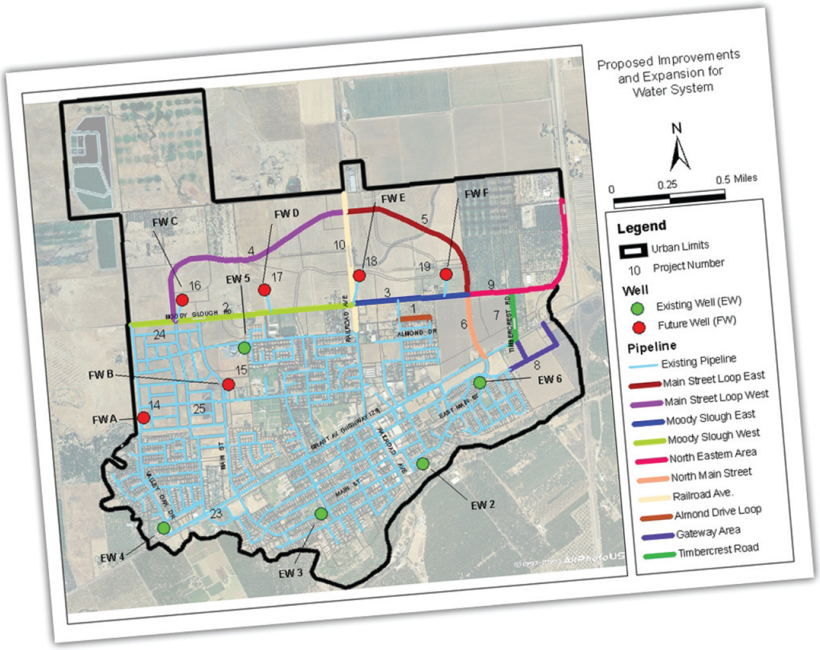
CITY OF WINTERS CALIFORNIA



Water Master Plan

December 2006

RMC
Water and Environment

RMC
Water and Environment

Los Angeles
Sacramento
San Francisco
San Jose
Walnut Creek

February 16, 2007

Mr. Alan Mitchell, P.E.
Project Manager
City of Winters
318 First Street
Winters, CA 95694

Subject: City of Winters Water Master Plan – Final

Dear Mr. Mitchell:

RMC Water and Environment is pleased to submit this Final Water Master Plan for the City of Winters, reflecting approval of the document by City Council on February 6, 2007. This Master Plan presents the comprehensive evaluation of the capacity of the City's water system and recommends water system improvement projects necessary to address the City's existing and future water conveyance needs.

We greatly appreciate the support and guidance received from the City's engineering and operations staff throughout the study. Their input and assistance in the field were critical in developing the recommendations presented in this Water Master Plan.

Sincerely,

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

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Project Manager

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Innovative Solutions for Water and the Environment

EXECUTIVE SUMMARY

The 2006 Water Master Plan is an update of the 1992 Water Master Plan (CH2M Hill, 1992). The information provided will assist the City of Winters (City) in their planning efforts as they approach new development and ultimate Buildout conditions. The objectives of this master plan are as follows:

1. Develop solid design criteria
2. Create a hydraulic model of the water system for the City's ongoing use
3. Update the City's Capital Improvement Program

Design Criteria

A summary of design criteria used to evaluate the City's water system is presented in Table ES-1.

Table ES–1: Summary of Design Criteria

EXISTING WELL CAPACITY			
Total Capacity[1] (mgd) **@ 50 psi**	**Total Capacity**[2] (mgd) **@ 30 psi**	**Firm Capacity**[3] (mgd) **@ 50 psi**	**Firm Capacity** (mgd) **@ 30 psi**
8.0	10.1	5.5	6.9

WATER USE PEAKING FACTORS				
	Existing Conditions		**Future Conditions**	
	Max Day/Average Day	*Max Hour/Average Day*	*Max Day/Average Day*	*Max Hour/Average Day*
1992 Master Plan	2.0	3.5	2.0	3.5
Recommended Values	2.6	3.9	2.6	3.9

DEMANDS						
Year	**Average Day**		**Max Day**		**Max Hour**	
	(gpm)	(MGD)	(gpm)	(MGD)	(gpm)	(MGD)
Existing (2002)	1,062	1.5	2,766	3.9	4,149	6.0
Build out[4]	3,415	4.9	8,877	12.8	13,316	19.0

PRESSURE CRITERIA		
Demand Scenario	**Minimum Pressure** (psi)	**Maximum Pressure** (psi)
Average Day	50	100
Max Day + Fire Flow	20	-
Max Hour	30	-

VELOCITY & HEADLOSS CRITERIA	
Maximum Velocity (fps)	**Headloss**
10	10 ft / 1,000 ft

Notes:
1. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
2. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.
3. Firm capacity is the total capacity with the largest well (Well #6) out of service.
4. Future demands assume build out conditions, as defined in the June 2003 Winters General Plan Amendment Map.

Capital Improvement Program

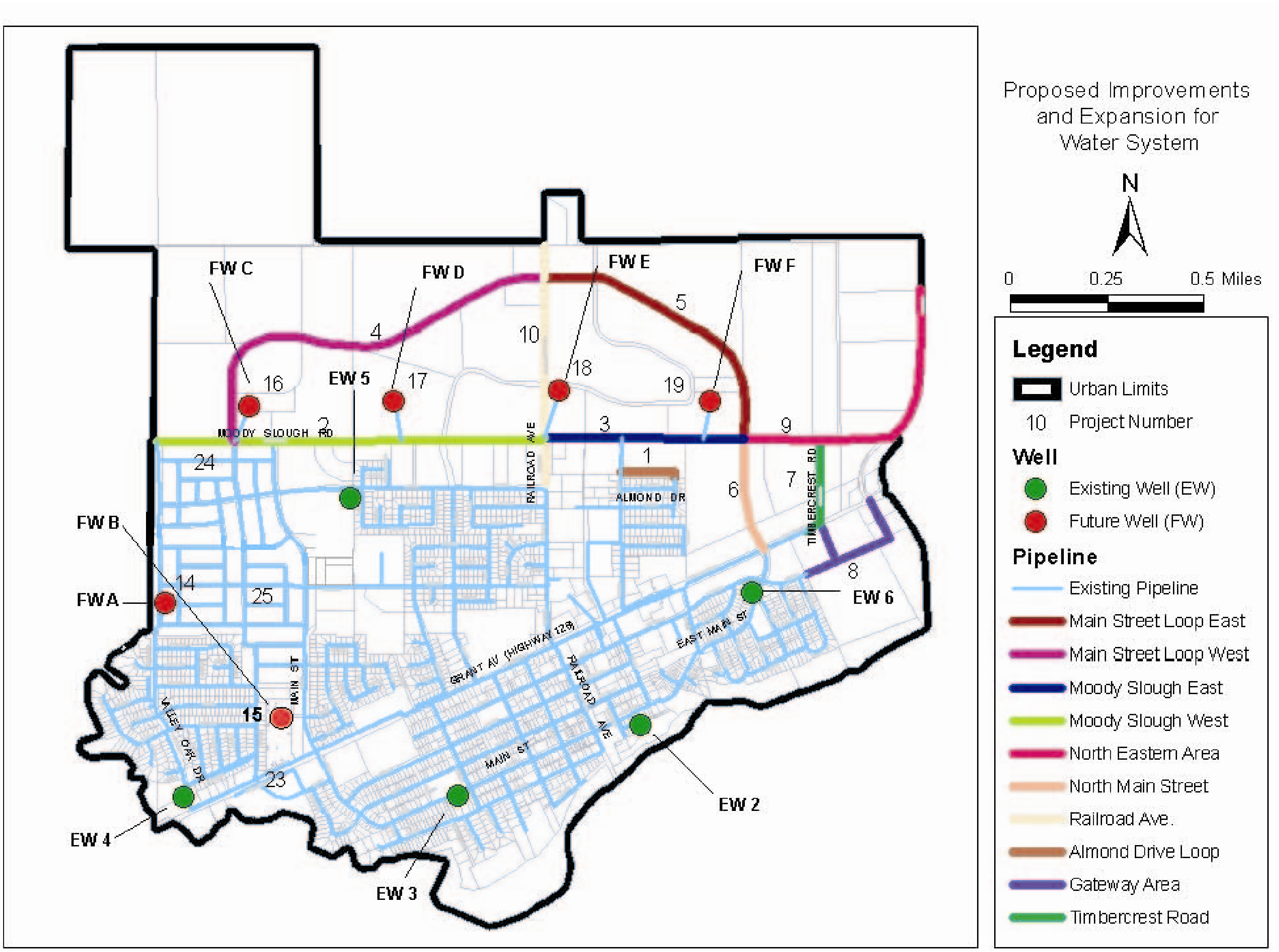
A summary of proposed water capital improvement projects is presented in Table ES-2.

Table ES – 2: Summary of Proposed Capital Improvement Projects

PROJECT NO.	DESCRIPTION	DIAMETER/ FIRM CAPACITY (in, gpm)	LENGTH (ft)	ESTIMATED CAPITAL COST
Existing Water Conveyance Improvements				
1	Almond Drive Loop Water Main	8	800	$108,000
11 [a]	8" Pipe Replacement	8	18,390	$2,476,000
	12" Pipe Replacement	12	5,700	$1,119,000
	14" Pipe Replacement	14	7,300	$1,677,000
Existing and Future Well Improvements				
14	Future Well A	1,320	---	$2,572,000
15	Future Well B	1,320	---	$2,572,000
16	Future Well C	1,320	---	$2,572,000
17	Future Well D	1,320	---	$2,572,000
18	Future Well E	1,320	---	$2,572,000
19	Future Well F	1,320	---	$2,572,000
20	System Control and Data Acquisition	---	---	$258,000
21	Major Well Maintenance/Rehab	---	---	$172,000
22	Portable Emergency Generator	---	---	$200,000
Future Water System Expansions				
2	Moody Slough (West) Water Mains	14	5,300	$1,037,000
3	Moody Slough (East) Water Mains	14	2,700	$529,000
4	Main Street Loop (West) Water Mains	14	5,700	$1,114,000
5	Main Street Loop (East) Water Mains	14	4,100	$802,000
6	North Main Street Water Mains	14	1,600	$313,000
7	Timbercrest Road Water Mains	14	1,200	$276,000
8	Gateway Area (14-inch) Water Mains	14	1,600	$312,700
	Gateway Area (8-inch) Water Mains	8	1,100	$110,400
9	North Eastern Area Water Main	14	4,200	$821,000
10	Railroad Ave Water Mains	14	2,700	$528,000
Other Proposed Projects				
12	Residential Water Use Study	---	---	$12,000
13	Removal of Elevated Water Tanks	---	---	$600,000
26	Urban Water Management Plan	---	---	$43,000
			TOTAL	**$27,940,100**

a. Refer to the City's 1992 Water System Master Plan Pipe Replacement Recommendations in Appendix E and Figure 5-2: Existing System Pipeline Replacement Program

Figure ES – 1: Proposed Improvements and Expansions for the Water System



Additional Recommendations

VALVE EXERCISE AND LOCATION PROGRAM

Regular valve exercising is needed to keep valves in good working condition, as well as to identify broken, inoperable and/or leaky valves. Exercising valves will help to reduce potential water quality problems, time needed to repair leaks, and customer service complaints. In many instances, valves may be buried too deep or paved over, making them difficult or impossible to locate. It is therefore recommended that the City use the newly developed water atlas maps as a tool to confirm the locations of valves.

MAIN FLUSHING PROGRAM

Periodic flushing of water mains is necessary to prevent potential water quality problems and corrosion caused by sediment buildup and biofilm growth in the distribution system. Periodic flushing also increases flow through pipes by reducing friction losses.

COMPREHENSIVE MAINTENANCE PLAN

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

LEAK DETECTION PROGRAM

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

HYDRANT MAINTENANCE PROGRAM

AWWA[1] recommends inspection and testing of hydrants at least one per year to ensure proper functionality during an emergency or scheduled flow test. The City should consider coordinating this effort with the local fire department.

HYDRANT AND VALVE ID PROGRAM

As discussed in Section 5.5.6, it is recommended that the City develop a system to track schedule and performed maintenance. As part of this effort, it is recommended that the City assign each hydrant and valve an identification number (ID) to ensure efficient tracking of each repair.

[1] AWWA Manual 17, "Installation, Field Testing, and Maintenance of Fire Hydrants, 1989

ACKNOWLEDGMENT

The 2006 Water Master Plan represents a collaborative effort between RMC and the City of Winters. We would like to acknowledge and thank the following key personnel from the City whose invaluable knowledge, experience, and contributions were instrumental in the preparation of this Master Plan.

John Donlevy, Jr. – City Manager
Charles Simpson – Director of Public Works
Karen Honer – Director of Public Works (former)
Nicholas Ponticello – City Engineer, Ponticello Enterprises Consulting Engineers, Inc.
Alan Mitchell – Project Manager, Ponticello Enterprises Consulting Engineers, Inc.
City Operations/Field Staff

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CHAPTER 1 INTRODUCTION

Chapter Synopsis: This chapter presents the purposes, objectives, and scope for the 2006 Water Master Plan. It also provides a summary of previous water master plans and studies completed by the City that are pertinent to the water system.

This 2006 Water Master Plan is an update and re-evaluation of the 1992 Master Plan. This Plan achieves several objectives, including 1) creating a computerized hydraulic model of the water system using H_2OMAP Water Version 5.0, 2) re-evaluating and updating the 1992 Capital Improvement Program to address potential conveyance, pumping capacity, storage, and metering deficiencies under existing (2002) and long-term conditions, and 3) re-evaluating and master planning future water system network for buildout expansion of the City within the urban service boundary.

The City of Winters (City) is located in the southwestern corner of Yolo County, immediately north of the Solano County line and just east of the Vaca Mountain range. As shown in Figure 1-1**,** the City lies approximately 34 miles west of the California state capital, Sacramento, and approximately 10 miles north of Vacaville. The City is bordered on the south by Putah Creek, which has a year round flow emanating from Monticello Dam, located 9 miles to the west. Monticello Dam backs up Lake Berryessa and is a major recreation area, drawing tourists from the San Francisco Bay Area and elsewhere.[2]

Figure 1-1: City of Winters Location

The settlement of the Winters area began in 1842 on the south side of Putah Creek. In 1875, the Vaca Valley Railroad Company sought financial assistance from Theodore Winters and others to build a railroad bridge across Putah Creek to extend their line to the north bank of the Creek. In the process, the Railroad Company laid out a forty acre town, named it for Theodore Winters, and thus created the City of Winters.[2]

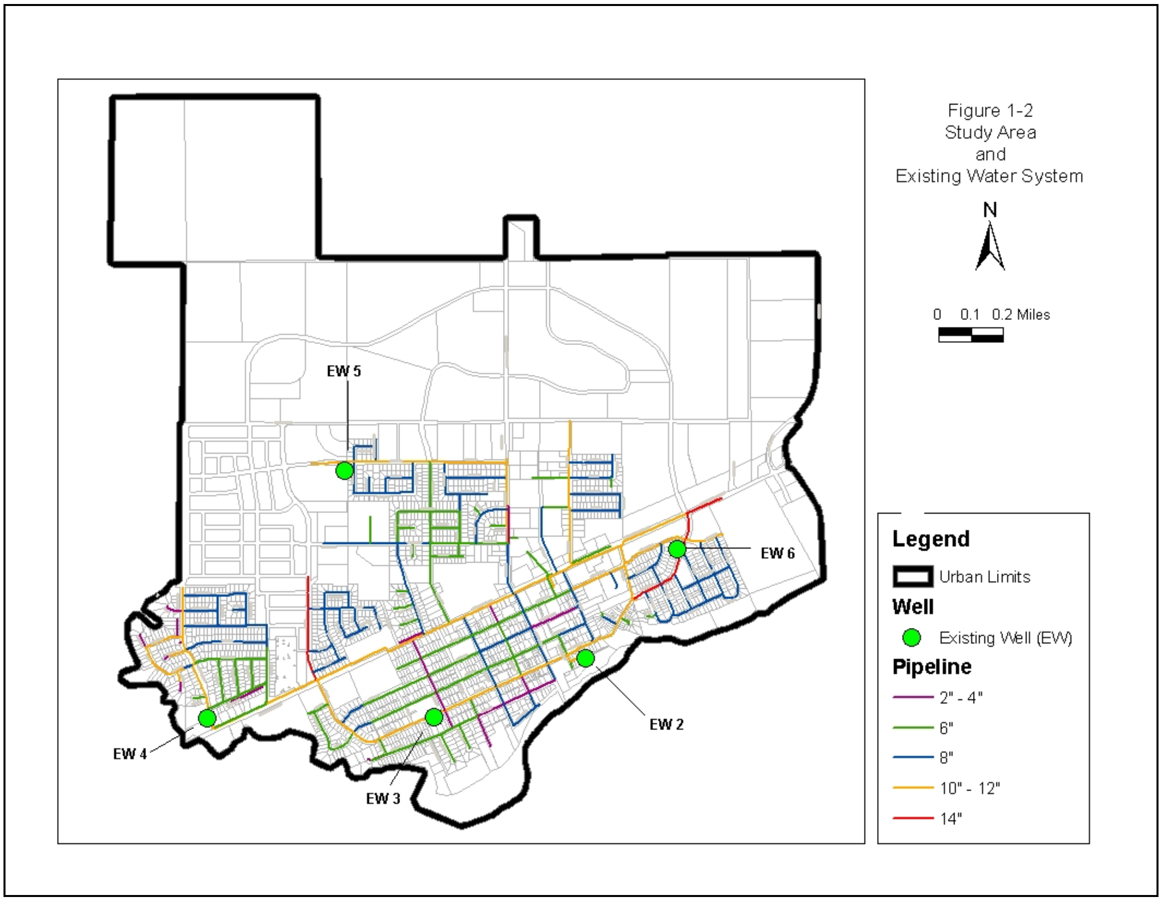
Although the City holds an entitlement to divert water from the Putah Creek, groundwater is the City's main source of municipal and industrial supply within the General Plan Boundary. The City lies within the Yolo Subbasin, which is bound on the east by the Sacramento River, on the

[2] Excerpted and summarized from the City of Winters website at http://www.cityofwinters.org/

west by the Coast Range, on the north by Cache Creek, and on the south by Putah Creek[3]. Groundwater is pumped via five wells located in the downtown, northwestern, south, southwestern, southeastern regions of the City. Based on the City of Winters' Water Supply Assessment[4], sources of groundwater recharge in the vicinity of Winters primarily include subsurface inflow from the west and north, deep percolation from precipitation and seepage from Putah Creek and Dry Creek. Data presented in the assessment show that Winters currently uses 1,900 acre-feet per year (1.7 mgd) from the underlying aquifer. The water supply assessment indicates that current groundwater supply can also meet future demands with no risk of overdraft even during consecutive dry years.

The City of Winters currently serves approximately 7,000 customers and maintains approximately 20 miles of pipeline. The current population is expected to double at buildout. The area of study discussed in this Master Plan is the City's urban limit area shown in Figure 1-2. The urban limit boundary is defined based on the 1992 General Plan and subsequent General Plan amendments.

Figure 1-2: Master Plan Study Area and the City's Water System



[3] "Revised Water Supply Assessment - Winters Highland, Callahan Estates, Creekside Estates, and Ogando/Hudson Residential Developments", Schlumberger Water Services, June 2004
[4] Water Supply Assessment Report, SKS, Sept. 2003

1.1 Project Purpose

The purpose of this Water Master Plan is to update and reevaluate the City's 1992 Water Master Plan (CH2M Hill, 1992) by providing the City with the following:

- An evaluation of its current water system operations and existing deficiencies.
- An improved understanding of how future growth and development will impact the City's current operations and facilities.
- A comprehensive guide to implementing projects that will ensure a more sustainable water system under existing (2002) and buildout (per City's June 2003 General Plan Amendment Map) conditions.

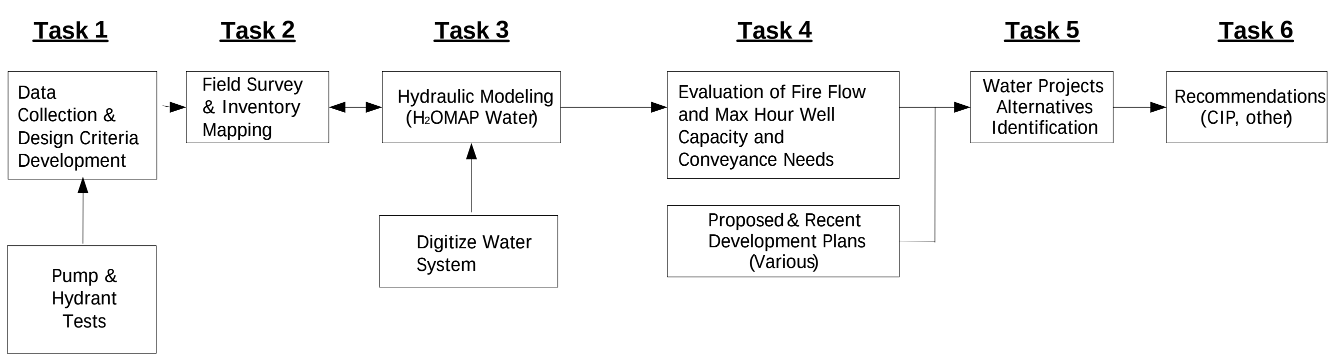
1.2 Objectives and Scope

The objectives of this Master Plan are threefold[5]:

1. Development of Solid Design Criteria: the City is poised to grow, in accordance with its approved General Plan. In order for City staff to appropriately guide new development, which may actually double the City's population, they will need a solid understanding of how the water system is intended to accommodate additional demand.
2. Development of a Working Model for the City's Ongoing Use: City staff correctly recognizes that a "live" system model is an important tool for assuring that planned improvements have the desired effect (i.e. water main upgrades improve fire flows downtown) and that new development doesn't have unintended consequences.
3. Development of a CIP that Preserves and Enhances the Quality of Water Service provided by the City: in a growing community, a carefully prioritized CIP helps assure that infrastructure is in place before new demands create additional stress.

To achieve these objectives, the scope of work was divided into six tasks as shown in Figure 1-3. Tasks 1 through 6 are discussed in Chapter 2 through 7 of this report, respectively.

Figure 1-3: Master Plan Flow Chart



1.3 Previous Studies

In 1992 CH2M Hill prepared the City of Winters Water Master Plan. Additional new development studies have also been prepared by other firms. The findings of these studies are summarized in the following sections.

[5] City of Winters Water Master Plan, Project Scope, RMC, May 2003

1.3.1 1992 Water Master Plan

Table 1-1 provides a summary of projects recommended as part of 1992 Water Master Plan as well as project implementation status. As part of this effort, CH2M Hill developed a Capital Improvements Program (CIP).

Table 1-1: CIP Projects Recommended in 1992 Water Master Plan

Project Number	Project Name	Project Description[1]	Project Implemented[2] Yes/No
1	Pipeline Replacement	Replace 4 to 8-inch pipe along Edwards Street between Main and East Streets with 12-inch diameter pipe	no
2	Pipeline Replacement	Replace 2 and 4-inch diameter pipe along Fourth Street between Grant Avenue and Russell Street with 12-inch diameter pipe	no
3	Pipeline Replacement	Replace 6-inch diameter pipe along Walnut Lane between Grant Avenue and Dutton Street with 12-inch diameter pipe	yes
4	Pipeline Replacement	Replace 4-inch diameter pipe along Russell Street between the west end of Russell Street and Emery Street with 8-inch diameter pipe	yes
5	Pipeline Replacement	Replace approximately 32,000 feet of old and/or undersized pipe in addition to the projects above, with 8- to 14-inch diameter pipe	no
6	Emergency Backup	Install a standby generator at each well	Yes at Well 6 only (auxiliary motor). All other wells have hookup for shared standby generator.
7	Telemetry System/VFDs	Install a new telemetry system with variable frequency drives (VFD) to monitor and operate water system	Yes. All wells have VFDs but there is no centralized system to control operations.
8	Well Replacement	Replace Well #1 with new well located in the eastern region of the service boundary	yes
9	New Well Installation	Construct 3 new wells to accommodate future development	no
10	New Pipeline Installation	Install 8- to 14-inch pipe to accommodate future development	Ongoing

Notes:
1. Source: City of Winters Water Master Plan, CH2M Hill, 1992
2. Per Water System Atlas Map and previous conversations with the City

1.3.2 Other City Studies

As part of this Master Plan, the consultant team also reviewed two studies that the City recently completed to assess existing and future water supply and identify potential multipurpose projects.

1.3.2.1 Gateway, Greyhawk, Winters Highland and Callahan Estates

Utility plans for these proposed developments were reviewed to ensure that all alternatives were considered prior to developing the recommended future water master planned facilities.

1.3.2.2 City of Winters Water Supply Assessment Report and Amendment

The City of Winters Water Supply Assessment Report was completed by Saracino, Kirby, and Snow (SKS) in September 2003 and later revised by Schlumber Water Services in June 2004. These reports evaluated the impact of new developments including Winters Highland, Callahan Estates, Creekside Estates, and Ogando/Hudson on the City's water supply. The water supply assessment indicates that current ground water supply can meet future demands with no risk of overdraft even during consecutive dry years.

1.4 Report Content

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

CHAPTER 1– INTRODUCTION
CHAPTER 2 – DESIGN CRITERIA
CHAPTER 3 – HYDRAULIC MODEL DEVELOPMENT
CHAPTER 4 – MODEL RESULTS
CHAPTER 5 – RECOMMENDED CAPITAL IMPROVEMENT PROJECTS
CHAPTER 6 – CAPITAL IMPROVEMENT COSTS

This report also contains five appendices that are referenced in Chapters 2 through 5.

APPENDIX A – DESIGN CRITERIA & MODEL INPUT DATA
APPENDIX B – MODELING RESULTS
APPENDIX C – CIP DATA
APPENDIX D – TECHNICAL MEMORANDA
APPENDIX E – 1992 WATER SYSTEM MASTER PLAN REPLACEMENT PROGRAM RECOMMENDATIONS

CHAPTER 2 DESIGN CRITERIA

Chapter Synopsis: This section provides summaries of the land use databases, existing (as of September 2002) and buildout land use estimates, demand factors, and various design criteria that were used during the development of this Master Plan.

2.1 Land Use Database

The land use database for this Master Plan was developed by incorporating the following information:

- **Yolo County Parcel Layer** – The City of Winters' parcel layer was extracted from the Yolo County geographical information system (GIS) parcel shape file and used as a base for developing the land use map. The horizontal projection, in feet, for this shapefile (and this Water Master Plan) is California State Plan Zone II, NAD 83.
- **Tentative Maps for Preliminary Utility Plans for Winters Highland and Callahan Estates Developments (November 2003)** – These tentative maps were overlaid on the parcel layer to transfer planned roadway and block designations onto the parcel maps.
- **City of Winters Zoning Map (June 2003)** - The zoning map provided by the City was overlaid on the parcel map using ArcView GIS Version 3.1 to transfer planned roadway information for vacant parcels at the north end of the City from the Zoning Map to the parcel layer. Some manual adjustments were required, as the zoning map did not overlay exactly on the parcel map. Next, the land use information was created as an attribute of the parcels, and zoning designations were transferred to the parcel map as land use categories for the future/buildout scenario. The existing land use map was then created manually from additional information listed below.
- **Orthorectified Aerial Photo** – The citywide aerial photo, flown on September 5, 2002 was overlaid on the land use map to identify undeveloped/vacant areas.
- **City of Winters General Plan** - The General Plan was used to identify possible areas where the actual land use differs from the zoning information.
- **City Input** - City staff identified unique vacant land use areas.

Water demands, discussed in detail in Section 2.4, were assigned to the nodes in the hydraulic model with the use of a demand allocation tool provided by H_2OMap Water. For a given GIS parcel layer, the tool uses an algorithm to determine the closest node to the centroid of each parcel, and then assigns a link that associates each parcel with a node. This method facilitates the rapid evaluation of impacts on water demands and conveyance capacity needs based on future modifications to land use designations. **Figure 2-1** provides an example of node-parcel links created by the tool.

Figure 2-1: Parcel-Node Demand Allocation

Links were thus created between the hydraulic model and the land use database developed for this Master Plan. Links were reviewed and revised as necessary based on the City's water system atlas and record drawing information, as well as input provided by City engineering staff.

2.2 Existing and Buildout Land Use

Land use information, unit base water use factors (discussed in Section 2.4), and the parcel-node linkages described above were used to distribute demands in the hydraulic model. Unit base water use factors are expressed in gallons per day per net acre (gpad) or gallons per day per capita (gpcd), and vary with the type of land use.

A list of 18 land use classifications was developed to reflect existing and buildout land uses with similar demand characteristics. The classifications were based on the General Plan land use and zoning designations. **Table 2-1** provides the list of land use and zoning categories and their associated densities. The densities were used to estimate the number of persons or constructed area per parcel, as this information is not an attribute of the parcel database. **Table 2-2** summarizes the total acreage for each land use category.

Existing and buildout land use maps are presented in **Figure 2-2** and **Figure 2-3**, respectively.

Table 2-1: Land Use Categories and Associated Densities

LAND USE CATEGORIES	LAND USE DATABASE CODE	ZONING DESIGNATION	ZONING CODE	EXISTING & BUILDOUT DENSITIES	
				Residential Density [1] (DU/net acre)	Population Density [3] (Person/DU)
Residential					
Rural	RR	Rural	RR	0.5 - 1.0	3.5
Low Density	LR	Single Family (7,000 SF Ave. Min.)	R-1	1.1 - 7.3	3.5
Medium Density	MR	Single Family (6,000 SF Ave. Min.)	R-2	5.4 - 8.8	3.0 / 3.5 [4]
Medium/High Density	MHR	Multi-Family	R-3	6.1 - 10.0 [2]	3.0
High Density	HR	High Density Multi-Family	R-4	10.1 - 20.0 [2]	3.0
Commercial				N/A	N/A
Neighborhood	NC	Neighborhood	C-1		
Central Business District	CBD	Central Business District	C-2		
Highway Service	HSC	Highway Service	C-2		
Planned	PC	Planned	P-C		
Planned/Business Park	PC/BP	Planned/Business Park	PC/BP		
Industrial					
Light	LI	Light	M-1		
Heavy	HI	Heavy	M-2		
Other					
Agriculture	AG	General Agriculture	A-1		
Office	OF	Office	O-F		
Public/Quasi-Public	PQP	Public/Quasi-Public	PQP		
Parks & Recreation	PR	Parks & Recreation	PR		
Open Space	OS	Open Space	OS		
Undeveloped/Vacant	Vacant	--	--		

1. Source: City of Winters General Plan, May 1992, and General Plan Land Use Diagram Amendment Map, June 2003;
2. The Residential Density used for MHR and HR parcels under existing condition is 6.1 and 10.1 DU/net acre, respectively.
3. Based on Section 7-2 of Winters Draft Design Standards.
4. The Population Density used for MR parcels under the existing and buildout condition scenarios are 3.0 persons/DU and 3.5 persons/DU, respectively.

Table 2-2: Existing (as of September 2002) and Buildout Land Use Acreage by Category

LAND USE CATEGORIES	LAND USE DATABASE CODE	EXISTING LAND USE		BUILDOUT LAND USE	
		TOTAL NET ACREAGE [a]	% OF TOTAL	TOTAL NET ACREAGE [a]	% OF TOTAL
Residential					
Rural	RR	0	0.0	47	2.6
Low Density	LR	89	5.0	299	16.8
Medium Density	MR	196	11.0	314	17.6
Medium/High Density	MHR	16	0.9	69	3.9
High Density	HR	15	0.8	41	2.3
Sub-Total		***316***	***17.7%***	***770***	***43.2%***
Commercial					
Neighborhood	NC	4	0.2	22	1.2
Central Business District	CBD	46	2.6	63	3.5
Highway Service	HSC	1	0.1	6	0.3
Planned	PC	0	0.0	24	1.4
Planned/Business Park	PC/BP	0	0.0	54	3.0
Sub-Total		***51***	***2.9%***	***169***	***9.4%***
Industrial					
Light	LI	0	0.0	65	3.6
Heavy	HI	0	0.0	37	2.1
Sub-Total		***0***	***0.0%***	***102***	***5.7%***
Other					
Agriculture	AG	0	0.0	4	0.2
Office	OF	4	0.2	5	0.3
Public/Quasi-Public	PQP	280	15.7	399	22.4
Parks & Recreation	PR	14	0.8	145	8.1
Open Space	OS	49	2.7	188	10.6
Vacant	Vacant	1068	60.0	0	0.0
Sub-Total		***1,415***	***79.3%***	***741***	***41.6%***
	TOTAL	**1,782**	**100%**	**1,782**	**100%**

a. Estimated acreage based on land use GIS database (Appendix A). Net acreage excluded streets and roadways. Winters' urban limit line contains approximately 1980 gross acres. For this Master Plan, the existing net acreage (1,782 acres) is approximately 90 percent of the gross acreage. For a conservative analysis, it is assumed that the net acreage will not decrease for the buildout scenario even though more streets will be built within existing vacant parcels.

Figure 2-2: Existing Land Use Map

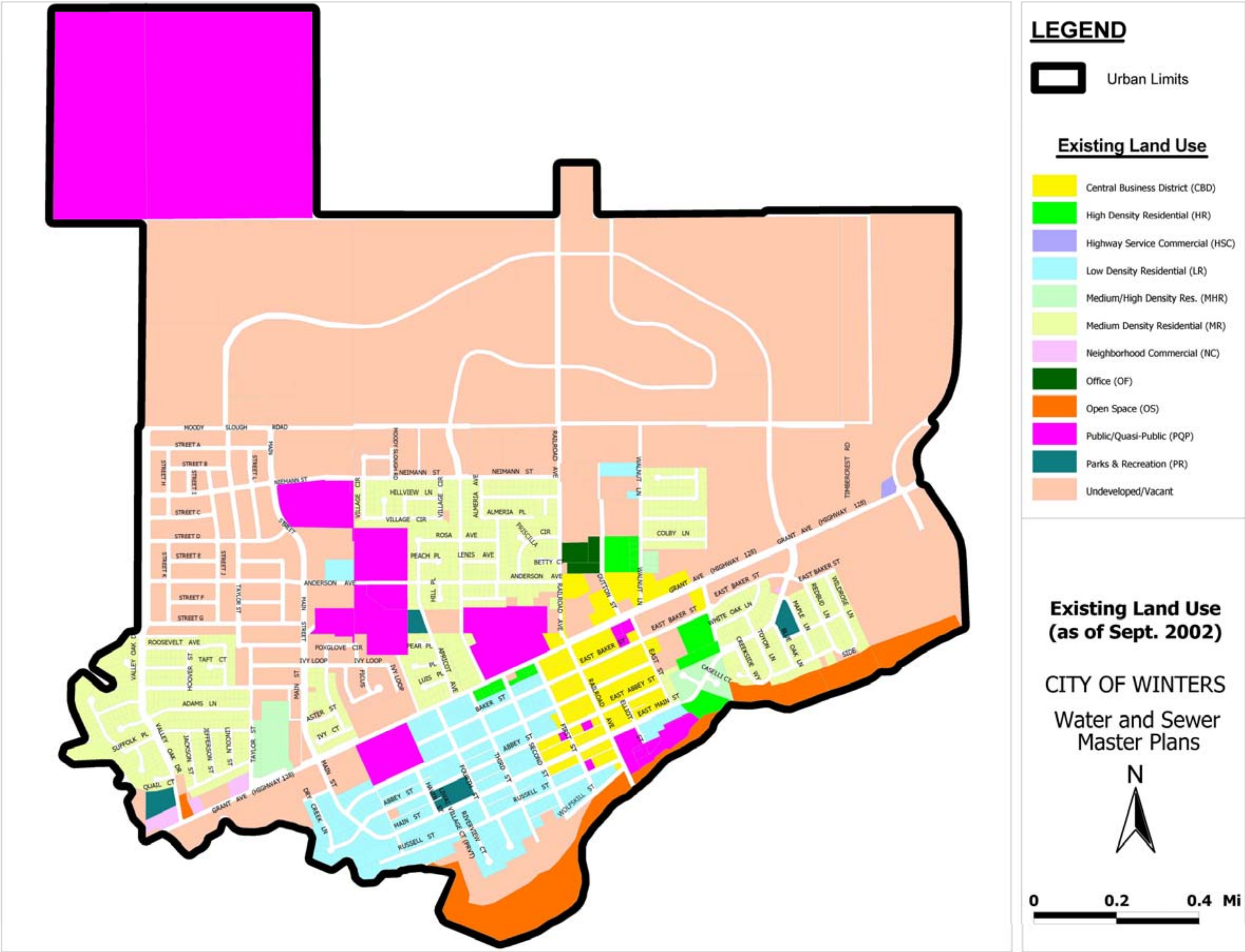
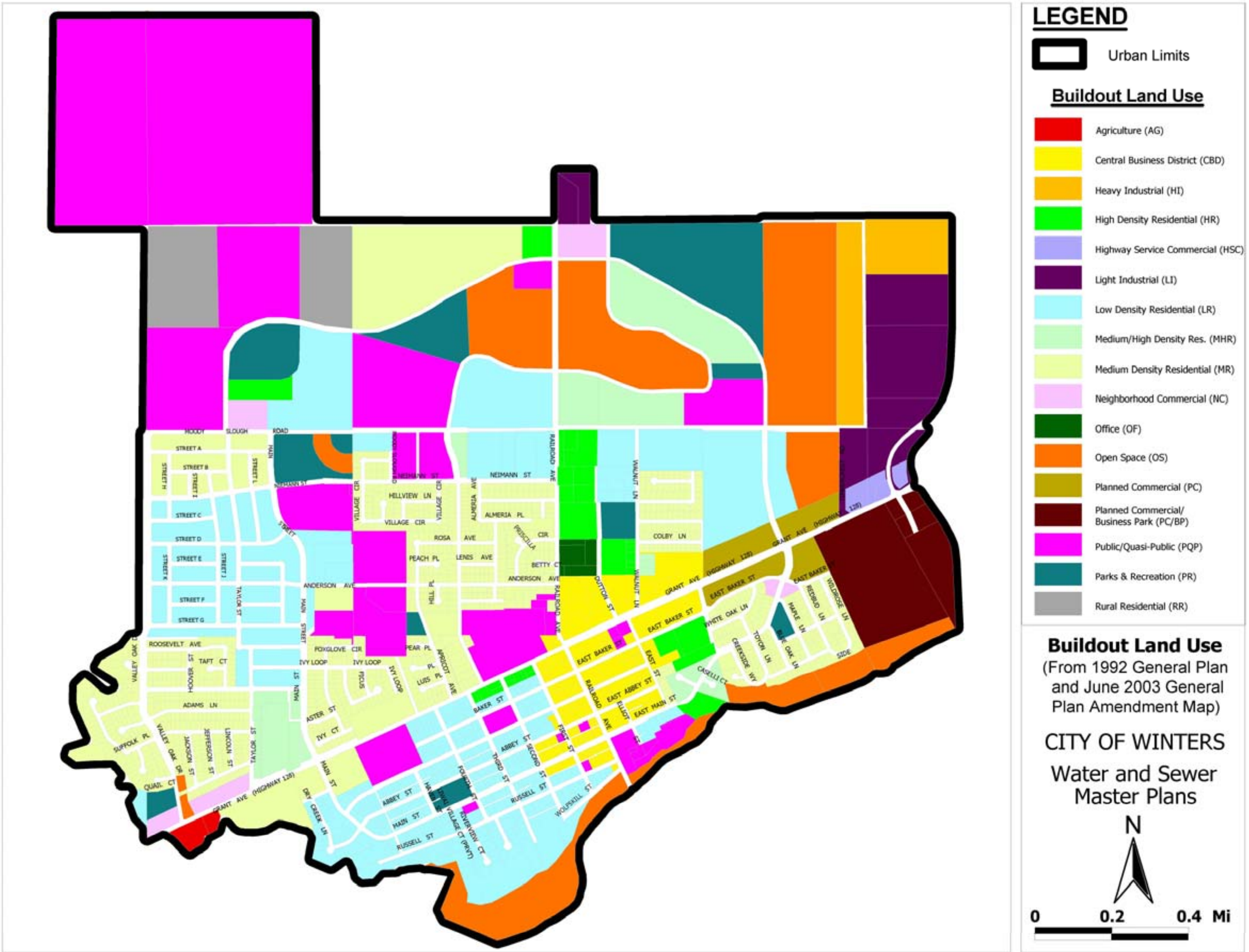


Figure 2-3: Buildout Land Use Figure



2.3 Peaking Factors and Demands

2.3.1 Peaking Factors

Water usage typically varies with the seasons, the days of the week, and the hours of the day. The variations in water demand throughout the seasons and throughout the day, and their effects on the distribution system, are important considerations in determining adequate capacity and sizing of conveyance facilities. Variations in water consumption are usually expressed as ratios to Average Day Demand (ADD), and are commonly referred to as peaking factors. Peaking factors are used in water master planning studies to estimate, from ADD, water demands occurring during Maximum Day Demand (MDD) and Maximum Hour Demand (MHD) events in a water distribution system.

For the City of Winters, ADD was determined by dividing the total volume of water produced by the groundwater supply wells in one year by the number of days in a year. Typically, a water distribution system's "maximum day" is marked by the largest volume of water used during any 24-hour period during the year. The MDD peaking factor is therefore defined as the ratio of MDD to ADD for a given year. MDD usually occurs during the warmest summer months. Similarly, a water distribution system's "maximum hour" is marked by the largest volume of water used during any one hour period during the year, and most often occurs in the morning during MDD conditions. In this Master Plan, the MHD peaking factor is expressed as the ratio of MHD to ADD. This Master Plan presents both ratios.

For this Master Plan, the 2004 Draft California Waterworks Standards, developed by the Sacramento Office of Regulations of the Department of Health Services (DHS), were used to determine MDD and MHD peaking factors. This approach was chosen because Winters does not have a comprehensive record of hourly or daily production at the wells; therefore, the peaking factors could not be calculated using actual well production data.

As noted in the online status table, DHS has completed most of the regulatory process and the 2004 Draft California Waterworks Standards are currently undergoing approval by the DHS Department of Finance. Section 64554 of the 2004 Draft California Waterworks Standards (Appendix A) provides guidelines on how to develop MHD factors when limited demand data is available. Presently, the majority of Winters' water customers are not metered. Therefore, the peaking factors (expressed as ratios to ADD) presented in **Table 2-5** were derived by applying the 2004 Draft California Waterworks Standards to eight to nine years of monthly well production data. These peaking factors were used to develop the hydraulic model.

Because existing and buildout demands are mostly residential, and because metered data were not available for the various user categories in Winters, the MDD and MHD peaking factors presented in Table 2-5 were used for both existing and buildout conditions.

2.3.2 Unaccounted for Water Usage

Unaccounted-for-water usage in a distribution system is defined as the difference between the amount of water entering a system (i.e., water that is produced or purchased) and the amount of water supplied to end users (according to meter and/or billing data), expressed as a percentage. Unaccounted-for-water usage is always present in a water system and can result from many factors, including unidentified leaks in a pipe network, periodic fire-hydrant flushing, unauthorized use, inaccurate and non-functioning meters, etc. It was assumed that 10 percent of the metered well production was lost through the system.

2.4 Average Day Demand - Existing and Buildout Conditions

The existing ADD for the City was developed using monthly well production data. Based on communication with City staff[6], the well production data collected after 1999 was more reliable than previous years' data. Calendar year 2002 represented the highest annual well production between 2000 and 2003. The total well production for 2002 was approximately 622 million gallons (MG), which corresponds to an average daily production of approximately 1.7 million gallons per day (mgd) or 1,180 gallons per minute (gpm). It was assumed that 10 percent of the daily well production is lost in the system (i.e., is unaccounted-for-water), resulting in an ADD of 1.5 mgd, or 1,062 gpm. For individual parcels, ADD was calculated based on land use categories and water use factors (WUFs). The WUFs used in this Master Plan, which are included in **Table 2-4**, were developed based information from the City's General Plan, and from planning criteria for the Cities of Woodland and Milpitas. WUFs for commercial, industrial, and other land use categories were multiplied by a factor of 1.07 to normalize the calculated projections to the assumed Winters' ADD of 1,062 gpm. Table 2-4 summarizes ADD by land use type.

2.4.1 Residential

Residential water use is comprised of two multi-family land uses [medium-high density and high density residential (MHR and HR)], and three single family land uses [medium density, low density, and rural residential (MR, LR, and RR)]. Each of these land uses has two water use components; irrigation and non-irrigation water use.

