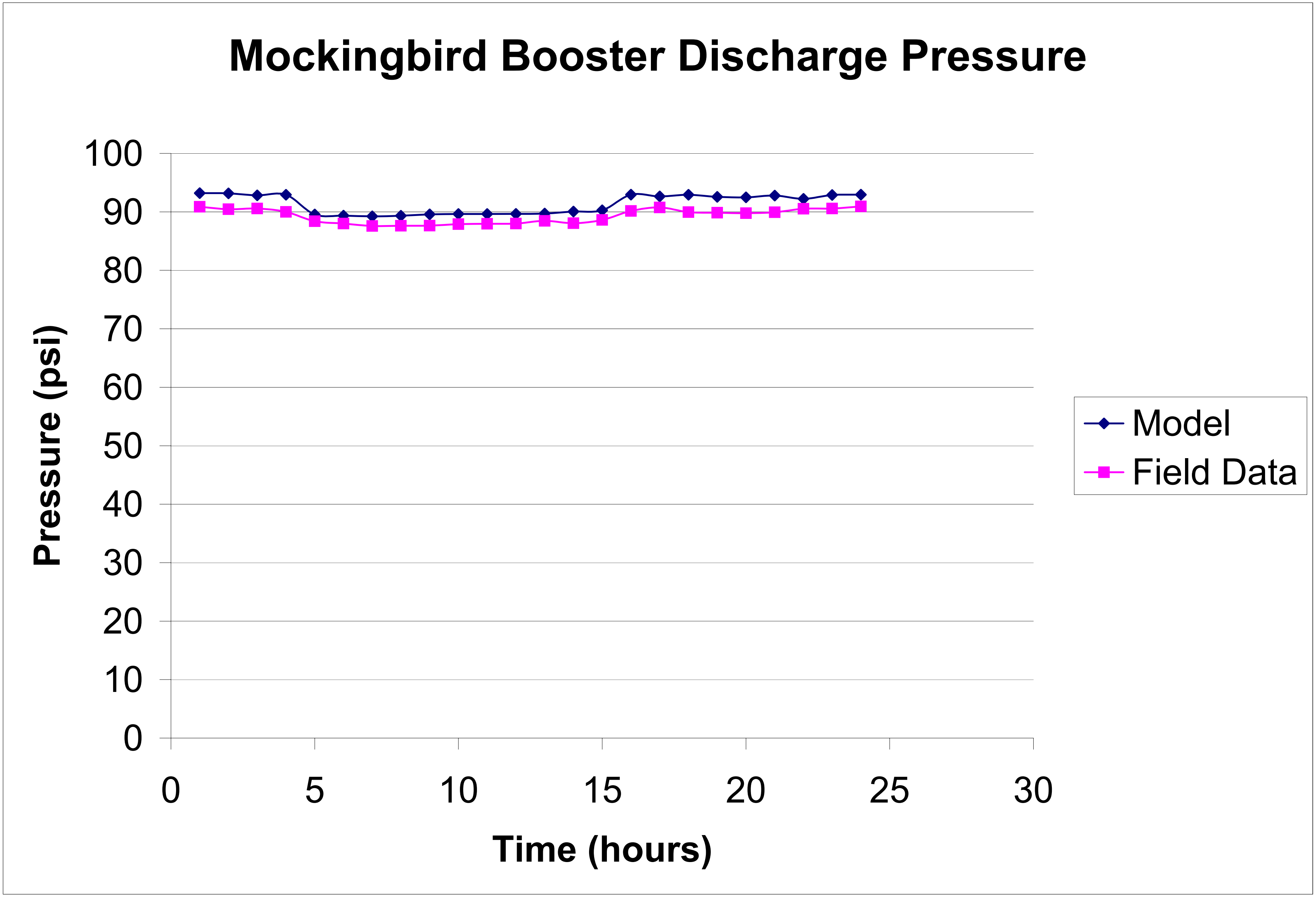

Industrial Booster Discharge Pressure
Pressure (psi)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

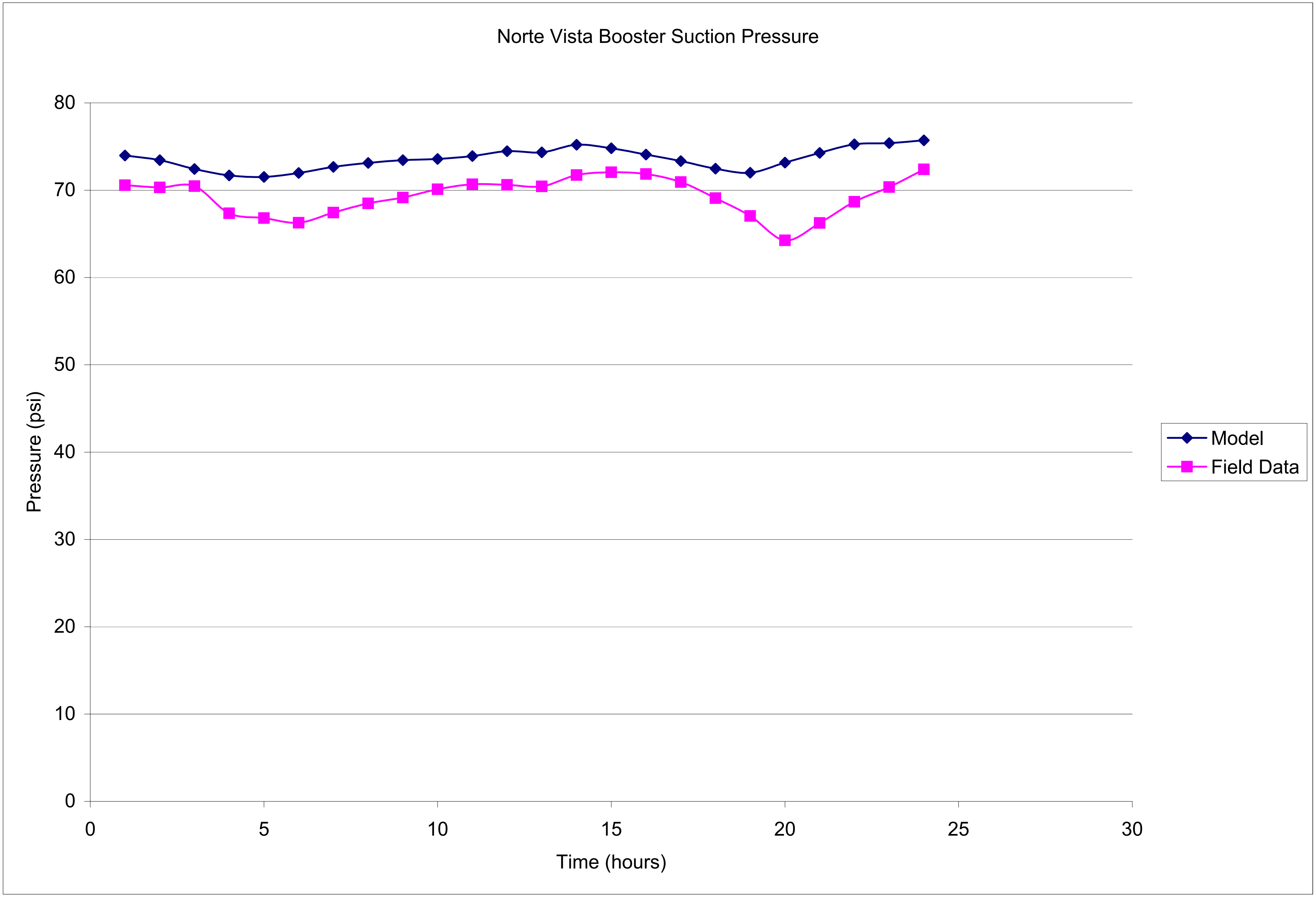


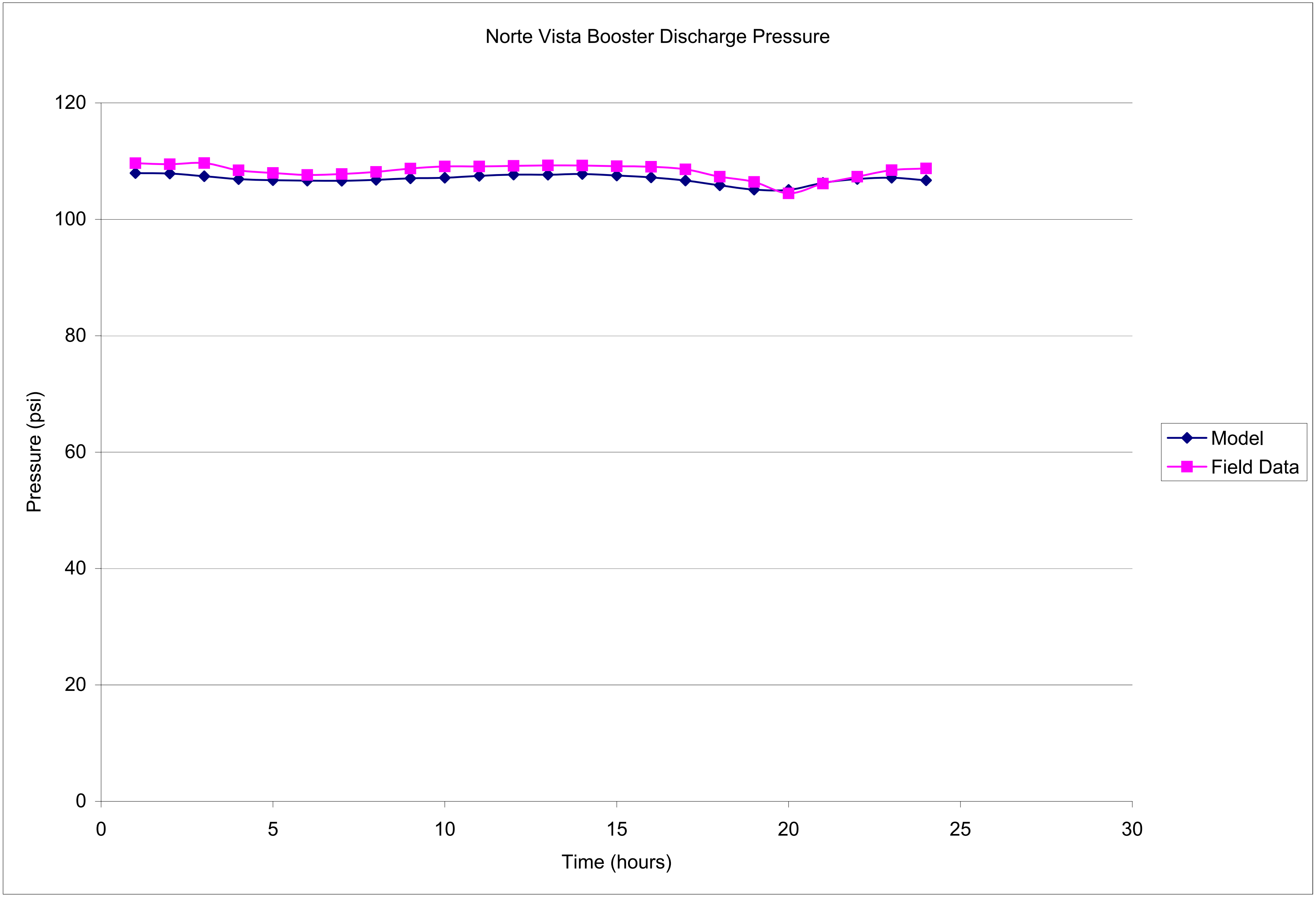
Mulberry Booster Pressure
60
50
40
30
20
10
0
Pressure (psi)
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



