CITY OF PALMDALE

# City of Palmdale Sewer Master Plan Final Report

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Water and Environment

In Association with:

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**September, 2009**

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# List of Abbreviations

| | |
|---|---|
| ACO | Accumulated Capital Outlay |
| BO | Buildout |
| CCTV | Closed-Circuit Television |
| CIP | Capital Improvement Program |
| CSMD | Consolidated Sewer Maintenance District |
| CY | Cubic Yard |
| d/D | Depth over Diameter |
| DU | Dwelling Unit |
| DWF | Dry Weather Flow |
| EAVTAM | Enhanced Antelope Valley Transportation Analysis Model |
| ENR | Engineering News Record |
| GPCEU | General Plan Circulation Element Update |
| GP Amendment | 2004-2005 General Plan Amendment to the 1993 Palmdale General Plan Update |
| gpd | Gallons per Day |
| gpm | Gallons per Minute |
| GWDR | General Waste Discharge Requirements |
| I/I | Infiltration and Inflow |
| LACSD | Sanitation District of Los Angeles County |
| LACSD-14 | Sanitation District 14 of the Sanitation Districts of Los Angeles County |
| LACSD-20 | Sanitation District 20 of the Sanitation Districts of Los Angeles County |
| LF | Linear Foot |
| LWRP | Lancaster Water Reclamation Plant |
| mgd | Million Gallons per Day |
| NASSCO | National Association of Sewer Service Companies |
| PACP | Pipeline Assessment and Certification Program |
| PVC | Polyvinyl Chloride Pipe |
| PWRP | Palmdale Water Reclamation Plant |
| PWRP Plan | Palmdale Water Reclamation Plan 2025 Plan and EIR |
| QSR | Quick Structural Rating |
| SCAG | Southern California Association of Governments |
| SSMP | Sewer System Management Plan |
| TAZ | Traffic Analysis Zone |
| VCP | Vitrified Clay Pipe |
| WWF | Wet Weather Flow |

# ES-1 Executive Summary

## ES-1.1 Background and Purpose

In July of 2008, the City of Palmdale (City) retained RMC Water Environment, Inc. (RMC), with Larson Consulting as a subconsultant, to assist City staff with a number of tasks related to the planning, operation and maintenance of its sewer system. Included in these assignments was the preparation of a Sewer System Management Plan (SSMP) satisfying the requirements of the State Water Resources Control Board Order 2006-0003: Statewide General Waste Discharge Requirements for Sanitary Sewer Systems. The City's SSMP was completed in May 2009. The SSMP includes several required elements, including a Rehabilitation and Replacement Program (part of Element 4 – Operations and Maintenance Program) and a System Evaluation and Capacity Assurance Plan (Element 8).

This Sewer Master Plan (Master Plan) Report documents in detail those two elements of the City's SSMP. The Master Plan is referenced in the SSMP, and supplements the summaries of those elements provided in the SSMP. Specifically, the Master Plan presents:

- An analysis of the hydraulic capacity of the City's sewer system under current and future flow conditions, and recommended capital improvements required to ensure adequate capacity to serve new development
- An assessment of the structural condition of the City's sewer system based on video inspections performed to date, and a recommended sewer repair/renewal/replacement program to maintain sound structural condition in the future

## ES-1.2 Study Area and Existing Sewer System

The study area for this Master Plan consists of the portion of the City's Sphere of Influence that is currently served and will be served in the future by gravity to the Palmdale Water Reclamation Plant (PWRP) or the Lancaster Water Reclamation Plant (LWRP), operated by the County Sanitation Districts of Los Angeles County (LACSD). This area excludes about 30 square miles of unincorporated land in the eastern portion of the City's Sphere of Influence that is expected to be served by a separate sewer system and a third treatment plant sometime after 2030.

The City's sewer system consists of 396 miles of sewers ranging in size from 8 to 21 inches in diameter. The system operates almost totally by gravity, having only two small pump stations. The City's sewers are constructed of clay pipe and are relatively new; the oldest pipes were installed in 1952, 86 percent were built after 1980, and the average age is only 21 years (the average service life of clay pipe is estimated to be 80 to 100 years).

Besides these 396 miles of City sewers, there are an additional 48 miles of large-diameter trunk sewers in the study area that are owned and operated by LACSD and that convey the City's wastewater to the PWRP and LWRP. There are also an additional 9 miles of small-diameter sewers serving unincorporated areas that are owned and operated by the Consolidated Sewer Maintenance District (CSMD) of the Los Angeles County Department of Public Works. Neither the LACSD trunk sewers nor the CSMD sewers are the City's responsibility, and therefore improvements to those sewers are not included in the Master Plan recommendations. However, the capacity assessment considered wastewater flow from the unincorporated areas served by CSMD sewers, and the capacity of the LACSD trunk sewers was assessed along with the City's sewers since they are hydraulically interconnected.

## ES-1.3 Hydraulic Capacity Analysis

The hydraulic capacity analysis covered 142 miles of the largest sewers in the study area, including all of the LACSD trunk sewers. The analysis was conducted using a computerized dynamic model (InfoWorks™ hydraulic modeling software). The information required for the model (pipe diameters and

lengths, invert and ground elevations, etc.) was obtained from the City's GIS database and validated to ensure the information was complete and accurate.

The current and future flows in the modeled sewers were estimated by dividing the study area into approximately 600 subareas and computing flows in each of the subareas for three time periods: 2006, 2030, and Buildout. The flows were estimated using planning information from several sources, primarily the City's detailed inventory and projections of its housing units and employment performed as part of its General Plan Circulation Element Update. Other data sources used in estimating flows included census data, general and specific plans, parcel-level land use and sewer billing data, and water consumption records for major dischargers. The flow projections also assumed that the 2,700 parcels in the study area that are currently on septic tanks (about 1,000 of which are within the City limits) would eventually be connected to the sewer system. The population within the City's Sphere of Influence is projected to increase from an estimated 151,000 in 2006 to 238,000 in 2030 to 300,000 at buildout. Employment is projected to increase at a much higher rate, from 41,000 in 2006 to 115,000 in 2030, to 168,000 at buildout.

The unit flow factors (e.g., flow per capita and per employee) and 24-hour flow profiles used to convert the population and employment estimates to wastewater flows were calibrated using the results of flow monitoring studies performed by LACSD at 34 locations in 2006. The resulting average dry weather flow from the study area (sum of flow to PWRP and LWRP) is projected to increase from 10.4 million gallons per day (mgd) in 2006 to 20.3 mgd in 2030, to 27.6 mgd at buildout. The additional peak flow that may enter the sewers briefly during extreme wet weather periods was determined based on a review of four years daily flow records from the PWRP, and was estimated to be about 6 mgd under 2006 conditions. Since the source of the additional wet weather flows could not be determined using available flow monitoring data, the flow was distributed to all sewers, with more flow distributed to older sewers.

The capacity of the modeled sewers was assessed under both peak dry and peak wet weather flow conditions. For Year 2006, all of the City's sewers were found to satisfy the City's criteria for adequate capacity under both dry and wet weather flow conditions. The LACSD trunk sewers in the City were found to have only minor capacity deficiencies under dry weather flow conditions, but had potential deficiencies under wet weather flow conditions that could occur during extreme rainfall events but that should not be severe enough to cause sewer overflows. One of these trunk sewer deficiencies was previously known and is being addressed by LACSD through construction of the new Trunk A Relief Sewer on Technology Drive.

Under 2030 dry weather flow conditions, only one reach of City sewer (along 45$^{th}$ St. E) is projected to have a capacity deficiency, but several LACSD trunk sewers are indicated to be deficient. Under 2030 wet weather conditions, one additional deficiency on a City sewer was identified (near 30$^{th}$ St. W) as a result of development in Joshua Ranch. Several deficiencies on LACSD trunk sewers are projected, including some that could pose a significant overflow risk if not relieved. Deficiencies that would not occur until after 2030 were not addressed in the Master Plan. However, the projected buildout flows were used to size sewers required to correct the deficiencies identified for 2006 and 2030 conditions.

A capital improvement project is recommended to address the deficiency on 45$^{th}$ St. E. This project consists of a mile of 18-inch diameter sewer between Ave. R and Ave. S, and has an estimated planning-level total capital cost of $2.7 million (including 30% contingency and 25% for engineering, construction management, legal, and administrative costs). The project is not needed until most of the planned upstream development occurs, and the Master Plan provides an estimate of the amount of development needed to trigger the project. It is noteworthy that the LACSD trunk sewer on 45$^{th}$ St. E downstream of the City sewer is projected to require relief prior to the City's project. The City will share the results of this Master Plan with LACSD and coordinate efforts on sewer projects along 45$^{th}$ St. E.

A second capital improvement project, related to the Joshua Ranch development, consists of a half-mile of 10-inch sewer with an estimated capital cost of $1.2 million. This project is not needed under 2030 dry

weather flow conditions, and would only be required if future wet weather flows reached the magnitude assumed in the analysis. The occurrence of the projected peak wet weather flows would need to be confirmed through flow monitoring before planning for this project proceeds, and the project should be deferred until such confirmation.

In addition to 142 miles of existing sewers, the hydraulic model included 28 miles of future sewer extensions that will be needed to serve outlying developments. The Master Plan shows the size and locations of those extensions, and provides a planning-level capital cost estimate of $54 million for all of these new sewers. This information may be useful to the City in future sewer planning studies as well as in financial planning of connection fees or other methods for recovering the costs of new development.

Because no site-specific monitoring of wet weather flows has been performed in the City, the Master Plan recommends that initial monitoring of water levels be performed at four high-priority sites where available capacity for high wet weather flows is most limited. These sites include two locations along 45th St. E where City and LACSD capital improvements are recommended to handle future development. The level monitoring, and follow-up flow monitoring as needed, should be used to help prioritize capacity projects.

## ES-1.4 Structural Condition Assessment

The Master Plan also includes an assessment of the structural condition of the City's sewer system and a near-term and long-term repair/renewal/replacement program to maintain sound structural condition in the future. The near-term program was based on the findings of initial internal video inspections of 62 miles of City sewers performed in 2008 by CSMD, using accumulated capital outlay (ACO) funds. The long-term program was based on the age distribution of sewers and their expected remaining service lives.

The condition of the 62 miles of inspected sewers was quantified using an industry-standard system for categorizing and rating structural defects. The system includes five grades of defects, ranging from Grade 1 to Grade 5. Grade 5 defects are the most severe, and are considered likely to result in pipe failure within 5 years. Grade 4 defects are the next-worst, and are considered likely to fail in 5 to 10 years. At the other end of the spectrum are Grade 1 defects, which are minor and unlikely to cause pipe failures in the foreseeable future. A failure would result in a partial or total blockage of the sewer that could lead to an overflow if not corrected. Because the 62 miles of inspected sewers included a distribution of pipes built in various decades starting in the 1950's, the findings of this initial condition assessment provided a solid basis for assessing the overall condition of the sewer system.

The inspections showed that the City's system is in excellent condition. Only a single Grade 5 defect was found, and only 2 percent of the inspected sewers had one or more Grade 4 defects. Almost 88 percent of the inspected pipes had no defects at all. These findings were extrapolated to the entire 396-mile system, assuming that pipes built in same decade are in similar condition. This extrapolation concluded that the overall system is likely to be in even better condition than the inspected sewers, since older sewers were somewhat over-represented. Only 1.5 percent of the overall system is expected to have Grade 4 or 5 defects.

The seven inspected pipe segments originally found to have Grade 4 or Grade 5 defects were referred to CSMD for further review and correction. CSMD lined four of the pipes using ACO funds and concluded that the other three did not pose an immediate risk of failure and should be re-inspected in the future. Additional review of all Grade 4 and 5 defects performed as part of this Master Plan study resulted in a recommendation to re-inspect the pipes in five years and to perform no improvements on those pipes at this time. The Master Plan also includes decision criteria for the City to use in the future to decide on appropriate re-inspection intervals ranging from 5 to 20 years based on the severity of observed defects, as well as to select a method for correcting Grade 5 defects (either spot repairs, manhole-to-manhole lining or other rehabilitation methods, or pipe replacement). The Master Plan also provides prioritization criteria for use in scheduling inspections of the remainder of the City's sewers over the next few years.

Continued video inspection and condition assessment will be used to make near-term repair/renewal/replacement decisions based on observed structural condition. Over the long-term, the condition of all sewers will degrade and eventually they will need to be renewed or replaced. The Master Plan provides estimates of long-term renewal and replacement budgetary needs based on the footage of City sewers built in various years, assumptions on sewer service lives, and unit costs for renewal/replacement. The key assumption in this long-term analysis is that clay pipe will have an average service life of 80 to 100 years, depending on whether they were built before or after 1959. Furthermore, it was assumed that pipes may fail as much as 30 years before or after the expected failure date based on the average service life. Using these failure estimates, the year in which each sewer pipe was built, and average costs for renewal/replacement of sewers by pipe size, year-by-year capital improvement costs were estimated for the next 100-plus years.

This long-term analysis concluded that the oldest sewers in the City have yet to reach their estimated service lives, but that some early failures can be expected to start occurring soon. The estimated annual capital costs for renewal/replacement (excluding repairs) over the next 50+ years (2010 to 2060) averages about $1.2 million (all costs are in 2008 dollars). In the first decade (2010 to 2019, including pre-2010 backlog), the annual cost is about $0.6 million. The cost rises to $0.8 million in the following decade, and then remains at about $1.5 million for the following three decades. The actual costs the City can expect to incur over the next 50 years are highly sensitive to the service life assumptions and the effectiveness of ongoing maintenance and spot repairs in extending those service lives.

A prudent approach for the City at this time would be to establish an annual repair/renewal/replacement budget of $0.6 to $1.2 million (in addition to the cost of inspection/assessment), and to periodically reassess this budget based on observed conditions from the ongoing video inspection program as well as actual costs for renewal/replacement work performed. These funds should be collected and deposited in a sinking fund each year irrespective of the actual construction done, to be available in years when costs exceed sewer service revenue. The funds should be earmarked as available only for repair/renewal/ replacement and not for normal operating expenses or other non-sewer related city operating costs. The City Council should formalize this process through a written policy statement or ordinance provision establishing the sanitary sewer replacement sinking fund to protect the accumulated reserves and to define the needs and allowable uses for the funds now and into the future.

# Chapter 1 Introduction

This introductory chapter provides background information on the scope and objectives of the City of Palmdale Sewer System Master Plan (Master Plan), the Study Area and sewer systems, and the contents and organization of the Master Plan report.

## 1.1 Background and Study Objectives

In July of 2008, the City of Palmdale (City) retained RMC Water Environment, Inc. (RMC) to assist City staff with a number of tasks related to the planning, operation and maintenance of its sewer system. RMC's team included Larson Consulting as a subconsultant.

The major deliverables of this overall consulting assignment are:

- Collection System Operation and Maintenance Implementation Plan (May, 2009), presenting organizational options and an implementation plan for the City to undertake the operation and maintenance of its sewer system beginning on July 1, 2009.
- Sewer System Management Plan (SSMP) (May, 2009), satisfying the requirements of the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems (GWDR)
- Sewer Master Plan Report (this report), documenting the wastewater flow and hydraulic capacity analysis, sewer condition assessment and the repair/renewal/replacement program, and recommended capital improvements.

The objectives of the Sewer Master Plan study documented in this report are:

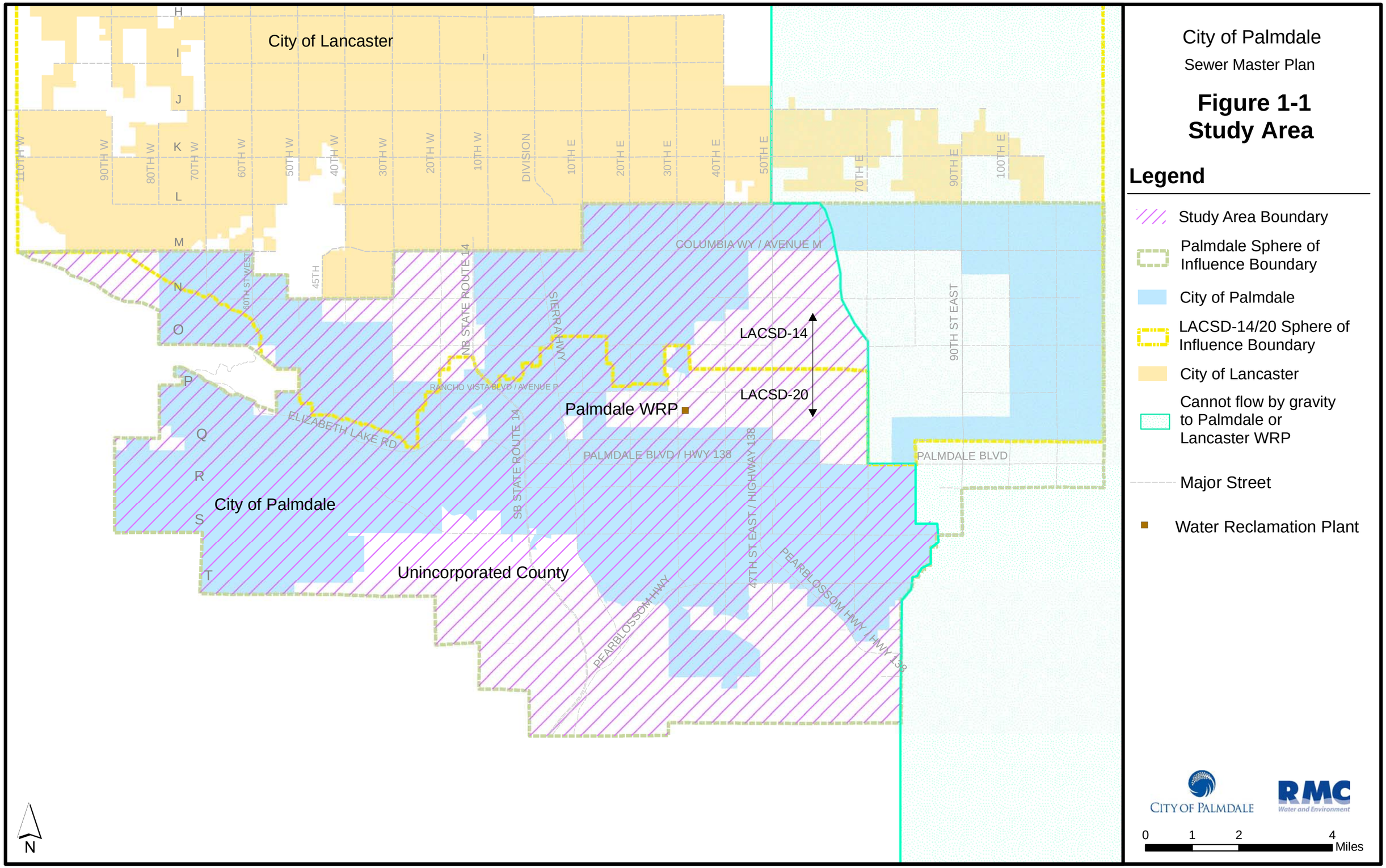
- Estimate existing and future wastewater flows in the Study Area
- Develop and apply a hydraulic model of the City's major sewers to identify any existing or future capacity deficiencies
- Prepare a capital improvement program consisting of projects required to ensure adequate capacity on the City's major sewers and to serve new development
- Assess the condition of the existing gravity sewer system through analysis of video inspections, and develop a repair/renewal/replacement program

## 1.2 Study Area

The Study Area for this Master Plan is shown on Figure 1-1, and generally coincides with the City of Palmdale's Sphere of Influence, which includes the current City limits and surrounding unincorporated areas of Los Angeles County. However, the Study Area excludes the eastern portion of the Sphere of Influence that cannot be served by gravity to the existing Palmdale Water Reclamation Plant (PWRP) or the Lancaster Water Reclamation Plant (LWRP). That area is not expected to develop until a new treatment plant is built, which is not anticipated before 2030. The Study Area covers all 105 square miles within the City limits and 143 of the 174 square miles that lie within the City of Palmdale's Sphere of Influence. Portions of the Study Area lie within Sanitation Districts 14 and 20 of the County Sanitation Districts of Los Angeles County (LACSD).

## 1.3 Existing Sewer System

The existing sewer systems within the Study Area are shown on Figure 1-2. They include sewers owned and operated by the City, trunk sewers owned and operated by LACSD, and sewers in unincorporated areas owned by Los Angeles County and operated by the Consolidated Sewer Maintenance District (CSMD), a sewer maintenance district managed by the Los Angeles County Department of Public Works.


City of Palmdale
Sewer Master Plan
Figure 1-1
Study Area
Legend
Study Area Boundary
Palmdale Sphere of Influence Boundary
City of Palmdale
LACSD-14/20 Sphere of Influence Boundary
City of Lancaster
Cannot flow by gravity to Palmdale or Lancaster WRP
Major Street
Water Reclamation Plant
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
PALMDALE BLVD
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
47TH ST EAST / HIGHWAY
90TH ST EAST
SB STATE ROUTE 14
NB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
110TH W
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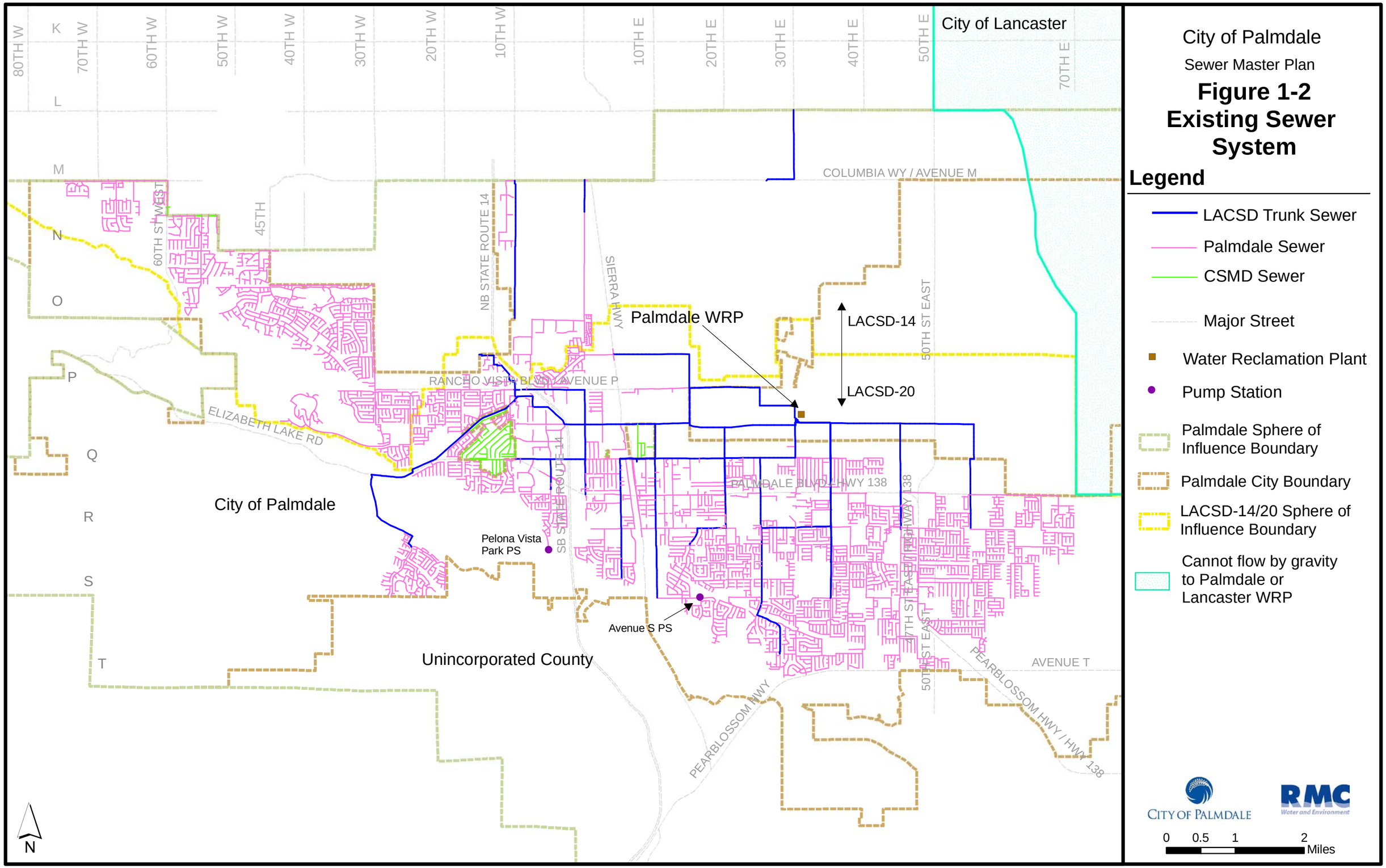
City of Palmdale
Sewer Master Plan
Figure 1-2
Existing Sewer System
Legend
LACSD Trunk Sewer
Palmdale Sewer
CSMD Sewer
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
Pelona Vista Park PS
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
AVENUE T
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
50TH ST EAST
47TH ST EAST
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Most of the City's sewers convey wastewater for treatment at the Palmdale Water Reclamation Plant (PWRP), and are within County Sanitation District 20 (LACSD-20). Some of the sewers in the northern portion of the Study Area discharge to LACSD trunk sewers that convey flow to the Lancaster Water Reclamation Plant (LWRP), and are within County Sanitation District 14 (LACSD-14).