As shown in Table 2-1, the City's General Plan provides a range of residential densities for residential land use categories, prompting the use of assumed densities for determining the number of dwelling units on residential parcels under buildout conditions (see Table 2-4 for the assumed residential densities). Under existing conditions, numbers of dwelling units (DUs) were known for single family parcels. Therefore, non-irrigation water demands for existing single family parcels were based on known dwelling unit counts and the population densities presented in Table 2-4. For multi-family parcels, numbers of DUs were not available. Non-irrigation water demands for multi-family parcels were therefore based on parcel acreages and the residential and population densities presented in Table 2-4. A non-irrigation, per capita water usage of 100 gpcd was assumed for all residential land uses.

Each single family residential parcel was also assigned an irrigation demand of 165 gpd/DU. This value was calculated based on the existing total ADD and the areal percentage of the service area comprised by single-family parcels. For comparison, the City of Roseville completed a Residential Water Use Study and determined that single family residential irrigation demand was 305 gpd/DU by comparing winter residential water meter data and summer residential water meter data. See the Use Factor Calculation Table in **Appendix A** for further detail. It was assumed that irrigation demands for multi-family parcels were negligible. Residential ADD was therefore calculated for each parcel using the following equations:

[6] Personal email communication with Michael Karoly, Ponticello Enterprises, City of Winters Engineer

Single Family (Medium Density) – Existing Scenarion:
ADD (gpd) = [(number of DUs)(3.0 persons/DU)*(100 gpcd)] + (165 gpd/DU)*

Single Family (Medium Density) – Buildout Scenario (applies to parcels currently vacant):
ADD (gpd) = [(buildout acreage)(residential density[7])*
**(3.5 persons/DU)*(100 gpcd)] + (165 gpd/DU)*

Multi Family – Existing and Buildout
ADD (gpd) = (acreage)(residential density[8])*(3.0 persons/DU)*(100 gpcd)*

2.4.2 COMMERCIAL, INDUSTRIAL, AND OTHERS

With the exception of Public/Quasi-Public (PQP) parcels, non-residential WUFs were derived using standards from the Cities of Woodland and Milpitas, and are presented in Table 2-4. Average day demands for PQP parcels are presented in Table 2-3 and were derived from public facility design criteria provided by the City. An additional demand of 1,300 gpad (0.9 gpm/acre) was added to schools, cemeteries, and community center/parks to account for irrigation demand. Per capita usages of 55 gpd/student and 66 gpd/student were derived from data provided by the City for elementary/middle schools and high schools, respectively. For comparison, current AWWA standards provide per capita usages of 10-30 gpd/student. Estimated existing and buildout ADD values for PQP parcels are presented in Table 2-3.

2.5 Max Day Demand and Peaking Factor

MDD was developed by applying peaking factors defined in the 2004 Draft California Waterworks Standards to monthly-recorded well meter readings from January of 1999 through December of 2002 (see Appendix A for regulations and peaking factor worksheet). The MDD peaking factors for the year with the highest monthly reading were calculated.

The 2004 Draft California Waterworks Standards state that if only monthly data are available, the MDD should be calculated by multiplying the average daily usage during the maximum month times a peaking factor of 1.5. Between January of 1999 and December of 2002, the maximum monthly demand occurred in July 2001. The total production for this month was approximately 90 MG, equaling an average daily usage of 2.9 mgd. It was assumed that 10 percent of the average daily usage during the maximum month became unaccounted-for-water, which yields an adjusted average daily usage of 2.6 mgd. Therefore, the MDD of 3.9 mgd (2,721 gpm) was used in this Master Plan.

Typical MDD for communities around the Sacramento and San Francisco Bay Areas can be up to three times the ADD. Dividing the calculated MDD (2,721 gpm) by the ADD (1,062 gpm) yields a peaking factor of 2.6, which is within the range provided in American Water Works Association (AWWA) standards: 1.5 to 2.8 for MDD:ADD and 2.5 to 4.0 for MHD:ADD.

2.6 Max Hour Demand and Peaking Factor

The 2004 Draft California Waterworks Standards state that if only monthly data are available, MHD should be estimated by multiplying MDD by a peaking factor of 1.5. This approach was chosen for this Master Plan (See Appendix A for regulations and peaking factor worksheet). Based on a MDD

[7] See Table 2-4 for specific land and population based densities
[8] See Table 2-4 for specific land and population based densities

of 3.9 mgd for existing conditions, a value of 5.9 mgd was calculated for the MHD. Dividing the calculated MHD (2,721 gpm) by the ADD (1,062 gpm) yields a peaking factor of 3.9. This peaking factor was also used for buildout demands.

The MHD peaking factor is usually developed from an hourly maximum day demand curve. Estimates of MHD were calculated based on metered maximum hour demands collected by the City over a 10 day period in August of 2003. Well readings were taken from Wells 2 through 6 between the hours of 8:00 AM and 9:00 AM (MHD typically occurs between the hours of 6:00 AM to 9:00 AM). The MHD (i.e., the largest of the combined well production volumes measured during all of the one-hour periods) calculated based on these readings was equal to 2,370 gpm. Considering an average demand of 1,036 gpm (average of ADD data for previous years of record), the calculated MHD peaking factor was 1.95. According to AWWA, the typical range of MHD:ADD ratios in the U.S. is 2.0 to 7.0. Due to the relatively short duration of the field measurements, it is difficult to validate the field measured MHD:ADD ratio. Retrieving hourly production data over several hours in the morning (from 5:00 AM to 9:00 AM) and over a longer number of days would have provided more reliable data for calculating the MHD peaking factor. In the absence of additional data, however, the field measured MHD data collected by the City were not used in the development of the MHD peaking factor. The assumed peaking factors for the 1992 and 2006 Master Plans are summarized in Table 2-5.

Table 2-3: Average Day Water Demand for PQP Parcels

Description	Acreage (acres)	Existing				Future			
		Non Irrigation Demand (gpd)	Irrigation Demand (gpd)	Total Water Demand (gpd)	Total Water Demand (gpm)	Non Irrigation Demand (gpd)	Irrigation Demand (gpd)	Total Water Demand (gpd)	Total Water Demand (gpm)
Shirley Rominger Intermediate School[1,2,4]	12.4	20,000	16,128	36,128	25	38,889	16,128	55,017	38.2
Winters Middle School[1,2,5]	10.7	25,556	13,824	39,380	27.3	33,334	13,824	47,158	32.7
Cemetery[1]	13.1	8,000	16,992	24,992	17.4	8,000	16,992	24,992	17.4
Waggoner Elementary School[1,2,6]	9.2	38,889	11,952	50,841	35.3	38,889	11,952	50,841	35.3
John Clayton Kinder School[1,2,7]	2.2	11,112	2,851	13,963	9.7	27,778	2,851	30,629	21.3
Winters High School[1,3,8]	19.4	41,800	25,200	67,000	46.5	50,000	25,200	75,200	52.2
City Hall/Police Dept.	0.23	906	906	906	0.63	906	906	906	0.63
Yolo County Library	0.31	1,213	1,213	1,213	0.84	1,213	1,213	1,213	0.84
Fire Department	0.33	1,299	1,299	1,299	0.9	1,299	1,299	1,299	0.9
Park/Community Center[1]	7.6	29,556	9,850	39,406	27.4	29,556	9,850	39,406	27.4
Corporation Yard	1.5	5,639	0	5,639	3.9	5,639	5,639	5,639	3.9
Future Agricultural School[1]	9.4	0	0	0	0	6,667	12,240	18,907	13.1
Future Elementary School[1,2]	12.7	0	0	0	0	38,889	16,459	55,348	38.4
Future High School[1]	3.9	0	0	0	0	66,667	0	106,454	74
Landfill (closed) and Future Park[1]	30.5	0	0	0	0	1,000	39,528	40,528	28.1
Future City Facility	30	0	0	0	0	33,333	0	33,000	23
TOTAL				**0.28 mgd**	**194 gpm**			**0.59 mgd**	**408 gpm**

Notes:
1. Additional irrigation demand of 1,300 gpd/acre added to all schools, parks and cemeteries (Cities of Woodlands and Milpitas).
2. Assumes water use of 55 gpd/cap
3. Assumes water use of 66 gpd/cap
4. Existing = 300 students, Buildout = 700 students
5. Existing = 460 students, Buildout = 575 students
6. Existing = 700 students, Buildout = 700 students
7. Existing = 200 students, Buildout = 200 students
8. Existing = 627 students, Buildout = 700 students

Table 2-4: Land Use and Demand Allocations

Land Use Category	Area[1] (acres)		Density		Per Capita Water Usage	Water Use Factor[3]				Average Day Demand			
										Existing[4]		Buildout	
	Existing	Buildout	Residential Density[2] (DU/net acre)	Population Density (persons/DU)	(gpcd)	Non-Irrigation	Units	Irrigation	Units	(MGD)	(gpm)	(MGD)	(gpm)
Rural	0	47	1	3.5	100	350	gpd/DU	165	gpd/DU	0.00	0	0.02	17
Low Density	89	299	7.3	3.5	100	350	gpd/DU	165	gpd/DU	0.23	156	1.01	705
Medium Density	196	314	8	3.5	100	350	gpd/DU	165	gpd/DU	0.57	395	1.06	733
Med-High Density	16	69	6.1	3	100	300 or 1,830	gpd/DU or gpad	-	-	0.03	20	0.13	88
High Density	15	41	10.1	3	100	300 or 1,830	gpd/DU or gpad	-	-	0.05	32	0.12	86
Residential Subtotal	**316**	**770**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.88**	**603**	**2.34**	**1,629**
Neighborhood	4	22	-	-	-	2,038	gpad	-	-	0.01	5	0.04	31
Central Business Dist.	46	63	-	-	-	2,038	gpad	-	-	0.08	59	0.13	89
Highway Service	1	6	-	-	-	2,038	gpad	-	-	0.00	1	0.01	8
Planned	0	24	-	-	-	2,038	gpad	-	-	0.00	0	0.05	34
Planned/Bus Park	0	54	-	-	-	2,038	gpad	-	-	0.00	0	0.11	76
Commercial Subtotal	**51**	**169**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.09**	**65**	**0.34**	**238**
Light	0	65	-	-	-	2,185	gpad	-	-	0.00	0	0.14	99
Heavy	0	37	-	-	-	5,651	gpad	-	-	0.00	0	0.21	145
Industrial Subtotal	**0**	**102**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.00**	**0**	**0.35**	**244**
Public/Quasi Public	280	399	-	-	Varies[4]	-	-	1,300	gpad	0.28	194	0.59	410
Large Users (Mariani)	N/A	N/A	-	-	-	-	-	-	-	0.16	111	0.16	110
Office	4	5	-	-	-	3,233	gpad	-	-	0.01	10	0.02	12
Agriculture	0	4	-	-	-	-	-	2,971	gpad	0.00	0	0.01	9
Parks & Recreation	14	145	-	-	-	-	-	7,585	gpad	0.11	79	1.10	821
Open Space	49	188	-	-	-	-	-	-	-	0.00	0	0.00	0
Vacant	1,068	0	-	-	-	-	-	-	-	0.00	0	0.00	0
Other Subtotal	**1,415**	**741**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.56**	**394**	**1.88**	**1,362**
TOTAL	**1,782**	**1,782**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.53**	**1,062**	**4.91**	**3,473**

Notes:
1. Land use areas derived from City of Winters 1992 General Plan and June 2003 General Plan Amendment Map.
2. Applied to currently vacant residential parcels under buildout conditions
3. WUFs include irrigation demand, where applicable, and are expressed in gpd/DU for residential and gpad for multi-family residential and all other uses.
4. See Table 2-3 for additional detail.

Table 2-5: Master Plan Peaking Factors

RECOMMENDED PEAKING FACTORS FOR EXISTING AND BUILD OUT CONDITIONS				
	Existing Conditions		Buildout Conditions	
	MDD:ADD	MHD:ADD	MDD:ADD	MHD:ADD
2006 Master Plan	2.6	3.9	2.6	3.9
1992 Master Plan	2.0	3.5	2.0	3.5
AWWA	Max Day (1.5 - 2.8)		Max Hour (2.5 – 4.0)	

Notes:
1. See Appendix A for DHS Peaking Factor calculations.

2.7 Pressure Criteria

Water system pressure criteria are used to evaluate the ability of the system to provide adequate pressures at points of delivery to customers under various demand conditions. It is important that the water pressure in a consumer's residence or place of business be neither too low nor too high. The desired range should encompass ADD, MDD, and MHD conditions. The desired range of pressure for water distribution systems, excluding fire flow conditions, is defined in AWWA Manual M32 as 30 to 90 psi. However, operating pressures for a water distribution system typically range from a minimum of 20 psi to a maximum of 80 psi depending on conditions. The recommended pressure criteria for this Water Master Plan are presented in **Table 2-6** and discussed in further detail below.

2.7.1 Maximum Pressure

Maximum static (no flow) pressures for distribution systems vary widely in the industry and are subject to local topography and pumping requirements. The AWWA manual does not provide recommendations for maximum static pressure. However, section 1007 of the Uniform Plumbing Code requires pressure-regulating valves on individual service connections where delivery pressures are greater than 80 psi. High pressures may cause faucets to leak, valve seats to wear out quickly, or water heater pressure relief valves to discharge. In addition, abnormally high pressures can result in water being wasted in system leaks. Section 8-10 of the City of Winters Design Standard manual provides a maximum service pressure of 100 psi during normal day operations.

2.7.2 Minimum Pressure

Minimum pressure required during Max Day Demand conditions should be adequate to meet customer needs. Typically, 40 psi is recommended as a minimum level of service for Max Day Demand conditions. In addition to the Max Day Demand criterion of 40 psi, many water systems in the Bay Area follow the recommended AWWA minimum pressure criterion for Max Hour of 30 psi. Pressure below 30 psi causes annoying flow reductions when more than one water-using device is in service. According to the City of Winters Design Standard manual, the minimum level of service for average day operations is 50 psi. Currently, there are no requirements to meet level of service criteria under MDD or MHD conditions at service connections. For the purposes of this Master Plan, MDD and MHD pressure criteria of 40 psi and 30 psi, respectively, were assumed.

2.7.3 Fire Flow Pressure

The ability to provide adequate minimum pressure for a water distribution system during fire suppression events is a basic indicator of acceptable distribution system performance. Adequate pressures during fire events are required to both suppress the fire and maintain positive pressure, with a margin of safety, throughout the distribution system. A minimum system pressure of 20 psi is recommended by federal and state agencies for fire emergency conditions. Additionally, City design standards require a minimum pressure at the fire hydrant location of 20 psi under simultaneous MDD and fire flow conditions. The model scenarios presented in this Master Plan pair MDD conditions with fire flows; therefore, a minimum pressure criterion of 20 psi was assumed for all MDD/fire flow scenarios. Because fires are not scheduled events, fires may occur when a well is out of service. For the purposes of this Master Plan, the fire scenarios were evaluated with the nearest well out of service.

Table 2-6: Pressure Criteria

PRESSURE CRITERIA		
Demand Scenario	**Pressure** (psi)	**Comments**
Normal	50 - 60	
Max Day + Fire Flow	20 (minimum)	With nearest well out of service
Max Hour	30 (minimum)	

2.8 Pipeline Velocity and Headloss Criteria

Pipeline flow velocity and headloss criteria are interrelated because headloss is a function of velocity and pipe roughness. As defined in the City of Winters Design Standard Manual, minimum pipe sizes of 8 and 6 inches for looped systems and dead end pipes not connected to the system, respectively, were the criteria used in the hydraulic model. The recommended pipe roughness coefficient, also defined in the City of Winters Standard, is 125 for cement-lined, polyvinyl chloride, and ductile iron pipes. Because pipe age and material data were not available, C-values of 125 were initially assigned throughout the City, and then adjusted during model calibration.

The allowable pipe headloss and water velocity are not specifically defined in the City of Winters design criteria. The AWWA Manual M32 sets an acceptable maximum velocity in pipe segments of 10 feet per second (fps). As velocities increase beyond 10 fps, pipe head losses increase dramatically and problems with water hammer develop.

For this Master Plan, the maximum headloss criterion was also used to evaluate the performance of the distribution system. Measured headloss exceeding 10 feet per 1,000 feet of pipe may indicate insufficient pipeline capacity.

CHAPTER 3 HYDRAULIC MODEL DEVELOPMENT

Chapter Synopsis: This chapter discusses the hydraulic model development process used to ensure that the physical model simulates 2002 conditions as accurately as possible. It also includes discussions on hydrant and pump test data input in H_2OMap Water for calibration and modeled scenarios (see also Chapter 4).

3.1 Software and Key Model Components

A steady state hydraulic model was developed as part of this Water System Master Plan using H2OMap Water Version 5.0. The model of the water system includes all pipes. Pipeline layout under buildout conditions was modeled using the 2003 Water System CAD Atlas as well as proposed design plans provided by the City for future residential tracts including the Creekside, Greyhawk, Callahan, and Winters Highland developments. The Water System CAD Atlas file was created as part of this project from the City's existing water atlas and updated with as-built maps. The CAD file was imported into H2OMap Water and used as a base for developing the existing model with pipe diameter and length information. Nodes in the model represent demand points within the system and were assigned elevations and demands based on available GIS data and land use information, respectively. Water mains south of Grant Avenue were assigned a 4 digit number in the 1,000 series while those located north of Grant Avenue were assigned a 4 digit number in the 2,000 series. Proposed wells were assigned a descriptive identifier. For example, Well #5 was given the identifier, "Well #5". The hydraulic model was run under existing and buildout demand scenarios as described in Table 3-3.

3.2 Well Testing

Well test data was used to establish system pump curves. Pump curve data for each well is provided in Appendix A. During the well testing, flow and pressure readings were taken at each well. These data, coupled with initial water levels within the well casings, were used to establish system pump curves. Table 3-1 shows the assumed well levels and capacities based on collected data.

Table 3-1: Groundwater Elevations and Well Capacities

Existing Well ID	Groundwater Elevation [1] (ft)	Water Elevation inside Well Casing [2] (ft)	Ground Surface Elevation [1] (ft)	Capacity at 50 psi [3] (gpm)	Capacity at 30 psi [4] (gpm)	Horse Power (hp)
2	42	37	130	1,320	1,520	100
3	84	79	134	970	1,170	60
4	76	71	153	825	1,160	75
5	84	79	141	700	960	75
6	69	64	127	1760	2,200	125

Notes:
1. Elevations are above sea level and were provided by City operations/field staff.
2. Assumes a 5-foot drawdown in groundwater elevation through the soil formation, gravel pack, and well casing.
3. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity.'
4. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.

3.3 Hydrant Testing and Model Calibration

With assistance from City field staff, hydrant test data (included in Appendix A) were collected. Two hydrants were opened per test, and the pressure and flow data collected were used to calibrate the model. Estimated C-factors ranged between 70 and 120, with the lowest C-factors located in the downtown areas and the northeastern residential areas. Low C-factors were presumed to be low due to pipe age and/or proximity to Well #3. The H_2OMap Water calibration tool was utilized and additional hand calibration was performed to refine model results. As shown in Table 3-2, modeled results were, on average, within 10 percent of the actual field measurements. Based on RMC's experience with other water master plans, models with calibration results within 10 percent of actual field results are considered accurate and reliable for this level of system planning.

Table 3-2: Fire Flow Data – Field vs. Modeled Results

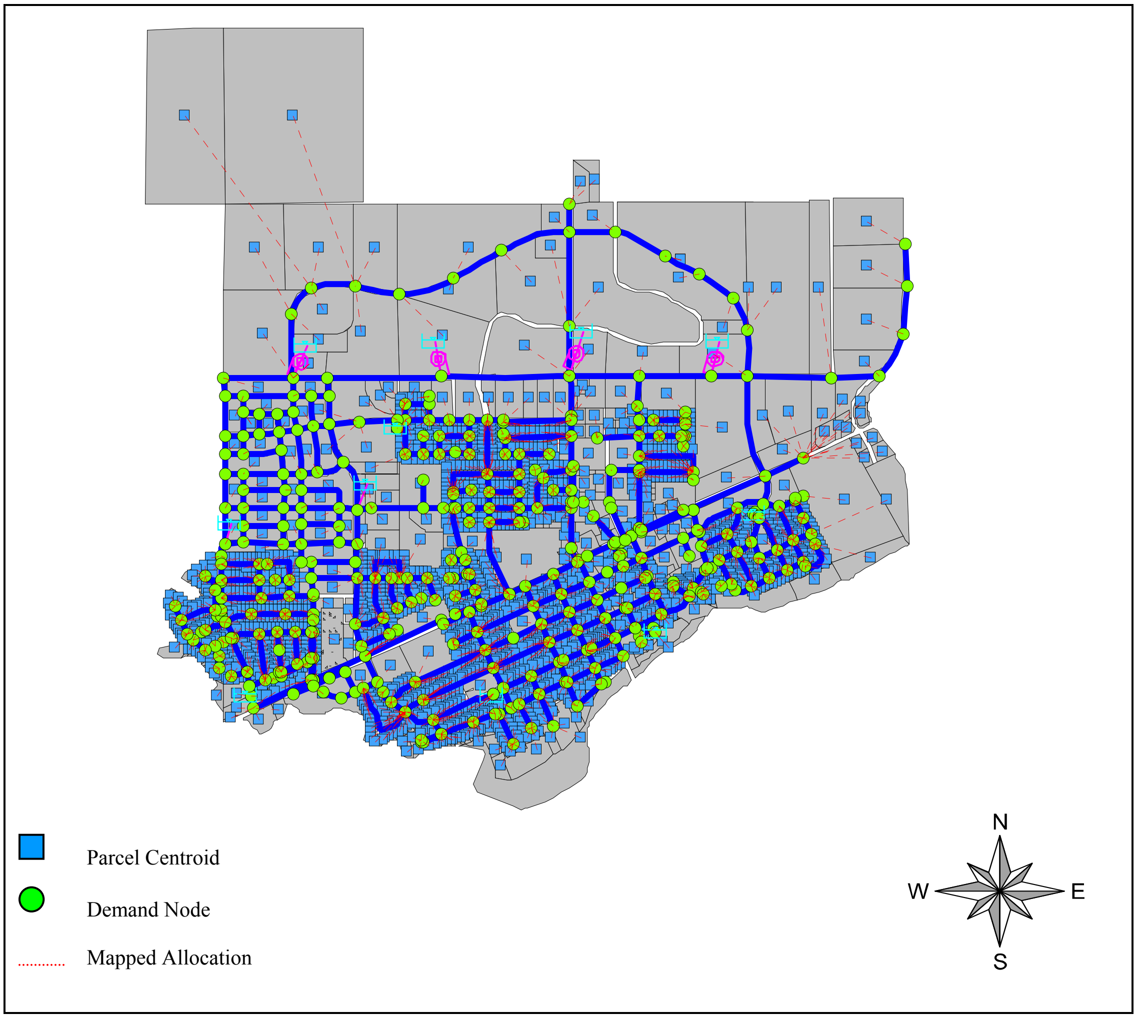
Fire Flow Test[1]	Flowing Hydrant Flowrate (gpm)	Residual Pressure at Hydrant (psi)		% Difference
		Field	Modeled[2,3]	
1	805 750	38	34	11
2	626 789	51	48	6
3	715 715	50	49	2
4	584 598	35	32	9
5	904 452	42	37	12
			Average	**8 %**

Notes:
1. Two hydrants were opened during each test.
2. Under existing MHD conditions
3. Assumes a 5-foot drawdown in groundwater elevation through the soil formation, gravel pack, and well casing.

3.4 Demand Allocation

Demands were allocated using the H_2OMap Water demand allocation tool. Demands were assigned to each parcel, and each parcel was assigned to the nearest node. Water usage factors, discussed previously in Chapter 2, were assumed for each land use type. Figure 1 in TM 1A (included in Appendix D) shows demand allocation mapping for the system.

Figure 3-1: Demand Allocation Mapping



3.5 Modeled Scenarios

The model scenarios shown in Table 3-3 were run in order to identify deficiencies with the existing system and under buildout conditions. Recommendations for improvements were made based on the system's ability to operate efficiently during critical demand conditions, such as MDD plus fire flow and MHD conditions. The results of these demand scenarios were also used to evaluate whether the existing hydraulic components meet the City's current design criteria. MHD conditions were simulated for both existing and buildout conditions. Fire flow scenarios 1 through 9 were performed under existing conditions. Fire flow scenarios 10 and 11 were performed under buildout conditions.

Table 3-3: Modeled Demand Scenarios

PROPOSED DEMAND SCENARIOS			
Scenario	**Demand Conditions**	**Minimum Pressure Criteria**	**Location of Study Hydrants (Fire Flow)**
Existing Max Hour	Max Hour w/all wells operating	30 psi @ service connection	
Fire #1	Max Day w/Fire at City Hall w/Well #3 out of service	20 psi @ hydrant	First and Main Streets (2,000 gpm)
Fire #2	Max Day w/fire near Mariani Storage and Shipping w/Well #2 (Fire #2A) or #6 (Fire #2B) out of service	20 psi @ hydrant	Baker St. (1,500 gpm) and Edwards St. (1,500 gpm)
Fire #3	Max Day w/fire in western residential area w/Well #4 out of service	20 psi @ hydrant	Jefferson or Mac Arthur St. (1,500 gpm)
Fire #4	Max Day w/fire in eastern residential area w/Well #6 out of service	20 psi @ hydrant	Wild Rose Lane (1,500 gpm)
Fire #5	Max Day w/fire in northeastern residential area w/Well #6 out of service	20 psi @ hydrant	Orchard Lane (1,500 gpm)
Fire #6	Max Day w/fire in northwestern residential area w/Well #5 out of service	20 psi @ hydrant	Village Cr. (1,500 gpm)
Fire #7	Max Day w/fire near Winters High School w/Well#6 out of service	20 psi @hydrant	Railroad St. between Grant St. (Route 128) and Anderson Ave. (2,000[1])
Fire #8	Max Day w/fire near John Clayton school w/Well#6 out of service	20 psi @hydrant	Edwards St. between 3rd and 2nd St. (2,000 gpm)[1]
Fire #9	Max Day w/fire near Wagoner School w/Well #4 out of service	20 psi @hydrant	Grant St. at the intersection of Grant St. and Cemetery Dr. (2,000 gpm)[1]
Buildout Max Hour	Max Hour w/all wells operating	30 psi @service connection	
Fire #10	Max Day w/fire in future northwestern residential area w/Future Well out of service	20 psi @ hydrant	West side of Winters Highland Callahan Development (1,500 gpm)
Fire #11	Max Day w/northeastern industrial fire w/Future Well out of service	20 psi @ hydrant	Located off of proposed 14-inch pipeline (3,000 gpm)

Notes:
1. The City does not currently have a specific fire flow requirement for schools. A maximum fire flow requirement of 2,000 gpm was assumed.

CHAPTER 4 MODEL RESULTS

Chapter Synopsis: This chapter presents the results of the water system analysis that identified conveyance and pumping capacity deficiencies. The descriptions of the individual projects and the rationale for identifying improvements are also discussed. Table 4-1 , Table 4-2, and Appendix B show model results for existing and buildout scenarios described above in Table 3-3.

4.1 Existing System Deficiencies

4.1.1 Maximum Hour Demands

Based on modeled results, MHD conditions can be met while maintaining a system pressure of 55 psi throughout the system, surpassing the criterion of 30 psi. The lowest of the modeled pressures under MHD conditions are found in the western part of the town, where elevations are highest.

4.1.2 Residential Fire Flows

Under existing conditions, modeled results show that during Fire Scenario #5, which features an out-of-service Well #6, the system is unable to meet the minimum fire flow requirement of 1,500 gpm. Model results show that the pressure at the hydrant was negative which indicates that the hydrant will not be able to meet the pressure criteria at the required flow rate. The lack of redundancy in the Almond Lane loop promulgates this deficiency. When the vacant parcel to the north of Almond Lane is developed, this deficiency will be mitigated by creating redundancy.

As shown in Appendix B, system pressures across the City during Fire Scenario #5 ranged between 5 and 45 psi, well below the City's normal level of service. This widespread decrease in pressure is caused by Well #6 being out of service, which forces the remaining wells to operate on the "right-hand side" of their pump curves (i.e., higher flows, but lower pressures) to meet the system demands.

4.1.3 School and City Hall Fire Flows

While the minimum pressure criterion of 20 psi is met during both the school fire flow (Fire #7) and City Hall fire flow (Fire #8) scenarios, the results indicate that a 2,000 gpm fire flow stresses the existing wells' ability to provide an adequate supply with Well #6 out of service. Pressures throughout the system in both scenarios range from about 20 psi to 35 psi. Again, the results show that the system depends, to a large extent, on Well #6.

4.1.4 Industrial Fire Flows

As expected, level of service issues are further exacerbated with fire flow demands of 3,000 gpm coupled with Wells #2 or #6 being out of service. Again, the results make it apparent that the existing system depends to a large extent on Well #6. This is primarily due to the larger capacity of Well #6 and the condition of the pipes located within its immediate vicinity. Pipes located near Well #6 are new (and smoother) when compared to older pipes in other parts of town. As shown in the Fire #2A and #2B figures of Appendix B, system pressures dropped below 15 psi at the flowing hydrants. Approximately 'half' of a well (approximately 660 gpm) is necessary to solve this deficiency.

Table 4-1: Model Results Under Existing Conditions

MODELED DEMAND SCENARIOS AND RESULTS					
Scenario Name	**Node ID**	**Demand Conditions**	**Minimum Pressure Criteria**	**Location of Study Hydrants (Fire Flow)**	**Pressure Criteria Met?**
Existing Max Hour	N/A	Max Hour w/all wells operating	30 psi @ service connection		Yes
Fire #1	J-2413 J-1275	Max Day w/Fire at City Hall w/Well #3 out of service	20 psi @ hydrant	First and Main Streets (2,000 gpm)	Yes
Fire #2A	J-2409 J-1091	Max Day w/fire near Mariani Storage and Shipping w/Well #2 out of service	20 psi @ hydrant	Baker St. (1,500 gpm) and Edwards St. (1500 gpm)	No
Fire #2B	J-2049 J-1091	Max Day w/fire near Mariani Storage and Shipping w/Well #6 out of service	20 psi @ hydrant	Baker St. (1,500 gpm) and Edwards St. (1,500 gpm)	No
Fire #3	J-2404	Max Day w/fire in western residential area w/Well #4 out of service	20 psi @ hydrant	Jefferson or Mac Arthur St. (1,500 gpm)	Yes
Fire #4	J-1207	Max Day w/fire in eastern residential area w/Well #6 out of service	20 psi @ hydrant	Wild Rose Lane (1,500 gpm)	Yes
Fire #5	J-2237	Max Day w/fire in northeastern residential area w/Well #6 out of service	20 psi @ hydrant	Orchard Lane (1,500 gpm)	No
Fire #6	J-2405	Max Day w/fire in northwestern residential area w/Well #5 out of service	20 psi @ hydrant	Village Cr. (1,500 gpm)	Yes
Fire #7	J-2417 J-1077	Max Day w/fire near Winters High School w/Well#6 out of service	20 psi @ hydrant	Railroad St. between Grant St. (Route 128) and Anderson Ave. (2,000 gpm[1])	Yes
Fire #8	J-2419 J-1243	Max Day w/fire near John Clayton school w/Well#6 out of service	20 psi @ hydrant	Edwards St. between 3rd and 2nd St. (2,000 gpm[1])	Yes
Fire #9	J-2095 J-2107	Max Day w/fire near Wagoner School w/Well #4 out of service	20 psi @ hydrant	Grant St. at the intersection of Grant St. and Cemetery Dr. (2,000 gpm[1])	Yes

Notes:

1. The City does not currently have a specific fire flow requirement for schools. A maximum fire flow requirement of 2,000 gpm was assumed

4.2 Buildout System Deficiencies

Model results under Buildout conditions are presented in Table 4-2, and in the following discussion.

Table 4-2: Model Results Under Buildout Conditions

MODELED DEMAND SCENARIOS					
Scenario Name	**Node ID**	**Demand Conditions**	**Minimum Pressure**	**Location of Study Hydrants**	**Criteria met?**
Buildout Max Hour w/5 new wells[1]	N/A	Buildout Max Hour w/ all existing wells and 5 new wells operating	30 psi at service connection	N/A	No
Buildout Max Hour w/6 new wells[1]	N/A	Buildout Max Hour w/ all existing wells and 6 new wells operating	30 psi at service connection	N/A	Yes
Fire #10	J-2471	Max Day w/ fire in future northwestern residential area w/Future Well A out of service	20 psi at hydrant	South of Moody Slough Rd. in Winters Highland (1,500 gpm)	Yes
Fire #11	J-2565	Max Day w/northeastern industrial fire w/Future Well F out of service	20 psi at hydrant	Northern portion of County Road 90 (3,000 gpm)	Yes

Notes:
1. A capacity 1,320 gpm was assumed for each new well.

The results from the Buildout Max Hour with 5 New Wells (Appendix B) show that five new wells are not adequate to meet the future Buildout Max Hour demands. The results from Buildout Max Hour with 6 New Wells (Appendix B) show that six new wells will meet the future Buildout Max Hour demands. Modeled wells, shown in **Figure 4-1**, were located by spreading the new wells throughout the buildout areas. Well locations were kept as far west as possible, however, because buildout areas in the western end of the City will be difficult to serve due to higher ground elevations. The exact location of each future well will depend on various factors, and can be adjusted to meet development configurations.

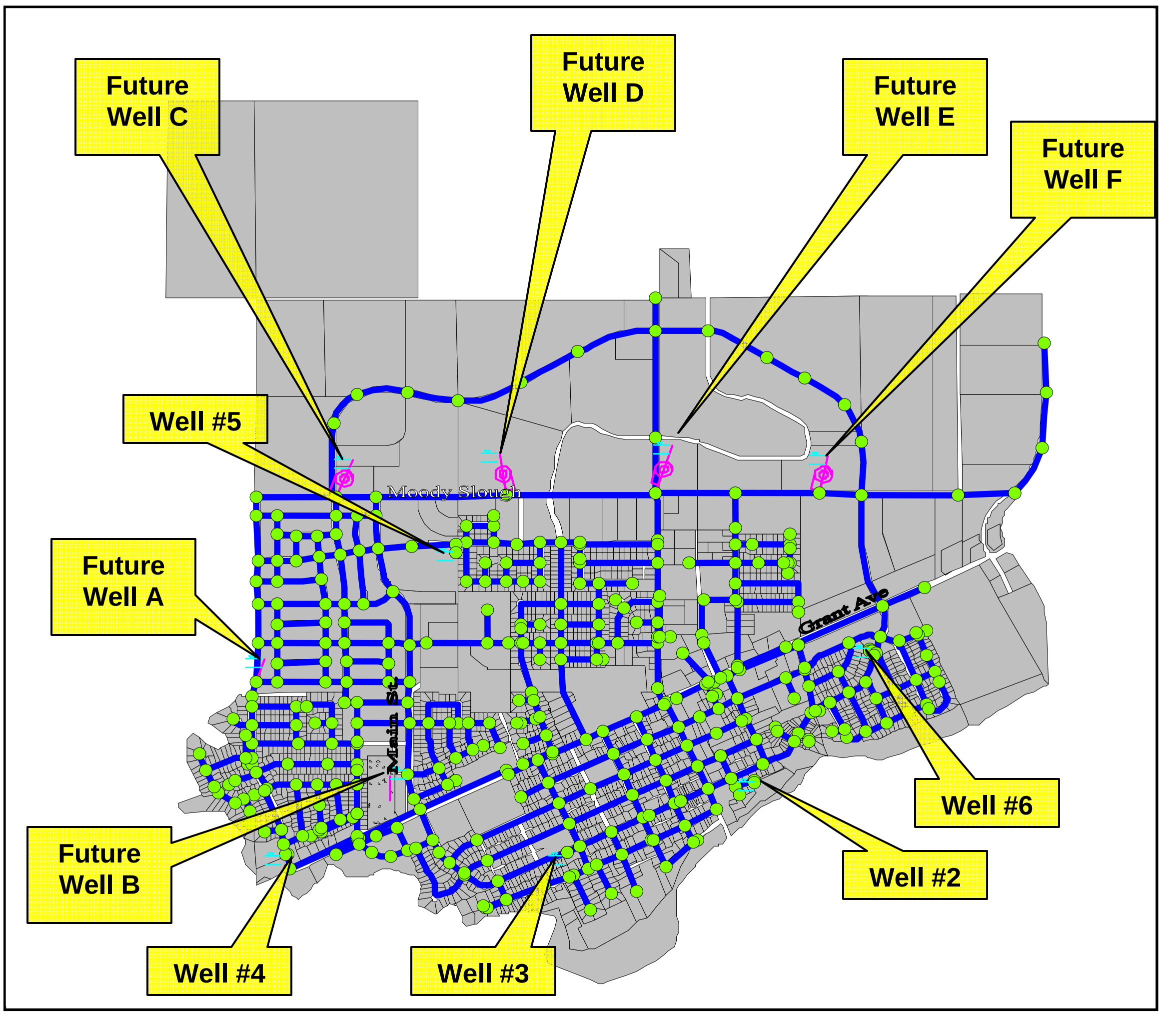
For the purposes of this Master Plan, each future well was assumed to be able to deliver water into the system at the same pressures and capacities as existing Well #2 (refer to Table 4-3). During the design of the new wells, however, this capacity should not be considered an upper limit. Rather, the capacity of the new wells should be sized to reliably deliver the maximum amount of water possible at adequate pressures.

Table 4-3: Groundwater Elevations and Well Capacities

Future Well ID	Assumed Groundwater Well Elev. (ft)[1]	Ground Surface Elev. (ft)[1]	Capacity at 50 psi[2] (gpm)	Capacity at 30 psi[3] (gpm)
A	80	165	1,320	1,520
B	55	140	1,320	1,520
C	77	162	1,320	1,520
D	55	140	1,320	1,520
E	42	127	1,320	1,520
F	42	127	1,320	1,520

Notes:
1. Above sea level
2. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
3. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.

Figure 4-1: Modeled Wells



CHAPTER 5 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

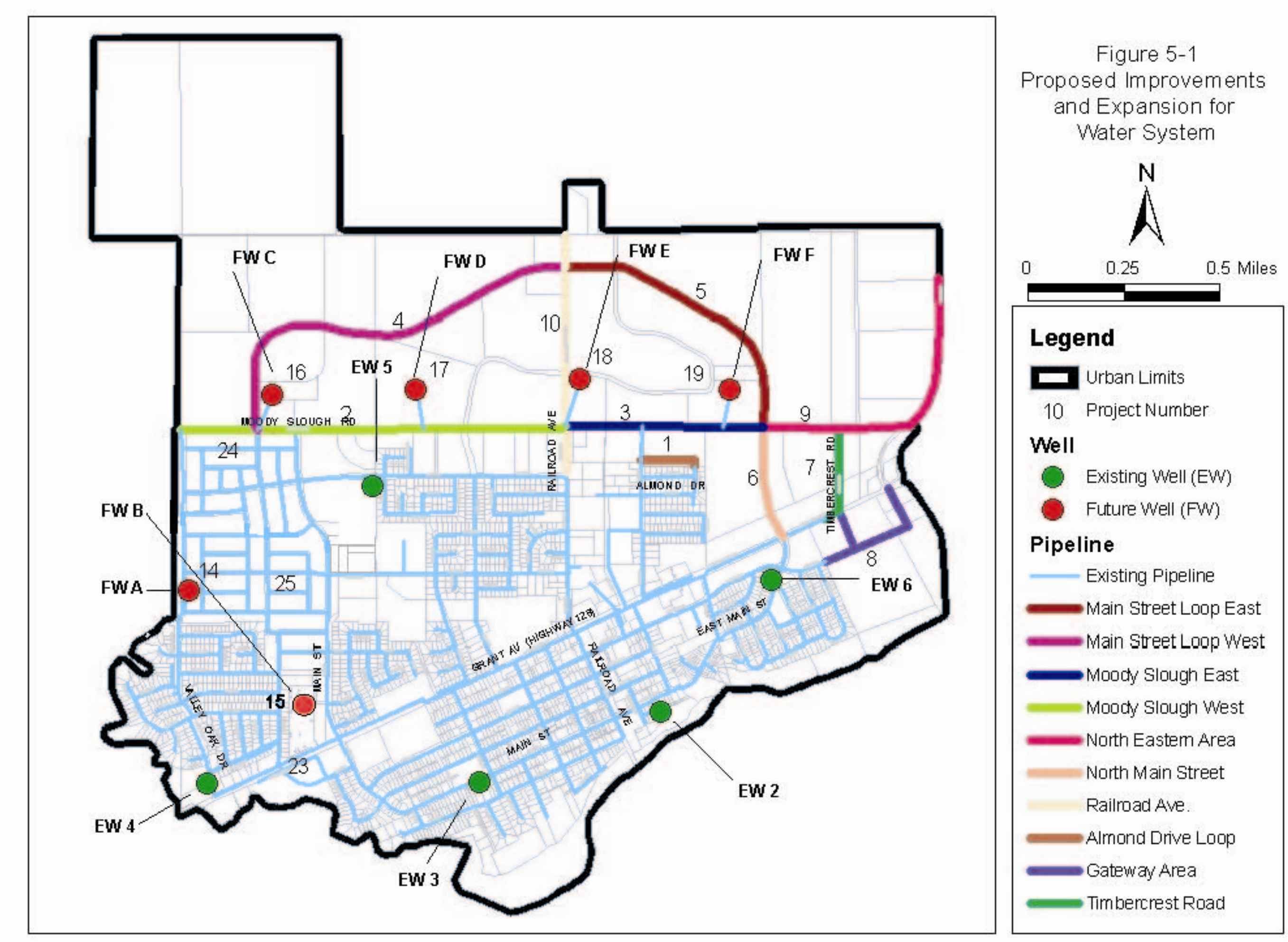
Chapter Synopsis: This chapter represents a summary of capital improvement projects recommended based on the existing and anticipated buildout deficiencies as outlined in the Sections 4.1 and 4.2. The projects highlighted in Figure 5-1 and listed in Table 5-1 were identified as projects that would provide additional capacity, improve conveyance, and ensure overall system control and reliability. Projects presented in Table 5-1 are not listed in order of priority.

Table 5-1: Proposed Projects

Project[1] ID	Project	Proposed Diameter (in)	Proposed Capacity (gpm)	Length (ft)	Existing or Buildout
1	Almond Drive Loop Water Main	8	-	800	Existing
2	Moody Slough (West) Water Mains	14	-	5,300	Buildout
3	Moody Slough (East) Water Mains	14	-	2,700	Buildout
4	Main Street Loop (West) Water Mains	14	-	5,700	Buildout
5	Main Street Loop (East) Water Mains	14	-	4,100	Buildout
6	North Main Street Water Mains	14	-	1,600	Buildout
7	Timbercrest Road Water Mains	14	-	1,200	Buildout
8	Gateway Area (14-inch) Water Mains	14	-	1,600	Buildout
	Gateway Area (8-inch) Water Mains	8	-	1,100	Buildout
9	North Eastern Area Water Main	14	-	4,200	Buildout
10	Railroad Ave Water Mains	14	-	2,700	Buildout
11[3]	8" Pipe Replacement	8	-	18,390	Existing
	12" Pipe Replacement	12	-	5,700	Existing
	14" Pipe Replacement	14	-	7,300	Existing
12	Residential Water Use Study	-	-	-	Buildout
13	Removal of Elevated Water Tanks	-	-	-	Existing
14	Future Well A	-	1,320	-	Buildout
15	Future Well B	-	1,320	-	Buildout
16	Future Well C	-	1,320	-	Buildout
17	Future Well D	-	1,320	-	Buildout
18	Future Well E	-	1,320	-	Buildout
19	Future Well F	-	1,320	-	Buildout
20	System Control and Data Acquisition (SCADA)	-	-	-	Buildout
21	Major Well Maintenance/Rehabilitation	-	-	-	Existing (50%) and Buildout (50%)
22	Portable Emergency Generator	-	-	-	Existing
23	Creekside Water Mains[2]	Varies	-	-	
24	Winters Highlands Water Mains[2]	Varies	-	-	
25	Callahan Estates Water Mains[2]	Varies	-	-	
26	Urban Water Management Plan	-	-	-	Buildout

1. Projects are not presented in order of priority.
2. Development currently in planning phase. Pipeline lengths are not included in this report.
3. For more information regarding these recommendations, refer to the City's *1992 Water System Master Plan Pipe Replacement Recommendations* (Appendix E) and Figure 5-2: Existing System Pipeline Replacement Program.