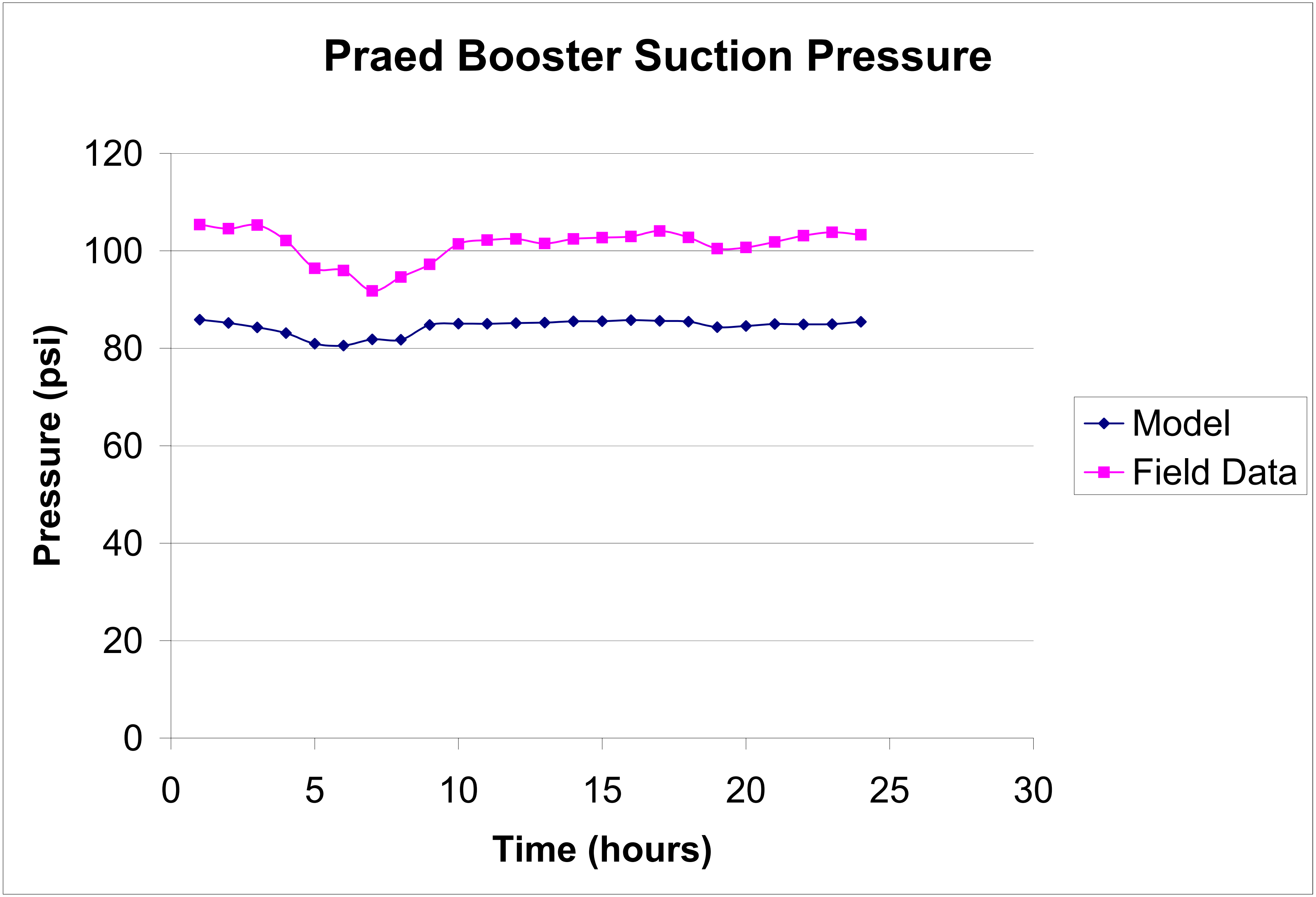
Mockingbird Booster Suction Pressure
Pressure (psi)
0
5
10
15
20
25
30
35
40
45
50
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

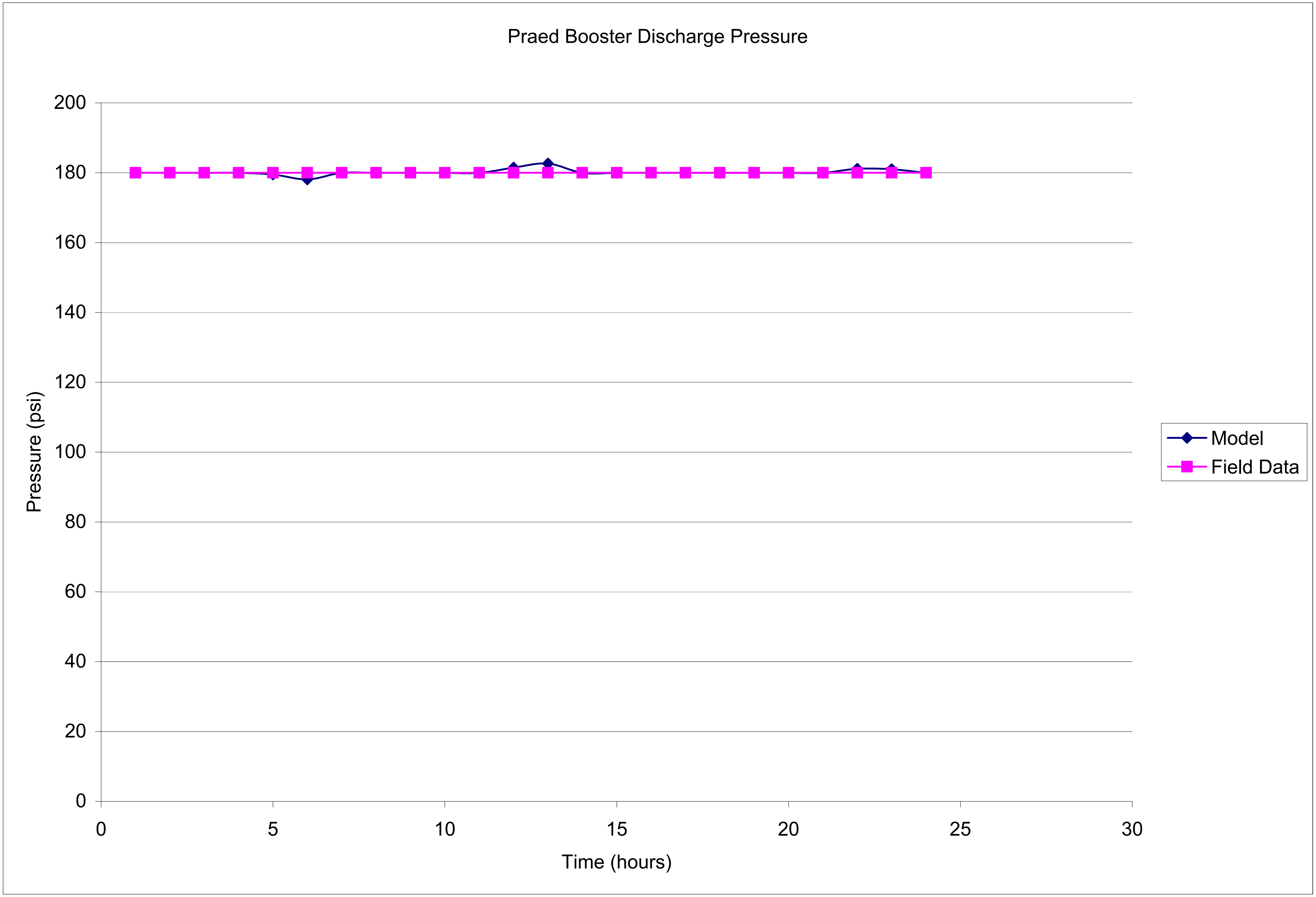

Mockingbird Booster Discharge Pressure
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

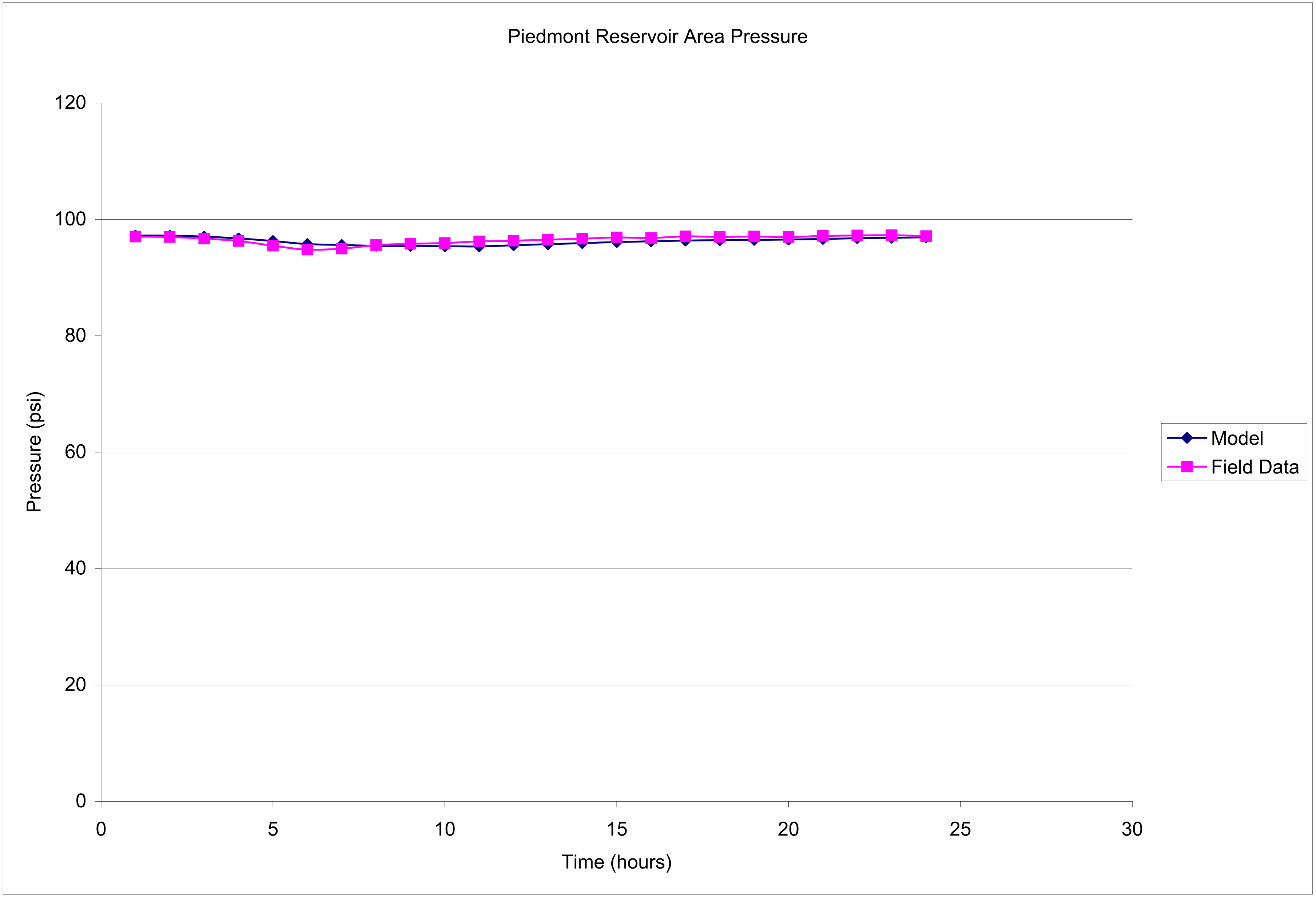

Norte Vista Booster Suction Pressure
Pressure (psi)
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