The estimated total length of sewers in the Study Area is 453 miles, of which 396 miles (87%) are City sewers, 48 miles (11%) are LACSD trunk sewers, and 9 miles (2%) are CSMD sewers. The sewer system operates almost entirely by gravity. There are also approximately 2,726 septic tanks, of which about 1,000 are within the City.

The primary focus of this Master Plan is the sewer system owned by the City, which the City is responsible for ensuring adequate hydraulic capacity, maintaining, repairing, renewing, and replacing as needed. The City's sewer system consists of about 396 miles of mains, 8,441 manholes, and two small pump stations. The Avenue S Pump Station consists of two 5-horsepower (hp) pumps and has a firm capacity of 0.22 mgd. Its 4-inch force main is 1,000 feet long. The Pelona Vista Pump Station serves a small restroom in a park, consists of a single 0.5 hp pump, and discharges to a 1,780-foot long 4-inch force main. A third pump station is pending approval from the City and is part of the Ritter Ranch development.

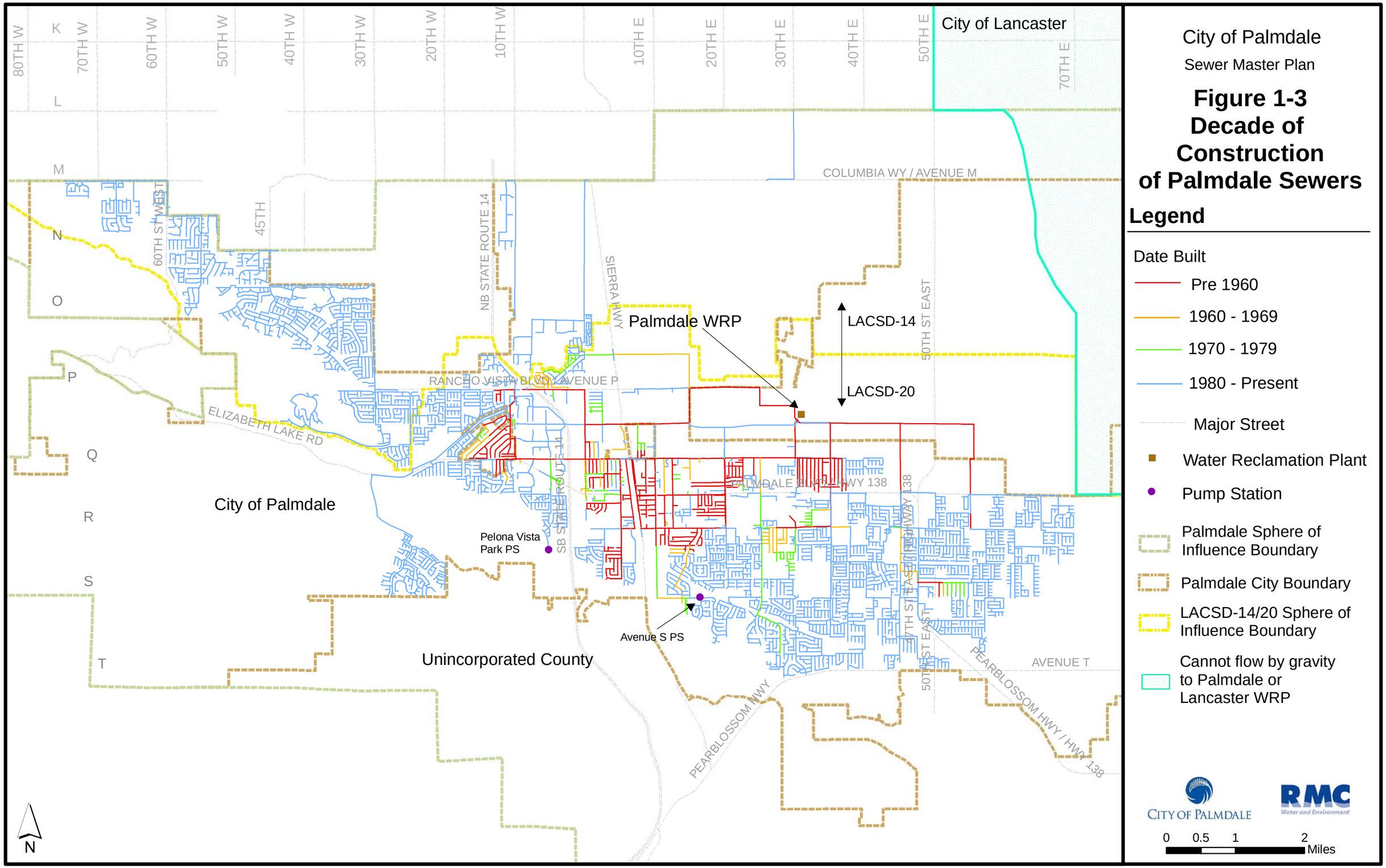
The City's 395 miles of gravity sewer mains range in size from 8 to 21 inches in diameter, with over 85 percent being 8 inches. Essentially all of the gravity mains are clay pipe. The oldest sewers were installed in 1952, but 86 percent were built after 1980 and the average sewer age is only 21 years. Table 1-1 provides a breakdown of City's gravity sewers by diameter, and Table 1-2 by decade of construction. Figure 1-3 shows the decade of construction of all sewers in the City, including the LACSD and CSMD sewers.

**Table 1-1: Pipe Diameters of City of Palmdale Gravity Sewers**

| Diameter (inches) | Number | Length (ft) | Length (miles) | % of Total |
|---|---|---|---|---|
| 8 | 7,347 | 1,782,884 | 337.7 | 85.5 |
| 10 | 543 | 129,634 | 24.6 | 6.2 |
| 12 | 367 | 87,175 | 16.5 | 4.2 |
| 15 | 286 | 74,920 | 14.2 | 3.6 |
| 16 | 1 | 248 | 0.1 | 0.01 |
| 18 | 40 | 9,056 | 1.7 | 0.4 |
| 21 | 3 | 700 | 0.1 | 0.03 |
| Unknown | 5 | 610 | 0.1 | 0.03 |
| Totals | 8,592 | 2,085,226 | 394.9 | 100.0 |

**Table 1-2: Decade of Construction of City of Palmdale Gravity Sewers**

| Year Constructed | Number | Length (ft) | Length (miles) | % of Total |
|---|---|---|---|---|
| 1950-1959 | 679 | 181,821 | 34.4 | 8.7 |
| 1960-1969 | 218 | 55,931 | 10.6 | 2.7 |
| 1970-1979 | 224 | 53,517 | 10.1 | 2.6 |
| 1980-Present | 7,471 | 1,793,956 | 339.8 | 86.1 |
| Totals | 8,592 | 2,085,226 | 394.9 | 100.0 |


City of Palmdale
Sewer Master Plan
Figure 1-3
Decade of Construction of Palmdale Sewers
Legend
Date Built
Pre 1960
1960 - 1969
1970 - 1979
1980 - Present
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
Pelona Vista Park PS
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
AVENUE T
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
50TH ST EAST
47TH STREET EAST
80TH W
70TH W
60TH W
50TH W
40TH W
30TH W
20TH W
10TH W
10TH E
20TH E
30TH E
40TH E
50TH E
70TH E
K
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0
0.5
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Miles
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The City sewers collect and discharge flow into LACSD trunk sewers at multiple locations. Likewise, the CSMD sewers typically discharge to LACSD trunk sewers without connecting to City of Palmdale sewers. However, there are a few cases in which City sewers discharge to CSMD sewers and vice versa prior to discharging to LACSD trunk sewers. There are no cases in which City of Palmdale sewers discharge to City of Lancaster sewers or vice versa. Figure 1-4 shows these interagency connections.

## 1.4 Scope of Study

The scope of the Master Plan includes analyzing the flows and determining hydraulic capacity deficiencies and required improvements for the major sewers within the City's sewer system. The LACSD trunk sewers and some of the CSMD sewers were included in the hydraulic model, but it is not within the scope of this work to develop improvements for any deficiencies in the trunk sewer or CSMD systems. However, wastewater flows from all sewered unincorporated areas were included in the analysis.

All of the City sewers were included in the assessment of structural condition and repair/renewal/replacement requirements. LACSD and CSMD sewers were not assessed.

## 1.5 Report Organization

The chapters in this report generally conform to the tasks in the scope of work. This section describes the contents of each of the six chapters and the appendices to this Master Plan report.

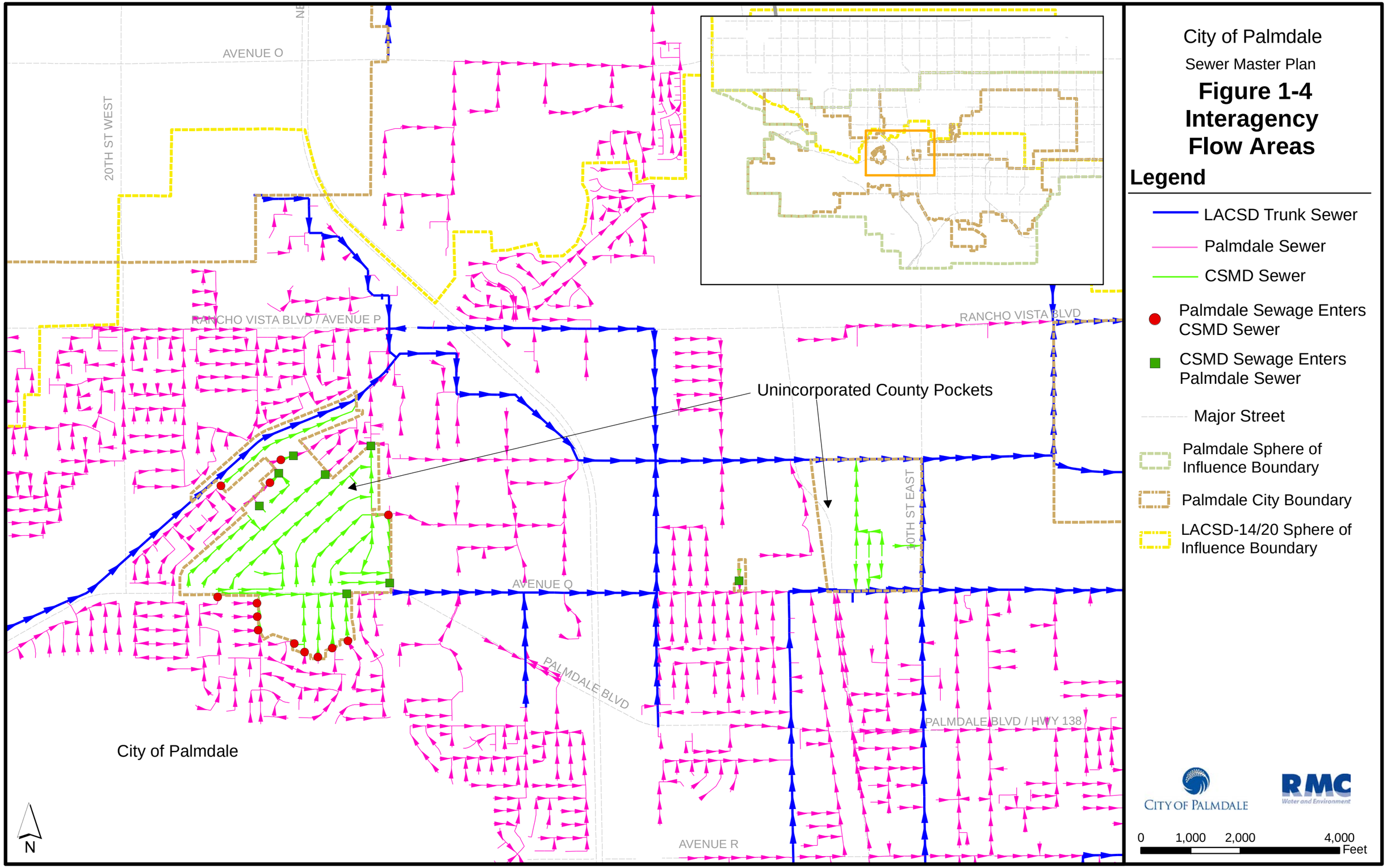
**Chapter 1 – Introduction**
This introductory chapter provides background information on the scope and objectives of the Master Plan, the Study Area and sewer systems, and the contents and organization of the Master Plan report.

**Chapter 2 – Wastewater Flow Estimates**
This chapter presents the methodology used to determine existing and future dry weather wastewater flows for the purposes of sewer capacity modeling. Data sources are documented, followed by a step-by-step description of the procedure used to estimate dry weather flows for the three planning scenarios (existing, 2030, and Buildout).

**Chapter 3 – Hydraulic Model Development**
This chapter documents the procedures used to build and calibrate the InfoWorks™ hydraulic model. The hydraulic model is the primary analytical tool used to determine the flows and capacities of the City's major sewers, and to identify any needed capacity improvements.

**Chapter 4 – Design Flow Criteria**
This chapter documents the design flow criteria that were applied to compute existing and future flows (including peak wet weather flows) for use in the hydraulic capacity analysis of the modeled sewer system. These criteria are based on the findings of the hydraulic model calibration (Chapter 3) and integrate with the wastewater flow estimation methodology (Chapter 2). Also included is a comparison of the criteria used in this Master Plan to the criteria the City uses in sewer studies for specific developments.

**Chapter 5 - Sewer System Capacity Analysis**
This chapter presents the results of the hydraulic capacity analysis of the City's sewer system. The first section of this chapter presents the capacity deficiency criteria used in the analysis. The rest of the chapter presents the results of the existing and future dry and wet weather capacity analysis, identifies existing sewers requiring capacity relief, and describes required capital improvement projects, including planning-level cost estimates.


City of Palmdale
Sewer Master Plan
Figure 1-4
Interagency
Flow Areas
Legend
LACSD Trunk Sewer
Palmdale Sewer
CSMD Sewer
Palmdale Sewage Enters CSMD Sewer
CSMD Sewage Enters Palmdale Sewer
Major Street
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Unincorporated County Pockets
AVENUE O
20TH ST WEST
RANCHO VISTA BLVD / AVENUE P
RANCHO VISTA BLVD
10TH ST EAST
AVENUE Q
PALMDALE BLVD
PALMDALE BLVD / HWY 138
AVENUE R
City of Palmdale
N
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0
1,000
2,000
4,000
Feet

**Chapter 6 – Sewer System Repair/Renewal/Replacement Program**

This chapter presents the City's near-term and long-term gravity sewer system repair, renewal, and replacement needs based on the characteristics of the City's sewer system and the results of the initial 62 miles of sewer video inspections performed. Also presented is a program for the on-going inspection, condition assessment, and repair/renewal/replacement of the City's sewers.

**Appendix A - Landuse and Population Geoprocessing Methodology**

Appendix A is a short summary of the geoprocessing concepts and processes used to generate dry weather flows for hydraulic modeling.

**Appendix B – Dry Weather Calibration Summary Table**

Appendix B shows dry weather calibration data summarized in a table with descriptive comments about each meter's calibration.

**Appendix C – Dry Weather Calibration Plots**

Appendix C shows dry weather calibration plots of modeled vs. metered flow, velocity, and depth for all meters used in calibration.

**Appendix D - Technical Provisions - Sanitary Sewer Condition Assessment and CCTV Inspection Services**

Appendix D consists of the City's technical provisions for sewer condition assessment and CCTV inspection services.

# Chapter 2 Wastewater Flow Estimates

This chapter presents the methodology used to determine existing and future dry weather wastewater flows for the purposes of sewer capacity modeling. Data sources are documented, followed by a step-by-step description of the procedure used to estimate dry weather flows for the three planning scenarios (existing, 2030, and Buildout).

## 2.1 Data Sources

The main sources of land use and flow data available for use in estimating wastewater flows are listed in Table 2-1. The table provides a brief description of each data source, its coverage, format, and use. Details on how each of these data sources was used are covered in subsequent sections of this chapter.

## 2.2 Geographic Units and Planning Scenarios

The existing (2006) sewer service area was divided into 478 geographic units called subcatchments. Each subcatchment is a tributary area for which wastewater flows are computed and then loaded to a manhole on a modeled sewer. The average size of a subcatchment is about 40 acres, with 95% of the subcatchments ranging in size from 20 areas to 150 acres. Figure 2-1 shows the City's existing sewer service area, modeled sewers, and subcatchments.

Since the available source data listed in Table 2-1 are provided in a variety of geographic units (e.g., census blocks, traffic analysis zones (TAZ), land use polygons, parcels, etc.), a significant task in estimating the wastewater flows was to process the available data into subcatchments. Appendix A provides an example of the geoprocessing performed to develop subcatchment data.

Flow estimates are needed for both existing and future development scenarios. The "existing" scenario corresponds to development conditions in the year 2006. The year 2006 was selected for two main reasons:

- The City performed a detailed inventory of its land uses as part of its General Plan Circulation Element Update (GPCEU), based on aerial photographs taken in April of 2006.
- The LACSD metered dry weather wastewater flows in approximately 86 manholes throughout their trunk sewer system in Palmdale during the months of May, October, and December of 2006.

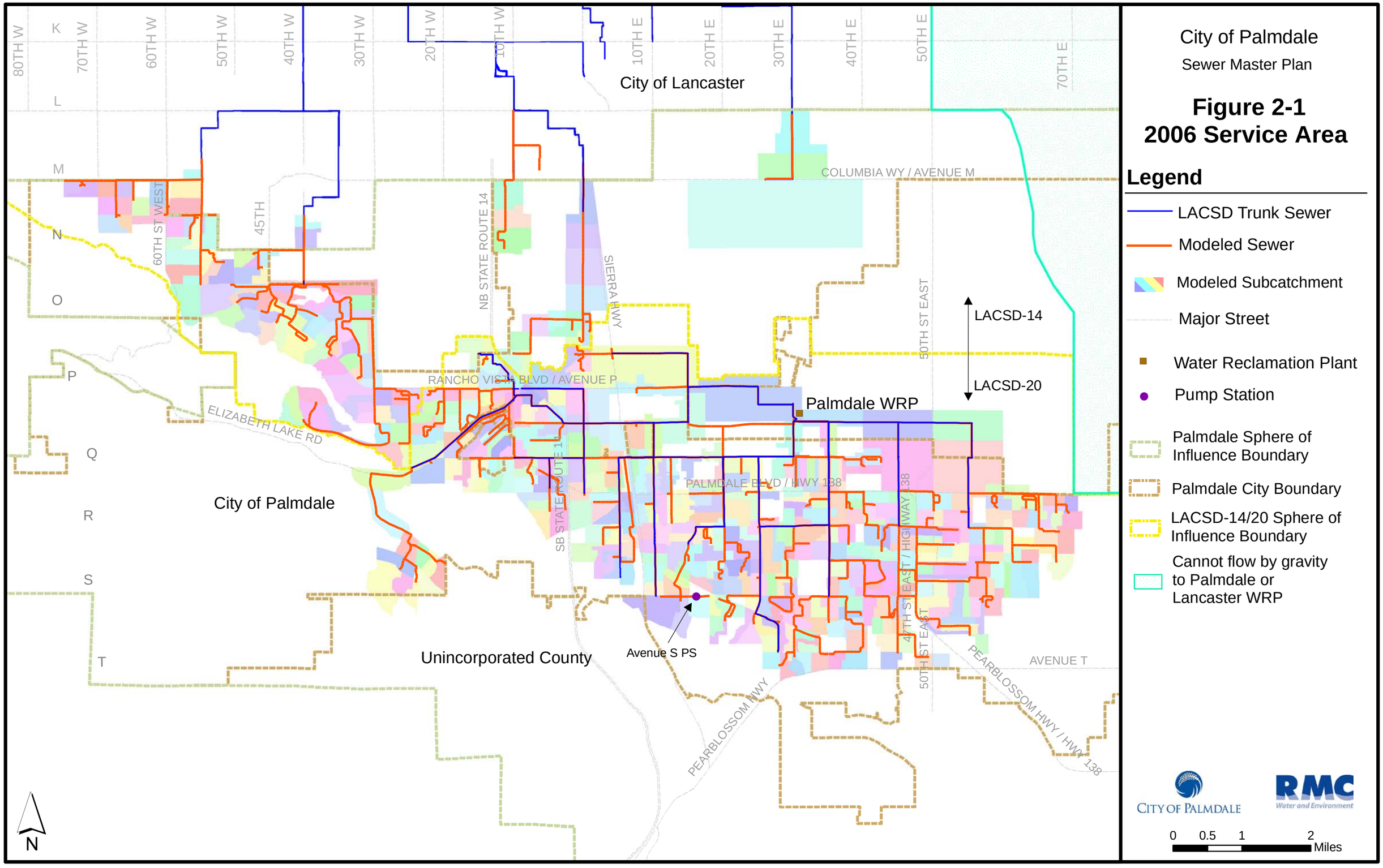
The approximate convergence of these two events was fortunate in that it allowed the model developed based on 2006 land uses to be calibrated using 2006 flow monitoring data.

Flow estimates were also developed for two future scenarios: Year 2030 and Buildout. The year 2030 corresponds to the planning horizon of the City's GPCEU. For this study, the flows projected for the year 2030 were used to identify sewer capacity needs extending over an appropriate planning horizon of 20-plus years. Buildout flows were also based on information from the City's GPCEU, and were used to size City sewers anticipated to be needed by the year 2030. Although the City's GPCEU included growth projections covering the entire City Sphere of Influence, flow estimates were developed only for the Study Area, which is that portion of the City's Sphere that can be served by gravity to either PWRP or LWRP.

