City of Victorville

Sewer System Master Plan and Collection System Model

DRAFT FINAL
FOR REVIEW

Rev. 1

March 2008

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TABLE OF CONTENTS

Section Title Page

CHAPTER 1 EXECUTIVE SUMMARY 1
1.1 PLANNING CRITERIA 1
1.2 DATA 5
1.3 SEWER MODEL 8
1.4 HYDRAULIC EVALUATION 9
1.5 RECLAIMED WATER 10
1.6 CAPITAL IMPROVEMENT PROGRAM 11

CHAPTER 2 PLANNING CRITERIA 13
2.1 INTRODUCTION AND OBJECTIVES 13
2.2 PROJECT PLANNING CRITERIA 13
2.2.1 Study Area 13
2.2.2 Population Estimates and Land Use 14
2.2.3 Wastewater Flow Generation Factor (FGF) 20
2.2.4 Equivalent Dwelling Unit (EDU) 21
2.2.5 Diurnal Flow and Peaking Factors 22
2.2.6 Flow Rates 24
2.2.7 Septic Systems 25
2.3 DESIGN CRITERIA 26
2.3.1 Sewer Design 26
2.3.2 Calculation of Pipe Size 27
2.3.3 Combined Sewers 29
2.3.4 Overflows 29
2.3.5 Gravity/Pressure Sewers 29
2.3.6 Trunk and Interceptor Sewers 30
2.3.7 Infiltration and Inflow 30
2.3.8 Pipe Materials 31
2.3.9 Alignment 31
2.3.10 Downsizing and bottlenecks 31
2.3.11 Manholes 31

CHAPTER 3 DATA 33
3.1 INTRODUCTION AND OBJECTIVES 33
3.2 SEWER DATA COLLECTION AND DATA GAP ANALYSIS 33
3.2.1 Existing Source Data 34
3.2.2 Data Gap Analysis 36
3.2.3 Data Gap Assessment Results 38
3.3 THE SEWER ATLAS GEODATABASE 41
3.4 FLOW DATA 42
3.4.1 Introduction and Objectives 42
3.4.2 Flow Monitoring 46
3.4.3 Development of Diurnal Flow Factors for Each Flow Monitoring Location 58
3.5 DEMAND FOR PLANNING HORIZONS 76

CHAPTER 4 SEWER MODEL 78

TABLE OF CONTENTS

Section Title Page

4.1 INTRODUCTION AND OBJECTIVES 78
4.2 MODEL CONSTRUCTION 78
4.3 CALIBRATION AND VERIFICATION 79
4.3.1 Base Loading from Prepared TAZ Data 79
4.3.2 Additional Loads 81
4.3.3 EPS Calibration 81
4.3.4 Baseline Calibration for Average Flows 82
4.3.5 Calibration to Match Diurnal Varying Flows 83
4.3.6 Calibration Performance 84

CHAPTER 5 HYDRAULIC EVALUATION 91
5.1 INTRODUCTION AND OBJECTIVES 91
5.2 METHODOLOGY 91
5.3 CURRENT CONDITIONS (2006) 94
5.4 YEAR 2014 CONDITIONS 94
5.5 YEAR 2030 CONDITIONS 94

CHAPTER 6 RECLAIMED WATER 102
6.1 INTRODUCTION 102
6.2 OBJECTIVES 103
6.3 RECLAIMED WATER SYSTEM COMPONENTS 104
6.4 RECLAIMED WATER USAGE 105
6.5 DEMAND AREAS 106
6.6 POTENTIAL SUB-REGIONAL TREATMENT PLANTS 111

CHAPTER 7 CAPITAL IMPROVEMENT PROGRAM 113
7.1 INTRODUCTION AND OBJECTIVES 113
7.2 CAPITAL IMPROVEMENT PROGRAM 113
7.2.1 2014 113
7.2.2 2030 113
7.3 BUDGETARY COST ESTIMATES 113

LIST OF FIGURES

Figure Title Page

Figure E-1 Residential and Commercial Diurnal Curves Derived from Flow Meter Data 9
Figure 2-1 Vicinity Map and Service Area 15
Figure 2-2 Planning Areas and TAZ Areas 16
Figure 2-3 Connections to the VVWRA Interceptor System and Nearby Temporary Flow Meter Sites 23
Figure 3-1 Land Use and Flow Monitoring Tributary Areas 44

Figure 3-2 Flow Monitoring Locations and Tributary Areas 45
Figure 3-3 Location of Flow Meter FM-1 46
Figure 3-4 Location of Flow Meter FM-2 47
Figure 3-5 Location of Flow Meter FM-3A 48
Figure 3-6 Location of Flow Meter FM-3B 49
Figure 3-7 Location of Flow Meter FM-4 50
Figure 3-8 Location of Flow Meter FM-5 51
Figure 3-9 Location of Flow Meter FM-6 52
Figure 3-10 Location of Flow Meter FM-7 53
Figure 3-11 Location of Flow Meter FM-8 54
Figure 3-12 Location of Flow Meter FM-9 55
Figure 3-13 Location of Flow Meter FM-10 56
Figure 3-14 Location of Flow Meter FM-12 57
Figure 3-15 Representative Diurnal Curves for MH V33-107 60
Figure 3-16 Calibration Diurnal Curves for Weekdays and Weekends at MH V33-107 61
Figure 3-17 Calibration Diurnal Curves for Weekdays and Weekends at MH X35-111 62
Figure 3-18 Calibration Diurnal Curves for Weekdays and Weekends at W46-105 63
Figure 3-19 Calibration Diurnal Curves for Weekdays and Weekends at MH W46-137 64
Figure 3-20 Calibration Diurnal Curves for Weekdays and Weekends at MH AC43-104 65
Figure 3-21 Calibration Diurnal Curves for Weekdays and Weekends at MH X45-119 66
Figure 3-22 Calibration Diurnal Curves for Weekdays and Weekends at MH X33-107 67
Figure 3-23 Calibration Diurnal Curves for Weekdays and Weekends at MH AA36-104 68
Figure 3-24 Calibration Diurnal Curves for Weekdays and Weekends at MH U43-108 69
Figure 3-25 Calibration Diurnal Curves for Weekdays and Weekends at MH AA37-126 71
Figure 3-26 Calibration Diurnal Curves for Weekdays and Weekends at MH Y38-135 72
Figure 3-27 Calibration Diurnal Curves for Weekdays and Weekends at MH AC43-106 73
Figure 3-28 Calibration Diurnal Curves for Weekdays and Weekends at V42-113 74
Figure 3-29 Calibration Diurnal Curves for Weekdays and Weekends at MH U43-107 75
Figure 4-1 Residential and Commercial Diurnal Curves Derived from Flow Meter Data 84
Figure 4-2 Calibration Graphs Comparing Model Flow and Field Flow on 11/5/07 86
Figure 5-1 Flow Chart for Evaluation of d/D Deficiencies and Determination of Improvements 92
Figure 5-2 Existing and Future Sewer Network 93
Figure 5-3 Manhole Loading for Modeling Current Conditions (Year 2006) 95
Figure 5-4 Hydraulic Evaluation Results for Year 2006 Conditions 96
Figure 5-5 Expansion for Year 2014 Planning Horizon and Manhole Loading for Modeling 97
Figure 5-6 Hydraulic Evaluation Results for Year 2014 Conditions 98
Figure 5-7 Expansion for Year 2030 Planning Horizon and Manhole Loading for Modeling 99
Figure 5-8 Hydraulic Evaluation Results for Year 2030 Conditions 100
Figure 6-1 Potential Reclaimed Water Users and Demands by Planning Area 107
Figure 7-1 Capital Improvement Pipes for Year 2014 114
Figure 7-2 Capital Improvement Pipes for Year 2030 116

LIST OF TABLES

Table	Title	Page
Table E-1	City of Victorville December 2005 Traffic Analysis Zone (TAZ) Population and Dwelling Unit Data	2
Table E-2	Projected Residential and Commercial Employee Population by Planning Area, Years 2014 and 2030	2
Table E-3	City of Victorville and VVWRA Flow Generation Factors by Land Use (Average Daily Flow)	3
Table E-4	Average Daily Flow and Peak Flow Factors at Connections to the VVWRA Interceptor	4
Table E-5	Hydraulic Criteria	5
Table E-6	Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2014	7
Table E-7	Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2030	8
Table E-8	Estimated Potential Reclaimed Water Demand	11
Table 2-1	Recent City of Victorville Population Trends	14
Table 2-2	City of Victorville December 2005 Traffic Analysis Zone (TAZ) Population and Dwelling Unit Data	17
Table 2-3	Residential and Commercial Employee Population by Planning Area, Year 2005	18
Table 2-3	Projected Residential and Commercial Employee Population by Planning Area, Year 2014	19
Table 2-4	Projected Residential and Commercial Employee Population by Planning Area, Year 2030	20
Table 2-5	City of Victorville and VVWRA Flow Generation Factors by Land Use (Average Daily Flow)	21
Table 2-6	Average Single Family Size	21
Table 2-7	Average Daily Flow and Peak-Hour Flow Factors at Connections to the VVWRA Interceptor	22
Table 2-8	Facility Design Peaking Factors	25
Table 2-9	Hydraulic Criteria	27
Table 2-10	Minimum Allowable Pipe Slope	28
Table 3-1	Land Use Types for Each Flow Meter	58
Table 3-2	Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2014	76
Table 3-3	Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2030	77
Table 4-1	Sample Residential Loading Source Data	79
Table 4-2	Sample Commercial Loading Source Data	80
Table 6-1	Estimated Potential Tier 1 Reclaimed Water Demand	108
Table 6-2	Estimated Potential Tier 2 Reclaimed Water Demand	109
Table 6-3	Estimated Potential Tier 3 Reclaimed Water Demand	110
Table 6-4	Estimated Potential Heavy Industrial Reclaimed Water Demand	110
Table 7-1	Capital Improvement Pipes for Year 2014	115

Table 7-2 Capital Improvement Pipes for Year 2030 117

LIST OF APPENDICES

Appendix	Title
Appendix A	City of Victorville Population Data and Wastewater Generation by TAZ Area
Appendix B	Technical Memorandum 4, Definition of the Geodatabase, Data Capture Standards, and Cartographic Standards
Appendix C	Unit Cost for Pipe Line Replacement and Installation
Appendix D	Detailed Costs for Capital Improvement Program

CHAPTER 1 EXECUTIVE SUMMARY

This *Sewer System Master Plan* (SMP) describes the City of Victorville's (City) plan for developing its system of trunk and interceptor sewers. It describes the existing sewers and pumping facilities, the City sewer atlas geodatabase, system planning criteria, hydraulic evaluation of the system for current conditions and future development, and the proposed Capital Improvement Program for the development of future sewer facilities.

1.1 PLANNING CRITERIA

Recently the City experienced a period of rapid growth. With few exceptions, new developments are being connected to the City's wastewater collection system. The Project Planning Criteria (PPC) specify the minimum requirements for the parameters that define the basis of sewer system design. For this project, the parameters that the PPC address and define are discussed below.

Study Area

The study area for this SMP is the boundary of the City of Victorville sphere of influence (See Figure 2-2). The SMP herein identifies the major sewer facilities needed to satisfy the sewage conveyance requirements within this area for the current conditions (year 2006), and for the years 2014 and 2030 planning horizons.

Population Estimates and Land Use

Population and land use form the basis of defining the Equivalent Dwelling Units (EDUs) and subsequently, the existing and future wastewater flows. Population estimates were made using the City-provided dwelling unit count and the recent Traffic Analysis Zone (TAZ) data for year 2005. The number of single family and multi-family EDUs and retail and non-retail employee population that existed within each TAZ area, and respective planning area, as of December 2005 were provided. These data were used to define residential and employment population figures for the current conditions (year 2006) scenario in the hydraulic model. A summary of this data is shown in Table E-1.

Table E-1 City of Victorville December 2005 Traffic Analysis Zone (TAZ) Population and Dwelling Unit Data

Land Use*	Totals
Single Family Dwelling Units (SDU)	25,970
Multi-Family Dwelling Units (MDU)	6,953
Total Dwelling Units	32,923
Retail Employees (RET)	10,105
Non Retail Employees (NRET)	17,159
Total Employees	27,264
Avg. persons/occupied Dwelling Unit**	2.94
Est. Dec. 2005 Population	**96,794**

* Data from spreadsheet filename: *VVSED-SubtotalbyPlngAreaDistricts-010208.xls*
**The average number of persons per occupied dwelling unit defines an EDU. Therefore, based on TAZ data the population equivalent of one EDU equals 3.2 persons. Note that the City of Victorville Planning Department uses a value of 2.9 persons per EDU for both single family and multi family land uses. This value was used to develop wastewater flows in the hydraulic model.

Population projections for 2014 and 2030 were estimated based on data provided by the City Planning Department. The projected total single family and multi-family EDUs and retail and non-retail employee population are presented for Years 2014 and 2030 in Table E-2.

Table E-2 Projected Residential and Commercial Employee Population by Planning Area, Years 2014 and 2030

Planning Horizon	SDU	MDU	RET	NRET
2014	35,291	16,674	18,472	29,523
2030	60,978	35,365	33,812	51,921

Notes: Population represented in this table is for residential and commercial units connected to the Victorville sewer system.
SDU – Single Family Dwelling Unit
MDU – Multi-Family Dwelling Unit
RET – Retail Employee
NRET – Non-Retail Employee

Wastewater Flow Generation Factor (FGF)

Victor Valley Wastewater Reclamation Authority (VVWRA) and City of Victorville wastewater flow generation factors (FGFs) are shown in Table E-3. The City of Victorville FGF values shown were derived from flow data recorded during October 2006. The VVWRA values were developed for the VVWRA and presented in their *"Sewage Facilities Plan Update, Year 2005 Amendment".* VVWRA FGFs were used for

establishing residential, industrial and commercial wastewater flows in the hydraulic model.

Table E-3 City of Victorville and VVWRA Flow Generation Factors by Land Use (Average Daily Flow)

Land Use	City of Victorville* FGF	VVWRA** FGF
Equivalent Dwelling Unit (SDU/MDU)	221 - 241 gpd	235 gpd
Residential	75 - 82 gpcd	80 gpcd
Office/Retail (RET/NRET)	varies	35 gped
Industrial	--	75 gped
Institutional	--	35 gped
High School	--	15,000 gpd
Junior High School	--	10,000 gpd
Elementary School	--	5,000 gpd

* From flow meter data recoded in October 2006, based on TAZ data for EDU counts.
** Data from Victor Valley Wastewater Reclamation Authority "*Sewage Facilities Plan Update, Year 2005 Amendment*".
gpd – gallons per day
gpcd – gallons per capita per day
gped - gallons per employee per day

Equivalent Dwelling Unit (EDU)

One EDU is defined as the average size of a single family household. Since residential land use in Victorville is a mix of single family and multi-family residences, future wastewater flows are based upon EDUs. The City of Victorville Planning Department is currently using a value of 2.94 people per EDU for both single and multi-family dwelling units, which is the value used in this study.

Diurnal Flow and Peaking Factors

The City of Victorville discharges to the Victorville Valley Wastewater Reclamation Authority (VVWRA) interceptor system at six (6) locations. Flow data was recorded by VVWRA at each of these locations during November 2004, and peak-hour flow factors (peaking factors) were calculated for each of the meter sites. The peaking factors developed by VVWRA are compared in Table E-4 with peaking factors that were developed from data collected during the temporary flow monitoring program conducted in October 2006 for this SMP.

Table E-4 Average Daily Flow and Peak Flow Factors at Connections to the VVWRA Interceptor

Victorville Valley Reclamation Authority*				City of Victorville**			
Meter	**Average Daily Flow (mgd)**	**Peak-hour Flow (mgd)**	**Peaking Factor**	**Avg. Daily Flow (mgd)**	**Peak-hour Flow (mgd)**	**Peaking Factor**	**Flow Meter**
VSD 1	0.606	1.345	2.22	0.65	1.12	1.74	6
VSD 2	2.284	4.312	1.89	2.35	3.50	1.49	3B,10
VSD 3	2.257	3.534	1.56	2.95	5.04	1.71	2,4
VSD 4	0.590	1.340	2.27	0.66	1.15	1.73	1
VSD 5	0.106	0.195	1.84	---	---	---	
VSD 6	0.873	1.448	1.66	1.24	1.73	1.40	5
Total	**6.716**	**12.174**	**1.81(avg)**	**7.85**	**12.54**	**1.60**	

*November 2004 VVWRA data from Victor Valley Wastewater Reclamation Authority "*Sewage Facilities Plan Update, Year 2005 Amendment*"
**City of Victorville temporary flow meter data recorded October 2006.

Flow

Flow in the Victorville sewage system is comprised of domestic, commercial and industrial wastes. All segments of the wastewater conveyance system must be capable of carrying the combined peak flows generated from each of these sources. The diurnal curve method was used to simulate wastewater flows in the hydraulic model. Diurnal patterns derived from October 2006 flow data were used for the hydraulic model.

Septic Systems

There are several areas within the Victorville sphere of influence where wastewater is treated with on-site septic systems. The VVWRA estimates in their *Sewage Facilities Plan Update Year 2005 Amendment* that 97% of Victorville's population is currently connected to the City's sewer system. For purposes of developing the hydraulic model, it was assumed that all existing septic systems will remain in operation.

Sewer Design

All sewer pipelines comprising the City's collection system shall be designed and constructed in accordance with the City's wastewater policies and the requirements put forth in this SMP. Wastewater system facilities shall be designed with sufficient capacity to convey peak flows from the tributary area for the design life of the facility, unless other criteria has been established and approved by the City.

The d/D criteria for existing sewers and the design of new sewers are summarized in Table E-5. The design flow rate for evaluating existing sewers and sizing new sewers is the peak hour dry weather flow rate (sewershed population x per capita load x peaking factor).

Table E-5 Hydraulic Criteria

Condition	d/D Criteria	
	Mainlines 8”-12” Dia.	Trunks > 12” Dia.
Threshold for rehabilitation of existing sewers	0.50	0.75
Maximum design depth allowed in new sewers	0.50	0.75

The required pipe size for new sewers was calculated based on flow velocity, slope, and capacity using d/D criteria. Gravity sewers shall be designed for a maximum velocity of 10 feet per second (fps) and a minimum velocity of 2 fps as calculated using the projected future peak-hour dry weather flow for the planning horizon. The required minimum pipe size, minimum slope, and pipe materials are provided in this SMP along with requirements for pipe alignment and manhole design.

1.2 DATA

Data collection and analysis for developing the sewer atlas geodatabase and constructing the hydraulic model consisted of collection of sewer data, population data, and flow data.

Sewer Data

Sewer data collection activities consisted of identifying and considering the availability and usefulness of the following sewer system source data:

1. As-Built Drawings
2. Pressure & Gravity Main Pipelines
3. Manholes
4. Pump Stations
5. Land Use Data
6. Population Data
7. Parcel and Street Centerline Data
8. Other Information

A Data Gap Analysis (DGA) was performed to identify the missing data necessary for developing the sewer atlas geodatabase and for constructing the hydraulic model.

Sewer Atlas Geodatabase

A new sewer atlas was developed for the City as part of this SMP. The new sewer atlas geodatabase is comprised of City of Victorville parcel information and sewer system data. In addition to providing an up-to-date depiction of the sewer system, the database features allow the atlas grid maps to be revised to reflect growth or changes in the sewer system.

Flow Data

The objectives for measuring wastewater flows in the City of Victorville were to determine the volume of wastewater being generated and conveyed through the major trunk and interceptor systems, to determine diurnal patterns for various areas of the City, and to calibrate the hydraulic model. Fourteen flow meter sites were selected to achieve these objectives. These flow meters measured the majority of the wastewater conveyed by the City conveyance system.

The flow monitoring locations were used as calibration points for the sewer hydraulic model. Recorded diurnal flows from two weeks of flow monitoring were used to develop a single representative diurnal curve for each flow monitoring location (separate representative curve for weekdays and weekends). The developed representative diurnal curves were used to calibrate the sewer hydraulic model.

Demand for Planning Horizons

Wastewater flows were estimated for planning horizons 2014 and 2030. The projected population for each planning area was used to calculate demand using flow generation factors based on land use. Estimated average daily wastewater flows for years 2014 and 2030 are summarized in Tables E-6 and E-7, respectively.

Table E-6 Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2014

Planning Area	Average Daily Wastewater Flow (MGD)	
	Residential	Commercial
Baldy Mesa	1,280	51
Central City	978	190
East Bear Valley	739	190
Golden Triangle	288	50
North Mojave	234	93
SCLA	38	208
Spring Valley Lake	0	0
West City	1,989	172
West Bear Valley	1,546	118
Northern Sphere Proposed Expansion	1,348	95
Outside Victorville Sphere of Influence	47	0
TOTAL	**8,487**	**1,167**

Notes: Residential includes Single Family Dwelling Units (SDU) and Multi-Family Dwelling Unit (MDU)
Commercial includes Retail Employees (RET) and Non-Retail Employee (NRET)

Table E-7 Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2030

Planning Area	Average Daily Wastewater Flow (MGD)	
	Residential	Commercial
Baldy Mesa	3,316	140
Central City	1,075	204
East Bear Valley	930	239
Golden Triangle	707	105
North Mojave	551	235
SCLA	82	451
Spring Valley Lake	0	0
West City	3,350	279
West Bear Valley	1,851	167
Northern Sphere Proposed Expansion	3,744	264
Outside Victorville Sphere of Influence	130	0
TOTAL	**15,736**	**2,084**

Notes: Residential includes Single Family Dwelling Units (SDU) and Multi-Family Dwelling Unit (MDU)
Commercial includes Retail Employees (RET) and Non-Retail Employee (NRET)

1.3 SEWER MODEL

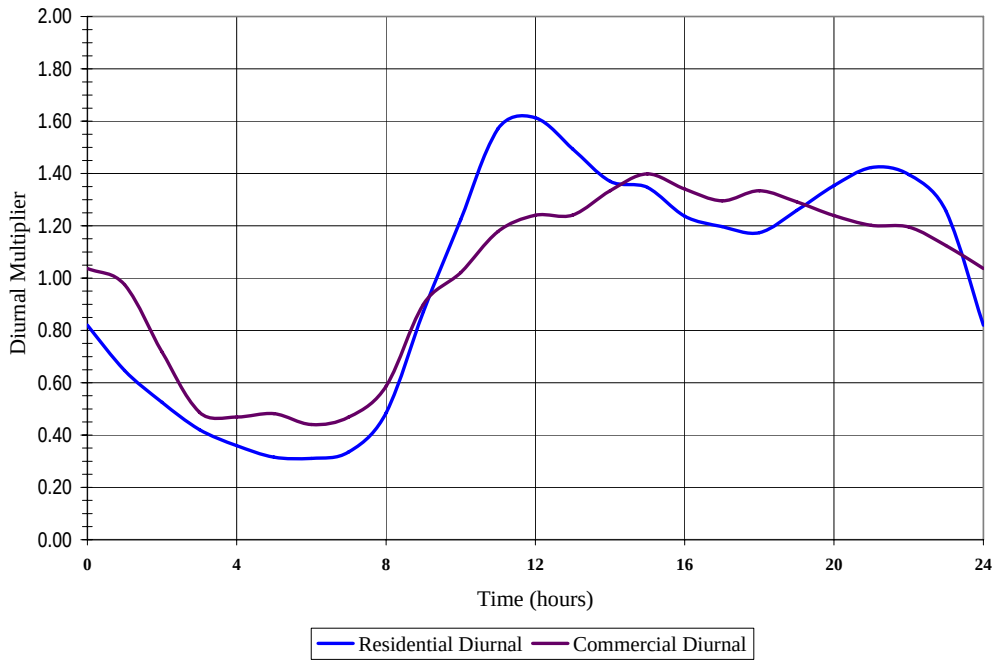
The purpose of the hydraulic model was to identify hydraulic deficiencies of the sewer collection system for current conditions, and to analyze the impact of future population growth on the system. The hydraulic evaluation was performed for current conditions (2006), and for years 2014 and 2030.

The City's existing wastewater collection system was constructed in the hydraulic model from the sewer atlas geodatabase. Once the pipe and manhole network were finalized, the model was loaded with wastewater flows calculated based on population data and hospital and industrial loads. For current conditions, diurnal patterns were derived from diurnal curves generated for each flow monitoring sewer shed.

Once the model calibration was complete, diurnal patterns were derived for residential and commercial land uses. A residential diurnal curve and a commercial diurnal curve were generated based on flow meter data collected in October 2006. These curves

were used in the hydraulic model to simulate diurnal patterns of flows from future developments. The derived residential and commercial diurnal curves are presented in Figure E-1.

Figure E-1 Residential and Commercial Diurnal Curves Derived from Flow Meter Data



1.4 HYDRAULIC EVALUATION

The hydraulic model was used to simulate three flow scenarios: current conditions (2006), year 2014 conditions, and year 2030 conditions using current and projected wastewater demands. Model simulations were performed to identify system deficiencies based on d/D criteria for existing and future demands, and to propose a Capital Improvement Program.

The methodology for evaluating system deficiencies for current conditions (2006) consisted of performing model simulations on the existing system and identifying pipes with d/D ratios higher than the d/D criteria. The existing wastewater system in the hydraulic model and manhole loading of current wastewater demands for model

simulation are shown on Figure 5-3. Deficiencies for current conditions, defined as pipes that exceeded the maximum allowable d/D criteria, are shown on Figure 5-4.

In order to evaluate system deficiencies for future conditions, sewer trunks were extended in the hydraulic model to simulate service of future development demands. Hydraulic simulations were run for 2014 conditions using existing and future projected pipes, and wastewater demands. The manhole loading for Year 2014 wastewater demands for model simulation is shown on Figure 5-5. Deficiencies for Year 2014 conditions are shown on Figure 5-6.

Hydraulic simulations were run for 2030 using the existing and projected future system with 2014 upgrades identified via the hydraulic evaluation performed for year 2014 conditions. The manhole loading for Year 2030 wastewater demands for model simulation is shown on Figure 5-7. Deficiencies for Year 2030 conditions are shown on Figure 5-8. If a pipe was deficient for both 2014 and 2030 conditions, the proposed pipe upgrade was sized for 2030 conditions.

1.5 RECLAIMED WATER

VVWRA has been working with its member agencies, including the City of Victorville, over the past several years to study the feasibility of developing recycled water programs.

One option studied was the concept of constructing sub-regional reclamation facilities located at strategic locations throughout the service area. Wastewater would be diverted from the existing sewer system at key points in the system and directed to a new reclaimed water treatment facility, thereby avoiding capacity improvements to the downstream pipe network.

Potential Reclaimed Water Users

Potential reclaimed water users were identified based on four categories: Tier 1, Tier 2, Tier 3, and Heavy Industrial. Tier 1 users consist of large irrigated areas such as golf courses, schools, parks, etc. Tier 2 users consist of right-of-ways, easements, and irrigated areas along highways and major roadways. Tier 3 users consist of residential and commercial reclaimed water use. For the purpose of this study, Tier 3 reclaimed

water use was assumed to be for residential toilet flushing and irrigation. Heavy industrial users consist of water use for industrial purposes such as cement factories and power plants. Figure 6-1 shows potential reclaimed water users and demands by planning area. Table E-8 summarizes potential reclaimed water demand for each type of user for the City of Victorville sphere of influence.

Table E-8 Estimated Potential Reclaimed Water Demand

Potential Reclaimed Water User	Potential Reclaimed Water Demand (acre-feet/year)
Tier 1	9,810
Tier 2	5,068
Tier 3	29,891
Heavy Industrial	21,650
Total Estimated Potential Reclaimed Water Demand	**66,420**

Potential Sub-regional Treatment Facility Sites

There are three sub-regional treatment facilities that have been studied by VVWRA: Green Tree, Upper Narrows, and West Sub-regional Facility. Based on a review of the Green Tree site, the City should consider a site nearby due to its beneficial location from a hydraulic perspective. The Upper Narrows site is also centrally located; however, fewer potential users are nearby. The West Sub-regional Facility is located in the Baldy Mesa planning area. This facility has excellent potential and its viability has increased due to planning work of the Baldy Mesa Water District. An in-depth study is recommended to identify additional sites in order to provide more options from which the City can choose.

1.6 CAPITAL IMPROVEMENT PROGRAM

The deficient pipes identified in the hydraulic evaluation were used as the basis for the capital improvement program for the 2014 and 2030 planning horizons. Deficient pipes were grouped into pipe reaches for budgetary cost estimates.

The Capital Improvement Program for the 2014 planning horizon is shown on Figure 7-1. There are 46 pipe reaches comprised of approximately 252,000 feet of pipe. Of this total, 157,000 feet of new pipe is required to service future growth areas, and 97,000 feet of existing pipe will require upsizing as a result of future growth. Improvements for year 2014 are summarized in Table 7-1.

The Capital Improvement Program for the 2030 planning horizon is shown on Figure 7-2. There are 23 pipe reaches comprised of 49,000 feet of existing pipe that will require upsizing as a result of future growth. Improvements for year 2030 are summarized in Table 7-2.

The total capital costs for the 2014 and 2030 Capital Improvement Programs are estimated at $43,199,000 and $12,669,000, respectively. The 2014 capital costs are comprised of $25,865,000 for installation of new piping to service future growth areas, and $17,334,000 to upgrade existing piping to meet the hydraulic criteria for 2014 demands. The 2030 Capital Improvement Program cost of $12,669,000 is for upgrading existing piping to meet the hydraulic criteria for 2030 demands.

CHAPTER 2 PLANNING CRITERIA

2.1 INTRODUCTION AND OBJECTIVES

This *Sewer System Master Plan* (SMP) describes the City of Victorville's (City) plan for developing its system of trunk and interceptor sewers. It describes the existing sewers and pumping facilities, the City sewer atlas geodatabase, system planning criteria, hydraulic evaluation of the system for current conditions and future development, and the proposed Capital Improvement Program for the development of future sewer facilities.

The City recently experienced a period of rapid growth. With few exceptions, new developments are being connected to Victorville's wastewater collection system. According to *The City of Victorville General Plan – Resource Element,* "…Sewer trunk lines are available for use by new development throughout the majority of the incorporated area of the City, including some areas where rural subdivisions containing lots in excess of 18,000 square feet exist. All new developments are required to connect to public sewer, excepting rural subdivisions not located within two hundred feet of a sewer line." In order to achieve maximum uniformity in planning, engineering, and construction practices, and to ensure the long-term integrity of its sewer infrastructure, the City closely regulates the construction of new sewers.

The Project Planning Criteria (PPC) specify the minimum requirements for sewer system design. City planning criteria and sewer design requirements are defined in this chapter.

2.2 PROJECT PLANNING CRITERIA

2.2.1 STUDY AREA

The City of Victorville is located in southwestern San Bernardino County, California. The City is located within Victor Valley, which is a sub region of the Mojave Desert where the geography and climate can be described as "High Desert" (Figure 2-1). Situated at an elevation of approximately 2,900 feet, Victorville experiences hot, dry summers and occasional snow in the winter. Temperatures range from below freezing up to 110ºF in the summer. Annual precipitation is approximately 3.9 inches per year.

The study area for this SMP is the City of Victorville sphere of influence boundary, which is shown on Figure 2-2. The SMP herein identifies the major sewer facilities needed to satisfy the sewage conveyance requirements within this area for the current conditions (year 2006), and for years 2014 and 2030 planning horizons.

The City Planning Department provided the distribution of planning areas in the City sphere of influence, as shown on Figure 2-2. Each planning area is divided into Traffic Analysis Zones (TAZ).

2.2.2 POPULATION ESTIMATES AND LAND USE

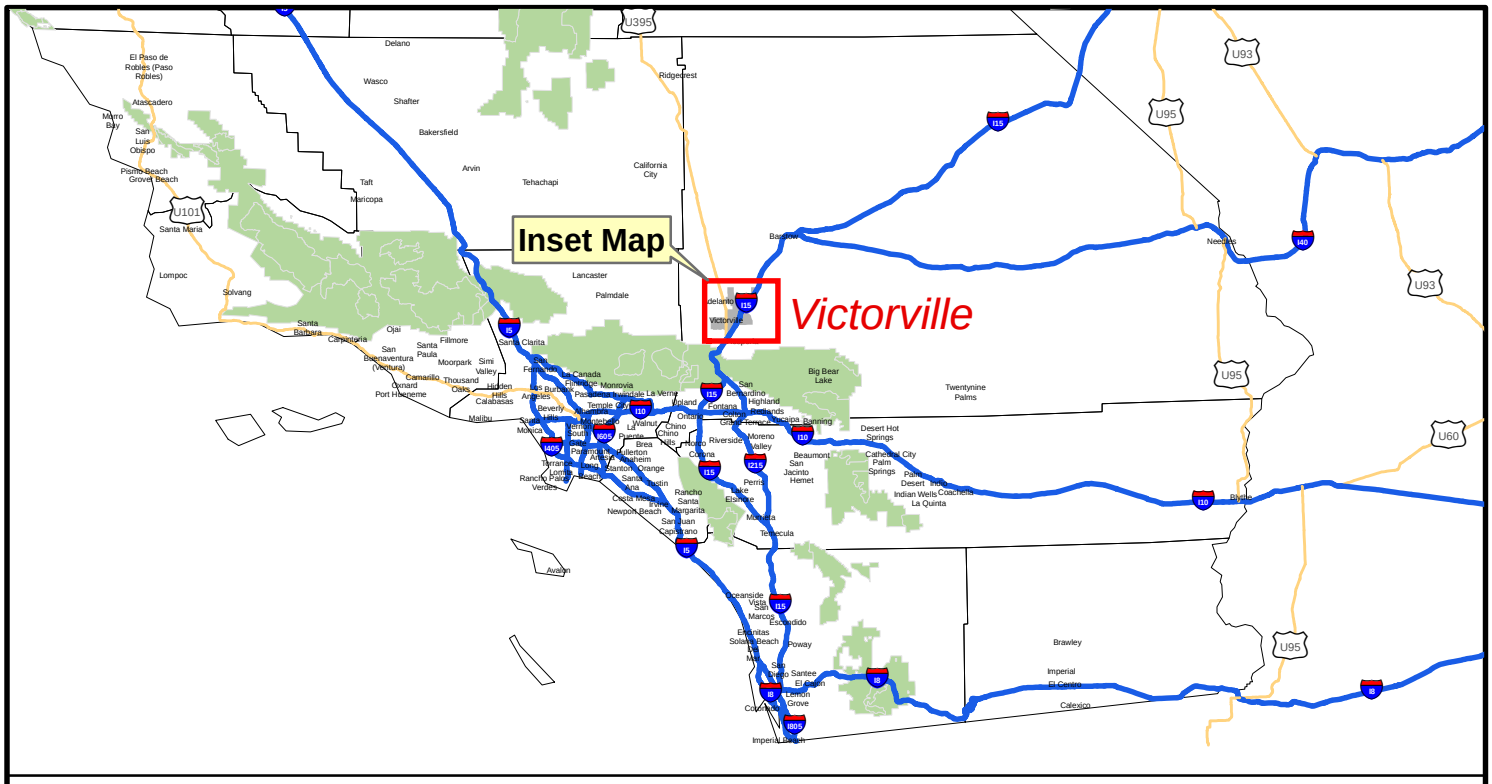
Population estimates for the City's sphere of influence forms the basis for computing wastewater flow. It is customary to develop wastewater design flows by multiplying the estimated population by an estimated per capita wastewater flow generation factor. In lieu of direct population data, equivalent dwelling units (EDU) data can be used. An EDU defines the number of people per dwelling unit. The EDU method was used to generate wastewater flows for this SMP.

Recent population trends were published in the *City of Victorville General Plan* (the General Plan) for Victorville and the surrounding communities. As part of Update 2000 of the General Plan, the official population estimates from the California Department of Finance were provided. Table 2-1 shows the estimated City of Victorville population estimates in five year increments for the years 1990 through 2005, based on data provided in the General Plan and from more recent Traffic Analysis Zone data.