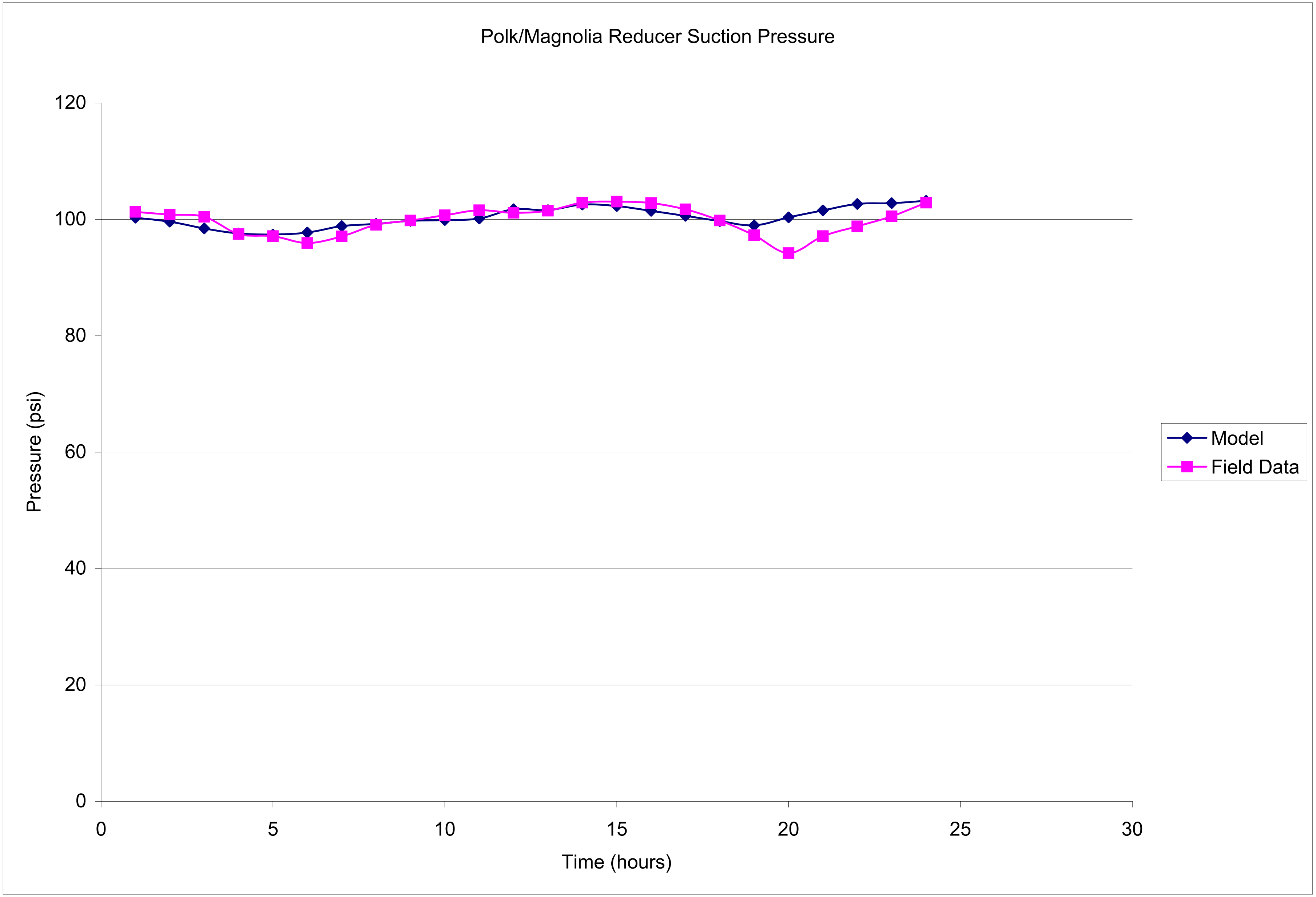


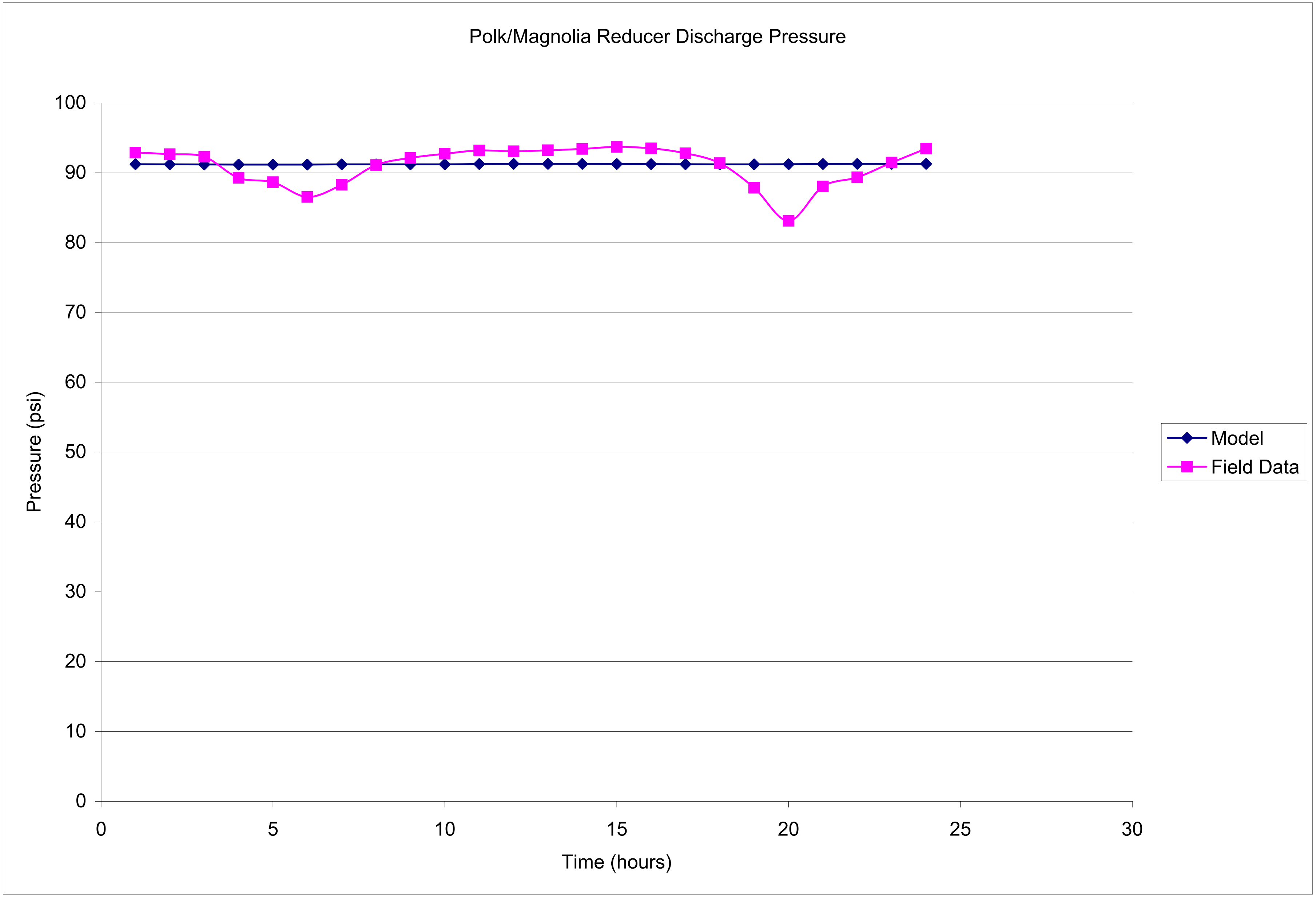
Norte Vista Booster Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Praed Booster Suction Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

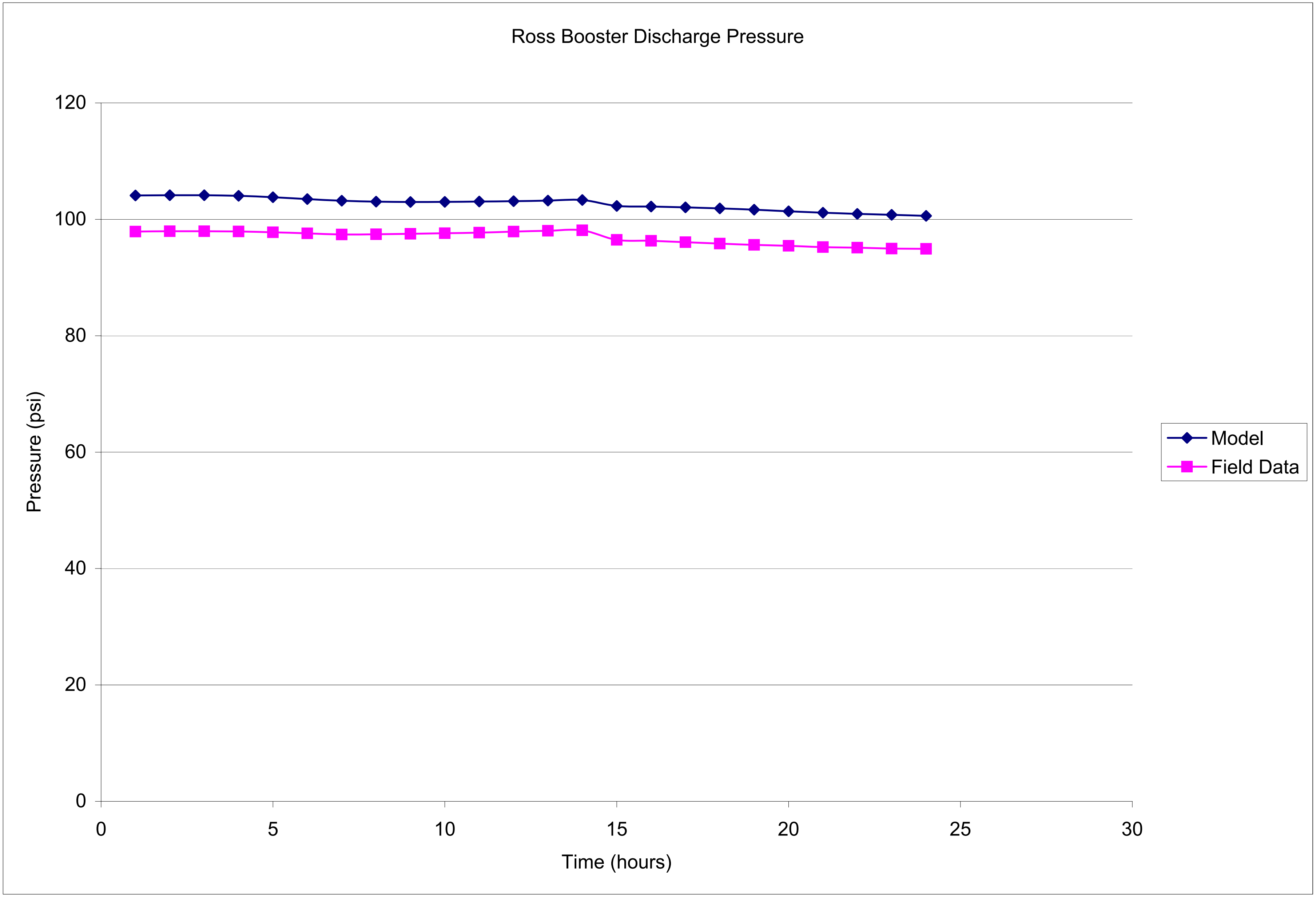

Praed Booster Discharge Pressure
Pressure (psi)
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Piedmont Reservoir Area Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