The existing and future wastewater flows in each subcatchment must be estimated for each scenario. The following sections describe the data and methods used to develop those estimates. Since the methodology varied by type of development and scenario, separate sections describe existing and future residential and non-residential flow estimates.

**Table 2-1: Data Sources for Wastewater Flow Estimation**

| Data | Source | Description | Geographic Level/ Coverage | Data Format | Use |
|---|---|---|---|---|---|
| Housing/Land Use Inventory and Projections | 2006 General Plan Circulation Element Update (GPCEU) | Year 2006, 2030, and Buildout residential dwelling unit counts and retail and non-retail employee counts by TAZ. | Traffic Analysis Zone (TAZ) Polygons/Sphere of Influence | *. xls | Basis for estimates of housing units and commercial and industrial employee counts by TAZ under 2006, 2030, and Buildout scenarios. |
| Special Trip Generators | Enhanced Antelope Valley Transportation Analysis Model III (City of Palmdale Planning) | Additional employee estimates for special trip-generating properties for 2006, 2030 and Buildout | Traffic Analysis Zone (TAZ) Polygons/Sphere of Influence | *.xls | Added to overall employee counts by TAZ. |
| 2000 Census | U.S. Census Bureau | Year 2000 Population and Household Counts | Census Block/Sphere of Influence | *.dbf, *.shp | Estimate household size by residential land use category and by census blocks. Household sizes were multiplied by dwelling units to compute populations. |
| Sewer Billing Database | Los Angeles County Consolidated Sewer Maintenance District | March 2008 Palmdale Sewer Fee database by APN of all parcels charged fees for collection system service | Parcels/Sphere of Influence | *.dbf, *.shp | Initial identification of developed parcels that were sewered in 2008 as well as parcels on septic in 2008. Adjustments had to be made based on inspection of aerial photographs and input from City staff. |
| Aerial photographs | City of Palmdale | April 2006 Aerial Photographs | Just beyond City boundary | *.tif | Refined identification of developed parcels and sewered parcels in 2006. |
| Residential Housing Unit Density Factors | City of Palmdale | Density factors (dwelling units/ac) by zoning category | Zoning polygons/Sphere of Influence | Hard Copy | Used along with zoning map to distribute housing unit estimates by TAZ to parcels and subcatchments. |
| General Plan maps | City of Palmdale Planning | Electronic maps showing land use categories for General Plan | General Plan polygon/Sphere of Influence | *. pdf, *.shp | General Plan land use categories (along with densities) were used to distribute incremental future housing units in 2030 and at Buildout by TAZ to parcels and subcatchments. |
| Regional Growth Projections | SCAG Regional Transportation Plan (2007) | Population, household counts, and employment for 2000-2030 | Census tract and City/SCAG Region | Hard Copy | Confirmation of 2006 and 2030 household sizes and population estimates. |
| 2006 Flow Monitoring Data | County Sanitation Districts of Los Angeles County | Measured depth of flow and flow velocity, and computed flows at 15-minute intervals | At 86 locations on the District trunk sewers in Palmdale | *.xls | Used to determine unit flow rates and diurnal flow patterns for residential and non-residential land uses. |
| Industrial Permit Data | County Sanitation Districts of Los Angeles County | Estimated wastewater flows from permitted non-residential dischargers | Sphere of Influence | *.shp | Used to estimate flows from major non-residential dischargers |


City of Palmdale
Sewer Master Plan
Figure 2-1
2006 Service Area
Legend
LACSD Trunk Sewer
Modeled Sewer
Modeled Subcatchment
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
Avenue S PS
LACSD-14
LACSD-20
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
AVENUE T
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
50TH ST EAST
47TH ST EAST / HIGHWAY 138
80TH W
70TH W
60TH W
50TH W
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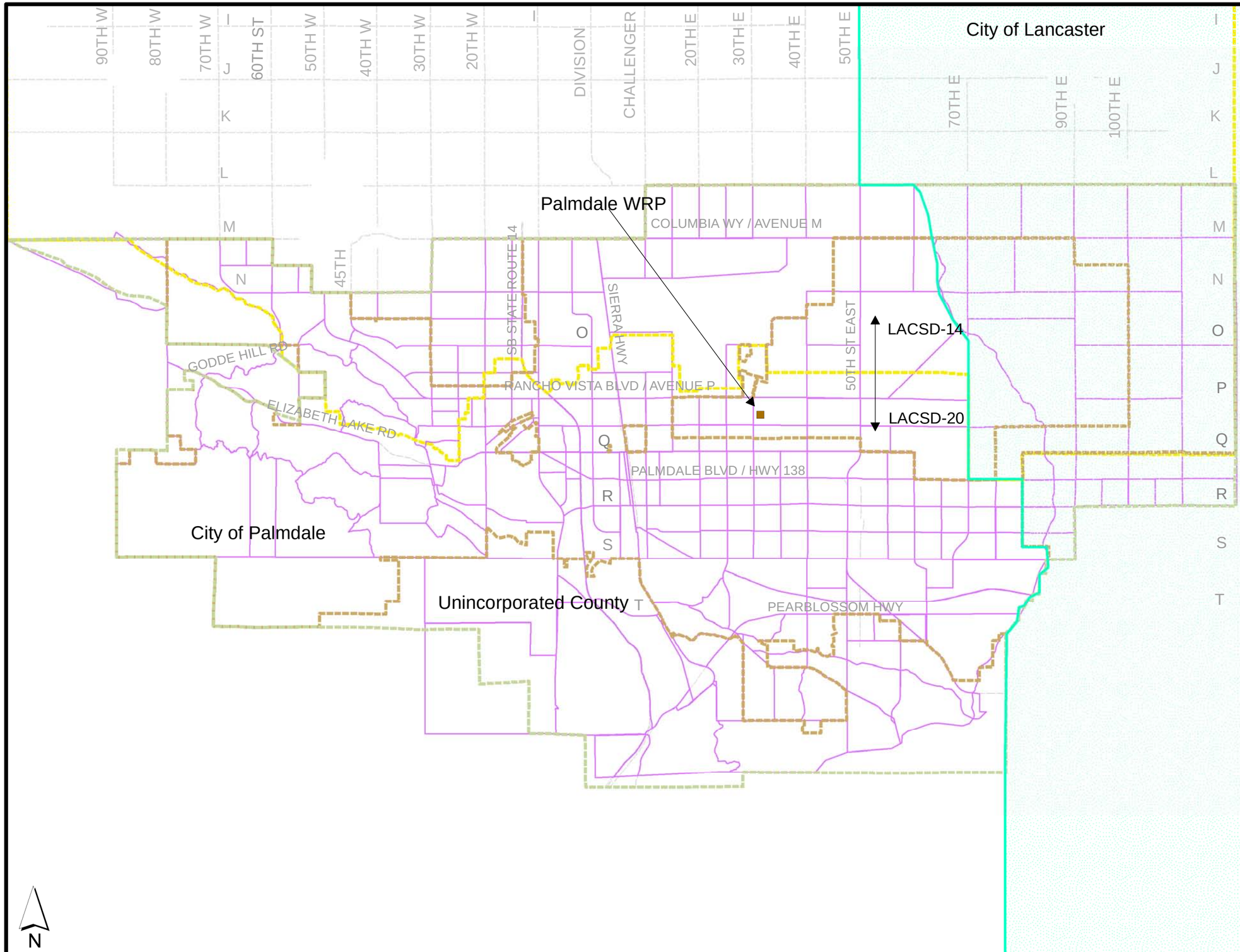
## 2.3 Existing Residential Flow

Experience has shown that residential wastewater flows are most accurate when based on population and per-capita unit flow factors, and that approach was adopted for this study. The distribution of the City's estimated population of 141,759 in 2006 was based on the GPCEU inventory of existing single-family and multi-family housing units along with estimated household sizes. The City compiled the number of housing units by geographic units called traffic analysis zones (TAZ), which vary in size but are typically 230 acres or smaller in developed areas. The City based the housing unit counts on roof counts, occupancy licenses, and building and safety permit numbers. Figure 2-2 shows the boundaries of the 264 TAZs in the City's Sphere of Influence. This housing inventory was the main data source utilized to estimate existing residential populations and flows, but several steps were required to refine and process the data to the subcatchment level:

- The housing units by TAZ were distributed to the developed areas in the underlying subcatchments. In order to do this as accurately as possible, it was necessary to categorize each parcel in the City as to land use by the use of the electronic general plan map, and to differentiate developed parcels from undeveloped parcels. The developed residential parcels were initially identified as the residential parcels included in the billing database provided by CSMD, but additional refinements were made through inspection of aerial photographs and sewer maps, and through consultations with City staff. These refinements ensured that all developed parcels were included in the distribution of housing units, even if they are on septic tanks or connect to private sewers that discharge directly to an LACSD trunk sewer (those parcels are not billed for sewer service by CSMD). Some 426 parcels were identified as connecting directly to trunk sewers (estimated to contribute between 0.4 and 0.5 mgd of average dry weather flow). Parcels on septic tanks are discussed further below.
- The distribution of housing units from the TAZ level to developed residential parcels within that TAZ was based on City-specified average densities (housing units per gross acre) in each of the City's General Plan and Specific Plan residential land use categories. Table 2-2 presents the densities for each residential category.
- The population associated with each housing unit was computed based on estimated household sizes. For the GPCEU, the City assumed an average household size of 3.559 persons/unit for all housing units within the City's Sphere of Influence. While using a single average household size was adequate for General Plan purposes, it could result in significant deviations from actual populations at the subcatchment level. The deviations would occur because household sizes tend to vary considerably in different neighborhoods depending on the category and density of housing units (single-family units tend to have more persons than multi-family units, for example) and demographic factors. In order to account for these variations, census block data (from the 2000 Census) on actual household sizes in developed areas was applied rather than the average value of 3.559. The overall population, however, remained consistent with the City's population estimate.
- Parcels on septic tanks were identified and flagged so that population on these parcels was excluded from the model when generating wastewater flows for the existing development scenario (but flows were included from these parcels for the future scenarios, as noted later in this chapter). The number of parcels on septic tanks is about 3,200 within the City's Sphere of Influence, 2,726 within the Study Area, and 1,016 within the City boundary. The parcels on septic tanks are shown in Figure 2-3.
- The sewered population in each subcatchment was computed by aggregating the population from all the parcels within that subcatchment.




City of Palmdale

Sewer Master Plan

# Figure 2-2 Traffic Analysis Zones

## Legend

- Traffic Analysis Zones
- Major Street
- Water Reclamation Plant
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary
- Cannot flow by gravity to Palmdale or Lancaster WRP

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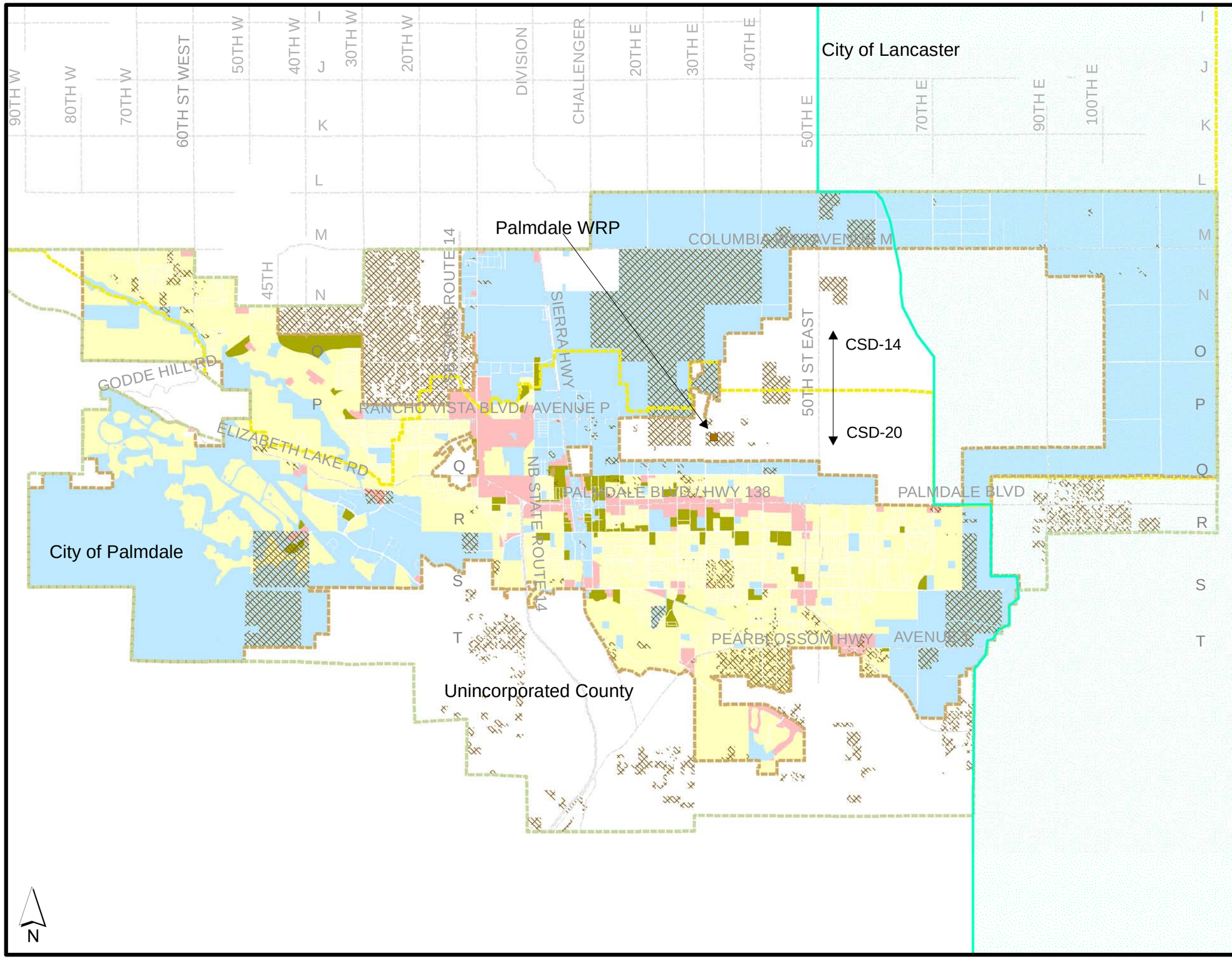
0 1 2 4 Miles

**Table 2-2: Residential Housing Unit Densities**

| Housing Unit Category | General Plan Category | General Plan Description | Specific Plan Description | Avg. Density (units/ gross acre) | 2006 Net Area (acres) |
|---|---|---|---|---|---|
| SF | ER | Equestrian | N/A | 0.4 | 120 |
| | LDR | Low Density | N/A | 1 | 3154 |
| | SD | Special Development | N/A | 1 | 55 |
| | SFR-1 | Single Family | N/A | 2.5 | 1474 |
| | SFR-2 | Single Family | N/A | 2.5 | 3033 |
| | SFR-3 | Single Family | N/A | 3.4 | 7658 |
| | | | Urban Residential (3.1 - 6.1 du/ac) | 3.4 | 51 |
| | SP-City Ranch | N/A | Single Family Attached | 1 | 90 |
| | | | Single Family Detached | 1 | 256 |
| | SP-College Park Palmdale | N/A | Estate 8,000-40,000 SF lot | 0.4 | 103 |
| | | | Single-Family 5,000-6,000 SF lot | 3.4 | 24 |
| | | | Single-Family 6,000-10,000 SF lot | 3.4 | 124 |
| | | | Single-Family 6,000-8,000 SF lot | 3.4 | 23 |
| | SP-Hillside Residential | N/A | Single Family Residential (0.5 du/ac) | 0.5 | 229 |
| | SP-Joshua Hills | N/A | Single-Family Detached ("Classic") | 1 | 49 |
| | | | Single-Family Detached ("Crest") | 1 | 288 |
| | | | Single-Family Detached ("Fairfield") | 1 | 33 |
| | SP-Rancho Vista | N/A | Urban Medium Residential (6.2 - 10 du/ac) | 8 | 35 |
| | | | Urban Residential (3.1 - 6.1 du/ac) | 3.4 | 779 |
| | SP-Ritter Ranch | N/A | Non-Urban Residential (0.5 du/ac) | 0.5 | 260 |
| | | | Urban Residential (3.1 - 6.1 du/ac) | 3.4 | 2082 |
| MF | MFR | Multi Family | N/A | 16 | 379 |
| | MR | Medium | N/A | 10 | 537 |
| | OS | N/A | Multiple-Family 2 | 22 | 21 |
| | SP-City Ranch | N/A | Multiple Family | 13 | 19 |
| | SP-Joshua Hills | N/A | Multiple-Family 1 | 13 | 15 |
| | | N/A | Multiple-Family 2 | 22 | 3 |
| | SP-Palmdale Transit Village | N/A | Multi-Family Residential (25-40 du/ac) | 33 | 10 |
| | | N/A | Residential (12-16 du/ac) | 14 | 6 |
| | | N/A | Residential (8-12 du/ac) | 10 | 30 |
| | | N/A | Residential/Civic (up to 58 du/ac) | 10 | 14 |
| | SP-Rancho Vista | N/A | Golf Course Community (3.1 - 26 du/ac) | 16 | 278 |
| | | N/A | Urban High Residential (18 - 26 du/ac) | 22 | 22 |
| | SP-Ritter Ranch | N/A | Urban High Residential - Senior (18.1 - 26.0 du/ac) | 22 | 22 |
| | | N/A | Urban Medium - High Residential (10.1 - 18.0 du/ac) | 14 | 16 |




City of Palmdale

Sewer Master Plan

# Figure 2-3 Parcels on Septic Systems

## Legend

General Plan Landuses

- Multi - Family Residential
- Single - Family Residential
- Retail Commercial
- Industrial; Public Facility; Other
- Parcels on Septic Systems
- Major Street
- Water Reclamation Plant
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary
- Cannot flow by gravity to Palmdale or Lancaster WRP

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0 1 2 4 Miles

- During the model calibration process, appropriate per-capita unit flow rates and typical hourly multipliers were determined based on matching the temporary flow monitoring data collected in 2006. The results of this calibration process are described in Chapter 3, and the design flow criteria are presented in Chapter 4.

## 2.4 Future Residential Flow

As was done for the 2006 scenario, housing units for the 2030 and Buildout scenarios were based on the City's TAZ-level estimates made as part of the GPCEU. The City's basic assumption was that the City population would increase by 87,000 between 2006 and 2030, which is significantly lower than the projection of 191,000 by the Southern California Association of Governments (SCAG). The City's position is that SCAG greatly overestimated the population and underestimated the non-residential development. The City further assumed that development outside the Study Area (i.e., areas that cannot be served by gravity to either the Palmdale or Lancaster Water Reclamation Plants) will not occur until after 2030.

The City allocated the future housing units and associated population to selected TAZs. For this study, the new housing units provided by the City were distributed to the vacant parcels in each TAZ. Since the City did not specify which parcels were to be developed by 2030 and which were to remain vacant, the housing units were distributed to all vacant parcels in proportion to the average densities of their planned residential categories as listed in Table 2-2. The population associated with these housing units was again refined from the City's assumption of an average 3.559 household size. Through analysis of census block data from currently developed areas, average household sizes were determined for the two main residential categories in the general plan: Single Family Residential (3.6), and Multi-Family Residential (3.3). Application of these household sizes results in the same population increase assumed by the City, but varies the location of the population increase somewhat. Once the new population was distributed to vacant parcels, the parcel populations were aggregated to subcatchments and added to the 2006 subcatchment populations to compute the total 2030 population.

It was further assumed that all housing units currently on septic tanks in 2006 (see Figure 2-3) would connect to the sewer system by 2030. Since that is considered to be a conservative assumption, any capacity deficiencies that are modeled to occur in areas affected by septic tank conversions were checked to determine if the deficiencies would still be predicted without the conversions, so that the associated relief sewer projects could be flagged as contingent on septic tank conversions.

The Buildout scenario was defined as development of all vacant land according to the General Plan land uses (Figure 2-4). The City provided the total number of housing units for that scenario by TAZ, and a similar process was used to distribute the housing units based on the general plan land use categories and assumed average densities and household sizes. Like the 2030 scenario, the Buildout scenario applies those densities and household sizes to only the vacant parcels in each TAZ, assuming that parcels already developed in 2006 will not change. To the extent that some of those future housing units are built on parcels that are not currently vacant (i.e., redevelopment at higher densities), the future distribution of population could differ from that assumed in this study.

Table 2-3 summarizes the housing unit and population estimates for each scenario (including parcels on septic tanks for all scenarios), aggregated by the current City limits and by the City's Sphere of Influence. The estimates for the Study Area are not shown on the table, but are essentially the same as for the Sphere of Influence (within 500 population) for all scenarios. Also shown for comparison are the estimates made by SCAG (for 2005 and 2030) and the California Department of Finance (2006 only). These other estimates are consistent with the City's estimates with the exception of the SCAG 2030 projections, as noted earlier.

The per-capita unit flow rates applied to future residential development are presented in Chapter 4, and were based on the results of the model calibration described in Chapter 3.