Table 2-1 Recent City of Victorville Population Trends

	1990 Pop.*	1995 Pop.*	% change in 5 yrs	2000* Pop.	% change in 5 yrs	2005 Pop. **	% change in 5 yrs
Victorville	40,674	58,851	45%	64,455	10%	96,794	50%

* Data from *City of Victorville General Plan*
** Data from spreadsheet filename: *VVSED-SubtotalbyPlngAreaDistricts-010208.xls*



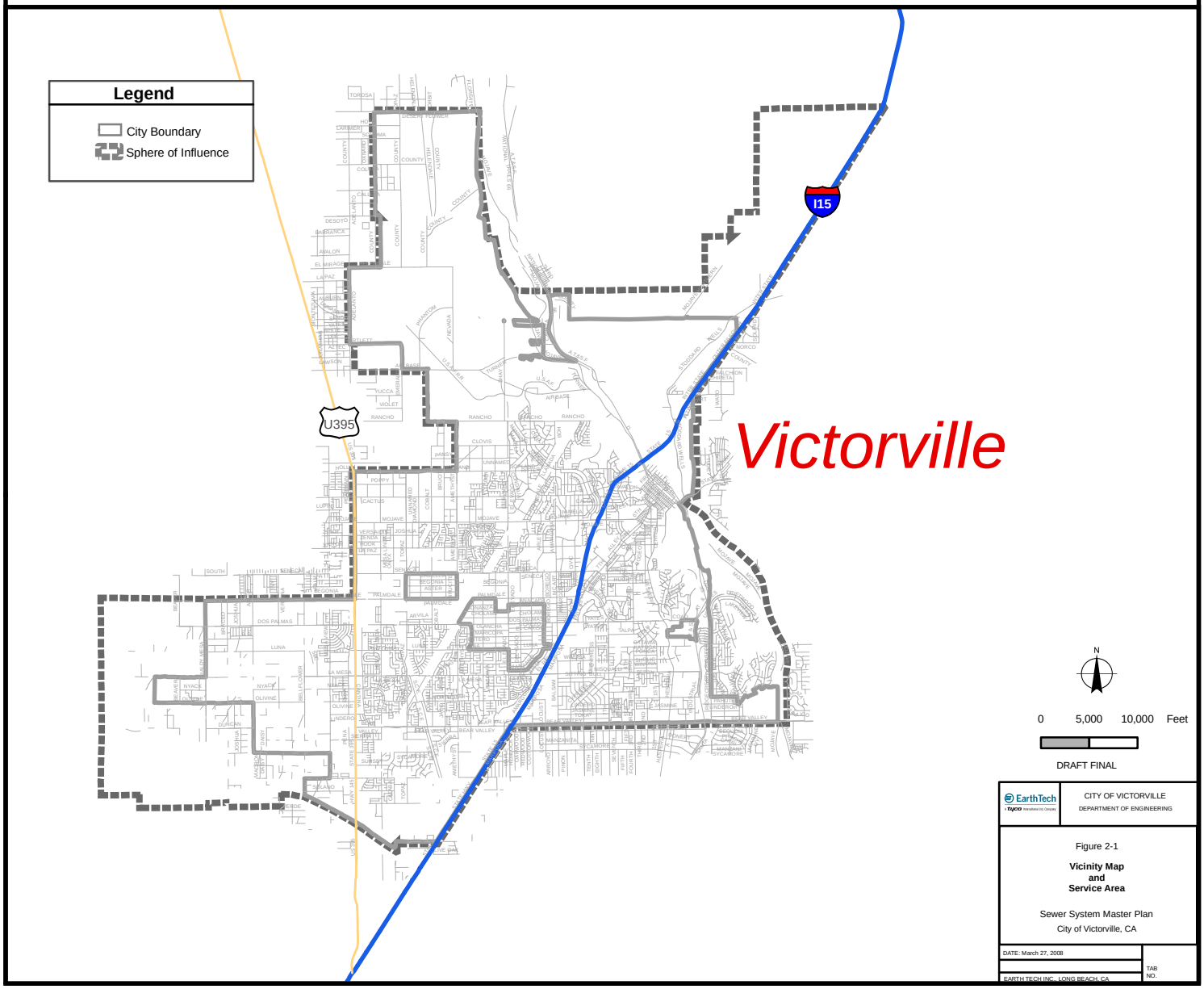


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Figure 2-1

Vicinity Map and Service Area

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

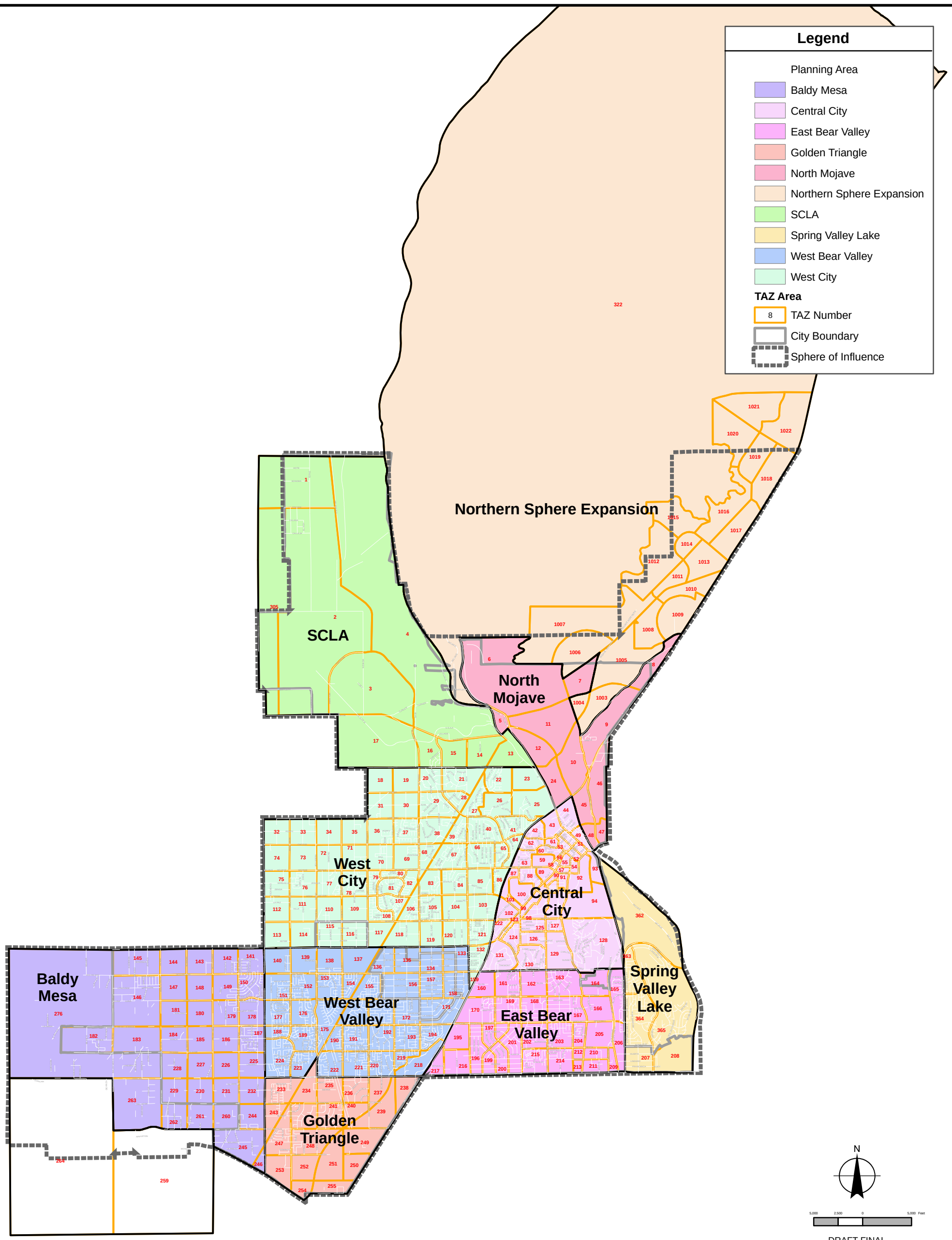

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Figure 2-2

Planning Areas and TAZ Areas

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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The City provided dwelling unit counts and population for the year 2005. This information was provided to Earth Tech in an Excel spreadsheet titled "*VVSED-SubtotalbyPlngAreaDistricts-010208.xls".* The heading on the file identifies the data as "City of Victorville Land Use & Socio-Economic Data – December 2005". In the spreadsheet these data were cross referenced with traffic analysis zones (TAZ) areas. The number of single family and multi-family EDUs and retail and non-retail employee population that existed within each TAZ area as of December 2005 was provided. These data were used to define residential and employment population figures for the current conditions (year 2006) scenario in the hydraulic model. A summary of the data is shown in Table 2-2.

Table 2-2 City of Victorville December 2005 Traffic Analysis Zone (TAZ) Population and Dwelling Unit Data

Land Use*	Totals
Single Family Dwelling Units (SDU)	25,970
Multi-Family Dwelling Units (MDU)	6,953
Total Dwelling Units	32,923
Retail Employees (RET)	10,105
Non Retail Employees (NRET)	17,159
Total Employees	27,264
Avg. persons/occupied Dwelling Unit**	2.94
Est. Dec. 2005 Population	**96,794**

* Data from spreadsheet filename: *VVSED-SubtotalbyPlngAreaDistricts-010208.xls*
**The average number of persons per occupied dwelling unit defines an EDU. Therefore, based on TAZ data the population equivalent of one EDU equals 3.2 persons. Note that the City of Victorville Planning Department uses a value of 2.9 persons per EDU for both single family and multi family land uses. This value was used to develop wastewater flows in the hydraulic model.

The number of single family and multi-family EDUs and retail and non-retail employee population that were connected to the sewer system as of December 2005 was estimated based on information provided by the City for each TAZ area. The number of "sewered" SDU, MDU, RET, and NRET as of December 2005 is presented in Table 2-3 for each planning area.

Table 2-3 Residential and Commercial Employee Population by Planning Area, Year 2005

Planning Area	SDU	MDU	RET	NRET
Baldy Mesa	829	0	5	0
Central City	3,574	2,074	2,742	4,743
East Bear Valley	2,404	1,468	2,707	3,959
Golden Triangle	321	0	665	118
North Mojave	55	287	50	479
SCLA	78	0	0	2,956
Spring Valley Lake	0	0	0	0
West City	5,162	2,331	1,215	3,363
West Bear Valley	8,418	0	2,459	1,279
Northern Sphere Proposed Expansion	0	0	0	27
Outside Victorville Sphere of Influence	0	0	0	0
TOTAL	**20,841**	**6,160**	**9,843**	**16,924**

Notes: Population represented in this table is for residential and commercial units connected to the Victorville sewer system.
SDU – Single Family Dwelling Unit
MDU – Multi-Family Dwelling Unit
RET – Retail Employee
NRET – Non-Retail Employee

Population projections for 2014 and 2030 were estimated based on data provided by the City Planning Department. The Planning Department provided the number of single family and multi-family EDUs and retail and year 2005, and projected population for 2035 and ultimate buildout in the Excel spreadsheet titled "VVSED-SubtotalbyPlngAreaDistricts-010208 ". The number of EDUs and employee population was then calculated for years 2014 and 2030 by TAZ area using straight-line interpolation between 2005 and 2035 data. The projected single family and multi-family EDUs and retail and non-retail employee population for each planning area are presented for Years 2014 and 2030 in Tables 2-3 and 2-4, respectively. Wastewater flows for these two planning horizons were based on the data presented in Tables 2-3 and 2-4, as further discussed in Section 3.5. The population data provided by the City Planning Department is provided in Appendix A.

Table 2-3 Projected Residential and Commercial Employee Population by Planning Area, Year 2014

Planning Area	SDU	MDU	RET	NRET
Baldy Mesa	4,967	2,872	1,912	167
Central City	3,802	2,183	3,010	4,807
East Bear Valley	2,875	1,652	3,424	4,375
Golden Triangle	1,296	467	1,883	168
North Mojave	990	443	111	3713
SCLA	231	0	75	8494
Spring Valley Lake	0	0	0	0
West City	7,633	4,546	3,043	4023
West Bear Valley	9,071	397	3,525	1344
Northern Sphere Proposed Expansion	4,139	4,113	1,489	2,432
Outside Victorville Sphere of Influence	286	0	0	0
TOTAL	**35,291**	**16,674**	**18,472**	**29,523**

Notes: Population represented in this table is for residential and commercial units connected to the Victorville sewer system.
SDU – Single Family Dwelling Unit
MDU – Multi-Family Dwelling Unit
RET – Retail Employee
NRET – Non-Retail Employee

Table 2-4 Projected Residential and Commercial Employee Population by Planning Area, Year 2030

Planning Area	SDU	MDU	RET	NRET
Baldy Mesa	12,324	7,978	5,302	465
Central City	4,208	2,376	3,487	4,921
East Bear Valley	3,713	1,979	4,698	5,116
Golden Triangle	3,029	1,298	4,048	256
North Mojave	2,652	721	220	9,461
SCLA	504	0	209	18,340
Spring Valley Lake	0	0	0	0
West City	12,025	8,485	6,294	5,197
West Bear Valley	10,233	1,103	5,419	1,458
Northern Sphere Proposed Expansion	11,498	11,426	4,136	6,708
Outside Victorville Sphere of Influence	794	0	0	0
TOTAL	**60,978**	**35,365**	**33,812**	**51,921**

Notes: Population represented in this table is for residential and commercial units connected to the Victorville sewer system.
SDU – Single Family Dwelling Unit
MDU – Multi-Family Dwelling Unit
RET – Retail Employee
NRET – Non-Retail Employee

2.2.3 WASTEWATER FLOW GENERATION FACTOR (FGF)

Victor Valley Wastewater Reclamation Authority (VVWRA) and City of Victorville wastewater flow generation factors (FGFs) are shown in Table 2-5. The VVWRA values were developed for the VVWRA and presented in their *"Sewage Facilities Plan Update, Year 2005 Amendment".* The City of Victorville FGF values shown were derived from flow data recorded during October 2006. VVWRA FGFs were used for establishing residential, industrial and commercial wastewater flows in the hydraulic model as shown in Table 2-5. These flows were verified using flow data discussed in Section 2.2.5.

Table 2-5 City of Victorville and VVWRA Flow Generation Factors by Land Use (Average Daily Flow)

Land Use	City of Victorville* FGF	VVWRA** FGF	Hydraulic Model FGF[1]
Equivalent Dwelling Unit (SDU/MDU)	256 gpd	235 gpd[2]	235 gpd
Residential	75 gpcd	80 gpcd	80 gpcd
Office/Retail (RET/NRET)	35 gped	35 gped	35 gped
Industrial	--	75 gped	varies
Institutional	--	35 gped	--
High School	--	15,000 gpd	15,000 gpd
Junior High School	--	10,000 gpd	10,000 gpd
Elementary School	--	5,000 gpd	5,000 gpd

* From flow meter data recoded in October 2006, based on TAZ data for EDU counts.
** Data from Victor Valley Wastewater Reclamation Authority "*Sewage Facilities Plan Update, Year 2005 Amendment*".
gpd – gallons per day
gpcd – gallons per capita per day
gped - gallons per employee per day
[1] See Chapter 4 for development of the hydraulic model
[2] SDU/MDU FGF calculated as 2.94 people per SDU or MDU multiplied by Residential FGF.

2.2.4 EQUIVALENT DWELLING UNIT (EDU)

The City Planning Department has historically published estimates of the average size of a single family household in the General Plan. Table 2-6 shows the variation that has occurred in the size of single family households since 1990.

Table 2-6 Average Single Family Size

Year	Population per EDU
1990	3.270*
1995	3.122*
2000	3.174*
2005	3.204**
2006	2.94***

*Data from *City of Victorville General Plan*
** Data from TAZ spreadsheet filename: *Land Use Data rev 9-12-06.xls*
***Data from City of Victorville Planning Department

One EDU is defined as the average size of a single family household. Since residential land use in Victorville is a mix of single family and multi-family residences and future population are estimated based on the number of parcels available for development, there is a need to determine future wastewater flows based upon EDU-based population. The City of Victorville Planning Department is currently using a value of 2.94

people per EDU for both single and multi-family dwelling units. This value was used in this study to define population in residential land use areas.

2.2.5 DIURNAL FLOW AND PEAKING FACTORS

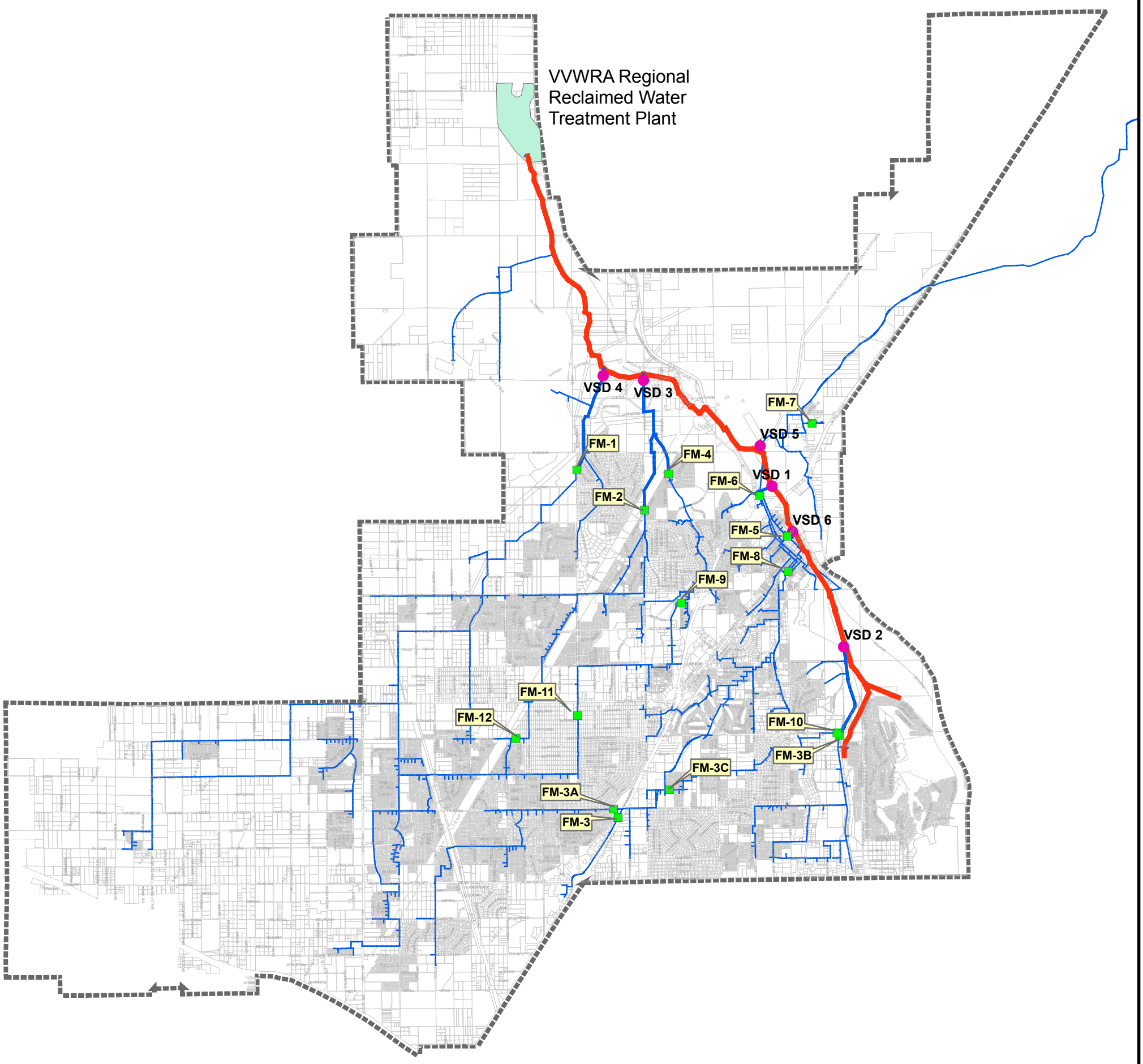
The City of Victorville discharges to the Victorville Valley Wastewater Reclamation Authority (VVWRA) interceptor system at six (6) locations. Flow data was recorded by VVWRA at each of these locations during November 2004 and presented in VVWRA's *Sewerage Facilities Plan Update, Year 2005 Amendment*. The meter sites are designated as VSD-1, VSD-2, VSD-3, VSD-4, VSD-5 and VSD-6 and are shown on the schematic in Figure 2-3.

Peak-hour flow factors (peaking factors) are used to convert average daily flows to peak daily flow rates for the hydraulic model's peak flow analysis. Daily average and peak flows were recorded during the VVWRA study and peaking factors were calculated for each of the meter sites. The peaking factors developed by VVWRA are compared in Table 2-7 with peaking factors that were developed from data collected during the temporary flow monitoring program conducted for this SMP in October 2006.

Table 2-7 Average Daily Flow and Peak-Hour Flow Factors at Connections to the VVWRA Interceptor

Victorville Valley Reclamation Authority*				City of Victorville**			
Meter	**Average Daily Flow (mgd)**	**Peak-Hour Flow (mgd)**	**Peaking Factor**	**Avg. Daily Flow (mgd)**	**Peak-Hour Flow (mgd)**	**Peaking Factor**	**Flow Meter**
VSD 1	0.606	1.345	2.22	0.65	1.12	1.74	6
VSD 2	2.284	4.312	1.89	2.35	3.50	1.49	3B+10
VSD 3	2.257	3.534	1.56	2.95	5.04	1.71	2+4
VSD 4	0.590	1.340	2.27	0.66	1.15	1.73	1
VSD 5	0.106	0.195	1.84	---	---	---	
VSD 6	0.873	1.448	1.66	1.24	1.73	1.40	5
Total	**6.716**	**12.174**	**1.81(avg)**	**7.85**	**12.54**	**1.60**	

*November 2004 VVWRA data from Victor Valley Wastewater Reclamation Authority "*Sewage Facilities Plan Update, Year 2005 Amendment*"
**City of Victorville temporary flow meter data recorded October 2006.



Legend

Wastewater Collection System

- Temporary Flow Meter Locations
- Victorville Sewer Discharge to VVWRA Meter Locations

VVWRA Interceptor System

- Trunk
- VVWRA Interceptor
- Sewer Network

Planimetric

- Flow Monitoring Locations
- VVWRA Reclamation Plant
- Parcels
- Sphere of Influence

N

4,000 2,000 0 4,000 Feet

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Figure 2-3

Connections to the VVWRA Interceptor System and Nearby Temporary Flow Meter Sites

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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2.2.6 FLOW RATES

Flow in the Victorville sewage system is comprised of domestic, commercial and industrial wastes. Groundwater infiltration and surface water inflow (I/I) are also common elements of a typical sewage flow regime. All segments of the wastewater conveyance system must be capable of carrying the combined peak flows generated from each of these sources. However, the high desert climate and soil type found in Victor Valley is believed to substantially reduce the impact of I/I on the City's collection system.

There are two common methods used to calculate the peak wastewater flow rates for new and existing wastewater systems: the peaking factor method and the diurnal curve method.

Peaking Factors

The peaking factor method applies a simple multiplier or flow generation factor to derive the maximum hourly flow which would occur during a defined period of time, usually 24-hours.

As an alternative, facility design peaking factors can be used to estimate wastewater flow in specific types of facilities. Commonly used factors are shown below in Table 2-8. The facility design peaking factor method is conservative to the point that a large margin of safety is often provided. For new sewers, the peaking factor method can allow for the uncertainties of future development. However, for an evaluation of existing sewers or design of new sewers in older, more completely developed areas, the peaking factor method of analysis may overestimate wastewater flows and subsequently lead to underestimating the remaining capacity available in existing sewers. This can result in the construction of unnecessary or oversized facilities.

Table 2-8 Facility Design Peaking Factors

Type of Facility	Design Peaking Factor*
Lateral and Local Sewers**	4.0
Trunks and Interceptors**	2.5
Heavy Industrial	2.0
Light Industrial	3.0
Commercial	3.0
Pump Station	2.5

*Peaking factors indicate the multiplier used to convert average-day flow to peak-hour flows, and does not account for infiltration and inflow.
**These facilities convey a combination of residential, industrial and commercial flow.

For convenience, peak wastewater flows can be quickly estimated using the facility peaking factors presented in Table 2-8; however, wastewater flows used to develop costly capital improvements should generally be developed using a hydraulic model applying the diurnal curve method.

Diurnal Curve Method

Diurnal curves reflect the wastewater flow pattern as it changes throughout the day. The diurnal curve method was used in the hydraulic model to generate wastewater flows. Diurnal patterns derived from October 2006 flow data were used to represent current condition (year 2006) wastewater flow in the hydraulic model. Diurnal curves for flow monitoring locations are provided in Section 3.4.3.

2.2.7 SEPTIC SYSTEMS

There are several areas within the Victorville sphere of influence where wastewater is treated with on-site septic systems. City code currently requires that when existing septic systems fail and are located within 200-feet of an existing sewer the owner must connect to the City's sewer system. In Victorville some residential areas are developed and served exclusively with on-site septic systems. Other areas are fully or even partially developed and served by a mix of septic system and connections to the City's sewer system.

The City anticipates that the use of septic systems within its sphere of influence will eventually be phased out as new development extends the area served by the collection system and as existing septic systems fail and properties are connected to the City's sewer system. The number of parcels that will actually convert to sewer is expected to

be fairly small. A uniform septic to sewer conversion rate is not anticipated to occur. For purposes of developing the hydraulic model, it was assumed that all existing septic systems will remain in operation. The VVWRA estimates in their *Sewage Facilities Plan Update Year 2005 Amendment* that 97% of Victorville's population is currently connected to the City's sewer system.

2.3 DESIGN CRITERIA

2.3.1 SEWER DESIGN

New sanitary sewers shall be designed by or under the direct supervision of a professional engineer registered in the State of California in accordance with the criteria described herein. All sewer pipelines comprising the City's collection system shall be designed and constructed in accordance with the City's wastewater policies and the requirements put forth in this SMP. Sewers shall be owned and maintained by the City. Except where otherwise defined in this SMP, sanitary sewer construction work and materials shall conform to the most current edition of the American Public Works Association (APWA) Standard Specifications and Standard Plans for Road, Bridge and Municipal Construction.

Wastewater system facilities shall be designed with sufficient capacity to convey peak flows from the tributary area for the design life of the facility, unless other criteria has been established and approved by the City. Wastewater systems shall be designed and constructed to achieve total containment of sanitary wastes and to minimize infiltration and inflow. In general, when the d/D criteria discussed below is exceeded or a pump station reaches 85 percent of capacity, the City will consider capital improvement in that area. The decision whether to increase conveyance capacity of gravity sewers by replacement, rehabilitation or by installing parallel sewer facilities is at the discretion of the City and should be made on a case by case basis.

It is necessary to define when existing sewers become hydraulically deficient and to develop criterion that can be used to define the size of new or rehabilitated sewers. Since the hydraulic capacity of a sewer pipe is a function of its diameter and slope, criteria to define when an existing pipe exceeds capacity is traditionally based on the ratio of depth of flow (d) to pipe diameter (D). Using this criterion, the point at which

sewer capacity is reached and the required diameter of new sewers was defined.

The d/D criteria for existing sewers and the design of new sewers are summarized in Table 2-9. The design flow rate for evaluating existing sewers and sizing new sewers is the peak-hour dry weather flow rate (sewershed population x per capita load x peaking factor). A sewer mainline is defined as having a nominal pipe size ranging from 8-inches to 12-inches in diameter. A sewer trunk is defined as having a nominal diameter larger than 12-inches.

Table 2-9 Hydraulic Criteria

Condition	d/D Criteria	
	Mainlines 8”-12” Dia.	Trunks > 12” Dia.
Threshold for rehabilitation of existing sewers	0.50	0.75
Maximum design depth allowed in new sewers	0.50	0.75

2.3.2 CALCULATION OF PIPE SIZE

The required pipe size shall be designed based on flow velocity, slope, and capacity using d/D criteria as defined above. Manning’s formula can be used to calculate the slope and velocity of the pipe:

$$Q = (1.486/n)\ AR^{2/3}\ S^{1/2}$$

Where, Q = Design Flow, cfs

A = Area of flow, ft^2

R = Hydraulic radius (A/P), ft

n = Manning’s roughness factor (use 0.013)

S = Slope, ft

As stated in Section 2.3.1, the design flow rate for sizing new sewers is the peak-hour dry weather flow rate.

2.3.2.1 Maximum and Minimum Flow Velocities

Where flow velocities greater than 10 feet per second are expected, special provisions shall be made to protect against internal erosion or displacement by shock or thrust forces. An energy dissipation device is required when a change in velocity of 5 feet per second or greater is anticipated through a structure. Approval by the City is required for both of these conditions.

Gravity sewers shall be designed for a minimum velocity of 2 feet per second as calculated using the peak dry weather flow anticipated at the time the sewer is placed into service. Use of peak dry weather flow in this calculation will provide a minimum scouring velocity of 2 feet per second at least once per day. City approval is required for design velocities below 2 feet per second.

2.3.2.2 Minimum Slope

All sewer pipelines shall be designed and constructed to provide minimum velocities of not less than 2 feet per second, as described above. The required minimum slope for pipelines of various sizes is provided in Table 2-10, although slopes greater than those shown are sometimes required to meet the minimum velocity criteria, which in turn, tends to reduce maintenance costs.

For side sewer connections, flows less than super-critical depth should be avoided because the associated shallow water depths often leave solids in the pipe. Over sizing sewers with respect to capacity in order to allow the use of flatter slopes should be avoided, as this can result in high maintenance costs resulting from low velocities, such as sedimentation and odor.

Sewer pipelines shall be laid with uniform slope between manholes. Sewer pipelines with slopes greater than 15% shall be anchored securely with concrete anchors or joint restraint devices. Energy dissipation should be given consideration in sewer pipelines with slopes in excess of 40%. Energy dissipation devices shall be reviewed by the City on a case-by-case basis.

Table 2-10 Minimum Allowable Pipe Slope

Pipe Size	Min. Slope	Pipe Size	Min. Slope
4-inch	2.00%*	16-inch	0.14%
6-inch	1.00%*	18-inch	0.12%
8-inch	0.40%	21-inch	0.10%
10-inch	0.28%	24-inch	0.08%
12-inch	0.22%	27-inch	0.07%
14-inch	0.17%	30-inch	0.06%
15-inch	0.15%	36-inch	0.05%

*4- and 6-inch pipe is allowed for side sewers only. Additional slope may be required to achieve adequate flushing velocity.

2.3.3 COMBINED SEWERS

No combined sanitary and storm sewers exist or are allowed within the City.

2.3.4 OVERFLOWS

No overflows or new overflow structures are permitted. However, during the design of a pump station, consideration should be given to situations where overflow could occur in the unlikely event that all emergency power provisions should fail.

2.3.5 GRAVITY/PRESSURE SEWERS

All new laterals and side sewers shall be a minimum of 4-inches and all sewer mains shall be a minimum of 8-inches in diameter.

Collection sewers and pump stations should be designed for ultimate development of the tributary areas based on the above design criteria unless otherwise approved by the City. In some situations, it may be prudent to construct pump station capacity in stages as the need for higher capacity develops over time. Approval by the City is required.

When evaluating the adequacy of the existing sewer pipelines to carry additional flows and to determine wastewater flow rates for future scenarios, it is recommended that a computer hydraulic model be used to simulate conditions in the collection system.

Gravity sewers shall be used wherever possible. Pump stations will be allowed only after thorough investigation has shown that no other feasible alternative exists. Cost effectiveness may be one of the criteria considered in the analysis. Force mains and inverted siphons should be designed as pressure pipelines. The pipe size for force

mains should be selected to provide for at least 2, and preferably 3 feet per second self-scouring velocity. The maximum velocity in force mains should be 8 feet per second. The minimum pipe size for force mains shall be 4-inch diameter pipe, except on low pressure systems which may require smaller diameter pipes.

The minimum size allowed for inverted siphons is 6-inch diameter pipe. All siphons shall have at least two barrels. Sediment buildup at low points in siphons is of major concern and therefore, blow off valves must be provided. Also, air relief valves should be placed at the necessary high points to avoid air locking. In general, proper facilities must be provided for force mains and inverted siphons to prevent blockage and plugging and to allow for proper maintenance and cleaning. In certain instances, where size of the area to be served is too small to warrant the expense of a pump station, or where the physical characteristics of the area make it impractical or difficult to otherwise serve an area, low pressure and/or vacuum sewer systems may be considered. Approval of such system will be at the sole discretion of the City.

2.3.6 TRUNK AND INTERCEPTOR SEWERS

Trunk and interceptor sewers shall be designed with sufficient capacity to carry peak flows at ultimate development conditions based on the results of the hydraulic evaluation and/or the criteria established herein. Peak flow represents the sum of several loadings calculated separately for each section of sewer or tributary area. These loadings consist of peak wastewater flows, groundwater infiltration and surface water inflow if any, plus any other quantities which are unique to the individual sewer basin.

2.3.7 INFILTRATION AND INFLOW

Infiltration is groundwater which enters the wastewater system through pipe joints, manhole connections, porous pipes or similar openings in the system. Inflow is surface water which enters the sewer system through manhole covers or illegal connections such as footings drains, roof drains or area drains. Limiting infiltration and inflow is a primary goal of many wastewater utilities. Infiltration and inflow contributes to the wastewater that must be conveyed through the system, reducing the remaining capacity available to convey future wastewater flows and adding to treatment and disposal costs.

In the Victorville sewer system, it is assumed that infiltration and inflow generally have little impact on the conveyance system. However, this assumption should be verified during the design of future conveyance pipelines and pumping facilities.

2.3.8 PIPE MATERIALS

Vitrified clay pipe (VCP) is the City of Victorville preferred pipe material. VCP may be used for gravity sewer pipelines where soil foundation conditions permit and for slopes less than fifteen percent and depths less than 22 feet, unless otherwise directed or approved by the City.

Cement lined ductile iron pipe or other pipe material as approved by the City, is required for all other areas and for force mains. Ductile iron pipe placed in potentially corrosive soils should be polyethylene encased. Material standards for ductile iron pipe are ANSI/AWWA C151/A21.51.

2.3.9 ALIGNMENT

Gravity sewer pipelines shall be designed with straight alignment between manholes. Curved pipe and vertical or horizontal bends are not allowed.

2.3.10 DOWNSIZING AND BOTTLENECKS

Downsizing of sewer pipelines, or the installation of a smaller diameter pipeline downstream of a larger diameter pipeline, is not allowed.

2.3.11 MANHOLES

Manholes shall be installed at the terminal end of each pipeline, at all changes in grade, size or alignment, at all intersections, and at distances not greater than 350 feet apart.

The minimum diameter of manholes shall be 48 inches. The minimum clear access opening in manholes shall be 23 inches. Larger size manholes may be required to accommodate special requirements or larger pipe.

Manholes shall be constructed and installed in accordance with current City standards. A 0.10-foot drop shall be provided between the inlet and the outlet pipe inverts for straight-through manholes. A straight-through manhole is defined as any structure where the

deflection angle between the inlet and outlet piping is 180 degrees, plus or minus 10 degrees. A 0.20-foot drop is required between the inlet and the outlet pipe inverts for manholes or other sewer structures not defined as straight-through.

Drop connections are discouraged by the City and shall be kept to an absolute minimum. If allowed by the City, it should be constructed so that the inlet sewer pipeline entering the manhole shall enter at an elevation of 24-inches or more above the invert of the outlet pipe. Where the difference in elevation between the inlet sewer pipeline and the outlet pipe invert is less than 24 inches, the invert of the manhole should be channeled to prevent deposition of solids.

CHAPTER 3 DATA

3.1 INTRODUCTION AND OBJECTIVES

Data collection and analysis were performed for sewer data, population data, and flow data. Sewer data was collected for the purpose of developing the sewer atlas geodatabase and constructing the hydraulic model. Missing data was identified and resolved via a data gap analysis.

Population data was provided by the City as Traffic Area Zone (TAZ) socio-economic data and future projected population by TAZ area. Population data was used to estimate future wastewater generation for hydraulic model to identify system deficiencies and to define the Capital Improvement Program.

The purpose of flow data collection was to determine the volume of wastewater being generated in various areas of the City and conveyed through the major trunk and interceptor systems, to determine diurnal patterns for various areas of the City, and to calibrate the hydraulic model.

3.2 SEWER DATA COLLECTION AND DATA GAP ANALYSIS

Sewer data collection activities consisted of identifying and considering the availability and usefulness of the following sewer system source data:

1. As-Built Drawings: Identify availability of as-built drawings and ensure that all as-built drawings represented on the City-provided, pre-conversion AutoCAD Map are included in the data conversion effort.

2. Pressure & Gravity Main Pipelines: Define the spatial location, material, diameter, upstream manhole (MH) identifier (ID), downstream MH ID, length and slope of each pipe segment.

3. Manholes: Determine rim and invert elevations for manholes and identify where elevation data is missing or erroneous for manholes located on the trunk system.

4. Pump Stations: Determine availability and usefulness of pump station information.

5. Land Use Data: Identify availability and usefulness of the City-provided land use data. Also, determine usefulness of San Bernardino County parcel data.

6. Population Data: Define the availability and usefulness of the City-provided population Traffic Analysis Zone (TAZ) data.

7. Parcel and Street Centerline Data: Identify availability and usefulness of parcel and street centerline data. Also, determine if parcel data includes assessor parcel numbers (APNs), street addresses and Land Use Codes.

8. Other Information: Data that must be considered for constructing the sewer system hydraulic model.

3.2.1 Existing Source Data

Existing source data evaluated for use in the sewer atlas geodatabase and hydraulic model are discussed in this section. The use of source data in the data conversion to the sewer atlas geodatabase is also defined in this section.

3.2.1.1 CADD Maps, Databases, Tables, and Reports

CADD Maps

The City of Victorville supplied various information sources for the development of the hydraulic model. CADD files provided an initial basis for the existing sewer pipe system. The key drawing, *city-sewer-map.dwg* contained vital information depicting the existing City of Victorville sewer lines and information about the Victor Valley Water Reclamation Authority (VVWRA) trunk lines. It also contained valuable information for the development of basemap features. This CADD file was used to identify pre-conversion conditions and used to identify missing data (data gaps) during the conversion process. Other CADD files provided by the City were used for the development of the hydraulic model. Of the files provided, the *CS-ST-SWR01A.dwg* and *CS-ST-SWR02A.dwg* provided some useful information for the as-built conditions in the old downtown area of the City.