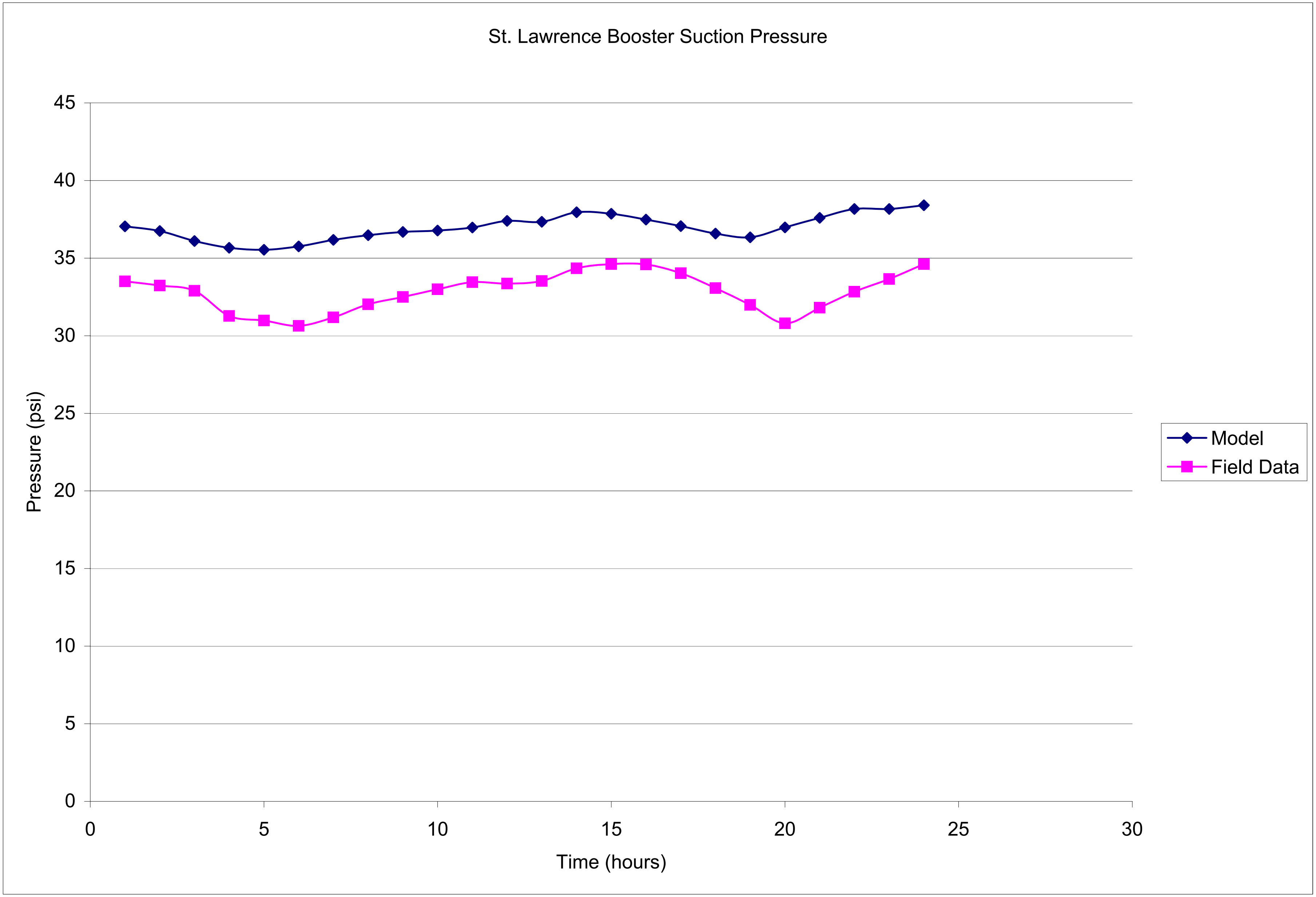

Polk/Magnolia Reducer Suction Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



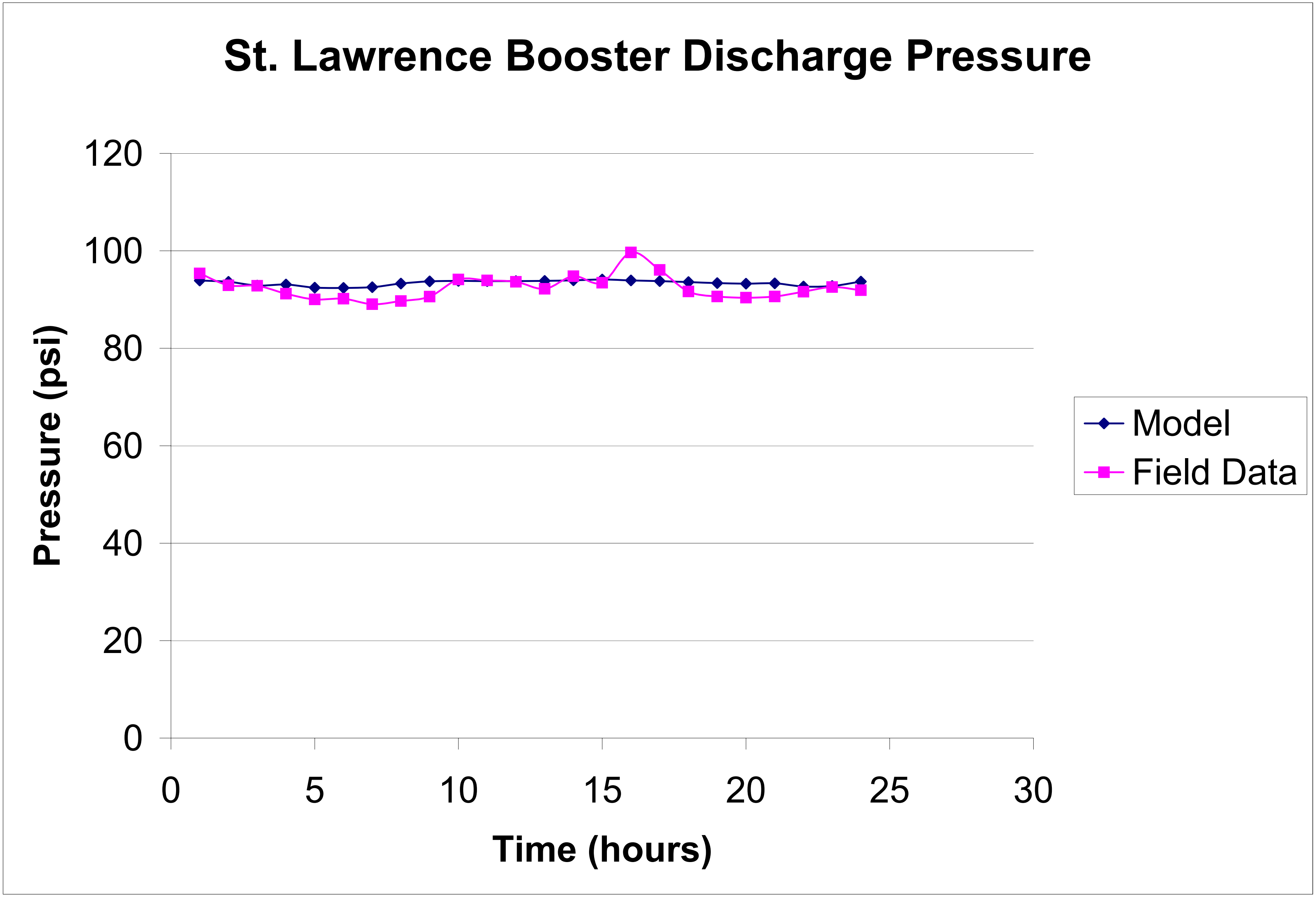
Polk/Magnolia Reducer Discharge Pressure
Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