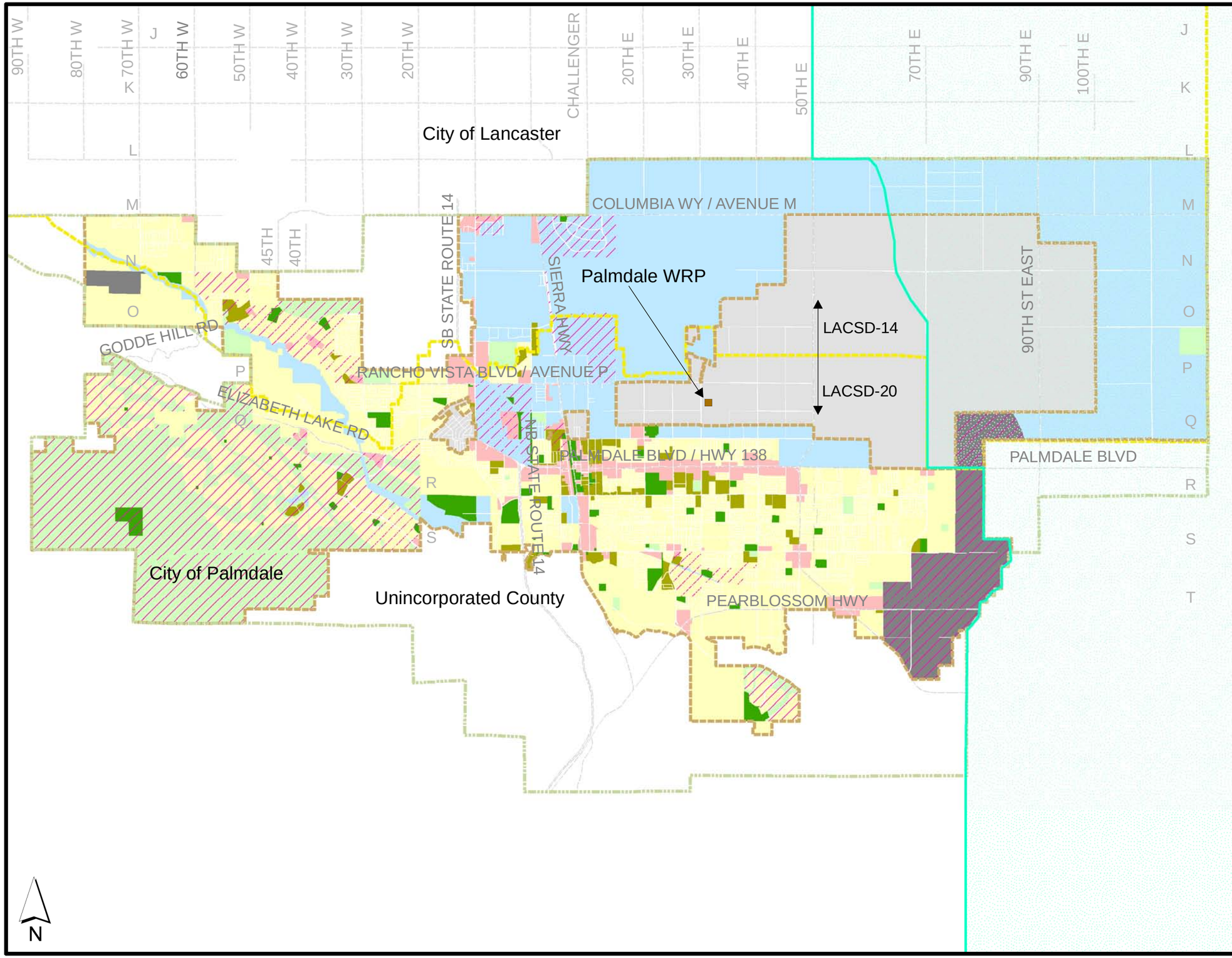
City of Palmdale
Sewer Master Plan
Figure 2-4
General Plan
Landuse
Legend
General Plan Landuse
Industrial
Commercial
Single Family Residential
Multi Family Residential
Open Space; Park
Public Facility; School
Mineral Resource Extraction
Other Jurisdiction
Specific Plan
Cannot flow by gravity to Palmdale or Lancaster WRP
Major Street
Water Reclamation Plant
Palmdale City Boundary
Palmdale Sphere of Influence Boundary
LACSD-14/20 Sphere of Influence Boundary
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
PALMDALE BLVD / HWY 138
PALMDALE BLVD
PEARBLOSSOM HWY
GODDE HILL RD
ELIZABETH LAKE RD
SB STATE ROUTE 14
NB STATE ROUTE 14
SIERRA HWY
90TH ST EAST
CHALLENGER
90TH W
80TH W
70TH W
60TH W
50TH W
40TH W
30TH W
20TH W
20TH E
30TH E
40TH E
50TH E
70TH E
90TH E
100TH E
45TH
40TH
J
K
L
M
N
O
P
Q
R
S
T
N
0
1
2
4
Miles
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**Table 2-3: Population and Housing Unit Estimates**

| Geographic Area | Population | | | Housing Units | | |
|---|---|---|---|---|---|---|
| | 2006 | 2030 | Buildout | 2006 | 2030 | Buildout |
| City of Palmdale (City Planning Dept. estimates) | 141,759 | 228,531 | 259,703 | 39,831 | 64,212 | 72,971 |
| City of Palmdale (SCAG, for comparison only) | 138,423 (2005) | 329,321 | N/A | 38,893 (2005) | 84,262 | N/A |
| City of Palmdale (CA Dept. of Finance, for comparison only) | 140,619 | N/A | N/A | 39,599 | N/A | N/A |
| Palmdale Sphere of Influence (City Planning Dept. estimates) | 151,090 | 238,161 | 300,429 | 42,453 | 66,918 | 84,414 |

## 2.5 Existing and Future Non-Residential Flow

The City's Planning Department estimated existing and future retail and non-retail employment by TAZ as well as housing units and population. These employment estimates were used as the basis for non-residential flow estimates.

The City estimated base year (2006) employee counts using the following resources:

1. Certificates of Occupancy
2. Permits
3. Aerial imagery
4. Business license data
5. Internal organizational knowledge
6. Phone calls to selected businesses to verify employment.

The number of employees was compiled by the City for each TAZ. The TAZ-level employment estimates developed by the City were distributed to the underlying subcatchments. The retail and non-retail employees were separately distributed to developed areas based on their non-residential land use categories, as determined from the City's General Plan map. Retail employees were distributed to all the commercial land uses. Non-retail employees were distributed to industrial land uses, schools, and public facilities. As was done for the residential parcels, the developed non-residential parcels were identified through use of the CSMD billing database, aerial photographs, and consultations with City staff.

In addition to the TAZ-level employment estimates, the City also provided about 25 specific "special trip generators" and their employment counts, as input to the Enhanced Antelope Valley Transportation Analysis Model III. These are the City's largest industrial, commercial, and public operations. The "special trip generators" employees were assigned to their specific parcels and added to the distributed TAZ-level employees.

During the model calibration process (Chapter 3), appropriate per-employee unit flow rates and typical hourly multipliers were determined based on matching the temporary flow monitoring data collected in 2006.

To supplement these employee-based non-residential flows, a check was made of LACSD's industrial permit database for Palmdale to identify any major dischargers based on their wastewater flow estimates in the permit database. The aerospace complex businesses located in the unincorporated area north of the

City discharge 0.29 mgd, but they discharge directly to the LACSD-14 trunk sewer on 30th St. E that drains to the LWRP and therefore has no impact on the Palmdale sewer system. The only major discharger in the permit database that is in the City is Lockheed Martin Corporation, which discharges 0.15 mgd to an LACSD-20 trunk sewer. This flow was input to the appropriate subcatchment in the model in lieu of the employment estimate for that business. The location of the Lockheed Martin discharge in shown in Figure 3-1 in Chapter 3.

To estimate the additional future employment in each TAZ for the 2030 and Buildout scenarios, the City considered the available gross land area, net area after right-of-way dedication, allowable floor area ratios, and the typical number of employees per square foot of building for different types of non-residential land uses. The City determined typical values for employees/square foot based on sampling of existing businesses. These TAZ-level future employment estimates were distributed to the underlying vacant non-residential parcels, added to the 2006 employee counts, and the aggregated to subcatchments.

Table 2-4 summarizes the City's employment estimates for each scenario, aggregated by the current City limits, the Study Area, and the City's Sphere of Influence. As can be seen from this table, the City is projecting very high increases in employment relative to the projected increases in population. As noted earlier, SCAG's employment projections are much lower than the City's; the SCAG employment projection for 2030 is only about 45,000 while the City's projection is over 100,000.

The per-employee unit flow rates applied to future non-residential development are presented in Chapter 4, and were based on the results of the model calibration described in Chapter 3.

**Table 2-4: Employment Estimates**

| | City of Palmdale | Study Area | Palmdale Sphere of Influence |
|---|---|---|---|
| **Retail Employees** | | | |
| 2006 | 7,160 | 7,216 | 7,216 |
| 2030 | 29,263 | 29,717 | 29,717 |
| Buildout | 33,130 | 36,081 | 36,081 |
| | | | **Non-Retail Employees** |
| 2006 | 13,809 | 16,386 | 16,534 |
| 2030 | 55,356 | 64,709 | 64,857 |
| Buildout | 91,855 | 106,372 | 110,524 |
| | | | **Special Trip Generators Employees** |
| 2006 | 16,165 | 17,115 | 17,115 |
| 2030 | 18,320 | 20,817 | 20,817 |
| Buildout | 18,433 | 20,930 | 20,930 |
| | | | **Total Employees** |
| 2006 | 37,134 | 40,717 | 40,865 |
| 2030 | 102,939 | 115,243 | 115,391 |
| Buildout | 143,418 | 163,743 | 167,535 |

# Chapter 3 Hydraulic Model Development

This chapter documents the procedures used to build and calibrate the InfoWorks™ hydraulic model. The hydraulic model is the primary analytical tool used to determine the flows and capacities of the City's major sewers, and to identify any needed capacity improvements.

## 3.1 Terminology

**Network** refers to the representation of the physical facilities being modeled. The primary components of the modeled network are pipes and manholes.

**Nodes** are primarily manholes, but also include outfalls (discharge points from the modeled system). The primary data associated with nodes are invert and ground elevations.

**Pipes** are connections between nodes. The primary data associated with pipes are upstream and downstream node IDs, pipe length, diameter, roughness factor, and upstream and downstream invert elevations.

**Subcatchments** are areas that contribute flow to the modeled sewer network, sometimes called sewersheds. Data associated with subcatchments include equivalent population (derived from population and employment estimates), contributing area, sanitary flow and infiltration/inflow (I/I) characteristics, and the node at which the flow from the subcatchment enters the modeled system.

**Model loads** are the flows associated with load manholes. Components of model loads are residential and non-residential dry weather flows and I/I. As a sum, they represent the total wastewater flow applied to modeled pipes.

**Models** are the combination of a modeled network, its associated subcatchments and loads, and other data files (e.g., diurnal profiles) that comprise a specific model scenario.

## 3.2 Model Software

The City, in conjunction with RMC, selected Wallingford Software's InfoWorks CS (version 9.0) to be used for this project. InfoWorks CS uses Wallingford's proprietary hydraulic engine, which provides a fully dynamic solution for modeling stormwater and sanitary sewer systems. The program has a GIS-based model interface and features many useful tools for model building, calibration, and simulation results analysis. RMC agreed to use its own InfoWorks license to perform the modeling analysis. This modeling software is not a deliverable per the terms of the current RMC consulting agreement. Future model updates could be performed by RMC under separate contract or by the City staff if they choose to purchase the software and obtain the training required to use it.

## 3.3 Data Sources

The following paragraphs describe the sources of data that were used to construct the model.

**Sewer GIS Layers.** RMC developed a process that the City implemented to enhance the City's existing sewer GIS data to make it suitable for use in the hydraulic model. The process included merging the trunk sewer data (facilities owned by LACSD) with the data on the City's sewers. Important attributes like pipe diameter, flow direction, slope, length, invert elevation, material, ground elevation, and jurisdiction were preserved or enhanced in the process. A final crucial step involved rectifying all data to a common vertical datum, the NAVD 88 datum.

**Subcatchments.** The City's sewer drainage area was divided into 478 subcatchments. They were digitized with the aid of the sewer GIS layers, contour layers, parcel layers, and digital orthographic photos.

**Record drawings.** Attribute data and other information needed to enhance the sewer GIS was obtained by the City as needed through record drawing research.

**Population, employment, and land use data.** For each subcatchment, the model requires the input of the residential population, which is converted to flow using an assumed per capita flow rate, and non-residential flow based on employment and/or land use information. These values were calculated for both existing (2006) and future (2030 and Buildout) scenarios using the methodologies described in the Chapter 2.

**Flow monitoring data.** Data from 34 temporary flow meters installed in May of 2006 by LACSD was used to calibrate the model under dry weather flow conditions.

## 3.4 Model Building

This section describes how the network for the model of the existing sewers and service areas was defined and built. The extension of the model to cover currently undeveloped areas is described later in this chapter.

### 3.4.1 Network and Subcatchment Definition

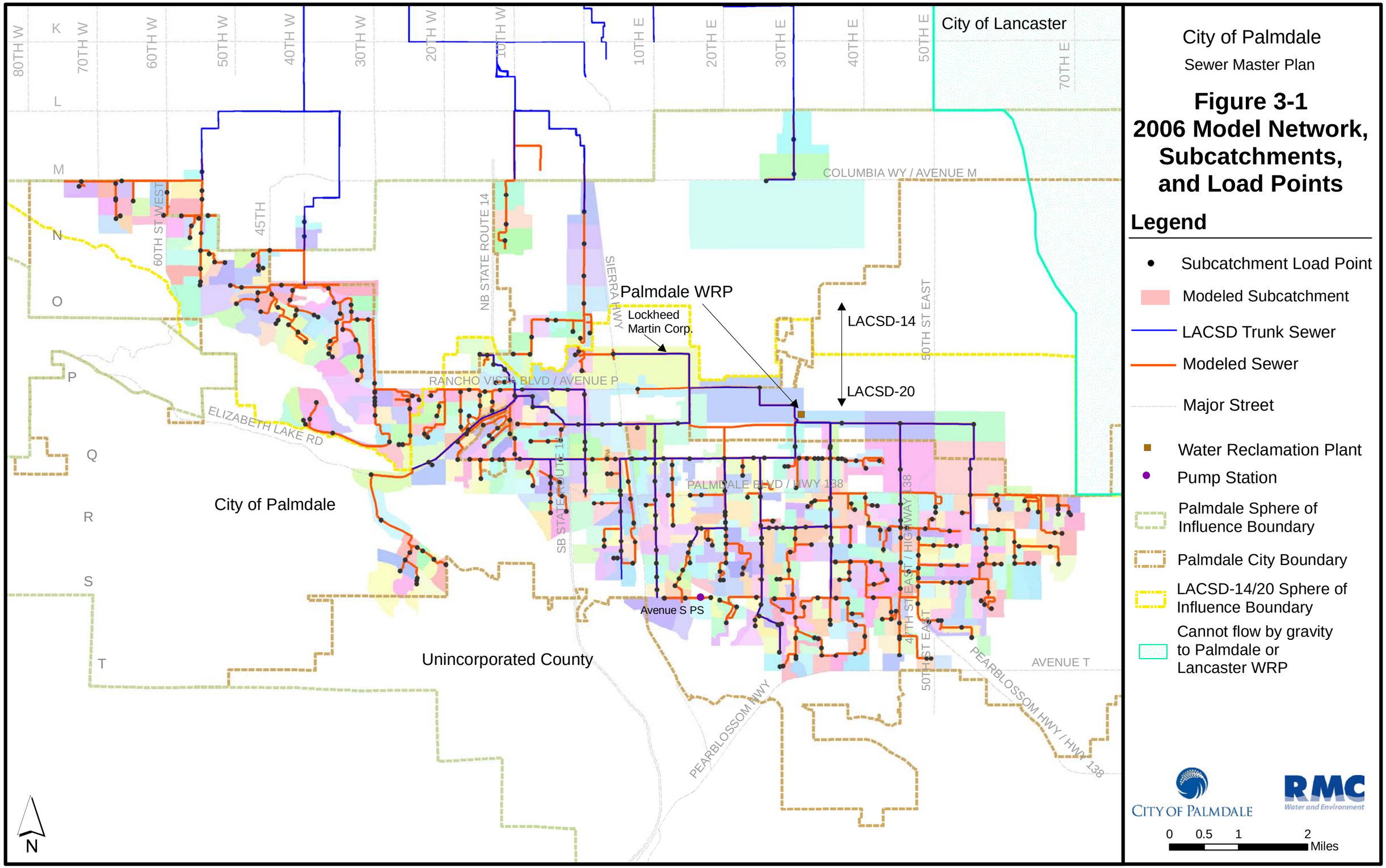
The modeled network was defined to include all the larger sewer pipes in the City's Sphere of Influence, including pipes owned by the City, pipes in the county owned by CSMD, and trunk sewers owned by LACSD. The CSMD and LACSD sewers were included to create a connected network, but the capacity analysis is focused on the City's sewers.

The network was initially defined as all pipes greater than or equal to 10 inches in diameter. Eight-inch pipes were then added to achieve an average subcatchment size of 40 acres. Smaller diameter lines located downstream of 10-inch or larger lines were also added to create a fully connected network. The model network has one main model outfall (endpoint) and 4 minor outfalls. The major outfall is at the PWRP. The other 4 minor outfalls are where LACSD trunks carrying flow from Palmdale cross into the Lancaster city limits.

The modeled network contains 2,770 pipe segments covering 142 miles. Of the 142 miles of modeled pipe, 65% are owned by the City, 2% by CSMD, and 33% by LACSD. The modeled network includes 96% of the 10-inch and larger pipes, and roughly 11% percent of the 8-inch pipes. The 93 miles of City sewers in the network represent 23 percent of the City's 396-mile system.

The Avenue S Lift Station and its force main are also included in the model. It is modeled as a duty/relief station with two 0.22 mgd fixed pumps.

Flows are loaded into the model at "load manholes," each of which represents the point where flows from unmodeled sewers discharge into the modeled network. Parcels connected to unmodeled sewers were grouped into sewer subcatchments, each with a unique load manhole in the modeled network. Subcatchments were given identifiers consistent with the identifiers of their load manholes. A total of 478 sewer subcatchments were delineated for defining the 2006 model loads. For initial calibration purposes, they cover only areas served by City or CSMD sewers in 2006. The 2006 subcatchments, load manholes, and modeled network are shown in Figure 3-1. The extension of the model into currently unsewered areas, including the delineation of additional subcatchments and future sewers, is described later in this chapter.


City of Palmdale
Sewer Master Plan
Figure 3-1
2006 Model Network, Subcatchments, and Load Points
Legend
Subcatchment Load Point
Modeled Subcatchment
LACSD Trunk Sewer
Modeled Sewer
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
Lockheed Martin Corp.
LACSD-14
LACSD-20
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
AVENUE T
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
50TH ST EAST
47TH ST EAST / HIGHWAY 138
80TH W
70TH W
60TH W
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Miles
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### 3.4.2 Data Validation

Once the model network was defined, a data validation procedure was followed to fill in missing information and create a fully-connected network.

The data validation process included the following steps:

- Ensure that each manhole and pipe have a unique identifier. City staff performed this task by adding the appropriate map sheet number to the existing manhole numbers and adding numbers to some previously un-numbered manholes. For modeling purposes, pipes were named using the upstream manhole identifier followed by a unique suffix integer, for example, "1994-0059.1". For flow splits where there are two pipes with the same upstream manhole, example names would be "1994-0059.1" and "1994-0059.2".
- Check the modeled network for connectivity, i.e., verify that correct upstream/downstream manholes are identified for each pipe and there are no missing links or manholes in the network.
- Perform a number of checks to identify missing data or data that is suspect and needs to be further verified and corrected. Much of this was done using InfoWorks built-in inference tools. Examples of missing or suspect data included missing rim or invert elevations, negative pipe slopes, or abrupt steps up or down in pipe inverts or diameters. These checks identified and corrected the most frequent major problems: human errors or missing data from the City's enhancement work. Further, there were no major data adjustments necessary where city lines entered LACSD trunks, indicating the GIS enhancement process was successful in that regard.
- Identify flow splits (manholes with more than one outlet pipe) which may require further verification of outlet pipe elevations and/or the existence of weir overflows or other control structures. Although some of the flow splits were on City sewers and were researched by City staff, most of the flow splits were on LACSD trunk sewers. Since an analysis of the capacity of the LACSD trunk sewers is not part of this project, those flow splits were not investigated. During model calibration, some critical flow split manhole inverts were adjusted to better match the relative distribution of flow seen in nearby downstream flow meters. Field verification of these LACSD flow splits could be performed by LACSD staff in the future if they wished to refine the City's model to study trunk sewer capacity issues.
- Populate global parameters which are required by the model, such as manhole diameters (assumed to be 4 feet) and Manning's 'n' (assumed to be 0.013 for all gravity sewers).

During the data validation process, system flags were used to document the source of each attribute stored in the model and the basis for any changes that were made. This documentation can be used to determine whether individual attribute changes made for modeling should also be made in the source files (typically the City's GIS). The data flags used are described in Table 3-1.

## 3.5 Dry Weather Flow Calibration

The appropriate unit flow rates to apply to the estimated 2006 population and employment were determined through the model calibration process. This process involved varying the unit flows within reasonable ranges to verify the computed flows are consistent with observed (monitored) flows. This section describes the flow monitoring data used, the calibration process, and the resulting unit flows rates.

### 3.5.1 Flow Monitoring Data

Data for model calibration came primarily from a temporary flow monitoring program consisting of 90 depth-velocity flow meters installed by LACSD staff on their District 20 trunk sewers in Palmdale over a 3.5-week period (approximately May 8th through June 1st, 2006). In addition, some of Palmdale's flow was monitored in a District 14 (LWRP) monitoring program conducted in late September of 2006. An analysis was performed to determine which of the meters would be most appropriate for isolating flows from different parts of the City. This analysis also showed that several of the meters should not be used in

**Table 3-1: InfoWorks Data Flags**

| Flag | Description |
|---|---|
| #A | Asset Data |
| #D | System Default |
| #G | Data from GeoPlan |
| #I | Model Import |
| #V | CSV Import |
| CA | Calibrated Value |
| CE | Census Data Analysis Adjustment |
| DC | Data Connectivity Validation |
| DD | Dummy data, added pipes, manholes, etc. |
| N0 | Inferred from closest accurate model import data, if originally 0 |
| NC | Inferred from closest accurate model import data, if incorrect. This consisted of either matching to known data, extending proximate known gradients, or interpolating from closest known points |
| ND | Inferred diameter from closest accurate model import data, if suspect |
| NR | Needs review |
| NW | Inferred from weighted average of known manhole ground levels |
| RD | Record drawing |

the calibration due to apparently inaccurate data (i.e., less flow at a downstream meter than at an upstream meter on the same trunk), or the fact that they were located downstream of flow diversions in the trunk sewers. Since the model's ability to determine the distribution of flow at the trunk diversion structures was limited without obtaining additional information on the diversion details (which could not be justified given that the capacity analysis was focused on City sewers rather than LACSD trunk sewers), it was deemed best to not use those meters in the calibration as they may provide misleading information on unit flows. In cases where both outlets of a flow diversion were monitored, the flows from the two meters were summed for comparison to the summed modeled flows. After screening, a total of 34 meters were judged to be useable for model calibration. The final total included 30 meters from LACSD-20 (Palmdale) and 4 from LACSD-14 (Lancaster). The District 20 meters are shown in Figure 3-2 and the District 14 meters are shown in Figure 3-3. Additionally, PWRP daily influent data was used to determine total flow from the area tributary to the PWRP.

### 3.5.2 Dry Weather Flow Calibration

The dry weather calibration involved establishing flow parameters that best fit the monitored data from the 34 meters and total system flow. The parameters included average flow rate per capita for residential uses, flow rate per employee for non-residential land uses, and 24-hour diurnal flow patterns for both residential and non-residential uses. These parameters were input to the hydraulic model on a trial basis and the routed flow hydrographs produced by the model at the meter sites were compared to the metered flows. The parameters were then varied in a systematic manner within a reasonable range until an acceptable fit to the observed flows was obtained. Comparisons of modeled vs. monitored flow depth and velocity were made, but significant differences are typically seen in all sewers because field conditions (e.g., sediment depth, minor defects and obstructions, actual pipe slope in the vicinity of the meter) may differ from the record-drawing data in the model.