Tables

Several tables were provided by the City including survey control points in electronic files *FIELDPTS.TXT and GPSnet Points.txt*. Tables in the report file *COV Survey Control*

Listing.pdf provided a complete listing of City-wide survey control points with field sketches of each survey location.

Reports

The report file *Master Plan of Sewers Victorville.pdf,* contains the JF Davidson 1990 Sewer Model Report which included a map of the 1990 trunk system, showing the modeled system (using the modeling software HYDRA). The map was extracted from the report and saved as a JPG file. Spatial links were added to the JPG to allow the map to be transformed as a GeoTIFF file which was overlayed at the same spatial reference as the as-built data being converted for the hydraulic model. The report also contained the 1990 Master Plan Technical Supplement containing detailed numeric data from the 1990 HYDRA model.

The City also provided a summary memorandum titled *Departmental Sewer Plan Summary* which provided a summary account of as-built plan sets.

3.2.1.2 As-Built Drawings

The City provided a comprehensive set of scanned TIFF images of all as-built drawing sets that were used to develop the sewer atlas geodatabase and the hydraulic model. The City provided TIFF files of both private systems and City systems.

The as-built TIFF images were cataloged and scrubbed by Earth Tech. Initial alignments were digitized and the as-built plan set number was tagged to each alignment.

3.2.1.3 Parcel and Street Centerline Data

Earth Tech obtained a copy of the San Bernardino County parcels and street centerlines from the Geographic Information Management System (GIMS). The parcel and street centerline data provided the basis for the planimetric basemap used for the conversion of the as-built drawing sets to the Sewer Atlas Geodatabase and for mapping developed for this SMP. Pipeline alignment offsets were digitized from the street centerline as noted in the as-built plan sheets. The parcel data was stored in a separate geodatabase.

3.2.1.4 Interviews with City of Victorville Staff

City of Victorville Engineering and Operations staff were interviewed to help characterize sewer system connectivity questions and to assist in identifying future land use and projected population.

3.2.1.5 Land Use (Current and Projected)

No current land use plan was available for the City. The City provided a land use plan for ultimate build out conditions along with projected developed areas by land use for each planning area. Land use categories are defined by the General Plan and include the following: Very Low Density Residential, Low Density Residential, Medium Density Residential, High Density Residential, Mixed Density Residential, Office Professional, Commercial, Light Industrial, Heavy Industrial, Mixed Use, Public/Institutional, Open Space, and Specific Plan. Specific Plan areas are described in the General Plan.

3.2.1.6 Population Data

The City provided Traffic Area Zone (TAZ) polygons and a spreadsheet containing socio-economic data. The TAZ polygons shapes contain an ID; the socio-economic table contains a TAZ_number. The TAZ_number consists of residential dwelling counts for MDU and SDU (multi-family and single family residential dwelling units, respectively), and commercial employee counts RET and NRET (retail employees and non-retail employees, respectively).

3.2.2 DATA GAP ANALYSIS

The primary objectives of the Data Gap Analysis (DGA) were the following:

- Identify available sewer system data.
- Identify the missing data necessary for developing the sewer atlas geodatabase and for constructing the hydraulic model.
- Provide recommendations for additional data collection activities.

3.2.2.1 Methodology

The methodology used for the data gap analysis included investigation of both spatial

data alignments (i.e. horizontal location of lines, points and polygons) as well as tabular data (i.e. sewer system attributes assembled from the as-built drawings).

The methodology first included spatial registration of the CADD data files into the same projections and coordinate system as the data being converted from the as-builts. The file *city-sewer-map.dwg* was transformed and rubber-sheeted to enable alignment of the City's pre-conversion pipe system to match the new land base. Sewer pipes and appurtenances in the CADD files were extracted as saved as shape files. This enabled visualization of the CADD-based piping system in GIS format prior to conversion. All of the known existing (pre-conversion) collectors and trunks were symbolized by diameter to aid in the depiction of the system and to compare those pre-conversion conditions to the results of the data conversion. The pre-conversion pipe conditions were compared to the converted data to identify extent of missing as-built drawings, if any. Then, various attributes of the converted data were analyzed to determine data gaps (i.e. missing invert elevations, missing slopes, negative slope values, missing rim elevations, missing manhole invert elevations, etc.).

3.2.2.2 Examination of Sewer System Alignments and Attribute Data

The sewer system (pipes and appurtenances) was analyzed by running a series of Structured Query Language (SQL) queries to identify missing data. While data gaps were investigated for all data converted, the examination focused on pipes and manholes that were required to be used to develop the hydraulic model (i.e. all pipes greater than 10-inch in diameter classified as "trunks" and any 8-inch pipe connected to a trunk and manholes on those trunks). Manholes missing rim or invert elevations were then investigated to see if data from the JF Davidson 1990 Master Plan Technical Supplement could fill those data gaps. Manholes still missing rim or invert elevations were then prioritized and scheduled for field survey to collect the missing elevation data. Only those manholes located on pipe segments to be modeled were included in the field survey, which was performed by the City of Victorville Survey Dept.

3.2.2.3 Horizontal and Vertical Accuracy

Horizontal and vertical accuracy of the sewer manholes and connecting gravity mains were compared graphically against the parcel and road centerline data and against as-

built data, where available.

3.2.2.4 Completeness and Consistency

The completeness of the as-built drawings was reviewed to determine whether these drawings represent the system extent and if any as-builts are missing. These were also reviewed to determine if the information on the as-builts contained the data necessary to construct the hydraulic model, i.e. pipe length, diameter, invert elevations and manhole rim elevations. In general, this information was provided in the as-built drawings.

3.2.2.5 Quality Control

Quality control was performed to determine if the methodology used for the data gap analysis was sound and a review of the SQL queries was also performed to confirm that data gaps critical to the development of the sewer atlas geodatabase and hydraulic model were properly executed.

3.2.3 DATA GAP ASSESSMENT RESULTS

The data gap assessment evaluated the following information: as-built drawing elevations, pressure and gravity main pipelines, manholes, pump stations, flow meter stations, land use data, population data, and parcel and street centerline data.

3.2.3.1 As-Built Drawings

The as-built drawings sets were converted in phases. In general, the as-built drawings supplied by the City adequately represented the current extent of the sewer collection system. Comparison of pre-conversion pipe to the scrubbed sewer lines shows that the as-builts supplied by the City cover the service area. As-built plan sets that were missing consisted mainly of sewers located in the Old Town area in atlas Grids AA37, AB37, AA38, & AA39; and in a few other scattered areas including Grids: AA32, AB32, AA42, AA47, AB47, T37, X45 and Y45. Notably missing were as-built plan sets: SP-VSD05 and SP-VSD32.

The information on the as-built plan sets necessary for the hydraulic model was generally available; however some of the vertical information on some as-built plan sets were not tied to City or county benchmarks and thus had local elevation values that are

not representative to the surrounding elevations. In these cases, a vertical correction factor was developed and used to correct the data used in the sewer atlas geodatabase and in the hydraulic model.

3.2.3.2 Pressure and Gravity Main Pipelines

When comparing the pre-conversion pipe system to the converted data, some 10-inch and larger gravity mains were found to be missing from the converted database. In some cases, individual pipe segments were missing while in other complete pipe runs were missing.

Missing pressure and gravity mains were investigated to determine data gaps relative to missing invert elevations, missing slopes and negative slopes. The number of trunk pipe segments with missing data included:

- Pipes missing invert elevations = 57 pipe segments
- Pipes with missing slopes = 41 pipe segments
- Pipes with negative slopes = 33 pipe segments

The missing pipe data were discussed with City staff and resolved using information derived from the CADD file *city-sewer-map.dwg* and City employee's first hand information of the sewer system.

3.2.3.3 Manholes

The converted manhole data were analyzed to determine which manholes were missing rim or invert elevations. There were 941 manholes missing either a rim or invert elevation. Of the 941, there were a total of 933 manholes missing a rim elevation and 131 manholes that were missing an invert elevation. These manholes were further analyzed to determine that 131 of these manholes fall on trunk lines. Of those manholes on the trunks, 86 were missing an invert elevation and 81 were missing a rim elevation.

The 86 manholes missing invert elevations (critical to the hydraulic model) were further analyzed to determine if invert elevations could be derived from records in the geodatabase that showed both a representative rim elevation and a manhole depth.

However, only two records fell into this category. Of the remaining manholes on trunk lines, some missing invert elevations were calculated using rim elevations obtained from the JF Davidson 1990 Sewer Master Plan Report.

The 81 manholes missing rim elevations were analyzed to determine if an invert elevation and a depth existed in the geodatabase in order to calculate the rim elevation. However, only seven records fell into this category. The remaining manholes missing a rim elevation were then checked against the JF Davidson 1990 Sewer Master Plan Report.

As noted previously, the JF Davidson 1990 HYDR map image was transformed to align with the data converted to date. The registration of this map showed the number scheme used in the JF Davidson report, and thus correlation of some of those manholes on trunks missing the rim or invert elevations was attempted. However, due to discrepancies between the current data and the manhole locations in the 1990 report, the elevation values for the original 86 manholes missing the inverts or the 81 manholes missing the rim elevation were not obtained using the JF Davidson Technical Supplement.

As a result, 86 manholes required field survey to obtain the missing rim or invert elevations.

3.2.3.4 Pump Station

The Stoddard Wells Pump Station is the only major wastewater pumping facility operated by the City. The City provided as-built drawings for the facility, which included details of the pumps, valves and electrical components. Pump curves, wet well dimensions, wet well volume or pump on/off elevations (pump set points) were provided by City of Victorville Operations staff and from physical inspection of the pump station. No data gaps were identified in this data.

3.2.3.5 Existing Land Use Data

Existing land use data was contained in the San Bernardino County Parcel data. The GIMS parcel data contained relatively complete 2-digit Land Use Type codes which were assigned to each parcel. The parcel data also included a 3-digit Land Use Type Code

that further refines the Land Use to more specific uses. These 2- and 3-digit land use designations were used for the development of preliminary sewer sheds, which is discussed further in Section 3.4.

3.2.3.6 Population Data

As previously discussed in Section 3.2.1.6, the City provided Traffic Area Zone (TAZ) polygons and a spreadsheet containing socio-economic data. The TAZ polygon shapes contain an ID; the socio-economic table contains a TAZ_number. The shape polygons were correlated to the TAZ IDs in the socio-economic table to derive existing population.

3.2.3.7 Parcel and Street Centerline Data

The GIMS parcel and street centerline data was complete to the extent necessary for the conversion of as-built drawing sets. The parcel data provided an adequate representation of the planimetric land based features for both parcel lots and street centerline data. The street centerline data was used to digitize the alignments of the pipes based on the offsets indicated on the as-built plan drawings. The parcel data contained an abundance of attribute information including: parcel ID, assessor parcel number, site address (situs_nbr), tract number, and as noted above, land use codes. The City approved use of the GIMS parcel and street centerline data for the conversion effort and no independent verification of the spatial accuracy of the parcel data was performed for the DGA.

3.3 THE SEWER ATLAS GEODATABASE

The City's existing sewer system atlas, which was developed over 15 years ago, is now out of date. A new sewer atlas was developed for the City as part of this SMP. The new sewer atlas is comprised of City of Victorville land use and parcel information, and sewer system entity information. In addition to providing an up to date depiction of the sewer system, the database features of the new atlas allows the atlas to be revised to reflect growth or changes in the sewer system. The atlas grid maps can now be revised as desired to reflect these changes.

In order to prepare the Sewer Atlas, the City's sewer system pipe and manhole data were entered into a geographic database (geodatabase). The geodatabase was, in turn,

used to prepare the atlas maps for the City. Technical Memorandum 4 *Definition of the Geodatabase, Data Capture Standards and Cartographic Standards* (Earth Tech, 2007) was prepared to describe the process and standards used to prepare the geodatabase and the sewer atlas. Technical Memorandum 4 is provided in Appendix B.

3.4 FLOW DATA

3.4.1 INTRODUCTION AND OBJECTIVES

The objectives for measuring wastewater flows in the City of Victorville were to determine the volume of wastewater being generated in various areas of the City and conveyed through the major trunk and interceptor systems, to determine diurnal patterns for various areas of the City, and to calibrate the hydraulic model.

Flow meter sites were identified using the following criteria, in order of preference: 1) Locate meters upstream of the confluence of interceptors and major trunk lines to isolate and quantify flows generated within its tributary area; and 2) Locate meters in sewer mains or trunks so that wastewater flows generated from a specific land use can be isolated.

The stated objectives listed above are described in further detail below.

1. **Determine wastewater flow rates and volumes being conveyed through the major interceptor and trunk systems.** Flow data was used to confirm the wastewater volumes recorded by the VVWRA flow meters and to verify VVWRA flow generation factors.

2. **Determine diurnal patterns for various areas of the City.** Diurnal patterns were developed for each of the fourteen flow monitoring locations for both weekdays and weekends. The weekday curves were used to load the current conditions flow into the hydraulic model to simulate the sewer system over a 24-hour period. Diurnal curves were also developed for residential and commercial land use for loading future flows into the hydraulic model.

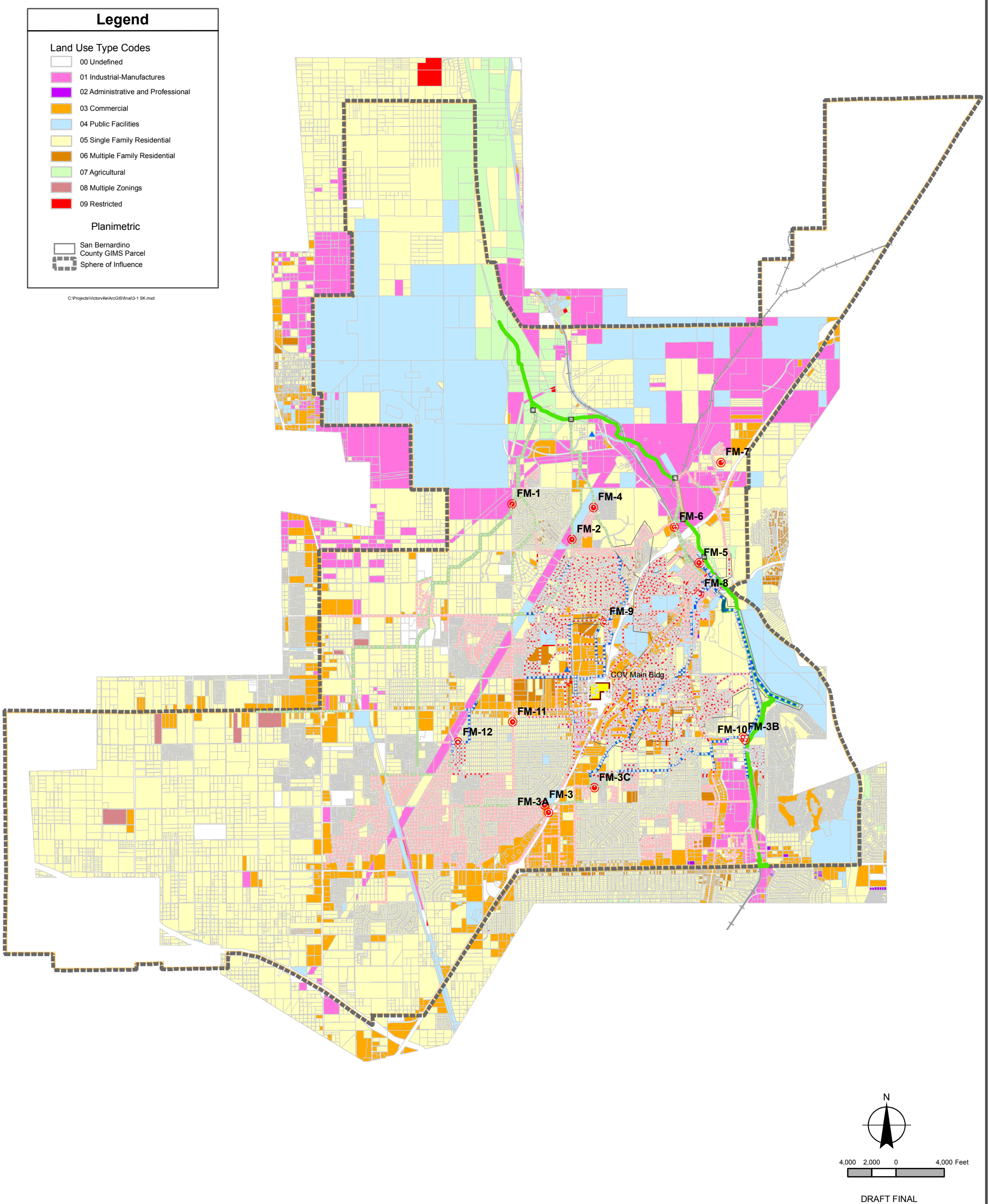
3. **Calibrate the hydraulic model.** The data recorded by the flow meters was used to calibrate the model. A model scenario that represents the conveyance system as it is currently operating was developed and calibrated. Existing wastewater flows were defined using population from TAZ data and verified using the measured wastewater data described herein.

   Calibration was accomplished by comparing the hourly-varying flow rates and daily volumes predicted by the model's simulation runs against measured

wastewater flow rates and volumes. Model parameters were adjusted until a reasonable match occurred between the two. An accurate comparison of the model's predictions against actual measured flows is the best way to confirm the accuracy of the model's flow predictions.

Each flow meter site was selected to assist in achieving the objectives listed above. Following are brief narratives which describe the location and purpose for selecting each of the flow meter sites, the land use that is tributary to each meter, and detailed mapping to show the specific location of each meter.

Figure 3-1 shows the location of all fourteen flow meter sites, San Bernardino County land use data, and the sewer shed tributary to each meter. As shown on this figure, each flow meter measures wastewater generated from within one or more land use types. Flow meter sites, tributary areas to each flow meter, and the modeled sewer network are shown on Figure 3-2.



DRAFT FINAL

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CITY OF VICTORVILLE
DEPARTMENT OF ENGINEERING

Figure 3-1

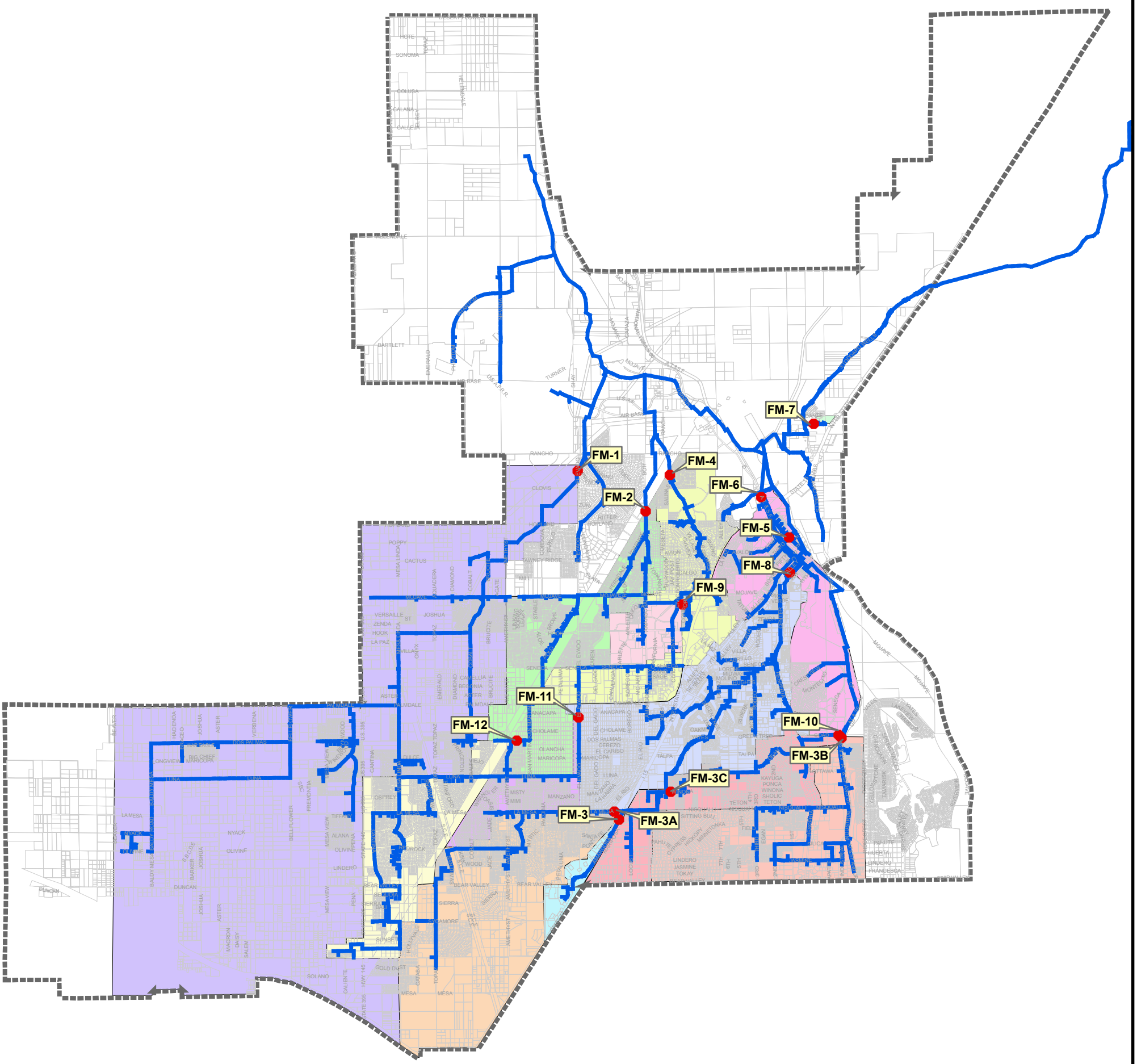
Land Use and Flow Monitoring Tributary Areas

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.



Legend

Wastewater Collection System

- Flow Monitoring Locations
- Modeled Sewer Network

Tributary Areas

- FM-1
- FM-2
- FM-3
- FM-3A
- FM-3B
- FM-4
- FM-5-6
- FM-7
- FM-8
- FM-9
- FM-10
- FM-11
- FM-12

Planimetric

- Parcels
- Sphere of Influence

N

2,400 1,200 0 2,400 Feet

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CITY OF VICTORVILLE
DEPARTMENT OF ENGINEERING

Figure 3-2

Flow Monitoring Locations and Tributary Areas

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

C:\Projects\Victorville\ArcGIS\final\3-2.mxd

3.4.2 FLOW MONITORING

3.4.2.1 Location and Description of Flow Meters

Flow Meter FM-1

This meter was installed in a 30-inch trunk line and measured wastewater flows from a very large area in the western and northwestern portion of the service area. This area includes much of the recent growth that has occurred and the trunk may require additional capacity to convey substantial future growth should it occur. Land use in most of the area is single-family residential.

Flow Meter FM-2

This meter was installed in a 15-inch trunk line to measure wastewater flows from a very large area in the central and western portions of the service area. The tributary area to this meter includes older portions of the collection system and new residential construction. Substantial growth has occurred in the upper reaches of this basin. This trunk may require additional capacity to convey substantial future growth should it occur. Land use in the area is predominantly single-family residential with some commercial.

Figure 3-3 Location of Flow Meter FM-1

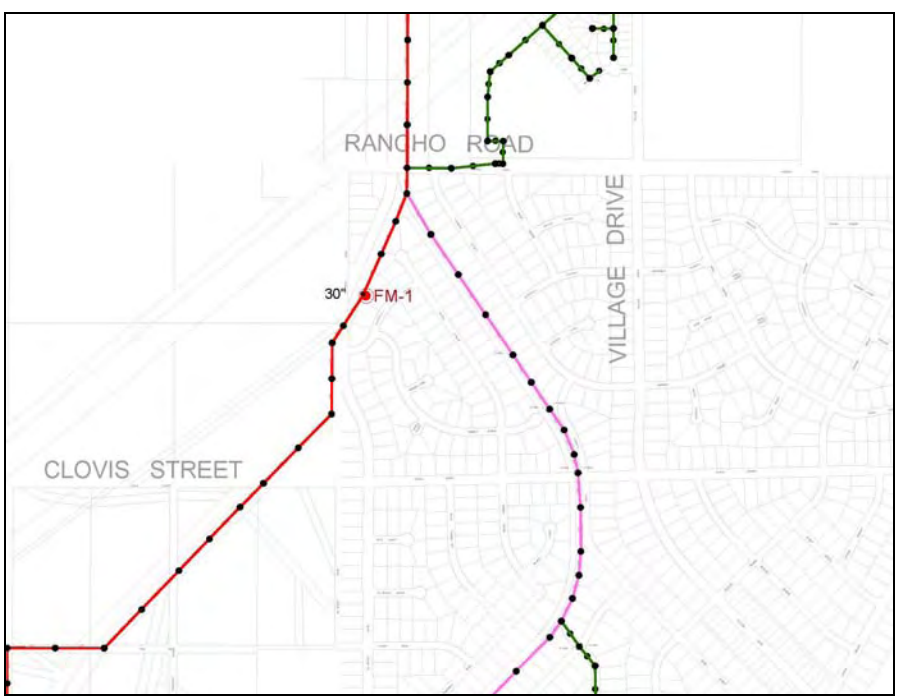


Figure 3-4 Location of Flow Meter FM-2

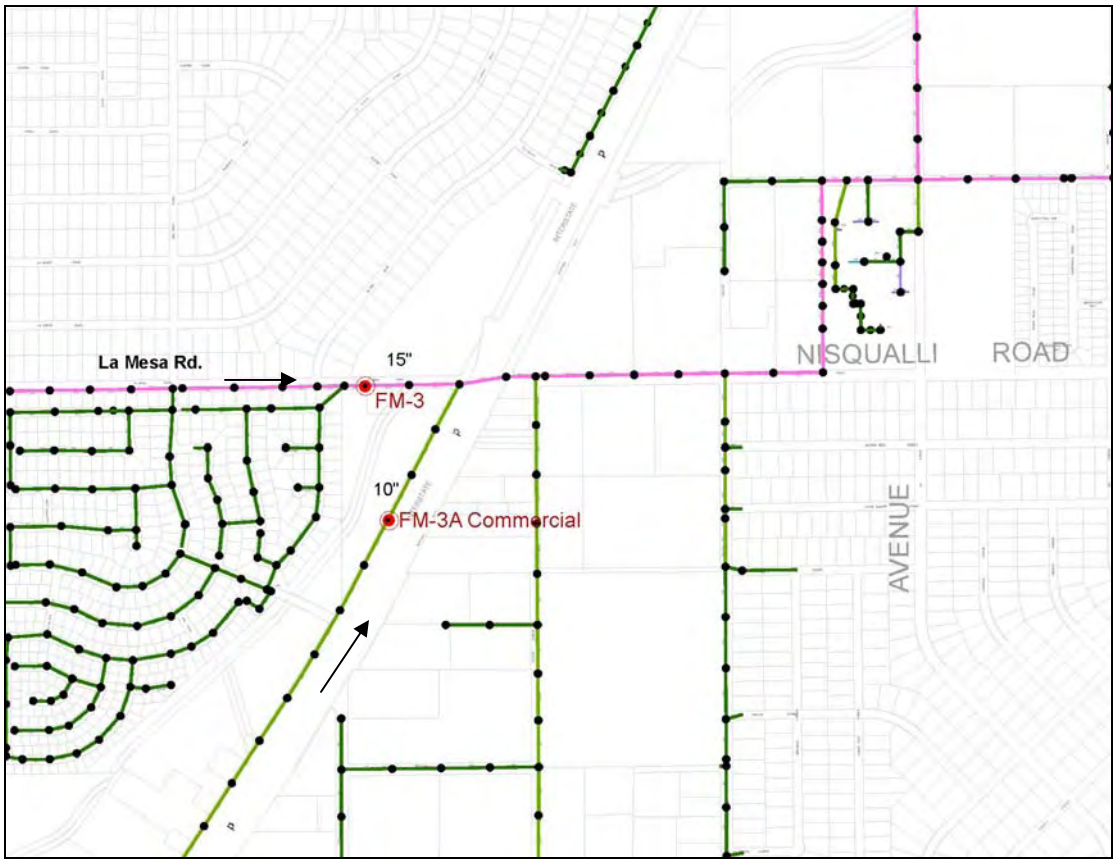
Flow Meter FM-3

This meter was installed in a 15-inch line and measured wastewater flows generated west of I-15 in the southern part of the service area. Land use is predominantly single-family residential; however, some commercial land use located on Bear Valley Rd. west of the freeway is also tributary to this flow meter.

Flow Meter FM-3A

This meter measured flows generated along Amargosa Rd. between La Mesa Rd. and Bear Valley Rd. in the southern part of the service area. The meter was located in a 10-inch line under Armargosa Rd.

Figure 3-5 Location of Flow Meter FM-3A



Flow Meter FM-3B

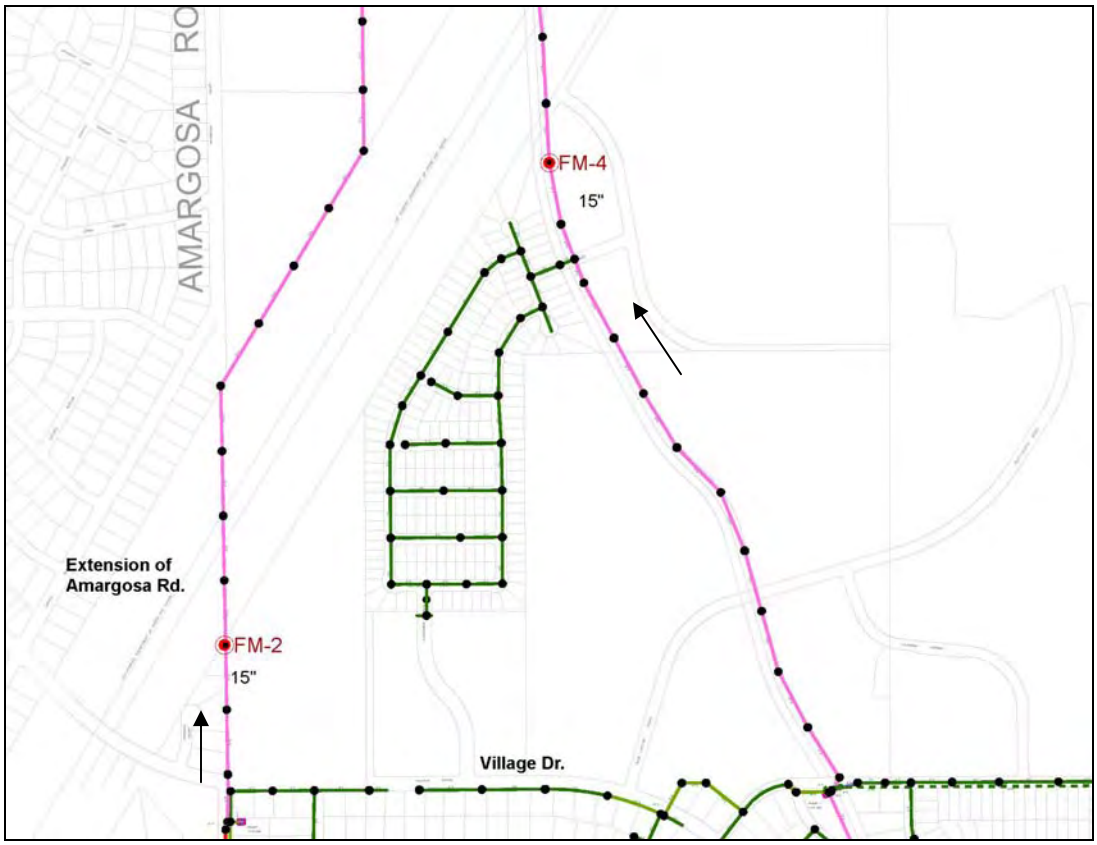
This meter measured flows in a 15-inch trunk line that runs parallel to the BNSF railroad tracks in the southeast portion of the service area. The site is located immediately south of Coad Rd. at its eastern terminus. Land use is a mix of industrial, commercial and residential.

Figure 3-6 Location of Flow Meter FM-3B

Flow Meter FM-4

This meter measured flow in a 15-inch line. The tributary area includes a very large portion the of the service area, including much of the central area west of I-15 and a large southwest portion of the service area. New development occurring in the southwest area connects to the upstream end of this trunk system. FM-9 and FM-11 are tributary to this meter.

Figure 3-7 Location of Flow Meter FM-4



Flow Meter FM-5

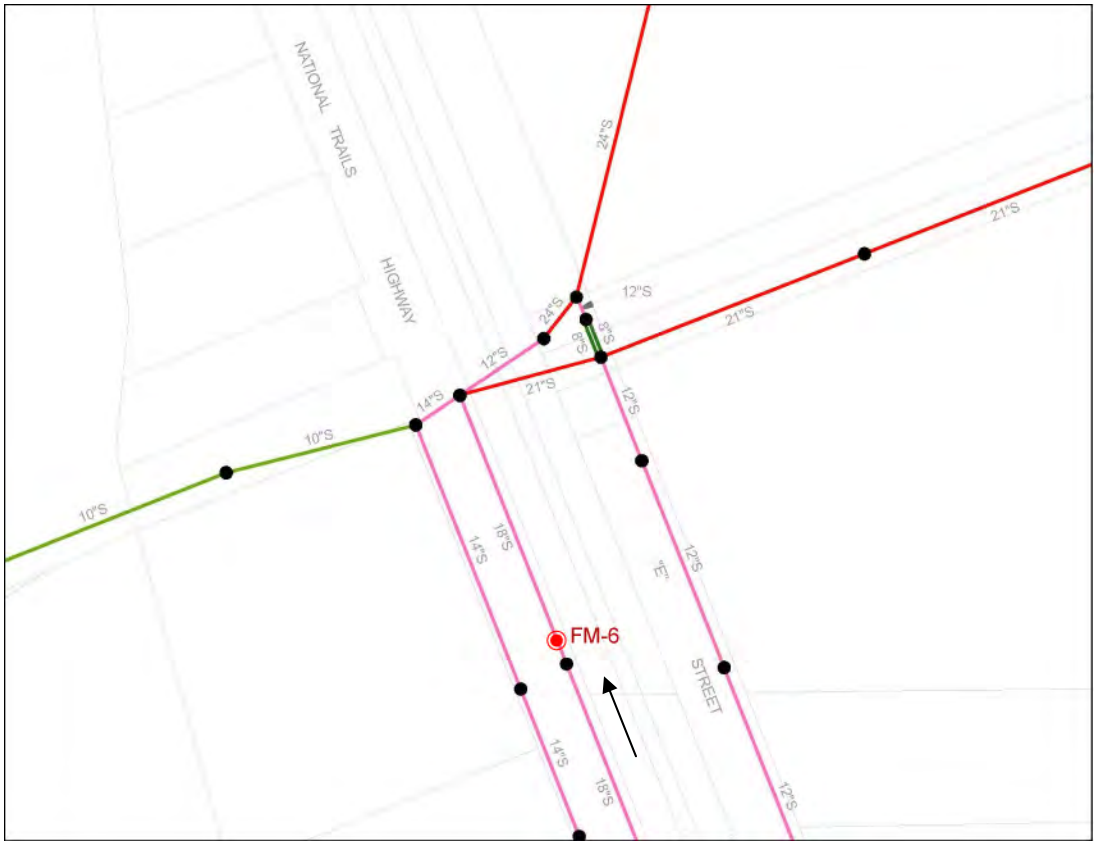
This meter, located near the intersection of 'E' St. and 3rd Ave, was placed just upstream of one of the City's connections to the VVWRA trunk. Conveyance pipes in Old Town are interconnected at several locations, diverting wastewater to one or more of the three trunks that discharge from this portion of the City. FM-5 measured flow in the 18-inch diameter 3rd St. bypass, which conveys a significant portion of the wastewater generated in the Old Town area.

Figure 3-8 Location of Flow Meter FM-5

Flow Meter FM-6

This meter was installed on 'D' St. near the I-15 overpass and measured wastewater in an 18-inch line just downstream of the commercial area of Old Town. The purpose of this meter was to isolate wastewater generated in the Old Town district. The intent was to subtract the wastewater volume measured by FM-5 and FM-6 from the volume measured at FM-8, thus isolating much of Old Town.