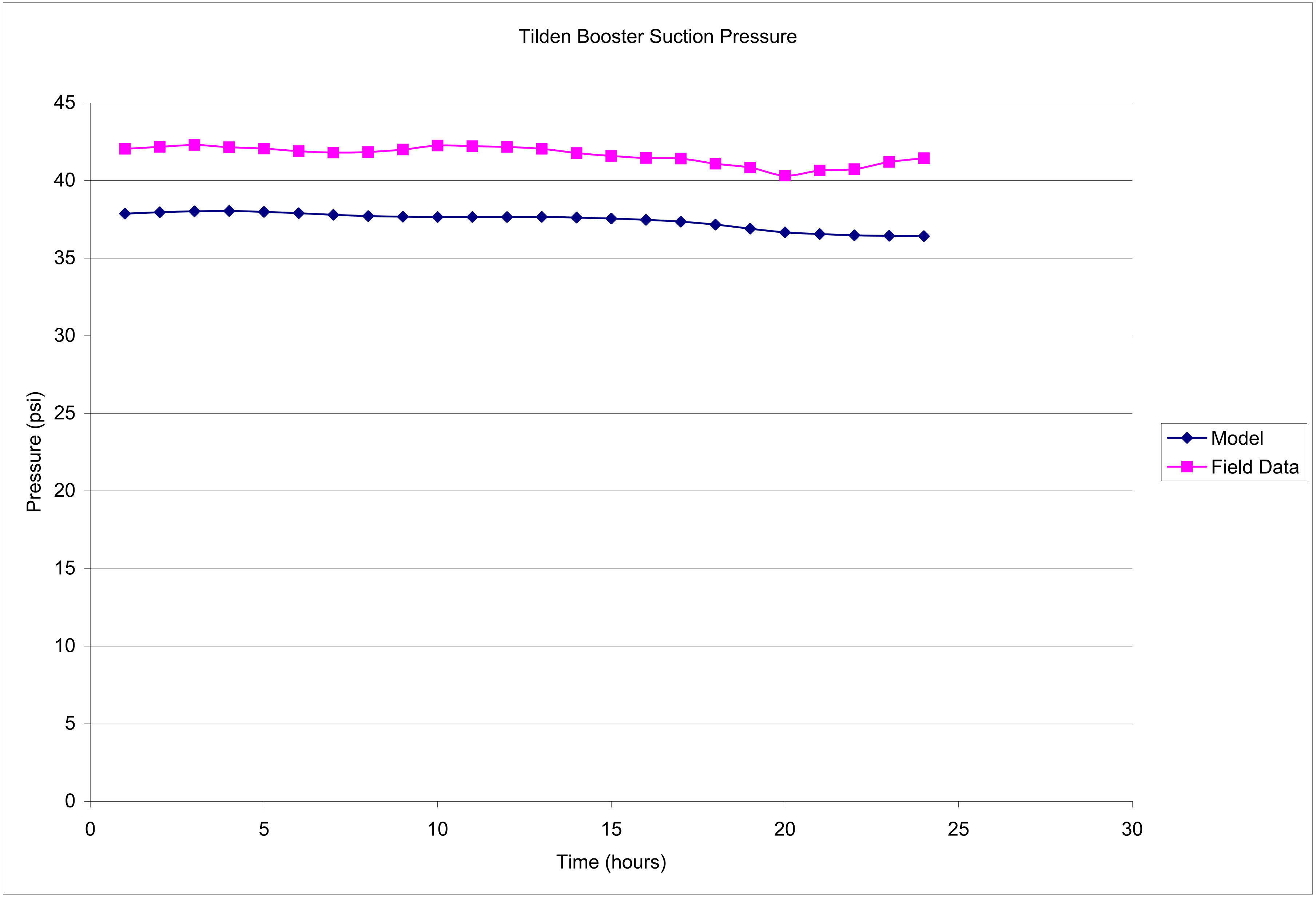


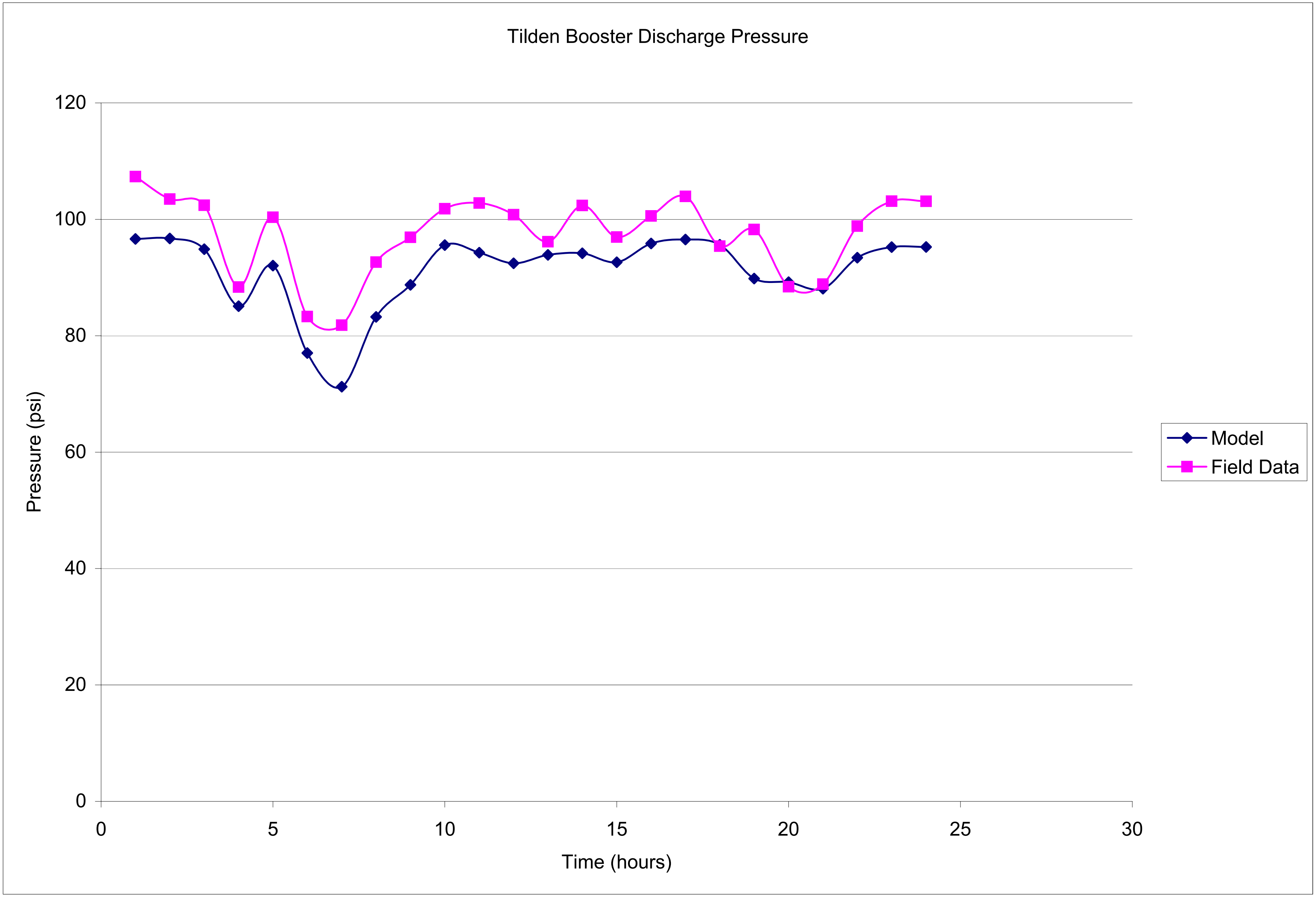
Ross Booster Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

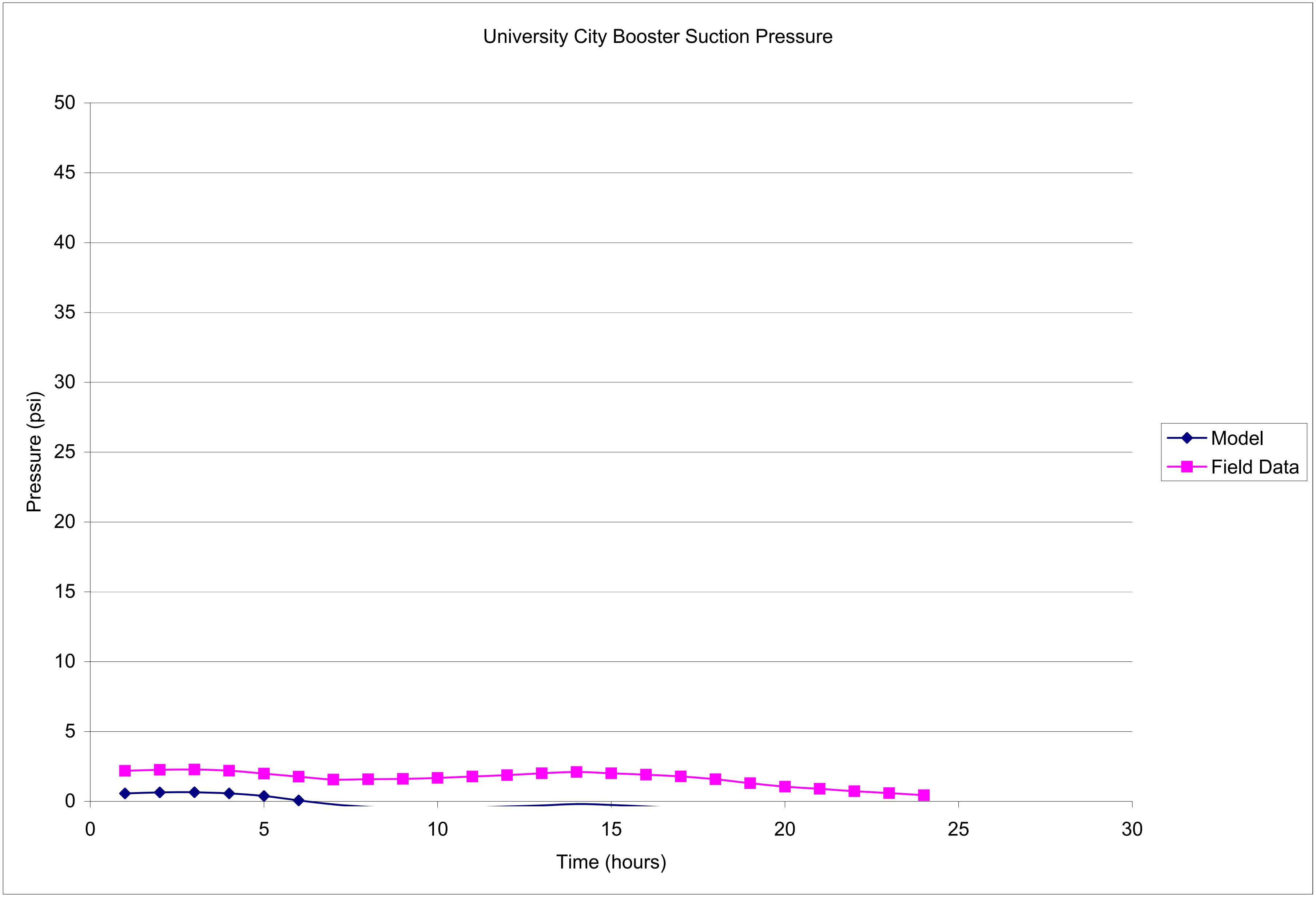


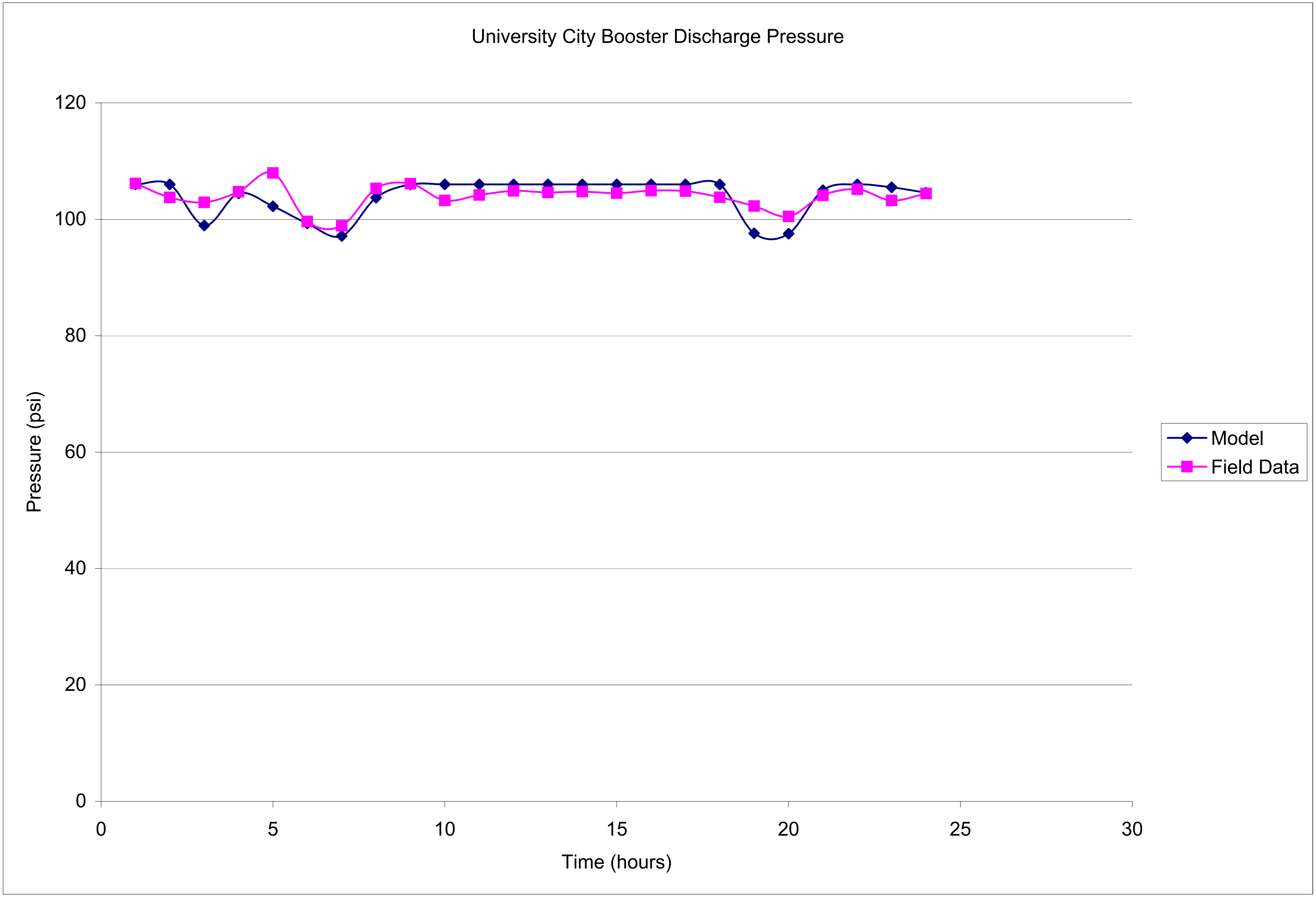
St. Lawrence Booster Suction Pressure
Pressure (psi)
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