Experience in the calibration of residential flows in other sewer systems has suggested that household size affects the per-capita unit flow rates. In general, the per-capita flow rates tend to be lower in larger households. Census data was therefore used to characterize household size in each subcatchment and to

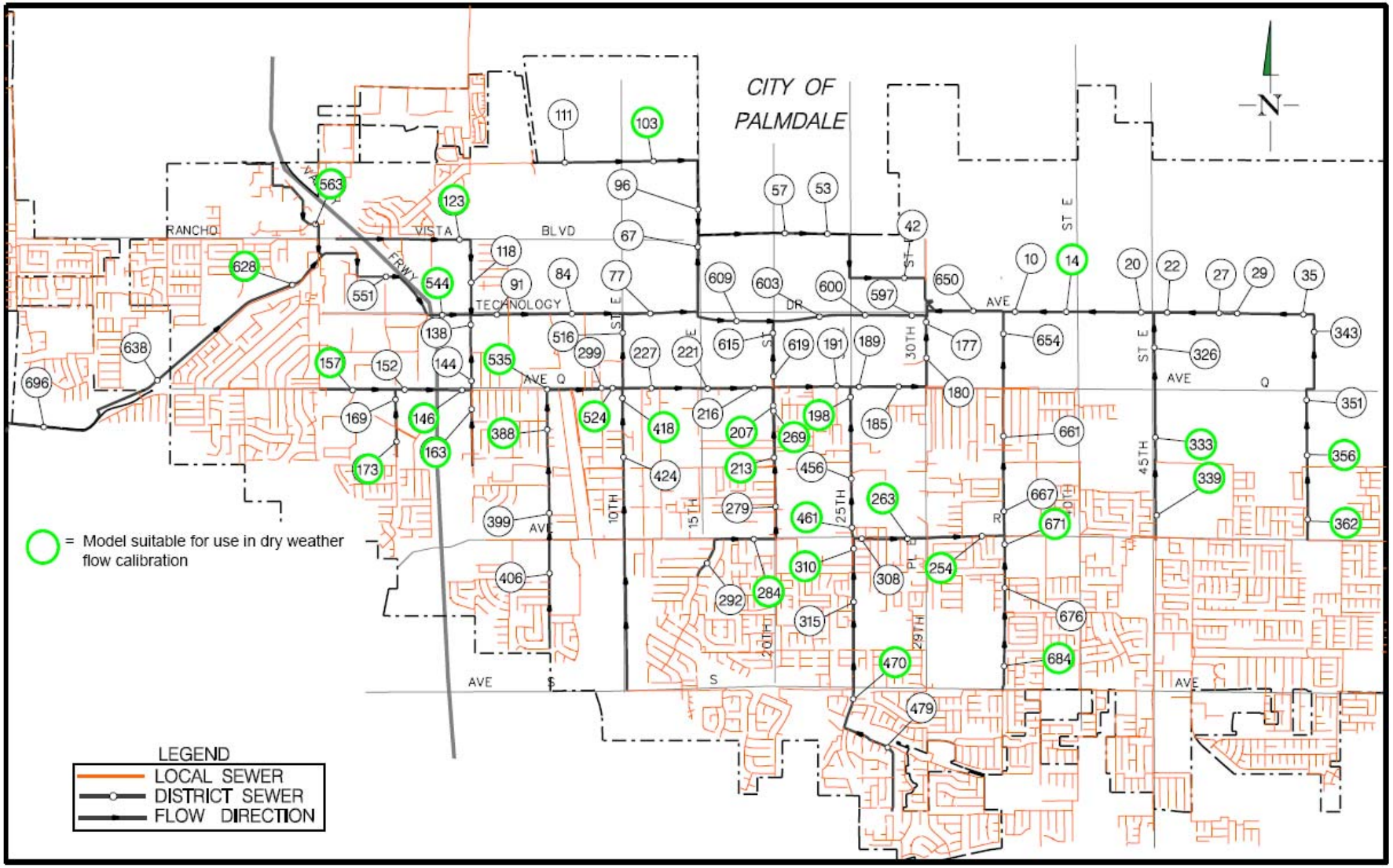



**Figure 3-2: LACSD-20 Temporary Flow Meters Used in Dry Weather Flow Calibration**

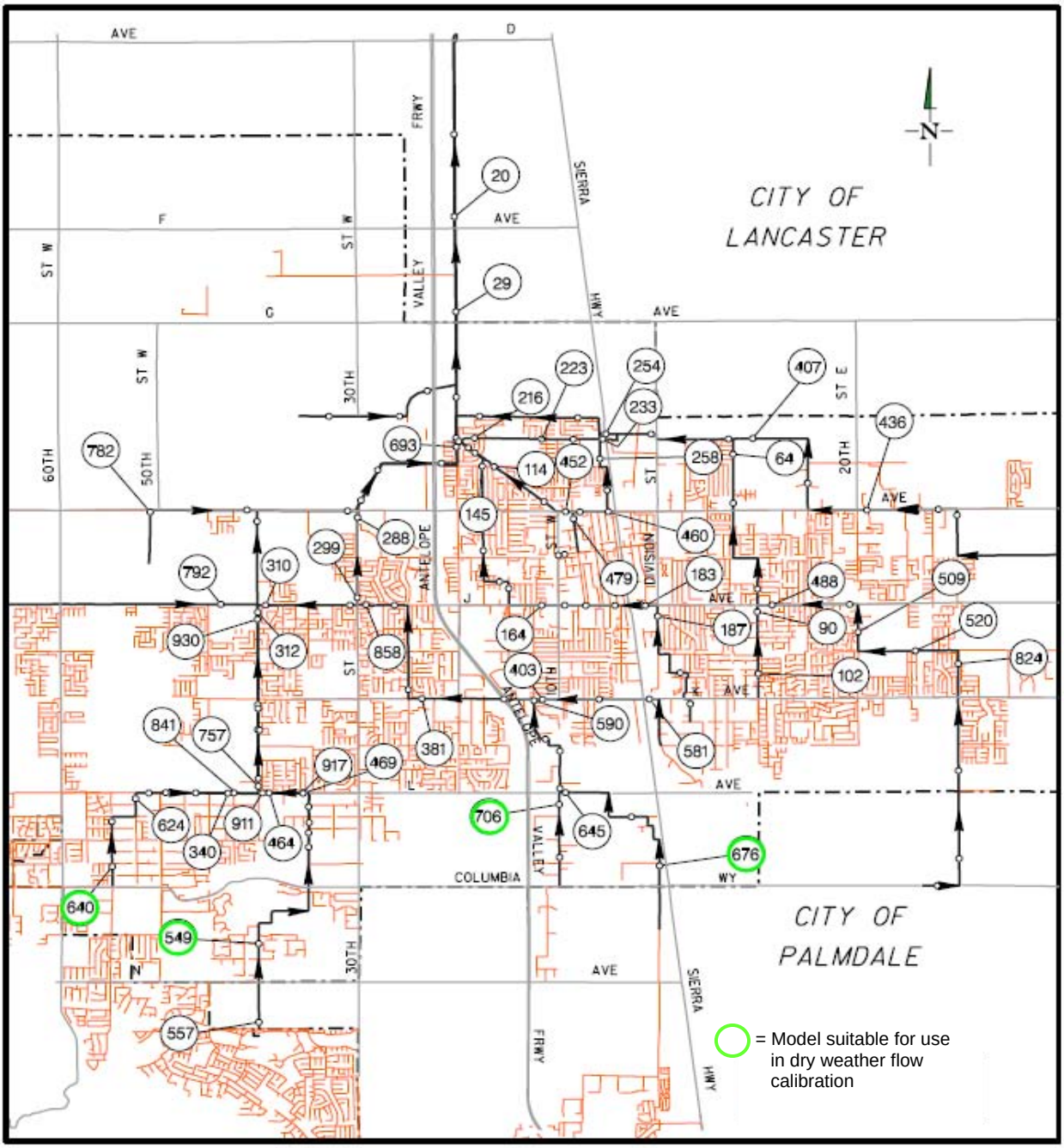



**Figure 3-3: LACSD-14 Temporary Flow Meters Used in Dry Weather Flow Calibration**

establish initial per-capita rates accordingly. Per-capita rates were modified in some places from those established by the census block data to better match the meters, but the overall calibration was improved by considering household size variations. In general, the per-capita rates varied from 55 gallons per day (gpd) per capita in the largest households to 80 gpd/capita in the smallest households. Figure 3-4 shows the variations in flow rates determined from the calibration.

Since few of the flow monitors isolated specific non-residential land uses (rather than a mix of residential and non-residential uses), a single per-employee unit flow rate was used for most areas. A rate of 50 gpd per employee was found to provide the best fit to the temporary meters having significant non-residential land use, and to the total flow at the PWRP. Note that this flow rate includes flows generated not only by employees but also by non-employees (e.g., customers) and by industrial processes.

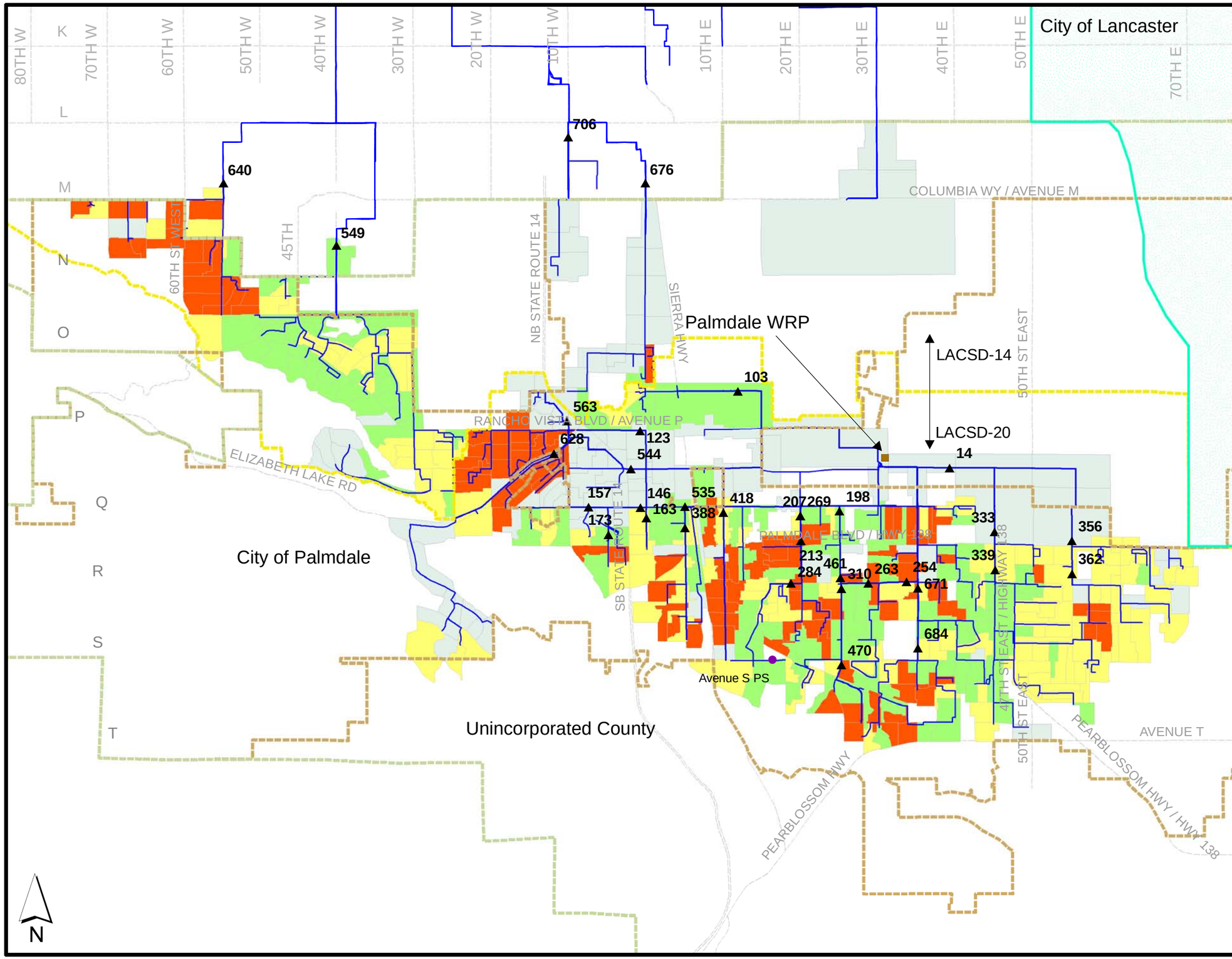
A limited number of changes to the standard rate of 50 gpd per employee were made in areas where there was sufficient non-residential flow that justified a different rate. Meters 563, 544, and 424 have many retail, office, and specific plan commercial parcels that appear to generate only 25-30 gpd per employee. Meters 207 and 213 captured flow from a few large schools, a movie theatre and several neighborhood commercial establishments that appear to generate a greater flow, which was added as an additional flow to those subcatchments.

After the model was matched well to the meters on average daily flow, the initial diurnal patterns or profiles were adjusted to better match the typical hourly flow variations on weekdays and weekends. The initial diurnal patterns were adopted from similar models, including a model recently created for the City of Lancaster. In other studies, it has been observed that the weekday residential profiles differ based on income level. In lower-income areas, the typical early-morning peak is attenuated relative to higher-income areas. This was found to be the case in the City as well, and a dividing line of $17,000 for per-capita income (determined from census data) was used for assigning two different diurnal profiles (high peak and low peak weekday profiles). Some areas displayed a trend toward significantly higher flows and peaks on the weekend relative to the weekday flows. Special diurnal profiles were developed for these areas in particular ("adjusted" profiles).

Figure 3-5 shows the final calibrated residential diurnal profiles and Figure 3-6 the final non-residential profiles. Figures 3-7 shows which residential profiles were used in each subcatchment and Figure 3-8 shows which non-residential profiles were used in each subcatchment.

Table 3-2 presents the results of the calibration in terms of both average and peak weekday flows, and Appendix B contains a more detailed calibration summary table with comments on individual meters. Plots of the modeled vs. metered flows are found in Appendix C. Overall, the model calibration resulted in a reasonable match of modeled to metered flow, considering the limitations of meter accuracy in the field. The model matched within 20% for 27 of the 34 meters and within 10% for 11 of the 34 meters. The meters with poorest matches tended to be in areas with large amounts of commercial and industrial areas, where the potential to under or over estimate flows was higher based on the limitations of the employee-based flow methods. This limitation should be considered when interpreting model results for sewers in which the total flow is mostly from commercial and industrial sources. These differences tend to average out over larger areas, and become diluted by residential flows which represent 85% of the system flow by volume and generally are more accurately estimated. Figure 3-9 shows the percent differences for average daily flows by net metershed (subcatchments tributary to a meter).

One area where the model greatly over-predicted on volume was at meter 640. The majority of the flow at this meter comes from residential development in Palmdale south of Avenue M, while the meter itself is located on an LACSD trunk on 55$^{th}$ Street West in Lancaster. The model assumes that a relatively new 10 to 12-inch sewer on Avenue M carries all the tributary Palmdale flow to the LACSD trunk sewer where meter 640 is located. The Avenue M sewer was included in the model since it is believed to have been completed in 2005, before the flow monitoring was performed in 2006. One explanation for the over-predicted flows at meter 640 could be that the Avenue M sewer was actually not yet fully connected during the monitoring period, and that some of the Palmdale flow south of Avenue M was still crossing




City of Palmdale
Sewer Master Plan

# Figure 3-4 Calibrated Residential Unit Flow Rates by Subcatchment

## Legend

Unit Flow Rate, gpcd
(gallons per capita day)

- 55 - 60
- 65 - 70
- 75 - 80
- 0 Residential Population
- CSD Flow Meter
- Modeled Sewer
- Major Street
- Water Reclamation Plant
- Pump Station
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary
- Cannot flow by gravity to Palmdale or Lancaster WRP

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0 0.5 1 2 Miles

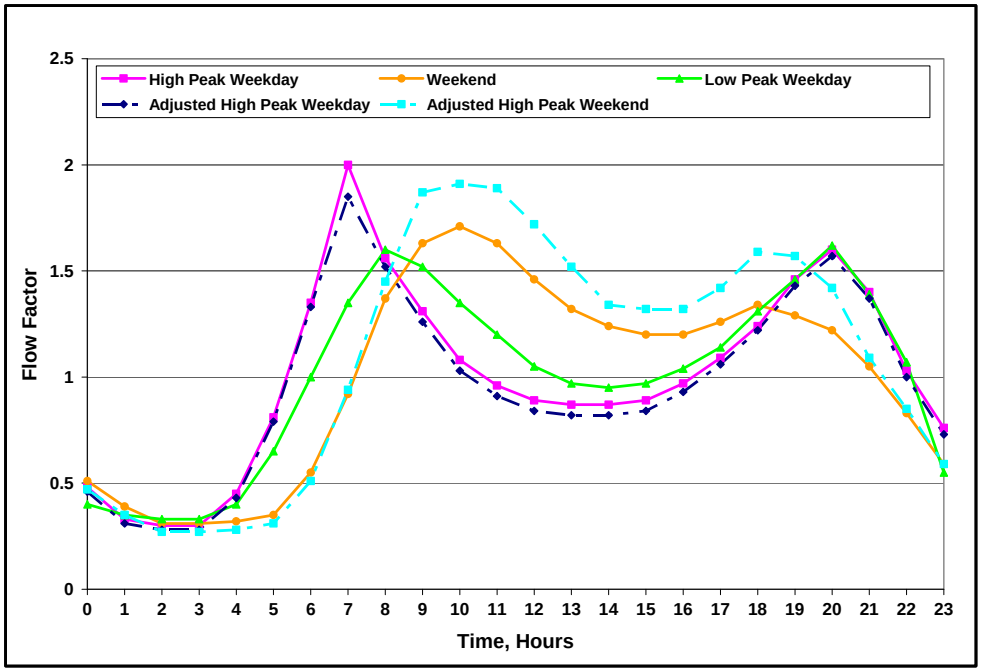



**Figure 3-5: Residential Diurnal Profiles**

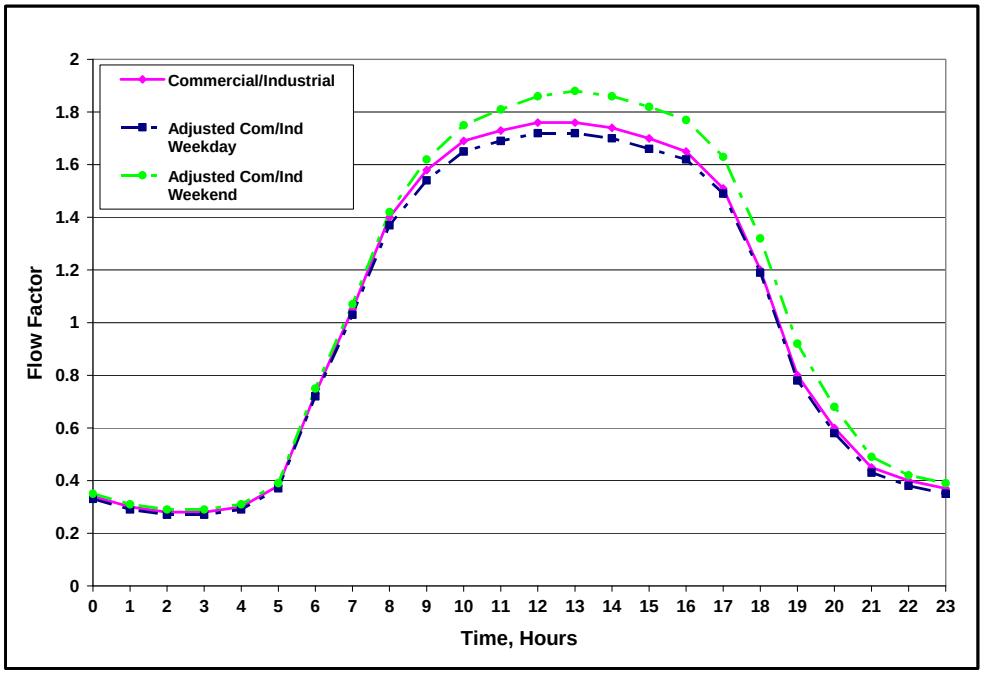
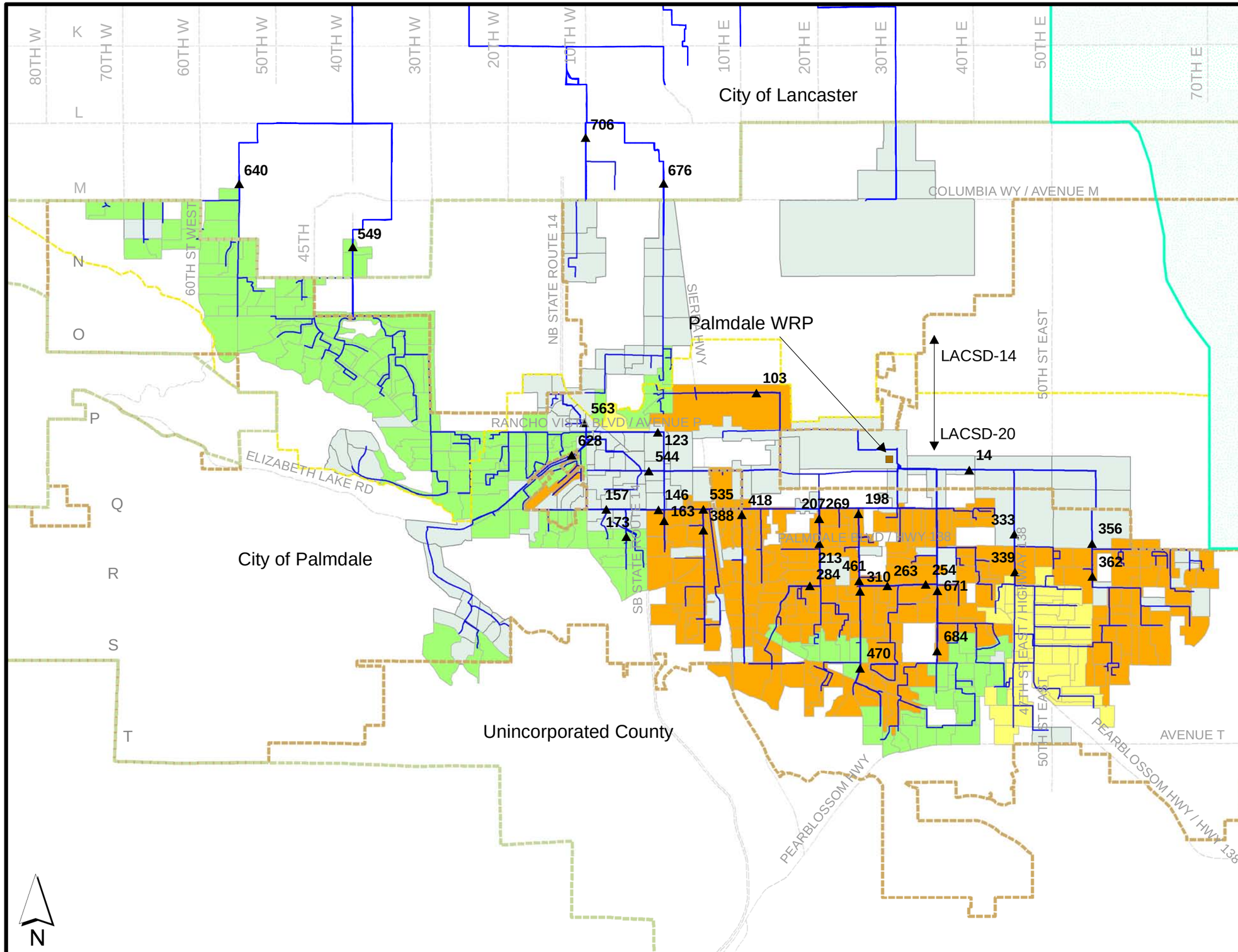



**Figure 3-6: Non-Residential Diurnal Profiles**




City of Palmdale

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# Figure 3-7 Calibrated Residential Diurnal Profiles by Subcatchment

## Legend

- Low Peak Profile (Per Capita Inc. < $17,000)
- High Peak Profile (Per Capita Inc. > $17,000)
- Adjusted High Peak Profile
- 0 Residential Population
- CSD Flow Meter
- Modeled Sewer
- Major Street
- Water Reclamation Plant
- Pump Station
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary
- Cannot flow by gravity to Palmdale or Lancaster WRP