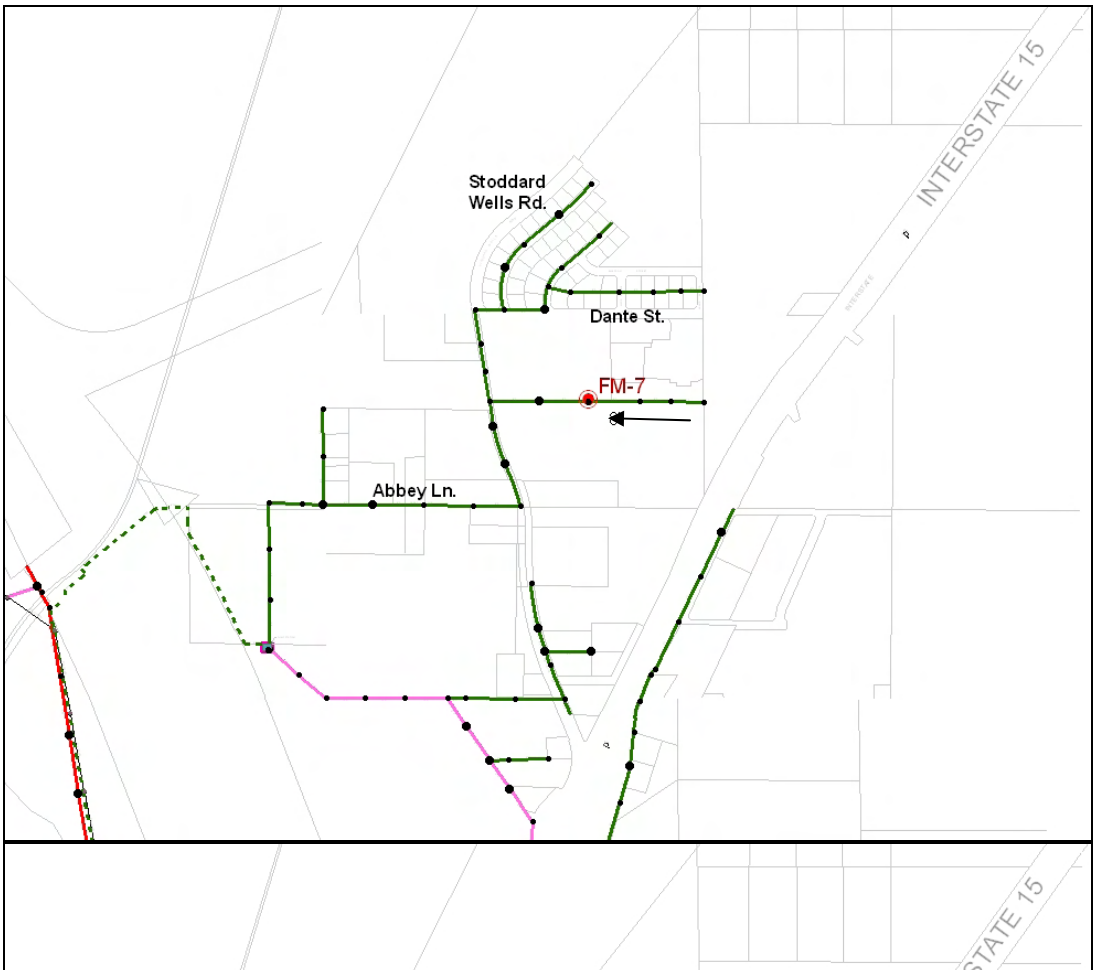
Figure 3-9 Location of Flow Meter FM-6



Flow Meter FM-7

This meter was installed in an 8-inch diameter main near the intersection of Dante St. and Stoddard Wells Rd. Only wastewater generated from multi–family residential land use is conveyed through this site. The depth of flow was quite low at this site and special equipment was required to avoid data lapse that can be caused by shallow depth and ragging.

Figure 3-10 Location of Flow Meter FM-7



Flow Meter FM-8

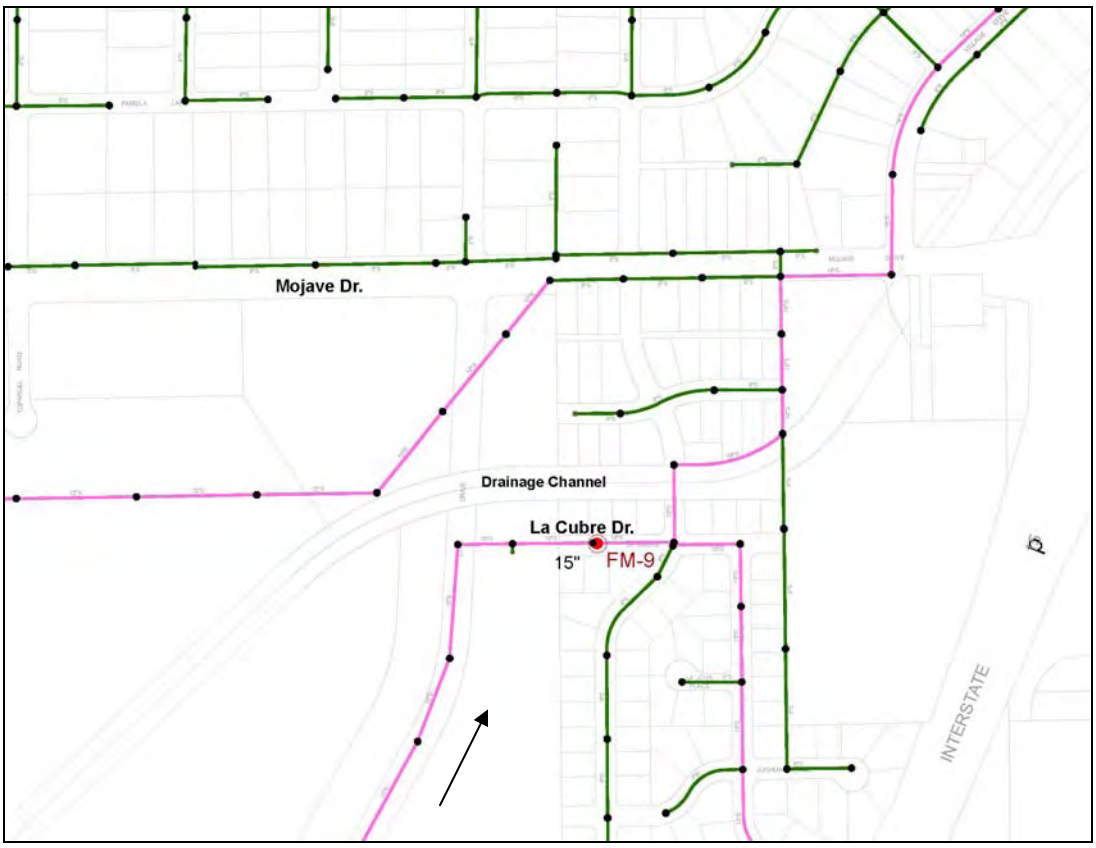
This meter was installed on 8th St. northeast of Forest Ave. and measured flows in an 18-inch line. The meter was sited just upstream of the commercial area of Old Town. The purpose of this meter was to isolate wastewater generated in the Old Town district. The intent was to subtract the wastewater volume measured by FM-5 and FM-6, which were downstream from the volume measured at FM-8, thus isolating much of Old Town.

Figure 3-11 Location of Flow Meter FM-8

Flow Meter FM-9

This meter was installed at the end of La Cubre Dr. and measured flows in an 18-inch line. This meter was located upstream of FM-4 and downstream of FM-11. It isolated wastewater generated in the central portion of the service area between these two meters.

Figure 3-12 Location of Flow Meter FM-9



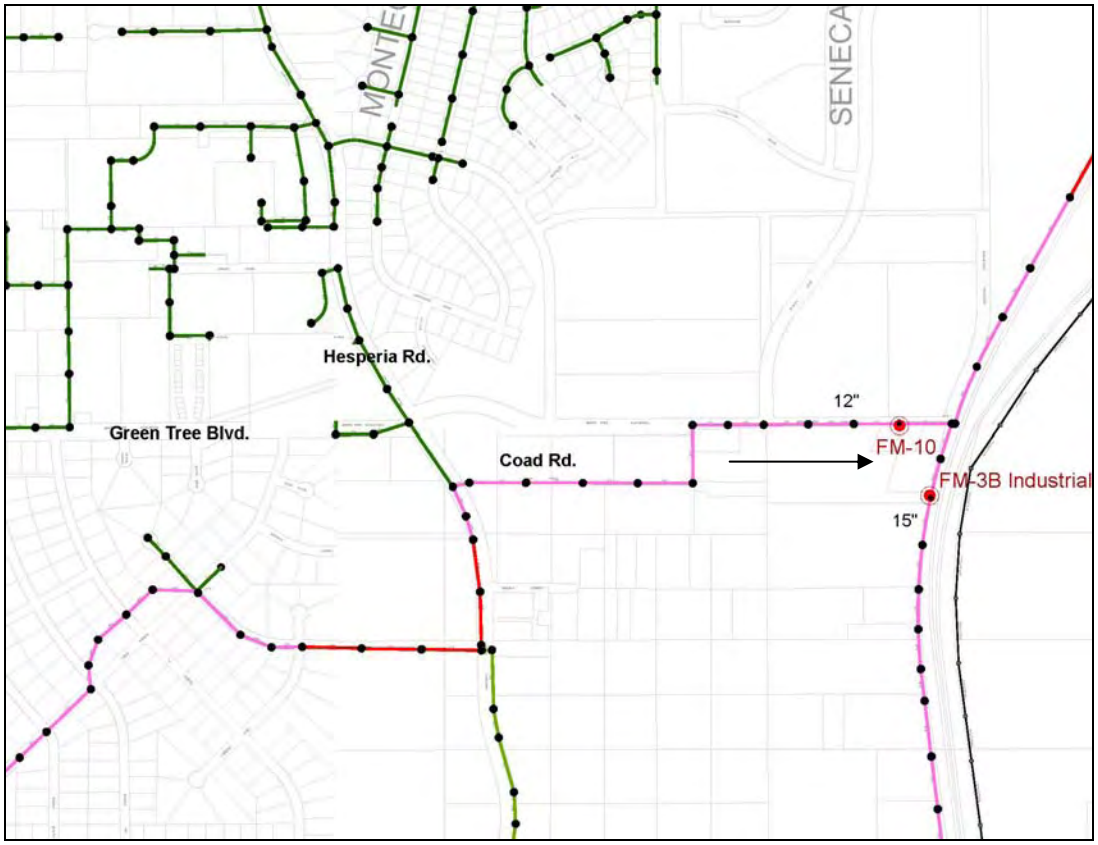
Flow Meter FM-10

This meter was installed near the eastern terminus of Coad Rd, east of Hesperia Rd. The site is also near the location of FM-3B Industrial, but measured flows in the 12-inch line under Coad Rd. The tributary area of FM-10 was dependant upon the operation of the 2-outlet manhole located at the intersection of 11th Ave. and Winona St. This

manhole has a diversion plug (sand trap) installed in the outlet to the north, effectively plugging it. When the plug is in place, as it currently is, flow is directed to the east along Winona St. When operating in this condition, the large area south of La Mesa Rd. and west of I-15 is tributary to FM-10.

If, however, the plug is removed and flows are directed to the north from the 11th and Winona manhole, the tributary area for FM-10 would become considerably smaller.

Figure 3-13 Location of Flow Meter FM-10



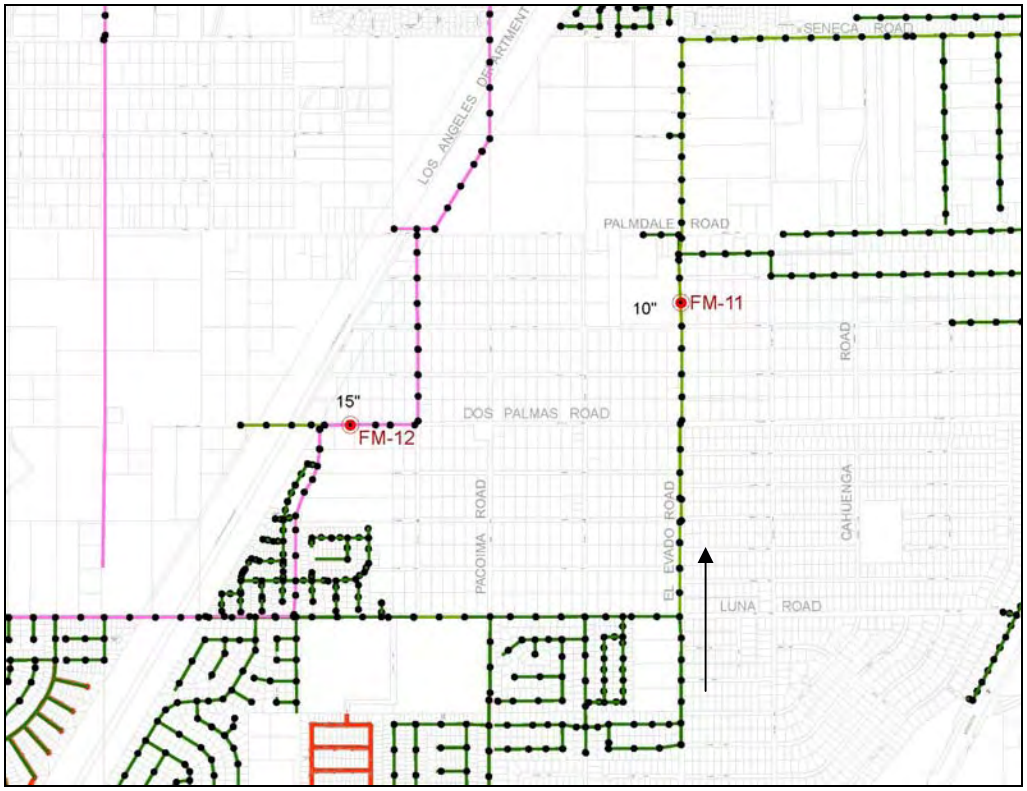
Flow Meter FM-11

This meter, installed at the intersection of Bonanza Rd. and Palmdale Rd., measured flows in a 10-inch line. The tributary area to FM-11 is a mix of older and new single family residential homes.

Flow Meter FM-12

This meter, installed on Dos Palmas Rd. east of Amethyst Rd. measured flows in a 12-inch line. The tributary area includes predominately new single family residential homes. A substantial portion of the new residential development occurring along the current western extremes of Luna Rd. and La Mesa Rd. was measured by this meter, allowing a good characterization of newly constructed single family residential development.

Figure 3-14 Location of Flow Meter FM-12



3.4.2.2 Land Use Types of Flow Metered Areas

Fourteen flow meter locations were utilized for the City of Victorville temporary flow monitoring program in October 2006. The meters measured the majority of the wastewater conveyed by the City conveyance system.

Each flow meter was located to measure flows from one or more land use. Table 3-1 shows the predominant land uses that were measured by each flow meter.

Table 3-1 Land Use Types for Each Flow Meter

Flow Meter	Predominant Land Use	Flow Meter	Predominant Land Use
FM-1	SFR	**FM-6**	SFR, MFR, C, I
FM-2	SFR	**FM-7**	MFR
FM-3	SFR	**FM-8**	SFR, C
FM-3A	C	**FM-9**	SFR, C
FM-3B	SFR, MFR, I	**FM-10**	SFR, C
FM-4	SFR, MFR, C	**FM-11**	SFR
FM-5	SFR, MFR, C, I	**FM-12**	SFR

Notes:
SFR = Single Family Residential
MFR = Multi Family Residential
C = Commercial
I = Industrial

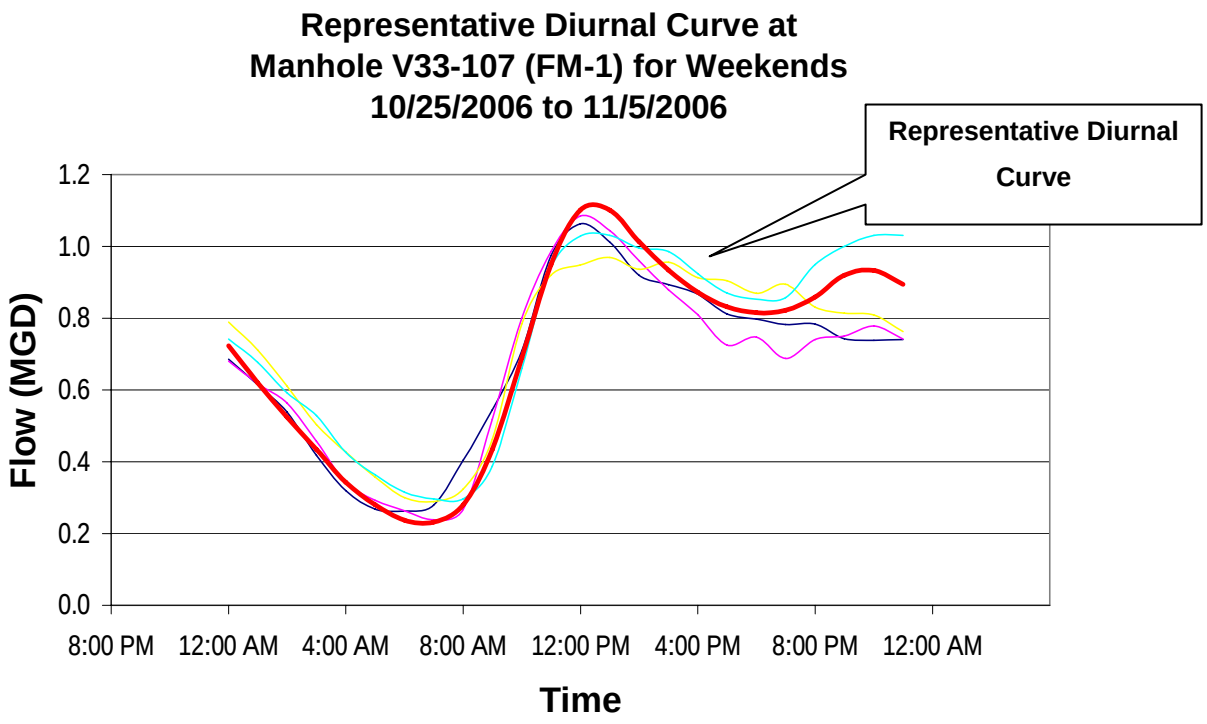
3.4.3 DEVELOPMENT OF DIURNAL FLOW FACTORS FOR EACH FLOW MONITORING LOCATION

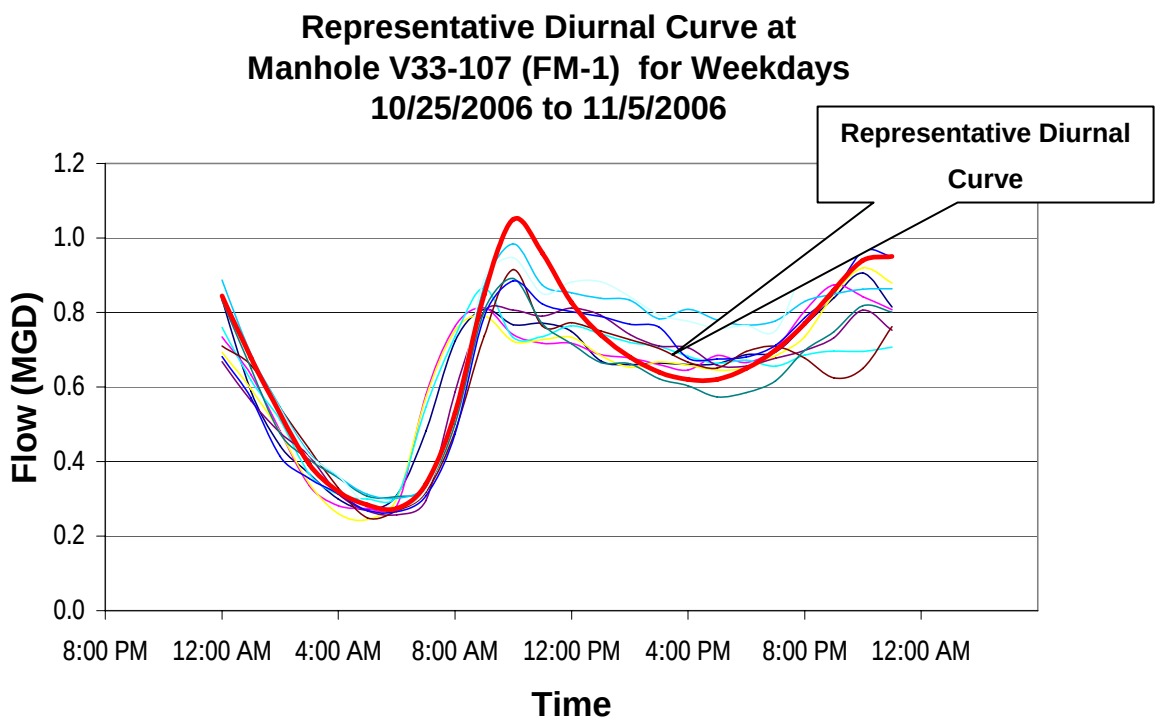
The flow monitoring locations were used as calibration points for the sewer hydraulic model. The recorded diurnal flows from two weeks of flow monitoring were used to develop a single representative diurnal curve for each flow monitoring location (separate representative curve for weekdays and weekends). The developed representative diurnal curve was used to calibrate the sewer hydraulic model. To develop a representative diurnal curve, the following key requirements are observed:

1. The general timing and the magnitude of the peaks are preserved
2. The overall shape of the diurnal flows must be preserved (rate of rise, rate of fall)
3. The full range of flows are covered
4. The volume of flow must be within 10% of the recorded average daily flow

For this study, a smooth representative curve that met the above criteria was hand-drawn for flow data collected at each flow meter in a manner to envelop the recorded flow peaks and troughs. As an example, Figure 3-15 illustrates the flow data and developed representative curves for data collected by flow meter FM-1, one for weekdays and one for weekends. Since the representative diurnal curve was used to calibrate the sewer hydraulic model, the representative diurnal curve is referred to as the “calibration diurnal curve”. The calibration diurnal curves for each of the flow monitoring locations are illustrated in the following sub-sections.

Figure 3-15 Representative Diurnal Curves for MH V33-107

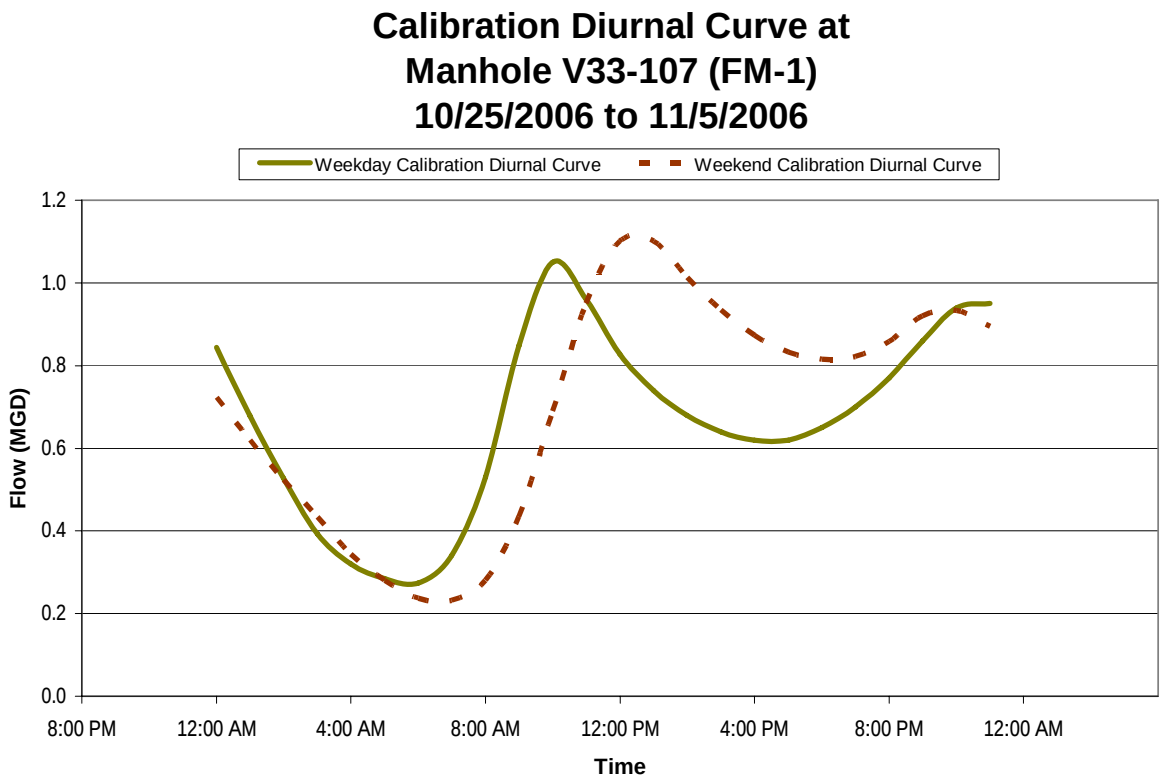




3.4.3.1 FM-1

Flow Meter ID:	FM-1
Manhole Name:	V33-107
Pipe Diameter (inches):	30
Daily Max. Volume (MG):	0.74
Daily Min. Volume (MG):	0.61
Daily Avg. Volume (MG):	0.66
Description of Pipe:	30" inlet from southwest
Predominant Land Use:	Residential

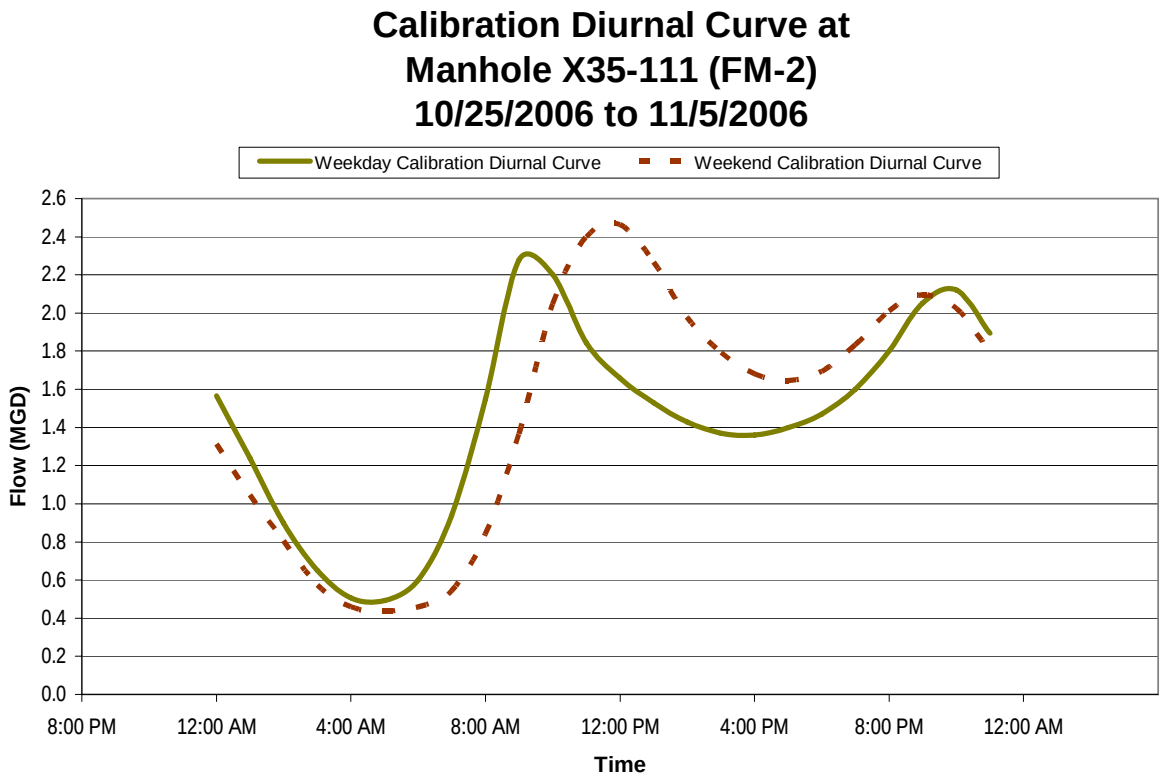
Figure 3-16 Calibration Diurnal Curves for Weekdays and Weekends at MH V33-107



3.4.3.2 FM-2

Flow Meter ID:	FM-2
Manhole Name:	X35-111
Pipe Diameter (inches):	15
Daily Max. Volume (MG):	1.54
Daily Min. Volume (MG):	1.30
Daily Avg. Volume (MG):	1.41
Description of Pipe:	15" inlet from south
Predominant Land Use:	Residential

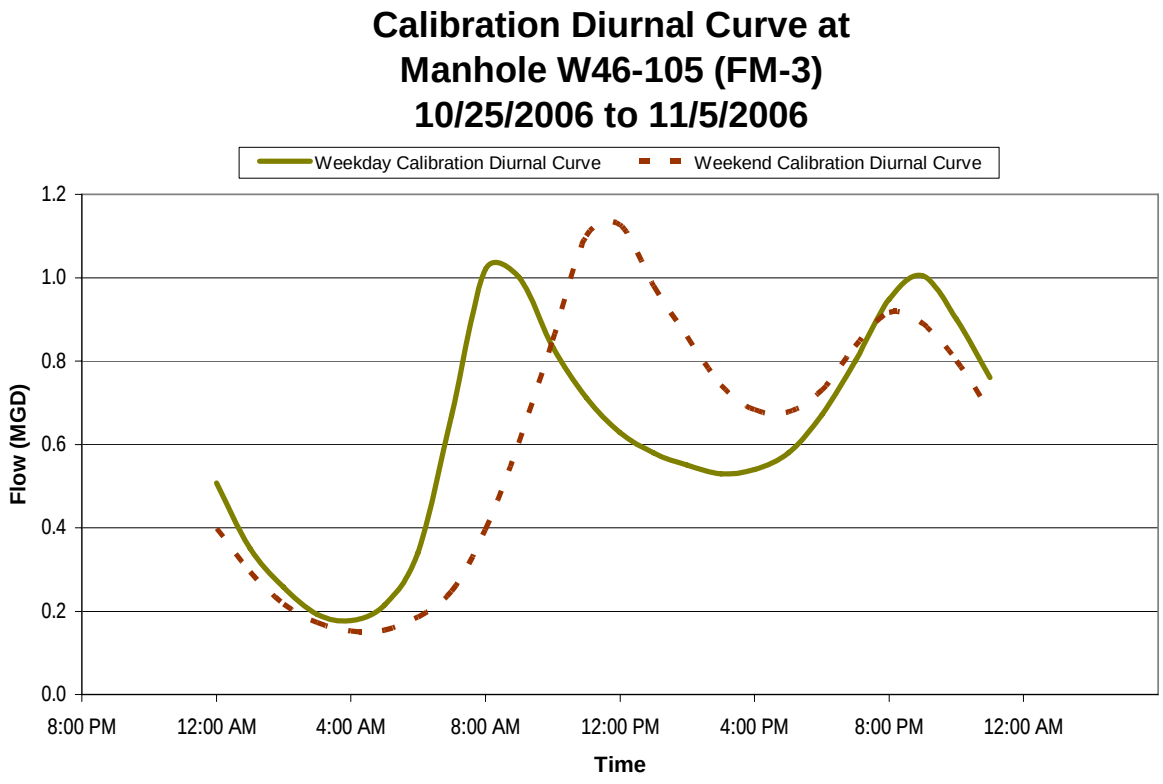
Figure 3-17 Calibration Diurnal Curves for Weekdays and Weekends at MH X35-111



3.4.3.3 FM-3

Flow Meter ID:	FM-3
Manhole Name:	W46-105
Pipe Diameter (inches):	15
Daily Max. Volume (MG):	0.63
Daily Min. Volume (MG):	0.53
Daily Avg. Volume (MG):	0.59
Description of Pipe:	15" inlet from east
Predominant Land Use:	Residential

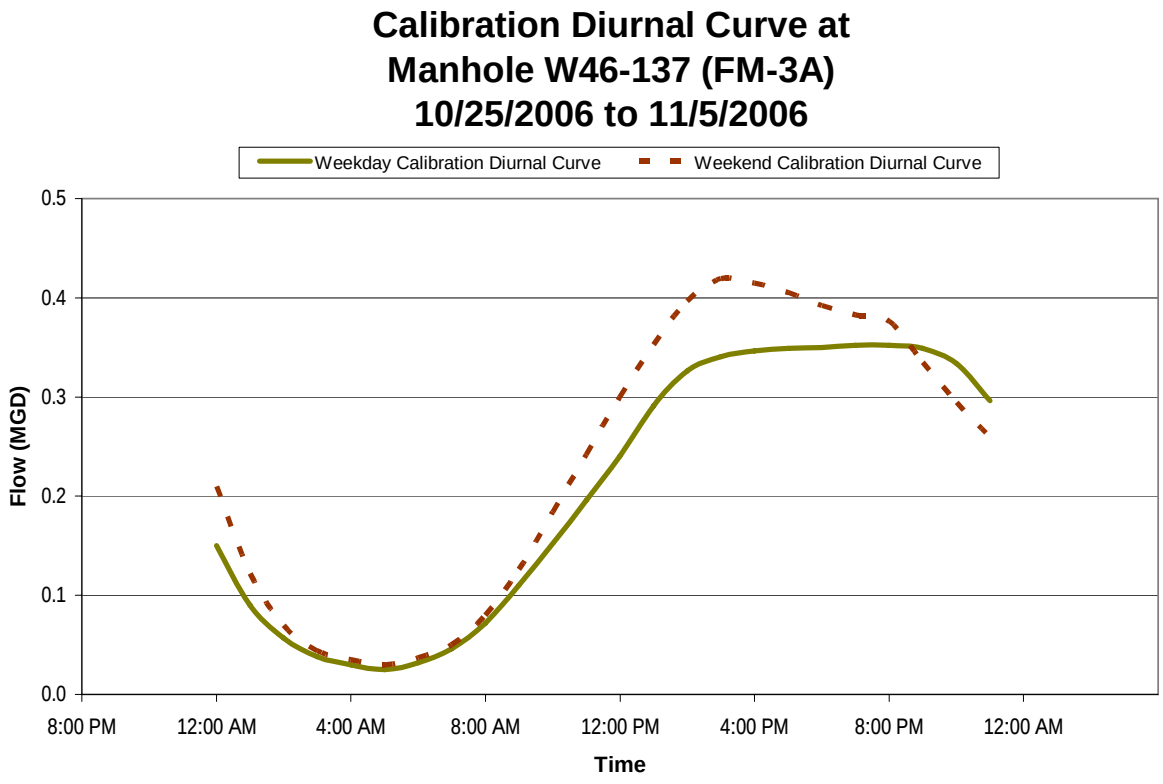
Figure 3-18 Calibration Diurnal Curves for Weekdays and Weekends at W46-105



3.4.3.4 FM-3A

Flow Meter ID:	FM-3A
Manhole Name:	W46-137
Pipe Diameter (inches):	10
Daily Max. Volume (MG):	0.23
Daily Min. Volume (MG):	0.18
Daily Avg. Volume (MG):	0.20
Description of Pipe:	10" inlet from Southwest
Predominant Land Use:	Commercial

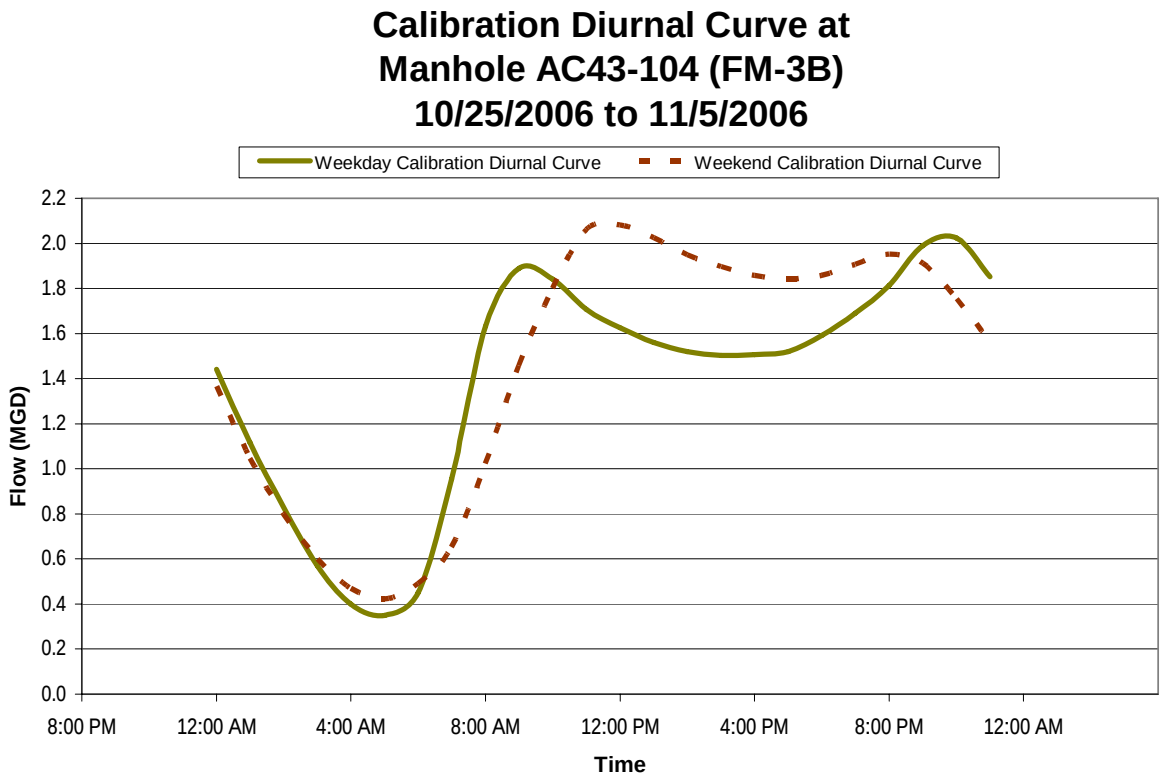
Figure 3-19 Calibration Diurnal Curves for Weekdays and Weekends at MH W46-137