Figure 5-1: Proposed Improvements and Expansions



5.1 Existing Water Conveyance Improvements

As discussed in Sections 4.1.2 and 4.1.3, the City's conveyance system experienced difficulty when conveying fire flows through the downtown areas and near the Almond Lane Loop. It is therefore recommended that the City implement two pipeline replacement projects to correct these deficiencies. The Almond Lane Loop project (Project 1) would involve extending the existing 8-inch water main approximately 600 feet west on Almond Drive to the 12-inch water main located on Walnut Lane. The new tie-in would provide additional flow during a fire located in the nearby residential area.

To provide improved conveyance in the downtown areas, it is recommended that the City implement a Water Main Replacement Program. This program, described in more detail in Section 5.4, would involve replacement of aging and/or small diameter pipes throughout the system, particularly in the downtown areas. These improvements would increase fire flow capacity and overall system reliability.

5.2 Existing and Future Well Improvements

Based on hydraulic modeling results, the City will need a total of six additional wells to meet fire flow and customer demand at buildout (Projects 14-19). However, in addition to increasing the number of wells, it is recommended that the City implement additional projects to ensure improved operational control, reliability, and emergency backup capabilities at existing well sites. It is anticipated that the City can meet these requirements by purchasing a single portable backup generator (Project 22) and installing a System Control and Data Acquisition system (SCADA) at each well location (Project 20). The SCADA system would provide the City with operational flexibility by eliminating manual control and establishing network control through a centralized computer system.

To improve overall reliability, it is also recommended that the City establish a Well Maintenance and Rehabilitation Program (Project 21). This program would provide an annual budget for the City to perform as-needed major rehabilitation upgrades, such as replacing mechanical and electrical pump components.

5.3 Future Water System Expansions

Major pipeline expansions will serve future development north of Moody Slough (Projects 2-5 and 10) and development on the eastern end of the City (Projects 6-9). Other proposed expansions will serve residential developments including Winters Highland, Callahan Estates, Creekside Estates, and Ogando/Hudson (Projects 23-25). These expansion projects are shown in Figure 5-1.

5.4 Pipe Replacement Program

The City's 1992 Water Master Plan recommended a pipe replacement program for pipes 30 years old or older (Project 11). A map of the City showing pipes in this category, along with recommended replacement sizes, is shown in **Figure 5-2**. Additional information regarding the replacement program is located in Appendix E.

- The 4- to 8-inch diameter pipe along Edwards Street between Main and East Streets with 12-inch diameter pipe
- The 2- and 4-inch-diameter pipe along Fourth Street between Grant Avenue and Russell Street with 12-inch diameter pipe

- Pipe along Main Street should be replaced with 14-inch diameter pipe
- Existing 2- through 8-inch diameter pipe should be replaced with a minimum 8-inch diameter pipe
- All other pipe larger than 8 inches should be replaced with pipe of the same diameter
- When the mainline is replaced, the adjacent service connections should also be replaced from the mainline to the face of the curb
- Approximately 31,700 feet of pipe should be replaced.

Two of the pipe replacement projects have been completed, as reflected Table 1-1 in Chapter 1. The 6-inch diameter pipe along Walnut Lane north of Grant Avenue has been replaced with 12-inch diameter pipe. The length of replaced pipe is approximately 2,240 feet. This length of pipe is subtracted from 7,940 feet of 12-inch pipe that is to be replaced as described in Appendix E. Additionally, the 4-inch diameter pipe along Russell Street between the west end of Russell Street and Emery Street has been replaced with 8-inch diameter pipe. The length of the replaced pipe is approximately 310 feet. This length is subtracted from the 18,700 feet of 8-inch pipe as described in Appendix E.

The overall length of pipe to be replaced is 31,390 feet, which is reflected in Tables 5-1 and 6-1.

5.5 Additional Recommendations

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

5.5.1 Removal of Elevated Tanks

The City currently owns two elevated water tanks that are no longer in service. Tank 1 is located at the Corporation Yard on Grant Avenue between East and Railroad Streets, and Tank 2 is located at the Well #3 site at the corner of Fourth and Main Streets. Without maintenance, these tanks pose potentially health and safety hazards. It is recommended that the tanks be demolished and removed (Project 13).

5.5.2 Residential Water Use Study

As discussed in Sections 2.4.1 and 2.4.2, irrigation demands of 165 gpd/du and 1,300 gpd/acre were assumed for low/medium/rural residential and park/school parcels, respectively. A Residential Water Use Study (Project 12) would provide the data necessary to refine estimates of actual water use in each of the City's residential zoning classifications, thereby increasing the accuracy and reliability of subsequent updates to this Master Plan. Additionally, the study would allow the City to determine which water conservation programs are most needed.

5.5.3 Urban Water Management Plan

The Urban Water Management Planning Act requires water suppliers with 3,000 or more connections to adopt an Urban Water Management Plan (UWMP). The City of Winters will cross the threshold of 3,000 connections before buildout is reached. Compliance with the Urban Water Management Planning Act will provide the City with the following benefits:

- Framework for regional cooperation and decision making
- Balanced integration of supply and demand management
- Sound basis for water supply assessments (SB 221 and 610 compliance)

- A foundation for securing additional supplies
- Eligibility for state grant or loan funding

It is therefore recommended that the City prepare and adopt an UWMP (Project 26) prior to the year 2010 (assumed year by which 3,000 connections will be reached).

5.5.4 Valve Exercise and Location Program

Regular valve exercising is one method to keep valves in good working condition, as well as to identify broken, inoperable and/or leaky valves. Repairing such valves will help to reduce water quality problems, time needed to repair leaks, and customer service complaints.

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

5.5.5 Main Flushing Program

Periodic flushing of water mains is necessary to prevent potential water quality problems and corrosion caused by sediment buildup and biofilm growth in the distribution system. Periodic flushing also increases flow through pipes by reducing friction losses. It is recommended that the City develop a main flushing program.

5.5.6 Comprehensive Maintenance Plan

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

5.5.7 Leak Detection Program

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

5.5.8 Hydrant Maintenance Program

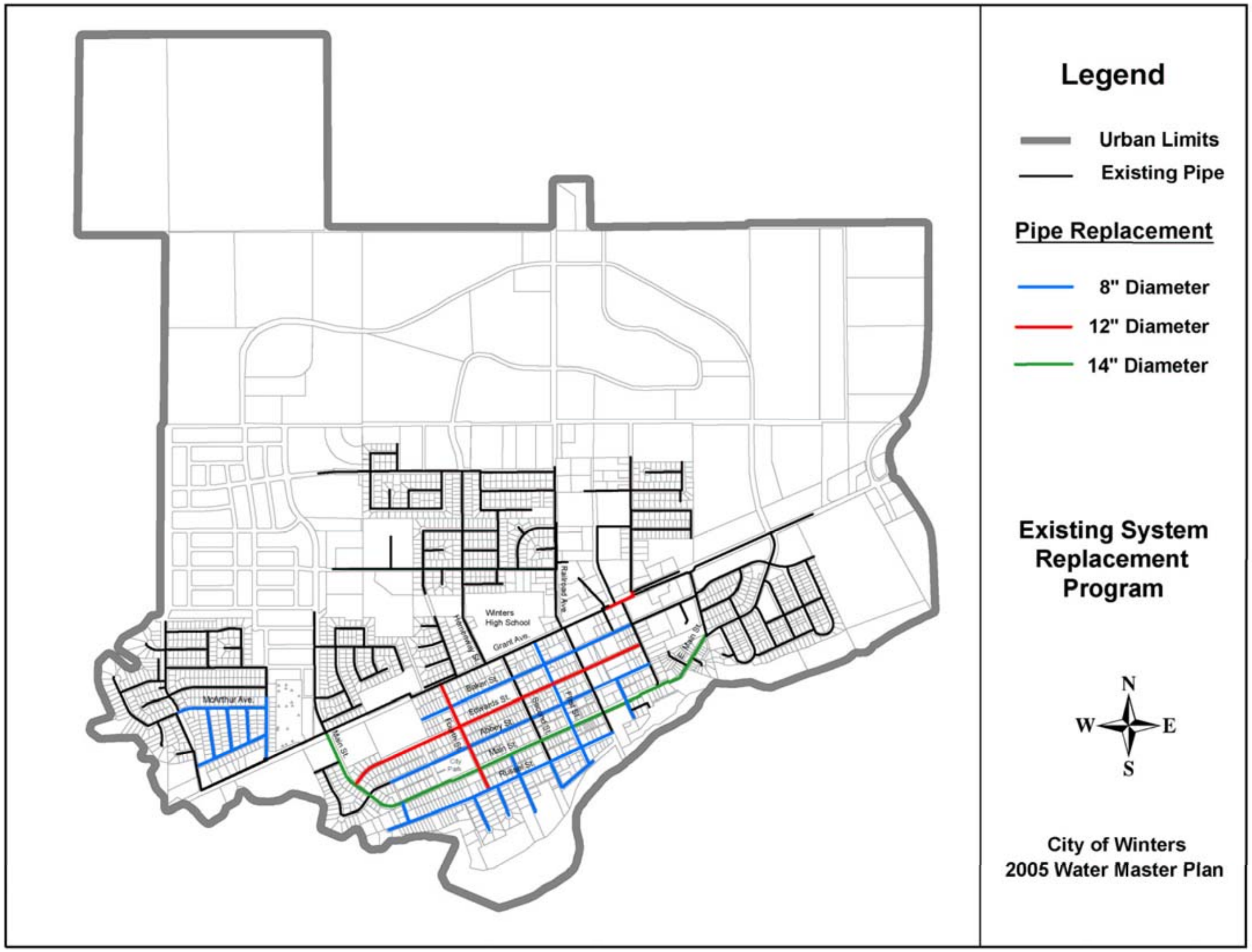
AWWA[9] recommends inspection and testing of hydrants at least once per year to ensure proper functionality during an emergency or scheduled flow test. The City should consider coordinating this effort with the local fire department.

5.5.9 Hydrant and Valve ID Program

As discussed in Section 5.5.6, it is recommended that the City develop a system to track both scheduled and performed maintenance. As part of this effort, it is recommend that the City assign each hydrant and valve an identification number (ID) to ensure efficient tracking of each repair.

[9] AWWA Manual 17, "Installation, Field Testing, and Maintenance of Fire Hydrants, 1989

Figure 5-2: Existing System Pipeline Replacement Program



CHAPTER 6 CAPITAL IMPROVEMENT COSTS

Chapter Synopsis: This chapter presents the cost estimating criteria and estimated project cost for the recommended capacity improvement and expansion projects presented in Chapter 5. Detailed cost breakdown for each project is documented in the project cost spreadsheet in Appendix C.

6.1 Cost Estimation Criteria

Estimated total project costs are presented in Table 6-1. The following cost estimating criteria were used to develop typical planning level capital cost estimates for the identified water system improvement projects.

6.1.1 Water Main, Well, and Other Project Construction Costs

Water main installation costs vary according to several factors including pipe materials, method and duration of construction, traffic control, and street repair. The unit costs used in this Master Plan for installation of water pipes were derived from previous City water projects, but due to the recent bidding climate, a 20% increase in unit costs was applied to historical unit costs. Additional unit costs were added to account for construction in existing roadways.

Well costs also vary according to several factors including location, capacity, and method and duration of construction. Construction costs were determined based on previous City well projects in addition to other similar projects.

For projects such as the Residential Water Use Study, Portable Emergency Generator, Removal of Elevated Tanks, and SCADA implementation, City input, manufacturers information, and other similar projects were used to estimate lump sum costs. As with all planning level costs, these costs should be refined during the CIP implementation period.

6.1.2 Construction Contingency and Project Implementation Multiplier

At the direction of City staff, a construction contingency and project implementation multiplier of 43 percent was applied to each potential improvement project estimated installation cost.[10] The contingency was used to cover:

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

It is assumed that costs for water main construction within Callahan Estates, Winters Highland, and Creekside developments will be paid for by each developer. Hence, those costs have not been included in this master plan.

[10] The City uses an overhead factor of 1.43 in estimating costs for CIP projects.

Table 6-1: Estimated Capital Cost for Water System Projects

PROJECT NO.	DESCRIPTION	DIAMETER/ FIRM CAPACITY (in, gpm)	LENGTH (ft)	ESTIMATED CAPITAL COST
Existing Water Conveyance Improvements				
1	Almond Drive Loop Water Main	8	800	$108,000
11 [a]	8" Pipe Replacement	8	18,390	$2,476,000
	12" Pipe Replacement	12	5,700	$1,119,000
	14" Pipe Replacement	14	7,300	$1,677,000
Existing and Future Well Improvements				
14	Future Well A	1,320	---	$2,572,000
15	Future Well B	1,320	---	$2,572,000
16	Future Well C	1,320	---	$2,572,000
17	Future Well D	1,320	---	$2,572,000
18	Future Well E	1,320	---	$2,572,000
19	Future Well F	1,320	---	$2,572,000
20	System Control and Data Acquisition	---	---	$258,000
21	Major Well Maintenance/Rehab	---	---	$172,000
22	Portable Emergency Generator	---	---	$200,000
Future Water System Expansions				
2	Moody Slough (West) Water Mains	14	5,300	$1,037,000
3	Moody Slough (East) Water Mains	14	2,700	$529,000
4	Main Street Loop (West) Water Mains	14	5,700	$1,114,000
5	Main Street Loop (East) Water Mains	14	4,100	$802,000
6	North Main Street Water Mains	14	1,600	$313,000
7	Timbercrest Road Water Mains	14	1,200	$276,000
8	Gateway Area (14-inch) Water Mains	14	1,600	$312,700
	Gateway Area (8-inch) Water Mains	8	1,100	$110,400
9	North Eastern Area Water Main	14	4,200	$821,000
10	Railroad Ave Water Mains	14	2,700	$528,000
Other Proposed Projects				
12	Residential Water Use Study	---	---	$12,000
13	Removal of Elevated Water Tanks	---	---	$600,000
26	Urban Water Management Plan	---	---	$43,000
			TOTAL	**$27,940,100**

a. Refer to the City's 1992 Water System Master Plan Pipe Replacement Recommendations in Appendix E and Figure 5-2: Existing System Pipeline Replacement Program

APPENDIX A
DESIGN CRITERIA & MODEL INPUT DATA

Section 64554. New and Existing Source Capacity.

(a) At all times, a public water system's water source(s) shall have the capacity to meet the system's maximum day demand (MDD). MDD shall be determined pursuant to subsection (b).

(1) For systems with 1,000 or more service connections, the system shall be able to meet four hours of peak hourly demand (PHD) with source capacity, storage capacity, auxiliary power, and/or emergency source connections.

(2) For systems with less than 1,000 service connections, the system shall have storage capacity equal to MDD, unless the system can demonstrate that it has an additional source of supply or has an emergency source connection that can meet the MDD requirement.

(3) Both the MDD and PHD requirements shall be met in the system as a whole and in each individual pressure zone.

(b) A system shall estimate MDD and PHD for the water system as a whole (total source capacity and number of service connections) and for each pressure zone within the system (total water supply available from the water sources and interzonal transfers directly supplying the zone and number of service connections within the zone), as follows:

(1) If daily water usage data are available, identify the day with the highest usage during the past ten years to obtain MDD; determine the average hourly flow during MDD and multiply by a peaking factor of at least 1.5 to obtain the PHD.

(2) If no daily water usage data are available and monthly water usage data are available:

(A) Identify the month with the highest water usage (maximum month) during at least the most recent ten years of operation or, if the system has been operating for less than ten years, during its period of operation;

(B) To calculate average daily usage during maximum month, divide the total water usage during the maximum month by the number of days in that month; and

(C) To calculate the MDD, multiply the average daily usage by a peaking factor that is a minimum of 1.5; and

(D) To calculate the PHD, determine the average hourly flow during MDD and multiply by a peaking factor that is a minimum of 1.5.

(3) If only annual water usage data are available:

(A) Identify the year with the highest water usage during at least the most recent ten years of operation or, if the system has been operating for less than ten years, during its years of operation;

(B) To calculate the average daily use, divide the total annual water usage for the year with the highest use by 365 days; and

(C) To calculate the MDD, multiply the average daily usage by a peaking factor of 2.25.

(D) To calculate the PHD, determine the average hourly flow during MDD and multiply by a peaking factor that is a minimum of 1.5.

(4) If no water usage data are available, utilize records from a system that is similar in size, elevation, climate, demography, residential property size, and metering to

determine the average water usage per service connection. From the average water usage per service connection, calculate the average daily demand and follow the steps in paragraph (3) to calculate the MDD and PHD.

(c) Community water systems using groundwater shall have a minimum of two approved sources before being granted an initial permit The system shall be capable of meeting MDD (or average day demand) with the highest-capacity source off line.

NOTE: Authority: Section 116375 Health and Safety Code.
Reference: Sections 116275 and 116555, Health and Safety Code.

Peaking Factor Calculations

Peaking factors presented as a ratio to Average Day demand.

Definitions:

MD: Max Day Demand = MMAD x CWW Max Day Factor

MH: Max Hour Demand = MD x CWW Max Hour Factor

MMAD: Max Month Average Day Demand = 1,812 gpm (2.6 mgd) in July 2001

AD: Average Day Demand for 2002 = 1,062 gpm (1.5 mgd)

AF: Average Day Factor = Ratio of MMAD to AD

CWW (California Water Works) Max Day Factor = 1.5

CWW Max Hour Factor = 1.5

Max Day Peaking Factor

AF =MMAD/AD = 2.6 mgd/1.5 mgd =1.7

MD =1.5 x MMAD = 1.5 x 1.7 x AD

Therefore, MD/AD = 1.5 x 1.7 = 2.6

Max Hour Peaking Factor

MH = MD x 1.5

MH = MMAD x 1.5 x 1.5 = 2.25 x MMAD = 2.25 x 2.6 mgd =5.9 mgd

↓ (1.7 x AD)

Therefore, MH = 1.7 x 2.25 x AD and MH/AD = 1.7 x 2.25 = 3.9

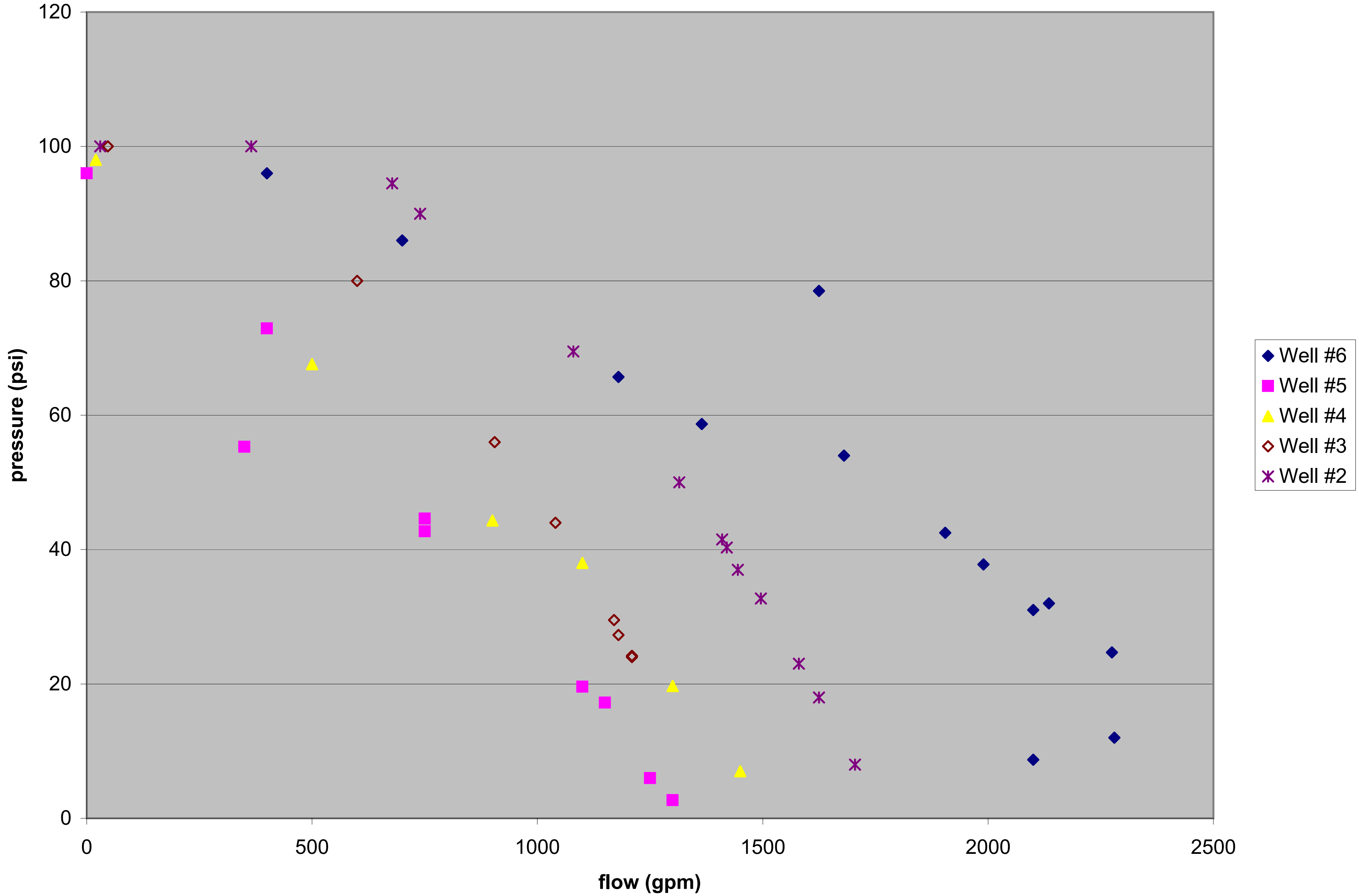
Test Date: October 30, 2003

Hydrant Data Sheet

Test	Hydrant	Time	Outlet Diameter (in)	Location	Static Pressure (psi)	Residual Pressure (psi)	Pitot Pressure (psi)	Outlet Coefficient	Flow (gpm)	Total Flow (gpm)
1	Flow 1		2.5	Kennedy Dr. between Valley Oak Dr. and Hoover St. (J-2361)	N/A	N/A	23	0.9	805	1555
	Flow (B)		2.5	Kennedy Dr. and Taylor St. (J-2021)	N/A	N/A	20	0.9	750	
	Observed			Kennedy Dr. between Taylor and Hoover St. (J-2363)	57	38	N/A	N/A	N/A	
2	Flow		2.5	Russell St. and Main St. (J-1251)	N/A	N/A	23	0.7	626	1415
	Flow (B)		2.5	Third St. and Main St. (J-1057)	N/A	N/A	28	0.8	789	
	Observed			Second St. and Main St. (J-1049)	65	51	N/A	N/A	N/A	
3	Flow		2.5	245 Wildrose Lane (J-2365)	N/A	N/A	30	0.7	715	1430
	Flow (B)		2.5	217 Wildrose Lane (J-2367)	N/A	N/A	30	0.7	715	
	Observed			233 Wildrose Lane (J-1207)	65	50	N/A	N/A	N/A	
4	Flow		2.5	Corner of Almond Dr. and Orchard Lane (J-2373)	N/A	N/A	20	0.7	584	1182
	Flow (B)		2.5	Almond Dr. between Almond Dr. and Walnut Lane (J-2371)	N/A	N/A	21	0.7	598	
	Observed			South East Corner of Almond Dr. (J-2369)	66	35	N/A	N/A	N/A	
5	Flow		2.5	(J-2379)	N/A	N/A	29	0.9	904	1356
	Flow (B)		2.5	Corner of Peach Pl. and Apricot Ave.(J-2375)	N/A	N/A	12	0.7	452	
	Observed			Anderson Ave., and Apricot Ave. (J-2377)	60	42/32	N/A	N/A	N/A	

Test Date: October 30, 2003

Well Pump Station Data (2 Hydrants Flowing)				
Well No.	**Time**	**Discharge Pressure (psi)**	**Discharge Flow (gpm)**	**% VFD Speed (rpm)**
Hydrant Test 1				
3	9:25	62	515	89
	9:30	61	835	93
6	9:25	60	650	85
	9:30	55.5	1700	
Hydrant Test 2				
3	9:58	62	500	88
	10:04	57	880	98
6	9:58	60.4	426	83
	10:04	52.2	1840	100
Hydrant Test 3				
	10:30	62	520	89
3	10:34	59.2	880	96
	10:04	60.2	632	85
6	10:34	48.2	1890	100
Hydrant Test 4				
	10:54	62	515	89
3	11:11	58	865	99
	10:54	59.9	495	83
6	11:11	49.5	1896	100
Hydrant Test 5				
	11:30	62	500	88
3	11:37	59	860	99
	11:30	59.8	490	83
6	11:37	53.4	1815	100



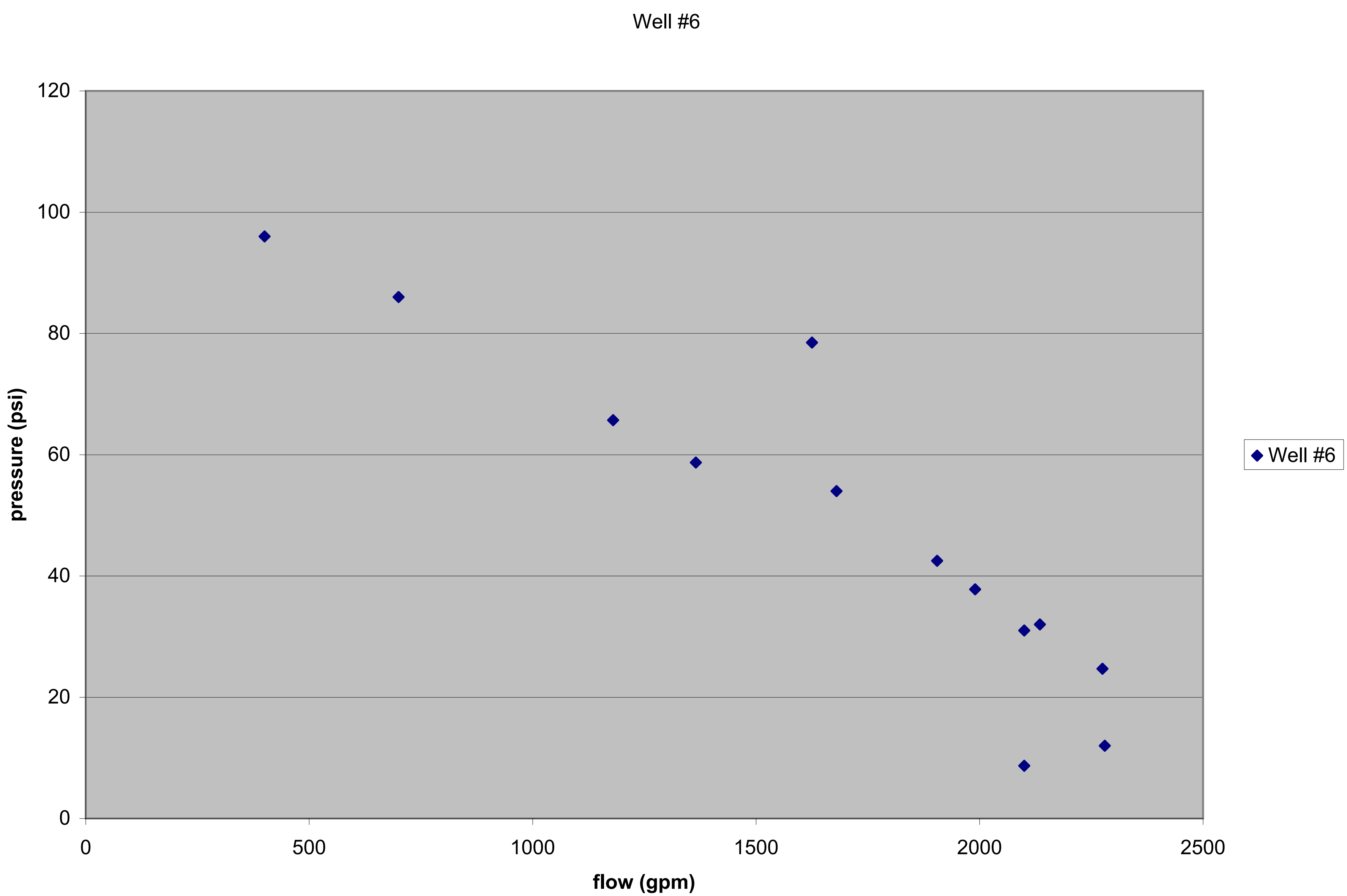
pressure (psi)
flow (gpm)
0
20
40
60
80
100
120
0
500
1000
1500
2000
2500
Well #6
Well #5
Well #4
Well #3
Well #2

WELL #: 6

Well Location	***East Main Street***
Motor Speed	***100%***
Test Date	***7/22/2004***
Test Start Time	***11:55***
Test Stop Time	***12:16***
VALVE LOCATIONS	
1	East Main Street at the intersection of East Main and Blue (?) Lane
2	Maple Lane at the intersection of Maple Lane and Manzanita
3	East of intersection of E. Baker and E. Main Streets
4	West of intersection of E. Baker and E. Main Streets
HYDRANT LOCATIONS	
1	E. Main Street at the intersction of E. Main and E. Baker Streets
2	North end of East Main Street on east side of street
3	North end of East Main Street on west side of street

WELL TEST DATA

Pressure (psi)		Flow (gpm)		Comments
SHUTOFF	**96**	**SHUTOFF**	**400**	
1st Reading	32	1st Reading	2135	1 hydrant w/4.5" fully opened
2nd Reading	24.7	2nd Reading	2275	1 hydrant w/4.5" and 2.5" fully opened
3rd Reading	12	3rd Reading	2280	2 hydrants (1 hydrant w/4.5" and 2.5" fully opened) and (1 hydrant w/4.5" fully opened)
4th Reading	8.7	4th Reading	2100	2 hydrants both w/4.5" and 2.5" fully opened
5th Reading	31	5th Reading	2100	1 hydrant w/4.5" fully opened
6th Reading	37.8	6th Reading	1990	1 hydrant w/4.5" partially opened
7th Reading	42.5	7th Reading	1905	1 hydrant w/4.5" partially opened
8th Reading	54	8th Reading	1680	1 hydrant w/4.5" partially opened
9th Reading	58.7	9th Reading	1365	1 hydrant w/4.5" partially opened
10th Reading	65.7	10th Reading	1180	1 hydrant w/4.5" partially opened
11th Reading	78.5	11th Reading	1625	1 hydrant w/4.5" partially opened
12th Reading	86	12th Reading	700	1 hydrant w/4.5" partially opened



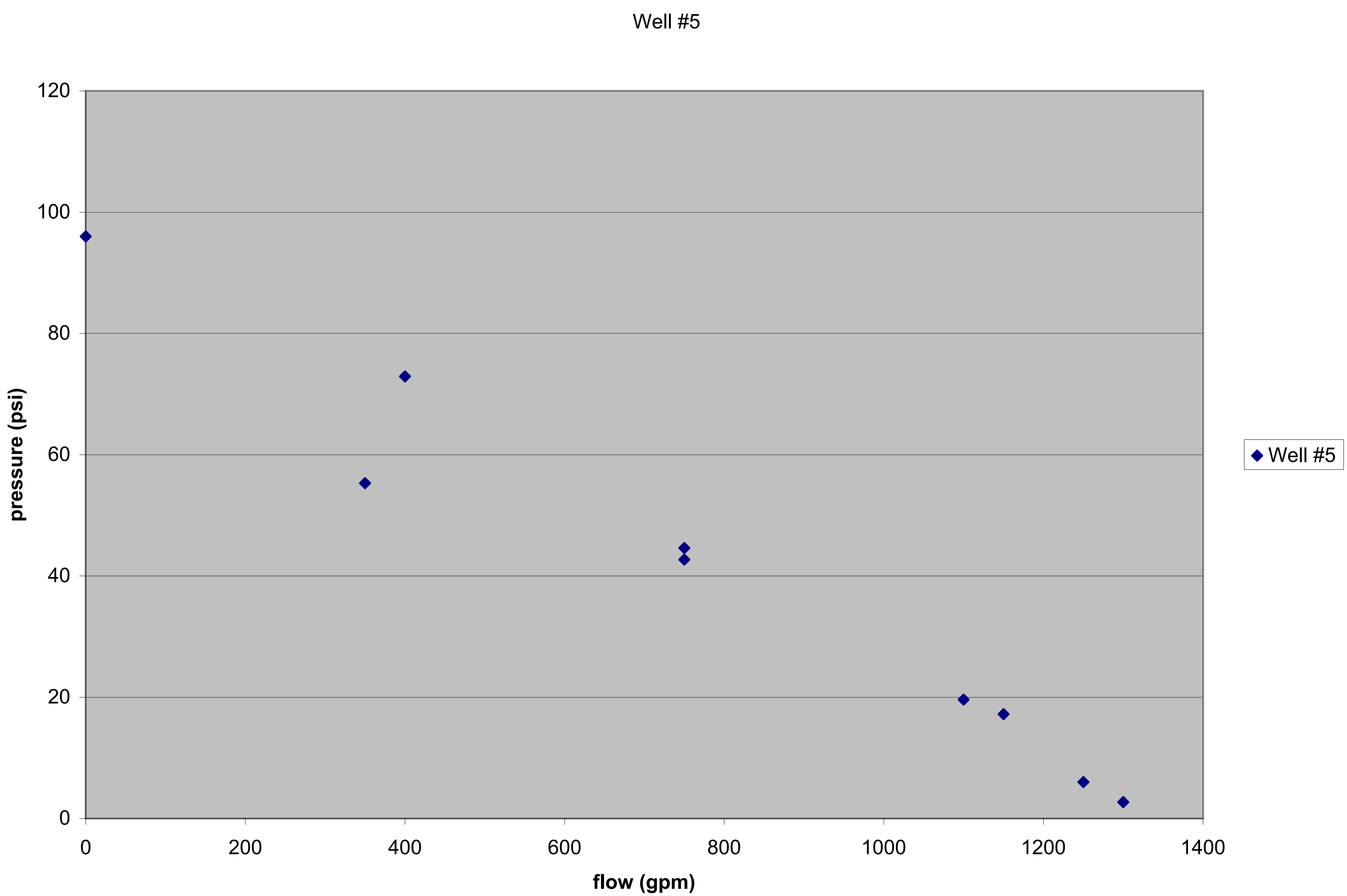
Well #6
120
100
80
60
40
20
0
pressure (psi)
0
500
1000
1500
2000
2500
flow (gpm)
Well #6

WELL #: 5

Well Location	***Nieman Street***
Motor Speed	***100%***
Test Date	***7/22/2004***
Test Start Time	***8:40***
Test Stop Time	***9:11***
VALVE LOCATIONS	
1	Neiman Street, east of Moody Slough Road
2	Village Circle at the intersection of Village Circle and Berryessa C
3	Intersection of Village Circle and Nieman Street
4	
HYDRANT LOCATIONS	
1	West end of Nieman Street
2	Nieman Street between Moody Slough Rd and Village Cr.

WELL TEST DATA

Pressure (psi)		Flow (gpm)		Comments
SHUTOFF	**96**	**SHUTOFF**	**0**	
1st Reading	2.7	1st Reading	1300	1 hydrant w/4.5" partially opened
2nd Reading	6	2nd Reading	1250	1 hydrant w/4.5" partially opened
3rd Reading	17.2	3rd Reading	1150	1 hydrant w/4.5" partially opened
4th Reading	42.7	4th Reading	750	1 hydrant w/4.5" partially opened
5th Reading	19.6	5th Reading	1100	1 hydrant w/4.5" partially opened
6th Reading	55.3	6th Reading	350	1 hydrant w/4.5" partially opened
7th Reading	44.6	7th Reading	750	1 hydrant w/4.5" partially opened
8th Reading	72.9	8th Reading	400	1 hydrant w/4.5" partially opened

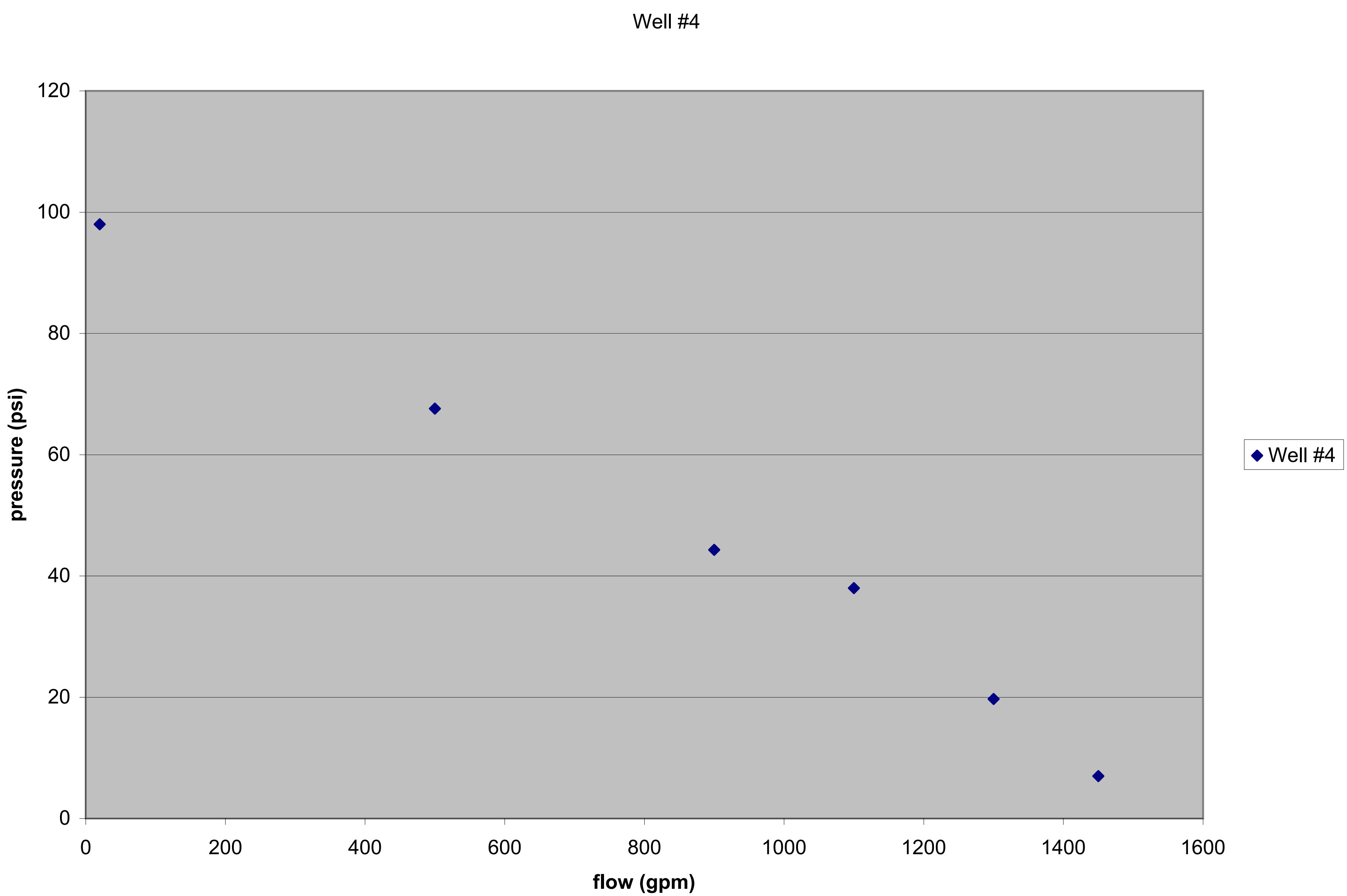

Well #5
120
100
80
60
40
20
0
pressure (psi)
0
200
400
600
800
1000
1200
1400
flow (gpm)
Well #5

WELL #: 4

Well Location	***Valley Oak Drive***
Motor Speed	***100%***
Test Date	***7/22/2004***
Test Start Time	***9:30***
Test Stop Time	***9:52***
VALVE LOCATIONS	
1	Intersection of Valley Oak Drive and Suffolk Place
2	Intersection of Valley Oak Drive and Washington Ave
3	South end of Valley Oak Drive
4	
HYDRANT LOCATIONS	
1	Valley Oak Drive at the intersection of Valley Oak Drive and Suffolk Place
2	Valley Oak Drive at the intersection of Valley Oak Drive and Quail Court

WELL TEST DATA

Pressure (psi)		**Flow (gpm)**		**Comments**
SHUTOFF	**98**	**SHUTOFF**	**20**	
1st Reading	19.7	1st Reading	1300	1 hydrant w/4.5" fully opened
2nd Reading	7	2nd Reading	1450	2 hydrants both w/4.5" fully opened
3rd Reading	38	3rd Reading	1100	1 hydrant w/4.5" partially opened
4th Reading	44.3	4th Reading	900	1 hydrant w/4.5" partially opened
5th Reading	67.6	5th Reading	500	1 hydrant w/4.5" partially opened



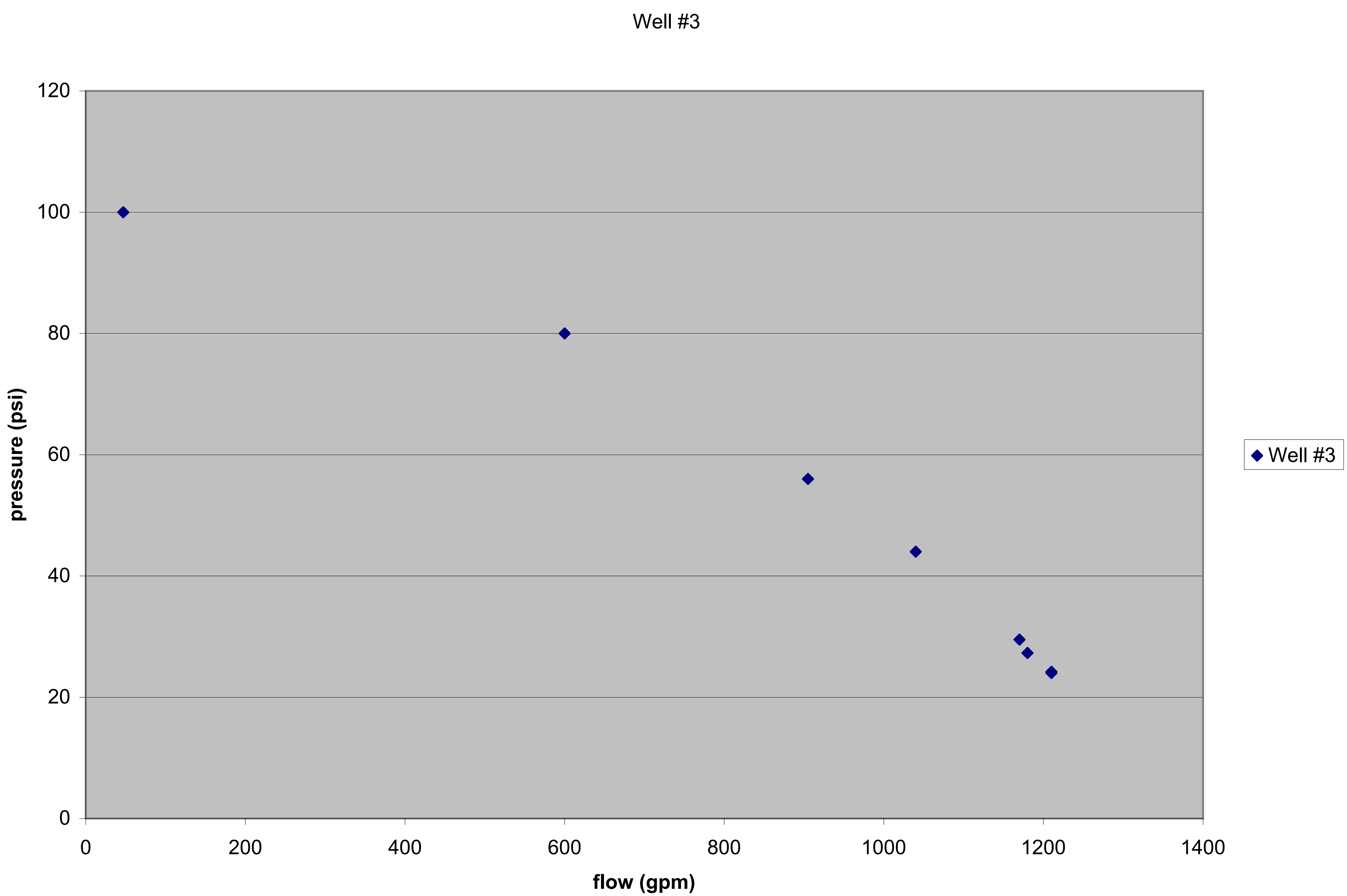
Well #4
120
100
80
60
40
20
0
pressure (psi)
0
200
400
600
800
1000
1200
1400
1600
flow (gpm)
Well #4