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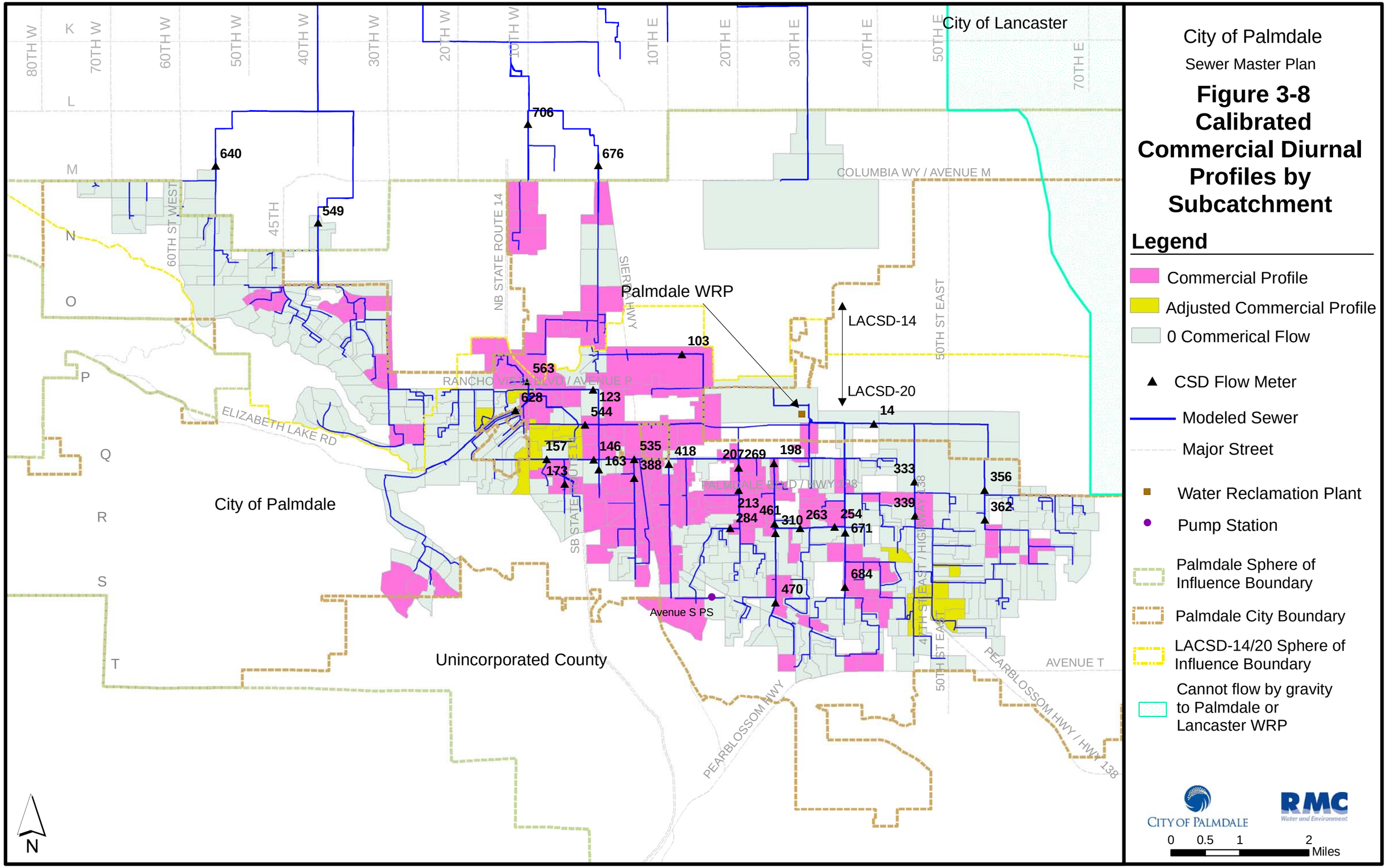
0 0.5 1 2 Miles


City of Palmdale
Sewer Master Plan
Figure 3-8
Calibrated
Commercial Diurnal
Profiles by
Subcatchment
Legend
Commercial Profile
Adjusted Commercial Profile
0 Commerical Flow
CSD Flow Meter
Modeled Sewer
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
Avenue S PS
LACSD-14
LACSD-20
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
AVENUE T
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
50TH ST EAST
47TH ST EAST
80TH W
70TH W
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103
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628
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544
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157
173
146
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388
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362
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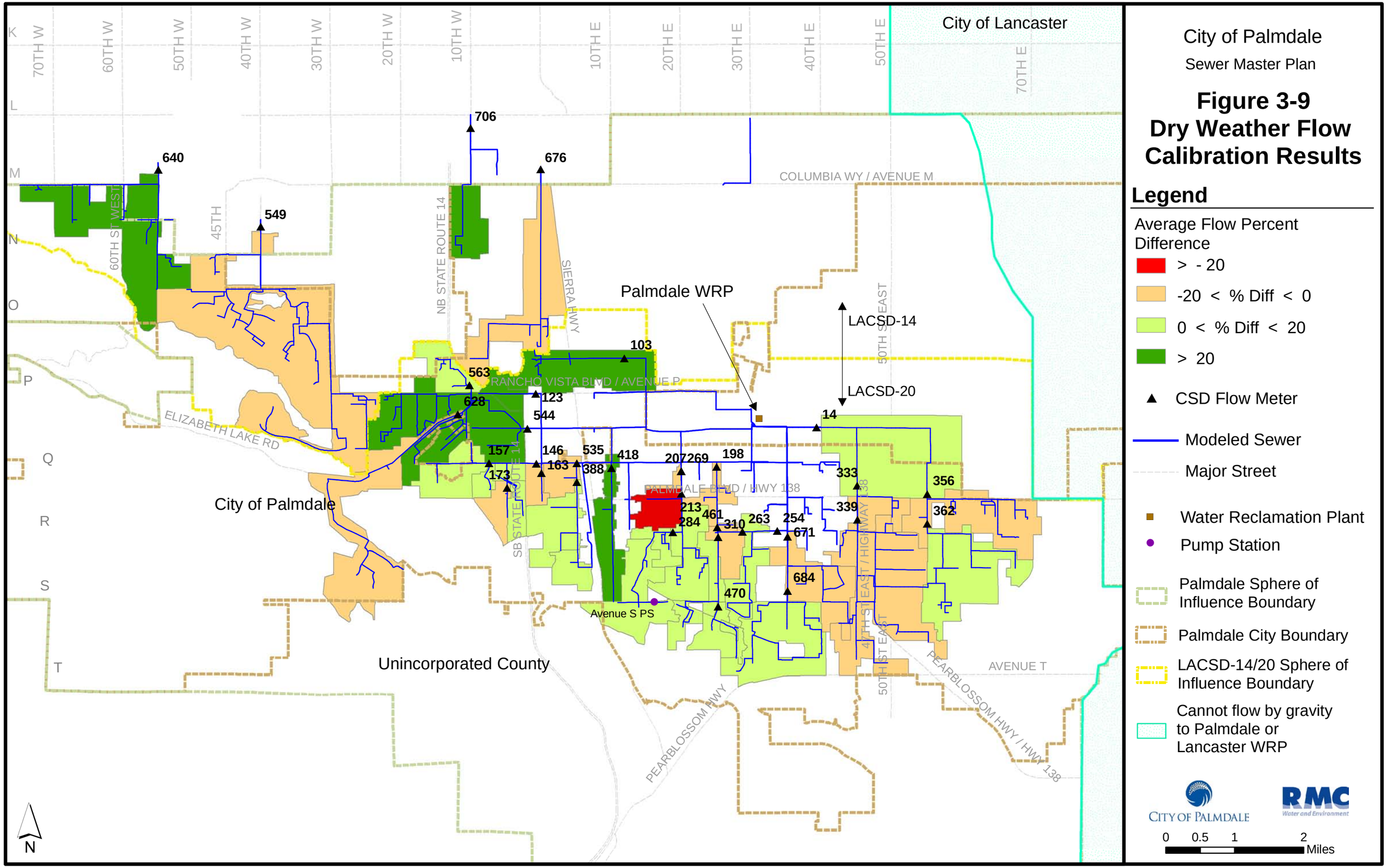
0 0.5 1 2
Miles
CITY OF PALMDALE
RMC
Water and Environment

**Table 3-2: Dry Weather Calibration Results for Average and Peak Flows**

| Flow Survey | Meter Avg. Flow (mgd) | Model Avg. Flow (mgd) | Avg. Flow % Diff | Weekday Meter Peak Flow | Weekday Model Peak Flow | Weekday Peak Flow % Diff |
|---|---|---|---|---|---|---|
| 14 | 1.70 | 1.70 | 0.40 | 2.92 | 2.68 | -8.13 |
| 103 | 0.06 | 0.08 | 32.40 | 0.15 | 0.14 | -4.14 |
| 123 | 0.05 | 0.06 | 20.18 | 0.09 | 0.09 | 1.93 |
| 146 | 0.37 | 0.41 | 12.64 | 0.58 | 0.78 | 35.25 |
| 157 | 0.15 | 0.17 | 10.30 | 0.27 | 0.32 | 19.55 |
| 163 | 0.11 | 0.09 | -10.59 | 0.25 | 0.16 | -36.56 |
| 173 | 0.09 | 0.08 | -9.55 | 0.25 | 0.16 | -38.44 |
| 198 | 0.56 | 0.55 | -2.79 | 1.16 | 0.86 | -25.96 |
| 207 | 0.42 | 0.34 | -18.84 | 0.60 | 0.50 | -15.98 |
| 213 | 0.26 | 0.21 | -20.61 | 0.41 | 0.32 | -20.96 |
| 254 | 0.30 | 0.36 | 19.15 | 0.44 | 0.56 | 28.00 |
| 263 | 0.17 | 0.17 | -0.25 | 0.29 | 0.26 | -8.38 |
| 269 | 0.82 | 0.90 | 9.66 | 1.52 | 1.41 | -7.82 |
| 284 | 0.55 | 0.56 | 2.89 | 1.04 | 0.88 | -14.73 |
| 310 | 0.38 | 0.44 | 14.18 | 0.67 | 0.69 | 2.18 |
| 333 | 1.25 | 1.17 | -6.15 | 2.03 | 2.06 | 1.33 |
| 339 | 0.67 | 0.67 | -0.44 | 1.31 | 1.11 | -15.66 |
| 356 | 0.57 | 0.54 | -5.05 | 0.98 | 0.85 | -13.26 |
| 362 | 0.41 | 0.42 | 1.87 | 0.70 | 0.66 | -5.58 |
| 388 | 0.33 | 0.37 | 13.40 | 0.70 | 0.59 | -16.39 |
| 418 | 0.11 | 0.14 | 21.86 | 0.21 | 0.21 | -3.38 |
| 461 | 0.37 | 0.35 | -4.67 | 0.67 | 0.56 | -16.78 |
| 470 | 0.24 | 0.24 | 1.34 | 0.43 | 0.39 | -9.36 |
| 479 | 0.07 | 0.07 | 6.97 | 0.14 | 0.13 | -6.85 |
| 535 | 0.74 | 0.62 | -16.72 | 1.00 | 0.94 | -6.63 |
| 544 | 0.65 | 0.80 | 22.45 | 1.16 | 1.18 | 1.75 |
| 549 | 1.37 | 1.27 | -7.00 | 2.39 | 2.32 | -2.86 |
| 563 | 0.11 | 0.11 | 0.10 | 0.18 | 0.19 | 9.92 |
| 628 | 0.13 | 0.12 | -10.82 | 0.26 | 0.17 | -35.01 |
| 640 | 0.18 | 0.33 | 80.78 | 0.52 | 0.60 | 15.90 |
| 671 | 1.30 | 1.05 | -19.58 | 2.00 | 1.80 | -10.15 |
| 676 | 0.06 | 0.05 | -21.85 | 0.10 | 0.08 | -24.34 |
| 684 | 0.57 | 0.59 | 2.15 | 0.89 | 1.04 | 17.04 |
| 706 | 0.07 | 0.07 | 1.50 | 0.19 | 0.13 | -31.02 |


City of Palmdale
Sewer Master Plan
Figure 3-9
Dry Weather Flow Calibration Results
Legend
Average Flow Percent Difference
> - 20
-20 < % Diff < 0
0 < % Diff < 20
> 20
CSD Flow Meter
Modeled Sewer
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
PALMDALE BLVD / HWY 138
ELIZABETH LAKE RD
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
AVENUE T
SIERRA HWY
NB STATE ROUTE 14
SB STATE ROUTE 14
60TH ST WEST
45TH
50TH ST EAST
47TH ST EAST / HIGHWAY 138
70TH W
60TH W
50TH W
40TH W
30TH W
20TH W
10TH W
10TH E
20TH E
30TH E
40TH E
50TH E
70TH E
K
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R
S
T
640
549
706
676
103
563
628
123
544
14
157
173
146
163
535
388
418
207
269
198
333
356
362
339
213
284
461
310
263
254
671
684
470
N
0 0.5 1 2 Miles
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the city boundary at one or more locations into Lancaster as it did previously, and thus bypassed meter 640. Lancaster and Palmdale staff have verified in the field that no flow currently (2009) crosses the city boundary, but it is not possible to verify what the conditions were in 2006 and thus determine the whether the calibration discrepancy was due to that or to other causes such as a metering error.

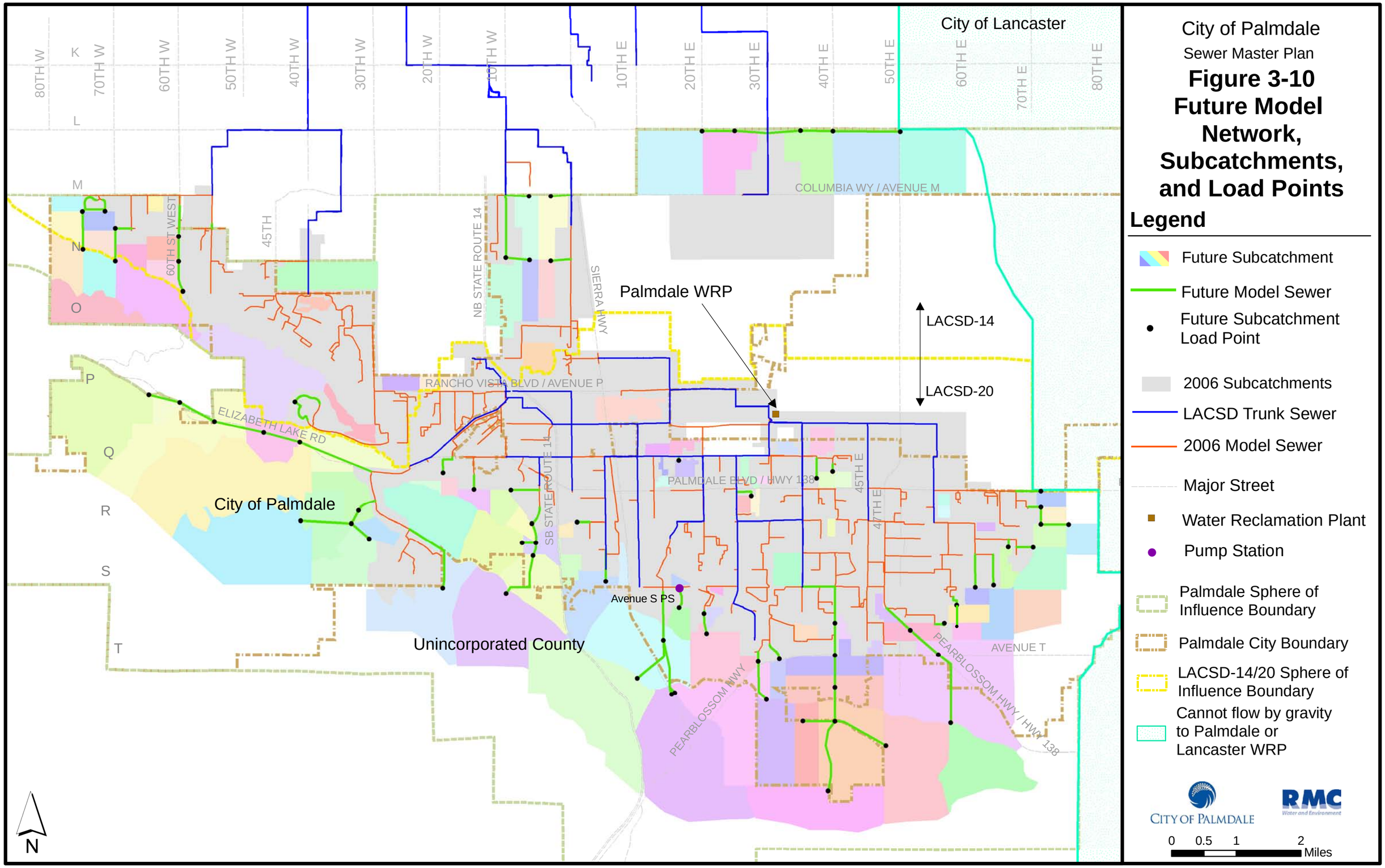
## 3.6 Hydraulic Model Extension

To model future flow conditions (2030 and Buildout scenarios), the model was extended to cover currently unsewered areas that are anticipated to be developed in those scenarios. An additional 199 sewer pipe segments covering 36 miles were added, as well as 111 subcatchments. Figure 3-10 shows these additional future sewers and subcatchments. Areas were not included in future subcatchments if they were not projected by the City to increase in population or employment, or would not affect any City sewers, including areas outside the Study Area (i.e., areas that cannot drain by gravity to the PWRP and would be served by a future treatment plant to the east).

Some of the added pipes are existing pipes, but most are future sewers. The alignment of future sewers and the boundaries of future subcatchments were generally based on ground topography and street right-of-ways, and connected to City or LACSD trunk sewers at the most logical locations. In some areas, available sewer studies provided information on future sewers, which was incorporated into the model. Specifically, studies were available for the Ritter Ranch, City Ranch, and College Park specific plan areas. Figure 3-11 shows the three specific plan areas that had sewer studies available, and the sewers that were called out in those studies. Also shown are the pipe diameters from those studies as well as the assumed diameters of all future pipes added to the model (which were later confirmed as appropriate through modeling).

Although none of the sewer studies provided details on manhole cover and pipe invert elevations, most provided plans and tables which showed pipe diameter, alignment, and minimum slopes, as well as tributary areas and load points. Because none of the studies had details on manhole or pipe elevations, all future manholes cover elevations were approximated by using an available 2-foot contour GIS layer. Pipe inverts were approximated by assuming that pipes would be 12 feet below ground for sewers larger than 12 inches in diameter and 10 feet below ground for sewers less than 12’ in diameter. After laying out the future sewers, all depths and slopes were checked to make sure they met City design standards.

The estimated wastewater flows from each of the future subcatchments was based on the City’s projections of population and employment at the TAZ level, as described in Chapter 2. The number of sewered acres (required for estimating infiltration/inflow) was estimated based on population and employment densities typical of the associated general plan land use categories, or from densities in nearby developments for areas outside the general plan boundaries.


City of Palmdale
Sewer Master Plan
Figure 3-10
Future Model Network, Subcatchments, and Load Points
Legend
Future Subcatchment
Future Model Sewer
Future Subcatchment Load Point
2006 Subcatchments
LACSD Trunk Sewer
2006 Model Sewer
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
City of Lancaster
Palmdale WRP
LACSD-14
LACSD-20
City of Palmdale
Unincorporated County
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
AVENUE T
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
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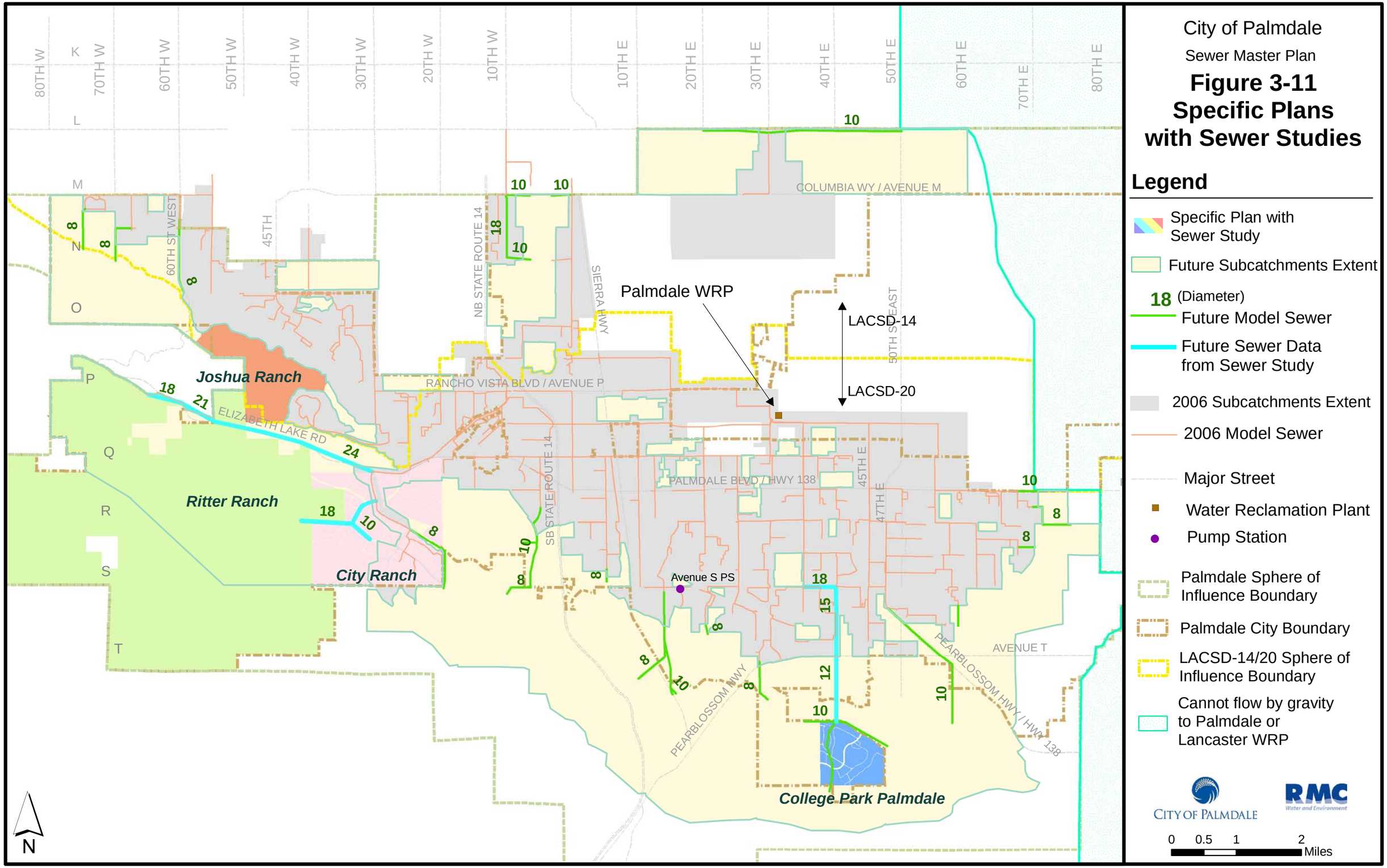
City of Palmdale
Sewer Master Plan
Figure 3-11
Specific Plans
with Sewer Studies
Legend
Specific Plan with Sewer Study
Future Subcatchments Extent
18 (Diameter)
Future Model Sewer
Future Sewer Data from Sewer Study
2006 Subcatchments Extent
2006 Model Sewer
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Cannot flow by gravity to Palmdale or Lancaster WRP
CITY OF PALMDALE
RMC
Water and Environment
0 0.5 1 2
Miles
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Palmdale WRP
LACSD-14
LACSD-20
Joshua Ranch
Ritter Ranch
City Ranch
College Park Palmdale
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
AVENUE T
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
50TH ST EAST
45TH E
47TH E
80TH W
70TH W
60TH W
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# Chapter 4 Design Flow Criteria

This chapter documents the design flow criteria that were applied to compute existing and future flows (including peak wet weather flows) for use in the hydraulic capacity analysis of the modeled sewer system. These criteria are based on the findings of the hydraulic model calibration (Chapter 3) and integrate with the wastewater flow estimation methodology (Chapter 2). Also included is a comparison of the criteria used in this Master Plan to the criteria the City uses in sewer studies for specific developments.