3.4.3.5 FM-3B

Flow Meter ID:	FM-3B
Manhole Name:	AC43-104
Pipe Diameter (inches):	12
Daily Max. Volume (MG):	1.48
Daily Min. Volume (MG):	1.27
Daily Avg. Volume (MG):	1.38
Description of Pipe:	12" inlet from east
Predominant Land Use:	Commercial and Residential

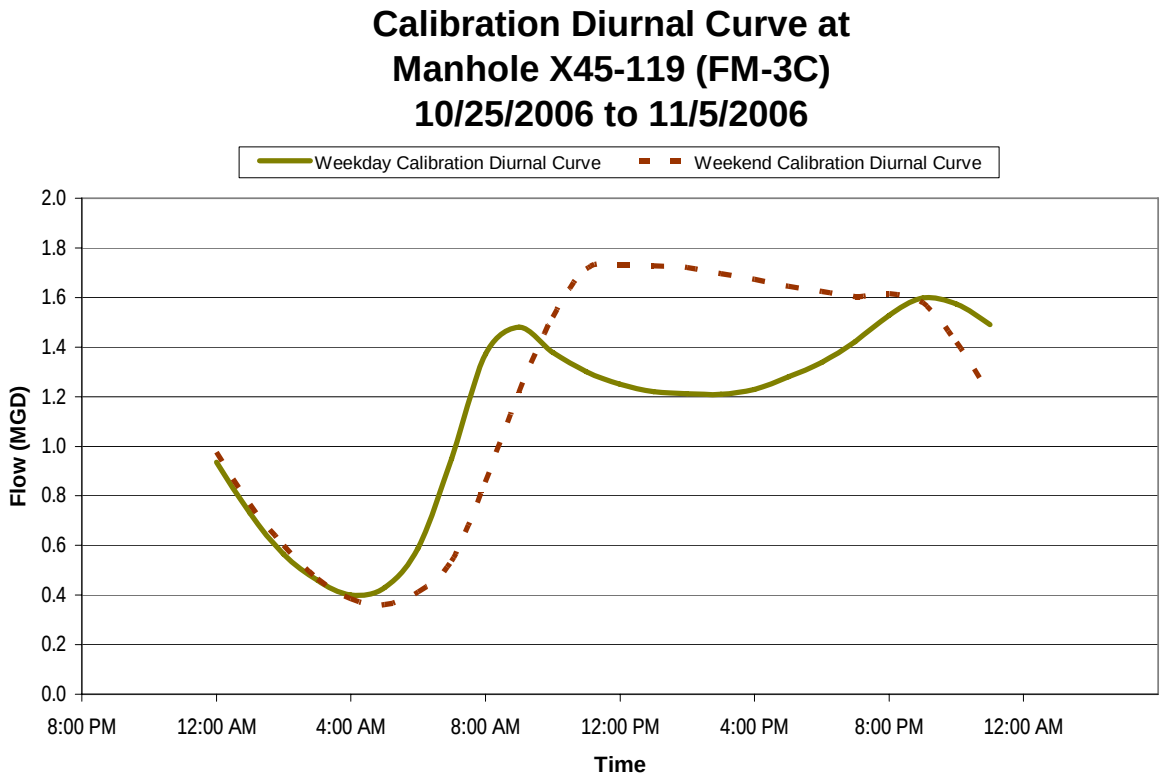
Figure 3-20 Calibration Diurnal Curves for Weekdays and Weekends at MH AC43-104



3.4.3.6 FM-3C

Flow Meter ID:	FM-3C
Manhole Name:	X45-119
Pipe Diameter (inches):	12
Daily Max. Volume (MG):	1.22
Daily Min. Volume (MG):	1.05
Daily Avg. Volume (MG):	1.12
Description of Pipe:	12" inlet from west
Predominant Land Use:	Commercial and Residential

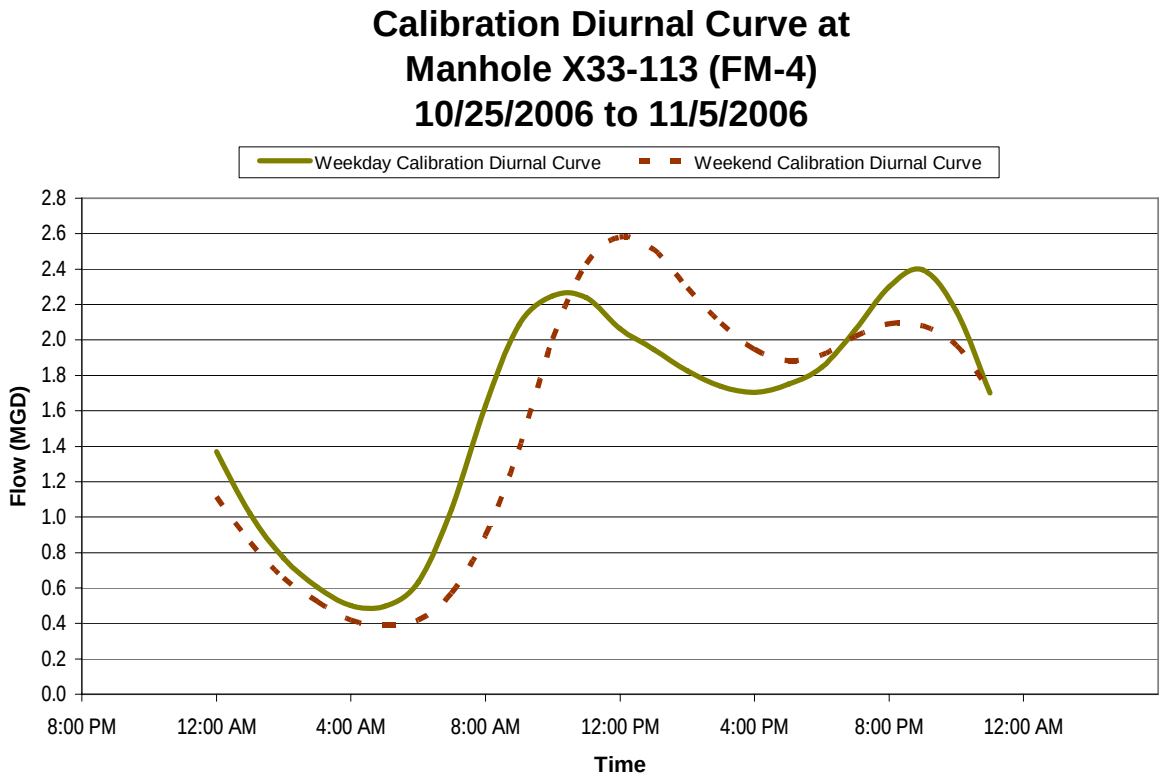
Figure 3-21 Calibration Diurnal Curves for Weekdays and Weekends at MH X45-119



3.4.3.7 FM-4

Flow Meter ID:	FM-4
Manhole Name:	X33-113
Pipe Diameter (inches):	15
Daily Max. Volume (MG):	1.64
Daily Min. Volume (MG):	1.46
Daily Avg. Volume (MG):	1.54
Description of Pipe:	15" inlet from south
Predominant Land Use:	Commercial and Residential

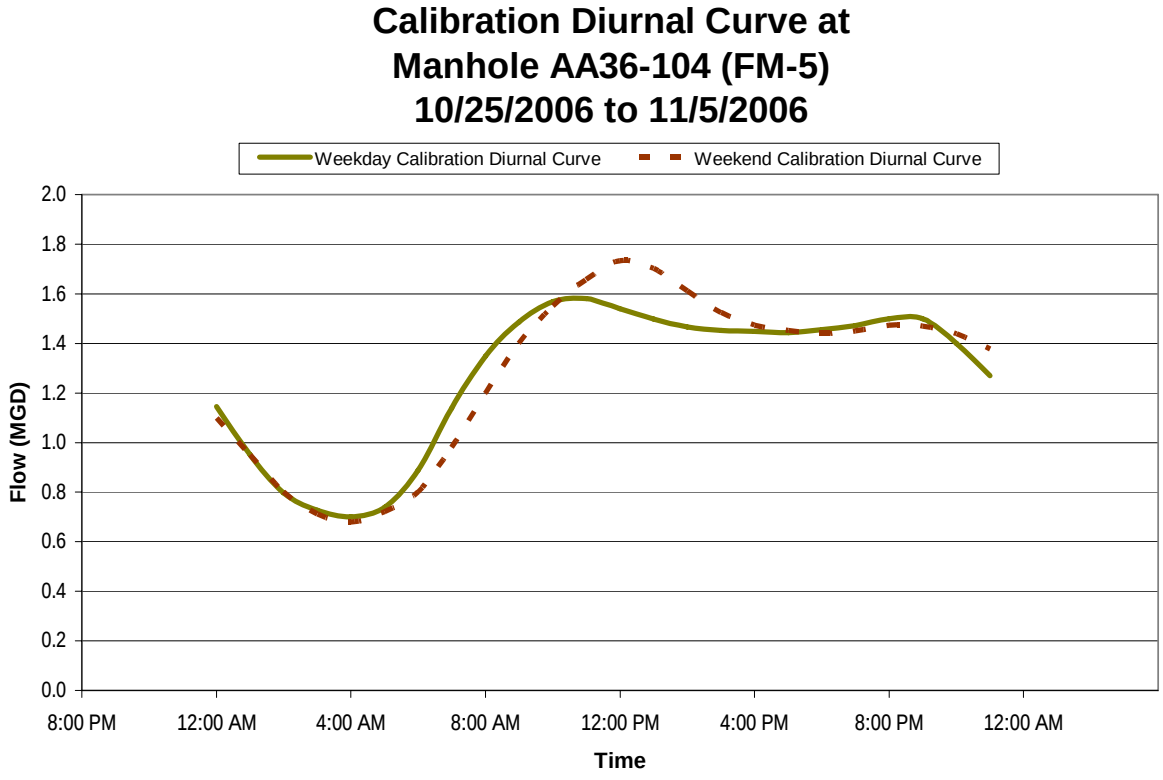
Figure 3-22 Calibration Diurnal Curves for Weekdays and Weekends at MH X33-107



3.4.3.8 FM-5

Flow Meter ID:	FM-5
Manhole Name:	AA36-104
Pipe Diameter (inches):	24
Daily Max. Volume (MG):	1.43
Daily Min. Volume (MG):	1.17
Daily Avg. Volume (MG):	1.25
Description of Pipe:	24" inlet from southwest
Predominant Land Use:	Commercial

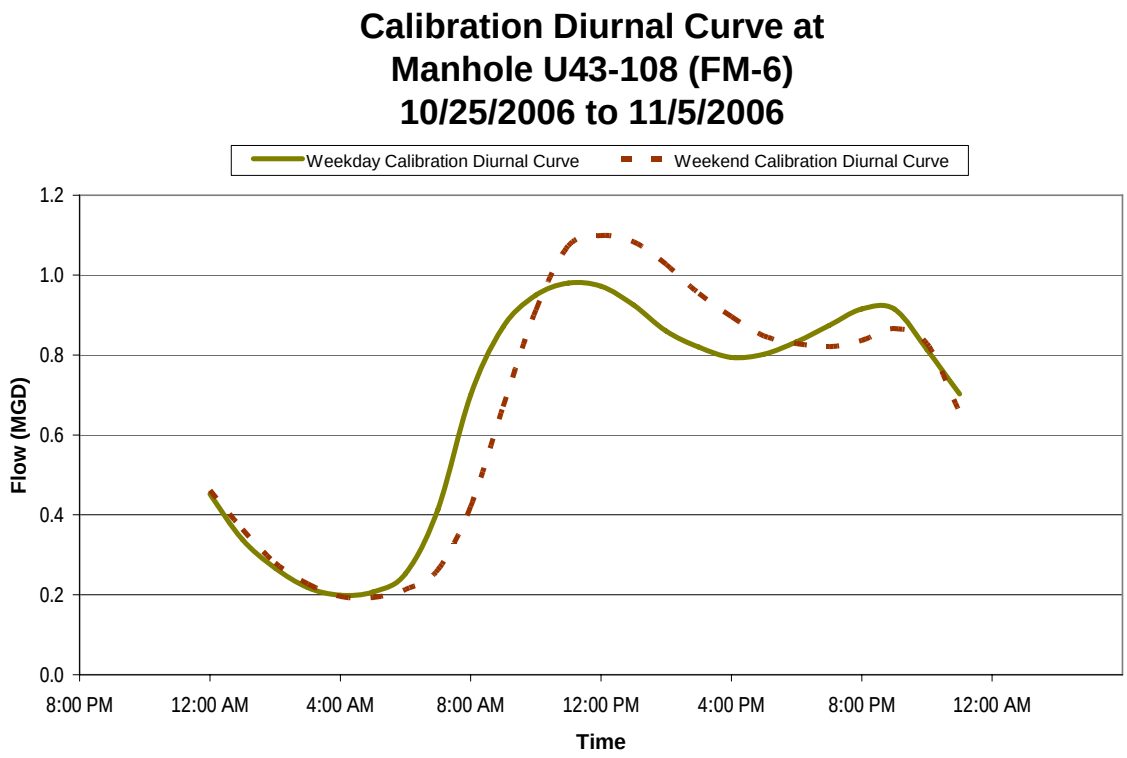
Figure 3-23 Calibration Diurnal Curves for Weekdays and Weekends at MH AA36-104



3.4.3.9 FM-6

Flow Meter ID:	FM-6
Manhole Name:	U43-108
Pipe Diameter (inches):	18
Daily Max. Volume (MG):	0.69
Daily Min. Volume (MG):	0.57
Daily Avg. Volume (MG):	0.64
Description of Pipe:	18" inlet from southeast
Predominant Land Use:	Commercial
Target Land Use:	

Figure 3-24 Calibration Diurnal Curves for Weekdays and Weekends at MH U43-108



3.4.3.10 FM-7

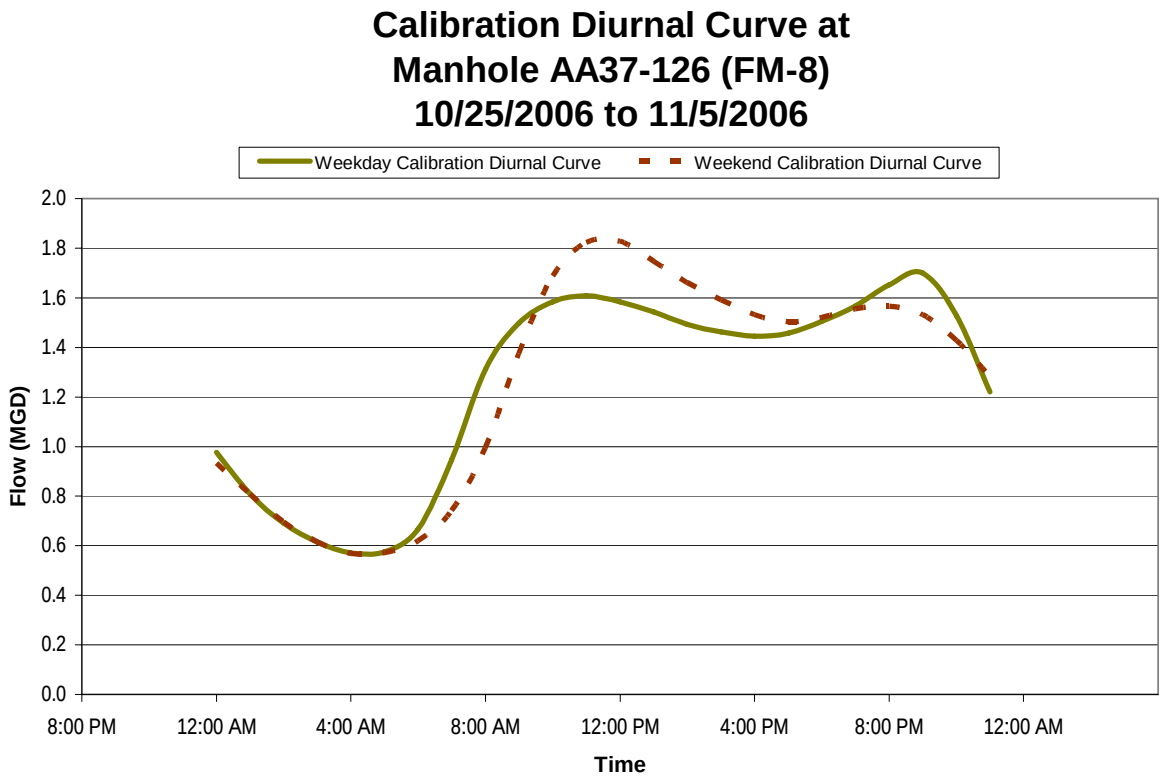
Flow Meter ID:	FM-7
Manhole Name:	AB32-105
Pipe Diameter (inches):	8
Daily Max. Volume (MG):	0.02
Daily Min. Volume (MG):	0.003
Daily Avg. Volume (MG):	0.01
Description of Pipe:	8" inlet from West
Predominant Land Use:	Residential

FM-7 collected flow measurements that fluctuated significantly due to low flow, therefore, diurnal curves were not generated for FM-7.

3.4.3.11 FM-8

Flow Meter ID:	FM-8
Manhole Name:	AA37-126
Pipe Diameter (inches):	18
Daily Max. Volume (MG):	1.31
Daily Min. Volume (MG):	1.17
Daily Avg. Volume (MG):	1.22
Description of Pipe:	18" inlet from southwest
Predominant Land Use:	Commercial

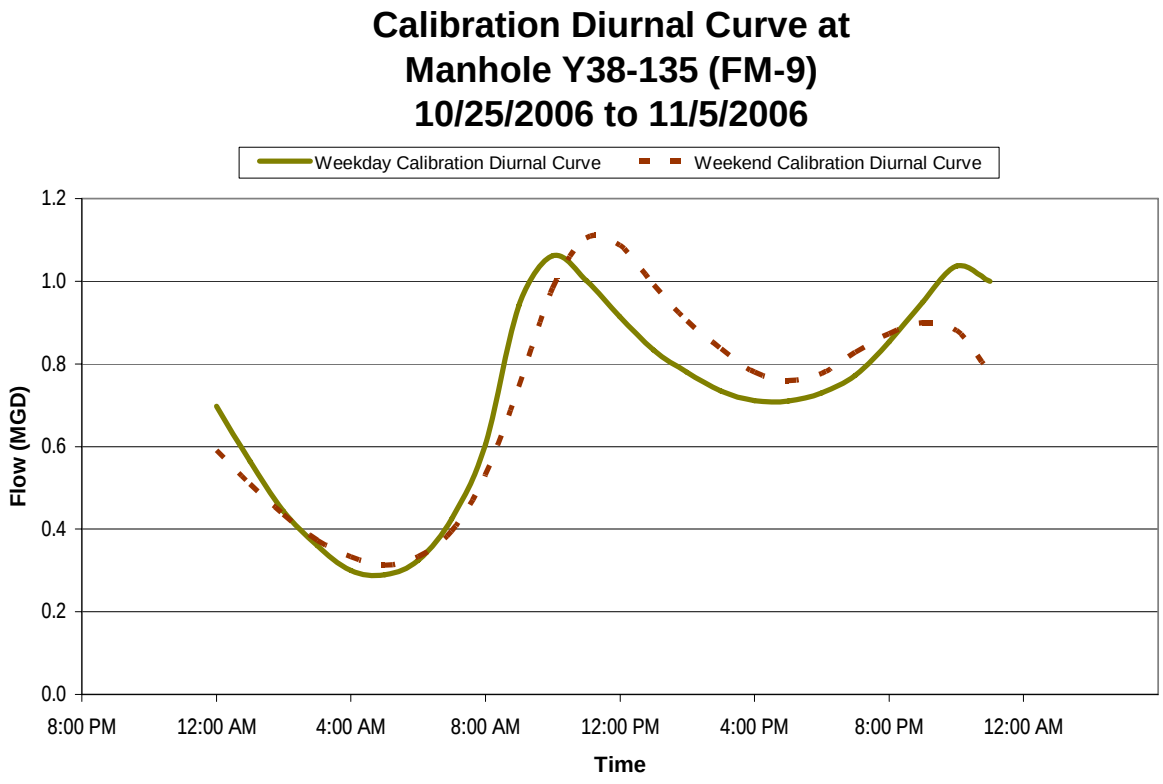
Figure 3-25 Calibration Diurnal Curves for Weekdays and Weekends at MH AA37-126



3.4.3.12 FM-9

Flow Meter ID:	FM-9
Manhole Name:	Y38-135
Pipe Diameter (inches):	15
Daily Max. Volume (MG):	0.75
Daily Min. Volume (MG):	0.64
Daily Avg. Volume (MG):	0.69
Description of Pipe:	15" inlet from East
Predominant Land Use:	Commercial and Residential

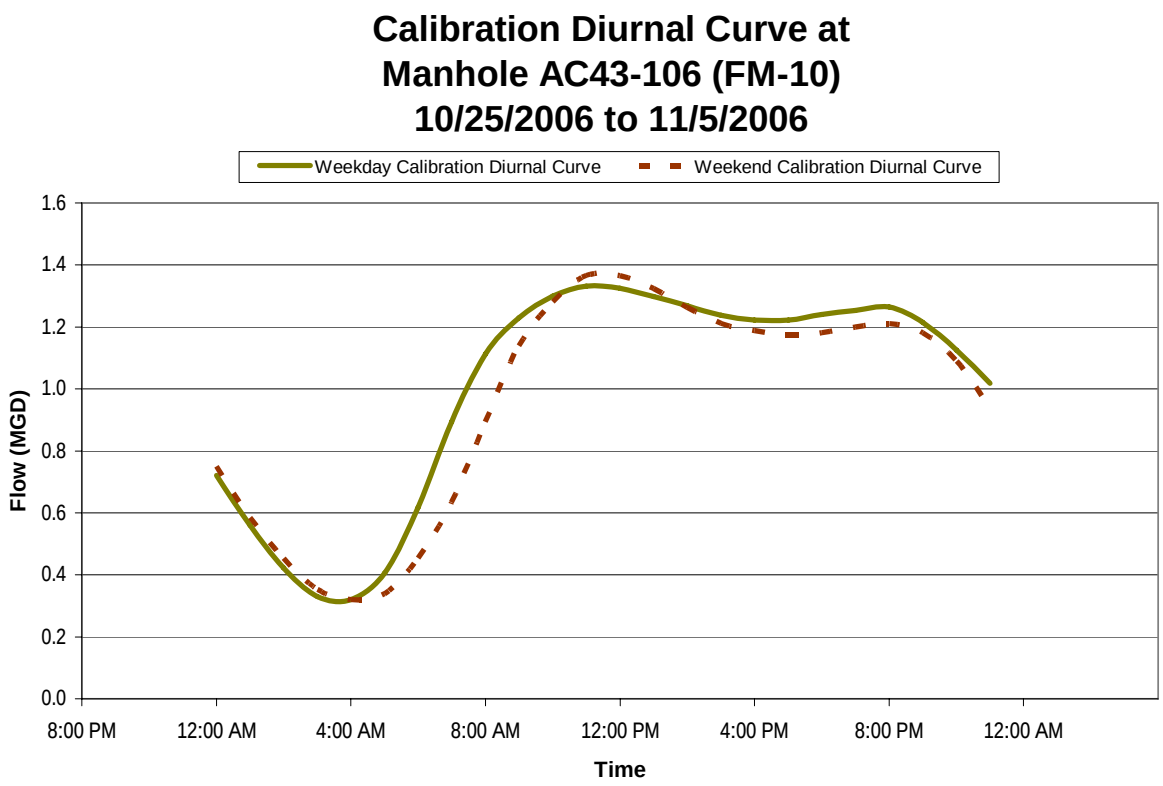
Figure 3-26 Calibration Diurnal Curves for Weekdays and Weekends at MH Y38-135



3.4.3.13 FM-10

Flow Meter ID:	FM-10
Manhole Name:	AC43-106
Pipe Diameter (inches):	15
Daily Max. Volume (MG):	1.01
Daily Min. Volume (MG):	0.88
Daily Avg. Volume (MG):	0.95
Description of Pipe:	15" inlet from South
Predominant Land Use:	Commercial

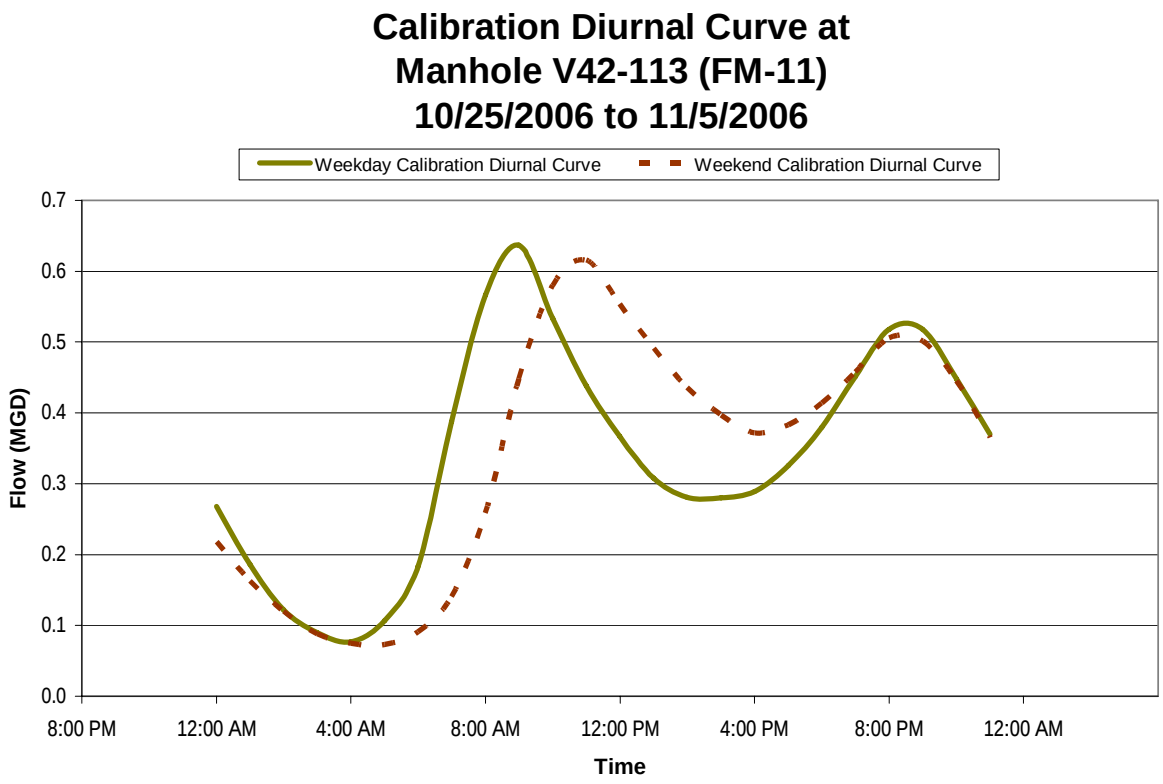
Figure 3-27 Calibration Diurnal Curves for Weekdays and Weekends at MH AC43-106



3.4.3.14 FM-11

Flow Meter ID:	FM-11
Manhole Name:	V42-113
Pipe Diameter (inches):	10
Daily Max. Volume (MG):	0.36
Daily Min. Volume (MG):	0.30
Daily Avg. Volume (MG):	0.32
Description of Pipe:	10" inlet from South
Predominant Land Use:	Residential

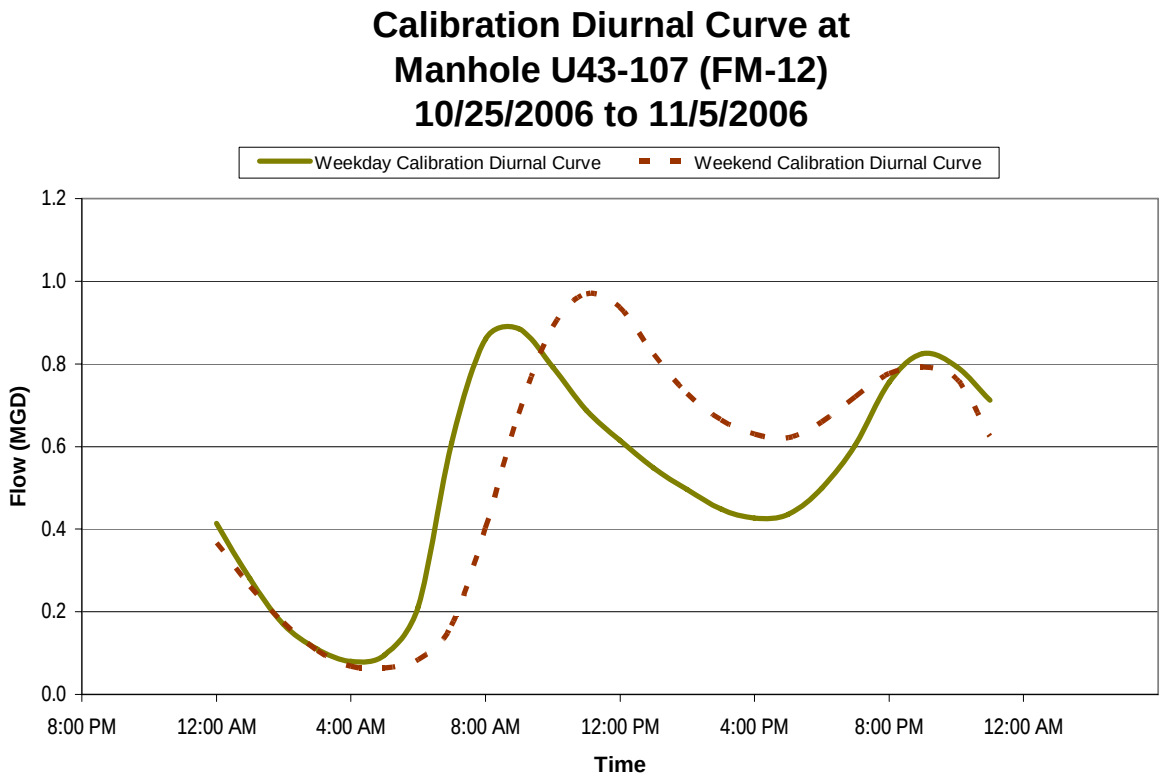
Figure 3-28 Calibration Diurnal Curves for Weekdays and Weekends at V42-113



3.4.3.15 FM-12

Flow Meter ID:	FM-12
Manhole Name:	U43-107
Pipe Diameter (inches):	15
Daily Max. Volume (MG):	0.54
Daily Min. Volume (MG):	0.45
Daily Avg. Volume (MG):	0.49
Description of Pipe:	15" inlet from East
Predominant Land Use:	Residential

Figure 3-29 Calibration Diurnal Curves for Weekdays and Weekends at MH U43-107



3.5 DEMAND FOR PLANNING HORIZONS

Wastewater flows were estimated for planning horizons 2014 and 2030. The projected population for each planning area was used to calculate demand using VVWRA flow generation factors presented in Table 2-5.

The projected population for planning horizons 2014 and 2030 by planning area is provided in Tables 2-3 and 2-4, respectively. Estimated average daily wastewater flows for years 2014 and 2030 are summarized in Tables 3-2 and 3-3, respectively.

Table 3-2 Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2014

Planning Area	Average Daily Wastewater Flow (MGD)	
	Residential	Commercial
Baldy Mesa	1,280	51
Central City	978	190
East Bear Valley	739	190
Golden Triangle	288	50
North Mojave	234	93
SCLA	38	208
Spring Valley Lake	0	0
West City	1,989	172
West Bear Valley	1,546	118
Northern Sphere Proposed Expansion	1,348	95
Outside Victorville Sphere of Influence	47	0
TOTAL	**8,487**	**1,167**

Notes: Residential includes Single Family Dwelling Units (SDU) and Multi-Family Dwelling Unit (MDU)
Commercial includes Retail Employees (RET) and Non-Retail Employee (NRET)

Table 3-3 Projected Residential and Commercial Average Daily Wastewater Flow by Planning Area, Year 2030

Planning Area	Average Daily Wastewater Flow (MGD)	
	Residential	Commercial
Baldy Mesa	3,316	140
Central City	1,075	204
East Bear Valley	930	239
Golden Triangle	707	105
North Mojave	551	235
SCLA	82	451
Spring Valley Lake	0	0
West City	3,350	279
West Bear Valley	1,851	167
Northern Sphere Proposed Expansion	3,744	264
Outside Victorville Sphere of Influence	130	0
TOTAL	**15,736**	**2,084**

Notes: Residential includes Single Family Dwelling Units (SDU) and Multi-Family Dwelling Unit (MDU)
Commercial includes Retail Employees (RET) and Non-Retail Employee (NRET)

CHAPTER 4 SEWER MODEL

4.1 INTRODUCTION AND OBJECTIVES

The purpose of the hydraulic model was to identify hydraulic deficiencies of the sewer collection system, and to analyze the impact of future population growth on the system. The hydraulic evaluation was performed for current conditions (year 2006) and future conditions (years 2014 and 2030). A Capital Improvement Program was developed based on deficiencies identified in the hydraulic evaluation.

4.2 MODEL CONSTRUCTION

The City's existing wastewater collection system, including pipe data and manhole data was constructed in the hydraulic model from GIS-converted as-builts. The as-builts pertaining to the wastewater collection system were digitized to GIS data by Nobel Systems, Inc. The wastewater collection system as-built data was evaluated for data gaps and completeness (Chapter 3). Missing data (i.e. pipe inverts and missing manhole rim elevations) were resolved by interpolating nearby available data of pipe invert and manhole rim elevation. To facilitate data processing, the most upstream 8-inch laterals were eliminated from the existing wastewater collection network, thus modeling the network of mainlines and trunks. This reduction in the modeled wastewater collection network does not have a significant impact on the flow conditions in the mainline and trunks, and the error caused is within the inaccuracies of the hydraulic model. Once the pipe and manhole network were finalized, the model was loaded based on calculated wastewater flows from the population data.

The TAZ boundary area and the socio-economic data, both supplied by the City, provided the number residential and commercial units within the study area. The wastewater flows were computed from the population data and the VVWRA's wastewater generation factors of 80 gpcd (for residential units) and 35 gallons per day per employee (for commercial units). The City provided a density factor of 2.94 people per EDU. The 2.94 people per EDU was multiplied by 80 gpcd to result in an equivalent dwelling unit flow of 235 gallons per EDU per day.

The manhole loading process involved dividing the City boundary into smaller catchments, calculating generated wastewater from each catchment, and loading the generated wastewater flow from each catchment into the nearest manhole. To calibrate the model using flow monitoring data, the manhole loading values were adjusted. A detailed calibration process is discussed in Section 4.3.

4.3 CALIBRATION AND VERIFICATION

4.3.1 BASE LOADING FROM PREPARED TAZ DATA

Loading of the hydraulic model was performed based on residential and commercial loads. These loads were derived based on 2005 TAZ data on a per-manhole basis as shown in Tables 4-1 and 4-2. In Table 4-1, the manhole to receive the load is identified in the first column. The associated TAZ number is presented in the second column. Finally, the number of EDUs for single family dwellings and multi-family dwellings are presented in the “2005_SDU” and “2005_MDU” columns, respectively.

Table 4-1 Sample Residential Loading Source Data

MH_ID	TAZ	2005_SDU	2005_MDU
AA32-112-M	12	10	0
AA32-112-M	0	4	0
AA36-121-M	49	68	0
AA36-126-M	50	16	26
AA36-158-M	61	15	85
AA37-109-M	0	9	0
AA37-117-M	60	35	60
AA37-118-M	52	0	13
AA37-122-M	0	2	0
AA38-113-M	57	5	135
AA38-113-M	92	22	0
AA38-141-M	91	60	0
AA38-159-M	90	222	0
AA39-114-M	96	0	0
AA39-127-M	97	0	0
AA39-134-M	98	0	0
AA39-134-M	98	0	0
AA40-117-M	95	0	0
AA40-118-M	127	0	254
AA41-148-M	129	0	25
AA41-148-M	129	0	0
AA42-107-M	129	0	50
AA42-128-M	128	0	0
AA42-133-M	129	0	25
AA42-134-M	129	0	100

In Table 4-2, the manhole to receive the load is identified in the first column. The associated TAZ number is presented in the second column. Finally, the employee population for Retail business and Non-Retail businesses are presented in the "2005RETPOP" and "2005NRTPOP" columns, respectively.

Table 4-2 Sample Commercial Loading Source Data

MH_ID_ET	TAZ_NO	2005RETPOP	2005NRTPOP
AA32-103-M	0	0	8
AA36-158-M	0	65	125
AA36-164-M	0	0	3
AA37-113-M	60	110	110
AA37-122-M	53	60	0
AA37-141-M	55	0	10
AA38-100-M	58	40	0
AA38-113-M	54	0	5
AA38-118-M	59	110	110
AA38-119-M	57	4	0
AA38-150-M	90	60	0
AA38-151-M	92	60	0
AA39-121-M	96	910	130
AA40-104-M	94	10	5
AA40-114-M	95	45	30
AA40-131-M	127	15	10
AA41-145-M	128	20	100
AA42-133-M	129	415	100
AA46-158-M	0	0	975
AA47-106-M	0	0	60
AA48-100-M	214	0	15
AA48-107-M	0	2080	200
AB33-104-M	0	0	7
AB35-108-M	0	0	60
AB37-117-M	93	98	0

These loading data were imported into the Manhole Information tables using the Exchange/Import feature of H2OMAP Sewer. The manhole ID was the common identifier used to assign the loading information to the proper model manhole. SDU, MDU, RET, and NRET data were imported to the 2005_MDU, 2005_SDU, 2005RETPOP, and 2005NRTPOP fields, respectively. These numbers served as the foundation for calculating the base sewer load at each manhole.