WELL #: 3

Well Location	***Main Street***
Motor Speed	***100%***
Test Date	***7/22/2004***
Test Start Time	***10:25***
Test Stop Time	***10:35***
VALVE LOCATIONS	
1	Intersection of Emery and Main Streets
2	Intersection of 4th and Main Streets
3	
4	
HYDRANT LOCATIONS	
1	Main Street between 4th and Haven Streets
2	Main Street between Emery and Haven Streets

WELL TEST DATA

Pressure (psi)		Flow (gpm)		Comments
SHUTOFF	**100**	**SHUTOFF**	**47**	
1st Reading	80	1st Reading	600	1 hydrant w/4.5" partially opened
2nd Reading	56	2nd Reading	905	1 hydrant w/4.5" partially opened
3rd Reading	44	3rd Reading	1040	1 hydrant w/4.5" partially opened
4th Reading	29.5	4th Reading	1170	1 hydrant w/4.5" fully opened
5th Reading	27.3	5th Reading	1180	1 hydrant w/4.5" fully opened and 2.5" partially opened
6th Reading	24.2	6th Reading	1210	2 hydrants (1 hydrant w/4.5" and 2.5" fully opened and 1 hydrant w/4.5" fully opened)
7th Reading	24	7th Reading	1210	2 hydrants (both hydrants w/4.5" and 2.5" fully opened)



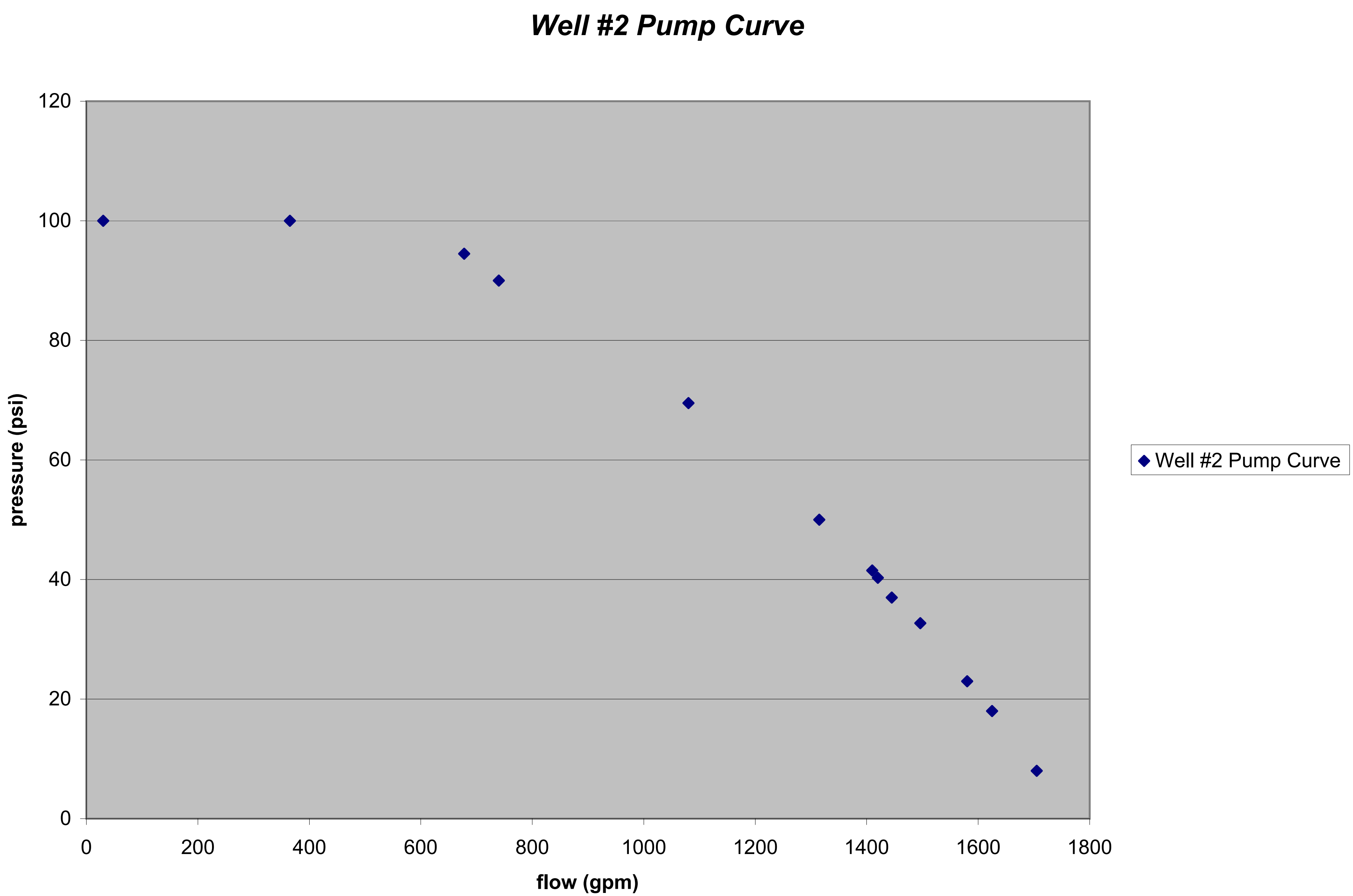
Well #3
120
100
80
60
40
20
0
pressure (psi)
0
200
400
600
800
1000
1200
1400
flow (gpm)
Well #3

WELL #: 2

Well Location	***East Main Street***
Motor Speed	***100%***
Test Date	***7/22/2004***
Test Start Time	
Test Stop Time	***11:30 AM***
VALVE LOCATIONS	
1	Northern corner of Elliot and E. Main Streets
2	Southern corner of Elliot and E. Main Streets
3	Southwest corner of East and East Main Streets
4	
HYDRANT LOCATIONS	
1	East Main Street between East and East Main Steeets
2	Southeasterly end of Elliot Street

WELL TEST DATA

Pressure (psi)		**Flow (gpm)**		**Comments**
SHUTOFF	**100**	**SHUTOFF**	**30**	
1st Reading	100	1st Reading	365	1 hydrant w/4.5" partially opened
2nd Reading	94.5	2nd Reading	678	1 hydrant w/4.5" partially opened
3rd Reading	41.5	3rd Reading	1410	1 hydrant w/4.5" partially opened
4th Reading	32.7	4th Reading	1496	1 hydrant w/4.5" partially opened
5th Reading	37	5th Reading	1445	1 hydrant w/4.5" partially opened
6th Reading	40.3	6th Reading	1420	1 hydrant w/4.5" partially opened
7th Reading	50	7th Reading	1315	1 hydrant w/4.5" partially opened
8th Reading	69.5	8th Reading	1080	1 hydrant w/4.5" partially opened
9th Reading	90	9th Reading	740	1 hydrant w/4.5" partially opened
10th Reading	23	10th Reading	1580	1 hydrant w/4.5" fully opened
11th Reading	18	11th Reading	1625	1 hydrant w/4.5" and 2.5" fully opened
12th Reading	8	12th Reading	1705	2 hydrants (1 hydrant w/4.5" and 2.5" fully opened and 1 hydrant w/4.5" fully opened)


Well #2 Pump Curve
pressure (psi)
120
100
80
60
40
20
0
0
200
400
600
800
1000
1200
1400
1600
1800
flow (gpm)
Well #2 Pump Curve

GATEWAY TO LAKE BERRYESSA

City of Winters
Founded in 1875
Phone: (530)-795-4910
Fax: (530)-795-4935
318 First Street
Winters, CA 95694

Fax

To: Charmin **From:** Terry Vender

Fax: 530-795-4291 **Date:** 7/28/04

Phone: 530-681-2873 **Pages:** 1

Re: Water Well Levels **CC:**

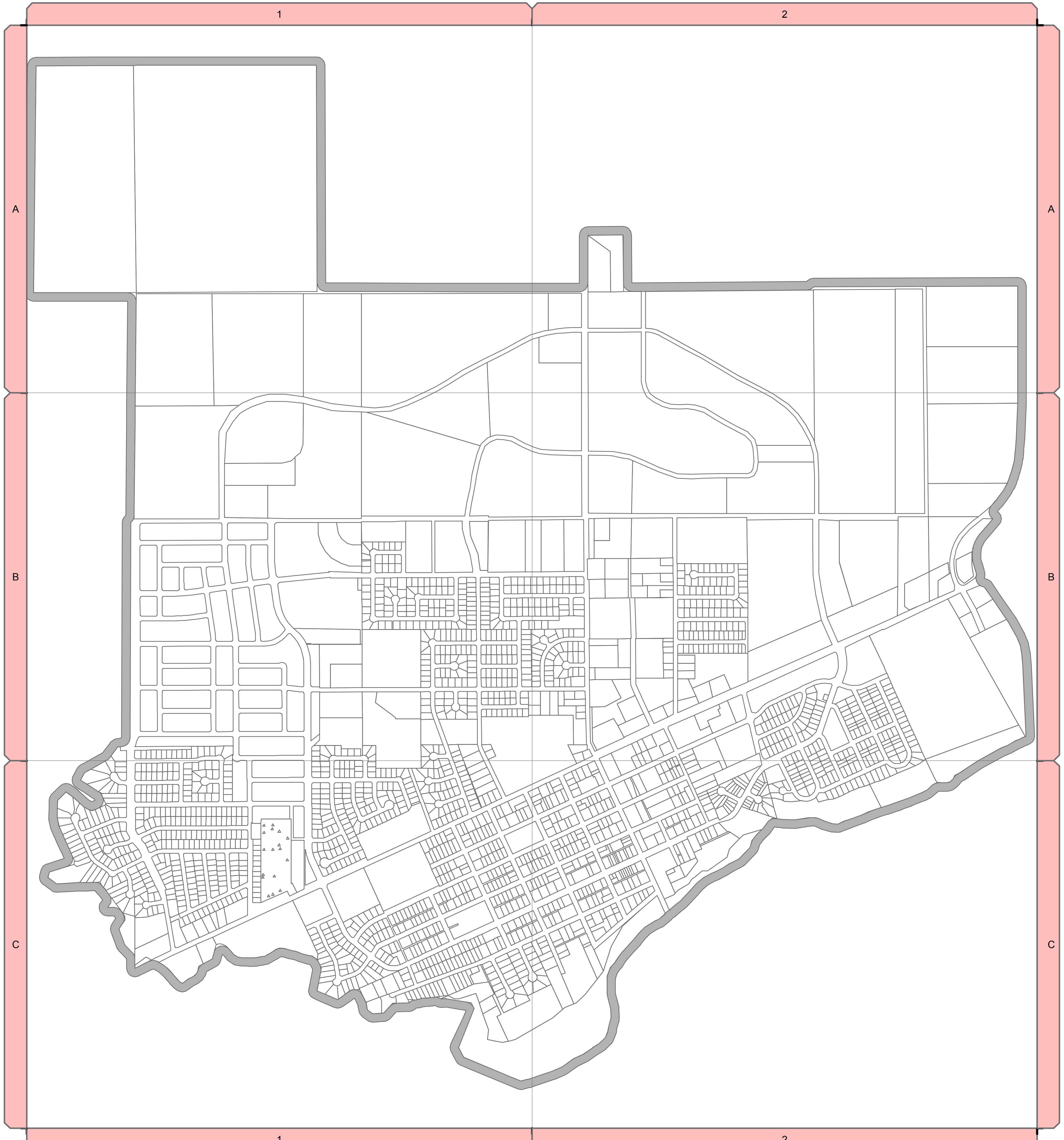
☐ Urgent ☑ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

•Comments:

Water levels
Well # 2 - 85 FT
Well # 3 - 50 FT
Well # 4 - 77 FT
Well # 5 - 58 FT
Well # 6 - 58 FT

City of Winters
Water Master Plan

Parcel Database Overview Atlas

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1963
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707
757
759
1992
1993
1994

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
0	Vacant	MHR	1.972	85,910
1	MR	MR	0.214	9,307
2	MR	MR	0.196	8,536
3	MR	MR	0.181	7,880
4	MR	MR	0.169	7,368
5	MR	MR	0.173	7,531
6	MR	MR	0.189	8,220
7	MR	MR	0.226	9,848
8	MR	MR	0.177	7,702
9	MR	MR	0.186	8,116
10	MR	MR	0.162	7,070
11	MR	MR	0.169	7,353
12	MR	MR	0.172	7,483
13	Vacant	MR	2.147	93,532
14	Vacant	MR	2.428	105,751
15	Vacant	MR	1.250	54,450
16	Vacant	LR	2.090	91,050
17	Vacant	LR	2.214	96,432
18	Vacant	LR	2.313	100,736
19	Vacant	LR	2.463	107,291
20	Vacant	LR	2.473	107,731
21	Vacant	LR	6.648	289,574
22	Vacant	NC	4.413	192,225
23	Vacant	MR	47.030	2,048,610
24	Vacant	OS	25.930	1,129,521
25	Vacant	PQP	30.722	1,338,243
26	Vacant	PQP	12.672	552,013
27	PR	PR	5.183	225,784
28	Vacant	PR	42.809	1,864,768
29	Vacant	HR	5.004	217,962
30	Vacant	MHR	2.058	89,625
31	Vacant	MHR	11.578	504,355
32	Vacant	MHR	24.510	1,067,671
33	Vacant	MHR	2.058	89,625
34	Vacant	PR	14.148	616,280
35	Vacant	PR	42.809	1,864,768
36	Vacant	NC	4.413	192,225
37	Vacant	HI	19.992	870,860
38	Vacant	HR	0.943	41,094
39	Vacant	LR	22.401	975,778
40	Vacant	LR	3.725	162,281
41	Vacant	LR	2.553	111,189
42	Vacant	LR	6.002	261,461
43	Vacant	PQP	29.945	1,304,404
44	Vacant	HSC	1.218	53,035
45	Vacant	OS	3.539	154,163
46	Vacant	HSC	2.213	96,384
47	Vacant	PQP	3.901	169,921
48	Vacant	HR	3.611	157,297
49	Vacant	PR	1.468	63,927
50	Vacant	PC	7.304	318,167
51	PQP	PQP	129.304	5,632,461
52	PQP	PQP	71.224	3,102,539
53	Vacant	HI	17.253	751,548
54	Vacant	LI	16.173	704,489
55	Vacant	LI	21.837	951,199
56	Vacant	LI	6.952	302,849
57	Vacant	LR	5.203	226,663
58	Vacant	HR	3.606	157,092
59	Vacant	HR	1.084	47,211
60	Vacant	LI	2.110	91,908
61	Vacant	HR	0.646	28,158
62	Vacant	PQP	4.215	183,606
63	Vacant	LR	2.806	122,229
64	Vacant	MR	0.162	7,071
65	Vacant	MR	0.142	6,206
66	Vacant	MR	0.142	6,206
67	Vacant	MR	0.142	6,206
68	Vacant	MR	0.138	6,028
69	Vacant	MR	0.191	8,300
70	Vacant	MR	0.185	8,055
71	Vacant	MR	0.149	6,477
72	Vacant	MR	0.180	7,850
73	Vacant	MR	0.178	7,770
74	Vacant	MR	0.178	7,770
75	Vacant	MR	0.198	8,630
76	LR	LR	0.310	13,500
77	LR	LR	1.715	74,701
78	Vacant	HR	1.520	66,220
79	Vacant	MR	0.037	1,593
80	Vacant	MR	0.158	6,888
81	MR	MR	0.184	8,025
82	MR	MR	0.156	6,813
83	MR	MR	0.162	7,055
84	Vacant	MR	0.182	7,941
85	MR	MR	0.178	7,748
86	Vacant	MR	0.180	7,849
87	MR	MR	0.155	6,740
88	Vacant	MR	0.181	7,867
89	MR	MR	0.163	7,086
90	Vacant	MR	0.201	8,759
91	MR	MR	0.166	7,241
92	MR	MR	0.212	9,236
93	MR	MR	0.163	7,109
94	Vacant	MR	0.180	7,833
95	MR	MR	0.171	7,455
96	Vacant	LR	0.340	14,832
97	Vacant	LR	0.834	36,351
98	Vacant	LR	0.441	19,215
99	MR	MR	0.216	9,409
100	MR	MR	0.205	8,942
101	MR	MR	0.167	7,283
102	MR	MR	0.170	7,385
103	MR	MR	0.198	8,616
104	MR	MR	0.164	7,152
105	MR	MR	0.163	7,119
106	MR	MR	0.157	6,848
107	MR	MR	0.192	8,352
108	MR	MR	0.165	7,184
109	MR	MR	0.180	7,819
110	MR	MR	0.172	7,485
111	MR	MR	0.169	7,362
112	MR	MR	0.165	7,193
113	MR	MR	0.159	6,912
114	MR	MR	0.173	7,558
115	MR	MR	0.164	7,153
116	MR	MR	0.169	7,368
117	MR	MR	0.172	7,502

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
118	MR	MR	0.192	8,378
119	MR	MR	0.201	8,758
120	MR	MR	0.165	7,186
121	MR	MR	0.160	6,967
122	MR	MR	0.160	6,987
123	MR	MR	0.172	7,504
124	MR	MR	0.167	7,279
125	MR	MR	0.159	6,923
126	MR	MR	0.174	7,601
127	MR	MR	0.165	7,189
128	MR	MR	0.169	7,379
129	MR	MR	0.163	7,084
130	MR	MR	0.149	6,509
131	MR	MR	0.334	14,530
132	MR	MR	0.197	8,572
133	MR	MR	0.186	8,099
134	MR	MR	0.184	8,002
135	MR	MR	0.201	8,734
136	PQP	PQP	0.163	7,105
137	MR	MR	0.169	7,374
138	Vacant	HR	1.386	60,360
139	MR	MR	0.136	5,935
140	MR	MR	0.132	5,731
141	MR	MR	0.138	5,996
142	MR	MR	0.167	7,254
143	MR	MR	0.182	7,917
144	MR	MR	0.217	9,448
145	MR	MR	0.177	7,727
146	MR	MR	0.178	7,754
147	MR	MR	0.170	7,410
148	MR	MR	0.173	7,520
149	MR	MR	0.177	7,728
150	MR	MR	0.171	7,434
151	MR	MR	0.193	8,389
152	MR	MR	0.163	7,116
153	MR	MR	0.167	7,284
154	MR	MR	0.173	7,535
155	MR	MR	0.173	7,520
156	MR	MR	0.195	8,475
157	MR	MR	0.189	8,223
158	MR	MR	0.170	7,406
159	Vacant	LR	0.648	28,236
160	Vacant	PC/BP	1.080	47,041
161	Vacant	LR	0.619	26,981
162	MR	MR	0.216	9,413
163	MR	MR	0.165	7,207
164	MR	MR	0.160	6,981
165	MR	MR	0.174	7,563
166	MR	MR	0.166	7,237
167	MR	MR	0.167	7,279
168	MR	MR	0.167	7,293
169	MR	MR	0.161	7,002
170	MR	MR	0.158	6,893
171	MR	MR	0.152	6,601
172	MR	MR	0.166	7,217
173	MR	MR	0.156	6,776
174	MR	MR	0.150	6,516
175	MR	MR	0.176	7,683
176	MR	MR	0.210	9,135
177	MR	MR	0.189	8,237
178	MR	MR	0.205	8,948
179	MR	MR	0.143	6,209
180	MR	MR	0.147	6,400
181	MR	MR	0.141	6,135
182	MR	MR	0.227	9,904
183	MR	MR	0.185	8,056
184	LR	LR	0.316	13,752
185	MR	MR	0.190	8,295
186	MR	MR	0.203	8,843
187	MR	MR	0.140	6,090
188	MR	MR	0.139	6,035
189	Vacant	PC/BP	0.974	42,411
190	MR	MR	0.133	5,776
191	MR	MR	0.203	8,861
192	MR	MR	0.172	7,510
193	MR	MR	0.143	6,228
194	MR	MR	0.137	5,989
195	MR	MR	0.191	8,340
196	MR	MR	0.186	8,112
197	MR	MR	0.238	10,371
198	MR	MR	0.219	9,526
199	MR	MR	0.177	7,714
200	MR	MR	0.177	7,718
201	MR	MR	0.171	7,456
202	MR	MR	0.171	7,447
203	MR	MR	0.185	8,051
204	MR	MR	0.173	7,529
205	MR	MR	0.161	7,026
206	MR	MR	0.182	7,925
207	MR	MR	0.199	8,681
208	MR	MR	0.191	8,318
209	MR	MR	0.160	6,972
210	MR	MR	0.164	7,159
211	MR	MR	0.158	6,868
212	MR	MR	0.154	6,723
213	MR	MR	0.171	7,433
214	MR	MR	0.166	7,249
215	MR	MR	0.153	6,679
216	MR	MR	0.176	7,674
217	MR	MR	0.146	6,362
218	MR	MR	0.186	8,093
219	MR	MR	0.166	7,228
220	MR	MR	0.167	7,287
221	MR	MR	0.167	7,296
222	MR	MR	0.207	9,027
223	MR	MR	0.186	8,099
224	Vacant	PC/BP	1.575	68,594
225	MR	MR	0.170	7,384
226	MR	MR	0.147	6,408
227	MR	MR	0.147	6,401
228	MR	MR	0.130	5,660
229	MR	MR	0.169	7,371
230	MR	MR	0.186	8,102
231	MR	MR	0.171	7,441
232	MR	MR	0.175	7,636
233	MR	MR	0.141	6,141
234	MR	MR	0.159	6,925
235	MR	MR	0.131	5,699

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
236	MR	MR	0.164	7,136
237	MR	MR	0.165	7,197
238	MR	MR	0.142	6,182
239	MR	MR	0.149	6,470
240	MR	MR	0.136	5,942
241	MR	MR	0.197	8,596
242	MR	MR	0.177	7,708
243	MR	MR	0.176	7,663
244	MR	MR	0.170	7,422
245	MR	MR	0.169	7,358
246	MR	MR	0.183	7,951
247	MR	MR	0.171	7,455
248	MR	MR	0.161	7,029
249	MR	MR	0.179	7,790
250	MR	MR	0.173	7,557
251	MR	MR	0.197	8,598
252	MR	MR	0.204	8,900
253	MR	MR	0.190	8,275
254	MR	MR	0.177	7,717
255	MR	MR	0.157	6,851
256	MR	MR	0.164	7,144
257	MR	MR	0.156	6,777
258	MR	MR	0.196	8,533
259	MR	MR	0.171	7,462
260	MR	MR	0.177	7,690
261	MR	MR	0.185	8,061
262	MR	MR	0.195	8,504
263	MR	MR	0.165	7,185
264	MR	MR	0.193	8,386
265	MR	MR	0.208	9,045
266	MR	MR	0.184	8,001
267	Vacant	MR	0.137	5,986
268	MR	MR	0.171	7,470
269	MR	MR	0.136	5,917
270	MR	MR	0.150	6,540
271	MR	MR	0.151	6,556
272	MR	MR	0.127	5,538
273	MR	MR	0.156	6,777
274	MR	MR	0.147	6,425
275	MR	MR	0.149	6,502
276	Vacant	PC/BP	0.888	38,675
277	MR	MR	0.173	7,556
278	Vacant	MR	0.179	7,780
279	MR	MR	0.156	6,788
280	MR	MR	0.138	5,995
281	MR	MR	1.331	57,969
282	Vacant	MR	0.140	6,088
283	MR	MR	0.220	9,601
284	MR	MR	0.249	10,864
285	MR	MR	0.206	8,989
286	MR	MR	0.143	6,216
287	MR	MR	0.182	7,911
288	MR	MR	0.139	6,042
289	MR	MR	0.176	7,675
290	MR	MR	0.194	8,472
291	MR	MR	0.160	6,973
292	MR	MR	0.208	9,051
293	MR	MR	0.199	8,690
294	MR	MR	0.165	7,193
295	MR	MR	0.153	6,670
296	MR	MR	0.151	6,575
297	MR	MR	0.181	7,864
298	MR	MR	0.162	7,044
299	MR	MR	0.176	7,669
300	MR	MR	0.170	7,411
301	MR	MR	0.169	7,367
302	MR	MR	0.184	8,030
303	MR	MR	0.165	7,204
304	MR	MR	0.181	7,898
305	MR	MR	0.187	8,137
306	MR	MR	0.180	7,838
307	MR	MR	0.167	7,253
308	MR	MR	0.199	8,676
309	MR	MR	0.164	7,146
310	MR	MR	0.179	7,781
311	MR	MR	0.175	7,613
312	MR	MR	0.175	7,607
313	MR	MR	0.182	7,942
314	MR	MR	0.166	7,230
315	MR	MR	0.184	8,002
316	MR	MR	0.168	7,332
317	MR	MR	0.193	8,407
318	MR	MR	0.182	7,921
319	MR	MR	0.137	5,955
320	MR	MR	0.130	5,649
321	MR	MR	0.282	12,298
322	MR	MR	0.130	5,656
323	MR	MR	0.149	6,482
324	MR	MR	0.188	8,177
325	MR	MR	0.252	10,956
326	MR	MR	0.278	12,089
327	MR	MR	0.185	8,044
328	MR	MR	0.177	7,701
329	MR	MR	0.192	8,371
330	MR	MR	0.195	8,479
331	MR	MR	0.170	7,423
332	MR	MR	0.189	8,252
333	MR	MR	0.195	8,511
334	MR	MR	0.201	8,745
335	MR	MR	0.214	9,325
336	MR	MR	0.184	8,004
337	MR	MR	0.169	7,352
338	MR	MR	0.246	10,708
339	MR	MR	0.185	8,067
340	MR	MR	0.190	8,297
341	MR	MR	0.183	7,991
342	MR	MR	0.189	8,246
343	PQP	PQP	10.694	465,843
344	MR	MR	0.245	10,677
345	MR	MR	0.150	6,518
346	MR	MR	0.090	3,936
347	MR	MR	0.102	4,461
348	MR	MR	0.127	5,543
349	MR	MR	0.152	6,628
350	MR	MR	0.131	5,691
351	MR	MR	0.137	5,946
352	MR	MR	0.139	6,075
353	MR	MR	0.151	6,578

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
354	MR	MR	0.146	6,341
355	MR	MR	0.140	6,085
356	MR	MR	0.137	5,956
357	MR	MR	0.122	5,324
358	MR	MR	0.154	6,719
359	MR	MR	0.166	7,219
360	MR	MR	0.230	10,038
361	MR	MR	0.171	7,457
362	MR	MR	0.152	6,628
363	Vacant	PC	4.442	193,490
364	HR	HR	0.112	4,892
365	HR	HR	3.425	149,202
366	OF	OF	1.139	49,610
367	Vacant	OF	0.609	26,508
368	MR	MR	0.153	6,680
369	MR	MR	0.184	8,018
370	MR	MR	0.197	8,595
371	MR	MR	0.170	7,399
372	MR	MR	0.162	7,058
373	MR	MR	0.184	8,024
374	HR	HR	0.168	7,338
375	MR	MR	0.229	9,965
376	MR	MR	0.180	7,849
377	MR	MR	0.106	4,608
378	MR	MR	0.095	4,136
379	MR	MR	0.142	6,200
380	MR	MR	0.148	6,439
381	MR	MR	0.129	5,639
382	MR	MR	0.157	6,827
383	MR	MR	0.142	6,184
384	MR	MR	0.144	6,282
385	MR	MR	0.133	5,805
386	MR	MR	0.143	6,228
387	MR	MR	0.153	6,684
388	MR	MR	0.133	5,790
389	MR	MR	0.150	6,524
390	MR	MR	0.167	7,261
391	MR	MR	0.154	6,692
392	MR	MR	0.167	7,287
393	MR	MR	0.135	5,899
394	MR	MR	0.163	7,108
395	MR	MR	0.146	6,344
396	MR	MR	0.163	7,105
397	MR	MR	0.148	6,449
398	MR	MR	0.159	6,948
399	MR	MR	0.172	7,499
400	MR	MR	0.135	5,895
401	MR	MR	0.151	6,566
402	MR	MR	0.157	6,833
403	MR	MR	0.154	6,707
404	MR	MR	0.160	6,973
405	MR	MR	0.149	6,491
406	MR	MR	0.159	6,925
407	OF	OF	1.970	85,822
408	MR	MR	0.171	7,457
409	MR	MR	0.156	6,786
410	MR	MR	0.212	9,230
411	HR	HR	0.191	8,329
412	MR	MR	0.163	7,080
413	MR	MR	0.177	7,689
414	MR	MR	0.225	9,819
415	MR	MR	0.193	8,404
416	MR	MR	0.188	8,202
417	MR	MR	0.201	8,777
418	Vacant	PC	5.793	252,345
419	MR	MR	0.183	7,966
420	HR	HR	0.329	14,352
421	MR	MR	0.244	10,641
422	MR	MR	0.165	7,175
423	MR	MR	0.151	6,557
424	MR	MR	0.141	6,132
425	MR	MR	0.164	7,162
426	MR	MR	0.167	7,263
427	MR	MR	0.128	5,592
428	MR	MR	0.145	6,295
429	MR	MR	0.152	6,617
430	MR	MR	0.162	7,071
431	MR	MR	0.179	7,801
432	MR	MR	0.249	10,862
433	MR	MR	0.180	7,849
434	MR	MR	0.146	6,356
435	MR	MR	0.148	6,439
436	MR	MR	0.190	8,264
437	MHR	MHR	0.446	19,425
438	MR	MR	0.175	7,614
439	MR	MR	0.161	7,030
440	MR	MR	0.166	7,216
441	MR	MR	0.196	8,558
442	MR	MR	0.193	8,425
443	MR	MR	0.218	9,507
444	MHR	MHR	0.404	17,584
445	HR	HR	0.197	8,585
446	MR	MR	0.164	7,151
447	MR	MR	0.144	6,263
448	MR	MR	0.302	13,134
449	MR	MR	0.139	6,073
450	MR	MR	0.175	7,619
451	MR	MR	0.162	7,062
452	MR	MR	0.162	7,044
453	MR	MR	0.133	5,798
454	OF	OF	1.338	58,271
455	Vacant	OF	0.213	9,259
456	MR	MR	0.255	11,115
457	MR	MR	0.196	8,546
458	MR	MR	0.152	6,603
459	MR	MR	0.149	6,477
460	MR	MR	0.164	7,142
461	MR	MR	0.171	7,439
462	MR	MR	0.153	6,671
463	MR	MR	0.138	6,017
464	MR	MR	0.149	6,506
465	MR	MR	0.158	6,880
466	MR	MR	0.156	6,787
467	MR	MR	0.144	6,281
468	MR	MR	0.145	6,325
469	MR	MR	0.198	8,612
470	HR	HR	0.251	10,951
471	MR	MR	0.165	7,193

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
472	MR	MR	0.140	6,108
473	MHR	MHR	0.442	19,269
474	MR	MR	0.133	5,790
475	MR	MR	0.146	6,358
476	MR	MR	0.190	8,273
477	CBD	CBD	0.908	39,532
478	MR	MR	0.152	6,635
479	MR	MR	0.137	5,968
480	MR	MR	0.164	7,136
481	MR	MR	0.440	19,186
482	MR	MR	0.171	7,428
483	MR	MR	0.191	8,305
484	MR	MR	0.155	6,752
485	MR	MR	0.140	6,113
486	MR	MR	0.150	6,547
487	MR	MR	0.282	12,294
488	MR	MR	0.160	6,981
489	MR	MR	0.157	6,835
490	MR	MR	0.161	7,030
491	MR	MR	0.201	8,746
492	MR	MR	0.146	6,352
493	MR	MR	0.146	6,348
494	MR	MR	0.192	8,348
495	MR	MR	0.204	8,876
496	MR	MR	0.208	9,069
497	CBD	CBD	2.995	130,443
498	MR	MR	0.150	6,537
499	MR	MR	0.157	6,822
500	CBD	CBD	0.911	39,665
501	Vacant	CBD	2.730	118,931
502	CBD	CBD	2.193	95,527
503	MR	MR	0.219	9,541
504	MR	MR	0.163	7,083
505	MR	MR	0.149	6,497
506	CBD	CBD	0.844	36,771
507	MR	MR	0.179	7,780
508	MR	MR	0.140	6,093
509	Vacant	NC	0.660	28,744
510	MR	MR	0.110	4,772
511	MR	MR	0.189	8,223
512	MR	MR	0.110	4,804
513	Vacant	NC	0.634	27,618
514	MR	MR	0.154	6,727
515	MR	MR	0.123	5,371
516	MR	MR	0.148	6,442
517	MR	MR	0.112	4,899
518	MR	MR	0.272	11,837
519	MR	MR	0.277	12,063
520	MR	MR	0.273	11,909
521	MR	MR	0.637	27,769
522	MR	MR	0.717	31,230
523	MR	MR	0.531	23,117
524	MR	MR	0.166	7,219
525	MR	MR	0.123	5,360
526	MR	MR	0.114	4,986
527	MR	MR	0.120	5,236
528	MR	MR	0.115	5,020
529	MR	MR	0.125	5,455
530	MR	MR	0.145	6,324
531	MR	MR	0.222	9,655
532	MR	MR	0.203	8,855
533	MR	MR	0.204	8,885
534	MR	MR	0.198	8,612
535	MR	MR	0.222	9,674
536	PQP	PQP	3.263	142,119
537	PQP	PQP	9.795	426,666
538	MR	MR	0.196	8,528
539	Vacant	MR	3.450	150,283
540	MR	MR	0.155	6,755
541	MR	MR	0.211	9,191
542	NC	NC	0.076	3,308
543	MR	MR	0.148	6,441
544	MR	MR	0.145	6,317
545	CBD	CBD	1.035	45,103
546	MR	MR	0.178	7,767
547	MR	MR	0.185	8,071
548	CBD	CBD	1.258	54,796
549	CBD	CBD	0.616	26,854
550	MR	MR	0.156	6,813
551	MR	MR	0.171	7,438
552	MR	MR	0.164	7,139
553	MR	MR	0.166	7,220
554	MR	MR	0.117	5,082
555	MR	MR	0.109	4,746
556	MR	MR	0.121	5,261
557	MR	MR	0.111	4,826
558	MR	MR	0.114	4,986
559	MR	MR	0.139	6,039
560	MR	MR	0.148	6,431
561	MR	MR	0.144	6,279
562	MR	MR	0.193	8,425
563	MR	MR	0.200	8,710
564	MR	MR	0.198	8,628
565	MR	MR	0.207	9,001
566	MR	MR	0.193	8,423
567	MR	MR	0.218	9,507
568	MR	MR	0.193	8,388
569	Vacant	PQP	0.431	18,775
570	MR	MR	0.156	6,814
571	CBD	CBD	0.360	15,702
572	MR	MR	0.127	5,533
573	Vacant	CBD	1.458	63,505
574	MR	MR	0.176	7,666
575	MR	MR	0.152	6,635
576	MR	MR	0.150	6,520
577	MR	MR	0.143	6,237
578	MR	MR	0.148	6,441
579	MR	MR	0.168	7,331
580	MR	MR	0.148	6,427
581	Vacant	CBD	1.024	44,610
582	MR	MR	0.161	7,028
583	MR	MR	0.126	5,489
584	MR	MR	0.185	8,037
585	MR	MR	0.165	7,171
586	Vacant	MR	0.378	16,455
587	MR	MR	0.237	10,330
588	MR	MR	0.150	6,545
589	MR	MR	0.188	8,208

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
590	Vacant	CBD	0.606	26,407
591	MR	MR	0.148	6,466
592	MR	MR	0.190	8,282
593	Vacant	PQP	1.605	69,904
594	MR	MR	0.196	8,518
595	MR	MR	0.160	6,951
596	MR	MR	0.143	6,237
597	MR	MR	0.108	4,688
598	MR	MR	0.146	6,345
599	CBD	CBD	0.299	13,044
600	MR	MR	0.156	6,815
601	PR	PR	1.947	84,813
602	MR	MR	0.159	6,915
603	MR	MR	0.144	6,288
604	MR	MR	0.147	6,412
605	MR	MR	0.133	5,782
606	MR	MR	0.126	5,500
607	MR	MR	0.118	5,121
608	MR	MR	0.132	5,771
609	MR	MR	0.122	5,311
610	MR	MR	0.122	5,329
611	MR	MR	0.130	5,650
612	MR	MR	0.118	5,147
613	MR	MR	0.126	5,469
614	MR	MR	0.236	10,265
615	MR	MR	0.274	11,920
616	MR	MR	0.140	6,091
617	MR	MR	0.105	4,573
618	MR	MR	0.146	6,359
619	MR	MR	0.204	8,901
620	MR	MR	0.153	6,656
621	MR	MR	0.104	4,533
622	MR	MR	0.154	6,723
623	MR	MR	0.141	6,154
624	MR	MR	0.219	9,540
625	MR	MR	0.192	8,378
626	MR	MR	0.244	10,632
627	MR	MR	0.168	7,333
628	MR	MR	0.150	6,551
629	MR	MR	0.147	6,425
630	MR	MR	0.122	5,317
631	CBD	CBD	1.137	49,506
632	MR	MR	0.144	6,269
633	MR	MR	0.099	4,326
634	MR	MR	0.212	9,229
635	Vacant	CBD	2.433	105,969
636	MR	MR	0.144	6,252
637	PQP	PQP	17.418	758,722
638	MR	MR	0.205	8,946
639	MR	MR	0.153	6,680
640	MR	MR	0.141	6,147
641	MR	MR	0.162	7,052
642	MR	MR	0.152	6,601
643	MR	MR	0.146	6,371
644	PQP	PQP	4.011	174,730
645	MR	MR	0.083	3,615
646	MR	MR	0.138	6,028
647	Vacant	CBD	1.916	83,481
648	MR	MR	0.220	9,597
649	Vacant	MR	2.728	118,843
650	PR	PR	1.413	61,553
651	MR	MR	0.130	5,664
652	MR	MR	0.139	6,069
653	MR	MR	0.154	6,693
654	MR	MR	0.101	4,402
655	MR	MR	0.160	6,969
656	MR	MR	0.141	6,124
657	MR	MR	0.148	6,434
658	MR	MR	0.079	3,449
659	MR	MR	0.147	6,415
660	HR	HR	3.465	150,919
661	MR	MR	0.208	9,065
662	MR	MR	0.094	4,107
663	MR	MR	0.149	6,508
664	MR	MR	0.146	6,342
665	MR	MR	0.148	6,465
666	MR	MR	0.180	7,829
667	MR	MR	0.176	7,649
668	MR	MR	0.148	6,431
669	MR	MR	0.140	6,095
670	MR	MR	0.150	6,529
671	PQP	PQP	1.047	45,592
672	MR	MR	0.152	6,610
673	MR	MR	0.124	5,409
674	MR	MR	0.192	8,345
675	MR	MR	0.152	6,610
676	MR	MR	0.150	6,524
677	MR	MR	0.146	6,345
678	MR	MR	0.131	5,725
679	MR	MR	0.152	6,622
680	MR	MR	0.150	6,555
681	PQP	PQP	0.406	17,675
682	MR	MR	0.117	5,104
683	MR	MR	0.147	6,403
684	MR	MR	0.172	7,479
685	MR	MR	0.134	5,817
686	MR	MR	0.150	6,517
687	MR	MR	0.152	6,607
688	MR	MR	0.101	4,406
689	MR	MR	0.164	7,166
690	MR	MR	0.128	5,593
691	Vacant	HR	1.884	82,076
692	MR	MR	0.168	7,338
693	MR	MR	0.110	4,784
694	CBD	CBD	0.226	9,864
695	MR	MR	0.162	7,067
696	MR	MR	0.150	6,540
697	MR	MR	0.131	5,712
698	MR	MR	0.160	6,977
699	MR	MR	0.156	6,813
700	CBD	CBD	0.389	16,957
701	CBD	CBD	0.227	9,902
702	MR	MR	0.151	6,579
703	MR	MR	0.099	4,324
704	MR	MR	0.103	4,466
705	MR	MR	0.166	7,230
706	MR	MR	0.111	4,825
707	CBD	CBD	1.515	65,985

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
708	MR	MR	0.149	6,484
709	MR	MR	0.200	8,716
710	MR	MR	0.171	7,449
711	MR	MR	0.226	9,855
712	MR	MR	0.596	25,971
713	MR	MR	0.172	7,484
714	MR	MR	0.144	6,252
715	CBD	CBD	0.413	17,982
716	MR	MR	0.199	8,676
717	MR	MR	0.146	6,353
718	MR	MR	0.211	9,205
719	Vacant	MR	0.204	8,873
720	Vacant	MR	0.207	9,005
721	Vacant	MR	0.213	9,274
722	Vacant	MR	0.271	11,795
723	Vacant	MR	0.142	6,164
724	MR	MR	0.161	7,021
725	Vacant	MR	0.242	10,550
726	MR	MR	0.148	6,434
727	MR	MR	0.142	6,198
728	MR	MR	0.108	4,699
729	MR	MR	0.140	6,104
730	MR	MR	0.514	22,411
731	MR	MR	0.094	4,078
732	MR	MR	0.211	9,209
733	CBD	CBD	0.259	11,265
734	MR	MR	0.153	6,654
735	MR	MR	0.211	9,191
736	Vacant	MR	0.146	6,373
737	Vacant	MR	0.150	6,516
738	Vacant	MR	0.146	6,375
739	MR	MR	0.119	5,171
740	CBD	CBD	0.209	9,088
741	MR	MR	0.150	6,551
742	MR	MR	0.185	8,075
743	CBD	CBD	0.267	11,611
744	MR	MR	0.128	5,595
745	MR	MR	0.240	10,440
746	MR	MR	0.165	7,202
747	MR	MR	0.645	28,076
748	MR	MR	0.131	5,712
749	MR	MR	0.095	4,150
750	Vacant	MR	0.137	5,958
751	CBD	CBD	0.266	11,581
752	MR	MR	0.168	7,310
753	MR	MR	0.140	6,080
754	MR	MR	0.146	6,371
755	CBD	CBD	0.186	8,118
756	MR	MR	0.154	6,710
757	CBD	CBD	1.025	44,656
758	MR	MR	0.114	4,952
759	HR	HR	1.900	82,780
760	CBD	CBD	0.256	11,153
761	MR	MR	0.111	4,847
762	Vacant	MR	0.139	6,049
763	MR	MR	0.185	8,039
764	MR	MR	0.175	7,619
765	MR	MR	0.182	7,929
766	Vacant	MR	0.157	6,841
767	MR	MR	0.221	9,647
768	CBD	CBD	0.240	10,462
769	MR	MR	0.301	13,119
770	CBD	CBD	0.114	4,956
771	Vacant	MR	0.137	5,951
772	MR	MR	0.126	5,505
773	MR	MR	0.205	8,913
774	MR	MR	0.151	6,579
775	MR	MR	0.117	5,088
776	MR	MR	0.146	6,343
777	MR	MR	0.114	4,971
778	CBD	CBD	0.094	4,084
779	MR	MR	0.106	4,624
780	MR	MR	0.203	8,832
781	MR	MR	0.179	7,819
782	CBD	CBD	0.254	11,046
783	MR	MR	0.221	9,613
784	MR	MR	0.145	6,314
785	CBD	CBD	0.105	4,564
786	MR	MR	0.201	8,742
787	MR	MR	0.160	6,962
788	Vacant	MR	0.152	6,642
789	Vacant	MR	0.134	5,831
790	Vacant	MR	0.134	5,827
791	Vacant	MR	0.134	5,824
792	Vacant	MR	0.143	6,232
793	MR	MR	0.442	19,238
794	CBD	CBD	0.233	10,151
795	Vacant	CBD	0.993	43,269
796	CBD	CBD	0.186	8,115
797	MR	MR	0.417	18,173
798	MR	MR	0.107	4,650
799	MR	MR	0.112	4,894
800	MR	MR	0.143	6,211
801	Vacant	MR	0.153	6,668
802	Vacant	MR	0.140	6,097
803	Vacant	MR	0.138	6,000
804	MR	MR	0.183	7,961
805	MR	MR	0.164	7,139
806	MR	MR	0.149	6,503
807	MR	MR	0.146	6,339
808	MR	MR	0.146	6,376
809	MR	MR	0.139	6,035
810	MR	MR	0.161	7,026
811	MR	MR	0.154	6,707
812	CBD	CBD	0.192	8,359
813	MR	MR	0.146	6,374
814	MR	MR	0.143	6,240
815	MR	MR	0.885	38,570
816	Vacant	CBD	0.251	10,951
817	CBD	CBD	0.247	10,750
818	CBD	CBD	0.158	6,871
819	MR	MR	0.177	7,717
820	MR	MR	0.151	6,561
821	MR	MR	0.061	2,648
822	MR	MR	0.149	6,478
823	CBD	CBD	0.144	6,285
824	MR	MR	0.144	6,293
825	MHR	MHR	0.265	11,533