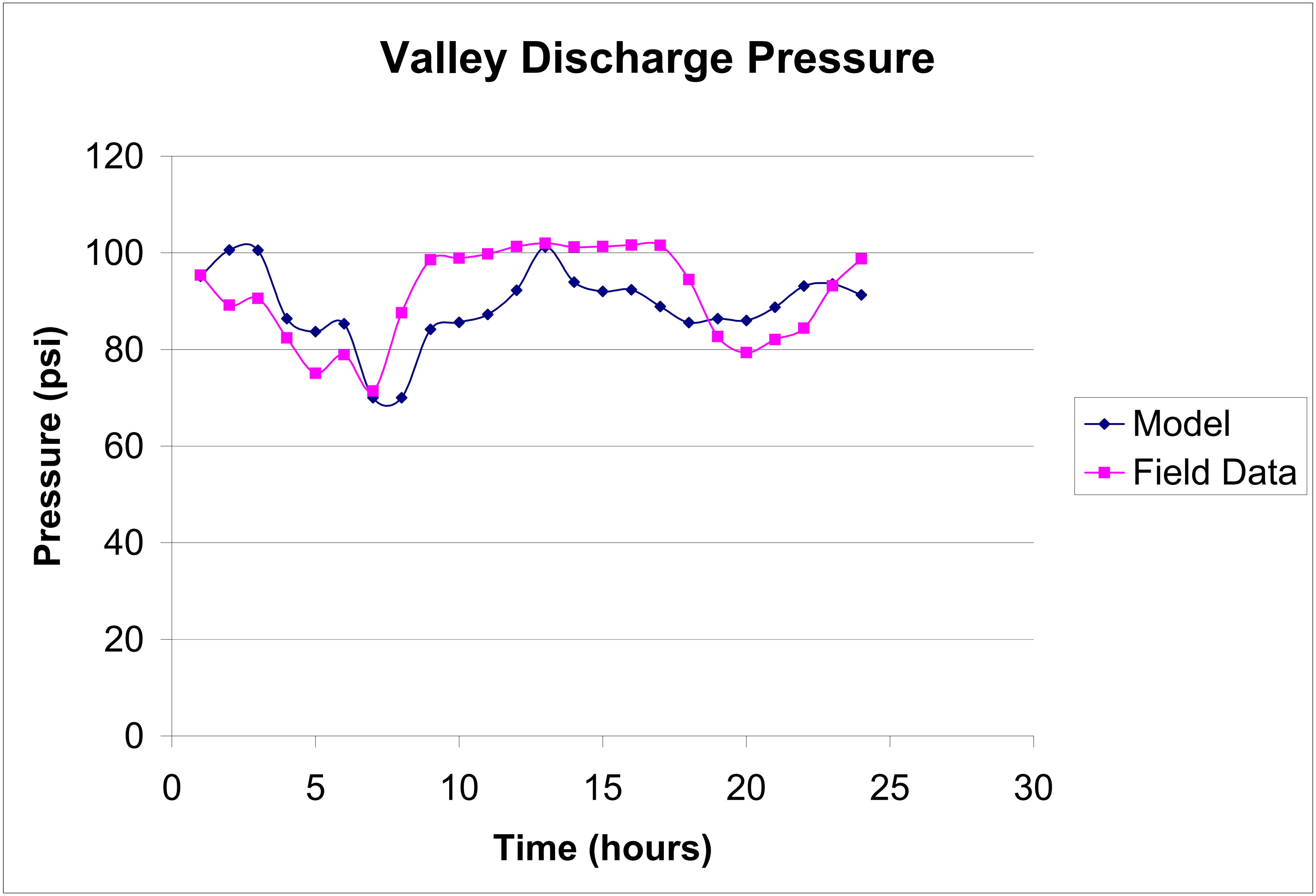

St. Lawrence Booster Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Tilden Booster Suction Pressure
Pressure (psi)
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


Tilden Booster Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


University City Booster Suction Pressure
Pressure (psi)
50
45
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data


University City Booster Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data



Valley Discharge Pressure
Pressure (psi)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hours)
Model
Field Data

Appendix D
Cost Tables

The following is the construction cost basis used for the City of Riverside distribution system master plan, not including land acquisition. **Tables D-1 through D-7** are based on actual costs from recent City projects and other MWH projects.

Table D- 1
Pipeline Cost Basis

Diameter (in)	Construction Cost ($/diam-in/ft)	Construction Cost ($/linear-ft)	20% Engineering, Legal & Admin ($/linear-ft)	20% Contingency ($/linear-ft))	Total Cost ($/linear-ft)
4	$ 16.00	$ 64.00	$ 13.00	$ 13.00	$ 90.00
6	$ 14.00	$ 84.00	$ 17.00	$ 17.00	$ 120.00
8	$ 12.50	$ 100.00	$ 20.00	$ 20.00	$ 140.00
10	$ 11.00	$ 110.00	$ 22.00	$ 22.00	$ 150.00
12	$ 10.00	$ 120.00	$ 24.00	$ 24.00	$ 170.00
16	$ 9.00	$ 144.00	$ 29.00	$ 29.00	$ 200.00
18	$ 9.00	$ 162.00	$ 32.00	$ 32.00	$ 230.00
20	$ 9.00	$ 180.00	$ 36.00	$ 36.00	$ 250.00
24	$ 8.50	$ 204.00	$ 41.00	$ 41.00	$ 290.00
30	$ 8.50	$ 255.00	$ 51.00	$ 51.00	$ 360.00
36	$ 9.00	$ 324.00	$ 65.00	$ 65.00	$ 450.00
42	$ 9.50	$ 399.00	$ 80.00	$ 80.00	$ 560.00
48	$ 10.00	$ 480.00	$ 96.00	$ 96.00	$ 670.00
54	$ 10.50	$ 567.00	$ 113.00	$ 113.00	$ 790.00
60	$ 11.00	$ 660.00	$ 132.00	$ 132.00	$ 920.00
66	$ 11.50	$ 759.00	$ 152.00	$ 152.00	$ 1,060.00
72	$ 12.00	$ 864.00	$ 173.00	$ 173.00	$ 1,210.00

Table D- 2
Pipeline Rehabilitation Cost Basis

Diameter (in)	Construction Cost ($/diam-in/ft)	Construction Cost ($/linear-ft)	20% Engineering, Legal & Admin ($/linear-ft)	20% Contingency ($/linear-ft))	Total Cost ($/linear-ft)
24	$ 6.40	$ 153.60	$ 31.00	$ 31.00	$ 220.00
30	$ 6.40	$ 192.00	$ 38.00	$ 38.00	$ 270.00
36	$ 6.75	$ 243.00	$ 49.00	$ 49.00	$ 340.00
42	$ 7.15	$ 300.30	$ 60.00	$ 60.00	$ 420.00
48	$ 7.50	$ 360.00	$ 72.00	$ 72.00	$ 500.00
54	$ 8.00	$ 432.00	$ 86.00	$ 86.00	$ 600.00
60	$ 8.25	$ 495.00	$ 99.00	$ 99.00	$ 690.00
66	$ 8.50	$ 561.00	$ 112.00	$ 112.00	$ 790.00
72	$ 9.00	$ 648.00	$ 130.00	$ 130.00	$ 910.00

Note: Pipeline Rehabilitation assumption based on recent values.

Table D- 3
Storage Reservoir Cost Basis

Size (MG)	Construction Cost ($/gal)	20% Engineering, Legal & Admin ($/gal)	20% Contingency ($/gal)	Total Cost ($/gal)
1.0	$ 1.20	$ 0.24	$ 0.24	$ 1.68
2.0	$ 0.94	$ 0.19	$ 0.19	$ 1.32
3.0	$ 0.79	$ 0.16	$ 0.16	$ 1.11
4.0	$ 0.73	$ 0.15	$ 0.15	$ 1.02
5.0	$ 0.65	$ 0.13	$ 0.13	$ 0.91
6.0	$ 0.61	$ 0.12	$ 0.12	$ 0.85
7.0	$ 0.59	$ 0.12	$ 0.12	$ 0.83
8.0	$ 0.56	$ 0.11	$ 0.11	$ 0.78
9.0	$ 0.53	$ 0.11	$ 0.11	$ 0.74
10 and Greater	$ 0.50	$ 0.10	$ 0.10	$ 0.70

Note: Cost Assumes Partially Buried Concrete Reservoirs

Table D- 4
New PRV Station Cost Basis

Construction Cost ($/station)	20% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
$ 50,000.00	$ 10,000.00	$ 10,000.00	$ 70,000.00

Table D- 5
New Booster Station Cost Basis

Size (hp)	Construction Cost ($/hp)	20% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
200	$ 3,000	$ 600.00	$ 600.00	$ 4,200.00
250	$ 2,700	$ 540.00	$ 540.00	$ 3,780.00
300	$ 2,550	$ 510.00	$ 510.00	$ 3,570.00
350	$ 2,300	$ 460.00	$ 460.00	$ 3,220.00
400	$ 2,100	$ 420.00	$ 420.00	$ 2,940.00
450	$ 1,900	$ 380.00	$ 380.00	$ 2,660.00
500	$ 1,800	$ 360.00	$ 360.00	$ 2,520.00
550	$ 1,700	$ 340.00	$ 340.00	$ 2,380.00
600	$ 1,650	$ 330.00	$ 330.00	$ 2,310.00
650	$ 1,600	$ 320.00	$ 320.00	$ 2,240.00
700	$ 1,550	$ 310.00	$ 310.00	$ 2,170.00
750 and larger	$ 1,500	$ 300.00	$ 300.00	$ 2,100.00

Table D- 6
Cost Basis to Replace Pump and Motor Only

Size (hp)	Construction Cost ($/hp)	20% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
50 and smaller	$ 1,000.00	$ 200.00	$ 200.00	$ 1,400.00
100	$ 750.00	$ 150.00	$ 150.00	$ 1,050.00
150	$ 600.00	$ 120.00	$ 120.00	$ 840.00
200	$ 500.00	$ 100.00	$ 100.00	$ 700.00
250	$ 450.00	$ 90.00	$ 90.00	$ 630.00
300	$ 430.00	$ 86.00	$ 86.00	$ 600.00
350	$ 380.00	$ 76.00	$ 76.00	$ 530.00
400	$ 350.00	$ 70.00	$ 70.00	$ 490.00
450	$ 320.00	$ 64.00	$ 64.00	$ 450.00
500	$ 300.00	$ 60.00	$ 60.00	$ 420.00
550	$ 280.00	$ 56.00	$ 56.00	$ 390.00
600	$ 280.00	$ 56.00	$ 56.00	$ 390.00
650	$ 270.00	$ 54.00	$ 54.00	$ 380.00
700	$ 260.00	$ 52.00	$ 52.00	$ 360.00
750 and larger	$ 250.00	$ 50.00	$ 50.00	$ 350.00

Table D- 7
Cost Basis to Upsize Existing Pump

Size (hp)	Construction Cost ($/hp)	20% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
50 and smaller	$ 3,000.00	$ 600.00	$ 600.00	$ 4,200.00
100	$ 2,250.00	$ 450.00	$ 450.00	$ 3,150.00
150	$ 1,800.00	$ 360.00	$ 360.00	$ 2,520.00
200	$ 1,500.00	$ 300.00	$ 300.00	$ 2,100.00
250	$ 1,350.00	$ 270.00	$ 270.00	$ 1,890.00
300	$ 1,290.00	$ 258.00	$ 258.00	$ 1,810.00
350	$ 1,140.00	$ 228.00	$ 228.00	$ 1,600.00
400	$ 1,050.00	$ 210.00	$ 210.00	$ 1,470.00
450	$ 960.00	$ 192.00	$ 192.00	$ 1,340.00
500	$ 900.00	$ 180.00	$ 180.00	$ 1,260.00
550	$ 840.00	$ 168.00	$ 168.00	$ 1,180.00
600	$ 840.00	$ 168.00	$ 168.00	$ 1,180.00
650	$ 810.00	$ 162.00	$ 162.00	$ 1,130.00
700	$ 780.00	$ 156.00	$ 156.00	$ 1,090.00
750 and larger	$ 750.00	$ 150.00	$ 150.00	$ 1,050.00

Note: Requires larger electrical, possibly new piping, valving, pump can. Cost includes these items

Appendix E
Pump Replacement Program

PUMP REPLACEMENT PROGRAM

The City has 108 booster pumps. Based on an expected pump life of 15 years, the City should replace 7 booster pumps each year. Estimated cost for pump replacement is an average of $55,000 per pump, including engineering and contingency.