Counts of dwelling units were converted to residential population using a conversion factor of 2.94 persons/dwelling unit for both SDU and MDU loads. These numbers were stored in the 05_SDU_POP and 05_MDU_POP fields in the Manhole Information tables. The actual residential load (in gallons per minute) was calculated using a conversion factor of 80 gallons per capita-day, and 1440 minutes per day to yield

gallons per minute. These residential loads were stored in the 05_SDULD and 05_MDULD fields in the Manhole Information tables.

The commercial population was converted to commercial flow using a conversion factor of 35 gallons per capita-day, and 1440 minutes per day to yield gallons per minute. These commercial loads were stored in the 05_RET_LD and 05_NRET_LD fields in the Manhole Information tables.

These loads were copied into the manhole loading tables, to the BASE loading data set. SDU loads were copied to the LOAD1 field, MDU to the LOAD2 field, RET to the LOAD3 field, and NRET to the LOAD4 field.

4.3.2 ADDITIONAL LOADS

A separate database was developed for hospital and industrial loads, which contained the estimated loading of wastewater produced in gallons per day and identified the nearest manhole to the hospital or industrial site. Industrial wastewater loads were estimated based on water demand data provided by the City of Victorville. The wastewater load for each industrial connection was converted into gallons per minute and loaded into the LAOD4 (NRET) field in the model at the manhole located nearest to the actual point of connection.

Wastewater flow data for the VVWRA interceptor was not available. It should be noted that hydraulic analysis of the interceptor was outside the scope of this investigation. Because data was not available, wastewater flows that are generated in communities outside the City of Victorville sphere of influence were not represented in the model and therefore their flows are not characterized in the VVWRA interceptor. A key assumption in model construction and flow loading is that the VWRA interceptor has adequate capacity to convey all the wastewater it needs to convey without backing up into the Victorville sewer system.

4.3.3 EPS CALIBRATION

Flow monitoring data was collected at fourteen locations throughout the collection system between October 24, 2006, and November 6, 2006, as discussed in Section 3.4.

The extended period simulation (EPS) calibration matched the model's performance to a "target" 24-hour period during the time of flow meter data collection.

First, the data were inspected to ensure that there were no anomalies and that the data provided would form a sound target for calibration. In general, the flow monitoring data was of a very high quality, and demonstrated a high degree of predictability and repeatability. Flow monitoring location FM-7 captured flows from a relatively small population, and at times it appears the flows were below the threshold of the monitoring equipment. Therefore, data from this location may need special consideration.

Upon analysis of the complete set of flow monitoring data, November 5, 2006, was selected as a characteristic "high load" day. That is, this 24-hour period demonstrated the greatest number of high average daily flows across all flow meter locations. Therefore, November 5, 2006, was selected as the calibration target day. The locations of the fourteen flow meters are shown on Figure 3-1.

4.3.4 BASELINE CALIBRATION FOR AVERAGE FLOWS

In order to preserve the original model loading, a copy of the BASE loads was made. This copy was adjusted to achieve EPS calibration. A new scenario was created and named 2006_CALIBRATION. The copied loading set was named 2006_PDWF and associated with the 2006_CALIBRATION scenario.

It was determined that the TAZ-based loading had yielded a commercial population that was very close to the current estimated commercial population. Therefore, no additional adjustments were necessary to the commercial loads. Only the SDU and MDU loads (in the LOAD1 and LOAD2 manhole loading fields, respectively) would be scaled in order to achieve calibration at the flow meter locations for the target calibration day.

The first step to achieve model calibration was to compare the average flows at each flow meter location for the November 5, 2006, calibration day to the average model flows. By dividing the average model flow into the average field flow, a residential load adjustment factor was developed for each flow meter area. For areas whose flows were only collected at a single flow meter location, this direct approach worked well.

These included areas whose flows were recorded at flow meters FM-1, FM-2, FM-3, FM-3A, FM-7, FM-10, FM-11, and FM-12.

For areas whose flows were captured by more than one flow meter, the adjustment factor was calculated so as to only adjust the residential loads between the flow meters of interest and the next upstream flow meter. Using this approach, loads were able to be adjusted at each manhole so that the average model flow matched the average flow meter flow at every flow meter location to within 1 percent.

4.3.5 CALIBRATION TO MATCH DIURNAL VARYING FLOWS

Once the average model flows matched the average field flows, the next step was to derive diurnal patterns for the different land uses. A residential diurnal curve and a commercial diurnal curve were generated based on the available flow meter data.

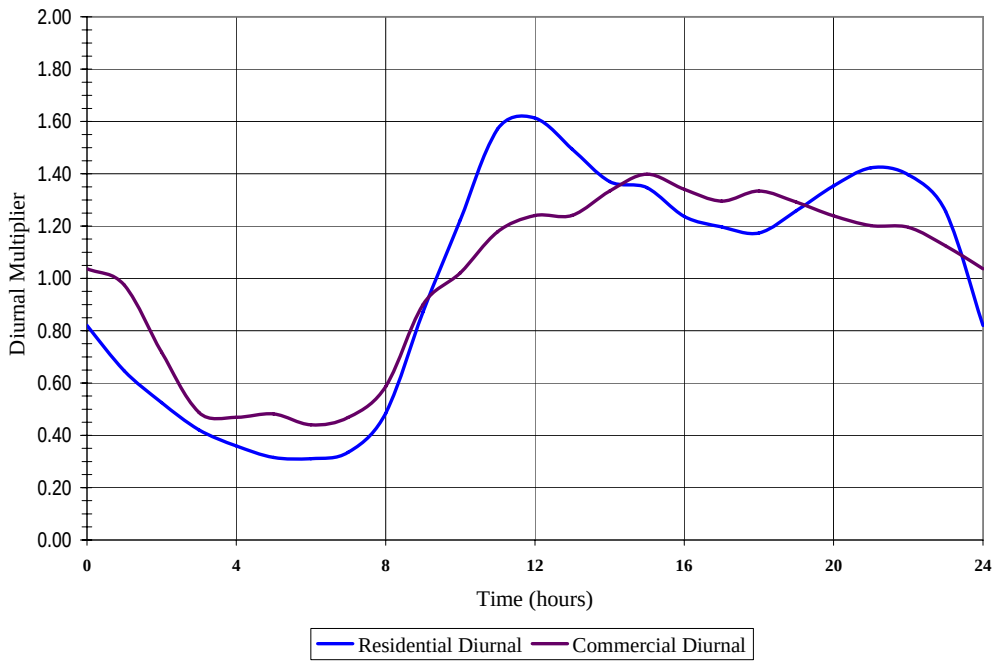
Flow meters FM-1, FM-2, FM-3, FM-11, and FM-12 captured flows from areas which were primarily residential. Therefore, the flow patterns from these meters on the November 5, 2006, calibration target day were used to derive a representative residential diurnal curve. Likewise, flow meters FM-3A, FM-5, and FM-8 captured flows from areas which were primarily commercial. Therefore, the flow patterns from these meters on the November 5, 2006, calibration target day were used to derive a representative commercial diurnal curve.

These diurnal patterns were titled RESID_DIURNAL and COMM_DIURNAL, respectively in the hydraulic model. All residential loads in the LOAD1 and LOAD2 categories were attributed with the RESID_DIURNAL pattern, and all commercial loads in the LOAD3 and LOAD4 categories were attributed with the COMM_DIURNAL pattern.

After applying the diurnal pattern in the model, the simulation was run again to evaluate system performance. It was observed that the model flow curves compared favorably with the field flow curves, although the early morning “trough” and midday “peak” in the model occurred approximately one hour later than these events as observed at the flow meter sites. In order to adjust the model to match observed field flows, the entire

residential diurnal curve was shifted back one hour. The final diurnal curves are presented in Figure 4-1.

Figure 4-1 Residential and Commercial Diurnal Curves Derived from Flow Meter Data



4.3.6 CALIBRATION PERFORMANCE

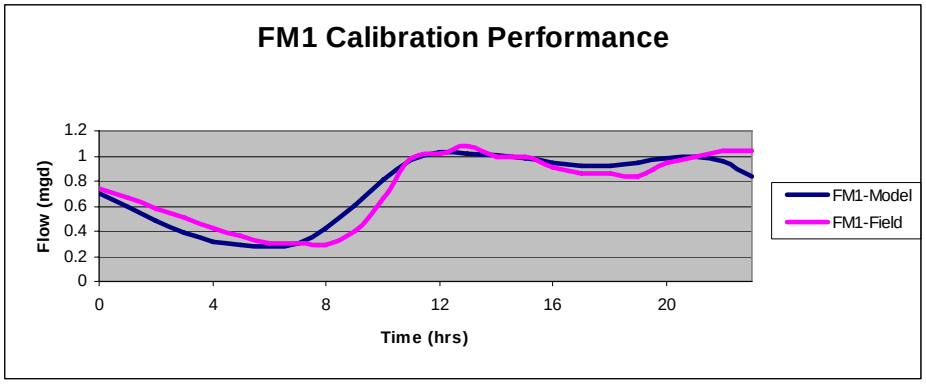
The final, calibrated model yields very close agreement to the performance of the system on the target calibration day of November 5, 2006. Figure 4-2 presents the flow meter graphs, comparing model flows and field flows.

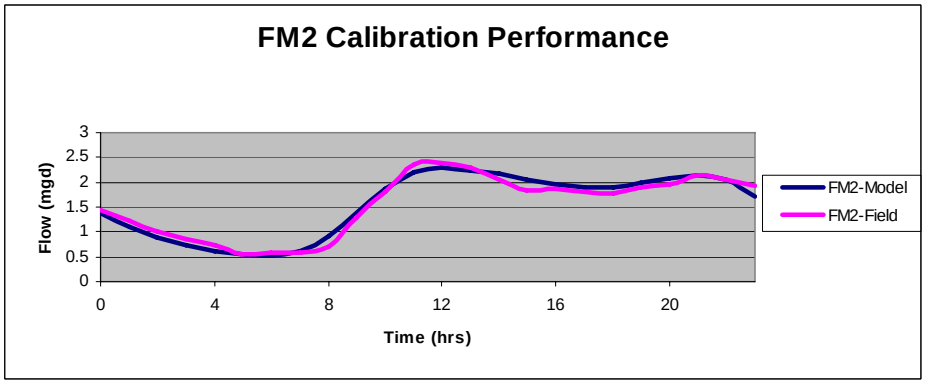
It should be noted that both the early morning “trough” and the midday “peak” at flow meter FM-3A are observed as occurring several hours later in the model than in the field, although the maximum and minimum observed model flows match up well with field results. This may be attributable to the fact that the area captured by FM-3A is almost exclusively commercial, with a high proportion of restaurants, and may exhibit sewer loading characteristics which differ from those observed in the rest of the City collection system.

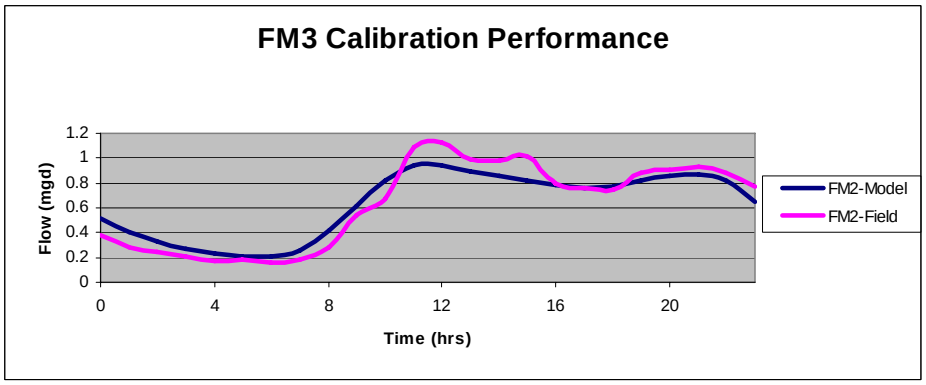
The other flow meter which shows significantly different results between the model and field is FM-7. This flow meter captured a very small number of multi-family residential units, and it was observed that the load from this area was so low that at times it was below the capacity of the flow monitoring equipment to measure. Because of these two factors it is unsurprising that the model yields results that differ from those recorded in the field.

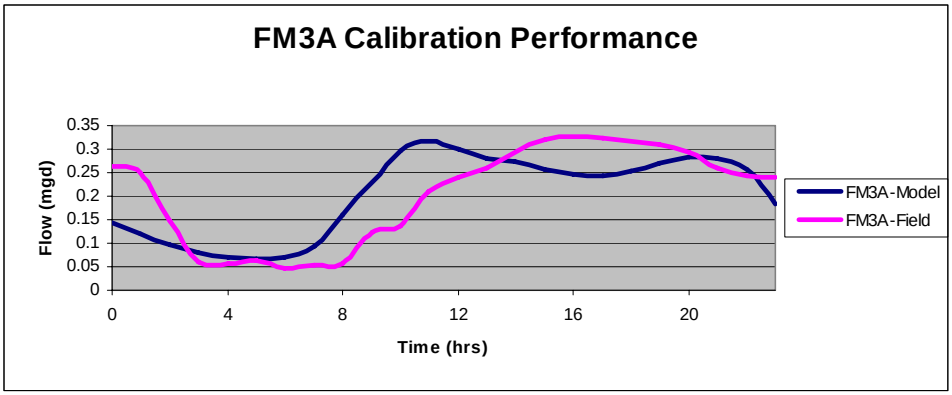
On balance, however, the model is very highly calibrated at a majority of the flow monitoring sites and for a large proportion of the total flow observed in the system on the November 5, 2006, target calibration day.

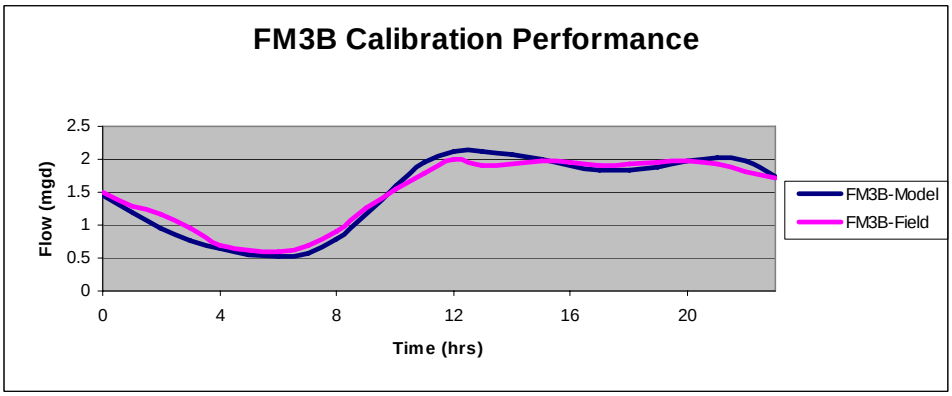
Figure 4-2 Calibration Graphs Comparing Model Flow and Field Flow on 11/5/07

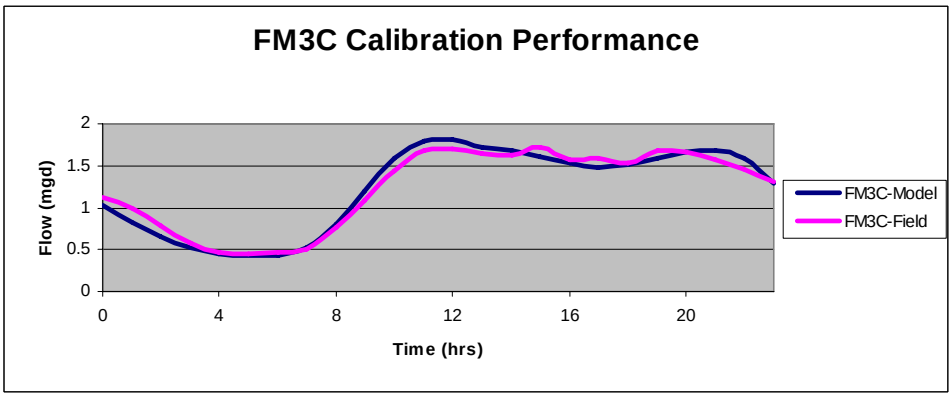


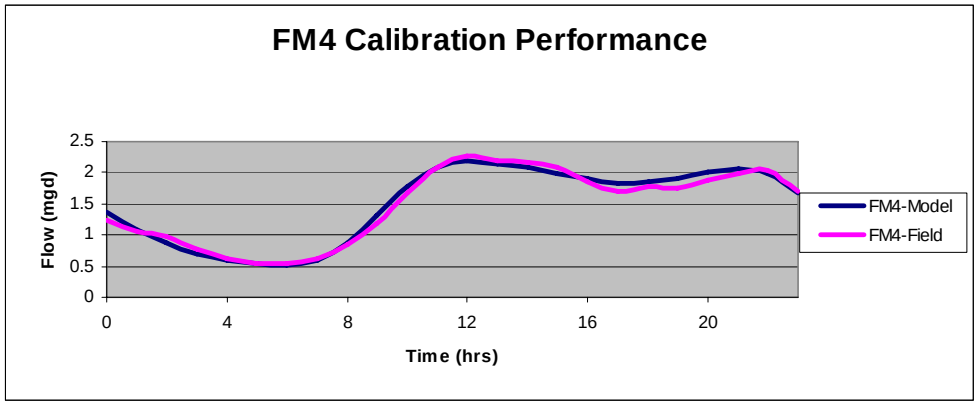


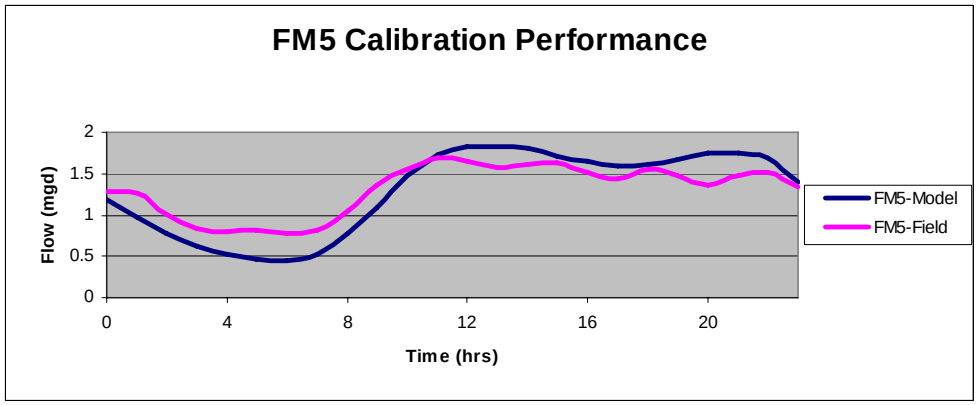


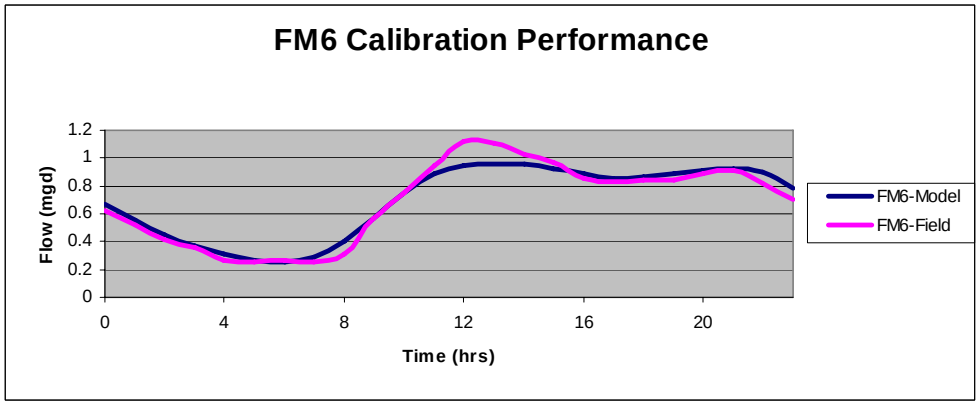

FM3A Calibration Performance
Flow (mgd)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
4
8
12
16
20
Time (hrs)
FM3A-Model
FM3A-Field

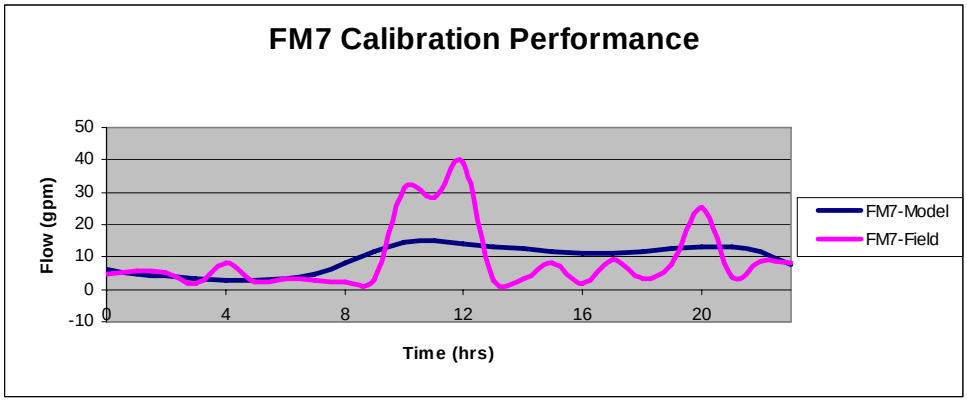

FM3B Calibration Performance
Flow (mgd)
2.5
2
1.5
1
0.5
0
0
4
8
12
16
20
Time (hrs)
FM3B-Model
FM3B-Field

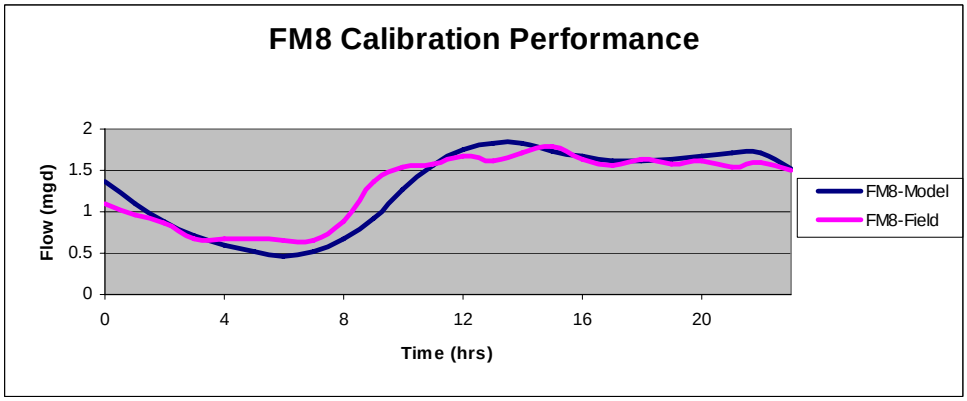

FM3C Calibration Performance
Flow (mgd)
2
1.5
1
0.5
0
0
4
8
12
16
20
Time (hrs)
FM3C-Model
FM3C-Field

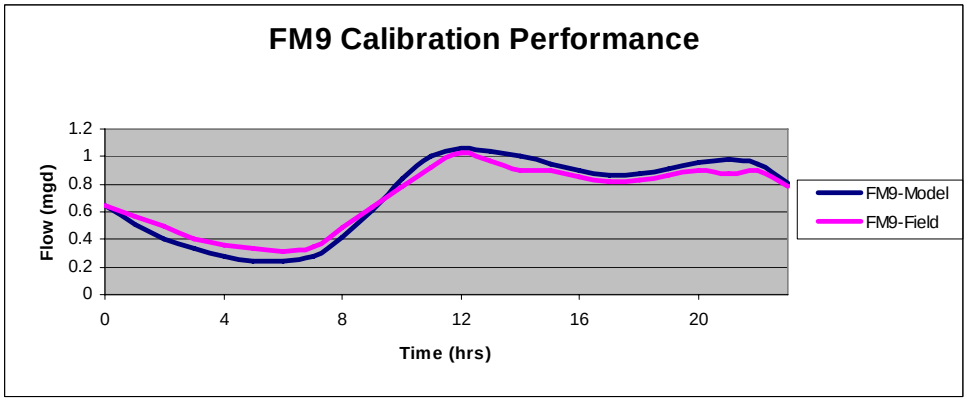

FM4 Calibration Performance
Flow (mgd)
2.5
2
1.5
1
0.5
0
0
4
8
12
16
20
Time (hrs)
FM4-Model
FM4-Field

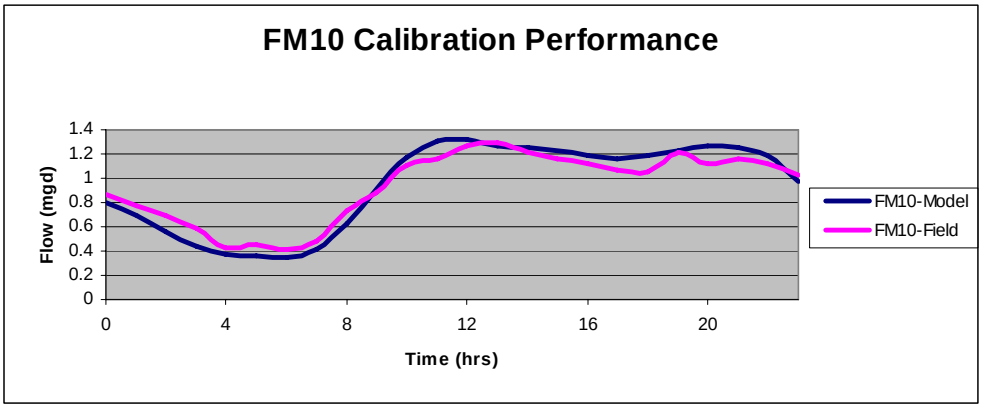

FM5 Calibration Performance
Flow (mgd)
2
1.5
1
0.5
0
0
4
8
12
16
20
Time (hrs)
FM5-Model
FM5-Field

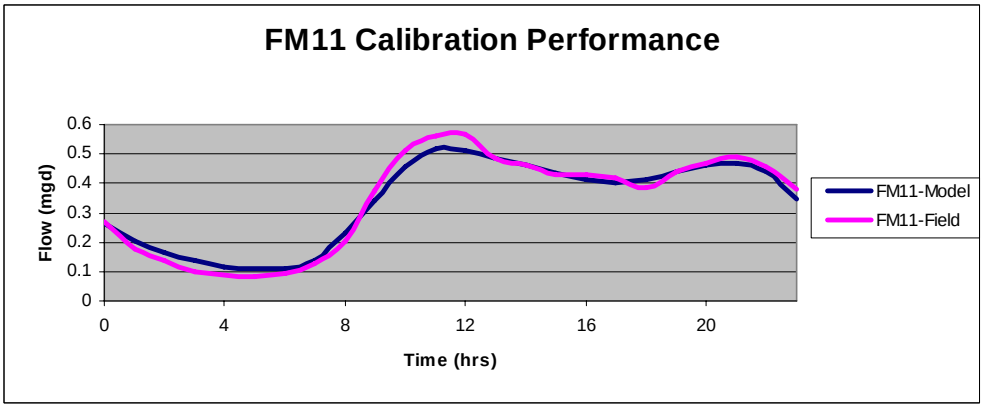

FM6 Calibration Performance
Flow (mgd)
1.2
1
0.8
0.6
0.4
0.2
0
0
4
8
12
16
20
Time (hrs)
FM6-Model
FM6-Field

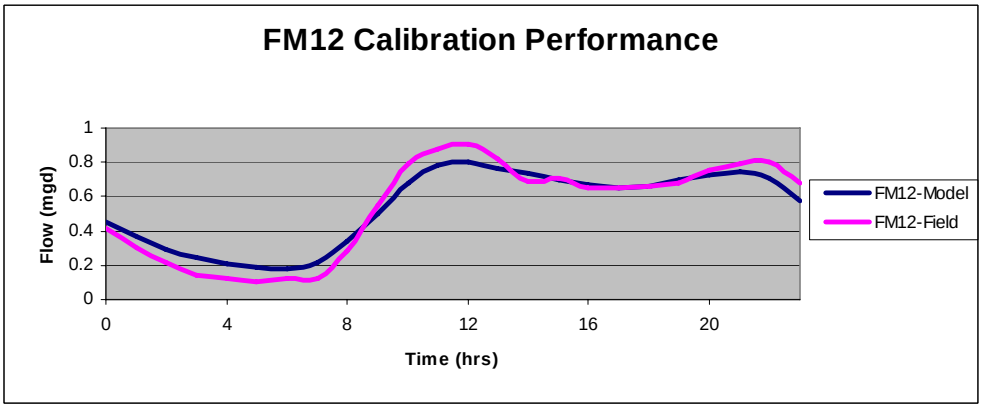

FM7 Calibration Performance
Flow (gpm)
50
40
30
20
10
0
-10
0
4
8
12
16
20
Time (hrs)
FM7-Model
FM7-Field


FM8 Calibration Performance
Flow (mgd)
2
1.5
1
0.5
0
0
4
8
12
16
20
Time (hrs)
FM8-Model
FM8-Field


FM9 Calibration Performance
Flow (mgd)
1.2
1
0.8
0.6
0.4
0.2
0
0
4
8
12
16
20
Time (hrs)
FM9-Model
FM9-Field


FM10 Calibration Performance
Flow (mgd)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
4
8
12
16
20
Time (hrs)
FM10-Model
FM10-Field


FM11 Calibration Performance
Flow (mgd)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
4
8
12
16
20
Time (hrs)
FM11-Model
FM11-Field


FM12 Calibration Performance
Flow (mgd)
1
0.8
0.6
0.4
0.2
0
0
4
8
12
16
20
Time (hrs)
FM12-Model
FM12-Field

CHAPTER 5 HYDRAULIC EVALUATION

5.1 INTRODUCTION AND OBJECTIVES

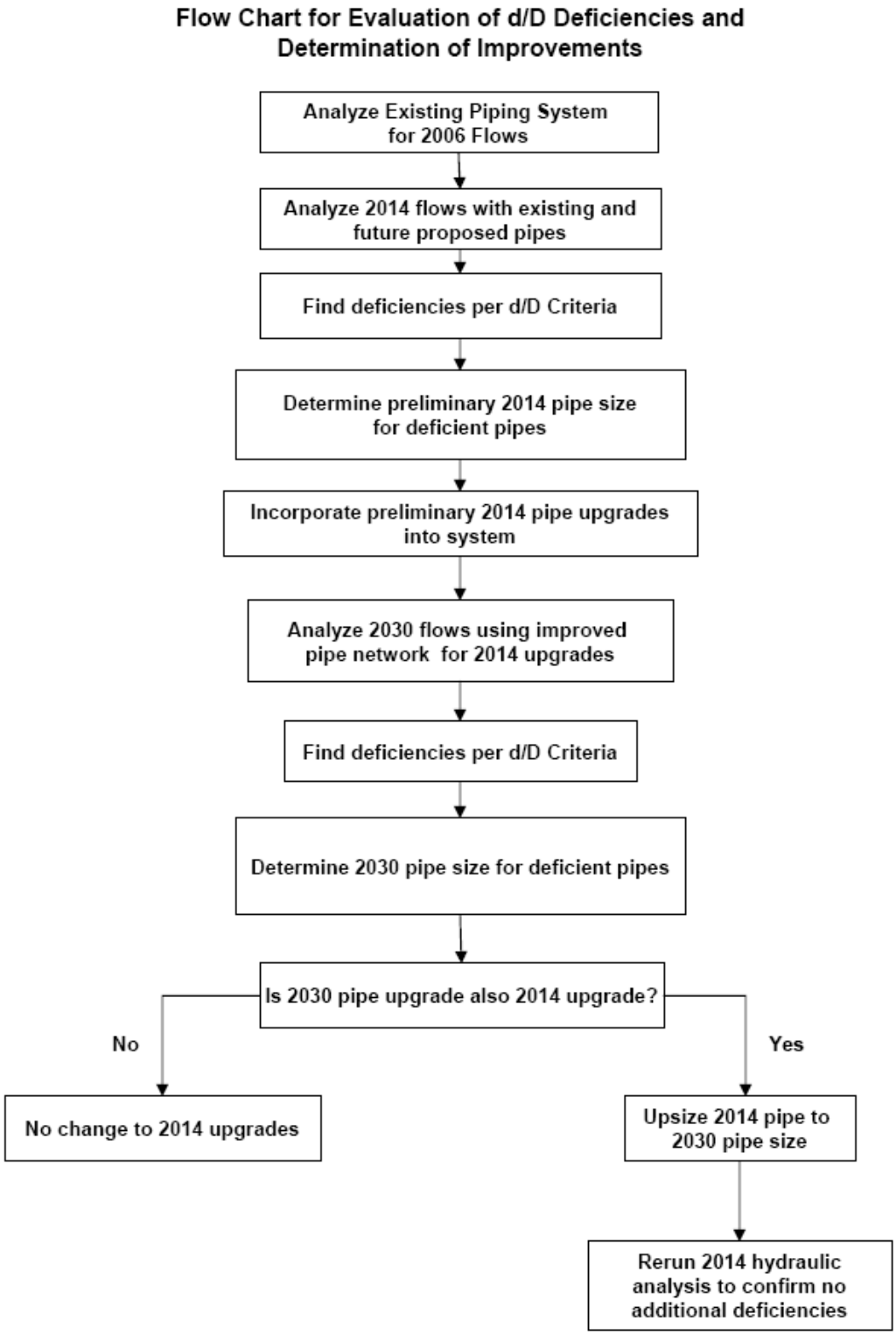
The hydraulic model discussed in Chapter 4 was used to simulate three scenarios: current conditions (2006), year 2014 conditions, and year 2030 conditions using current and projected wastewater demands, as provided in Section 3.5 of this SMP. Model simulations were performed to identify system deficiencies based on d/D criteria for existing and future demands, and to propose a Capital Improvement Program (Chapter 7).

5.2 METHODOLOGY

The methodology for evaluating system deficiencies for current conditions (2006) consisted of performing model simulations on the existing system and identifying pipes with d/D ratios higher than the d/D criteria shown in Table 2-9. The methodology for evaluating system deficiencies and determination of associated improvements is illustrated in the flow chart provided as Figure 5-1.

In order to evaluate system deficiencies for future conditions, sewer trunks were extended in the hydraulic model to simulate service of future development demands. Existing and projected future pipes are shown on Figure 5-2. Hydraulic simulations were run for 2014 conditions to identify deficiencies based on d/D criteria. Since some pipes were deficient for both 2014 and 2030 conditions, sizing improvements for 2014 was an iterative process, as illustrated on Figure 5-1. Initial pipe upgrades (proposed new pipe diameters) were identified for deficient pipes based on 2014 conditions. Simulations were then run for 2030 using the existing and projected future system with 2014 upgrades. Deficient pipes were identified for 2030 conditions, and proposed pipe grades were identified. If a pipe was deficient for both 2014 and 2030 conditions, the proposed pipe upgrade was sized for 2030 conditions.