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Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
826	CBD	CBD	1.160	50,525
827	Vacant	MR	0.133	5,811
828	MR	MR	0.155	6,756
829	Vacant	MR	0.150	6,537
830	Vacant	MR	0.143	6,243
831	MR	MR	0.196	8,539
832	Vacant	MR	0.138	6,021
833	MR	MR	0.145	6,312
834	CBD	CBD	0.246	10,720
835	MR	MR	0.454	19,787
836	MR	MR	0.153	6,657
837	MR	MR	0.106	4,613
838	MR	MR	0.209	9,084
839	MR	MR	0.177	7,728
840	MR	MR	0.160	6,984
841	MR	MR	0.335	14,572
842	Vacant	MR	0.217	9,464
843	Vacant	MR	0.169	7,375
844	Vacant	MR	0.144	6,271
845	Vacant	MR	0.144	6,282
846	Vacant	MR	0.144	6,282
847	Vacant	MR	0.144	6,282
848	MR	MR	0.159	6,931
849	CBD	CBD	0.104	4,530
850	Vacant	MR	0.135	5,873
851	Vacant	MR	0.135	5,869
852	Vacant	MR	0.145	6,296
853	Vacant	MR	0.135	5,876
854	CBD	CBD	0.078	3,416
855	MR	MR	0.170	7,401
856	MR	MR	0.807	35,159
857	MR	MR	0.144	6,269
858	CBD	CBD	0.169	7,381
859	MR	MR	0.142	6,191
860	CBD	CBD	0.201	8,772
861	MHR	MHR	0.094	4,109
862	MR	MR	0.100	4,352
863	MR	MR	0.185	8,065
864	MR	MR	0.169	7,378
865	Vacant	MR	0.155	6,745
866	MR	MR	0.143	6,246
867	CBD	CBD	0.177	7,715
868	MR	MR	0.138	6,026
869	MR	MR	0.150	6,514
870	MR	MR	0.144	6,252
871	CBD	CBD	0.270	11,754
872	MR	MR	0.146	6,366
873	MR	MR	0.138	6,027
874	Vacant	MR	0.160	6,987
875	MR	MR	0.158	6,894
876	Vacant	MR	0.152	6,635
877	Vacant	MR	0.147	6,394
878	MR	MR	0.109	4,732
879	MR	MR	0.208	9,060
880	CBD	CBD	0.199	8,655
881	MHR	MHR	0.112	4,892
882	MHR	MHR	0.187	8,166
883	CBD	CBD	0.487	21,197
884	MR	MR	0.495	21,546
885	Vacant	MR	0.472	20,556
886	MR	MR	0.141	6,156
887	MR	MR	0.177	7,711
888	MR	MR	0.158	6,867
889	CBD	CBD	0.742	32,301
890	MR	MR	0.104	4,533
891	MR	MR	0.174	7,561
892	Vacant	MR	0.150	6,518
893	MHR	MHR	0.147	6,418
894	CBD	CBD	0.141	6,123
895	CBD	CBD	0.384	16,742
896	HR	HR	0.217	9,455
897	CBD	CBD	0.155	6,750
898	MR	MR	0.462	20,123
899	MHR	MHR	0.164	7,141
900	MR	MR	0.144	6,293
901	MR	MR	0.158	6,879
902	MR	MR	0.143	6,237
903	MHR	MHR	0.181	7,891
904	MHR	MHR	0.080	3,486
905	MR	MR	0.149	6,501
906	CBD	CBD	0.279	12,140
907	MR	MR	0.136	5,909
908	MR	MR	0.439	19,137
909	MR	MR	0.155	6,749
910	MR	MR	0.151	6,587
911	CBD	CBD	0.861	37,488
912	MR	MR	0.317	13,790
913	MR	MR	0.550	23,976
914	MHR	MHR	0.124	5,386
915	MR	MR	0.162	7,053
916	MR	MR	0.160	6,987
917	Vacant	MR	0.154	6,710
918	MR	MR	0.295	12,833
919	MR	MR	0.162	7,041
920	MHR	MHR	0.083	3,634
921	HR	HR	0.158	6,891
922	Vacant	MR	0.178	7,743
923	Vacant	MR	0.146	6,359
924	Vacant	MR	0.146	6,359
925	Vacant	MR	0.155	6,765
926	Vacant	MR	0.149	6,509
927	Vacant	MR	0.142	6,177
928	MR	MR	0.210	9,145
929	CBD	CBD	0.153	6,683
930	MHR	MHR	0.134	5,820
931	MR	MR	0.145	6,333
932	MR	MR	0.244	10,621
933	MR	MR	0.156	6,795
934	Vacant	MR	0.145	6,323
935	Vacant	MR	0.141	6,162
936	MR	MR	0.170	7,405
937	MR	MR	0.159	6,942
938	MR	MR	0.159	6,933
939	MHR	MHR	0.109	4,763
940	HR	HR	0.329	14,322
941	MHR	MHR	0.191	8,339
942	MR	MR	0.226	9,832
943	HR	HR	0.164	7,131

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
944	MR	MR	0.150	6,555
945	MR	MR	0.242	10,546
946	MR	MR	0.190	8,296
947	CBD	CBD	0.166	7,211
948	MR	MR	0.171	7,441
949	MR	MR	0.144	6,262
950	MHR	MHR	0.078	3,402
951	MR	MR	0.141	6,146
952	MHR	MHR	0.091	3,974
953	MR	MR	0.149	6,479
954	MR	MR	0.138	6,004
955	MR	MR	0.141	6,147
956	MR	MR	0.147	6,394
957	MR	MR	0.183	7,958
958	MR	MR	0.168	7,307
959	MHR	MHR	0.131	5,696
960	MR	MR	0.140	6,108
961	MR	MR	0.166	7,241
962	CBD	CBD	0.252	10,988
963	MHR	MHR	0.088	3,813
964	Vacant	MR	0.154	6,710
965	CBD	CBD	0.172	7,498
966	MR	MR	0.235	10,242
967	MHR	MHR	0.127	5,517
968	Vacant	HR	0.230	10,027
969	CBD	CBD	0.214	9,306
970	Vacant	MR	0.150	6,518
971	Vacant	MR	0.133	5,778
972	MR	MR	0.140	6,118
973	MHR	MHR	0.132	5,764
974	CBD	CBD	0.294	12,803
975	MR	MR	0.210	9,129
976	Vacant	MR	0.137	5,950
977	MR	MR	0.133	5,781
978	LR	LR	0.148	6,460
979	MR	MR	0.152	6,600
980	MR	MR	0.148	6,468
981	MR	MR	0.139	6,076
982	CBD	CBD	0.816	35,527
983	MHR	MHR	0.096	4,180
984	MR	MR	0.142	6,188
985	LR	LR	0.257	11,187
986	MR	MR	0.151	6,558
987	MR	MR	0.102	4,449
988	Vacant	MR	0.162	7,076
989	Vacant	MR	0.215	9,363
990	MR	MR	0.189	8,245
991	Vacant	MR	0.186	8,118
992	CBD	CBD	0.194	8,458
993	MR	MR	0.144	6,278
994	Vacant	MR	0.154	6,710
995	MR	MR	0.186	8,106
996	MR	MR	0.827	36,040
997	CBD	CBD	0.126	5,470
998	MHR	MHR	0.102	4,448
999	LR	LR	0.262	11,423
1000	Vacant	MR	0.121	5,278
1001	MR	MR	0.345	15,011
1002	MR	MR	0.196	8,539
1003	CBD	CBD	0.122	5,317
1004	Vacant	MR	0.152	6,601
1005	MR	MR	0.171	7,463
1006	MR	MR	0.199	8,652
1007	MR	MR	0.176	7,675
1008	MR	MR	0.176	7,671
1009	MR	MR	0.177	7,695
1010	MR	MR	0.142	6,180
1011	MR	MR	0.141	6,129
1012	MR	MR	0.162	7,047
1013	MR	MR	0.147	6,404
1014	MHR	MHR	0.092	3,997
1015	Vacant	MR	0.139	6,072
1016	MR	MR	0.137	5,963
1017	MR	MR	0.133	5,779
1018	HR	HR	0.178	7,737
1019	MR	MR	0.141	6,124
1020	MR	MR	0.354	15,424
1021	MR	MR	0.145	6,316
1022	MR	MR	0.105	4,588
1023	MR	MR	0.166	7,222
1024	MR	MR	0.149	6,473
1025	MR	MR	0.139	6,070
1026	CBD	CBD	0.132	5,765
1027	HR	HR	0.464	20,215
1028	CBD	CBD	0.282	12,304
1029	MR	MR	0.202	8,808
1030	MHR	MHR	0.131	5,701
1031	Vacant	MR	0.149	6,500
1032	Vacant	MR	0.256	11,149
1033	MHR	MHR	0.196	8,547
1034	MR	MR	0.170	7,388
1035	LR	LR	0.165	7,202
1036	MHR	MHR	0.137	5,974
1037	CBD	CBD	0.107	4,645
1038	MR	MR	0.156	6,797
1039	Vacant	MR	0.154	6,710
1040	MR	MR	0.212	9,220
1041	MHR	MHR	0.086	3,740
1042	CBD	CBD	0.089	3,870
1043	MHR	MHR	0.103	4,486
1044	MR	MR	0.151	6,587
1045	LR	LR	0.094	4,106
1046	Vacant	MR	0.136	5,930
1047	CBD	CBD	0.158	6,883
1048	Vacant	MR	0.155	6,760
1049	CBD	CBD	0.182	7,907
1050	CBD	CBD	0.948	41,316
1051	MHR	MHR	0.179	7,802
1052	LR	LR	0.151	6,560
1053	MR	MR	0.352	15,342
1054	MR	MR	0.155	6,773
1055	Vacant	MR	0.130	5,682
1056	MR	MR	0.160	6,986
1057	MR	MR	0.152	6,611
1058	MR	MR	0.153	6,675
1059	MR	MR	0.133	5,806
1060	MHR	MHR	0.071	3,092
1061	LR	LR	0.096	4,174

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1062	MHR	MHR	0.119	5,171
1063	CBD	CBD	0.155	6,746
1064	CBD	CBD	0.086	3,745
1065	MHR	MHR	0.085	3,716
1066	MR	MR	0.147	6,420
1067	Vacant	MR	0.161	7,000
1068	CBD	CBD	0.070	3,052
1069	CBD	CBD	0.512	22,303
1070	MHR	MHR	0.398	17,318
1071	HR	HR	0.206	8,981
1072	Vacant	MR	0.053	2,310
1073	HR	HR	0.341	14,871
1074	MHR	MHR	0.120	5,236
1075	Vacant	MR	0.139	6,059
1076	MHR	MHR	0.070	3,032
1077	CBD	CBD	0.226	9,838
1078	MR	MR	0.158	6,878
1079	Vacant	MR	0.155	6,735
1080	MR	MR	0.206	8,954
1081	MHR	MHR	0.217	9,442
1082	MHR	MHR	0.111	4,837
1083	Vacant	MR	0.139	6,036
1084	Vacant	MR	6.280	273,536
1085	CBD	CBD	0.134	5,834
1086	MR	MR	0.175	7,627
1087	MR	MR	0.258	11,244
1088	Vacant	MR	0.189	8,232
1089	MR	MR	0.219	9,545
1090	LR	LR	0.192	8,382
1091	MR	MR	0.350	15,265
1092	MR	MR	0.146	6,358
1093	MHR	MHR	0.110	4,787
1094	MR	MR	0.162	7,076
1095	CBD	CBD	0.860	37,445
1096	Vacant	MR	0.134	5,816
1097	MHR	MHR	0.057	2,500
1098	CBD	CBD	0.325	14,167
1099	MR	MR	0.154	6,727
1100	CBD	CBD	0.219	9,549
1101	Vacant	MR	0.138	6,000
1102	MR	MR	0.209	9,095
1103	LR	LR	0.447	19,456
1104	HR	HR	0.170	7,388
1105	MR	MR	0.258	11,255
1106	LR	LR	0.226	9,844
1107	Vacant	MR	0.156	6,815
1108	MHR	MHR	0.342	14,903
1109	MR	MR	0.175	7,604
1110	MR	MR	0.159	6,938
1111	Vacant	MR	0.157	6,817
1112	MR	MR	0.184	8,028
1113	MR	MR	0.163	7,102
1114	MR	MR	0.152	6,626
1115	MR	MR	0.144	6,267
1116	MR	MR	0.154	6,692
1117	MR	MR	0.157	6,832
1118	MR	MR	0.148	6,429
1119	HR	HR	0.171	7,469
1120	MR	MR	0.163	7,098
1121	MR	MR	0.147	6,386
1122	MR	MR	0.151	6,577
1123	MR	MR	0.157	6,833
1124	MR	MR	0.158	6,893
1125	Vacant	MR	0.147	6,382
1126	MR	MR	0.141	6,148
1127	MR	MR	0.158	6,897
1128	MR	MR	0.152	6,636
1129	CBD	CBD	0.331	14,409
1130	MR	MR	0.304	13,229
1131	MR	MR	0.155	6,751
1132	MR	MR	0.153	6,646
1133	MR	MR	0.166	7,216
1134	MR	MR	0.177	7,725
1135	MR	MR	0.217	9,437
1136	MR	MR	0.165	7,184
1137	MR	MR	0.278	12,115
1138	MR	MR	0.247	10,754
1139	MR	MR	0.252	10,996
1140	MR	MR	0.183	7,987
1141	MR	MR	0.320	13,944
1142	LR	LR	0.164	7,140
1143	MR	MR	0.151	6,569
1144	MR	MR	0.298	12,979
1145	Vacant	MR	0.145	6,307
1146	MR	MR	0.140	6,113
1147	MR	MR	0.139	6,038
1148	CBD	CBD	0.130	5,642
1149	MR	MR	0.193	8,389
1150	MR	MR	0.262	11,406
1151	LR	LR	0.166	7,228
1152	Vacant	MR	0.152	6,600
1153	CBD	CBD	0.196	8,524
1154	LR	LR	0.136	5,911
1155	MR	MR	0.140	6,102
1156	LR	LR	0.202	8,813
1157	CBD	CBD	0.309	13,447
1158	LR	LR	0.424	18,474
1159	Vacant	MR	0.140	6,089
1160	CBD	CBD	0.210	9,126
1161	Vacant	MR	0.152	6,600
1162	LR	LR	0.197	8,599
1163	MR	MR	0.215	9,354
1164	MR	MR	0.139	6,067
1165	MR	MR	0.142	6,177
1166	LR	LR	0.266	11,568
1167	CBD	CBD	0.176	7,688
1168	MR	MR	0.162	7,060
1169	LR	LR	0.264	11,484
1170	MR	MR	0.150	6,528
1171	CBD	CBD	0.239	10,416
1172	Vacant	MR	0.152	6,600
1173	MR	MR	0.149	6,497
1174	LR	LR	0.116	5,070
1175	CBD	CBD	0.116	5,040
1176	CBD	CBD	0.182	7,912
1177	LR	LR	0.201	8,750
1178	LR	LR	0.343	14,959
1179	MR	MR	0.178	7,750

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1180	MR	MR	0.158	6,884
1181	MR	MR	0.145	6,333
1182	MR	MR	0.140	6,095
1183	MR	MR	0.147	6,409
1184	Vacant	MR	0.139	6,075
1185	MR	MR	0.152	6,605
1186	MR	MR	0.143	6,223
1187	Vacant	MR	0.152	6,600
1188	MR	MR	0.158	6,872
1189	MR	MR	0.142	6,195
1190	MR	MR	0.147	6,387
1191	MR	MR	0.154	6,695
1192	MR	MR	0.153	6,656
1193	MR	MR	0.139	6,044
1194	MR	MR	0.153	6,674
1195	MR	MR	0.145	6,307
1196	MR	MR	0.153	6,649
1197	MR	MR	0.134	5,822
1198	MR	MR	0.194	8,463
1199	MR	MR	0.184	8,001
1200	CBD	CBD	0.149	6,498
1201	LR	LR	0.137	5,979
1202	MR	MR	0.134	5,822
1203	MR	MR	0.144	6,274
1204	MR	MR	0.180	7,835
1205	MR	MR	0.245	10,676
1206	CBD	CBD	0.246	10,736
1207	MR	MR	0.298	12,973
1208	LR	LR	0.326	14,179
1209	Vacant	MR	0.150	6,543
1210	CBD	CBD	0.116	5,055
1211	LR	LR	0.248	10,788
1212	LR	LR	0.227	9,878
1213	MR	MR	0.155	6,747
1214	MR	MR	0.159	6,941
1215	CBD	CBD	0.125	5,466
1216	Vacant	MR	0.239	10,403
1217	MR	MR	0.166	7,225
1218	MR	MR	0.174	7,589
1219	MR	MR	0.204	8,867
1220	CBD	CBD	0.162	7,053
1221	CBD	CBD	0.244	10,641
1222	CBD	CBD	0.188	8,188
1223	PQP	PQP	2.189	95,342
1224	Vacant	MR	0.203	8,830
1225	MR	MR	0.213	9,292
1226	MR	MR	0.196	8,539
1227	LR	LR	0.185	8,055
1228	LR	LR	0.148	6,442
1229	MR	MR	0.144	6,259
1230	LR	LR	0.174	7,566
1231	CBD	CBD	0.594	25,880
1232	Vacant	MHR	0.489	21,293
1233	LR	LR	0.319	13,903
1234	CBD	CBD	0.278	12,121
1235	CBD	CBD	0.304	13,259
1236	MR	MR	0.155	6,738
1237	MR	MR	0.326	14,190
1238	LR	LR	0.177	7,694
1239	LR	LR	0.154	6,698
1240	MR	MR	0.153	6,646
1241	MR	MR	0.159	6,920
1242	LR	LR	0.239	10,415
1243	MR	MR	0.128	5,557
1244	CBD	CBD	0.169	7,378
1245	MR	MR	0.174	7,583
1246	LR	LR	0.158	6,868
1247	MR	MR	0.141	6,163
1248	CBD	CBD	0.274	11,921
1249	LR	LR	0.229	9,974
1250	CBD	CBD	0.273	11,887
1251	MR	MR	0.132	5,743
1252	MR	MR	0.161	7,030
1253	LR	LR	0.187	8,130
1254	LR	LR	0.143	6,226
1255	LR	LR	0.160	6,964
1256	MR	MR	0.130	5,653
1257	LR	LR	0.111	4,829
1258	MR	MR	0.236	10,283
1259	Vacant	MR	0.151	6,582
1260	MR	MR	0.154	6,719
1261	LR	LR	0.170	7,416
1262	MR	MR	0.142	6,170
1263	LR	LR	0.162	7,039
1264	CBD	CBD	0.231	10,073
1265	MR	MR	0.181	7,902
1266	MR	MR	0.149	6,484
1267	MR	MR	0.155	6,767
1268	MR	MR	0.147	6,406
1269	MR	MR	0.146	6,348
1270	MR	MR	0.144	6,260
1271	MR	MR	0.153	6,685
1272	MR	MR	0.144	6,285
1273	MR	MR	0.146	6,348
1274	MR	MR	0.138	6,016
1275	MR	MR	0.151	6,597
1276	MR	MR	0.159	6,921
1277	MR	MR	0.149	6,492
1278	MR	MR	0.143	6,218
1279	MR	MR	0.142	6,201
1280	CBD	CBD	0.407	17,711
1281	MR	MR	0.151	6,560
1282	MR	MR	0.138	5,997
1283	MR	MR	0.155	6,769
1284	CBD	CBD	0.300	13,060
1285	LR	LR	0.172	7,491
1286	MR	MR	0.141	6,123
1287	PQP	PQP	0.150	6,516
1288	MR	MR	0.181	7,902
1289	LR	LR	0.170	7,408
1290	LR	LR	0.131	5,710
1291	LR	LR	0.212	9,223
1292	MR	MR	0.176	7,672
1293	MR	MR	0.209	9,100
1294	CBD	CBD	0.133	5,775
1295	MR	MR	0.147	6,418
1296	CBD	CBD	0.186	8,083
1297	LR	LR	0.148	6,453

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1298	LR	LR	0.166	7,231
1299	LR	LR	0.130	5,684
1300	MR	MR	0.153	6,673
1301	LR	LR	0.170	7,407
1302	MR	MR	0.232	10,112
1303	LR	LR	0.447	19,488
1304	CBD	CBD	0.426	18,541
1305	MR	MR	0.178	7,733
1306	MR	MR	0.151	6,592
1307	LR	LR	0.178	7,764
1308	CBD	CBD	0.059	2,569
1309	MR	MR	0.189	8,214
1310	LR	LR	0.170	7,407
1311	MR	MR	0.133	5,774
1312	MR	MR	0.129	5,624
1313	CBD	CBD	0.102	4,432
1314	CBD	CBD	0.095	4,136
1315	MR	MR	0.141	6,141
1316	MR	MR	0.177	7,716
1317	LR	LR	0.134	5,830
1318	LR	LR	0.170	7,384
1319	MR	MR	0.165	7,183
1320	LR	LR	0.132	5,763
1321	LR	LR	0.204	8,894
1322	MR	MR	0.228	9,949
1323	LR	LR	0.178	7,740
1324	LR	LR	0.403	17,533
1325	PQP	PQP	0.334	14,566
1326	LR	LR	0.227	9,878
1327	LR	LR	0.121	5,290
1328	MR	MR	0.219	9,521
1329	MHR	MHR	0.149	6,473
1330	MR	MR	0.150	6,513
1331	MR	MR	0.148	6,451
1332	MR	MR	0.151	6,568
1333	MR	MR	0.155	6,767
1334	MR	MR	0.153	6,643
1335	MR	MR	0.151	6,588
1336	MR	MR	0.143	6,223
1337	LR	LR	0.248	10,818
1338	MR	MR	0.125	5,465
1339	MR	MR	0.152	6,617
1340	MR	MR	0.150	6,515
1341	MR	MR	0.151	6,576
1342	MR	MR	0.161	7,032
1343	MR	MR	0.158	6,896
1344	LR	LR	0.142	6,178
1345	MR	MR	0.202	8,787
1346	MR	MR	0.156	6,791
1347	CBD	CBD	0.118	5,142
1348	MR	MR	0.139	6,050
1349	MR	MR	0.173	7,533
1350	MR	MR	0.133	5,797
1351	LR	LR	0.175	7,616
1352	MR	MR	0.141	6,148
1353	LR	LR	0.410	17,853
1354	LR	LR	0.140	6,100
1355	MR	MR	0.152	6,628
1356	LR	LR	0.176	7,674
1357	CBD	CBD	0.101	4,381
1358	LR	LR	0.156	6,800
1359	PQP	PQP	9.193	400,439
1360	MR	MR	0.165	7,192
1361	MR	MR	0.166	7,237
1362	MR	MR	0.153	6,682
1363	MR	MR	0.225	9,785
1364	MR	MR	0.164	7,148
1365	MR	MR	0.177	7,728
1366	LR	LR	0.154	6,725
1367	LR	LR	0.185	8,072
1368	LR	LR	0.165	7,184
1369	CBD	CBD	0.077	3,365
1370	LR	LR	0.120	5,214
1371	LR	LR	0.093	4,059
1372	MR	MR	0.151	6,564
1373	LR	LR	0.115	5,012
1374	CBD	CBD	0.169	7,364
1375	MR	MR	0.135	5,897
1376	CBD	CBD	0.203	8,835
1377	LR	LR	0.183	7,955
1378	MHR	MHR	0.131	5,724
1379	LR	LR	0.215	9,350
1380	LR	LR	0.123	5,355
1381	CBD	CBD	0.113	4,911
1382	MR	MR	0.151	6,559
1383	MR	MR	0.148	6,455
1384	LR	LR	0.127	5,537
1385	CBD	CBD	0.148	6,437
1386	LR	LR	0.184	8,009
1387	MR	MR	0.148	6,444
1388	MR	MR	0.158	6,878
1389	MR	MR	0.226	9,848
1390	LR	LR	0.156	6,804
1391	LR	LR	0.126	5,468
1392	PQP	PQP	2.622	114,220
1393	LR	LR	0.144	6,289
1394	LR	LR	0.346	15,088
1395	MR	MR	0.133	5,774
1396	CBD	CBD	0.076	3,309
1397	LR	LR	0.165	7,183
1398	LR	LR	0.135	5,894
1399	LR	LR	0.158	6,896
1400	CBD	CBD	0.176	7,648
1401	MR	MR	0.165	7,190
1402	MR	MR	0.187	8,146
1403	Vacant	MHR	0.608	26,487
1404	MR	MR	0.166	7,229
1405	LR	LR	0.129	5,627
1406	MR	MR	0.161	7,010
1407	MHR	MHR	0.136	5,943
1408	MR	MR	0.149	6,477
1409	LR	LR	0.133	5,802
1410	MR	MR	0.175	7,633
1411	CBD	CBD	0.114	4,975
1412	LR	LR	0.170	7,398
1413	PQP	PQP	0.101	4,390
1414	MR	MR	0.236	10,262
1415	MR	MR	0.146	6,348

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1416	LR	LR	0.109	4,742
1417	MR	MR	0.193	8,387
1418	MR	MR	0.126	5,500
1419	LR	LR	0.145	6,327
1420	CBD	CBD	0.049	2,150
1421	LR	LR	0.133	5,796
1422	MR	MR	0.215	9,365
1423	MR	MR	0.219	9,524
1424	MR	MR	0.222	9,676
1425	MR	MR	0.198	8,605
1426	MR	MR	0.204	8,891
1427	LR	LR	0.113	4,912
1428	MR	MR	0.230	10,038
1429	CBD	CBD	0.068	2,974
1430	MR	MR	0.205	8,913
1431	MR	MR	0.219	9,558
1432	MR	MR	0.177	7,697
1433	MR	MR	0.173	7,542
1434	MR	MR	0.148	6,442
1435	MR	MR	0.144	6,277
1436	CBD	CBD	0.110	4,776
1437	MR	MR	0.177	7,710
1438	LR	LR	0.171	7,451
1439	LR	LR	0.130	5,653
1440	LR	LR	0.324	14,134
1441	LR	LR	0.097	4,231
1442	LR	LR	0.133	5,793
1443	CBD	CBD	0.245	10,668
1444	PQP	PQP	0.132	5,768
1445	MR	MR	0.152	6,625
1446	CBD	CBD	0.073	3,190
1447	MHR	MHR	0.135	5,868
1448	MR	MR	0.130	5,660
1449	CBD	CBD	0.227	9,875
1450	LR	LR	0.139	6,040
1451	MR	MR	0.256	11,172
1452	MR	MR	0.149	6,469
1453	LR	LR	0.143	6,231
1454	MR	MR	0.160	6,986
1455	PQP	PQP	0.518	22,543
1456	LR	LR	0.150	6,544
1457	MR	MR	0.136	5,926
1458	LR	LR	0.266	11,567
1459	LR	LR	0.155	6,748
1460	CBD	CBD	0.184	8,029
1461	LR	LR	0.189	8,233
1462	MR	MR	0.156	6,779
1463	MR	MR	0.211	9,200
1464	MR	MR	0.144	6,280
1465	MR	MR	0.144	6,264
1466	MR	MR	0.149	6,475
1467	MR	MR	0.140	6,087
1468	LR	LR	0.131	5,690
1469	MR	MR	1.858	80,927
1470	MR	MR	0.150	6,517
1471	CBD	CBD	0.214	9,307
1472	MR	MR	0.159	6,927
1473	MR	MR	0.151	6,559
1474	LR	LR	0.123	5,340
1475	MHR	MHR	0.136	5,922
1476	CBD	CBD	0.142	6,172
1477	CBD	CBD	0.285	12,433
1478	MR	MR	0.184	8,016
1479	LR	LR	0.152	6,613
1480	LR	LR	0.126	5,500
1481	MR	MR	0.142	6,199
1482	MR	MR	0.179	7,793
1483	MR	MR	0.355	15,448
1484	LR	LR	0.099	4,317
1485	CBD	CBD	0.126	5,473
1486	LR	LR	0.301	13,094
1487	LR	LR	0.123	5,348
1488	LR	LR	0.127	5,530
1489	CBD	CBD	0.151	6,585
1490	MR	MR	0.148	6,432
1491	MR	MR	0.156	6,780
1492	MR	MR	0.111	4,832
1493	CBD	CBD	0.180	7,833
1494	MR	MR	0.210	9,151
1495	MR	MR	0.219	9,552
1496	MR	MR	0.185	8,053
1497	MR	MR	0.134	5,841
1498	PQP	PQP	0.505	21,976
1499	LR	LR	0.126	5,497
1500	CBD	CBD	0.062	2,691
1501	MR	MR	0.145	6,329
1502	MR	MR	0.124	5,402
1503	LR	LR	0.128	5,597
1504	MR	MR	0.301	13,132
1505	MR	MR	0.123	5,357
1506	MR	MR	0.148	6,447
1507	LR	LR	0.142	6,204
1508	CBD	CBD	0.064	2,777
1509	MHR	MHR	0.134	5,855
1510	LR	LR	0.164	7,135
1511	CBD	CBD	0.568	24,755
1512	LR	LR	0.249	10,850
1513	CBD	CBD	0.065	2,844
1514	MR	MR	0.135	5,882
1515	LR	LR	0.126	5,486
1516	LR	LR	0.187	8,127
1517	Vacant	MR	5.240	228,239
1518	PQP	PQP	0.110	4,801
1519	CBD	CBD	0.061	2,667
1520	LR	LR	0.124	5,415
1521	MR	MR	0.248	10,801
1522	CBD	CBD	0.063	2,747
1523	MR	MR	0.157	6,832
1524	MR	MR	0.138	6,003
1525	CBD	CBD	0.063	2,758
1526	MR	MR	0.205	8,933
1527	LR	LR	0.130	5,666
1528	MR	MR	0.135	5,893
1529	MR	MR	0.139	6,043
1530	CBD	CBD	0.354	15,428
1531	LR	LR	0.124	5,395
1532	MR	MR	0.134	5,831
1533	MR	MR	0.143	6,214

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1534	LR	LR	0.127	5,517
1535	CBD	CBD	0.126	5,493
1536	MR	MR	0.155	6,763
1537	MR	MR	0.169	7,371
1538	MHR	MHR	0.124	5,403
1539	MR	MR	0.211	9,175
1540	MR	MR	0.143	6,250
1541	MR	MR	0.207	9,028
1542	LR	LR	0.251	10,953
1543	LR	LR	0.248	10,821
1544	LR	LR	0.122	5,329
1545	CBD	CBD	0.050	2,175
1546	CBD	CBD	0.192	8,378
1547	LR	LR	0.139	6,067
1548	CBD	CBD	0.050	2,170
1549	MR	MR	0.220	9,591
1550	LR	LR	0.130	5,680
1551	LR	LR	0.137	5,986
1552	CBD	CBD	0.239	10,401
1553	MR	MR	0.154	6,714
1554	MR	MR	0.140	6,080
1555	LR	LR	0.148	6,443
1556	LR	LR	0.129	5,613
1557	MR	MR	0.144	6,259
1558	MR	MR	0.144	6,276
1559	MR	MR	0.180	7,845
1560	MR	MR	0.259	11,277
1561	MR	MR	0.220	9,562
1562	MR	MR	0.133	5,813
1563	LR	LR	0.124	5,393
1564	MR	MR	0.164	7,161
1565	LR	LR	0.135	5,890
1566	LR	LR	0.295	12,836
1567	MR	MR	0.136	5,925
1568	MHR	MHR	0.141	6,121
1569	LR	LR	0.135	5,886
1570	CBD	CBD	0.157	6,850
1571	CBD	CBD	0.086	3,760
1572	MR	MR	0.156	6,789
1573	CBD	CBD	0.148	6,456
1574	LR	LR	0.307	13,389
1575	LR	LR	0.123	5,349
1576	LR	LR	0.124	5,396
1577	CBD	CBD	0.238	10,367
1578	LR	LR	0.170	7,413
1579	CBD	CBD	0.257	11,198
1580	LR	LR	0.132	5,738
1581	MR	MR	0.140	6,096
1582	LR	LR	0.164	7,156
1583	MR	MR	0.341	14,872
1584	MR	MR	0.126	5,479
1585	MR	MR	0.235	10,248
1586	MR	MR	0.124	5,422
1587	MR	MR	0.179	7,778
1588	MR	MR	0.141	6,125
1589	MR	MR	0.147	6,412
1590	MR	MR	0.169	7,366
1591	LR	LR	0.299	13,034
1592	PQP	PQP	0.312	13,610
1593	LR	LR	0.148	6,468
1594	LR	LR	0.123	5,352
1595	MHR	MHR	0.130	5,654
1596	MR	MR	0.158	6,862
1597	CBD	CBD	0.112	4,875
1598	LR	LR	0.239	10,425
1599	LR	LR	0.130	5,660
1600	LR	LR	0.198	8,623
1601	LR	LR	0.300	13,087
1602	MR	MR	0.138	6,011
1603	MR	MR	0.144	6,267
1604	CBD	CBD	0.111	4,841
1605	MR	MR	0.150	6,514
1606	MR	MR	0.175	7,623
1607	MR	MR	0.315	13,719
1608	CBD	CBD	0.152	6,631
1609	MR	MR	0.232	10,106
1610	MR	MR	0.188	8,197
1611	LR	LR	0.224	9,751
1612	CBD	CBD	0.127	5,513
1613	LR	LR	0.201	8,775
1614	LR	LR	0.260	11,304
1615	MHR	MHR	0.143	6,219
1616	LR	LR	0.172	7,477
1617	MR	MR	0.194	8,434
1618	MR	MR	0.173	7,556
1619	Vacant	MR	2.834	123,463
1620	LR	LR	0.304	13,253
1621	CBD	CBD	0.124	5,410
1622	MR	MR	0.148	6,441
1623	LR	LR	0.117	5,084
1624	LR	LR	0.159	6,926
1625	LR	LR	0.139	6,069
1626	MR	MR	0.152	6,600
1627	CBD	CBD	0.130	5,666
1628	MR	MR	0.174	7,579
1629	LR	LR	0.150	6,513
1630	LR	LR	0.122	5,295
1631	LR	LR	0.133	5,776
1632	MR	MR	0.126	5,476
1633	MR	MR	0.184	8,026
1634	MR	MR	0.140	6,107
1635	LR	LR	0.197	8,569
1636	LR	LR	0.132	5,769
1637	MR	MR	0.161	7,008
1638	MR	MR	0.246	10,703
1639	LR	LR	0.126	5,470
1640	LR	LR	0.203	8,855
1641	LR	LR	0.209	9,114
1642	MR	MR	0.166	7,252
1643	MHR	MHR	0.129	5,638
1644	LR	LR	0.137	5,954
1645	MR	MR	0.137	5,956
1646	LR	LR	0.178	7,765
1647	LR	LR	0.158	6,887
1648	MR	MR	0.154	6,729
1649	MR	MR	0.153	6,664
1650	LR	LR	0.168	7,318
1651	LR	LR	0.278	12,107

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1652	LR	LR	0.181	7,903
1653	LR	LR	0.287	12,485
1654	LR	LR	0.134	5,844
1655	MR	MR	0.204	8,875
1656	MR	MR	0.134	5,836
1657	MR	MR	0.138	5,994
1658	MR	MR	0.191	8,326
1659	LR	LR	0.237	10,305
1660	MR	MR	0.453	19,728
1661	LR	LR	0.181	7,883
1662	NC	NC	1.294	56,359
1663	LR	LR	0.145	6,305
1664	MR	MR	0.330	14,393
1665	LR	LR	0.197	8,582
1666	LR	LR	0.210	9,129
1667	MR	MR	0.141	6,159
1668	LR	LR	0.312	13,579
1669	MHR	MHR	0.130	5,648
1670	LR	LR	0.137	5,951
1671	LR	LR	0.308	13,419
1672	LR	LR	0.250	10,871
1673	Vacant	OS	0.497	21,653
1674	LR	LR	0.226	9,861
1675	MR	MR	0.176	7,675
1676	MR	MR	0.134	5,855
1677	LR	LR	0.180	7,842
1678	LR	LR	0.148	6,432
1679	MR	MR	0.153	6,657
1680	Vacant	MR	10.545	459,335
1681	PR	PR	3.090	134,587
1682	LR	LR	0.146	6,367
1683	MR	MR	0.146	6,359
1684	LR	LR	0.179	7,791
1685	LR	LR	0.141	6,153
1686	LR	LR	0.087	3,775
1687	LR	LR	0.086	3,767
1688	LR	LR	0.147	6,422
1689	LR	LR	0.635	27,677
1690	MR	MR	0.140	6,097
1691	LR	LR	0.183	7,984
1692	LR	LR	0.136	5,907
1693	LR	LR	0.155	6,773
1694	MR	MR	0.221	9,637
1695	LR	LR	0.176	7,672
1696	MR	MR	0.173	7,539
1697	LR	LR	0.146	6,373
1698	LR	LR	0.248	10,811
1699	MR	MR	0.144	6,270
1700	MR	MR	0.167	7,296
1701	MR	MR	0.142	6,165
1702	MR	MR	0.148	6,440
1703	LR	LR	0.221	9,648
1704	LR	LR	0.150	6,556
1705	LR	LR	0.180	7,852
1706	LR	LR	0.144	6,259
1707	LR	LR	0.100	4,372
1708	Vacant	NC	0.461	20,097
1709	MR	MR	0.242	10,563
1710	LR	LR	0.117	5,084
1711	MR	MR	0.142	6,200
1712	LR	LR	0.144	6,267
1713	LR	LR	0.135	5,892
1714	LR	LR	0.179	7,777
1715	LR	LR	0.122	5,307
1716	MR	MR	0.147	6,395
1717	LR	LR	0.148	6,450
1718	LR	LR	0.164	7,128
1719	LR	LR	0.338	14,739
1720	LR	LR	0.262	11,413
1721	Vacant	NC	0.265	11,531
1722	LR	LR	0.116	5,032
1723	LR	LR	0.153	6,671
1724	PR	PR	2.587	112,711
1725	LR	LR	0.144	6,281
1726	LR	LR	0.206	8,976
1727	MR	MR	0.168	7,326
1728	LR	LR	0.171	7,457
1729	Vacant	LR	1.313	57,207
1730	LR	LR	0.126	5,467
1731	LR	LR	0.282	12,299
1732	LR	LR	0.154	6,726
1733	LR	LR	0.160	6,960
1734	Vacant	MR	0.274	11,946
1735	LR	LR	0.100	4,349
1736	Vacant	NC	0.460	20,035
1737	MR	MR	0.152	6,602
1738	LR	LR	0.127	5,525
1739	LR	LR	0.120	5,238
1740	LR	LR	0.239	10,402
1741	LR	LR	0.220	9,604
1742	LR	LR	0.190	8,277
1743	LR	LR	0.120	5,209
1744	LR	LR	0.420	18,274
1745	LR	LR	0.138	6,027
1746	Vacant	NC	0.544	23,690
1747	LR	LR	0.185	8,054
1748	LR	LR	0.160	6,971
1749	LR	LR	0.183	7,962
1750	OS	OS	0.831	36,201
1751	LR	LR	0.237	10,339
1752	LR	LR	0.221	9,629
1753	LR	LR	0.142	6,174
1754	LR	LR	0.207	8,996
1755	LR	LR	0.128	5,577
1756	LR	LR	0.164	7,137
1757	LR	LR	0.142	6,178
1758	LR	LR	0.162	7,062
1759	LR	LR	0.181	7,867
1760	NC	NC	0.676	29,461
1761	LR	LR	0.134	5,838
1762	LR	LR	0.209	9,101
1763	LR	LR	0.158	6,870
1764	LR	LR	0.156	6,781
1765	LR	LR	0.258	11,238
1766	LR	LR	0.203	8,864
1767	LR	LR	0.142	6,193
1768	LR	LR	0.239	10,424
1769	LR	LR	0.131	5,698

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1770	LR	LR	0.165	7,181
1771	LR	LR	0.224	9,752
1772	LR	LR	0.295	12,865
1773	LR	LR	0.347	15,120
1774	LR	LR	0.137	5,966
1775	PQP	PQP	0.503	21,929
1776	LR	LR	0.183	7,975
1777	LR	LR	0.132	5,742
1778	LR	LR	0.187	8,149
1779	LR	LR	0.234	10,196
1780	LR	LR	0.138	6,001
1781	LR	LR	0.164	7,130
1782	LR	LR	0.152	6,632
1783	LR	LR	0.204	8,905
1784	LR	LR	0.323	14,084
1785	LR	LR	0.162	7,053
1786	LR	LR	0.223	9,724
1787	LR	LR	0.305	13,305
1788	LR	LR	0.134	5,837
1789	LR	LR	0.126	5,478
1790	LR	LR	0.127	5,524
1791	LR	LR	0.146	6,340
1792	LR	LR	0.155	6,773
1793	LR	LR	0.158	6,877
1794	LR	LR	0.150	6,528
1795	NC	NC	1.865	81,244
1796	LR	LR	0.133	5,790
1797	LR	LR	0.246	10,718
1798	LR	LR	0.139	6,066
1799	LR	LR	0.149	6,476
1800	Vacant	LR	0.352	15,342
1801	LR	LR	0.153	6,681
1802	LR	LR	0.148	6,457
1803	LR	LR	0.168	7,299
1804	LR	LR	0.161	7,005
1805	LR	LR	0.114	4,948
1806	LR	LR	0.245	10,673
1807	LR	LR	0.161	7,013
1808	LR	LR	0.134	5,837
1809	Vacant	AG	1.022	44,506
1810	LR	LR	0.154	6,705
1811	LR	LR	0.181	7,881
1812	LR	LR	0.128	5,557
1813	LR	LR	0.153	6,670
1814	LR	LR	0.239	10,391
1815	LR	LR	0.352	15,352
1816	LR	LR	0.279	12,135
1817	LR	LR	0.127	5,523
1818	LR	LR	0.150	6,519
1819	LR	LR	0.154	6,687
1820	LR	LR	0.219	9,525
1821	LR	LR	0.143	6,243
1822	LR	LR	0.121	5,290
1823	LR	LR	0.142	6,180
1824	LR	LR	0.146	6,378
1825	LR	LR	0.146	6,377
1826	LR	LR	0.073	3,178
1827	LR	LR	0.156	6,802
1828	LR	LR	0.185	8,043
1829	LR	LR	0.144	6,292
1830	LR	LR	0.348	15,179
1831	LR	LR	0.138	6,014
1832	LR	LR	0.235	10,225
1833	LR	LR	0.220	9,575
1834	LR	LR	0.160	6,983
1835	LR	LR	0.190	8,259
1836	LR	LR	0.179	7,794
1837	LR	LR	0.187	8,147
1838	Vacant	AG	2.760	120,213
1839	LR	LR	0.157	6,844
1840	LR	LR	0.195	8,481
1841	LR	LR	0.185	8,065
1842	LR	LR	0.136	5,911
1843	LR	LR	0.178	7,734
1844	LR	LR	0.111	4,835
1845	LR	LR	0.258	11,243
1846	LR	LR	0.273	11,901
1847	LR	LR	0.192	8,363
1848	LR	LR	0.176	7,663
1849	LR	LR	0.172	7,483
1850	LR	LR	0.161	7,009
1851	LR	LR	0.185	8,058
1852	LR	LR	0.134	5,847
1853	LR	LR	0.327	14,256
1854	LR	LR	0.210	9,135
1855	LR	LR	0.171	7,463
1856	LR	LR	0.272	11,862
1857	LR	LR	0.145	6,309
1858	LR	LR	0.203	8,829
1859	LR	LR	0.155	6,738
1860	LR	LR	0.174	7,592
1861	LR	LR	0.218	9,477
1862	LR	LR	0.127	5,524
1863	LR	LR	0.228	9,950
1864	LR	LR	0.149	6,489
1865	LR	LR	0.173	7,517
1866	LR	LR	0.379	16,510
1867	LR	LR	0.133	5,786
1868	LR	LR	0.157	6,829
1869	LR	LR	0.169	7,378
1870	LR	LR	0.236	10,288
1871	LR	LR	0.200	8,716
1872	LR	LR	0.128	5,596
1873	LR	LR	0.441	19,210
1874	LR	LR	0.168	7,318
1875	LR	LR	0.197	8,595
1876	LR	LR	0.167	7,263
1877	Vacant	NC	0.196	8,532
1878	LR	LR	0.218	9,516
1879	LR	LR	0.259	11,280
1880	LR	LR	0.127	5,527
1881	LR	LR	0.157	6,850
1882	LR	LR	0.122	5,326
1883	LR	LR	0.162	7,060
1884	LR	LR	0.139	6,067
1885	LR	LR	0.095	4,142
1886	LR	LR	0.150	6,525
1887	LR	LR	0.162	7,040