## 4.1 Dry Weather Flow Criteria

The following dry weather flow criteria was applied:

- The per-capita residential flow rates and diurnal profiles calibrated for currently developed subcatchments were applied under all scenarios. This assumes no major changes in wastewater generation rates from currently developed areas in the future.
- For subcatchments that are currently undeveloped or less than 25 percent developed, the per-capita flow rate was assumed to be 75 gallons per day with the high-peak diurnal profile.
- The per-employee non-residential flow rate was assumed to be 50 gallons per day for all scenarios, with the calibrated commercial/industrial diurnal profile.
- All parcels currently on septic tanks in 2006 were assumed to connect to the sewer system by 2030. As noted in Chapter 2, since that is considered to be a conservative assumption, any capacity deficiencies that were modeled to occur in areas affected by septic tank conversions were further analyzed to determine if the deficiencies would still be predicted without the conversions, so that the associated relief sewer projects could be noted as being contingent on septic tank conversions if that were the case.

## 4.2 Summary of System-Wide Wastewater Flows

The hydraulic model was run using the above dry weather flow criteria for each of the three scenarios, and the resulting average wastewater flows for both the LACSD-20 sphere of influence (i.e., at the PWRP), LACSD-14 (flows originating in Palmdale but flowing to the LWRP), and the entire Study Area are summarized in Table 4-1. The difference in flows generated within the Study Area and the Palmdale Sphere of Influence is negligible.

**Table 4-1: Summary of Modeled System-Wide Average Dry Weather Flows**

| Service Area | Scenario | Residential Flow (mgd) | Non-Residential Flow (mgd) | Total Average Dry Weather Flow (mgd) |
|---|---|---|---|---|
| LACSD-20 (PWRP) | Existing (2006) | 7.9 | 1.1 | 8.9 |
| | 2030 | 13.3 | 3.4 | 16.7 |
| | Buildout | 18.5 | 4.1 | 22.6 |
| Flows from Palmdale to LACSD-14 (LWRP) | Existing (2006) | 1.3 | 0.2 | 1.5 |
| | 2030 | 2.3 | 1.2 | 3.5 |
| | Buildout | 2.5 | 2.5 | 5.0 |
| Study Area | Existing (2006) | 9.2 | 1.2 | 10.4 |
| | 2030 | 15.6 | 4.6 | 20.2 |
| | Buildout | 20.9 | 6.6 | 27.6 |

The flow estimates and projections for the PWRP are significantly lower than flow projections made in the past by LACSD and documented in the Palmdale Water Reclamation Plan 2025 Plan and EIR,

September 2005 (PWRP Plan) and in the 2004-2005 General Plan Amendment to the 1993 Palmdale General Plan Update, adopted July 2004 (GP Amendment). The flow projections in those documents were based on SCAG population projections and a single average per capita unit flow rate of 88 gallon per day per capita that covers all flow other than permitted industrial flows, which were only about 0.2 mgd.

The projections in both reports were performed starting with observed flows through 2002 or 2003, and the flow estimates presented for 2005 were projections. The GP Amendment presents the observed PWRP flow in 2002 as 8.9 mgd, and the 2005 flow projection as 11.9 mgd. The PWRP Plan projected a 2005 flow of 11.0 mgd. Actual observed PWRP flow in 2005 was only about 9.7 mgd, and it has decreased slightly since then to about 9.4 mgd in 2008. The reason for the high 2005 flow projections is a combination of aggressive SCAG population projections and the use of high per capita unit flow rates that have been decreasing in recent years due to water conservation. The modeled PWRP flow for 2006 of 8.9 mgd shown in Table 4-1 is much closer to the observed PWRP flow, albeit slightly lower because the model calibration set unit flows that provided the best overall match to a number of flow meters located throughout the system and not to match the PWRP flow perfectly.

Given the high projection for 2005, the aggressive SCAG population projections, and the high per capacity unit flow rates used, it is not surprising that the PWRP Plan and GP Amendment projections of flow in 2025 (the latest year for which projections were made) are considerably higher than the projections developed in this Master Plan based on the latest City estimates for population and employment growth. The PWRP Plan 2025 projection for the PWRP was 22.4 mgd, and GP Amendment projection was 20.5 mgd. By comparison, the projection for 2030 PWRP flow made for this Master Plan and shown in Table 4-1, is 16.7 mgd. These flows assume that the calibrated unit flows for residential and non-residential land uses, as well as the flows from major non-residential wastewater dischargers, will remain the same in the future. It is considered unlikely that unit flows will increase significantly in the future given the ongoing emphasis on water conservation in the area.

## 4.3 Wet Weather Flow Criteria

This section presents an analysis of the amount of inflow and infiltration (I/I) in the Palmdale sewer system and describes how I/I was included in the hydraulic model to generate peak wet weather flows for the sewer capacity analysis. Inflow is storm water that directly enters the sanitary sewer system through improper or illicit connections. Infiltration is generally groundwater or storm water that enters the sanitary sewer system more slowly through cracks or leaks in the sewers.

### 4.3.1 Historical Wet Weather Flows

The City has a very dry climate, with an average annual rainfall of 7.4 inches. Nearly 90 percent of the annual rainfall occurs in the wet weather season of November through April. Due to its dry climate, pervious soils, and low groundwater levels, the City's sewer system does not experience elevated flows due to I/I except during rainfall events. This is illustrated in Figure 4-1, which shows the average and peak daily flows recorded at the Palmdale Water Reclamation Plant (PWRP) as well as daily rainfall at General William J. Fox Field during three wet weather seasons between 2002 and 2005. The three seasons shown are representative of a dry year (3.3 inches in 2003-2004), an average year (7.5 inches in 2002-2003), and a very wet year (18.5 inches in 2004-2005).

In Figure 4-1, the peak daily flow is the highest instantaneous flow recorded on that day. Due to a recent change in the SCADA system used at the PWRP, it was not possible to retrieve hourly historical flow data to determine when the peak flows occurred and how much of the peak flow could be attributed to I/I on an hourly basis.

It is clear from Figure 4-1 that wastewater flow increases only during rainfall events exceeding about an inch. It is also clear that the period of increased flow is limited to the period of rainfall and does not persist in subsequent days. Typically, flows are back to normal the day after the storm. A reasonable interpretation of this type of wet weather response is:

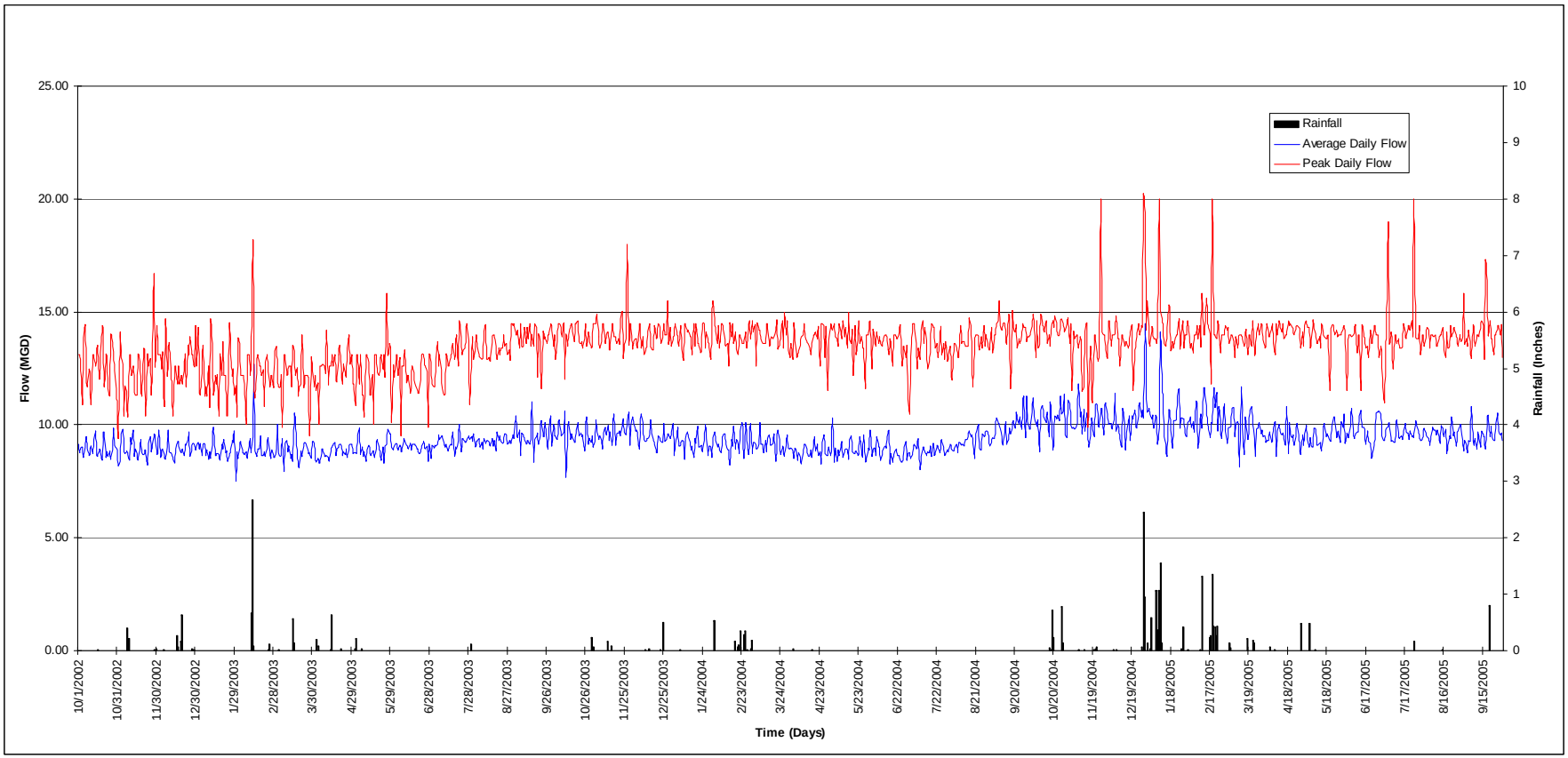



**Figure 4-1: Palmdale WRP Daily Influent Flows and General William J. Fox Field Rainfall – Oct. 2002 Through Sept. 2005**

- There is no significant I/I caused by temporarily elevated groundwater levels, since groundwater infiltration typically persists for many days and weeks.
- Direct inflow due to drainage of rooftops, roadways, and other impervious surfaces may occur, but does not appear to be the main source of I/I. If it were, one would expect the flows to increase noticeably during every rainfall event, in proportion to the amount of rainfall. However, the PWRP influent only increases during storms of over an inch.
- The primary sources of I/I are likely to be sources that are active only during major storm events, which are sufficient in size cause significant surface runoff and localized flooding. Examples of possible sources would be submerged manhole covers in flooded streets and leaky shallow mains and laterals that become conduits to temporarily drain away rainfall that cannot be absorbed quickly enough into the soil.

The PWRP influent data during major storms were analyzed to quantify the effect of rainfall on peak flows. The three largest storms in recent history (since the start of 2000) can be seen on Figure 4-1 as the days in which both the average and peak flows increased significantly. Those days were 2/12/03, 12/28/04, and 1/9/05. For each of those days, the increase in peak flow attributable to the rainfall was determined by comparison to the normal dry weather daily peak flow for that day of the week over the previous month. The increases were 6.3, 6.3, and 5.9 mgd respectively for the three storms. Note that the actual amount of peak I/I that occurred during each storm could have been more than these amounts, if the timing of the peak I/I did not coincide with the timing of the peak diurnal dry weather flow. In any event, these increases represent the net effect of the storms on peak flows at the PWRP.

### 4.3.2 Infiltration/Inflow Rates

Based on the observed flows at the PWRP, it is appropriate to include an allowance for infiltration/inflow in the hydraulic model for assessing the capacity of the modeled sewers. The allowance was based on a storm event that would generate a peak flow at the PWRP of about 20 mgd, which is 6.3 mgd higher than the modeled peak dry weather flow. The I/I from the storm event was represented as a constant flow from each subcatchment, in proportion to its net sewered area. The assumption of a constant flow is a simplification of the actual time-varying I/I response, but is deemed to be appropriate in view of the fact that no time-varying influent data were available upon which to base I/I hydrographs. Furthermore, the overestimated flow volumes that would result from the constant flow simplification would have little consequence in the capacity analysis, since the only the peak flows determine capacity deficiencies, and solutions involving storage of peak flows (which would not be valid under the constant flow simplification) were not considered.

The distribution of I/I sources throughout the City's sewer system is unknown, as there has been no monitoring performed simultaneously at multiple locations in the system during major wet weather events. Performing such wet weather flow monitoring in the City at multiple locations would be problematic from the standpoint that it could take several years of monitoring before a storm occurred of sufficient size to generate enough I/I for a meaningful analysis. Monitoring over the past three wet seasons, for example, would have been unlikely to yield any useful flow data due to lack of major storms.

Given the lack of wet weather flow data to determine the variations in I/I in different portions of the City's sewer system, one option for modeling wet weather flows would be to assume that all areas contribute the same amount of I/I on a per-acre basis. Another option would be assume that I/I is higher in some portions of the system than in others, based on characteristics of the area that might make it more likely that higher I/I occurs. In other studies which included extensive wet weather flow monitoring, higher I/I was typically found to occur in older sections of the system, particularly in areas that were developed prior to 1960. Sewers in those areas tend to be "leakier" due to their rigid joints and age. Video inspections of the sewers in Palmdale confirm that the pre-1960 sewers have more significant

structural defects than do newer sewers. As noted above, the City may also experience I/I from submerged manholes in addition to leaky pipes, and the year of development may not be a good indicator of the presence of that source of I/I. Thus, it seemed appropriate to assume some of the I/I comes from all areas, regardless of age, but more comes from the pre-1960 areas on a per-acre basis. For this study, the assumption was made that the pre-1960 areas would contribute three times as much I/I per acre as the post-1960 areas.

Trial-and-error runs of the hydraulic model determined that applying an I/I rate of 666 gallons per day per net acre (gpad) of sewered development in the post-1960 areas and 2000 gpad in the pre-1960 areas generates a peak flow at the PWRP of 20 mgd for the 2006 scenario. Therefore, these per-acre I/I were used in the wet weather scenario for the capacity analysis. For development after 2006, the same 666 gpad I/I rate was applied. Also, the same pair of per-acre rates were used for the areas of Palmdale that are tributary to the LWRP as for those tributary to the PWRP.

The hydraulic criteria used to determine the adequacy of the hydraulic capacity of sewers under dry and wet weather flow conditions (e.g., percent of full pipe depth) are described in Chapter 5. Recognizing the limitations and simplifications involved in the development of the wet weather flow criteria, deficiencies identified in modeling will need to be verified, particularly if the deficiency is expected to occur only under wet weather flow conditions. In those cases, additional monitoring of water levels and/or flows in key locations is recommended to confirm the need for the identified projects, as described further in Chapter 5.

## 4.4 Current City Design Criteria

Criteria used for estimating flows and capacities for specific developments is generally not appropriate for use in master planning studies. The criteria used by the City as well as other agencies is intentionally conservative because it is typically applied to small areas rather than larger areas where the mix of uses tend to reduce the average flow. The application of these conservative flow criteria on a citywide basis would generate unrealistic flows and indicate capacity deficiencies which do not or would not actually occur. Also, comparisons of City criteria to master plan criteria are difficult due to the fundamentally different methodologies used (e.g., peaking curves rather than routed diurnal profiles). Thus, comparisons to current city criteria are of limited value.

City's current residential flow design criteria include:

- Household size of 3
- Per-capita flow rate of 100 gallons per day
- Peaking based on a curve related to population (about 3 times average flow for a population of 1,000)
- No allowance for I/I
- Sizing of new pipes for 50% full (up to 15") or 75% full (over 15")

In terms of dry weather flow, these City criteria are conservative in the use of 100 gallons per day per capita and peaking factors of 3 in small areas, compared to the calibrated rates of 55 to 80 gallons per day and diurnal profiles having peaks less than 2 times average at the subcatchment level. The sizing criteria is also conservative, but indirectly provide capacity for unspecified I/I.

The non-residential flows are also based on different methodologies. In this Master Plan, a flow rate of 50 gallons per day per employee was applied, which is equivalent to 1000 to 1200 gallons per day per net acre (parcel areas only, excluding dedicated right of way), based on the City's estimated floor area ratios and square feet per employee that yield a range of 20 to 24 employees per net acre. These flow rates are reasonable for master planning estimates for the density and type of non-residential development in the

City. They are also consistent with a flow rate of 100 gallons per day per developed square foot (with a 25% floor area ratio), which is specified by LACSD for many non-residential uses. The City uses non-residential flow rates that vary depending on the specific use, which is appropriate when the uses are known. In comparison to the Master Plan rates, they are generally very conservative. In master plans, it is more appropriate to apply rates that would be expected to be observed as an average of multiple unknown uses, supplemented with point discharges for major existing wastewater generators, based on water consumption data, as was done in this Master Plan.

In conclusion, the City's flow and capacity criteria are more conservative than the criteria use in this Master Plan, but that is appropriate given the way in which the criteria are used. Therefore, there is no need for the City to modify its criteria.

# Chapter 5 Sewer System Capacity Analysis

This chapter presents the results of the hydraulic capacity analysis of the City's sewer system. The first section of this chapter presents the capacity deficiency criteria used in the analysis. The rest of the chapter presents the results of the existing and future dry and wet weather capacity analyses, identifies existing sewers requiring capacity relief, and describes required capital improvement projects, including planning-level cost estimates. All of these tasks are necessary to comply with the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, specifically the System Evaluation and Capacity Assurance Plan element of the SSMP.

## 5.1 Hydraulic Deficiency Criteria

Sewer capacity deficiency criteria are used to determine when the capacity of a sewer is exceeded to the extent that a relief sewer or larger replacement sewer is required. These are sometimes called "trigger" criteria in that they trigger the need for a project. These criteria often differ from criteria that are applied to determine the size of a new sewer, which are typically more conservative.

For this study, a capacity deficiency is considered to occur when either of the following occurs:

- Under peak dry weather flow (DWF) conditions, the hydraulic grade line (i.e., water level) exceeds 75 percent of the pipe diameter in any sewer.
- Under peak wet weather flow (WWF) conditions, the hydraulic grade line surcharges by more than two feet above the crown of the pipe in any sewer.

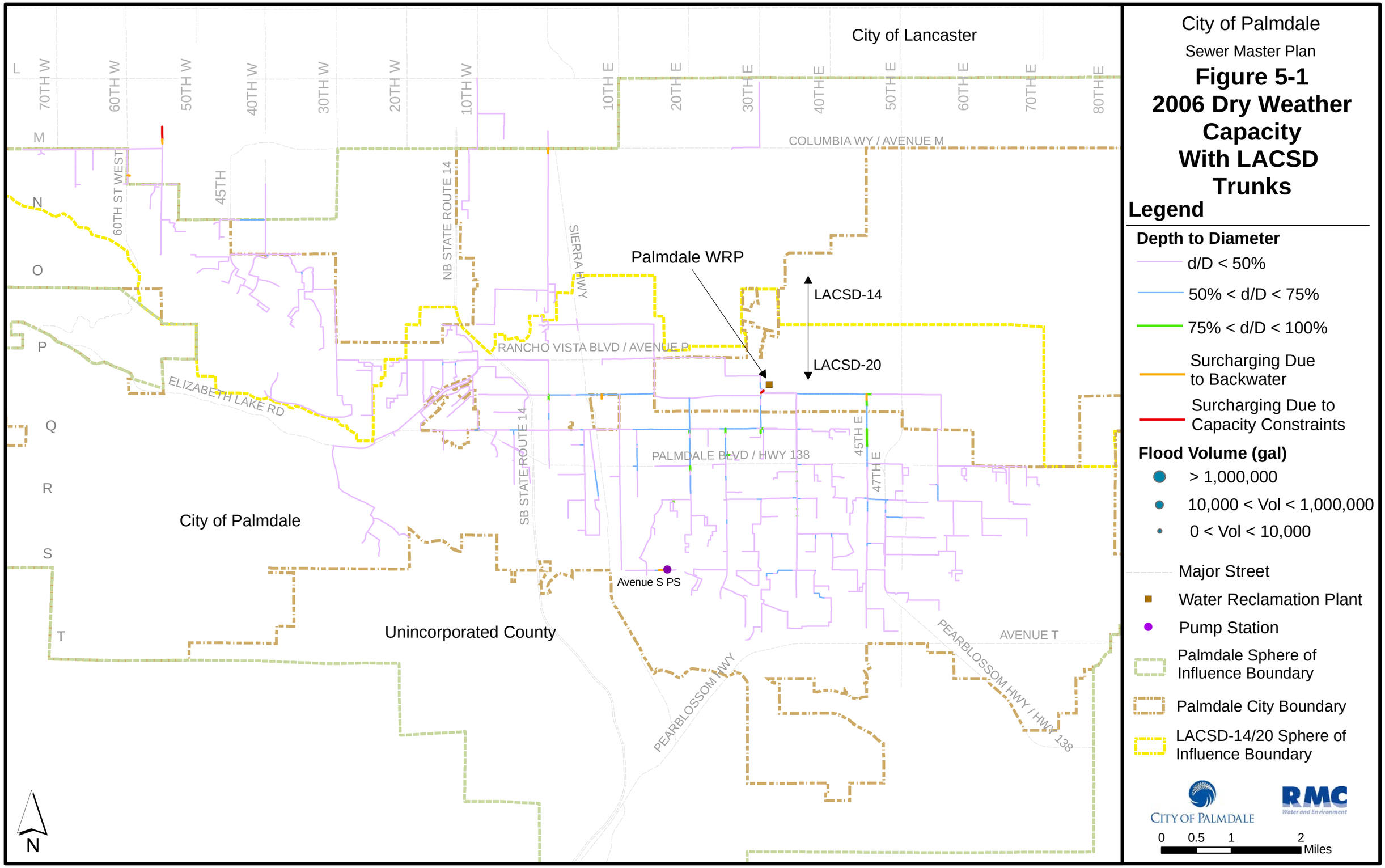
Higher priority is given to deficiencies that are triggered by the dry weather flow criteria, particularly those that also exceed the wet weather flow criteria.