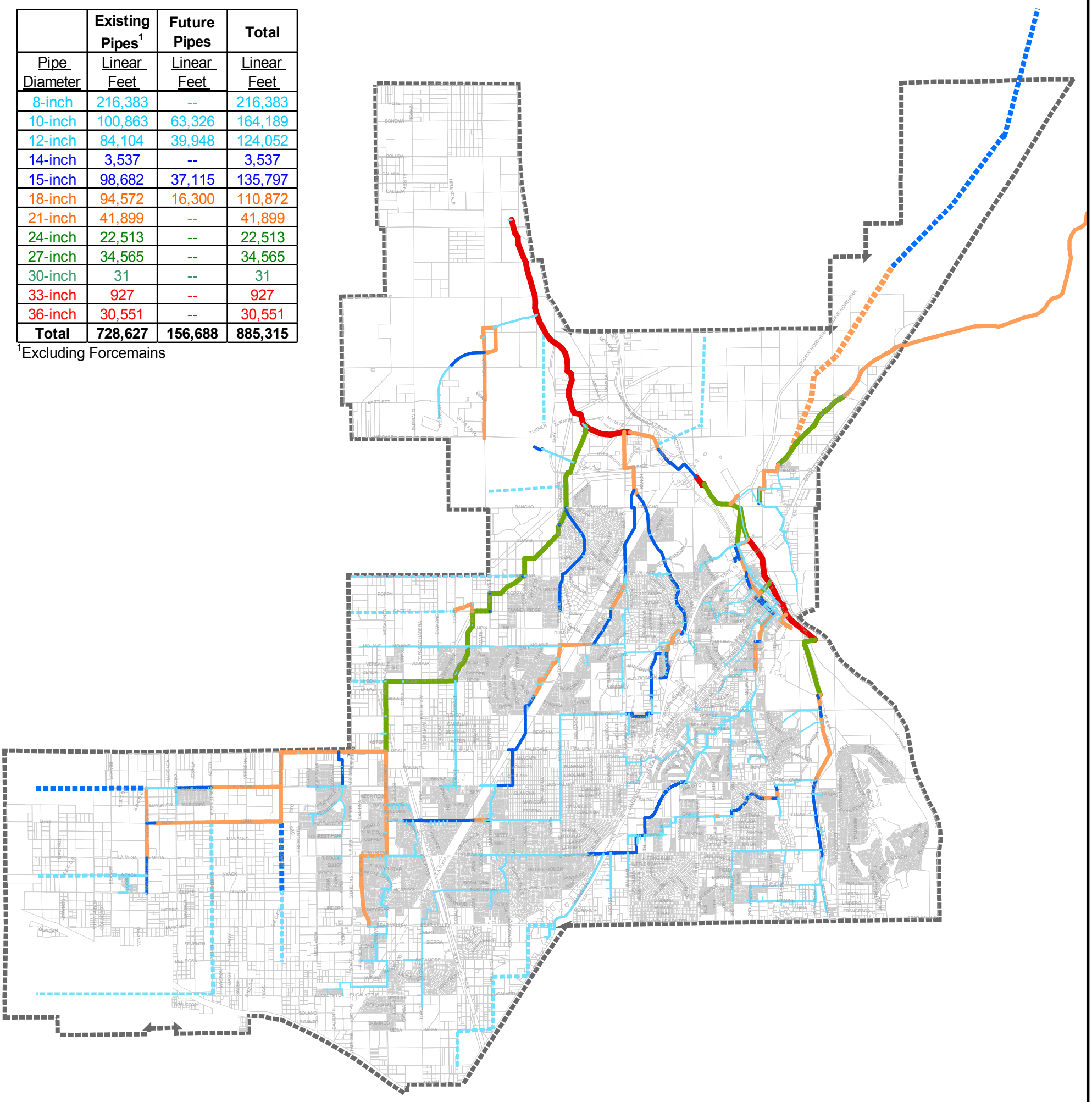
Figure 5-1 Flow Chart for Evaluation of d/D Deficiencies and Determination of Improvements



Summary of Modeled Existing
and
Projected Future Pipes

	Existing Pipes[1]	Future Pipes	Total
Pipe Diameter	Linear Feet	Linear Feet	Linear Feet
8-inch	216,383	--	216,383
10-inch	100,863	63,326	164,189
12-inch	84,104	39,948	124,052
14-inch	3,537	--	3,537
15-inch	98,682	37,115	135,797
18-inch	94,572	16,300	110,872
21-inch	41,899	--	41,899
24-inch	22,513	--	22,513
27-inch	34,565	--	34,565
30-inch	31	--	31
33-inch	927	--	927
36-inch	30,551	--	30,551
Total	**728,627**	**156,688**	**885,315**

[1]Excluding Forcemains



Legend

Wastewater Collection System

Pipe Lines Sizes

- 4 - 8 inch
- 9 - 12 inch
- 13 - 15 inch
- 16 - 21 inch
- 22 - 30 inch
- 31 - 36 inch
- Projected Future Pipes
- Existing Pipes

Planimetric

- Parcels
- Sphere of Influence

N

4,000 2,000 0 4,000 Feet

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DEPARTMENT OF ENGINEERING

Figure 5-2

Existing and Future Sewer Network

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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5.3 CURRENT CONDITIONS (2006)

The hydraulic model discussed in Chapter 4 was queried to identify pipes that exceeded the maximum allowable d/D criteria shown in Table 2-9 for existing (2006) conditions. The existing wastewater system in the hydraulic model and manhole loading of current wastewater demands for model simulation are shown on Figure 5-3. Deficiencies for current conditions, defined as pipes that exceeded the maximum allowable d/D criteria, are shown on Figure 5-4.

5.4 YEAR 2014 CONDITIONS

As described in Section 5.2, hydraulic simulations were run for 2014 conditions using existing and future projected pipes, and wastewater demands discussed in Section 3.5 of this SMP. The manhole loading of year 2014 wastewater demands for model simulation is shown on Figure 5-5. Deficiencies for Year 2014 conditions are shown on Figure 5-6.

If upsizing or new extension sewers were required, the new facilities were entered into the model and analyzed to verify that the maximum d/D for the new sewers remains less than the criteria shown in Table 2-9, and that the velocity criteria discussed in Section 2.3 were met.

5.5 YEAR 2030 CONDITIONS

Hydraulic simulations were run for 2030 using the existing and projected future system with 2014 upgrades identified via the hydraulic evaluation performed for Year 2014 conditions. The manhole loading of year 2030 wastewater demands for model simulation is shown on Figure 5-7. Deficiencies for Year 2030 conditions are shown on Figure 5-8.

If upsizing or new extension sewers were required, the new facilities were entered into the model and analyzed to verify that the maximum d/D criteria for the new sewers remains less than the values shown in Table 2-9 and that the velocity criteria were met. If a pipe was deficient for both 2014 and 2030 conditions, the proposed pipe upgrade

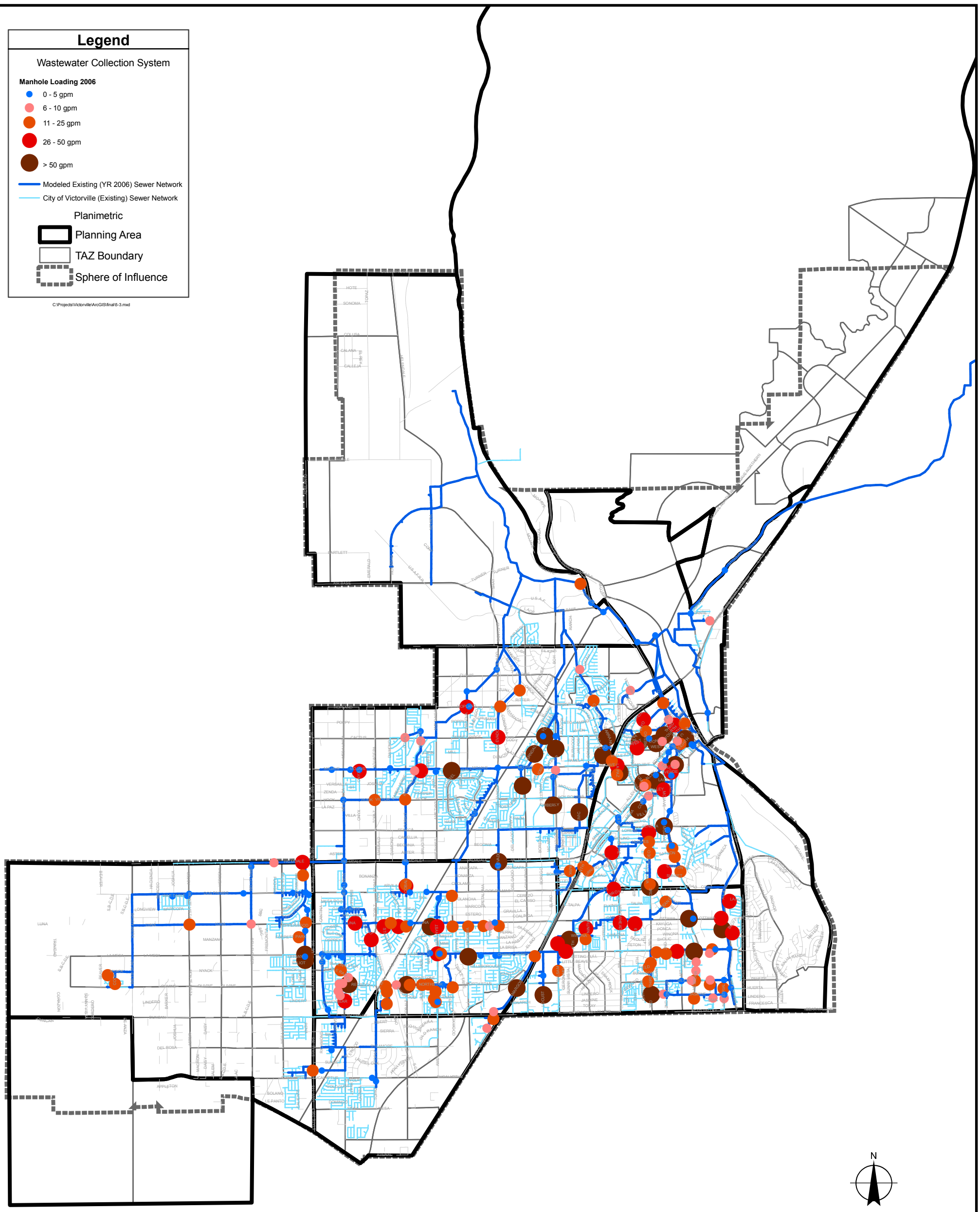

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Figure 5-3

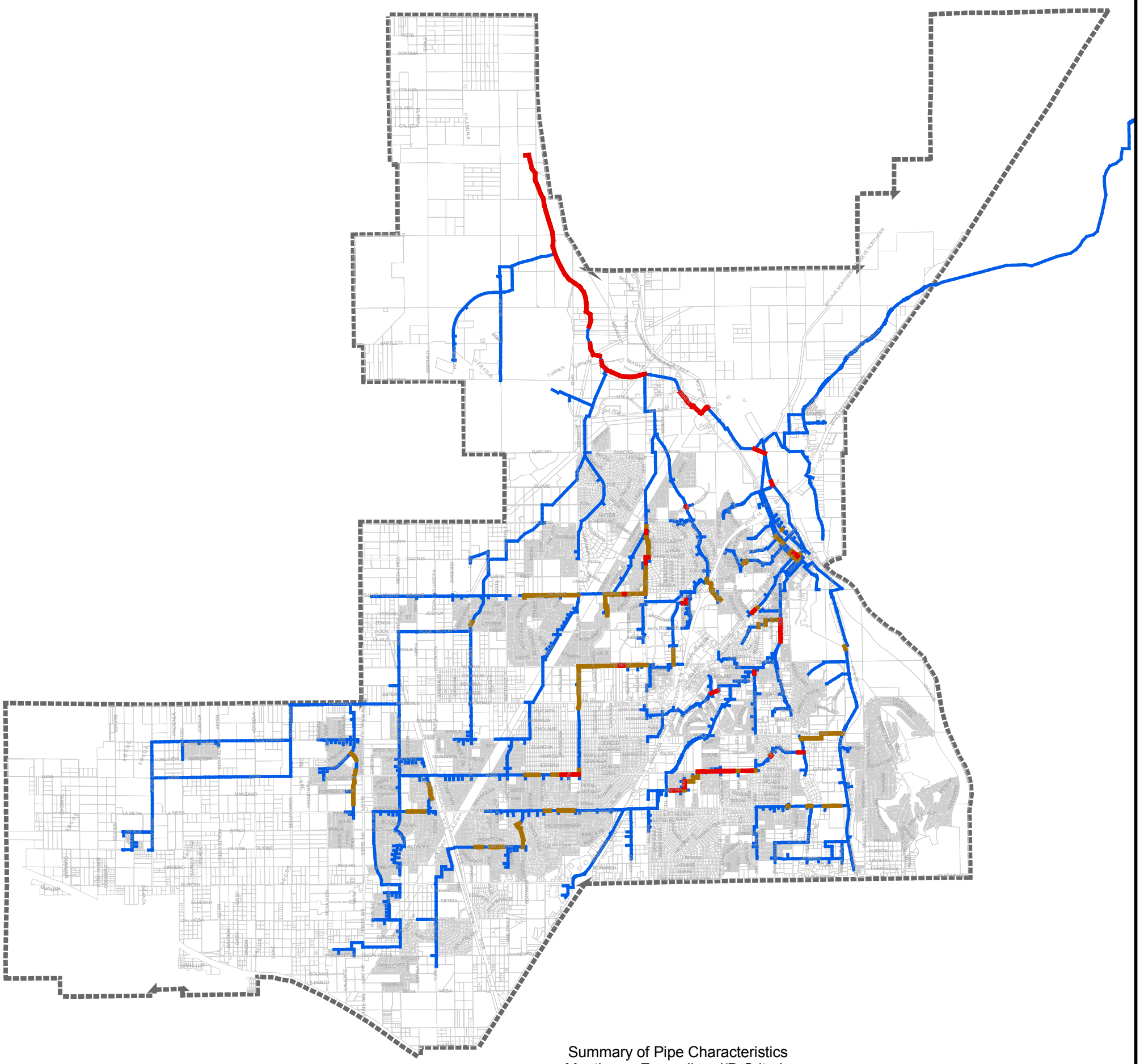
Manhole Loading for Modeling Current (Year 2006) Conditions

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.



Legend

Wastewater Collection System

- Surcharged Pipes
- Pipes Exceeding d/D Criteria
- Pipes Meeting d/D Criteria

Planimetric

- Parcels
- Sphere of Influence

d/D Criteria for Existing and Future Pipe

Pipe Diameter	Max d/D
8" to 12"	0.5
> 12"	0.75

Summary of Pipe Characteristics
Meeting or Exceeding d/D Criteria

	Pipes Meeting d/D Criteria	Pipes Exceeding d/D Criteria[1]	Surcharged Pipes[2]	Total Pipe Length[2]
Pipe Diameter	Linear Feet	Linear Feet	Linear Feet	Linear Feet
8-inch	191,945	19,048	5,389	216,382
10-inch	87,779	12,782	302	100,863
12-inch	66,981	12,884	4,239	84,104
14-inch	3,537	--	--	3,537
15-inch	98,258	--	424	98,682
18-inch	94,572	--	--	94,572
21-inch	41,899	--	--	41,899
24-inch	22,513	--	--	22,513
27-inch	33,477	--	1,087[3]	34,564
30-inch	31	--		31
33-inch	927	--		927
36-inch	11,665	--	18,886[3]	30,551
Total	**653,584**	**44,956**	**30,327**	**728,625**

[1]Excluding Surcharged Pipes
[2]Excluding Frorce Mains
[3]VVWRA Lines

N

4,000 2,000 0 4,000 Feet

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Figure 5-4

Hydraulic Evaluation Results for Year 2006 Conditions

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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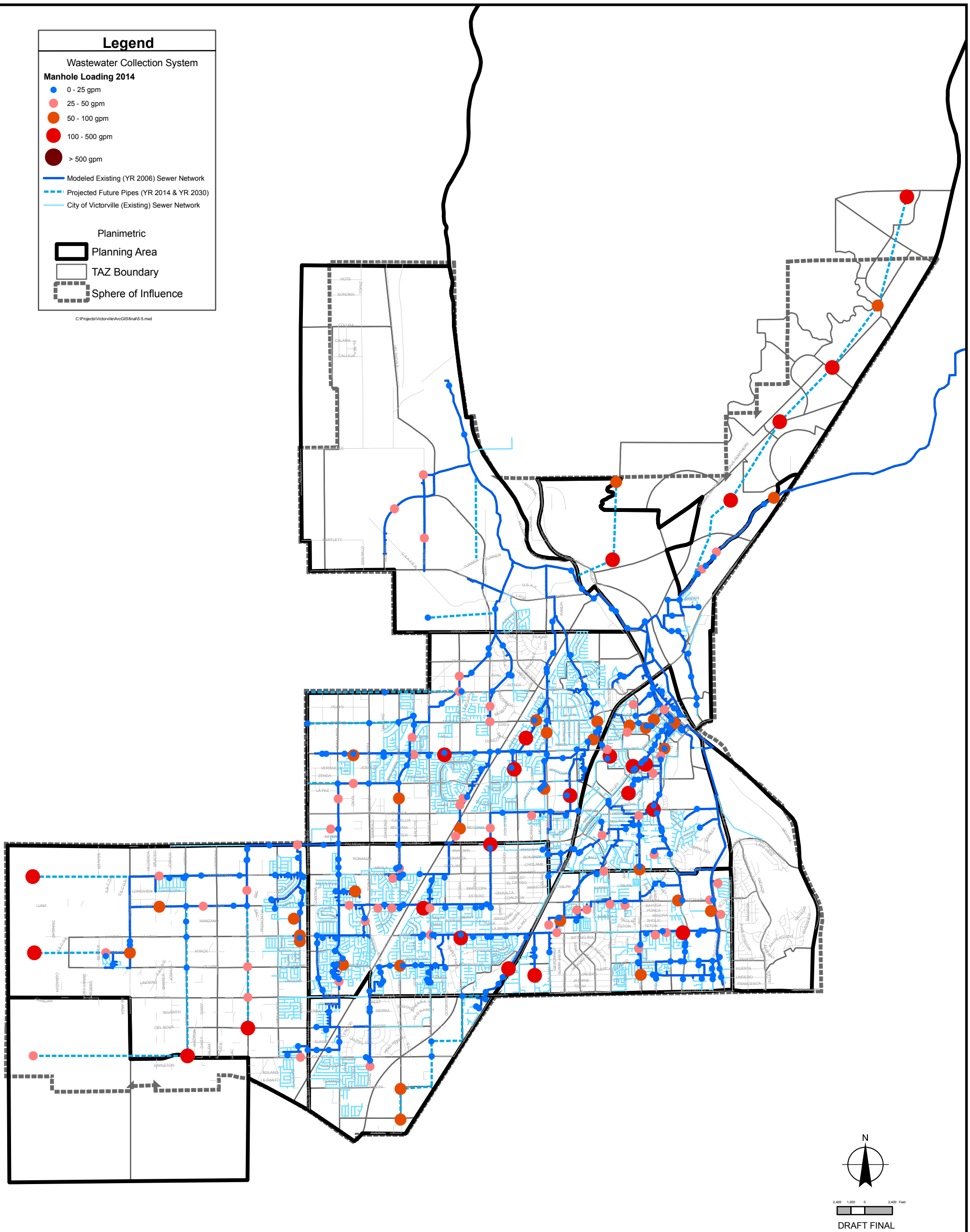

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Figure 5-5

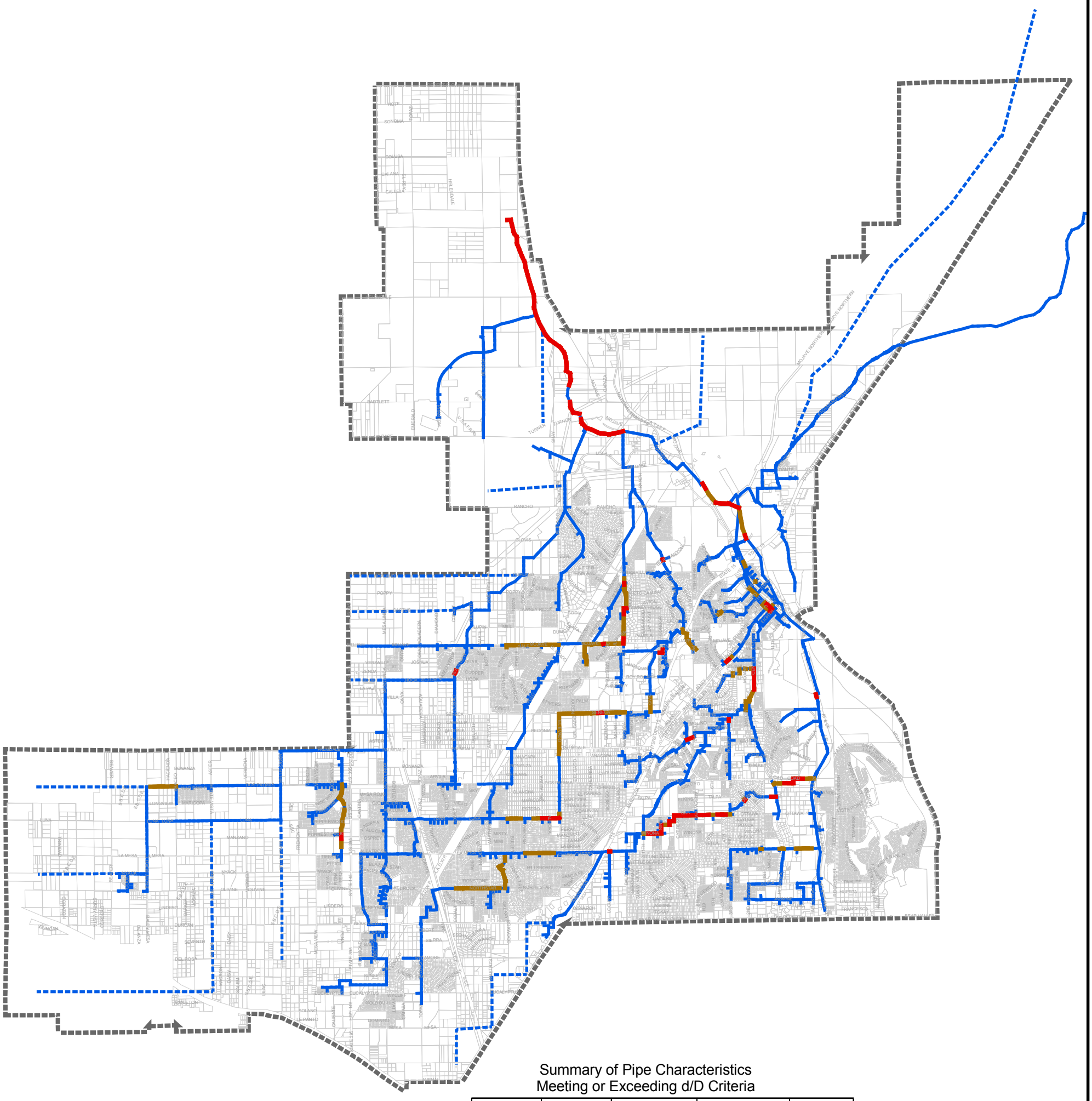
Expansion for Year 2014 Planning Horizon and Manhole Loading for Modeling

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.



Summary of Pipe Characteristics
Meeting or Exceeding d/D Criteria

	Pipes Meeting d/D Criteria[1]	Pipes Exceeding d/D Criteria[2]	Surcharged Pipes[3]	Total Pipe Length[3]
Pipe Diameter	Linear Feet	Linear Feet	Linear Feet	Linear Feet
8-inch	188,627	22,367	5,389	216,383
10-inch	149,570	14,016	603	164,189
12-inch	103,207	13,979	6,866	124,052
14-inch	3,537		--	3,537
15-inch	134,953	150	694	135,797
18-inch	110,872		--	110,872
21-inch	41,899		--	41,899
24-inch	22,513		--	22,513
27-inch	28,810	3,896[4]	1,859[4]	34,565
30-inch	31	--	--	31
33-inch	927	--	--	927
36-inch	11,665	--	18,886[4]	30,551
Total	**796,611**	**54,408**	**34,297**	885,316

[1]Includes Projected Future Pipes
[2]Excluding Surcharged Pipes
[3]Excluding Forcemains
[4]VVWRA Lines

Legend

Wastewater Collection System

- Surcharged Pipes
- Pipes Exceeding d/D Criteria
- Pipes Meeting d/D Criteria
- Projected Future Pipes

Planimetric

- Parcels
- Sphere of Influence

d/D Criteria for Existing and Future Pipe

Pipe Diameter	Max d/D
8" to 12"	0.5
> 12"	0.75

N

4,000 2,000 0 4,000 Feet

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Figure 5-6

Hydraulic Evaluation Results for Year 2014 Conditions

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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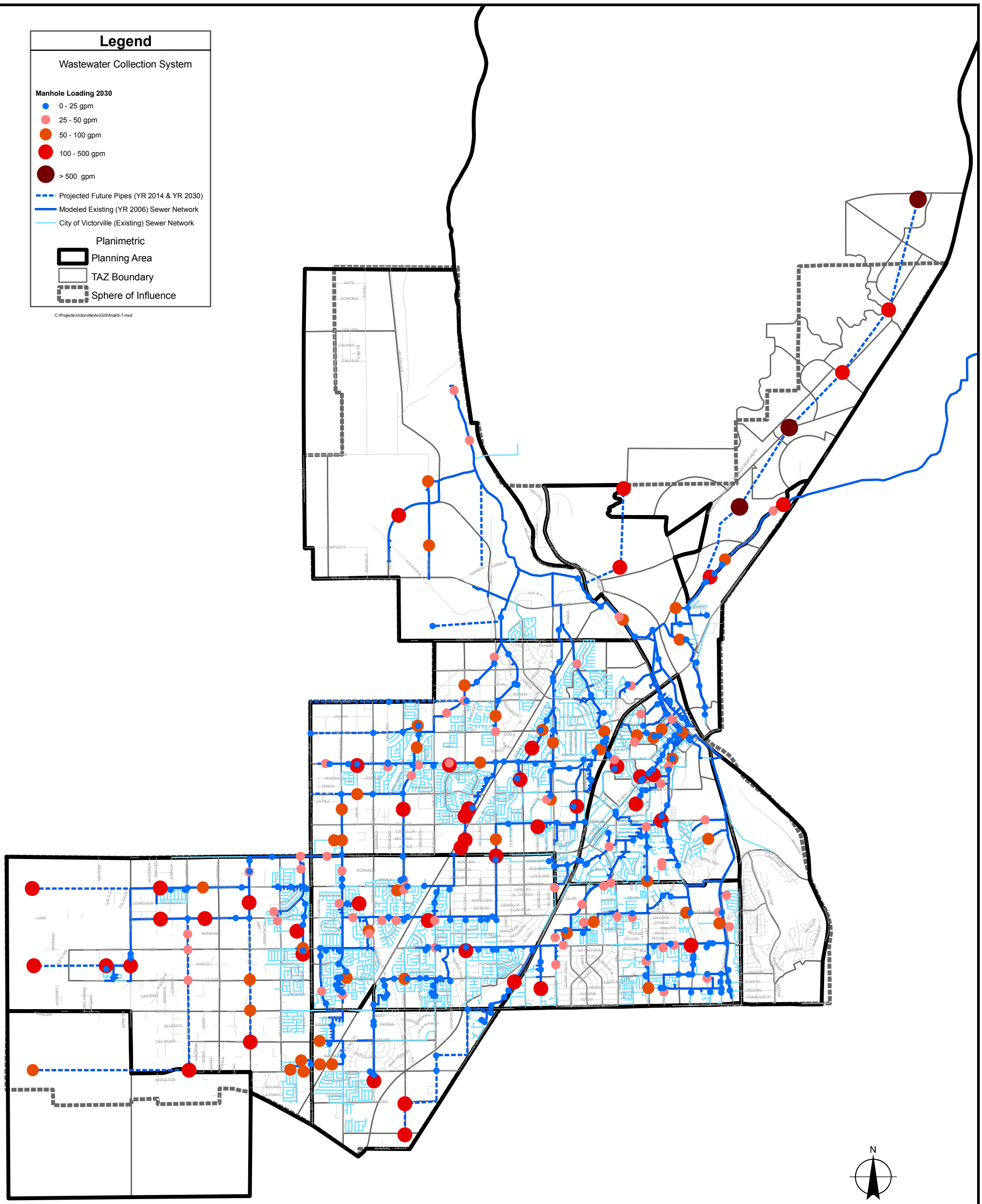

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DEPARTMENT OF ENGINEERING

Figure 5-7

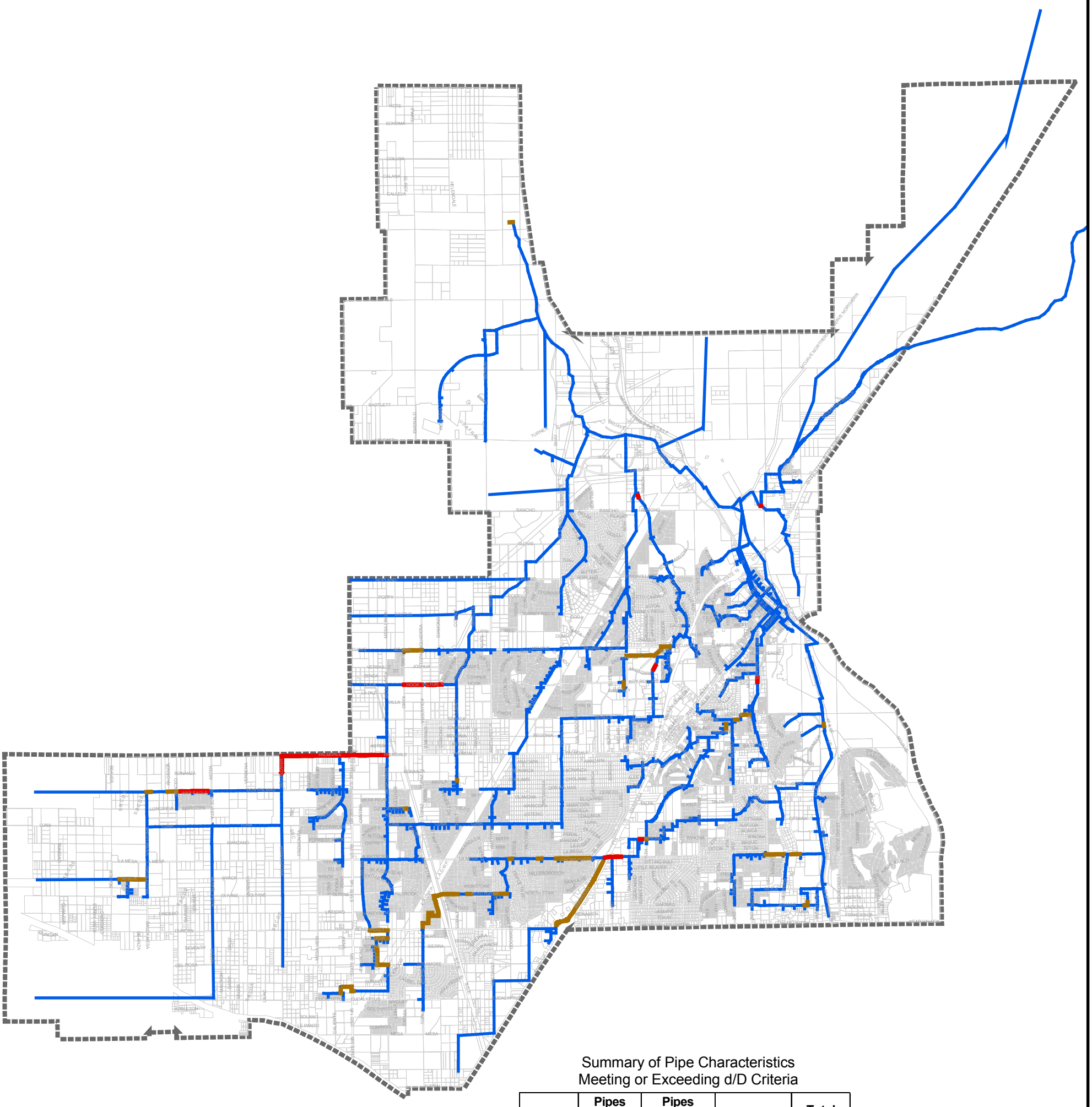
Expansion for Year 2030 Planning Horizon and Manhole Loading for Modeling

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.



Summary of Pipe Characteristics Meeting or Exceeding d/D Criteria

	Pipes Meeting d/D Criteria[1]	Pipes Exceeding d/D Criteria[2]	Surcharged Pipes[3]	Total Pipe Length[3]
Pipe Diameter	Linear Feet	Linear Feet	Linear Feet	Linear Feet
8-inch	176,118	12,208	--	188,326
10-inch	146,837	10,309	--	157,146
12-inch	114,338	10,432	--	124,770
14-inch	3,522	--	15	3,522
15-inch	158,664	332	3,545	162,541
18-inch	107,450	459	8,953	107,450
21-inch	42,666	231	---	42,666
24-inch	20,149	--	2,363	20,149
27-inch	29,213	--	--	35,210
30-inch	31	--	--	31
33-inch	926	--	--	926
36-inch	11,664	--	--	30,550
UPSIZED VVWRA PIPE (TBD)[4]	24,883			
Total	**836,461**	**33,971**	**14,876**	**885,307**

[1]Includes Projected Future Pipes.
[2]Excluding Surcharged Pipes.
[3]Excluding Forcemains.
[4]Future pipe sizes for VVWRA trunk lines were not determined because future inflows to VVWRA trunk lines from outside the City of Victorville were not known. It is assumed that all VVWRA deficiencies were upsized in year 2014.

Legend

Wastewater Collection System

- Surcharged Pipes
- Pipes Exceeding d/D Criteria
- Pipes Meeting d/D Criteria

Planimetric

- Parcels
- Sphere of Influence

d/D Criteria for Existing and Future Pipe

Pipe Diameter	Max d/D
8" to 12"	0.5
> 12"	0.75

N

4,000 2,000 0 4,000 Feet

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DEPARTMENT OF ENGINEERING

Figure 5-8

Hydraulic Evaluation Results for Year 2030 Conditions

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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for year 2014 was sized for 2030 conditions, and the 2014 hydraulic simulation was rerun with relevant 2030 upgrades to confirm that there were no additional deficiencies.

CHAPTER 6 RECLAIMED WATER

6.1 INTRODUCTION

VVWRA has been working with its member agencies, including the City of Victorville, over the past several years to identify ways to minimize expansion costs due to growth in their trunk sewer lines and at the Regional Treatment Facility. In addition, there is a clear need to preserve precious water resources in Southern California. These agencies have determined that there is a critical need to maximize beneficial use of all available water resources, including the use of reclaimed water. The production and use of reclaimed water can serve to minimize expansion costs, preserve water resources, and serve beneficial uses.

The desert southwest is a national leader in the practice of water reclamation. Recycled water, often referred to as reclaimed water consists of processing wastewater to a very high level of treatment, which typically includes primary, secondary and advanced or tertiary treatment. The treated effluent can then used for non-potable uses such as irrigation or groundwater recharge, where incidental human contact can take place without danger to the public. Such water in general, must be treated to standards defined in Title 22.

Both the City and VVWRA have studied the feasibility of developing recycled water programs. VVWRA's Regional Plant currently produces recycled water that is used for irrigation or is discharged to the Mojave River or to percolation ponds. One of the options studied by VVWRA was to treat wastewater at the Regional Facility and to pump recycled water to the major use areas; however the plant is located at a low elevation and is distant from most of the potential reclaimed water users in its service area.

Another option studied was the concept of constructing sub-regional reclamation facilities. The 2005 VVWRA report titled *Planning and Environmental Services to Develop Subregional Reclamation Facilities*, prepared by Boyle Engineering Corp. states that the agency has elected to pursue an approach that would "address the capacity problems of the trunk sewers as well as the desire to introduce water recycling

in the High Desert area." The concept would include construction of sub-regional reclamation facilities located at strategic locations throughout the service area.

The existing reclamation facility at the Regional Plant plus three additional potential sub-regional plant sites (Upper Narrows, Green Tree and Apple Valley) were identified in the Boyle report; all three are located within the City of Victorville's sphere of influence.

Information provided in the Boyle report was in part, based on information provided in a study prepared for the City of Victorville in 2002 by RBF Consulting titled *Victorville Recycled Water Reuse Study.* The RBF Study discussed potential sub-regional Facility locations at the Upper Narrows and Green Tree sites. Information presented in this report was, in part developed from data presented in the Boyle and RBF reports.

VVWRA continues to focus on the sub-regional facility concept, particularly in regard to the Town of Apple Valley and the City of Hesperia. The City of Victorville is considering a local solution.

6.2 OBJECTIVES

The objectives of this chapter are to discuss the potential for reclaimed water use in the City of Victorville to reduce the cost of capital improvements that will otherwise be required to adequately serve future growth and to reduce demands on the potable water system.

Wastewater would be diverted from the existing sewer system at key points in the system and directed to a new reclaimed water treatment facility, thereby avoiding capacity improvements to the downstream pipe network.

The costs associated with treating and distributing reclaimed water can be high; however, there are several benefits to implementing a recycled water program should the city decide to do so. Some benefits to reclaimed water use are listed below:

- Wastewater diverted from the sewer conveyance system for reclaimed water use can delay or eliminate conveyance improvements that may be required to serve future population.

- Reclaimed water use reduces the volume and therefore the cost to the City for treatment at the Regional Plant.
- Reclaimed water use provides treatment capacity for future population.
- Reclaimed water use reduces demands on the potable water system.
- Reclaimed water use provides water for beneficial uses such as irrigation and reclaimed water use provides enhanced stability for the potable water system, as it reduces demands on that system during peak use periods.
- Reclaimed water can be used for groundwater recharge.
- Other non-potable uses

6.3 RECLAIMED WATER SYSTEM COMPONENTS

A typical recycled water system will include most of the following components:

- Diversion structures to remove wastewater from trunk sewers
- Conveyance piping to treatment facility
- Treatment Facility (Title 22 effluent)
    - Influent pump station
    - Primary treatment facilities
        - Headworks/screens/Grit chamber
        - Aeration basins
        - Clarification
    - Secondary treatment facilities
        - BNR or activated sludge, or
        - MBR with membrane filters
    - Tertiary treatment facilities (not required with MBR)
        - Filtration
    - Disinfection
        - Chlorination/dechlorination, or
        - Ultraviolet disinfection
    - Effluent storage pond
    - Discharge pump station to convey treated water to elevated storage, to a constant pressure zone, or to other permitted discharge
- Elevated storage
    - Pressure zones with an assumed minimum pressure of 30 psi and maximum pressure of 100 psi can serve properties within an elevation range of approximately 160 ft.