Attributes of parcel_loading_to_manhole.shp

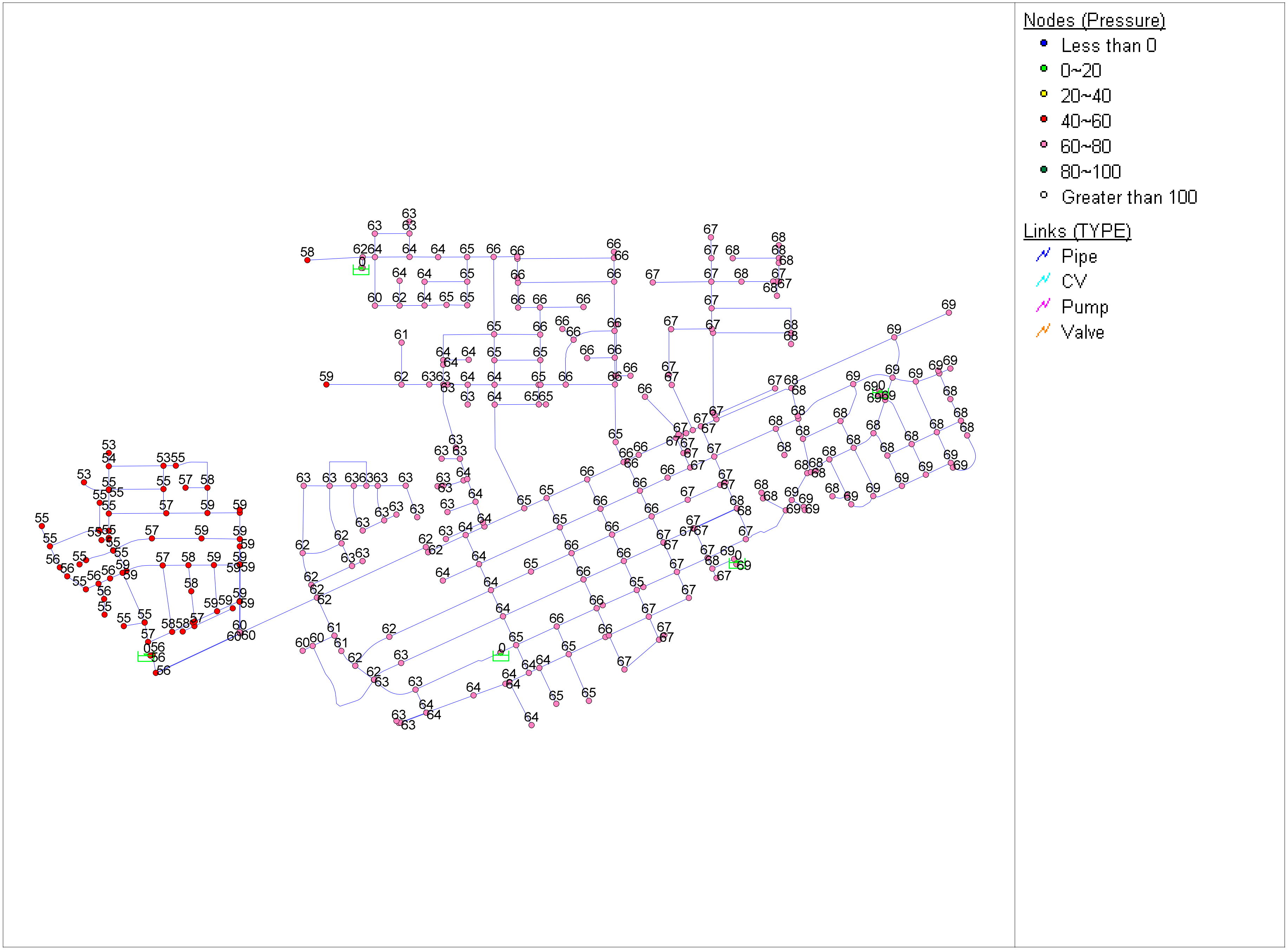
Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
1888	LR	LR	0.102	4,456
1889	LR	LR	0.154	6,718
1890	LR	LR	0.201	8,749
1891	LR	LR	0.110	4,772
1892	LR	LR	0.215	9,370
1893	LR	LR	0.163	7,095
1894	LR	LR	0.256	11,170
1895	LR	LR	0.165	7,192
1896	LR	LR	0.157	6,851
1897	LR	LR	0.133	5,815
1898	Vacant	LR	0.591	25,762
1899	LR	LR	0.212	9,221
1900	LR	LR	0.151	6,597
1901	LR	LR	0.382	16,639
1902	LR	LR	0.187	8,139
1903	LR	LR	0.117	5,098
1904	LR	LR	0.145	6,301
1905	LR	LR	0.149	6,493
1906	LR	LR	0.161	6,994
1907	LR	LR	0.200	8,708
1908	LR	LR	0.241	10,484
1909	LR	LR	0.143	6,238
1910	LR	LR	0.214	9,302
1911	LR	LR	0.149	6,507
1912	LR	LR	0.281	12,238
1913	LR	LR	0.159	6,917
1914	LR	LR	0.255	11,107
1915	LR	LR	0.338	14,723
1916	LR	LR	0.312	13,591
1917	LR	LR	0.219	9,553
1918	LR	LR	0.219	9,555
1919	LR	LR	0.361	15,731
1920	LR	LR	0.221	9,617
1921	LR	LR	0.194	8,440
1922	LR	LR	0.322	14,037
1923	LR	LR	0.233	10,165
1924	LR	LR	0.246	10,694
1925	LR	LR	0.177	7,690
1926	LR	LR	0.232	10,086
1927	LR	LR	0.308	13,416
1928	LR	LR	0.259	11,298
1929	LR	LR	0.212	9,215
1930	LR	LR	0.477	20,784
1931	LR	LR	0.197	8,587
1932	LR	LR	0.178	7,744
1933	LR	LR	0.179	7,785
1934	LR	LR	0.471	20,517
1935	LR	LR	0.231	10,071
1936	LR	LR	0.322	14,027
1937	LR	LR	0.214	9,317
1938	LR	LR	0.326	14,187
1939	LR	LR	0.244	10,648
1940	LR	LR	0.217	9,451
1941	LR	LR	0.422	18,387
1942	LR	LR	0.207	8,997
1943	LR	LR	0.205	8,950
1944	LR	LR	0.233	10,171
1945	LR	LR	0.698	30,393
1946	LR	LR	0.189	8,231
1947	LR	LR	0.357	15,534
1948	LR	LR	0.179	7,816
1949	LR	LR	0.255	11,125
1950	LR	LR	0.156	6,788
1951	LR	LR	0.208	9,079
1952	LR	LR	0.149	6,488
1953	LR	LR	0.136	5,922
1954	LR	LR	0.113	4,908
1955	LR	LR	0.314	13,695
1956	LR	LR	0.438	19,089
1957	LR	LR	0.247	10,744
1958	LR	LR	0.549	23,897
1959	Vacant	LR	0.580	25,249
1960	LR	LR	0.604	26,315
1961	LR	LR	0.402	17,528
1962	Vacant	LI	4.651	202,619
1963	Vacant	PC/BP	40.493	1,763,867
1964	HR	HR	2.707	117,911
1965	PQP	PQP	3.682	160,384
1966	Vacant	LR	4.384	190,969
1967	Vacant	LR	0.868	37,812
1968	Vacant	LR	6.032	262,736
1969	Vacant	LR	1.691	73,641
1970	Vacant	LR	1.447	63,025
1971	Vacant	LR	1.560	67,969
1972	MR	MR	0.225	9,781
1973	MR	MR	0.250	10,903
1974	Vacant	MR	0.239	10,403
1975	Vacant	MR	0.242	10,523
1976	MR	MR	0.218	9,517
1977	MR	MR	0.211	9,212
1978	Vacant	MR	0.217	9,439
1979	MR	MR	0.208	9,069
1980	MR	MR	0.195	8,504
1981	MR	MR	0.184	8,035
1982	MR	MR	0.172	7,504
1983	MR	MR	0.169	7,346
1984	MR	MR	0.170	7,426
1985	MR	MR	0.170	7,420
1986	MR	MR	0.172	7,505
1987	MR	MR	0.159	6,921
1988	MR	MR	0.249	10,867
1989	MR	MR	0.332	14,445
1990	MR	MR	0.224	9,752
1991	Vacant	PC/BP	9.434	410,966
1992	OS	OS	6.296	274,252
1993	OS	OS	5.071	220,890
1994	OS	OS	7.109	309,679
1995	Vacant	LR	1.196	52,077
1996	OS	OS	26.839	1,169,104
1997	OS	OS	3.011	131,162
1998	Vacant	RR	19.831	863,817
1999	Vacant	RR	27.111	1,180,972
2000	Vacant	PQP	30.455	1,326,608
2001	Vacant	PR	13.236	576,547
2002	LR	LR	2.350	102,374
2003	Vacant	LR	3.475	151,374
2004	Vacant	OS	56.008	2,439,727
2005	Vacant	HSC	1.247	54,321

Attributes of parcel_loading_to_manhole.shp

Parcel ID	Existing Land Use	Buildout Land Use	Area (acres)	Area (ft^2)
2006	Vacant	PR	2.919	127,167
2007	Vacant	OS	39.892	1,737,681
2008	Vacant	NC	6.070	264,413
2009	Vacant	LI	3.416	148,795
2010	Vacant	LI	2.883	125,591
2011	Vacant	PQP	5.231	227,855
2012	Vacant	HR	5.229	227,779
2013	Vacant	HR	1.127	49,089
2014	HSC	HSC	0.844	36,776
2015	Vacant	CBD	5.119	223,001
2016	Vacant	LI	6.771	294,933
2017	Vacant	LR	24.765	1,078,768
2018	Vacant	LR	10.102	440,042
2019	MR	MR	0.166	7,251
2020	MR	MR	0.169	7,361
2021	MR	MR	0.169	7,373
2022	MR	MR	0.170	7,397
2023	MR	MR	0.173	7,541
2024	MR	MR	0.193	8,397
2025	MR	MR	0.200	8,732
2026	MR	MR	0.227	9,876
2027	Vacant	PC	6.018	262,130
2028	Vacant	OS	13.364	582,132
2029	LR	LR	0.731	31,852
2030	Vacant	PR	4.808	209,437
2031	LR	LR	0.339	14,773
2032	Vacant	MR	1.250	54,450
2033	Vacant	MR	4.388	191,143
2034	Vacant	LR	2.707	117,925
2035	Vacant	MR	1.853	80,719
2036	Vacant	LR	2.874	125,186
2037	Vacant	MR	2.085	90,838
2038	Vacant	LR	1.858	80,926
2039	MR	MR	0.242	10,549
2040	MR	MR	0.207	9,032
2041	MR	MR	0.174	7,589
2042	MR	MR	0.169	7,357
2043	MR	MR	0.211	9,183
2044	MR	MR	0.373	16,227
2045	MR	MR	0.213	9,285
2046	MR	MR	0.134	5,829
2047	MR	MR	0.129	5,628
2048	MR	MR	0.147	6,425
2049	MR	MR	0.133	5,805
2050	MR	MR	0.144	6,274
2051	MR	MR	0.141	6,142
2052	MR	MR	0.144	6,271
2053	MR	MR	0.135	5,862
2054	MR	MR	0.142	6,178
2055	MR	MR	0.144	6,263
2056	MR	MR	0.141	6,131
2057	MR	MR	0.142	6,192
2058	MR	MR	0.169	7,350
2059	MR	MR	0.153	6,683
2060	MR	MR	0.201	8,772
2061	MR	MR	0.143	6,211
2062	MR	MR	0.172	7,495
2063	MR	MR	0.200	8,727
2064	MR	MR	0.172	7,472
2065	Vacant	LR	2.797	121,816
2066	Vacant	LR	3.101	135,062
2067	Vacant	LR	4.607	200,687
2068	Vacant	LR	3.316	144,461
2069	Vacant	LR	5.216	227,220
2070	Vacant	LR	2.154	93,807
2071	Vacant	LR	24.443	1,064,742
2072	Vacant	LR	2.827	123,134
2073	Vacant	LR	1.247	54,303
2074	Vacant	MHR	1.080	47,037
2075	PQP	PQP	12.384	539,439
2076	Vacant	MHR	1.633	71,148
2077	MHR	MHR	7.335	319,514
2078	Vacant	LR	2.786	121,375
2079	Vacant	LR	2.786	121,375
2080	Vacant	MR	1.247	54,300
2081	Vacant	LR	3.876	168,850
2082	Vacant	LR	2.097	91,348
2083	Vacant	LR	2.607	113,546
2084	Vacant	LR	2.607	113,546
2085	Vacant	LR	2.239	97,514
2086	Vacant	LR	1.054	45,934
2087	MR	MR	0.173	7,524
2088	Vacant	LR	2.698	117,504
2089	Vacant	PR	8.920	388,565
2090	Vacant	MR	1.006	43,817
2091	Vacant	LR	2.926	127,459
2092	Vacant	LR	1.231	53,623
2093	Vacant	MR	3.213	139,961
2094	Vacant	LR	3.234	140,862
2095	Vacant	MHR	7.793	339,477

APPENDIX B
MODELING RESULTS

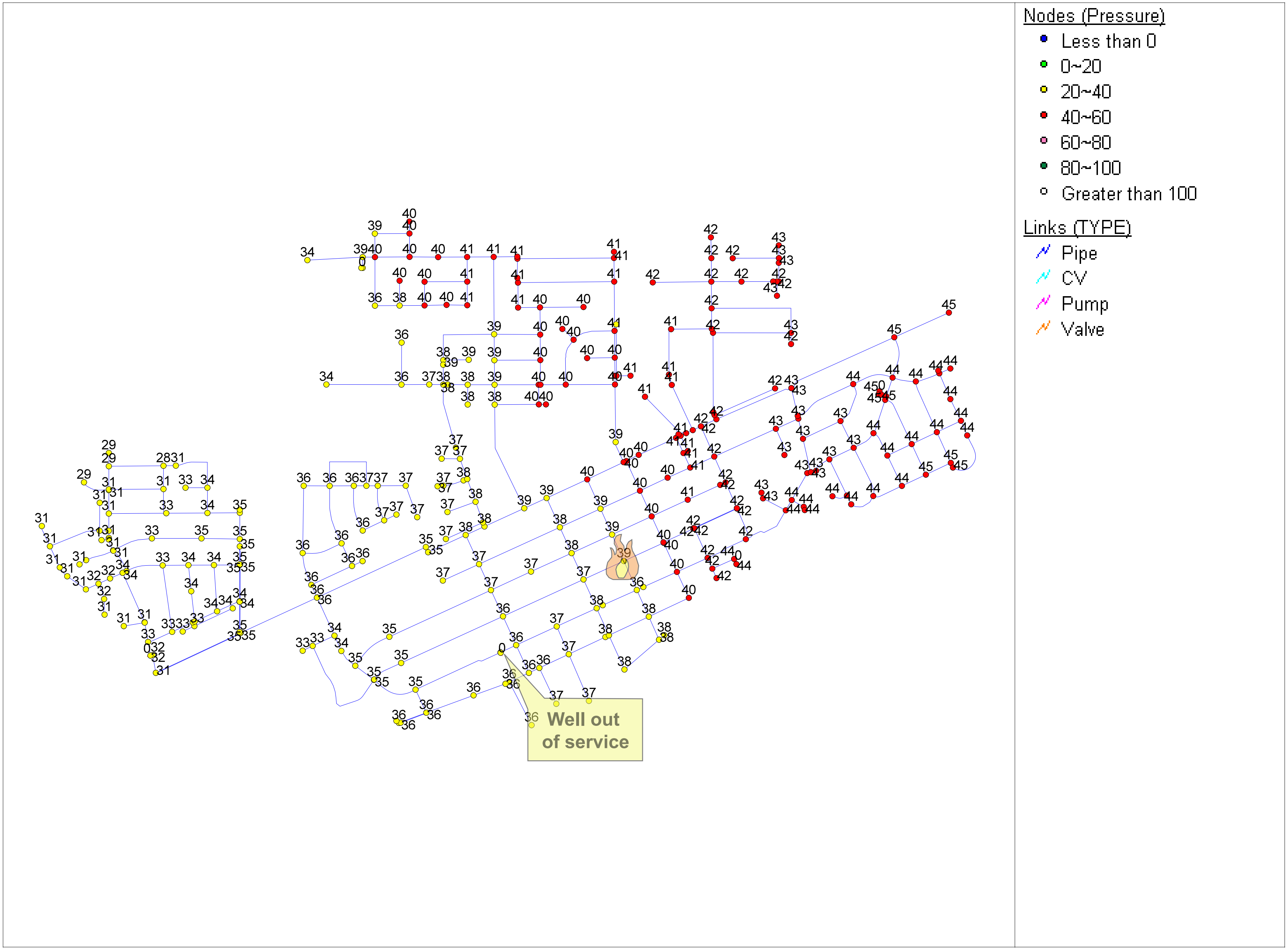
Max Hour Demand - Existing System - All Wells Operating



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

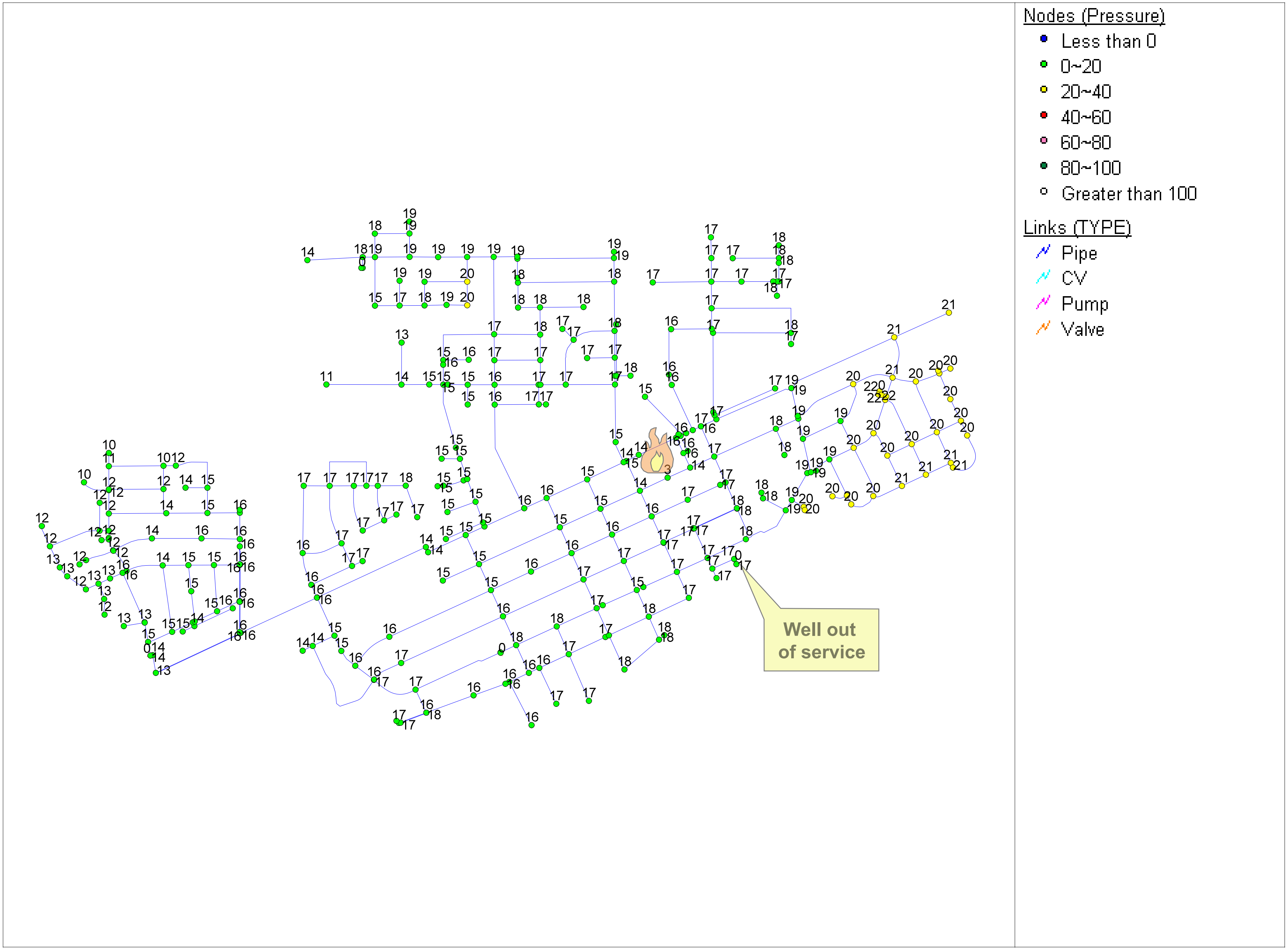
Fire #1 - Existing System - Fire at City Hall and Well #3 Out of Service



Prepared By: Andrew Smith

Date: Thursday, August 17, 2006

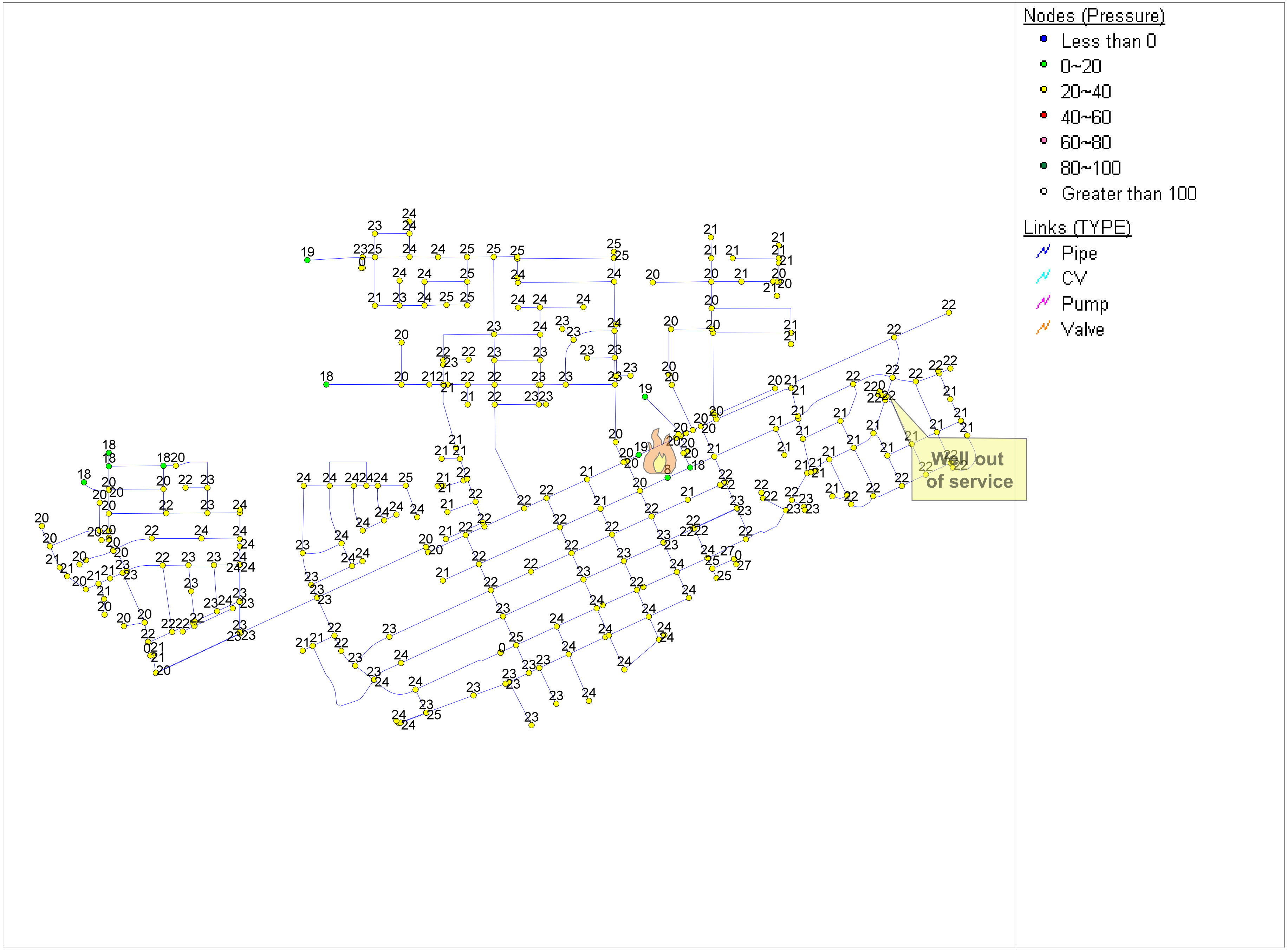
Fire #2A - Existing System - Fire at Mariana and Well #2 Out of Service



Prepared By: Andrew Smith

Date: Thursday, August 17, 2006

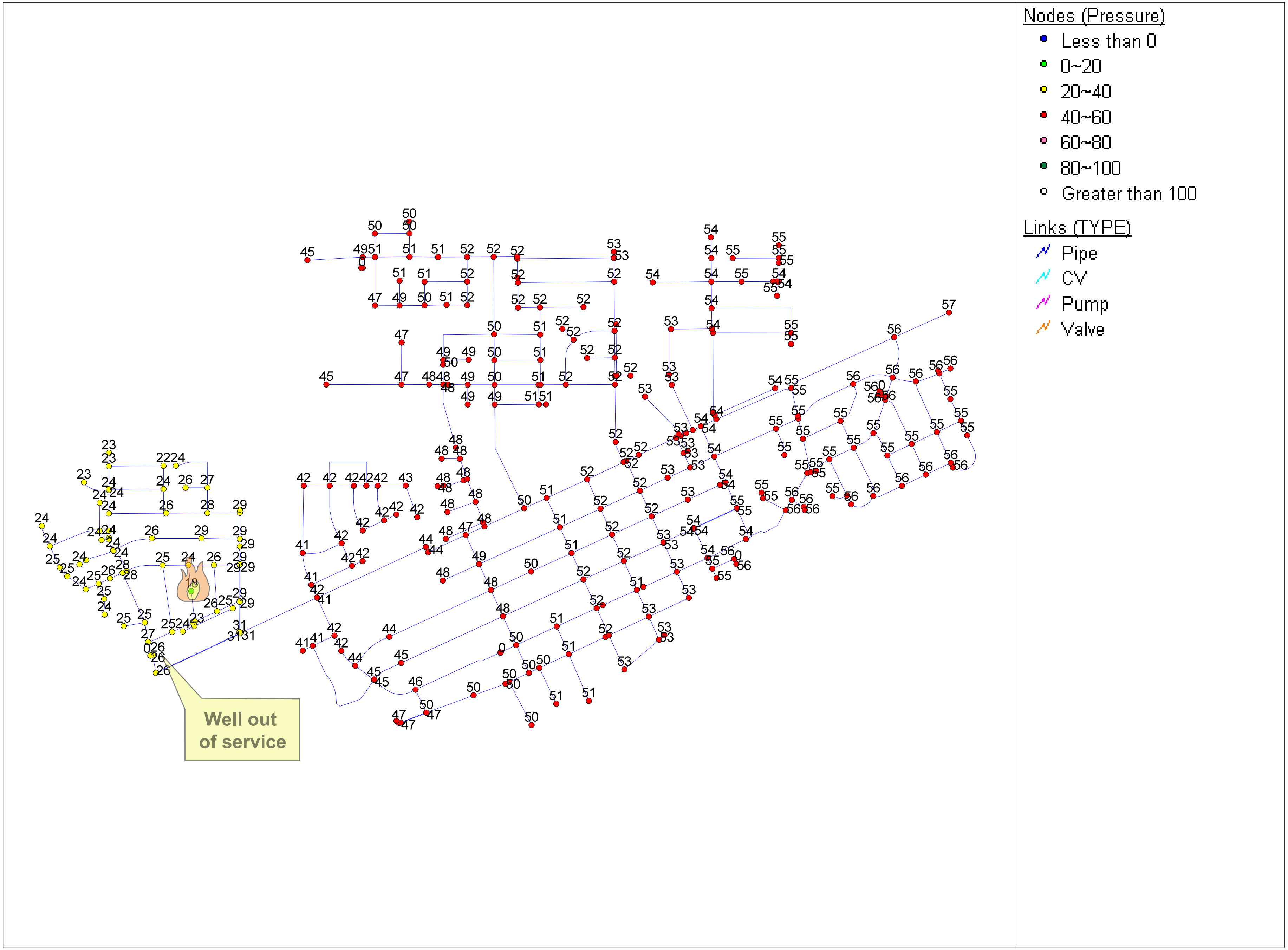
Fire #2B - Existing System - Fire at Mariana and Well #6 Out of Service



Prepared By: Andrew Smith

Date: Thursday, August 17, 2006

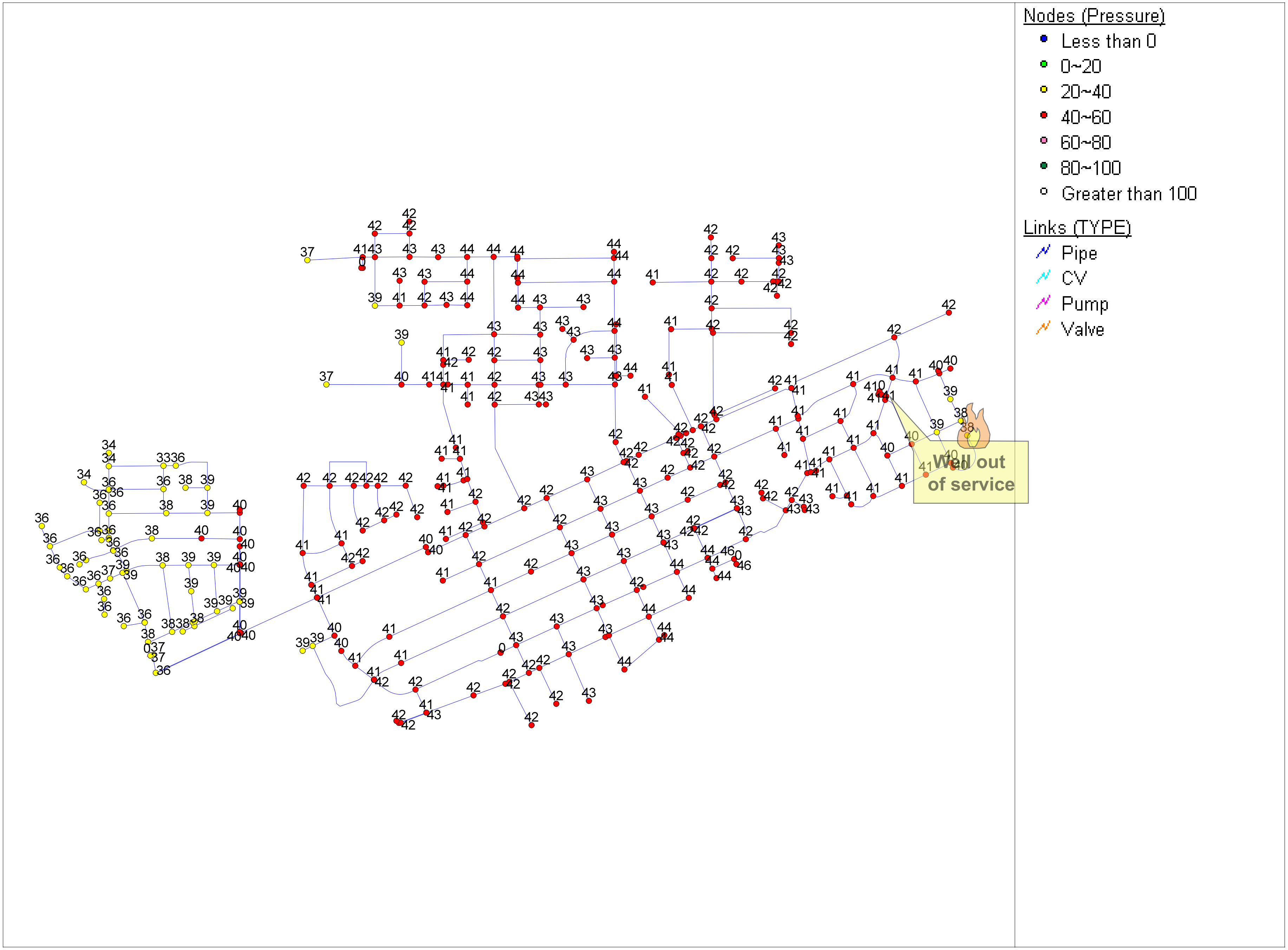
Fire #3 - Max Day Demand - Existing System - Fire in Western Residential Area and Well #4 Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

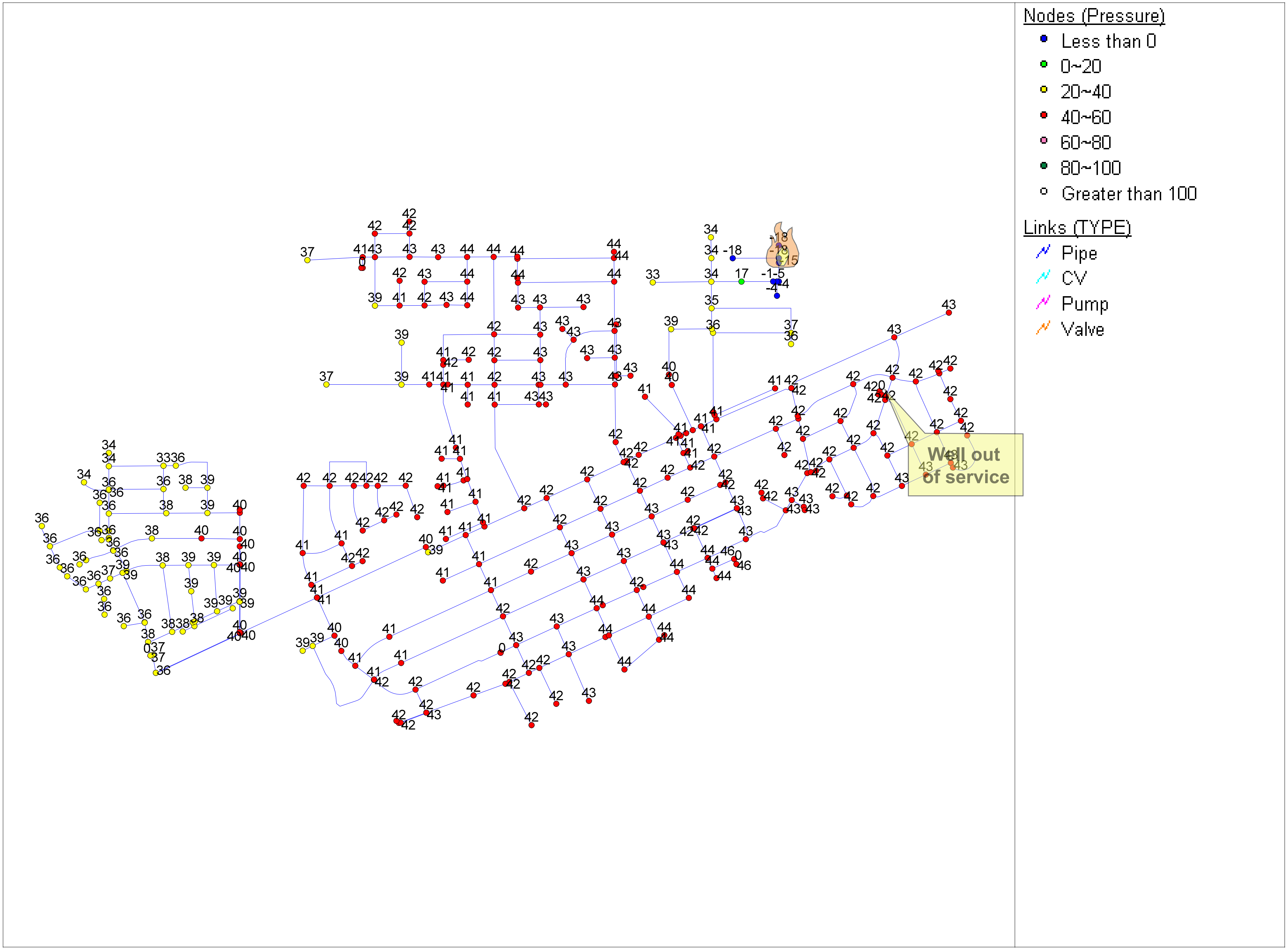
Fire #4 - Max Day Demand - Existing System - Fire in Eastern Residential Area and Well #6 Out of Service



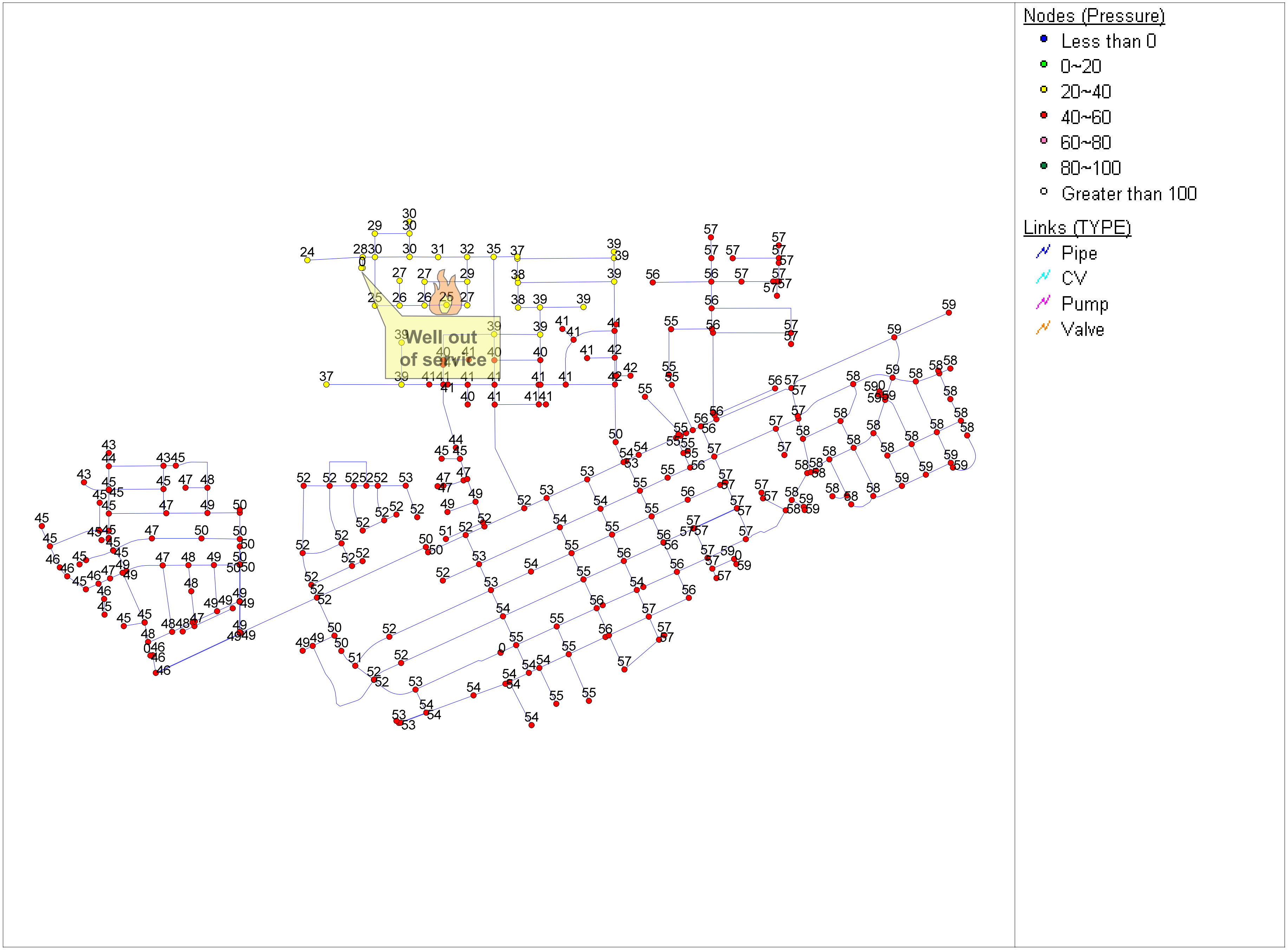
Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

Fire #5 - Max Day Demand - Existing System - Fire in Northeastern Residential Area and Well #6 Out of Service



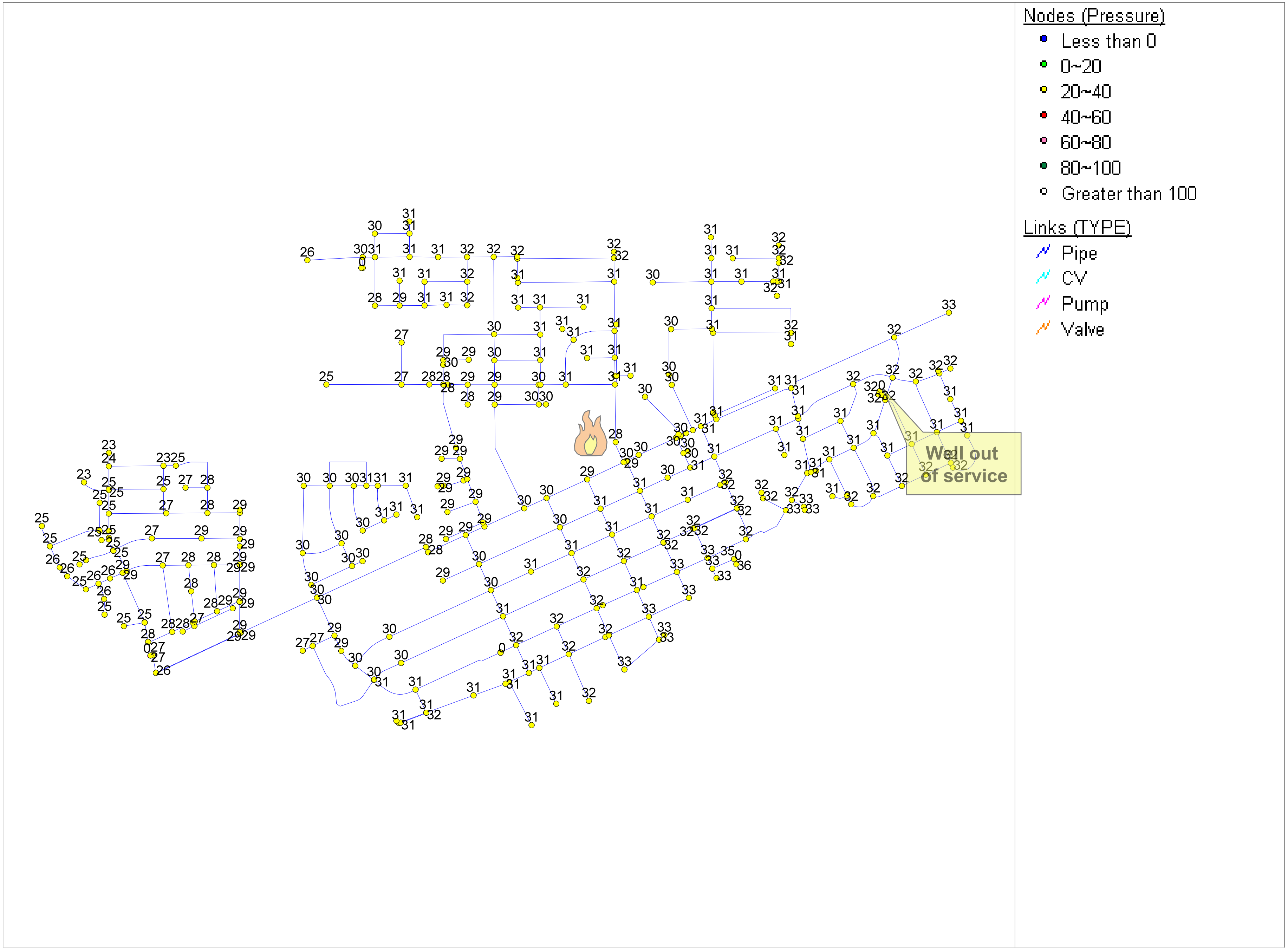
Fire #6 - Max Day Demand - Existing System - Fire in Northwestern Residential Area and Well #5 Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