MWH has developed a ranking system to determine which booster pumps should be replaced first. The points associated with each criteria are summed in total; pumps with the highest number are recommended to be replaced first. The following ranking criteria are used:

Obsolete Manufacturer:
Yes (5), No (0)

Gross Age:
Gross age is calculated as follows:
If no major retrofit, pump age = years since installation
If major retrofit, pump age = 0.5*years since installation + 0.5*years since retrofit

Less than 15 years (0), 15-20 years (2), 20-25 years (3), 25-30 years (4), Greater than 30 years (5)

Efficiency:
No data (0), Greater than 70% (0), 65-70% (1), 60-65% (2), Less than 60% (3)

Operational Deficiencies (cavitation, cannot deliver flow, etc…):
Yes (5), No (0)

Critical Facility:
Continuous/Regular Operation (4), Seasonal/Intermittent Use (2), Emergency (0)

Appendix F
Model Use Memorandum

To:	City of Riverside Water Engineering Planning Staff	**Date:**	January 10, 2005
From:	Sarah Munger & Matthew Huang	**Reference:**	1341878/6.2
Subject:	*H_2OMAP* User Guide to City of Riverside Water System Model		

This memorandum is intended to act as a quick reference user guide to the City of Riverside water system *H_2OMAP Water* model. This memorandum will cover the scenarios, data sets, and databases that are existing in the model. A model key is provided at the end of this document to help in the identification of the facilities within the model.

DATABASE TABLES

Several customized columns are added to the model database tables to assist with model operation. These columns and their intended purpose are covered below.

Fire flow – This column is added only in the Junction database table. The column has the expected fire flow for a demand node, representative of the fire flow in the surrounding region. The fire flow that is input in this column is based on the surrounding land use and the planning criteria.

Existing – The Existing column appears in all model element types – junctions, tanks, pipes, pumps, and valves. The intended purpose is to identify which facilities, pipes, nodes or valves are currently existing and operational. Facilities that are currently under construction are also included as existing. The column contains a simple YES or NO.

Calibration – The Calibration column appears in all model element types – junctions, tanks, pipes, pumps, and valves. The intended purpose is to identify which facilities, pipes, nodes or valves were operational on the date of model calibration data collection, July 8, 2004. The column contains a simple YES or NO.

Future – The Future column appears in all model element types – junctions, tanks, pipes, pumps, and valves. The intended purpose is to identify which facilities, pipes, nodes or valves will exist in the future build-out condition. All existing and planned facilities, except for those that are planned to be abandoned are included. The column contains a simple YES or NO.

Demand – This column is used to apply existing and future demands to the model. Demand in this database is average day demands in gpm. DEMAND1 is used for existing demands and DEMAND2 is used for future demands. Each demand is assigned a diurnal pattern based on the calibration data for that zone or other similar zones.

Patterns – Patterns represent variations in model inputs over time. Patterns that are used for demand nodes represent a multiplier against which baseline demands are applied. The patterns that are currently in the model represent diurnal curves.

Roughness – This column is only used for pipes and is used to identify a roughness coefficient for a pipe. The roughness coefficients were based on pipe age and diameter. The roughness coefficients that were used in the model can be found in the table below.

C-Factors Used in Model

Pipe Diameter (inches)	Year 1973-Present	Year 1963-72	Year 1953-62	Year 1943-52	Year 1933-42	Year 1923-32	Year 1922 and earlier
4	110	110/100	100/90	100/80	95/75	90/70	90/65
6 to 10	120	120/110	110/100	110/90	105/85	100/75	100/70
12 to 20	130	130/100	120/110	120/100	115/90	110/80	110/75
24 to 30	135	135/125	125/115	125/105	120/95	115/85	115/80
36 to 48	140	140/130	130/120	130/110	125/100	120/90	120/85
54	145	---	---	---	---	---	---
60-72	150	---	---	---	---	---	---

Curves – This column can be found in both the pump and reservoir databases. Pump curves are input into the model to allow the model to simulate the actual operation of the pump in terms of the relationship between head and flow. For variable area tanks, a curve must be used to establish a relationship between the water depth and the volume in the reservoir. In both cases curve information was provided by the City of Riverside. For throttle control valves, curves are used to establish a relationship between the percent open or closed and the amount of flow that passes through the valve. These curves were estimated using industry standards.

QUERY SETS

Query sets are used to group information in the model together. These are used in the model for several reasons: 1) to identify which facilities are included in each scenario and 2) to identify features in the model by color. In scenarios, query sets (used as facility sets) are used to identify what junctions, tanks, pipes, pumps and valves are included in the scenario.

Calibration set – This query set identifies all of the system elements that was existing and operational on the day of the calibration. It is used to select the proper facilities for the calibration model scenarios.

Existing set - This query set identifies all of the existing facilities, pipes, nodes or valves, or those facilities that are under construction. It is used to select the proper facilities for the existing model scenarios.

Future set – This query set refers to all system elements including both existing and proposed facilities. It represents the future water system. It is used to select the proper facilities for the future model scenarios.

Pressure Zones – This query set groups pipelines by pressure zone.

Pipe Material – This query set groups pipelines by material groupings.

Pipe Diameter – This query set groups pipelines by diameter.

Nodes by Pressure Zone – This query set groups together the junctions by pressure zone. It refers to all facility, transmission and demand nodes.

DATA SETS

Data sets store attribute data for various system elements. Data sets are used because an individual system element could have different attribute data in different scenarios, for example, a junction could have different demands in different scenarios.

Demand Sets

Demand Sets store information regarding demands and demand patterns within the model. There are three demand sets that will be used to analyze the water system under different scenarios.

Calibration Demand Set – The calibration demand set is based on the 2003 billing data, but the demands have been multiplied by zone such that the total demand is equal to the demand on calibration day, July 8, 2004. The demand is in gpm. Additional information on the development of the calibration demand set is included at the end of this memorandum.

Existing Demand set - The existing demand set is the existing (2003) average day demand (ADD) of the system based on billing records in gpm. This demand set is adjusted in different scenarios by using a global peaking factor as part of the simulation options.

Future Demand set - The future demand set is the projected future build-out average day demand (ADD) of the system in gpm. This demand set is adjusted in different scenarios by using a global peaking factor as part of the simulation options.

Tank Sets

Tank sets are used to store information regarding reservoirs or storage tanks, such as different depth-volume curves or initial status. There are two tank sets that will be used in the scenarios.

Calibration set - The calibration tank set uses an initial water level as read on the start of the calibration day. This is done to simulate the initial status of the water system on the day the field data was collected.

Analysis set – The analysis tank set uses an initial water level of 75 percent of the maximum water level for each of the reservoirs

Control Sets

Control sets are used when it is necessary to give a facility different controls or initial status depending on the scenario. This model will use four different control sets.

Calibration Control set - The calibration control set uses the initial status of the facilities as they were at the start of the calibration day. The controls at the facilities are set such that the data that the model produces resembles the field data that was collected. These controls consist of reservoir level control, pressure control, flow control and time control.

Existing Control set - The Existing Control set does not use time controls, and assumes pump start/stop status based on reservoir levels, high/low pressure and high/low flows. The initial status of the facilities in this control set is adjusted to ensure the proper operation of the facilities.

Future Control set - The Future Control set is also similar to the existing control set, but it includes both existing and proposed facilities. This control set assumes that all water is provided at the Linden and Evans Reservoirs.

Future Control Set with Mills - The Future Control set with Mills uses the same facilities as the Future control set, but it assumes that all pressure zones above the 1200 Zone is served with water from the Mills connection.

Simulation Options

Simulation Options are used to determine the peaking factor used in the model. For example the demand set previously mentioned might be multiplied by a global peaking factor to account for the higher demands that occur during maximum day consumption. Four simulation options will be used in the different scenarios.

Calibration – The calibration simulation option will use a global peaking factor of one. This is because a separate demand set is included in the model for calibration.

Minimum Day Demand – The simulation option will adjust the average day demands, by using a global peaking factor of 0.60. This adjustment will be used to represent days where demand is lowest, such as cool winter days.

Average Day Demand – This simulation option will use a global peaking factor of one, because the demands in the model are the average day demands.

Maximum Day Demand – This simulation option will use a global peaking factor of 1.7 to adjust the average day demand to represent days where maximum water consumption occurs.

MODEL SCENARIOS

As mentioned previously the scenarios are used to analyze how different combinations of demands or controls will work with the model. A total of eight different scenarios are set up in the model, they are described below.

Calibration Scenario

This scenario is the information that is used to calibrate the model to the field data that was collected during the 24-hour test period. This scenario is set up differently than others included in the model and is only provided to the City for reference. The following data sets are used for this scenario:

Facility Set – Calibration Query Set
Demand Set – Calibration Demand Set
Tank Set – Calibration Tank Set
Control Set – Base
Simulation Options – Calibration Day

Existing Maximum Day Demand

This scenario contains the existing water system under MDD conditions. The following data sets are used for this scenario:

Facility Set – Existing Facilities Query Set
Demand Set – Existing Demand Set
Tank Set – Analysis Tank Set
Control Set – Existing Control Set
Simulation Options – Maximum Day Demand

Existing Average Day Demand

This scenario contains the existing water system under ADD conditions. The following data sets are used for this scenario:

Facility Set – Existing Facilities Query Set
Demand Set – Existing Demand Set
Tank Set – Analysis Tank Set
Control Set – Existing Control Set
Simulation Options – Average Day Demand

Existing Minimum Day Demands

This scenario contains the existing water system under Minimum Day Demand conditions. The following data sets are used for this scenario:

Facility Set – Existing Facilities Query Set
Demand Set – Existing Demand Set
Tank Set – Analysis Tank Set
Control Set – Existing Control Set
Simulation Options – Minimum Day Demand

Future Maximum Day Demand

This scenario contains the future water system under MDD conditions. This scenario assumes all flow is provided through Linden and Evans Reservoirs. The following data sets are used for this scenario:

Facility Set – Future Facilities Query Set
Demand Set – Future Demand Set
Tank Set – Analysis Tank Set
Control Set – Future Control Set
Simulation Options – Maximum Day Demand

Future Average Day Demand

This scenario contains the future water system under ADD conditions. This scenario assumes all flow is provided through Linden and Evans Reservoirs. The following data sets are used for this scenario:

Facility Set – Future Facilities Query Set
Demand Set – Future Demand Set
Tank Set – Analysis Tank Set
Control Set – Future Control Set
Simulation Options – Average Day Demand

Future Minimum Day Demand

This scenario contains the future water system under Minimum Day Demand conditions. This scenario assumes all flow is provided through Linden and Evans Reservoirs. The following data sets are used for this scenario:

Facility Set – Future Facilities Query Set
Demand Set – Future Demand Set
Tank Set – Analysis Tank Set
Control Set – Future Control Set
Simulation Options – Minimum Day Demand

Future Maximum Day Demand from Mills Connection

This scenario contains the future water system under MDD conditions, however, the controls are modified so that zones 1300 and higher are served from the Mills connection. The following data sets are used for this scenario:

Facility Set – Future Facilities Query Set
Demand Set – Future Demand Set
Tank Set – Analysis Tank Set
Control Set – Future Control Set with Mills
Simulation Options – Maximum Day Demand

MODEL KEY

The following is a listing of model IDs included in the model.

This section presents the design criteria and methodologies for analysis used to evaluate both the existing system and the future system facilities. For most of the analyses, the hydraulic model runs (discussed in Section 6) were used for system evaluation.

DESIGN CRITERIA

Design criteria are developed using typical criteria from similar water utilities, local codes, engineering judgement, commonly accepted industry standards and input from City staff. The "industry standards" typically represent typically ranges of values acceptable for the criteria in question and are used as a check to confirm that the values being developed are reasonable. A summary of the developed system evaluation criteria used in this Water Master Plan is shown below in **Table 7-1**.

System Pressures

Minimum system pressures are evaluated under two different scenarios: Peak Hour Demand (PHD) and Maximum Day Demand (MDD) plus fire flow. The minimum pressure criterion under peak hour demand is 40 psi under normal conditions with 35 psi as the absolute minimum service pressure. Under maximum day demand plus fire flow conditions, the minimum pressure is 20 psi.