- Constant pressure zones can be developed using constant pressure pumps. Elevated storage is not required, but less reliable than elevated storage option

- Distribution piping system to convey reclaimed water to end users, or

- Typical permitted discharge

  - Reclaimed water user
  - Ground water recharge
  - Ground infiltration
  - Surface water discharge

6.4 RECLAIMED WATER USAGE

The predominant use for reclaimed water is irrigation; however, reclaimed water can be used for a wide range of purposes. Special conditions apply to the use of reclaimed water in regard to its use in irrigating food crops or where direct human contact is possible. Special conditions not withstanding, some common, allowed uses for non-potable water, including Title 22 reclaimed water are listed below:

Irrigation
*Food crops
*School yards
*Cemeteries
*Golf courses
Play grounds
Residential landscaping
Commercial landscaping
Freeway landscaping

Other Uses
*Recreational impoundments (fishing, boating)
*Fish hatcheries
*Cooling towers
*Toilet flushing
*Commercial laundries
*Industrial process water
Decorative fountains
Artificial snow
Soil compaction
Dust control
Concrete mixing
Sewer flushing

* indicates potential high volume users

6.5 DEMAND AREAS

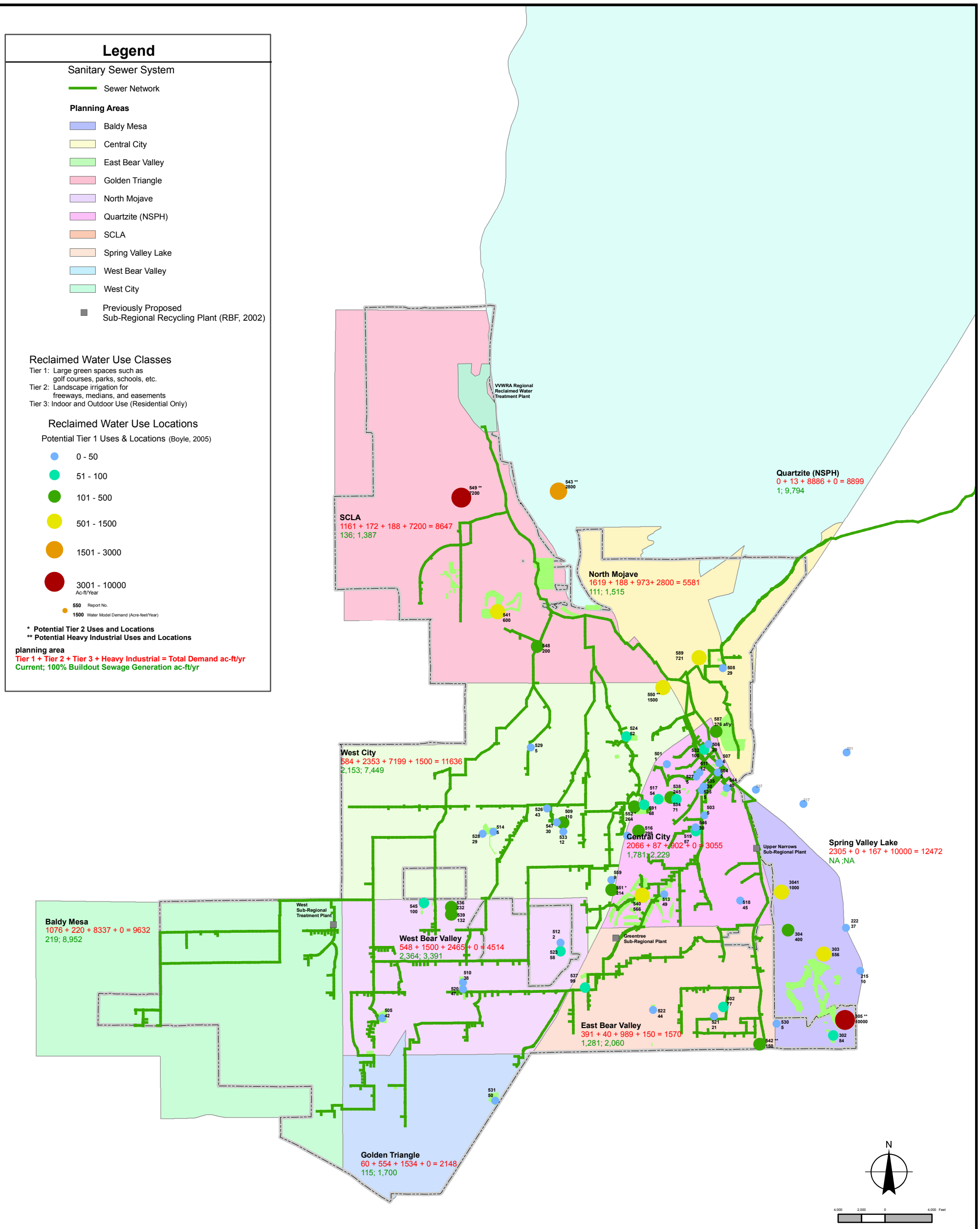
Potential reclaimed water users were defined based on several sources: ultimate land use designations and existing estimated percentage buildout (both provided by the City), the General Plan (including Specific Plan data), and based on a review of previous work performed by Boyle Engineering (2005) and RBF (2002).

Reclaimed water users were identified based on four categories: Tier 1, Tier 2, Tier 3, and Heavy Industrial. Tier 1 users consist of large irrigated areas such as golf courses, schools, parks, etc. Tier 2 users consist of right-of-ways, easements, and irrigated areas along highways and major roadways. Tier 3 users consist of residential reclaimed water use. For the purpose of this study, Tier 3 reclaimed water use was assumed to be for residential toilet flushing and irrigation. Heavy industrial users consist of water use for industrial purposes such as cement factories and power plants. Potential reclaimed water users are discussed in the following sections. Figure 6-1 shows potential reclaimed water users and demands by planning area.

6.5.1.1 Potential Tier 1 Users and Demand

A review of the Boyle Engineering and RBF reports provided information regarding Tier 1 users. According to the Boyle Engineering report, all data regarding potential reclaimed water users identified in the RBF report was incorporated into the Boyle Engineering report. Therefore, Tier 1 users and associated demands identified in the Boyle Engineering report were used in order to evaluate potential reclaimed water demand for these categories. In addition, the City of Victorville ultimate land use areas and estimated current percent buildout were used as a check for these data points.

Specific City of Victorville ultimate land use designations, such as “Park”, “Open Space”, or “Institutional”, were used to identify potential Tier 1 users. The future area (in acres) for each Tier 1 land use was used to estimate potential Tier 1 reclaimed water demand for each planning area. These demands were compared with the total demands of users identified in the Boyle report for each planning area. The more conservative of these numbers was used to estimate the Tier 1 user demand for each planning area. Reclaimed water demands for Tier 1 users were calculated based



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DEPARTMENT OF ENGINEERING

Figure 6-1

Potential Reclaimed Water Users and Demands by Planning Area

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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on an assumed percent area of irrigation for each use (i.e. park, golf course, etc.) and an average annual irrigation demand per acre of 4.3 acre-feet. Estimated potential Tier 1 user demand for each planning area is summarized in Table 6-1.

Table 6-1 Estimated Potential Tier 1 Reclaimed Water Demand

Planning Area	Potential Reclaimed Water Demand (acre-feet/year)
Baldy Mesa	1,076
Central City	2,066
East Bear Valley	391
Golden Triangle	60
North Mojave	1,619
Northern Sphere Expansion	0
SCLA	1,161
Spring Valley Lake	2,305
West Bear Valley	548
West City	584
Total Estimated Potential Reclaimed Water Demand	**9,810**

6.5.1.2 Potential Tier 2 Users and Demand

Tier 2 users were identified based on the City of Victorville future land use areas and estimated current percent buildout, and aerial photos. Several Victorville Specific Plans in the General Plan specified areas planned for right-of-ways and easements. These areas were used to calculate potential Tier 2 reclaimed water demand. In addition, several large right-of-ways, easements, and freeways were identified on land use plans and aerial photos as potential reclaimed water users.

Estimated reclaimed water demand was calculated based on an assumed percentage of irrigated area (i.e. 85 percent for easements) and an average annual irrigation demand per acre of 4.3 acre-feet, as discussed for Tier 1 users above. Estimated potential Tier 2 user demand for each planning area is summarized in Table 6-2.

Table 6-2 Estimated Potential Tier 2 Reclaimed Water Demand

Planning Area	Potential Reclaimed Water Demand (acre-feet/year)
Baldy Mesa	220
Central City	87
East Bear Valley	40
Golden Triangle	554
North Mojave	188
Northern Sphere Expansion	13
SCLA	114
Spring Valley Lake	0
West Bear Valley	1,500
West City	2,353
Total Estimated Potential Reclaimed Water Demand	**5,068**

6.5.1.3 Potential Tier 3 Users and Demand

Tier 3 users were defined as future residential buildout which could feasibly install dual piping systems in order to convey reclaimed water for indoor and outdoor use. Tier 3 users were identified by calculating projected growth: subtracting the existing number of dwelling units (DUs) from ultimate buildout number of DUs.

Present and ultimate residential population were provided by the City in terms of DU's for each the TAZ areas. The estimated number of potential Tier 3 users was obtained by subtracting the present number of DU's from ultimate number of DU's.

Tier 3 demands were calculated using a factor for toilet flushing based on total interior domestic water demand. Total interior domestic water demand was assumed to be 80 gallons/day/capita, resulting in 235 gallons/day/DU (assumed 2.94 persons per DU). Toilet flushing is estimated as 15 percent of total interior domestic water use based on general industry guidelines. This results in reclaimed water demand factor of 38.16 gallons/day/DU for indoor use. The residential irrigation demand was based on 200 gallons per day per DU.

The Tier 3 reclaimed water demand was then calculated for each planning area using the estimated Tier 3 users and reclaimed water demand factor described above. Estimated potential Tier 3 user demand for each planning area is summarized in Table 6-3.

Table 6-3 Estimated Potential Tier 3 Reclaimed Water Demand

Planning Area	Potential Reclaimed Water Demand (acre-feet/year)
Baldy Mesa	8,337
Central City	902
East Bear Valley	989
Golden Triangle	1,534
North Mojave	973
Northern Sphere Expansion	8,886
SCLA	172
Spring Valley Lake	167
West Bear Valley	2,465
West City	5,465
Total Estimated Potential Reclaimed Water Demand	**29,891**

6.5.1.4 Heavy Industrial Users and Demand

Heavy industrial users and demand were identified in the Boyle report. For the purpose of this study, this data was used to estimate heavy industrial users and potential reclaimed water demand. Estimated potential heavy industrial user demand for each planning area is summarized in Table 6-4.

Table 6-4 Estimated Potential Heavy Industrial Reclaimed Water Demand

Planning Area	Potential Reclaimed Water Demand (acre-feet/year)
Baldy Mesa	0
Central City	0
East Bear Valley	150
Golden Triangle	0
North Mojave	2,800
Northern Sphere Expansion	0

SCLA	7,200
Spring Valley Lake	10,000
West Bear Valley	0
West City	1,500
Total Estimated Potential Reclaimed Water Demand	**21,650**

6.6 POTENTIAL SUB-REGIONAL TREATMENT PLANTS

As previously discussed, in addition to the Regional Plant there are three sub-regional treatment facilities that have been studied by VVWRA. These sites are shown on Figure 6-1. The Green Tree site is centrally located near several potential users and is within a reasonable distance of good storage reservoir sites. The Green Tree site has been removed from consideration by VVWRA at this time; however the City should consider a site near the same location, due to its beneficial location from a hydraulic perspective. The Upper Narrows site is also centrally located; however, fewer potential users are nearby, with the notable exceptions of Spring Valley Lake and the cement mixing industries.

The West Sub-regional Facility, or Apple Valley Facility as it is identified in the Boyle report, is located in the Baldy Mesa planning area. This facility has excellent potential, as it is currently largely undeveloped, but growth in anticipated soon. Additionally, its viability has increased due to planning work of the Baldy Mesa Water District, which has recently been taken over by the City of Victorville. From conversations with District staff and from information provided in the Baldy Mesa Water District's *2006 Water Study for Special Area,* prepared by So & Associates Engineers, it is understood that property has been purchased for the reclaimed water treatment facility, a surface water treatment facility, and for a recharge basin.

It is possible that other sites may be better suited or in some way preferable to locate future treatment facilities than the sites listed above. An in-depth study should be conducted to identify additional sites in order to provide more options from which the City can choose. In such a case, careful consideration should be given to the placement of new facilities. Below are some of the issues that should be considered when selecting locations for future reclaimed water treatment facilities.

- The plant should be located near potential users in order to minimize the length and complexity of the distribution network.
- Future treatment facilities should be located in order to maximize the use of topography in order to minimize pumping requirements to elevated storage tanks and effectively develop pressure zones.
- The site must be large enough to provide adequate room to allow for future expansion of the plant and for effluent storage facilities.
- The site must be located so that property can be purchased at a reasonable price and where aesthetics of the plant are not offensive to neighboring properties.
- Environmental concerns such as odor, noise and visual obstruction are minimized.

CHAPTER 7 CAPITAL IMPROVEMENT PROGRAM

7.1 INTRODUCTION AND OBJECTIVES

The deficient pipes identified in Chapter 5 were used as the basis for the Capital Improvement Program for the 2014 and 2030 planning horizons. Deficient pipes identified in 2006 were included in the 2014 capital improvement program. Deficient pipes were grouped into pipe reaches for preparing budgetary cost estimates. A pipe reach was defined as a contiguous section of pipe requiring improvement or several discontinuous sections of pipe part of the same line and in close proximity to each other. Capital improvement costs were based on either removing the existing pipe and replacing with vitrified clay pipe (VCP) or installing new VCP to areas requiring new sewer service. Costs were based on 2007 construction costs.

7.2 CAPITAL IMPROVEMENT PROGRAM

7.2.1 2014

The Capital Improvement Program for the 2014 planning horizon is shown on Figure 7-1. There are 46 pipe reaches comprised of approximately 252,000 feet of pipe. Of this total, 157,000 feet of new pipe is required to service future growth areas, and 97,000 feet of existing pipe will require upsizing as a result of future growth. Reach 37 and 48 are comprised of 25,000 feet of pipe that belongs to the VVWRA. Improvements for 2014 are summarized by reach in Table 7-1.

7.2.2 2030

The Capital Improvement Program for the 2030 planning horizon is shown on Figure 7-2. There are 23 pipe reaches comprised of 49,000 feet of pipe. These pipes are existing and will require upsizing as a result of future growth. Improvements for 2030 are summarized by reach in Table 7-2.

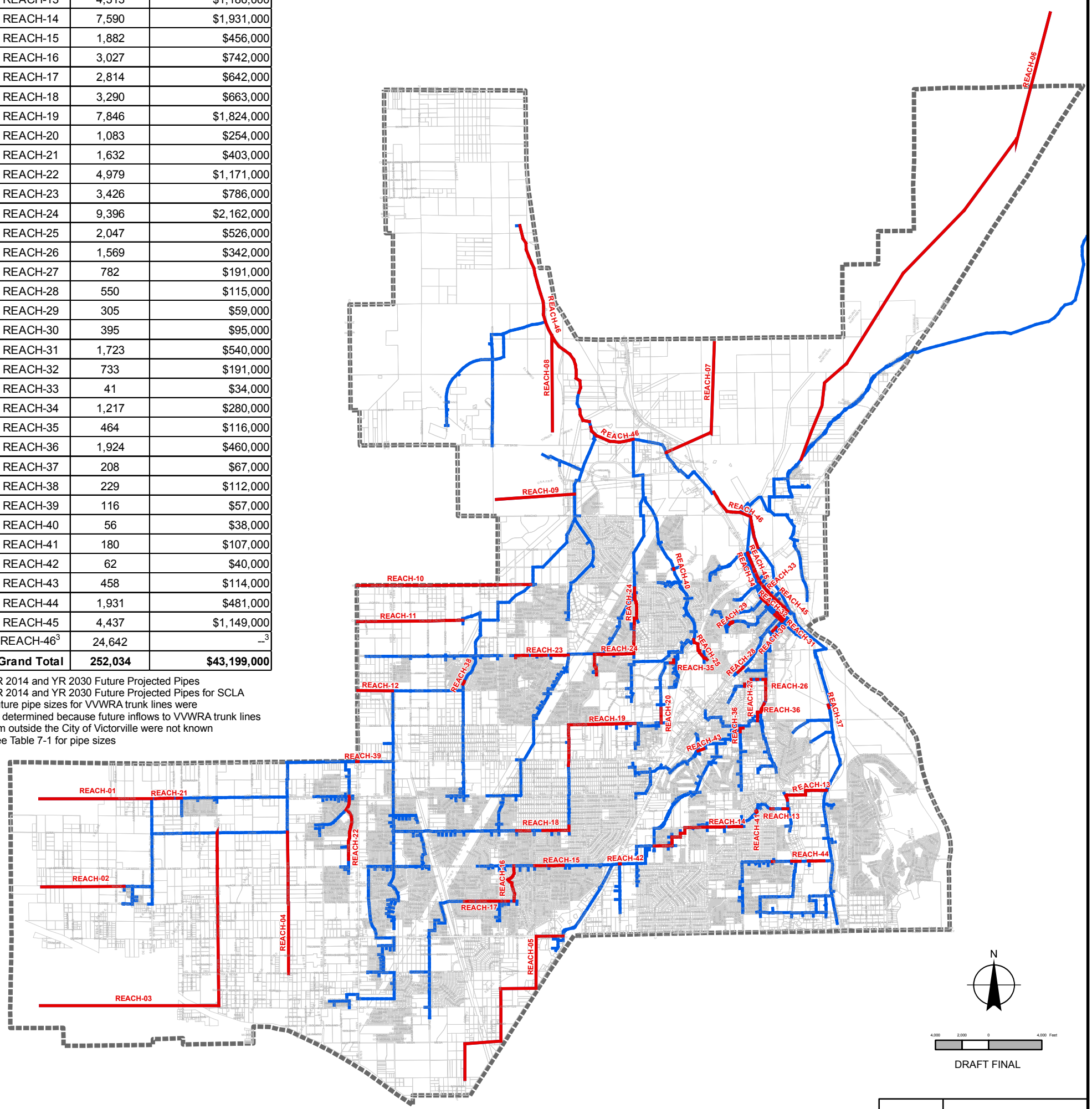
7.3 BUDGETARY COST ESTIMATES

Budgetary cost estimates are provided for Capital Improvement Programs for the 2014 and 2030 planning horizons in Tables 7-1 and 7-2, respectively. The unit costs for pipe

Year 2014
Capital Improvement Pipes

REACH	Total Pipe Length (feet)	Estimated Total Pipe Improvement Cost ($)
REACH-01[1]	8,406	$1,512,000
REACH-02[1]	6,203	$979,000
REACH-03[1]	26,526	$4,080,000
REACH-04[1]	10,661	$1,819,000
REACH-05[1]	17,961	$2,867,000
REACH-06[1]	39,710	$7,447,000
REACH-07[1]	10,577	$1,594,000
REACH-08[1,2]	7,175	$1,080,000
REACH-09[1,2]	5,879	$879,000
REACH-10[1]	13,064	$1,988,000
REACH-11[1]	7,932	$1,217,000
REACH-12[1]	2,595	$403,000
REACH-13	4,313	$1,186,000
REACH-14	7,590	$1,931,000
REACH-15	1,882	$456,000
REACH-16	3,027	$742,000
REACH-17	2,814	$642,000
REACH-18	3,290	$663,000
REACH-19	7,846	$1,824,000
REACH-20	1,083	$254,000
REACH-21	1,632	$403,000
REACH-22	4,979	$1,171,000
REACH-23	3,426	$786,000
REACH-24	9,396	$2,162,000
REACH-25	2,047	$526,000
REACH-26	1,569	$342,000
REACH-27	782	$191,000
REACH-28	550	$115,000
REACH-29	305	$59,000
REACH-30	395	$95,000
REACH-31	1,723	$540,000
REACH-32	733	$191,000
REACH-33	41	$34,000
REACH-34	1,217	$280,000
REACH-35	464	$116,000
REACH-36	1,924	$460,000
REACH-37	208	$67,000
REACH-38	229	$112,000
REACH-39	116	$57,000
REACH-40	56	$38,000
REACH-41	180	$107,000
REACH-42	62	$40,000
REACH-43	458	$114,000
REACH-44	1,931	$481,000
REACH-45	4,437	$1,149,000
REACH-46[3]	24,642	--[3]
Grand Total	**252,034**	**$43,199,000**

[1]YR 2014 and YR 2030 Future Projected Pipes
[2]YR 2014 and YR 2030 Future Projected Pipes for SCLA
[3]Future pipe sizes for VVWRA trunk lines were not determined because future inflows to VVWRA trunk lines from outside the City of Victorville were not known
[4]See Table 7-1 for pipe sizes



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Legend

Wastewater Collection System

- Pipes for 2014 CIP
- Existing Pipes Meeting d/D Criteria

Planimetric

- Parcels
- Sphere of Influence

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DEPARTMENT OF ENGINEERING

Figure 7-1

Capital Improvement Pipes for Year 2014

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

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TABLE 7-1: Capital Improvement Pipes for YR 2014

	Installed Pipe Length (feet)								CONSTRUCTION COST						
REACH	8-inch	10-inch	12-inch	15-inch	18-inch	21-inch	27-inch	36-inch	**Total Pipe Length (feet)**	**Pipe Removal and Installation Cost ($)**	**Approximate number of Manholes Required**	**Estimated Manhole Cost ($)**	**Estimated Total Construction Cost (including Manhole) ($)**	**Estimated Engineering, Contingency Costs[4] ($)**	**Estimated Total Pipe Improvement Cost ($)**
REACH-01[1]				8,406					8,406	$620,000	25	$500,000	$1,120,000	$392,000	$1,512,000
REACH-02[1]			6,203						6,203	$365,000	18	$360,000	$725,000	$254,000	$979,000
REACH-03[1]		13,421	13,105						26,526	$1,480,000	77	$1,540,000	$3,020,000	$1,060,000	$4,080,000
REACH-04[1]			5,362	5,299					10,661	$707,000	32	$640,000	$1,347,000	$472,000	$1,819,000
REACH-05[1]		2,683	15,278						17,961	$1,042,000	54	$1,080,000	$2,122,000	$745,000	$2,867,000
REACH-06[1]				23,410	16,300				39,710	$3,194,000	116	$2,320,000	$5,514,000	$1,933,000	$7,447,000
REACH-07[1]		10,577							10,577	$560,000	31	$620,000	$1,180,000	$414,000	$1,594,000
REACH-08[1,2]		7,175							7,175	$380,000	21	$420,000	$800,000	$280,000	$1,080,000
REACH-09[1,2]		5,879							5,879	$311,000	17	$340,000	$651,000	$228,000	$879,000
REACH-10[1]		13,064							13,064	$692,000	39	$780,000	$1,472,000	$516,000	$1,988,000
REACH-11[1]		7,932							7,932	$421,000	24	$480,000	$901,000	$316,000	$1,217,000
REACH-12[1]		2,595							2,595	$138,000	8	$160,000	$298,000	$105,000	$403,000
REACH-13				3,406	539	368			4,313	$470,000	20	$400,000	$870,000	$316,000	$1,186,000
REACH-14				3,351	3,935	304			7,590	$861,000	28	$560,000	$1,421,000	$510,000	$1,931,000
REACH-15				1,882					1,882	$195,000	7	$140,000	$335,000	$121,000	$456,000
REACH-16			1,236	1,791					3,027	$285,000	13	$260,000	$545,000	$197,000	$742,000
REACH-17		701	2,113						2,814	$231,000	12	$240,000	$471,000	$171,000	$642,000
REACH-18		1,674	1,289	326					3,290	$266,000	11	$220,000	$486,000	$177,000	$663,000
REACH-19			2,217	5,629					7,846	$760,000	29	$580,000	$1,340,000	$484,000	$1,824,000
REACH-20				1,083					1,083	$108,000	4	$80,000	$188,000	$66,000	$254,000
REACH-21					1,632				1,632	$197,000	5	$100,000	$297,000	$106,000	$403,000
REACH-22		1,839	3,139						4,979	$400,000	23	$460,000	$860,000	$311,000	$1,171,000
REACH-23		161	553	2,711					3,426	$338,000	12	$240,000	$578,000	$208,000	$786,000
REACH-24		4,289	5,108						9,396	$750,000	42	$840,000	$1,590,000	$572,000	$2,162,000
REACH-25		1,021	1,026						2,047	$164,000	11	$220,000	$384,000	$142,000	$526,000
REACH-26				1,569					1,569	$151,000	5	$100,000	$251,000	$91,000	$342,000
REACH-27		782							782	$60,000	4	$80,000	$140,000	$51,000	$191,000
REACH-28		300	250						550	$44,000	2	$40,000	$84,000	$31,000	$115,000
REACH-29		305							305	$23,000	1	$20,000	$43,000	$16,000	$59,000
REACH-30	395								395	$30,000	2	$40,000	$70,000	$25,000	$95,000
REACH-31		158	813	752					1,723	$157,000	12	$240,000	$397,000	$143,000	$540,000
REACH-32			733						733	$60,000	4	$80,000	$140,000	$51,000	$191,000
REACH-33				41					41	$5,000	1	$20,000	$25,000	$9,000	$34,000
REACH-34				1,217					1,217	$126,000	4	$80,000	$206,000	$74,000	$280,000
REACH-35				464					464	$45,000	2	$40,000	$85,000	$31,000	$116,000
REACH-36				1,924					1,924	$198,000	7	$140,000	$338,000	$122,000	$460,000
REACH-37						208			208	$29,000	2	$40,000	$49,000	$18,000	$67,000
REACH-38							229		229	$42,000	1	$20,000	$82,000	$30,000	$112,000
REACH-39							116		116	$22,000	1	$20,000	$42,000	$15,000	$57,000
REACH-40						56			56	$8,000	1	$20,000	$28,000	$10,000	$38,000
REACH-41				180					180	$18,000	3	$60,000	$78,000	$29,000	$107,000
REACH-42						62			62	$9,000	1	$20,000	$29,000	$11,000	$40,000
REACH-43				458					458	$44,000	2	$40,000	$84,000	$30,000	$114,000
REACH-44			1,610	321					1,931	$172,000	9	$180,000	$352,000	$129,000	$481,000
REACH-45			3,216	1,221					4,437	$405,000	22	$440,000	$845,000	$304,000	$1,149,000
REACH-46[3]							5766[2]	18,886[2]	24,642	--[3]	--[3]	--[3]	--[3]	--[3]	--[3]
Grand Total	**395**	**74,555**	**63,251**	**65,443**	**22,406**	**998**	**6,111**	**18,886**	**252,034**	**$16,583,000**	**765**	**$15,300,000**	**$31,883,000**	**$11,316,000**	**$43,199,000**

Notes:

[1] YR 2014 & YR 2030 Future Projected Pipes

[2] YR 2014 & YR 2030 Future Projected Pipes for SCLA

[3] Future pipe sizes for VVWRA trunk lines were not determined because future inflows to VVWRA trunk lines from outside the City of Victorville were not known.

[4] 10% for Engineering Cost and 25% for Contingency. Percentage of Total Construction Cost.

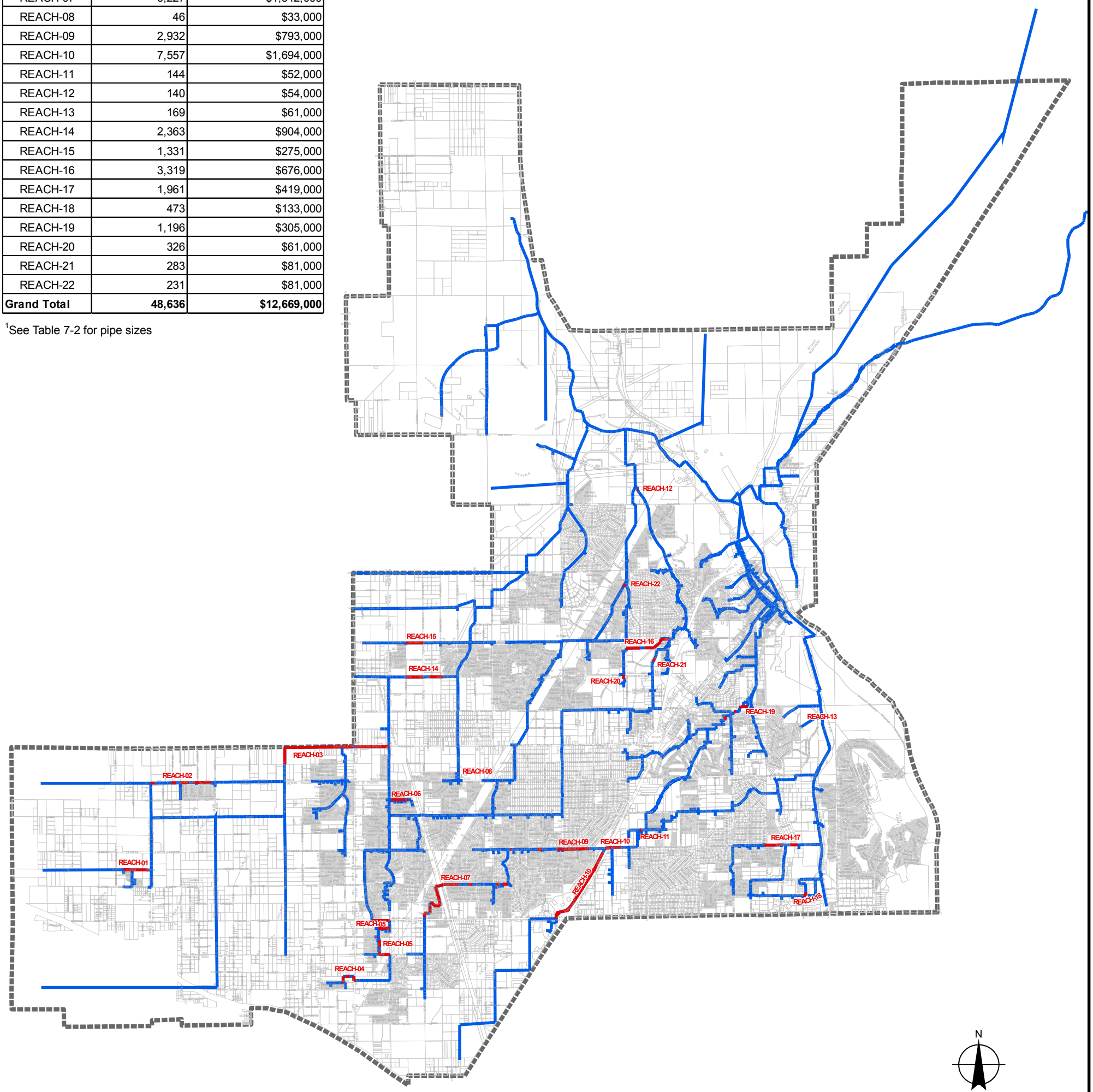
Assumptions:

1) Average distance between two manholes (in 350
2) Estimated Cost of one 48-inch manhole ($): $20,000
3) Engineering Markup (% of total construction) 10%
4) Contingency Markup (% of total construction 25%
5) Contingency includes:
 i) Geotechnical investigation;
 ii) Temporary pipeline bypasses;
 iii) Permitting;
 iii) Administrative Costs

Year 2030
Capital Improvement Pipes

REACH	Total Pipe Length[1] (feet)	Estimated Total Pipe Improvement Cost ($)
REACH-01	1,877	$483,000
REACH-02	2,611	$655,000
REACH-03	9,104	$3,010,000
REACH-04	1,279	$270,000
REACH-05	3,918	$1,018,000
REACH-06	1,149	$269,000
REACH-07	6,227	$1,342,000
REACH-08	46	$33,000
REACH-09	2,932	$793,000
REACH-10	7,557	$1,694,000
REACH-11	144	$52,000
REACH-12	140	$54,000
REACH-13	169	$61,000
REACH-14	2,363	$904,000
REACH-15	1,331	$275,000
REACH-16	3,319	$676,000
REACH-17	1,961	$419,000
REACH-18	473	$133,000
REACH-19	1,196	$305,000
REACH-20	326	$61,000
REACH-21	283	$81,000
REACH-22	231	$81,000
Grand Total	**48,636**	**$12,669,000**

[1]See Table 7-2 for pipe sizes



DRAFT FINAL

Legend

Wastewater Collection System

- Pipes for 2030 CIP
- Existing Pipes Meeting d/D Criteria

Planimetric

- Parcels
- Sphere of Influence

EarthTech
A tyco International Ltd. Company

CITY OF VICTORVILLE
DEPARTMENT OF ENGINEERING

Figure 7-2

Capital Improvement Pipes for Year 2030

Sewer System Master Plan
City of Victorville, CA

DATE: March 27, 2008

EARTH TECH INC., LONG BEACH, CA

TAB NO.

C:\Projects\Victorville\ArcGIS\CIP\2030 cip.mxd

TABLE 7-2: Capital Improvement Pipes for YR 2030

REACH	Installed Pipe Length (feet)								CONSTRUCTION COST				Estimated Total Construction Cost (including Manhole) ($)	Estimated Engineering, Contingency Costs[1] ($)	Estimated Total Pipe Improvement Cost ($)
	8-inch	10-inch	12-inch	15-inch	18-inch	21-inch	27-inch	36-inch	Total Pipe Length (feet)	Pipe Removal and Installation Cost ($)	Approximate number of Manholes Required	Estimated Manhole Cost ($)			
REACH-01			1,877						1,877	$195,000	8	$160,000	$355,000	$128,000	$483,000
REACH-02			620	1,991					2,611	$304,000	9	$180,000	$484,000	$171,000	$655,000
REACH-03					1,289	6,397	1,418		9,104	$1,520,000	35	$700,000	$2,220,000	$790,000	$3,010,000
REACH-04	1279								1,279	$98,000	5	$100,000	$198,000	$72,000	$270,000
REACH-05			3,918						3,918	$408,000	17	$340,000	$748,000	$270,000	$1,018,000
REACH-06		1,149							1,149	$98,000	5	$100,000	$198,000	$71,000	$269,000
REACH-07	5564	662							6,227	$486,000	25	$500,000	$986,000	$356,000	$1,342,000
REACH-08		46							46	$4,000	1	$20,000	$24,000	$9,000	$33,000
REACH-09			2,932						2,932	$304,000	14	$280,000	$584,000	$209,000	$793,000
REACH-10		6,407		1,149					7,557	$689,000	29	$580,000	$1,269,000	$454,000	$1,694,000
REACH-11				144					144	$18,000	1	$20,000	$38,000	$14,000	$52,000
REACH-12					140				140	$20,000	1	$20,000	$40,000	$14,000	$54,000
REACH-13					169				169	$25,000	1	$20,000	$45,000	$16,000	$61,000
REACH-14								2,363	2,363	$507,000	8	$160,000	$667,000	$237,000	$904,000
REACH-15	1331								1,331	$102,000	5	$100,000	$202,000	$73,000	$275,000
REACH-16	3319								3,319	$256,000	12	$240,000	$496,000	$180,000	$676,000
REACH-17		1,961							1,961	$169,000	7	$140,000	$309,000	$112,000	$419,000
REACH-18	389	84							473	$38,000	3	$60,000	$98,000	$35,000	$133,000
REACH-19			1,196						1,196	$124,000	5	$100,000	$224,000	$81,000	$305,000
REACH-20	326								326	$25,000	1	$20,000	$45,000	$16,000	$61,000
REACH-21					283				283	$40,000	1	$20,000	$60,000	$21,000	$81,000
REACH-22						231			231	$40,000	1	$20,000	$60,000	$21,000	$81,000
Grand Total	**12,208**	**10,310**	**10,544**	**3,284**	**1,882**	**6,628**	**1,418**	**2,363**	**48,636**	**$5,470,000**	**194**	**$3,880,000**	**$9,350,000**	**$3,350,000**	**$12,669,000**

Notes:
[1] 10% for Engineering Cost and 25% for Contingency. Percentage of Total Construction Cost.

Assumptions:
1) Average distance between two manholes (in ft): 350
2) Estimated Cost of one 48-inch manhole ($): $20,000
3) Engineering Markup (% of total construction): 10%
4) Contingency Markup (% of total construction): 25%
5) Contingency includes:
 i) Geotechnical investigation;
 ii) Temporary pipeline bypasses;
 iii) Permitting;
 iii) Administrative Costs

installation and removal were estimated utilizing Timberline Estimating Software Version 9.2 (See Appendix C). The unit costs were based on local market conditions for materials, labor productivity rates, equipment, vendors, subcontractors and other direct costs. A thirty-five percent industry standard markup was added to the construction costs to account for easement acquisition, engineering design, construction bonding, administrative and contingency costs.

The total capital costs for the 2014 and 2030 Capital Improvement Programs are estimated at $43,199,000 and $12,669,000, respectively. The 2014 capital costs are comprised of $25,865,000 for installation of new piping to service future growth areas, and $17,334,000 to upgrade existing piping to meet the hydraulic criteria for 2014 demands. The 2030 Capital Improvement Program cost of $12,669,000 is for upgrading existing piping to meet the hydraulic criteria for 2030 demands. A detailed cost estimate by pipe reach for each Capital Improvement Program is provided in Appendix D.