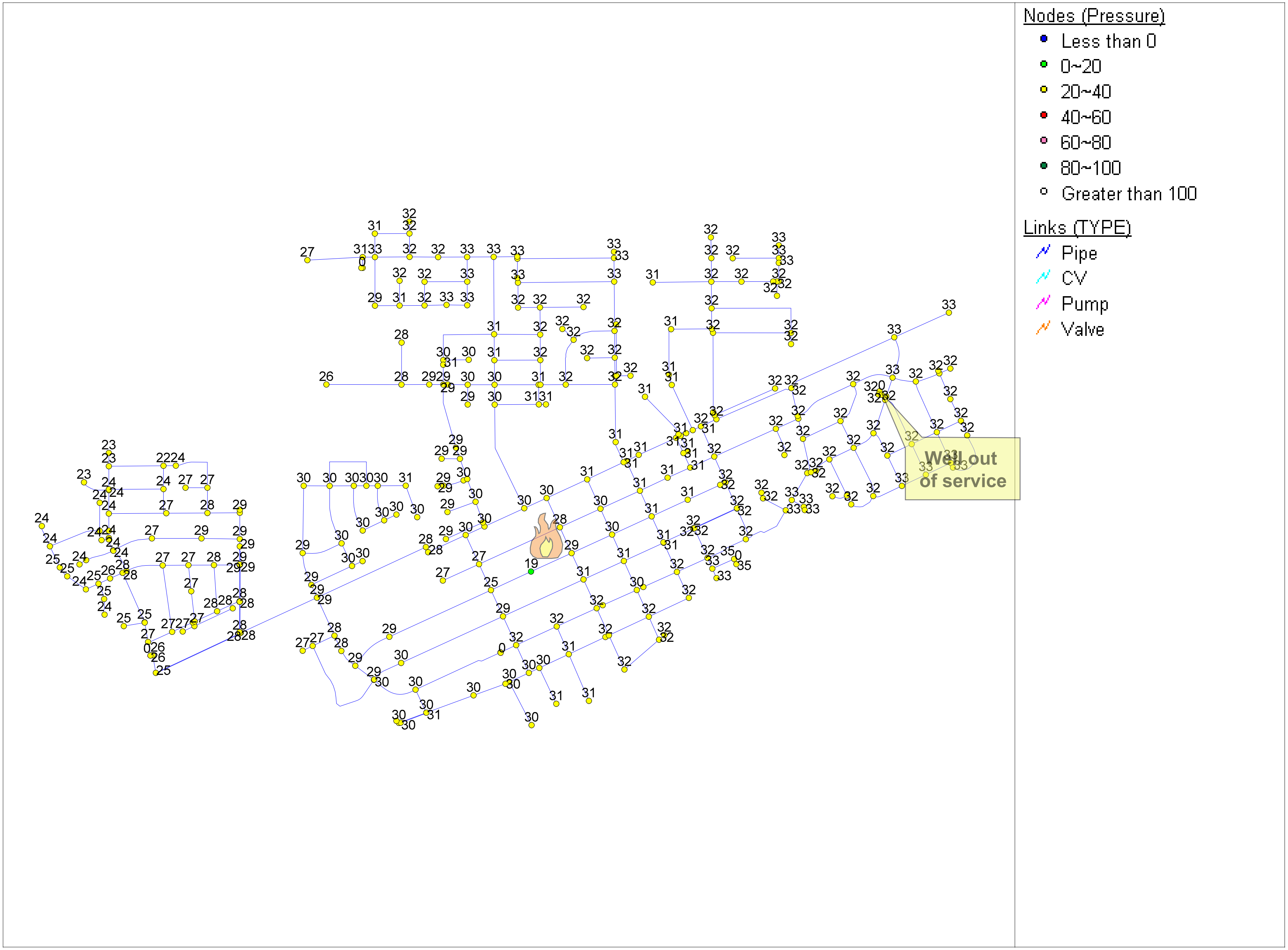
Fire #7 - Max Day Demand - Existing System - Fire near Winters High School and Well #6 Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

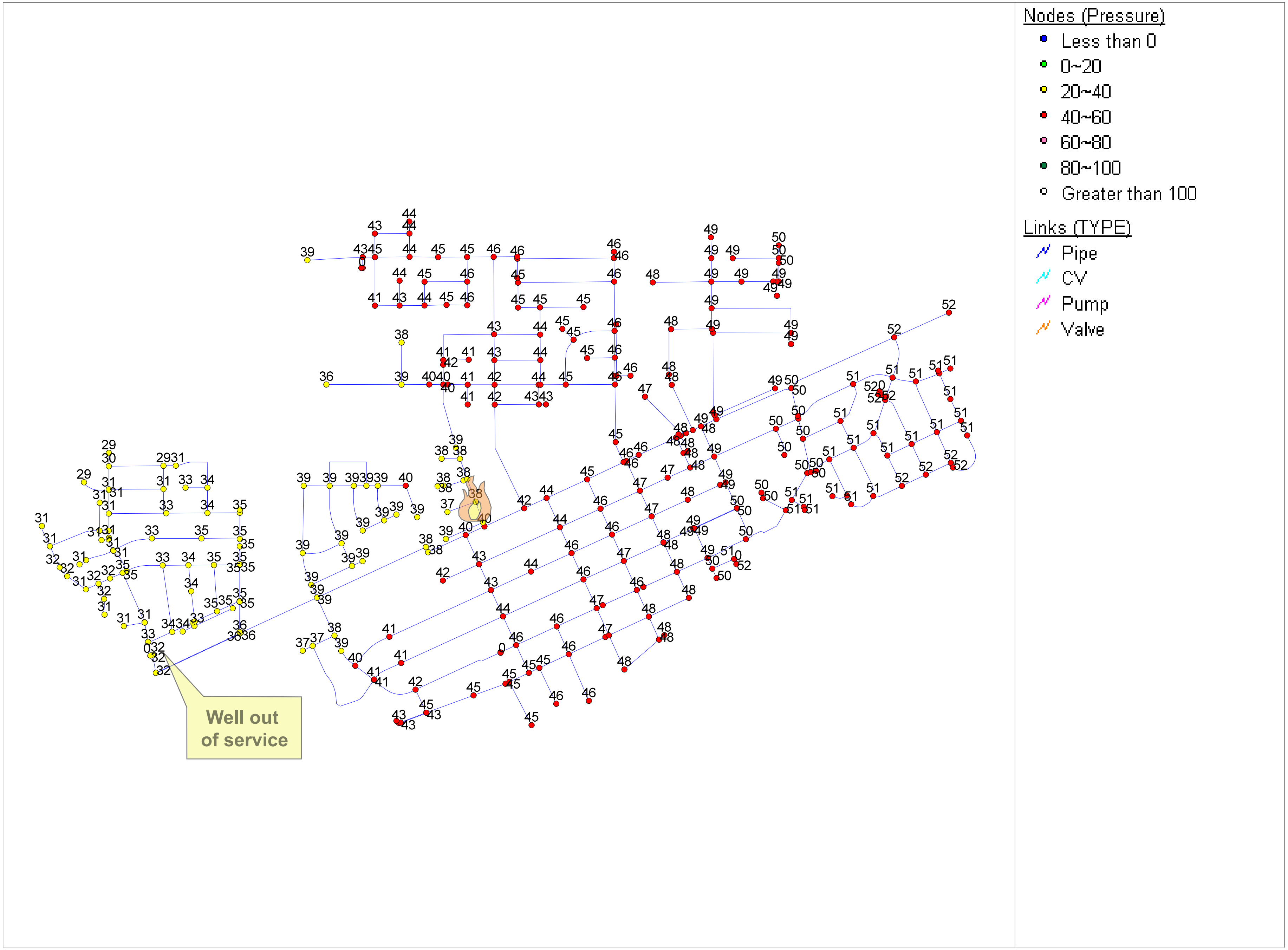
Fire #8 - Max Day Demand - Existing System - Fire near John Clayton School and Well #6 Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

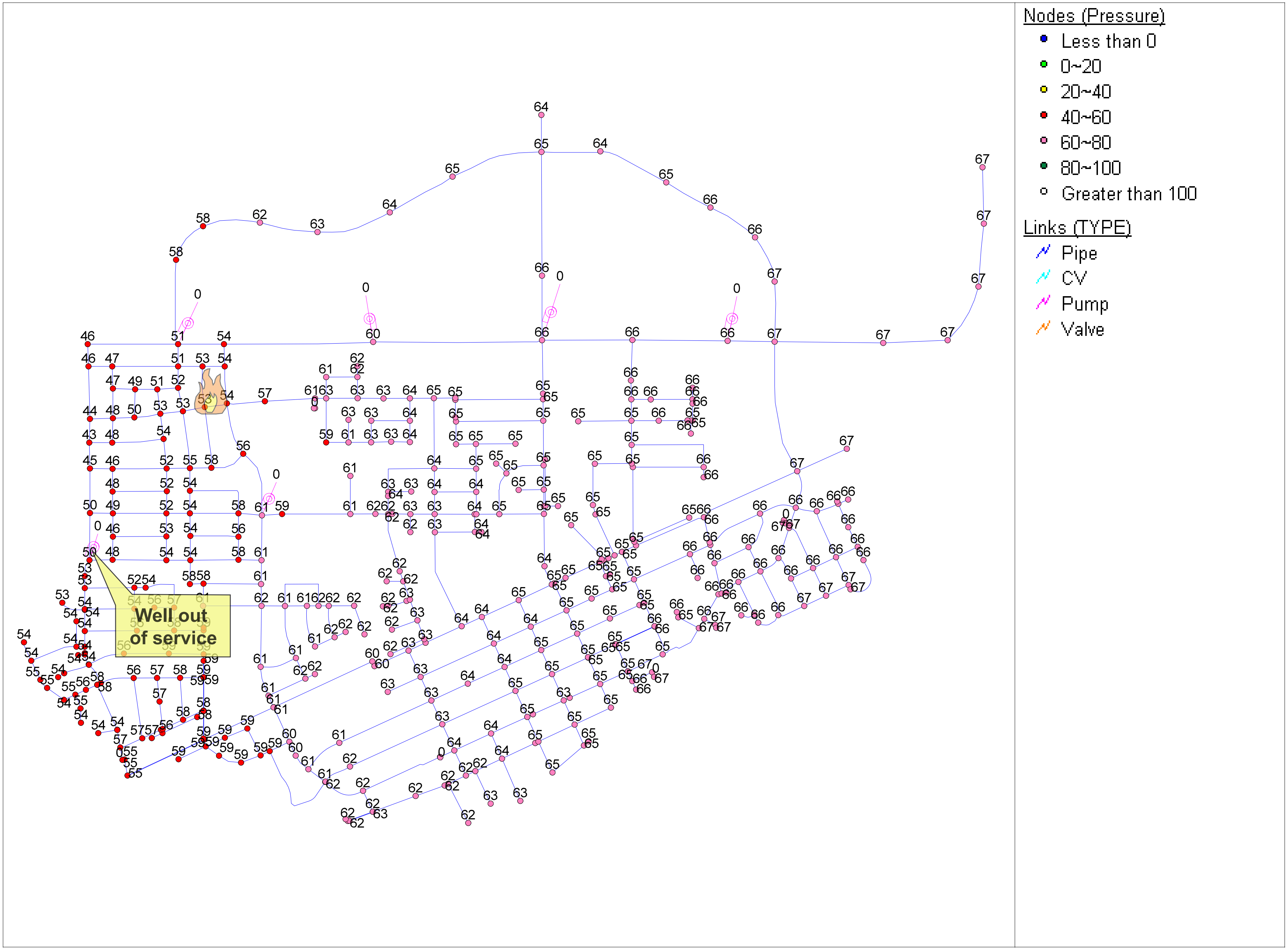
Fire #9 - Max Day Demand - Existing System - Fire near Waggoner School and Well #4 Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

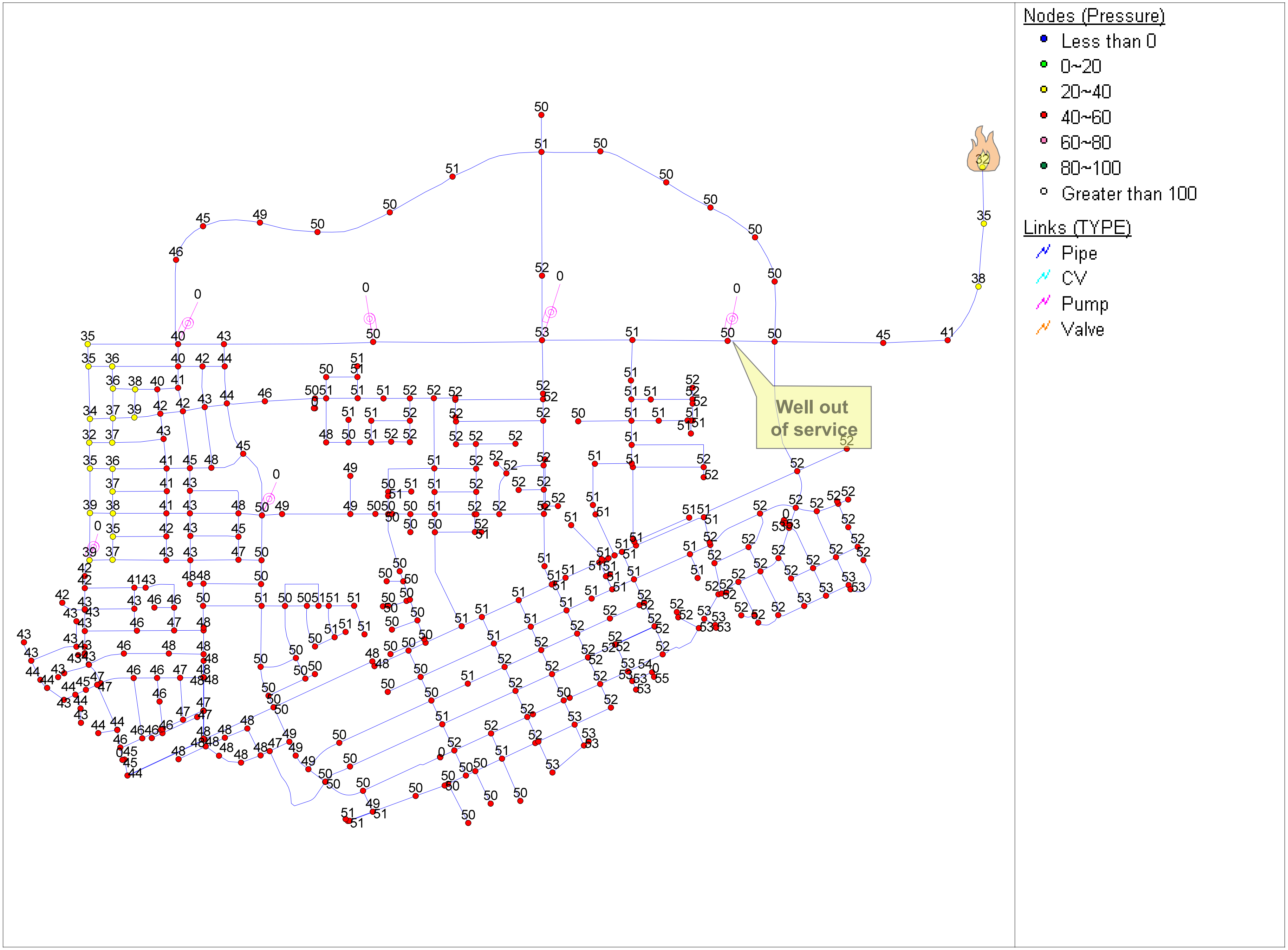
Fire #10 - Max DayDemand - Buildout with 6 Additional Wells - Fire in Future Northwestern Residential Area and Future Well Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

Fire #11 - Max DayDemand - Buildout with 6 Additional Wells - Industrial Fire in Future Northeastern Area and Future Well Out of Service



Prepared By: Andrew Smith

Date: Tuesday, May 16, 2006

APPENDIX C
CIP DATA

Project No.	Street	Size	Ex. Street[1]	Length	Unit Cost[2]	OH Factor[3]	Total Amount
1	Almond Drive Loop Water Main	8 in.	Yes	800 ft	94 $/LF	1.43	$ 107,700
1 Total				**800 ft**			**$ 108,000**
2	Moody Slough (West) Water Mains	14 in.	No	5,300 ft	137 $/LF	1.43	$ 1,036,800
2 Total				**5,300 ft**			**$ 1,037,000**
3	Moody Slough (East) Water Mains	14 in.	No	2,700 ft	137 $/LF	1.43	$ 528,200
3 Total				**2,700 ft**			**$ 529,000**
4	Main Street Loop (West) Water Mains	14 in.	No	5,700 ft	137 $/LF	1.43	$ 1,114,000
4 Total				**5,700 ft**			**$ 1,114,000**
5	Main Street Loop (East) Water Mains	14 in.	No	4,100 ft	137 $/LF	1.43	$ 801,300
5 Total				**4,100 ft**			**$ 802,000**
6	North Main Street Water Mains	14 in.	No	1,600 ft	137 $/LF	1.43	$ 312,700
6 Total				**1,600 ft**			**$ 313,000**
7	Timbercrest Road Water Mains	14 in.	Yes	1,200 ft	161 $/LF	1.43	$ 275,700
7 Total				**1,200 ft**			**$ 276,000**
8	Gateway Area (14-inch) Water Mains	14 in.	No	1,600 ft	137 $/LF	1.43	$ 312,700
	Gateway Area (8-inch) Water Mains	8 in.	No	1,100 ft	70 $/LF	1.43	$ 110,400
8 Total				**2,700 ft**			**$ 424,000**
9	North Eastern Area Water Main	14 in.	No	4,200 ft	137 $/LF	1.43	$ 820,800
9 Total				**4,200 ft**			**$ 821,000**
10	Railroad Ave Water Mains	14 in.	No	2,700 ft	137 $/LF	1.43	$ 527,700
10 Total				**2,700 ft**			**$ 528,000**
11	Annual Water Main Replacement[8]	Varies	Yes	1 LS	$50,000/Year	1.43	$ 71,500
11 Total				**1 LS**			**$ 72,000**
12	Residential Water Use Study[4]	---	---	1 LS	$ 8,000	1.43	$ 11,500
12 Total				**1 LS**			**$ 12,000**
13	Removal of Elevated Water Tanks[5]	---	---	1 LS	420000 $/LF	1.43	$ 600,000
13 Total				**1 LS**			**$ 600,000**
14	Future Well A	1,320 gpm	---	1 LS	$ 1,800,000	1.43	$ 2,571,500
14 Total				**1 LS**			**$ 2,572,000**
15	Future Well B	1,320 gpm	---	1 LS	$ 1,800,000	1.43	$ 2,571,500
15 Total				**1 LS**			**$ 2,572,000**
16	Future Well C	1,320 gpm	---	1 LS	$ 1,800,000	1.43	$ 2,571,500
16 Total				**1 LS**			**$ 2,572,000**
17	Future Well D	1,320 gpm	---	1 LS	$ 1,800,000	1.43	$ 2,571,500
17 Total				**1 LS**			**$ 2,572,000**
18	Future Well E	1,320 gpm	---	1 LS	$ 1,800,000	1.43	$ 2,571,500
18 Total				**1 LS**			**$ 2,572,000**
19	Future Well F	1,320 gpm	---	1 LS	$ 1,800,000	1.43	$ 2,571,500
19 Total				**1 LS**			**$ 2,572,000**
20	System Control and Data Acquisition (SCADA)	---	---	6 LS	$ 30,000	1.43	$ 257,200
20 Total				**6 LS**			**$ 258,000**
21	Major Well Maintenance/Rehabilitation[6]	---	---	1 LS	$ 120,000	1.43	$ 171,500
21 Total				**1 LS**			**$ 172,000**
22	Portable Emergency Generator	---	---	1 LS	140,000 LS	1.43	$ 200,000
22 Total				**1 LS**			**$ 200,000**
23	Creekside Water Mains[7]	Varies	No			1.43	
23 Total				**0 LS**			
24	Winters Highlands Water Mains[7]	Varies	No			1.43	
24 Total				**0 LS**			
25	Callahan Estates Water Mains[7]	Varies	No			1.43	
25 Total				**0 LS**			
26	Urban Water Management Plan	---	---	1 LS	30,000 LS	1.43	$ 42,900
26 Total				**1 LS**			**$ 43,000**
27	8" Pipe Replacement	8 in.	Yes	18,390 LS	94 $/LF	1.43	$ 2,475,800
27 Total				**18,390 ft**			**$ 2,476,000**
28	12" Pipe Replacment	12 in.	Yes	5,684 LS	138 $/LF	1.43	$ 1,118,700
28 Total				**5,684 ft**			**$ 1,119,000**
29	14" Pipe Replacement	14 in.	Yes	7,300 LS	161 $/LF	1.43	$ 1,677,000
29 Total				**7,300 ft**			**$ 1,677,000**
Grand Total				**31,001 ft**			**$ 27,941,000**

Notes:

1 An additional $20/LF was added to pipeline cost where the street currently exist. This cost was added to account for traffic contol, pavement breakup, etc.

2 Unit costs for mains and portable generator provided by the City.

3 Per the City's request, an overhead markup of 43% was applied to cover engineering, admin, legal, contruction contigency, etc.

4 Residential Water Use Study to be performed by City staff

5 Total project cost assume 100 K for West Main water tank (per City + inflation) and 250 K for Corp Yard water tank (based on cost info prvided by Plant Reclamation and includes demo, permitting, and lead based paint removal)

6 Total project budget to be used over a period of 5 years

7 Cost to be determined by developer.

8 Not included in Grand Total, as costs are annual

Table C-1: Master Plan Unit Costs

Facility	Size	Unit	Unit Cost		Unit
			Existing Street	Not in Existing Street	
Water Main	8	inches	94 [a]	70 [a]	$/LF
	12	inches	138 [a]	n/a	$/LF
	14	inches	161 [a]	137 [a]	$/LF
Future Well	1,320	gpm	1,800,000 [a]		$
Portable Emergency Generator	--	--	140,000		$

Footnotes:

a) Includes 20% markup from unit costs originally derived from historical Winters projects.

APPENDIX D
TECHNICAL MEMORANDA (TMs 1A & 2A/3A)

Technical Memorandum 1A

City of Winters – Water Master Plan

Subject: Recommended Water Distribution System Hydraulic Performance Criteria

Prepared For: Michael Karoly, P.E. - City of Winters

Prepared By: Charmin R. Roundtree and Jose Gutierrez, P.E.

Reviewed By: Glenn Hermanson, P.E.
Mai-Tram Le, P.E.

Date: November 3, 2004 (REVISED DRAFT)
November 24, 2003 (Draft)

Reference: 098.0010

INTRODUCTION

As part of the Water Master Plan Project, Raines, Melton, & Carella, Inc. (RMC) is tasked with developing a hydraulic model[1] of the City of Winters' (Winters) water distribution system, analyzing the City's water distribution system under current (2002) and build out land use scenarios[2], identifying deficiencies based on this analysis, and recommending capital improvement plan (CIP) projects to mitigate the identified deficiencies. The calibrated hydraulic model of the City's distribution system will be used to simulate the system's performance under different water demand patterns (e.g. Max Hour, Max Day with fire flow, etc). Model results will be compared with water system performance criteria to determine if improvements are needed. The distribution system will be analyzed based on distribution system residual pressure, pipeline headloss, pipeline velocity, and storage capacity.

Peaking factors are used to create the expected high water use demand scenario, which is then modeled and analyzed to identify hydraulic deficiencies in the distribution system. The typical standards by which the adequacy of a water distribution system can be analyzed are known as water system performance criteria. For water master planning purposes, these performance criteria are compared against the results obtained from the water system computer model to evaluate the adequacy of the distribution system. The criteria are also used as design standards for planning and developing CIP projects to upgrade the existing distribution system as necessary. Hence, before the hydraulic model can be analyzed to identify deficiencies, demand peaking factors and performance criteria need to be developed to establish guidelines for evaluating the current system under different land use scenarios.

This memorandum discusses the development of the proposed water demand peaking factors and water system performance criteria used as guidelines in the evaluation of the existing system. The memorandum is organized as follows:

I. Summary of Recommended Values and Criteria
II. Existing Well Capacity and Estimated Water Demands
III. Peaking Factors
IV. Well Production Criteria
V. Fire Flow Criteria
VI. Pipe Pressure Criteria

[1] This project will utilize MWH Soft H_2OMap Water (version 4.5) computer hydraulic model. A description of the development and calibration process will be provided in the *Water Master Plan Report*
[2] Based on the Winters 1992 General Plan

I. SUMMARY OF RECOMMENDED VALUES AND CRITERIA

In developing the recommended demands and performance criteria for evaluating the distribution system, a review of the 1992 City of Winters Master Plan and standards used by other municipalities in Northern California with similar water distribution systems was performed. The review and comparison of criteria utilized by other Northern California water purveyors was used to provide a method and basis for determining if the proposed performance criteria are consistent with other local water agencies with similar service areas. American Water Works Association (AWWA) M32 manual of water supply practices for Distribution Network Analysis for Water Utilities was also used to compare industry accepted guidelines to the recommended performance criteria. Some refinements to the 1992 Master Plan criteria were developed and the rationale for these changes is presented herein. Table 1 gives a summary of the recommended criteria for this Master Plan.

Table 1: Summary of Recommended Values and Criteria for this Master Plan

EXISTING WELL CAPACITY			
Total Capacity[1] (mgd) @ 50 psi	**Total Capacity[2] (mgd) @ 30 psi**	**Firm Capacity[3] @ 50 psi**	**Firm Capacity @ 30 psi**
8.0	10.1	5.5	6.9

WATER USE PEAKING FACTORS				
	Existing Conditions		**Future Conditions**	
	Max Day/Average Day	*Max Hour/Average Day*	*Max Day/Average Day*	*Max Hour/Average Day*
1992 Master Plan	2.0	3.5	2.0	3.5
Recommended Values	2.6	3.9	2.6	3.9

DEMANDS						
Year	**Average Day**		**Max Day**		**Max Hour**	
	(gpm)	(MGD)	(gpm)	(MGD)	(gpm)	(MGD)
Existing (2002)	1,062	1.5	2,719	3.9	4,142	6.0
Build out[4]	3,374	4.9	8,772	12.6	13,159	18.9

PRESSURE CRITERIA		
Demand Scenario	**Minimum Pressure (psi)**	**Maximum Pressure (psi)**
Average Day	50	100
Max Day + Fire Flow	20	-
Max Hour	30	-

VELOCITY & HEADLOSS CRITERIA	
Maximum Velocity (ft/sec)	**Headloss**
10	10 ft / 1,000 ft

Notes:
1. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
2. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.
3. Firm capacity is the total capacity with the largest well (Well #6) out of service
4. Future demands assume build out conditions defined in 1992 Winters General Plan

II. EXISTING WELL CAPACITY AND ESTIMATED WATER DEMANDS

The City's well supply will be used to meet the water demands. The firm capacity (capacity with largest well out of service) is less than the anticipated peak demand for existing conditions. If Well 6 is out of service during a peak demand (i.e. Max Day demand + 3000 gpm Fire flow) period, then the distribution system supply could be deficient by approximately 903 gpm (1.3 mgd). Therefore, based on conservative assumptions one additional well will be necessary to meet existing demand conditions. At buildout, a total of six additional wells (assumes 1,320 gpm capacity for each well) will be required. One well is necessary at present with the five remaining wells constructed as demands increase in the future.

Table 2A: Well Capacities

Well	Capacity at 50 psi[1] (gpm)	Capacity at 30 psi[2] (gpm)
2	1,320	1,520
3	970	1,170
4	825	1,160
5	700	960
6	1760	2,200
Total	**5,575 gpm (8.0 mgd)**	**7,010 gpm (10.1 mgd)**

Notes:
1. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
2. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.

Table 3B: Comparison of Well Capacity and Water Demands

WELL CAPACITY AND WATER DEMAND		
	Existing Conditions	**Build Out Conditions**
Total Well Capacity (mgd)	8.0	-
Firm Well Capacity[1] (mgd)	6.9	-
Max Day Demand (mgd)	3.9	12.6
Max Day Demand + Fire Flow[2] (mgd)	8.2	16.9
Max Hour Demand (mgd)	6.0	18.9
Additional Well Capacity Needed (mgd)[3]	1.3	10.9
Additional Number of Wells Needed[4]	1	3

Notes:
1. Firm capacity is the total capacity at 30 psi with the largest well out of service. Well 6 is the largest well with a maximum capacity of approximately 1,760 gpm (based on well testing data).
2. Fire flow demand assumed at 3,000 gpm (4.3 mgd) (Industrial)
3. Additional Well Capacity Needed = (Max Day Demand + Fire flow) – Firm Well Capacity or (Max Hour Demand) – Total Well Capacity, whichever is greater
4. New well capacity assumed at 1,320 gpm (1.9 mgd) at 50 psi or 1,520 gpm (2.2 mgd) at 30 psi

III. PEAKING FACTORS

Water usage normally varies with the seasons, the days of the week, and the hours of the day. The variations in water demand throughout the seasons and throughout the day and their effects on the distribution systems are important considerations in determining adequate capacity and sizing conveyance facilities. Variations in water consumption are usually expressed as ratios to the Average Day demand. These ratios are commonly termed peaking factors. Peaking factors are used in water master planning to estimate water demands occurring during Max Day and Max Hour events in a water distribution system.

For the City of Winters, the Average Day demand is the total water produced by the groundwater supply wells divided by the number of days in a year. The Max Day demand is the largest volume of water used during any 24 hour period during the year. The Max Day peaking factor is then defined as the ratio of Max Day demand to Average Day demand for a given year. The Max Day demand typically occurs during the hot summer months. Similarly, the Max Hour demand is the largest volume of water used during any one hour period for the year. The Max Hour demand usually occurs in the morning, during Max Day demand periods. The Max Hour peaking factor is expressed as either the ratio of Max Hour demand to the Max Day demand or Max Hour to Average Day demand.

For this Technical Memorandum (TM), the Proposed California Water Works Standards were used to determine Max Day and Max Hour peaking factors. This approach was taken because Winters does not record hourly production at the wells; therefore, the peaking factors could not be calculated using well production data.

The California Water Works Standards were developed by the Sacramento Office of Regulations of the Department of Health Services (DHS). The current Water Works Standards were adopted in March of 2002. However, the current standards do not provide guidelines on how to determine peaking factors when only limited demand data is available. See Appendix A for California Water Works regulatory code approval.

As noted in the online status table, the DHS has completed the regulatory process and the Proposed Water Works Standards are currently undergoing approval by the DHS Budget Office and Department of Finance. RMC recommends these guidelines to be used as part of developing the hydraulic model. Specifically, Section 64554 of the Proposed Water Workers Standards provides guidelines on how to develop Max Hour factors when limited demand data is available. Presently, the majority of Winters' water customers are not metered. Therefore, peaking factors (expressed as ratios to average day demand) presented in this TM were derived by applying the DHS Proposed Water Works Standards to eight to nine years of monthly well production data.

For systems where demands are mostly residential, one Max Day factor and one Max Hour factor will typically be used. However, because the usage pattern often varies greatly between residential, quasi-public, commercial, and industrial users, these land use categories can be considered individually with respect to peaking factors. Specifically, the Max Hour factor tends to be lower for Industrial/Commercial water users when compared to Residential users. Applying one Max Day and Max Hour factor for the entire City could result in an overly conservative demand for the distribution system. However, because metered data is not available for various user categories in Winters, a single peaking factor will be assumed for all users. As part of the CIP projects to be presented in this Master Plan, RMC will recommend that the City invest in the installation of a Supervisory Control and Data Acquisition (SCADA) system so that peaking factors for future master plan updates can be determined based on the City's metered data.

1992 Master Plan

Max Day

The 1992 Master Plan peaking factors are listed in Table 3[3]. The 1992 Max Day factor was derived by reviewing well production data from the City of Winters and metered data from the Cities of Davis and Folsom.

The future demand in the 1992 Master Plan was based on build out conditions summarized in the 1992 Winters General Plan. Future demands were derived from land use information and were estimated to be 3,210 gpm (4.6 mgd) for Average Day and 6,420 gpm (9.2 mgd) for Max Day.

[3] The City of Winters 1992 Plan, CH2M Hill

Max Hour

Limited data was available to calculate the Max Hour peaking factor. Therefore, a typical daily demand curve for municipalities was used to derive the peaking factor. The resultant value was also used for future demand scenarios.

Table 4: 1992 Master Plan Peaking Factors

WATER USE PEAKING FACTORS				
1992 Master Plan	**Existing Conditions**		**Future Conditions**	
	Max Day/Average Day	***Max Hour/Average Day***	***Max Day/Average Day***	***Max Hour/Average Day***
	2.6	3.9	2.6	3.9

Parameters for Current Master Plan

Unaccounted for Water Usage

Unaccounted-for-water usage in a distribution system is defined as the difference between the amount of water entering a system (supplied or purchased) and the amount of water sold (metered and billing data), expressed as a percentage. Unaccounted-for-water usage is always present in a water system and can result from many factors such as unidentified leaks in a pipe network, periodic fire-hydrant flushing, unauthorized use, inaccurate and nonfunctioning meter, etc. Since well production rates presented in this TM include the system water loss, unaccounted for water use will be inherent in the water use factors developed for each user. It is assumed that 10 percent of the metered well production is lost through the system.

Existing and Buildout Conditions - Average Day Demand

The Average Day demand was developed using monthly well production data. Based on personal communication with Winters' staff[4], the well production data since 1999 was more reliable than previous years. Year 2002 represented the highest annual well production out of these four years. The total well production for 2002 was approximately 622 million gallons (mg) which translates to an average daily production of approximately 1.7 million gallons per day (mgd) or 1,180 gallons per minute (gpm). It was assumed that 10 percent of the daily well production can be considered unaccounted for water which results in an Average Day Demand of 1.5 mgd or 1,062 gpm. The average day demand was allocated based on existing land use conditions and use demand factors. The land use method of demand allocation requires using water use factors to accurately assign demand for each land use category. The water use factors used in this Master Plan and shown in Table 5 were derived from the City's General Plan, Standards for Peak Hour Water Flows, and Average Dry Weather Wastewater Flows (ADWF). Water use factors for commercial, industrial, and other land use categories were adjusted upward by a factor of 1.07 to normalize the calculated projections to the assumed Winters' average day demand of 1,062 gpm.

Water usage factors (WUF) for each land use type were determined as follows.

Residential

Residential water use is comprised of two multi-family land uses (high and medium/high density) and three single family land uses (medium density, low density, and rural residential). Each of these land uses has two water use components; irrigation and non-irrigation water use.

High Density and Medium/High Density Residential. The General Plan provides a range of land densities for high (HR) and medium/high (MHR) multi-family residential parcels, therefore

[4] Personal email communication with Michael Karoly, Ponticello Enterprises, City of Winters Engineer

it is not possible to determine exactly how many units comprise a multi-family parcel. Therefore, usage factors for multi-family land use types were calculated based on sewer ADWF[5] generation. It was assumed that irrigation demands for multi-family parcels were negligible and also assumed that 90 percent of total water use was turned into sewage. Hence;

HR: *WUF (gpm/acre) = [ADWF]/[0.9]*
= [2,747 gpd/net acre]/[0.9]
= 3,067 gpd/net acre or 2.13 gpm/net acre

MHR: *WUF (gpm/acre) = [ADWF]/[0.9]*
= [1,647 gpd/net acre]/[0.9]
= 1,875 gpd/net acre or 1.3 gpm/net acre

Medium Density, Low Density, and Rural Residential. The non-irrigation water demand for medium density (MR), low density (LR), and rural residential (RR) land uses was assumed to be 100 gallons per day per capita. Hence;

Non-irrigation water demand (gpm/du) = [Pop. density][Per Capita Water Usage]*
= [3.5 people/du][100 gpd/capita]*
= 350 gpd/dwelling unit or 0.24 gpm/du

The irrigation water demand for medium density (MR), low density (LR), and rural residential (RR) land uses was calculated by subtracting all other water demands from the Existing Average Day Demand. This calculation resulted in a residential irrigation demand of 165 gpd per dwelling unit. The City of Roseville completed a Residential Water Use Study and determined that their irrigation demand was 305 gpd/du by comparing winter residential water meter data and summer residential water meter data. A demand of 165 gpd/du is low compared to 305 gpd/du, but appears reasonable.

Thus, the residential water use factor (irrigation plus non-irrigation) for medium density, low density, and rural residential land uses is calculated to be 515 gpd per dwelling unit.

Residential WUF = [Non-Irrigation Water Demand]+[Irrigation Water Demand]
= [350 gpd/du]+[165 gpd/du]
= 515 gpd/dwelling unit or 0.36 gpm/du

In order to calculate total water demand use for rural, low density, and medium density residential parcels, population densities of 1, 7.3, and 8 dwelling units per net acre were assumed at buildout conditions.

Commercial, Industrial, and Others

With the exception of public quasi parcels (PQP), non-residential demands were derived using design standards from Cities of Woodland and Milpitas. ADWFs were used to derive demands for PQP parcels. As shown in Table 4, it was assumed that 90 percent of total water demand is treated at the City's wastewater plant. An additional demand of 1,300 gpd/net acre (0.9 gpm/net acre) was added to schools,

[5] Average Dry Weather Flows derived from City's Design Standards and listed in TM1B2, City of Winters Sewer Master Plan

cemeteries, and community center/parks to account for irrigation water use. Table 5 summarizes average day demand by land use type.

Max Day Demand and Peaking Factor

The Max Day demand was developed by applying use factors defined in the Proposed California Water Works code of regulations criteria to monthly-recorded well meter readings from January of 1999 through December of 2002. The Max Day peaking factors for the year with the highest monthly reading were calculated.

The 2003 Draft California Water Works code of water regulations has been developed and states that if only monthly data are available, then the Max Day demand should be calculated by multiplying the average daily usage during the maximum month times a peaking factor of 1.5. Between January of 1999 and December of 2002, the maximum month demand occurred in July 2001. The total production for this month was approximately 90 mg and yielded an average daily usage equal to 2.9 mgd. It is assumed that 10 percent of the average daily usage during the max month is considered unaccounted for water, which yields an average daily usage of 2.6 mgd. Therefore, it is recommended that the Max Day demand of 3.9 mgd or 2,719 gpm be used in the Master Plan.

Typical Max Day Demand peaking factors for communities around the Sacramento and Bay Area can be as high as three times the Average Day Demand. Dividing the calculated Max Day Demand (2,719 gpm) by the Average Day demand (1,062 gpm) yields a peaking factor of 2.6, which is within the range of acceptability according to American Water Works Association (AWWA) standards (1.5 to 2.8 for Max Day and 2.5 to 4.0 for Max Hour).

Max Hour Demand and Peaking Factor

The California Water Works Code states that if only monthly data are available, the Max Hour demand should be estimated by multiplying the Max Day Demand by a peaking factor of 1.5. This approach is recommended for the Master Plan. Based on a Max Day demand of 3.9 mgd for existing conditions, the Max Hour demand will be 5.9 mgd. Dividing the calculated Max Hour demand by the Average Day demand (1,062 gpm) yields a peaking factor of 3.9. This peaking factor will also be used for build out demands.

The Max Hour factor is usually developed from an hourly demand curve of the Max Day. Estimates of Max Hour demands could have been calculated from the field measured Max Hour demands collected by the City of Winters over a 10 day period. Well readings were taken from Wells 2 through 6 in August of 2003 between the hours of 8:00 AM and 9:00 AM (Max Hour demand typically occurs between the hours of 6 AM to 9 AM). The Max Hour demand (sum of the well production during one hour period) calculated based on these readings was equal to 2,370 gpm. Considering an average demand of 1,036 gpm (average of Average Day demand data for previous years of record), the calculated Max Hour peaking factor was 1.95. According to AWWA, the common range of Max Hour to Average Day demand for the U.S. is 2.0 to 7.0. Unfortunately it is difficult to assess the accuracy of this data. Therefore, field measured Max Hour demands collected by the City was not used in developing the peak hour factor. Retrieving hourly production data over several hours in the morning (from 5 AM to 9 AM) and over a longer period of days would have provided more reliable data for calculating the Max Hour peaking factor. The recommended peaking factors for the 2003 Master Plan are summarized in Table 6.

Table 4: Average Day Water Demand for PQP Parcels

	Existing				Buildout			
Description	**ADWF[2] (gpd)**	**Water Demand (gpd)**	**Total Water Demand (gpd)**	**Total Water Demand (gpm)**	**ADWF[2] (gpd)**	**Water Demand (gpd)**	**Total Water Demand (gpd)**	**Total Water Demand (gpm)**
Shirley Rominger[1] Intermediate School	18,000	20,000	36,128	25	35,000	38,889	55,017	38.2
Winters Middle School[1]	23,000	25,556	39,380	27.3	30,000	33,334	47,158	32.7
Cemetery[1]	7,200	8,000	24,992	17.4	7,200	8,000	24,992	17.4
Waggoner Elementary School[1]	35,000	38,889	50,841	35.3	35,000	38,889	50,841	35.3
John Clayton Kinder School[1]	10,000	11,112	13,963	9.7	25,000	27,778	30,629	21.3
Winters High School[1]	37,620	41,800	67,000	46.5	45,000	50,000	75,200	52.2
City Hall/Police Dept.	816	906	906	0.63	816	906	906	0.63
Yolo County Library	1,092	1,213	1,213	0.84	1,092	1,213	1,213	0.84
Fire Department	1,169	1,299	1,299	0.9	1,169	1,299	1,299	0.9
Park/Community Center[1]	26,600	29,556	39,406	27.4	26,600	29,556	39,406	27.4
Corporation Yard	5,075	5,639	5,639	3.9	5,075	5,639	5,639	3.9
Future Agricultural School[1]	0	0	0	0	6,000	6,667	18,907	13.1
Future Elementary School	0	0	0	0	35,000	38,889	55,348	38.4
Future High School[1]	0	0	0	0	60,000	66,667	106,454	74
Landfill (closed) and Future Park[1]	0	0	0	0	900	1,000	40,528	28.1
Future City Facility	0	0	0	0	30,000	33,333	33,000	23
TOTAL			**0.28 MGD**	**194**			**0.59 MGD**	**408**

Notes:
1. Additional irrigation demand of 1,300 gpd/acre added to all schools, parks and cemeteries
2. Data provided in TM 1B2 (Table 2), Wastewater Flow Design Criteria of the City's Sewer Master Plan

Table 5: Land Use and Demand Allocations

EXISTING AND BUILDOUT AVERAGE DAY DEMANDS							
Land use Category	Net Area[1]		Existing & Buildout	Existing Demand		Buildout Demand	
	Existing (acres)	Buildout (acres)	Water Use Factor (gpm/acre)	(gpm)	(mgd)	(gpm)	(mgd)
High-Density Multi-family Residential	15	41	2.1	31.5	0.01	86	0.12
Low Density Single Family Residential	89	299	n/a[2]	153	0.22	690[4]	0.99
Medium Density Single-family Residential	196	314	n/a[2]	387	0.56	750[5]	1.08
Med-High Density Multi-family Residential	16	69	1.3	21	0.03	90	0.13
General Agriculture	0	4	2.18[3]	0	0	8.7	0.01
Rural Residential	0	47	0.36[6]	0	0	17	0.02
Public/Quasi Public	280	399	n/a[7]	195	0.28	410	0.60
Parks and Recreation	14	145	5.56[8]	78	0.11	806	1.16
Open Space	49	188	n/a	0	0.00	0	0
Neighborhood Commercial	4	22	1.5[8]	6	0.01	33	0.05
Central Business District	46	63	1.5[8]	69	0.1	94.5	0.14
Highway Service Commercial	1	6	1.5[8]	1.5	0.01	9	0.01
Planned Commercial	0	24	1.5[8]	0	0	36	0.05
Planned/Business Park	0	54	1.5[8]	0	0	81	0.12
Office	4	5	2.37	9.5	0.01	12	0.02
Light Industrial	0	65	0.63	0	0	41	0.06
Heavy Industrial	0	37	1.58	0	0	58.6	0.08
Vacant	1068	0	n/a	0	0	0	0
Large Users - Mariani	n/a	n/a	n/a	111[9]	0.16	111[9]	0.16
Total	**1,782**	**1,782**		**1,062**	**1.5**	**3,374**	**4.9**

Notes:
1. Land use areas derived from City of Winters 1992 General Plan
2. Demand calculated based on use per dwelling unit (du) of 0.36gpm/du.
3. WUF derived from the Winters Highland and Callahan Developments Water Supply and Assessment Report, Saracino, Kirby, and Snow
4. Demand = Net acreage*7.3 du/net acre*0.36 gpm/du
5. Demand = Net acreage*8.1du/net acre*0.36 gpm/du
6. Demand = Net acreage*1.0 du/net acre*0.36 gpm/du
7. PQP demand derived from wastewater design flow data provided by the City. See Table 4.
8. WUF derived from City of Woodlands' Design Standards. Irrigation accounted for in Park WUF.
9. Demand derived from ADWF data. Assume 90 percent of water demand is treated at the City's wastewater plant.