The model is run for a 24-hour simulation and the minimum pressure evaluated for all demands nodes in the model. Transmission and water facility junctions not directly serving customers are excluded from the low pressure evaluation. All demand nodes with minimum pressure less than 40 psi under peak hour conditions or less than 20 psi for maximum day conditions plus fire flow, are presented as part of the analysis of both existing and future scenarios and are discussed in a later section of this report.

Pipeline Velocities

Pipeline velocities are evaluated using three different maximum velocity criteria for selected flow conditions under both existing and future demand scenarios. For transmission and distribution pipelines, a maximum velocity during peak hour demand of 10 fps was used for existing pipelines and 6 fps as the design criteria for new pipelines. Fire hydrant laterals are excluded from these criteria, as higher velocities are acceptable. Ideally, all transmission and distribution pipelines should have maximum velocities less than 6 fps in order to minimize headloss; however, higher velocities in existing pipelines is not, by itself sufficient justification for pipeline replacement. The third maximum velocity criteria of 4 fps applies to pump station suction pipelines operating at the maximum station capacity; MDD for pressure zones with storage or PHD for zones without storage.

Supply Storage

The total storage required for a water system is evaluated in three components: 1) storage for operational use, 2) storage for fire fighting, and 3) storage for emergencies. These three components are determined for each pressure zone in order to evaluate the ability of the water system to meet the storage criteria on both a zone by zone basis as well as a system wide basis. These three storage requirements are discussed in more detail below.

Operational Storage

Operational storage is defined as the quantity of water that is required to meet daily fluctuations in demand beyond the quantity of water that is produced on a daily basis. It is necessary to coordinate the production rates of water sources and the available storage capacity in a water system to ensure that a continuous treated water supply is provided to the system. Water systems are often designed to produce the average flow on the day of maximum demand. Water storage is then used to supply water for peak flows that may occur throughout the day. This operational storage is replenished during off peak hours when the demand is less.

The majority of pressure zones within the City of Riverside's water system are fed by gravity reservoirs. AWWA recommends an operational supply volume ranging from one-quarter to one-third of the demand experienced during one maximum day. It is recommended that each zone in the City's water system have operational storage of 25 percent of the maximum day demand fed by that reservoir.

Fire Flow Storage and Criteria

The fire flow requirements used for the City of Riverside's water system are based on the Uniform Fire Code (UFC), and conversations with the City of Riverside Fire Department and City staff. The fire flow requirements used are listed in Table 7-1. The duration increases with flow rate based on the UFC requirements. For flows between 0 and 2,500 gpm the duration is 2 hours; for flow between 3,000 and 3,500 gpm the duration is 3 hours; and for flows greater than or equal to 4,000 gpm the duration is 4 hours.

In addition to these general fire flow requirements, the downtown Specific Plan has more specific requirements as outlined in Table 7-1.

Fire flow storage is determined based on the single greatest fire flow requirement (flow and duration) within each zone. For example, if the highest fire flow of a zone is 3,000 gpm for a duration of 3 hours, the required storage for that zone is 0.54 MG. When multiple zones are fed by the same reservoir, these zones are combined and the highest fire flow among them is used to determine the necessary storage requirement. This calculation assumes that there will be only one fire in a zone or group of zones served by a single reservoir at any one time.

Emergency Storage

The volume of water that is needed during an emergency is usually based on past experience and on the estimated time expected to lapse before the emergency is corrected. Possible emergencies include earthquakes, water contamination, several simultaneous fires, unplanned electrical outages, pipeline ruptures, or other unplanned events. The occurrence and magnitude of emergencies is difficult to predict, therefore the emergency storage criteria is based on past experience and engineering judgement.

Typically, emergency storage is set as a percentage of either average day demand or maximum day demand. For the City, a criteria of 150 percent of average day demand is recommended. Given the MDD to ADD peaking factor of 1.70, the emergency storage criteria of 1.50 times ADD is equivalent to 0.88 times the MDD.

Table F-1
Water System Evaluation Criteria

Description	Value	Units	Evaluation Demand Conditions
System Pressure			
Maximum Pressure	125	psi [1]	ADD [2]
Minimum Design Pressure, normal conditions	40	psi	PHD [2]
Minimum Evaluation Pressure, normal conditions	35	psi	PHD
Minimum Pressure, with fire flow	20	psi	MDD [2]
Pipeline Velocity			
Maximum Evaluation Velocity (excludes fire hydrant runs)	10	fps [1]	PHD
Maximum Design Velocity (network)	6	fps [1]	PHD
Maximum Design Velocity (pump station suction pipelines)	4	fps [1]	MDD/PHD
Storage Volume			
Operational	25 percent of MDD	MG [1]	MDD
Fire Fighting	Highest fire flow requirement	MG	MDD
Emergency	1.5 times ADD	MG	ADD [2]
Booster Station Capacity			
Pressure Zones with Storage	Zone segment capacity of MDD with largest single pump out of service		MDD
Pressure Zones without Storage	Zone segment capacity of PHD or MDD plus Fire, whichever is larger, with largest single pump out of service		PHD
Pressure Reducing Station Capacity			
Pressure Zones with Storage	Zone segment capacity of MDD		MDD
Pressure Zones without Storage	Zone segment capacity of PHD or MDD plus Fire, whichever is larger		PHD
Fire Flow Requirements [3]			
Agricultural and Rural Residential 0.2 Du/Acre	1000	gpm for 2 hours	MDD
Hillside Residential 0.2 DU/Acre	1000	gpm for 2 hours	MDD
Very Low Density Residential 1 DU/Acre	1000	gpm for 2 hours	MDD
Semi-Rural Residential 1.5 DU/Acre	1000	gpm for 2 hours	MDD
Low Density Residential 3 DU/Acre	1000	gpm for 2 hours	MDD
Medium Density Residential 4 DU/Acre	1000	gpm for 2 hours	MDD
Medium High Density Residential 12 DU/Acre	1750	gpm for 2 hours	MDD
High Density Residential 20 DU/Acre	2500	gpm for 2 hours	MDD
Very High Density Residential 40 DU/Acre	3500	gpm for 3 hours	MDD
Business Office Park	3000	gpm for 3 hours	MDD
Neighborhood Commercial	1500	gpm for 2 hours	MDD
General Commercial	3000	gpm for 3 hours	MDD
Regional Commercial	4000	gpm for 4 hours	MDD
Industrial	3000	gpm for 3 hours	MDD
Mixed Use Horizontal Building	2000	gpm for 2 hours	MDD
Mixed Use Vertical 2-3 Stories	4000	gpm for 4 hours	MDD
Mixed Use Vertical 4-5 Stories	4000	gpm for 4 hours	MDD
Public Facilities and Institutions	3500	gpm for 3 hours	MDD
Office	2000	gpm for 2 hours	MDD
Downtown Specific Plan:			

Almond Street	2,000	gpm for 2 hours	MDD
Health Center	3,500	gpm for 3 hours	MDD
Health Center (Community Hospital Campus)	5,000	gpm for 4 hours	MDD
Justice Center	6,000	gpm for 4 hours	MDD
Justice Center (Market St Corridor)	6,000	gpm for 4 hours	MDD
Market St Gateway	3,500	gpm for 3 hours	MDD
Market St Gateway (adjacent to Freeway)	3,000	gpm for 3 hours	MDD
Mission Inn Historic District	4,000	gpm for 4 hours	MDD
Neighborhood Commercial	3,000	gpm for 3 hours	MDD
North Main St Specialty Services	3,000	gpm for 3 hours	MDD
Prospect Place Office	3,000	gpm for 3 hours	MDD
Prospect Place Office (14th St Corridor)	5,000	gpm for 4 hours	MDD
Raincross	4,500	gpm for 4 hours	MDD
Residential	1,500	gpm for 2 hours	MDD
System Reliability			
Pipe Breaks	Maintain service with a single supply/transmission pipeline out of service		MDD
Single Source Out of Service	Maintain service for 7 days with a single source out of service		ADD
Electric Power Out of Service	Maintain service at 20 psi with power failure during 6 hours of highest MDD period		MDD
No Natural Gas Supplies	Maintain service without natural gas supplies during 24-hour period		MDD
Emergency	Maintain service for 3 days with a single source out of service and no electrical power		MinMD

[1] psi = pounds per square inch, fps = feet per second, gpm = gallons per minute, MG = million gallons
[2] PHD = peak hour demand, MDD = maximum day demand, ADD = average day demand
[3] Based on the 1997 Uniform Fire Code (UFC) and Riverside County Fire Department requirements.

Booster Pumping Stations

Booster pumping station capacity is evaluated under two scenarios:

- The largest single pump out of service for pressure zones with storage under maximum day demand conditions
- The largest single pump out of service for pressure zones without storage under peak hour demand conditions or maximum day demand plus fire flow conditions, whichever is larger.

The hydraulic model will be used to evaluate the booster station capacity with the largest single pump serving each zone out of service.

Pressure Reducing Stations

There are a few zones within the City's water system that are either served solely through a pressure reducing station or are served through a pressure reducing station in addition to a booster station. In the latter case, the pressure reducing station may serve the zone in conjunction with the booster station or may act as an emergency supply. For the zones where it is necessary to rely on a pressure reducing station to meet demands, the capacity is evaluated under two different scenarios:

- Capacity of pressure reducing stations at maximum day demand for pressure zones with storage
- Capacity of pressure reducing stations at peak hour demand or maximum day demand plus fire flow, whichever is larger, for pressure zones without storage

Again, the hydraulic model will be used to evaluate the ability of the pressure reducing stations to satisfy the demands within each zone with the largest single pressure reducing valve out of service.

EVALUATION METHODOLOGY

Analyses for water supplies, storage quantities and inter-zone transfer capabilities are conducted outside of the hydraulic model. Water supply requirements are determined based on projected maximum day demand for the years 2005, 2007, 2010, 2015, 2020 and 2025. The maximum day demand (MDD) projections are evaluated based on existing capacity and supplemented by additional supply as needed. Hydraulic evaluations are performed for both the existing system and build-out (assumed to be 2025) conditions.

Requirements for reservoir storage are evaluated both on a system wide basis and on a zone by zone basis. Criteria discussed previously in this section are used to identify deficiencies within the existing system as well as to project the future system storage needs. Recommendations for additional reservoir facilities are based on the comparison of the existing and anticipated storage volume requirements.

Pumping station capacities are evaluated on a zone by zone basis. Maximum day demands are compared to capacities of the pumping stations with the largest unit out of service. This comparison will identify the necessary upgrades to deficient pumping stations.

The existing system and the projected future system configurations are evaluated with respect to the optimum locations for the recommended improvements in storage facilities and booster pumps. Each zone is analyzed to determine how water will be supplied in the appropriate quantities and pressures from the available water sources and storage facilities.

Hydraulic model runs are made for the existing and future systems after the completion of the analyses described above. The model runs include recommended facilities such as additional storage reservoirs, booster pumps and PRV's. Model runs are made using steady state and 24-hour EPS runs to evaluate anticipated system pressures and pipeline velocities. Recommendations are made for any additional pipelines necessary due to system hydraulics and the adequacy of pipelines with respect to system redundancy.

Model runs have been completed using the following three conditions:

- Average day demands (ADD) conditions, 24-hour EPS simulation
- Maximum day demand (MDD) conditions, 24-hour EPS simulation
- Maximum day demand conditions with fire flow demands, steady state simulation

Maximum day plus fire flow situations are evaluated at every demand node in the existing and future system having fire hydrants. Each demand node is given fire flow criterion based on the maximum fire flow requirement for the services that the node represents. Using the model, each node is then evaluated to determine if the fire flow requirements can be met while maintaining a pressure of 20 psi at all demand nodes in that pressure zone. Where fire flow cannot be met using a single node and the fire flow demand is 1,250 gpm or more, then the fire flow analysis is performed using two adjacent nodes. Nodes with fire flow requirements that could not be brought within acceptable parameters are identified and are presented as part of the analyses of both the existing and future scenarios in later sections of the report.