Table 6: Recommended Master Plan Peaking Factors

RECOMMENDED PEAKING FACTORS FOR EXISTING AND BUILD OUT CONDITIONS				
Current Master Plan	Existing Conditions		Build out Conditions	
	Max Day/Average Day	*Max Hour/Average Day*	*Max Day/Average Day*	*Max Hour/Average Day*
	2.6	3.9	2.6	3.9

Notes:
1. See Appendix B for Peaking Factor calculations.

Water Conservation

Water conservation will not be included in modeling existing or future use scenarios. The production factors listed in Table 5 do not include potential water conservation.

IV. WELL PRODUCTION CRITERIA

According to the existing California Water Works code of regulations, a water system must be able to demonstrate adequate source capacity. Based on the City of Winters' Water Supply Assessment[6], sources of groundwater recharge in the Winters vicinity primarily include subsurface inflow from the west and north, deep percolation from precipitation and seepage from Putah Creek and Dry Creek. Data presented in the assessment show that Winters currently uses 1,900 acre-feet per year (1.7 mgd) from the underlying aquifer. The water supply assessment indicates that current supply can also meet future demands with no risk of overdraft even during consecutive dry years.

The City currently operates 5 wells with variable frequency drives (VFD) to meet water demands. Table 7 provides well capacities and horse power ratings for each well. The City does not have pump performance curves and VFD settings. Well testing was conducted by the City and RMC staff to develop representative pump curves. See TM 2A and 3A for full pump curves and field test data. The pumps are currently operated to maintain a system pressure between 50 and 60 psi.

Table 7: Well Capacities

Well	Capacity at 50 psi[1] (gpm)	Capacity at 30 psi[2] (gpm)	Horse Power (hp)
2	1,320	1,520	100
3	970	1,170	60
4	825	1,160	75
5	700	960	75
6	1760	2,200	125
Total	**5,575 gpm (8.0 mgd)**	**7,010 gpm (10.1 mgd)**	

Notes:
1. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
2. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.

V. FIRE FLOW DESIGN CRITERIA

Fire flow design criteria are defined in section 8-12 of the City of Winters' Design Standards manual. Fire flow rates are listed in Table 8. Durations are not specified in the City of Winters design standard, as the system currently has no storage.

[6] Water Supply Assessment Report, SKS, Sept. 2003

Table 8: Minimum Fire Flow Requirements for Various Types of Development

FIRE FLOW RATES	
Type of Development	**Minimum Fire Flow Rate (gpm)**
Residential and Multifamily	1,500
Schools and Central Business District	2,000
Industrial/Other Business District	3,000

VI. PIPE PRESSURE CRITERIA

Water system pressure criteria are used to evaluate the ability of the system to provide acceptable pressures at points of delivery to customers under various demand conditions. It is important that the water pressure in a consumer's residence or place of business be neither too low nor too high. The desired range should encompass Average Day demand, Max Day demand, maximum storage replenishment rate, and Max Hour demand conditions. The desired range of pressure for water distribution systems, excluding fire flow conditions, is defined in AWWA M32 Manual as 30 to 90 psi. However, operating pressures for a water distribution system typically range from a minimum of 20 psi to a maximum of 150 psi. The recommended pressure criteria for this Water Master Plan is presented in Table 9 and discussed in detailed below.

Maximum Pressure

Maximum static (no flow) pressures for distribution system vary widely in the industry and are subject to available topography and pumping requirements. The AWWA manual does not provide recommendations for maximum static pressure. However, section 1007 of the Uniform Plumbing Code requires pressure-regulating valves on individual service connections where delivery pressures are greater than 80 psi. High pressures may cause faucets to leak, valve seats to wear out quickly, or water heater pressure relief valves to discharge. In addition, abnormally high pressures can result in water being wasted in system leaks. Section 8-10 of the City of Winters Design Standard manual requires a maximum service pressure of 100 psi during normal day operations.

Minimum Pressure

Minimum pressure required during Max Day Demand conditions should be adequate to meet customer needs. Typically, 40 psi is recommended as a minimum level of service for Max Day Demand conditions. If system pressures remain below 40 psi for an extended period, there may be a significant increase in customer complaints. In addition to the Max Day Demand criterion of 40 psi, many water systems in the Bay Area follow the recommended AWWA minimum pressure criterion for Max Hour of 30 psi. Pressure below 30 psi causes annoying flow reductions when more than one water-using device is in service. According to the City of Winters Design Standard manual, the minimum level of service for average day operations is 50 psi. Currently there is no requirement to meet level of service criteria for Max Day or Max Hour demands at service connections. For the purpose of this Master Plan, a Max Day (without fire flows) and Max Hour pressure criteria of 40 psi and 30 psi, respectively, shall be assumed. It should be noted that the model scenarios presented in this Master Plan pair Max Day demands with fire flow; therefore, a minimum pressure criteria of 20 psi will be assumed for all Max Day demand scenarios.

Fire Flow Pressure

Provision of adequate minimum pressure for a water distribution system during fire suppression events is also one of the basic indicators of acceptable distribution system performance. A minimum system pressure of 20 psi is recommended by federal and state agencies for fire emergency conditions. City of

Winters design standards require a minimum pressure at the fire hydrant location of 20 psi during periods of Max Day plus fire flow. Adequate pressures during fire events are required to both suppress the fire and maintain positive pressure with a margin of safety throughout the distribution system. Negative pressures rarely occur in water distribution systems because demands will decrease with decreasing delivery pressure. However, backflow, potentially causing cross contamination created by a vacuum on the system, is a health concern addressed by defining minimum pressure criteria. Because fires are not scheduled events, fires may occur when a well is out of service. For the purpose of this Master Plan, the fire scenarios were evaluated with the nearest well out of service.

Table 9: Pipe Pressure Criteria

PRESSURE CRITERIA		
Demand Scenario	**Pressure (psi)**	**Comments**
Normal Maximum	100	
Max Day + Fire Flow Minimum	20	With largest well out of service
Max Hour Minimum	30	

VII. PIPELINE VELOCITY AND HEADLOSS CRITERIA

Pipeline flow velocity and headloss criteria are interrelated because headloss per 1,000 feet is a function of velocity and pipe roughness. As defined in the City of Winters Design Standard Manual, the assumed pipe diameter criteria will be a minimum pipe size of 8 inches for looped systems and 6 inches for dead end pipes not connected to the system. The pipe roughness coefficient, also defined in the City of Winters Standard, is 125 for cement-lined, polyvinyl chloride, and ductile iron pipes. Because data on exact pipe material is not available, RMC will assign initial C values for the City and will make adjustments throughout the distribution system via model calibration. The allowable pipe headloss and water velocity are not specifically defined in the City of Winters Design criteria. The AWWA M32 Manual sets an acceptable maximum velocity in pipe segments of 10 ft/s. As velocities increase beyond 10 ft/s, pipe head losses increase exponentially and problems with water hammer develop. However, the ultimate test of piping system adequacy is the pressure at the point of delivery.

For the Master Plan, it is recommended that the maximum headloss criterion also be used to evaluate the distribution systems performance. Measured headloss exceeding 10 ft/1,000 ft of pipe may indicate insufficient pipeline capacity. Maximum pipe headloss criteria are established to reduce pressure variations within the transmission-distribution system. When headloss in a pipe segment approaches 10ft/1,000 ft of pipe, a substantial loss of pressure occurs in that length of pipe.

VIII. PROPOSED PEAK FLOW MODELING SCENARIOS

Modeling will be performed to identify existing system deficiencies and deficiencies under build out conditions. Recommendations for improvements will be made based on the systems ability to operate efficiently during critical demand periods such as Max Day plus fire flow and Max Hour conditions. The Max Day demands alone will not be modeled, unless storage is provided in the system. With no storage in the system, the Max Day demands will be less critical than either the Max Hour or Max Day plus fire flow scenarios. Table 10 provides a listing of proposed demand scenarios. The results of these demand scenarios will be used to evaluate whether the existing hydraulic components meet the City’s current distribution system performance standards. Max Hour conditions will be simulated for both existing and build out conditions. Fire flow scenarios Number 1 through 9 will be performed at existing conditions. Fire flow scenarios Number 10 and 11 will be performed at build out conditions.

Table 10: Proposed Demand Scenarios

PROPOSED DEMAND SCENARIOS			
Scenario	**Demand Conditions**	**Minimum Pressure**	**Proposed Location of Study Hydrants (fire flow)**
Existing Max Hour	Max Hour w/all wells operating	30 psi @ service connection	
Fire #1	Max Day w/Fire at City Hall w/Well #3 out of service	20 psi @ hydrant	First and Main Streets (2000 gpm)
Fire #2	Max Day w/fire near Mariani Storage and Shipping w/Well #2 or #6 out of service	20 psi @ hydrant	Baker St. (1500 gpm) and Edwards St. (1500 gpm)
Fire #3	Max Day w/fire in western residential area w/Well #4 out of service	20 psi @ hydrant	Jefferson or Mac Arthur St. (1500 gpm)
Fire #4	Max Day w/fire in eastern residential area w/Well #6 out of service	20 psi @ hydrant	Wild Rose Lane (1500 gpm)
Fire #5	Max Day w/fire in northeastern residential area w/Well #6 out of service	20 psi @ hydrant	Orchard Lane (1500 gpm)
Fire #6	Max Day w/fire in northwestern residential area w/Well #5 out of service	20 psi @ hydrant	Village Cr. (1500 gpm)
Fire #7	Max Day w/fire near Winters High School w/Well#6 out of service	20 psi @hydrant	Railroad St. between Grant St. (Route 128) and Anderson Ave. (TBD[1])
Fire #8	Max Day w/fire near John Clayton school w/Well#6 out of service	20 psi @hydrant	Edwards St. between 3rd and 2nd St. (2000 gpm)[1]
Fire #9	Max Day w/fire near Wagoner School w/Well #4 out of service	20 psi @hydrant	Grant St. at the intersection of Grant St. and Cemetery Dr.(2000 gpm)[1]
Buildout Max Hour	Max Hour w/all wells operating	30 psi @service connection	
Fire #10	Max Day w/fire in future northwestern residential area w/Future Well out of service	20 psi @ hydrant	West side of Winters Highland Callahan Development (1500 gpm)
Fire #11	Max Day w/northeastern industrial fire w/Future Well out of service	20 psi @ hydrant	Located off of proposed 14-inch pipeline (3000 gpm)

Notes:
1. The City does not currently have a specific fire flow requirement for schools. A maximum fire flow requirement of 2,000 gpm was assumed.

IX. POTENTIAL USE OF STORAGE

Since firm well capacity is not currently provided for peak flow demands, the use of storage can be considered to meet these demands. This information is provided for discussion purposes with the City.

Storage Volume Criteria

The principal function of storage, as reported in the American Water Works Association Hydraulic Design Handbook, is to provide reserve supply for:

- Operational flow equalization,
- Fire suppression reserves, and
- Emergency needs

Operational storage is the amount of water necessary to meet peak demands above normal operation supply delivery. Operational storage makes up the difference between the consumers' peak demands and the available supply into the system and is typically the difference between Max Day demand and Max Hour demand. Fire storage is the amount of stored water required to provide a specified fire flow for a specified duration. Emergency storage is the volume of water reserved to meet demand during emergency situations such as supply failures from one or more of the water supply wells.

In order to compute the required storage capacity, criteria for the three components of storage need to be established. Listed below is a presentation of storage criteria and a survey of criteria used by other cities and water supply agencies.

Storage Criteria Adopted by Other Cities/Agencies

The storage criteria used by other cities and water agencies to develop operational, fire, and emergency storage requirements are summarized in Table 11. From Table 11, the typical range of criteria for operational, fire, and emergency storage requirements are:

- Operational Storage: 20 to 25 percent of Max Day demand,
- Fire Storage: Maximum fire flow rate times duration, and
- Emergency Storage: 50 to 150 percent of Max Day demand.

The cities and water agencies that did not compute operational storage or combined all three components into one value of operational storage were excluded from the above comparison, but are shown in Table 11.

Table 11: Comparison of Storage Criteria

STORAGE CRITERIA			
Agency	**Operational Storage**	**Fire Storage**	**Emergency Storage**
Contra Costa Water District	25 percent of Max Day	Maximum fire flow rate times duration	150 percent of Average Day (1.5 avg. days)
City of Milpitas	20 to 25 percent of Max Day (1)	Maximum fire flow rate times duration	50 percent of Max Day (1 avg. day)
EBMUD – Pump Zones	50 percent of Max Day	Maximum fire flow rate times duration	100 percent of Max Day (2 avg. days)
EBMUD – Gravity Zones	150 percent of Max Day	Included in Operational Storage	Included in Operational Storage
City of Pleasanton	20 percent of Max Day (1)	Maximum fire flow rate times duration	50 percent of Max Day (1 avg. day)
ACWD/Fremont	210 percent of Max Day (2)	Included in Operational Storage	Included in Operational Storage
City of Sunnyvale	(3)	(3)	50 percent of Max Day (1 avg. day)
AWWA Manual 32	20 to 25 percent of Max Day	Maximum fire flow rate times duration	(4)
ISO	(4)	Maximum fire flow rate times duration	(4)

Source: Contra Costa Water District Treated Water Master Plan, Montgomery Watson/Carollo Engineers, 1997
Notes:
1. Based on the analysis of the diurnal demand curve.
2. Based on 4.2 Average Days assuming a Max Day to Average Day peaking factor of 2.0. Includes fire and emergency storage.
3. Supplies from SFWD, SCVWD and wells can meet 100 percent of operational and fire storage needs.
4. No criteria given.

Recommended Storage Criteria

Based on the comparison of storage criteria used by other cities and water agencies, the following criteria should be considered and discussed further with Winters staff in determining the City's total system storage requirements under build out conditions.

- Operational Storage: 20 percent of Max Day demand
- Fire Storage: One fire at 1,500 gpm for two hours
- Emergency Storage: 50 percent of Max Day demand

Based on the build out Max Day demands, the gross reservoir storage capacity required is shown in Table 12. The total required gross storage is approximately 9 mg.

Table 12: Gross Reservoir Storage Requirement

REQUIRED STORAGE CAPACITY				
Max Day Demand (mgd) [1]	**Operational Storage (mg)**	**Fire Storage (mg)**	**Emergency Storage (mg)**	**Total Required Storage (mg)**
12.6	2.5	0.2	6.3	**9**

Notes:

1. Assumes build out Average Day demand of 4.9 mgd (3,374 gpm) and a Max Day demand of 12.6 mgd (4.85 x 2.6 [peaking factor] = 12.6 mgd).

Application of the above criteria results in a "gross" storage requirement that excludes reliable water supplies from the water supply wells that are provided with emergency power. The "net" storage requirement is calculated by reducing the gross storage requirement by the volume of reliable water available from city wells, approximately 6.9 mgd (Well #6 out of service).

The City's ability to utilize groundwater wells as reliable available supply sources allows the system to operate without storage. However, a storage tank and booster pump may be desired if it is less expensive than construction of additional wells. Further discussion is required with Winters staff to determine whether storage should be evaluated as part of the master plan project and the validity of assuming a reliable supply from the wells during emergency conditions.

REFERENCES

1. American Water Works Associations, "M31 Manual: Distribution System Requirements for Fire Protection", 1998.

2. American Water Works Associations, "M32 Manual: Distribution Network Analysis for Water Utilities," 1989.

3. City of Milpitas, "2000 Urban Water Management Plan," December 2000

4. City of Milpitas, "Water Master Plan Update," June 1994.

5. City of Winter, "DRAFT Sewer Master Plan," August 2004.

6. City of Winters 1992 General Plan with 2003 Land use map Amendment

7. Contra Costa Water District, "1997 Treated Water Master Plan," July 1997.

8. Department of Health Services, Office of Regulations, "Proposed California Water Works Standards,"May,2003 http://www.dhs.cahwnet.gov/ps/ddwem/publications/Regulations/regulations_index.htm#PROPOSED%20REGULATIONS

9. Mays, Larry W., "Water Distribution Systems Handbook," 2000.

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12. Saracino, Kirby and Snow, "Water Supply Assessment – Winters Highland and Callahan Residential Developments", September 2003

Technical Memorandum 2A & 3A

City of Winters – Water System Master Plan

Subject: Water System Modeling Results & Recommended System Improvements - DRAFT

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I. Introduction

This Technical Memorandum (TM) presents the water system modeling results and recommended system improvements for the City of Winters' (City) Water Master Plan. The modeling results, system analysis, and recommended system improvements presented in this TM will be used as a basis to develop a prioritized water system capital and maintenance program for the City.

This TM is organized as follows:

I. Introduction
II. Capacity Deficiency Criteria
III. Model Development
IV. Modeling Results
V. Proposed Water System Improvements and Expansions

II. Capacity Deficiency Criteria

Table 1 summarizes the criteria that were used to determine pipeline and well capacity deficiencies.

Table 1: Capacity Deficiency Criteria

CAPACITY DEFICIENCY CRITERIA
The system is considered deficient if any of the following condition are met with design flows [a]: 1. System pressures < 20 psi during max day demands + fire flow 2. System pressures < 50 psi during max hour demands

a. As established in the *DRAFT Recommended Water Distribution System Hydraulic Performance Criteria TM 1A*, City of Winters – Water Master Plan, November 2004.

III. Model Development

A hydraulic model was developed as part of this Water System Master Plan using H2OMap Water Version 5.0 model. The model of the water system includes all pipes. Pipeline layout under buildout conditions was modeled using engineering expertise as well as proposed design plans provided by the City for future residential tracts (i.e. Creekside, Greyhawk, Callahan, and Winters Highland). Points within the system are represented by nodes whose elevations and demands were determined using available GIS data and land use information, respectively. The hydraulic model was run under the existing and buildout demand scenarios described in TM 1A (Table 10).[1]

Well Test Data

Well test data was used to establish system pump curves. Pump curve data for each well is provided in Attachment B. During the well testing, flow and pressure reading were taken at each well. This data coupled with initial water levels within the well casing was used to establish system pump curves. Table 2 shows well levels and capacities assumed based on collected data.

Table 2: Groundwater Elevations and Well Capacities

Existing Well ID	Groundwater Well Elev. (ft)[1]	Ground Surface Elev. (ft)[1]	Capacity at 50 psi[2] (gpm)	Capacity at 30 psi[3] (gpm)
2	42	130	1,320	1,520
3	84	134	970	1,170
4	76	153	825	1,160
5	84	141	700	960
6	69	127	1760	2,200

Notes:
1. Above sea level
2. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
3. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.

Model Calibration

With assistance from City field staff, hydrant (Table 1 in Attachment B1) and well test data (Table B2 in Attachment B) were collected. Two hydrants were flowed per test and the collected pressure and flow data was used to calibrate the model by adjusting the roughness coefficient factors (C factors). Estimated C factors ranged between 70 and 120, with the lowest C-factors located in the downtown areas and the northeast residential areas. The H2O Map Water calibrator was utilized and additional hand calibration was performed to refine model results. As shown in Table 3, modeled results were within 10 percent of the actual field results. Based on our experience with other water master plans, models with calibration results within 10 percent of actual field results are considered accurate and reliable for this level of system planning.

Table 3: Fire Flow Data – Field vs. Modeled Results

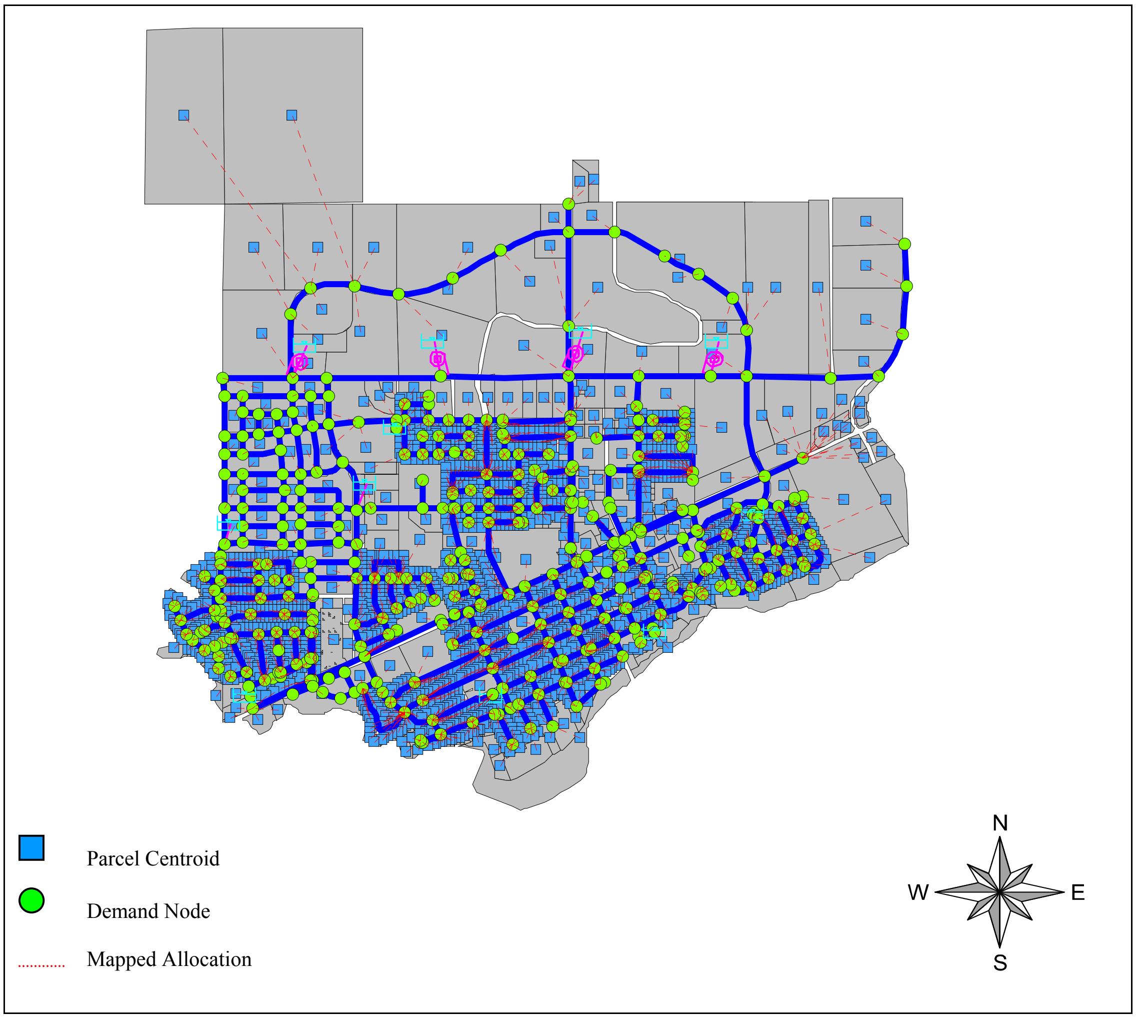
Fire Flow Test	Flowing Hydrant Flowrate (gpm)	Residual Pressure at Hydrant (psi)		% Difference
		Field	Modeled	
1	805 750	38	34	10
2	626 789	51	47	7
3	715 715	50	47	6
4	584 598	35	32	9
5	904 452	42	38	9
Average				**8**

[1] As established in the *DRAFT Recommended Water Distribution System Hydraulic Performance Criteria TM 1A*, City of Winters – Water System Master Plan, November, 2004

Demand Allocation

Demands were allocated using the H2O Map Water Allocator tool and were assigned to each parcel and each parcel was assigned to the closest node. Water usage factors were assumed for each land use type as described in TM 1A (Tables 4 and 5). Figure 1 shows demand allocation mapping for the system. No distinction was made between week day and weekend flows due to limited available data.

Figure 1: Demand Allocation Mapping



IV. Modeling Results

Modeling results under existing and buildout conditions are based upon max hour demand and several fire flow demand scenarios presented in TM 1A and summarized in Table 4 and Figure 2. The following modeling results are the basis for the recommended system improvements.

Figure 2: Fire Scenario Locations

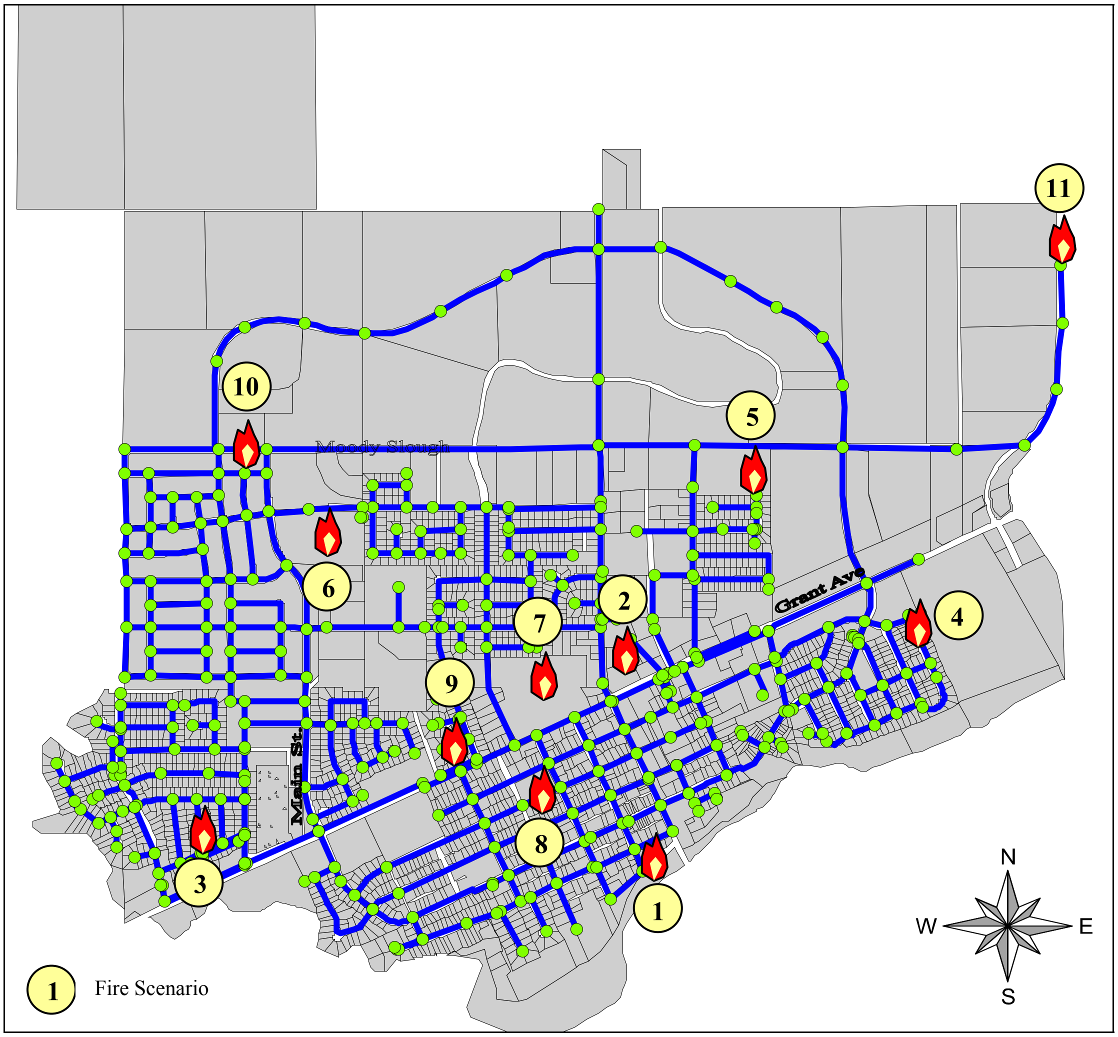


Table 4: Model Results Under Existing Conditions

MODELED DEMAND SCENARIOS AND RESULTS					
Scenario Name	**Node ID**	**Demand Conditions**	**Minimum Pressure**	**Location of Study Hydrants (fire flow)**	**Criteria met? Yes/No**
Existing Max Hour		Max Hour w/all wells operating	30 psi @ service connection		Yes
Fire #1	J-2413 J-1275	Max Day w/Fire at City Hall w/Well #3 out of service	20 psi @ hydrant	First and Main Streets (2000 gpm)	Yes
Fire #2A	J-2409 J-1091	Max Day w/fire near Mariani Storage and Shipping w/Well #2 out of service	20 psi @ hydrant	Baker St. (1500 gpm) and Edwards St. (1500 gpm)	Yes
Fire #2B	J-2049 J-1091	Max Day w/fire near Mariani Storage and Shipping w/Well #6 out of service	20 psi @ hydrant	Baker St. (1500 gpm) and Edwards St. (1500 gpm)	No
Fire #3	J-2404	Max Day w/fire in western residential area w/Well #4 out of service	20 psi @ hydrant	Jefferson or Mac Arthur St. (1500 gpm)	Yes
Fire #4	J-1207	Max Day w/fire in eastern residential area w/Well #6 out of service	20 psi @ hydrant	Wild Rose Lane (1500 gpm)	Yes
Fire #5	J-2237	Max Day w/fire in northeastern residential area w/Well #6 out of service	20 psi @ hydrant	Orchard Lane (1500 gpm)	No
Fire #6	J-2405	Max Day w/fire in northwestern residential area w/Well #5 out of service	20 psi @ hydrant	Village Cr. (1500 gpm)	Yes
Fire #7	J-2417 J-1077	Max Day w/fire near Winters High School w/Well#6 out of service	20 psi @ hydrant	Railroad St. between Grant St. (Route 128) and Anderson Ave. (2,000[1])	Yes
Fire #8	J-2419 J-1243	Max Day w/fire near John Clayton school w/Well#6 out of service	20 psi @ hydrant	Edwards St. between 3rd and 2nd St. (2,000[1])	Yes
Fire #9	J-2095 J-2107	Max Day w/fire near Wagoner School w/Well #4 out of service	20 psi @ hydrant	Grant St. at the intersection of Grant St. and Cemetery Dr. (2,000[1])	Yes

Notes:

1. The City does not currently have a specific fire flow requirement for schools. A maximum fire flow requirement of 2,000 gpm was assumed.

System Deficiencies - Existing Conditions
The model results of each scenario are shown in Table 4 and Attachment A and discussed in further detail in the following sections.

Max Hour – Based on modeled results, max hour demands can be met while maintaining a system pressure of 55 psi throughout the system, which is much higher than the criteria of 30 psi. The lowest pressures are in the western part of the town where elevations are highest.

Residential Fire Flows - Under existing conditions, the model showed that during Fire Scenario #5, the system could not meet the minimum fire flow requirement of 1,500 gpm, with Well #6 out of service. The partially completed Almond Lane loop is responsible for this deficiency. When the vacant parcel to the north of Almond Lane is developed, this deficiency will be solved. As shown in the Fire #5 Figure of Attachment A, system pressures during Fire #5 ranged between 5 and 45 psi, well below the City's normal level of service. Model results show that the pressure at the hydrant was negative which indicates that the hydrant will not be able to meet the pressure criteria at the required flow rate.

School and City Hall Fire Flows – In general the City's existing network can meet the school fire flow requirement of 2,000 gpm while maintaining a level of service requirement of 20 psi at the hydrant. While the model results do meet the minimum pressure criteria of 20 psi, the results, especially Fire #8, show that the downtown pipe system is barely adequate to convey fire flows. An annual replacement program to replace undersized water mains in the downtown areas should be initiated.

Industrial Fire Flows - As expected, level of service issues are further exacerbated with fire flow demands of 3,000 gpm coupled with Well #6 is out of service. The results make it apparent that the existing system depends to a large extent on Well #6. This is primarily due to the larger capacity of Well #6 and the condition of the pipes located within its immediate vicinity. Pipes located near Well #6 are new (and smoother) compared to older pipes in other parts of town. As shown in the Fire #2A and #2B Figures of Attachment B, system pressures dropped below 15 psi at the flowing hydrants. Approximately one half of a well (approximately 660 gpm) is necessary to solve this deficiency.

System Deficiencies-Buildout Conditions
The model results of each scenario are shown in Table 6 and Attachment A and discussed in further detail in the following sections.

Buildout Max Hour
Two Buildout Max Hour scenarios were modeled. The results from Buildout Max Hour with 5 New Wells (Attachment A) show that five new wells are not adequate to meet the future Buildout Max Hour demands. The results from Buildout Max Hour with 6 New Wells (Attachment A) show that six new wells will meet the future Buildout Max Hour demands. Well locations (Figure 3) were determined by spreading the new wells throughout the buildout areas, while still keeping their locations as far west as possible because the western buildout areas are difficult to serve due to higher ground elevations. The exact location of each future well will depend on various factors and can be adjusted to meet development configurations.

For the purpose of this master plan, each future well was assumed to be able to deliver water into the system at the same pressures and capacities as existing Well #2 (Table 5). During the design of the wells, the capacity of the wells should be increased as much as possible.

Table 5: Groundwater Elevations and Well Capacities

Future Well ID	Assumed Groundwater Well Elev. (ft)[1]	Ground Surface Elev. (ft)[1]	Capacity at 50 psi[2] (gpm)	Capacity at 30 psi[3] (gpm)
A	80	165	1,320	1,520
B	55	140	1,320	1,520
C	77	162	1,320	1,520
D	55	140	1,320	1,520
E	42	127	1,320	1,520
F	42	127	1,320	1,520

Notes:

1. Above sea level
2. The capacity of a well at 50 psi represents the approximate capacity during a max hour scenario that will supply adequate working pressure to the system. It is commonly referred to as 'the well capacity'.
3. The capacity of a well at 30 psi represents the approximate capacity during a fire scenario.

Figure 3: Modeled Wells

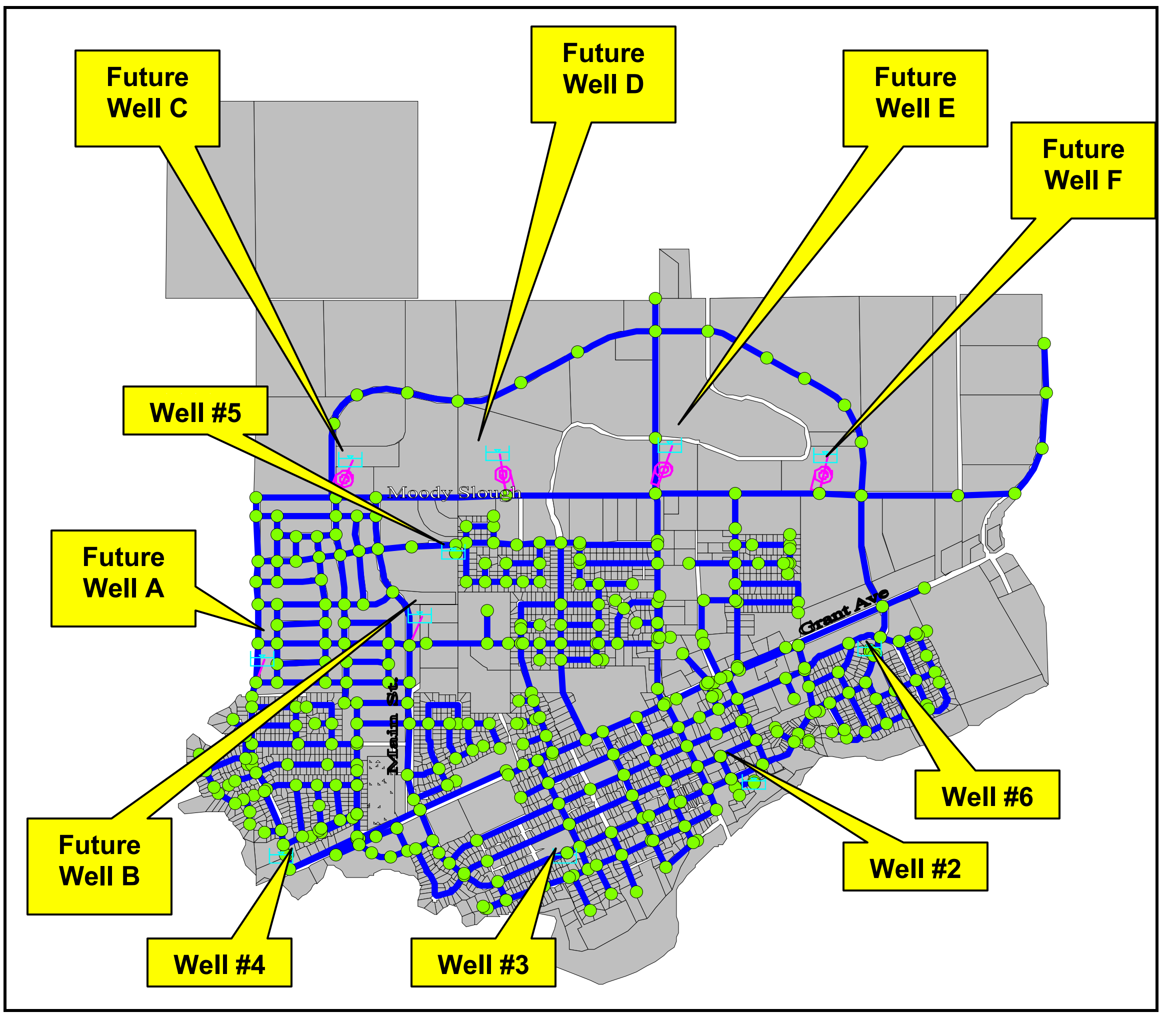


Table 6: Model Results Under Buildout Conditions

MODELED DEMAND SCENARIOS					
Scenario Name	**Node ID**	**Demand Conditions**	**Minimum Pressure**	**Location of Study Hydrants (fire flow)**	**Criteria met? Yes/No**
Buildout Max Hour w/5 new wells		Buildout Max Hour w/all existing wells and 5 new wells operating	30 psi at service connection		No
Buildout Max Hour w/6 new wells		Buildout Max Hour w/all existing wells and 6 new wells operating	30 psi at service connection		Yes
Fire #10	J-2471	Max Day w/fire in future northwestern residential area w/Future Well A out of service	20 psi at hydrant	South of Moody Slough Rd. in Winters Highland (1,500 gpm)	Yes
Fire #11	J-2565	Max Day w/northeastern industrial fire w/Future Well F out of service	20 psi at hydrant	Northern portion of County Road 90 (3,000 gpm)	Yes

V. Proposed Water System Improvements and Expansions

Table 7 and Figure 4 provide a summary of the proposed Capital Improvement Projects (CIP). Detailed cost and rate analysis will be presented in the City of Winters Water Master Plan.

Table 7: Proposed Projects

Project[2] ID	Project	Proposed Diameter (in)	Proposed Capacity (gpm)	Length (ft)	Existing or Buildout
1	Almond Drive Loop Water Main	8	-	800	Existing
2	Moody Slough (West) Water Mains	14	-	5,300	Buildout
3	Moody Slough (East) Water Mains	14	-	2,700	Buildout
4	Main Street Loop (West) Water Mains	14	-	5,700	Buildout
5	Main Street Loop (East) Water Mains	14	-	4,100	Buildout
6	North Main Street Water Mains	14	-	1,600	Buildout
7	Timbercrest Road Water Mains	14	-	1,200	Buildout
8	Gateway Area (14-inch) Water Mains	14	-	1,600	Buildout
	Gateway Area (8-inch) Water Mains	8	-	1,100	Buildout
9	North Eastern Area Water Main	14	-	4,200	Buildout
10	Railroad Ave Water Mains	14	-	2,700	Buildout
11	Annual Water Main Replacement	Varies	-	Varies	Existing
12	Residential Water Use Study	-	-	-	Buildout
13	Removal of Elevated Water Tanks	-	-	-	Existing
14	Future Well A	-	1,320	-	Buildout
15	Future Well B	-	1,320	-	Buildout
16	Future Well C	-	1,320	-	Buildout
17	Future Well D	-	1,320	-	Buildout
18	Future Well E	-	1,320	-	Buildout
19	Future Well F	-	1,320	-	Buildout
20	System Control and Data Acquisition (SCADA)	-	-	-	Buildout
21	Major Well Maintenance/Rehabilitation	-	-	-	Existing (50%) and Buildout (50%)
22	Portable Emergency Generator	-	-	-	Existing
23	Creekside Water Mains[1]	Varies	-	-	
24	Winters Highlands Water Mains[1]	Varies	-	-	
25	Callahan Estates Water Mains[1]	Varies	-	-	

Notes:

1. This Development is under design. Pipeline lengths are not included in this report.
2. Projects are not presented in order of priority.

APPENDIX E
1992 WATER SYSTEM MASTER PLAN PIPE REPLACEMENT RECOMMENDATIONS

From 1992 Water System Master Plan by CH2M Hill

EXISTING SYSTEM REPLACEMENT PROGRAM

The mainline pipe is quite old and is already beyond its expected service life. Galvanized portions of the system are suffering from galvanic corrosion rather then from age. The life expectancy of galvanized services and corporation stops connected to galvanically incompatible pipe is about 30 years. City staff estimates that a switch from brass to galvanized steel was made in the 1960s. Therefore, both mainline pipe and the galvanized parts of the system will need to be replaced in the future regardless of the alternative selected.

A regular replacement program for pipe older than 30 years should be implemented. Currently about 34,140 feet of pipe is over 30 years old. Existing 2- through 8-inch-diameter pipe should be replaced with a minimum 8-inch-diameter pipe. Pipe along Main Street should be replaced with 14-inch-diameter pipe. All other pipe larger than 8 inches should be replaced with pipe of the same diameter. New pipe should be a minimum of Class 150 PVC or ductile iron (see Appendix B). When the mainline is replaced, the adjacent service connections should also be replaced from the mainline to the face of curb. Polyethylene pipe, with a minimum class equal to a working pressure of 150 psi, and bronze corporation stops should be used for all service connections.

Order-of-magnitude replacement pipe costs are shown in Table 5 in the Cost Estimate section. To replace all of the pipe within the next 10 years, about 3,400 feet per year should be installed at a cost of approximately $377,000 per year.

Pipe that should be replaced during the first 3 years of the program is as follows:

- The 4- to 8-inch-diameter pipe along Edwards Street between Main and East Streets with 12-inch-diameter pipe
- The 2- and 4-inch-diameter pipe along Fourth Street between Grant Avenue and Russell Street with 12-inch-diameter pipe
- The 6-inch-diameter pipe along Walnut Lane between Grant Avenue and Dutton Street with 12-inch-diameter pipe *Completed
- The 4-inch-diameter pipe along Russell Street between the west end of Russell Street and Emery Street with 8-inch-diameter pipe *Completed

These improvements will add a main looped connection between the east and west sides of town to improve service throughout the downtown area and provide more pressure at the north end of Walnut Lane. They also eliminate approximately 6,900 feet of 80- to 100-year-old pipe.

Table 5 Estimated Costs for Replacement Program				
Item	**Quantity**	**Unit**	**Unit Cost $**	**Estimate $**
8″ Pipe	18,700	lin ft	49	916,000
12″ Pipe	7,940	lin ft	75	596,000
14″ Pipe	7,300	lin ft	88	642,000
Service Connections	830	each	302	249,000
VFDs/Telemetry	2	each	41,000	82,000
Subtotal				**2,485,000**
Contingency (30%)				746,000
Subtotal				**3,231,000**
Engineering, Legal, and Administration (20%)				646,000
Total				**3,877,000***
Note: All items benefit the existing city.				

*in 1992 Dollars

APPENDIX F

CD CONTAINING FINAL REPORT AND ALL APPENDICES

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