Deficiencies were identified based on both existing (2006) and 2030 scenarios. A special case involved parcels on septic tanks. For this study, it was assumed that all parcels currently on septic tanks in 2006 will connect to the sewer system by 2030. Since this is considered to be a very conservative assumption, any capacity deficiencies that were modeled to occur in areas affected by septic tank conversions were checked to determine if the deficiencies would still be predicted without the conversions, and if so, the associated capital improvement projects were indicated as being contingent on septic tank conversions. This check was performed on one of the capital improvement projects identified in this study, and the deficiency was found to not be contingent on septic tank conversions (discussed further in the next section).

## 5.2 Hydraulic Capacity Analysis Results

Flows in the City's existing sewer system are expected to increase in the future due to infill and outlying development. The City's major sewers were assessed to ensure they would have adequate hydraulic capacity to convey those future wastewater flows. The calibrated hydraulic model was used to identify any capacity deficiencies in the system for both DWF and WWF under existing and future conditions. Although the City is not responsible for the capacity of the LACSD trunk sewers, potential capacity deficiencies in the trunk sewers were identified in this analysis. However, a second set of model runs was also made with the LACSD trunk sewers removed from the modeled sewer network, in order to isolate capacity deficiencies in the City sewers from those in the trunks. This was necessary because backwater from deficient trunk sewers can surcharge City sewers and obscure the identification of deficient City sewers.

In general, there were very few City sewers that violated the hydraulic deficiency criteria under either DWF or WWF conditions for model runs with the trunks removed to isolate City sewer problems. Figures 5-1 through 5-8 present the model results in terms of depth-to-diameter ratio (d/D, maximum depth of


City of Palmdale
Sewer Master Plan
Figure 5-1
2006 Dry Weather Capacity With LACSD Trunks
Legend
Depth to Diameter
d/D < 50%
50% < d/D < 75%
75% < d/D < 100%
Surcharging Due to Backwater
Surcharging Due to Capacity Constraints
Flood Volume (gal)
> 1,000,000
10,000 < Vol < 1,000,000
0 < Vol < 10,000
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
Avenue S PS
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
AVENUE T
PEARBLOSSOM HWY
PEARBLOSSOM HWY / HWY 138
NB STATE ROUTE 14
SB STATE ROUTE 14
SIERRA HWY
60TH ST WEST
45TH
45TH E
47TH E
70TH W
60TH W
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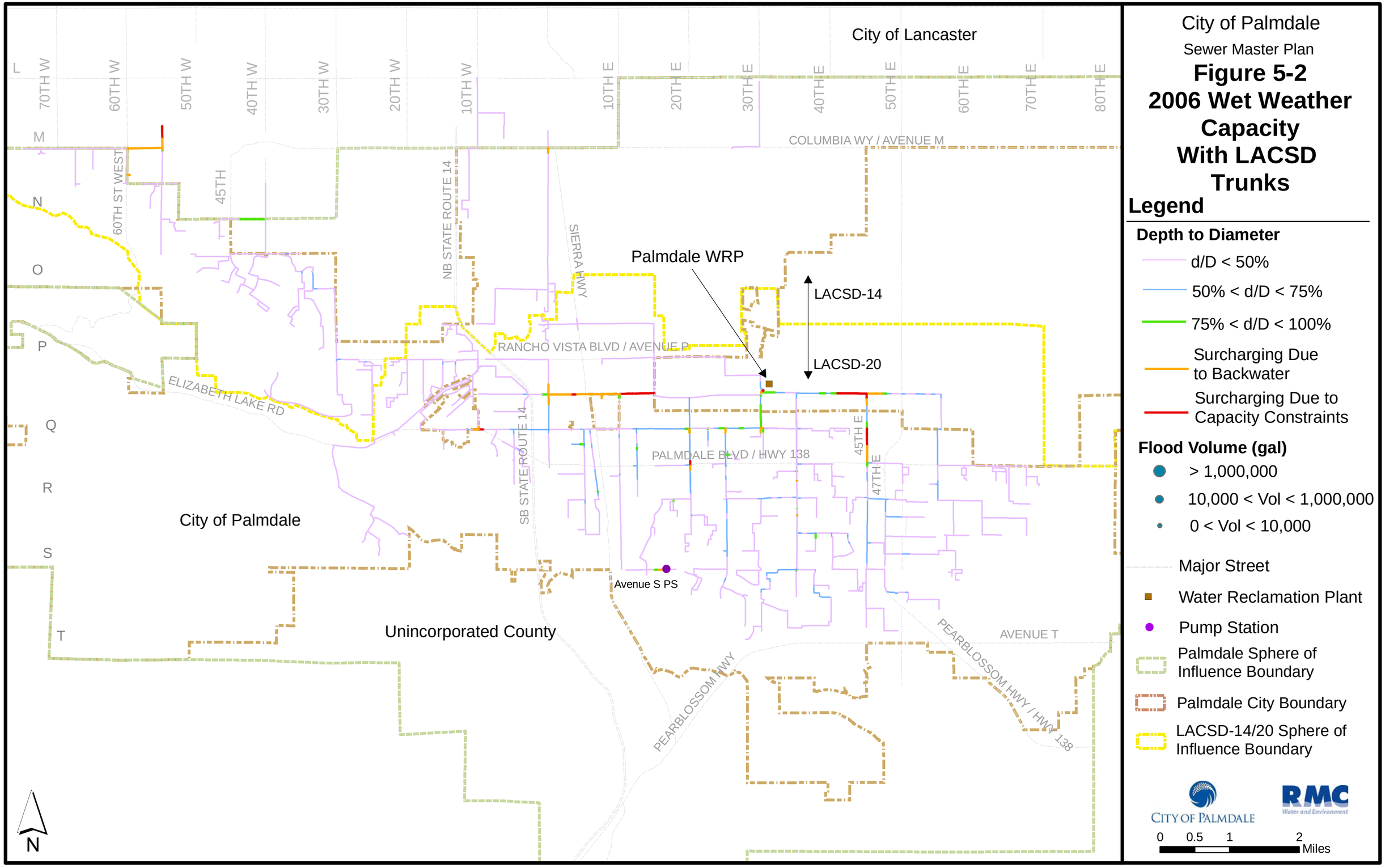
Miles


City of Palmdale
Sewer Master Plan
Figure 5-2
2006 Wet Weather Capacity With LACSD Trunks
Legend
Depth to Diameter
d/D < 50%
50% < d/D < 75%
75% < d/D < 100%
Surcharging Due to Backwater
Surcharging Due to Capacity Constraints
Flood Volume (gal)
> 1,000,000
10,000 < Vol < 1,000,000
0 < Vol < 10,000
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
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City of Lancaster
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Unincorporated County
Palmdale WRP
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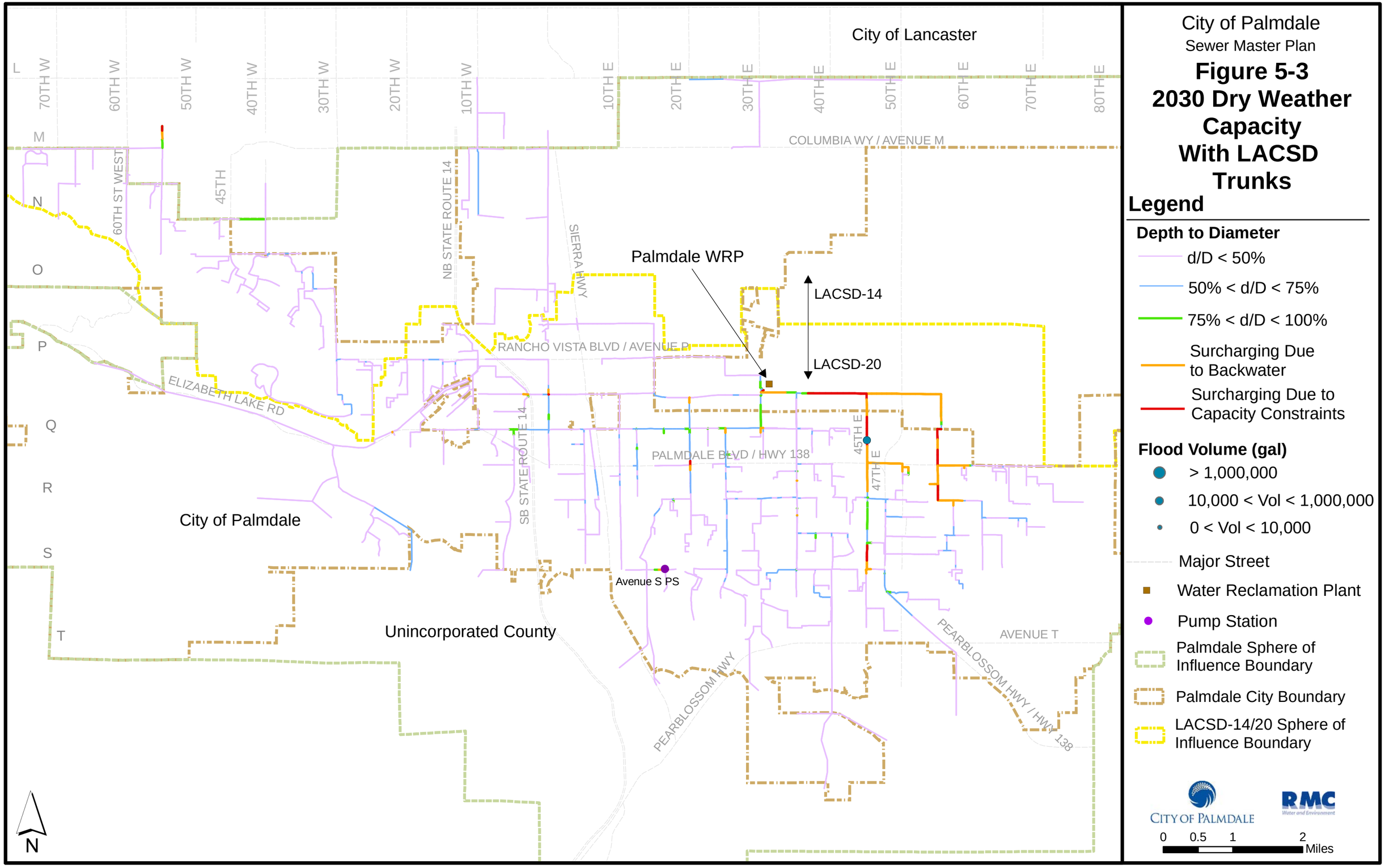
City of Palmdale
Sewer Master Plan
Figure 5-3
2030 Dry Weather Capacity With LACSD Trunks
Legend
Depth to Diameter
d/D < 50%
50% < d/D < 75%
75% < d/D < 100%
Surcharging Due to Backwater
Surcharging Due to Capacity Constraints
Flood Volume (gal)
> 1,000,000
10,000 < Vol < 1,000,000
0 < Vol < 10,000
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
City of Lancaster
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Unincorporated County
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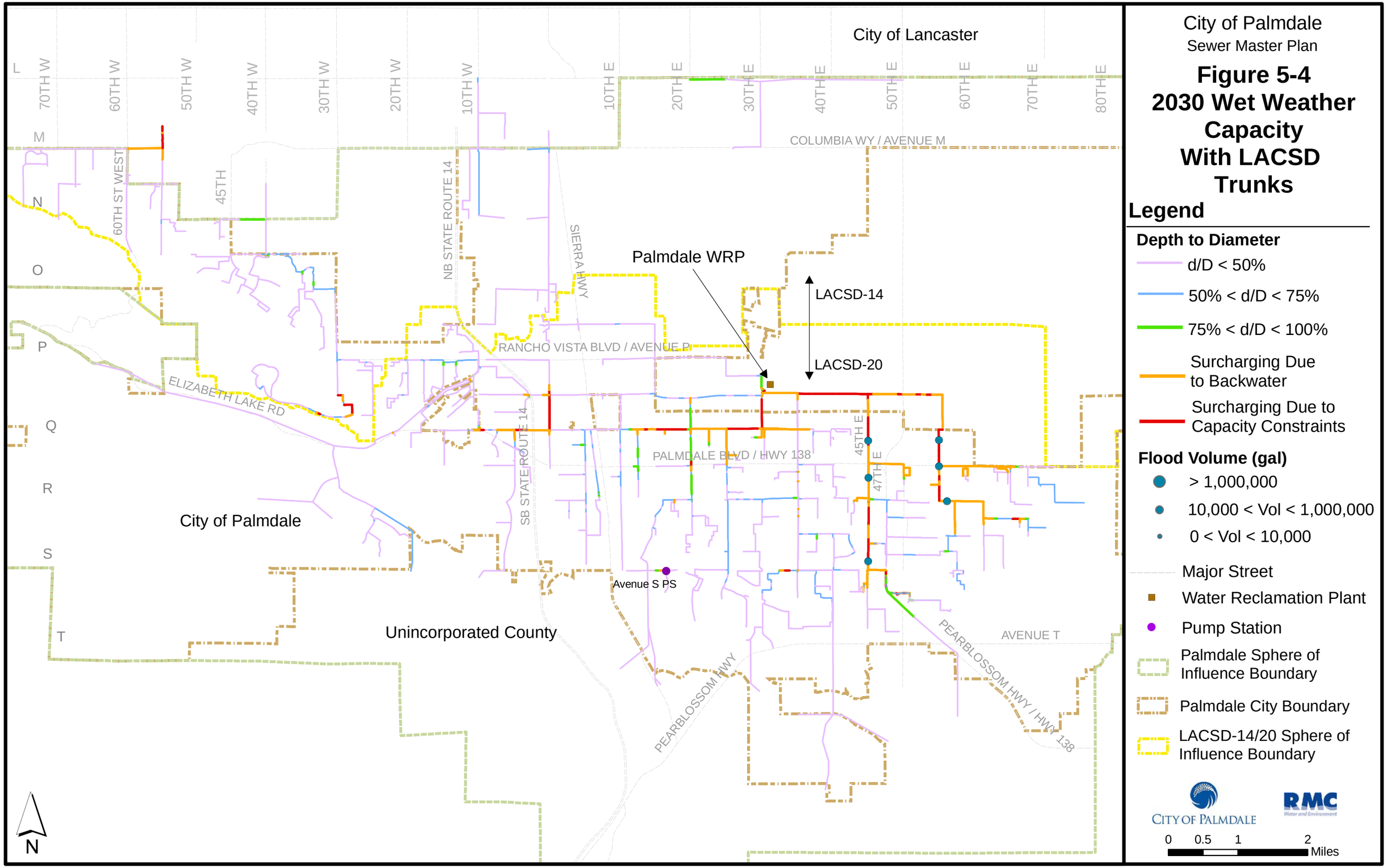
City of Palmdale
Sewer Master Plan
Figure 5-4
2030 Wet Weather Capacity With LACSD Trunks
Legend
Depth to Diameter
d/D < 50%
50% < d/D < 75%
75% < d/D < 100%
Surcharging Due to Backwater
Surcharging Due to Capacity Constraints
Flood Volume (gal)
> 1,000,000
10,000 < Vol < 1,000,000
0 < Vol < 10,000
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
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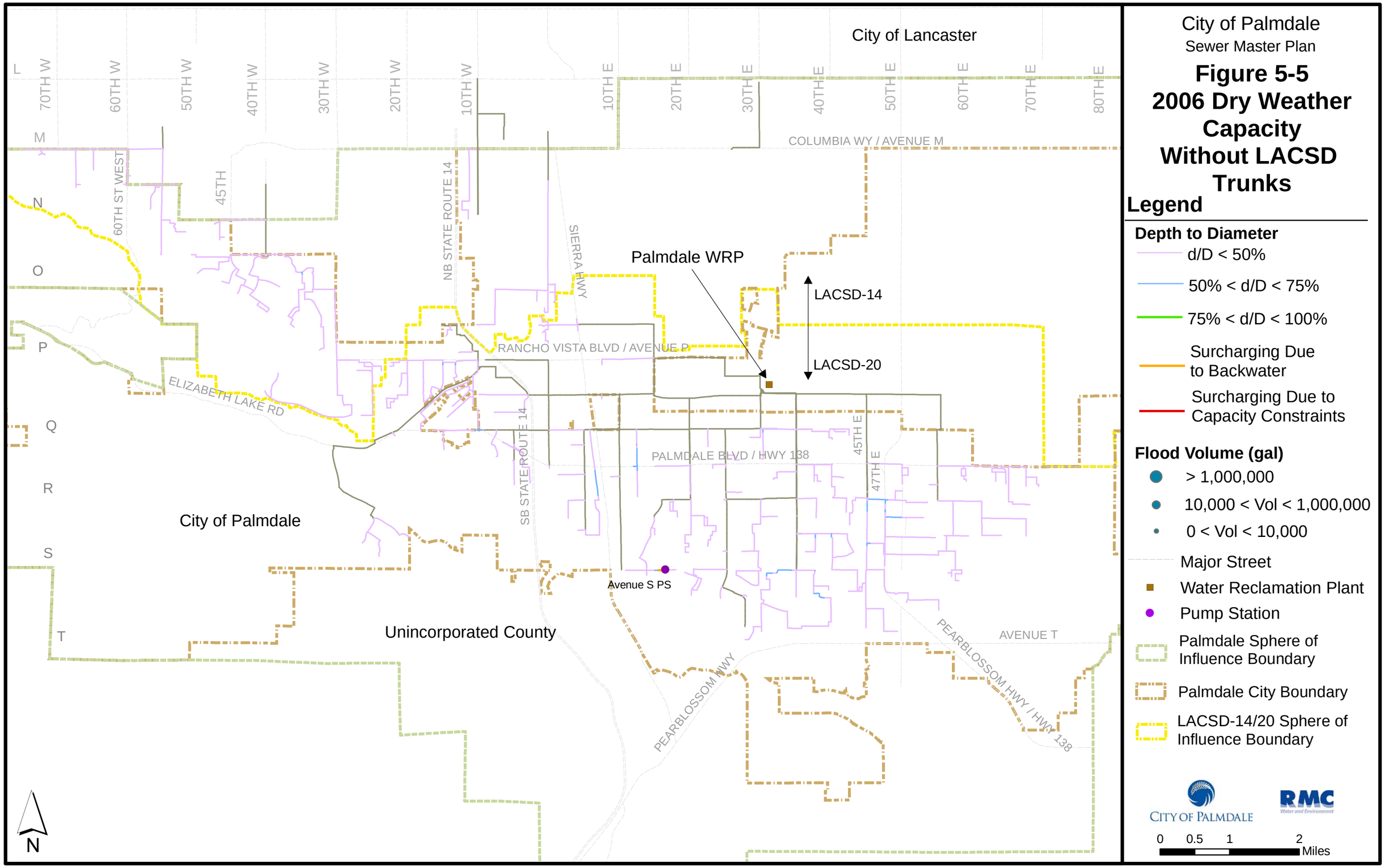
City of Palmdale
Sewer Master Plan
Figure 5-5
2006 Dry Weather Capacity Without LACSD Trunks
Legend
Depth to Diameter
d/D < 50%
50% < d/D < 75%
75% < d/D < 100%
Surcharging Due to Backwater
Surcharging Due to Capacity Constraints
Flood Volume (gal)
> 1,000,000
10,000 < Vol < 1,000,000
0 < Vol < 10,000
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
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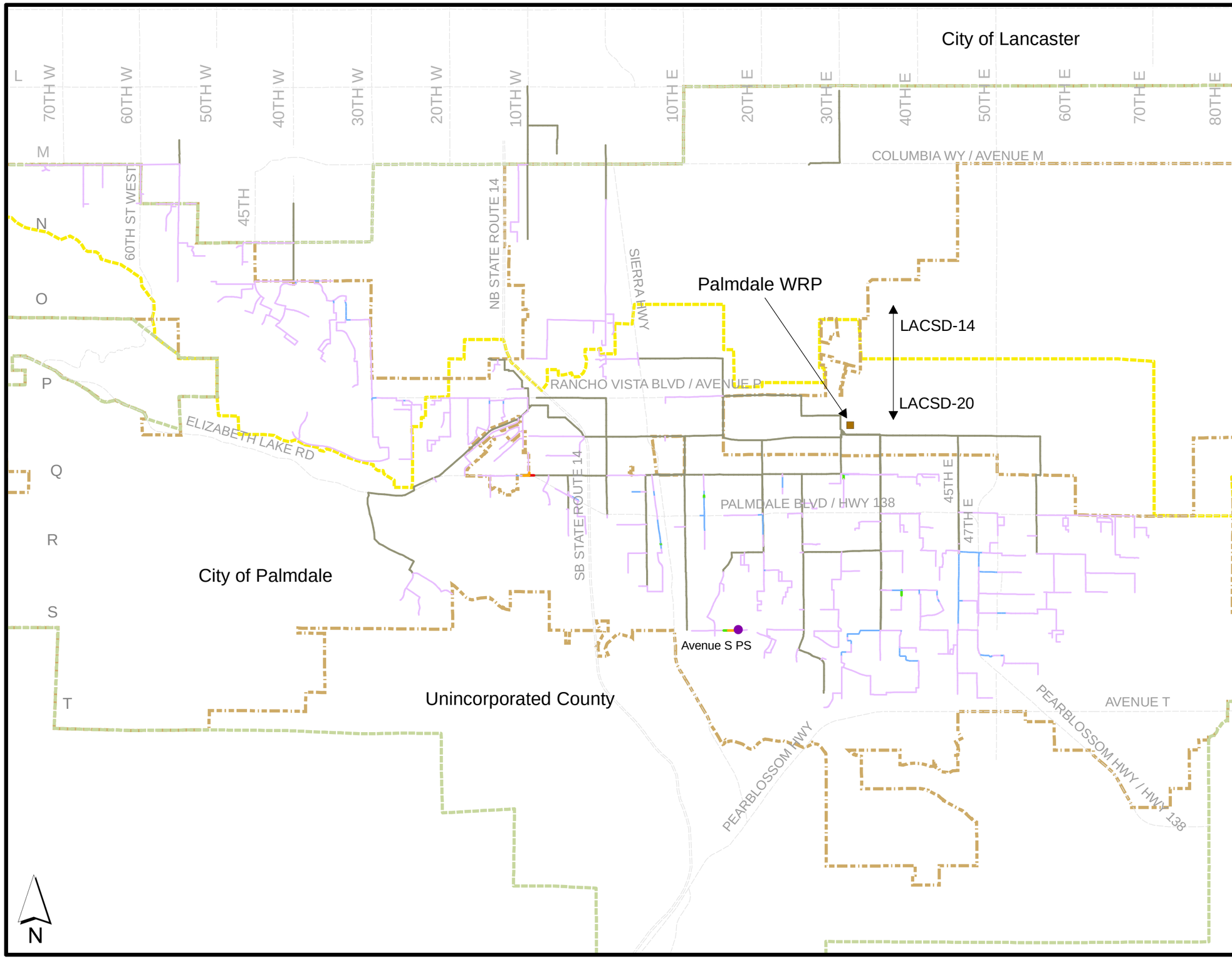
Sewer Master Plan

# Figure 5-6
# 2006 Wet Weather Capacity Without LACSD Trunks




## Legend

**Depth to Diameter**

- d/D < 50%
- 50% < d/D < 75%
- 75% < d/D < 100%
- Surcharging Due to Backwater
- Surcharging Due to Capacity Constraints

**Flood Volume (gal)**

- > 1,000,000
- 10,000 < Vol < 1,000,000
- 0 < Vol < 10,000

- Major Street
- Water Reclamation Plant
- Pump Station
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary

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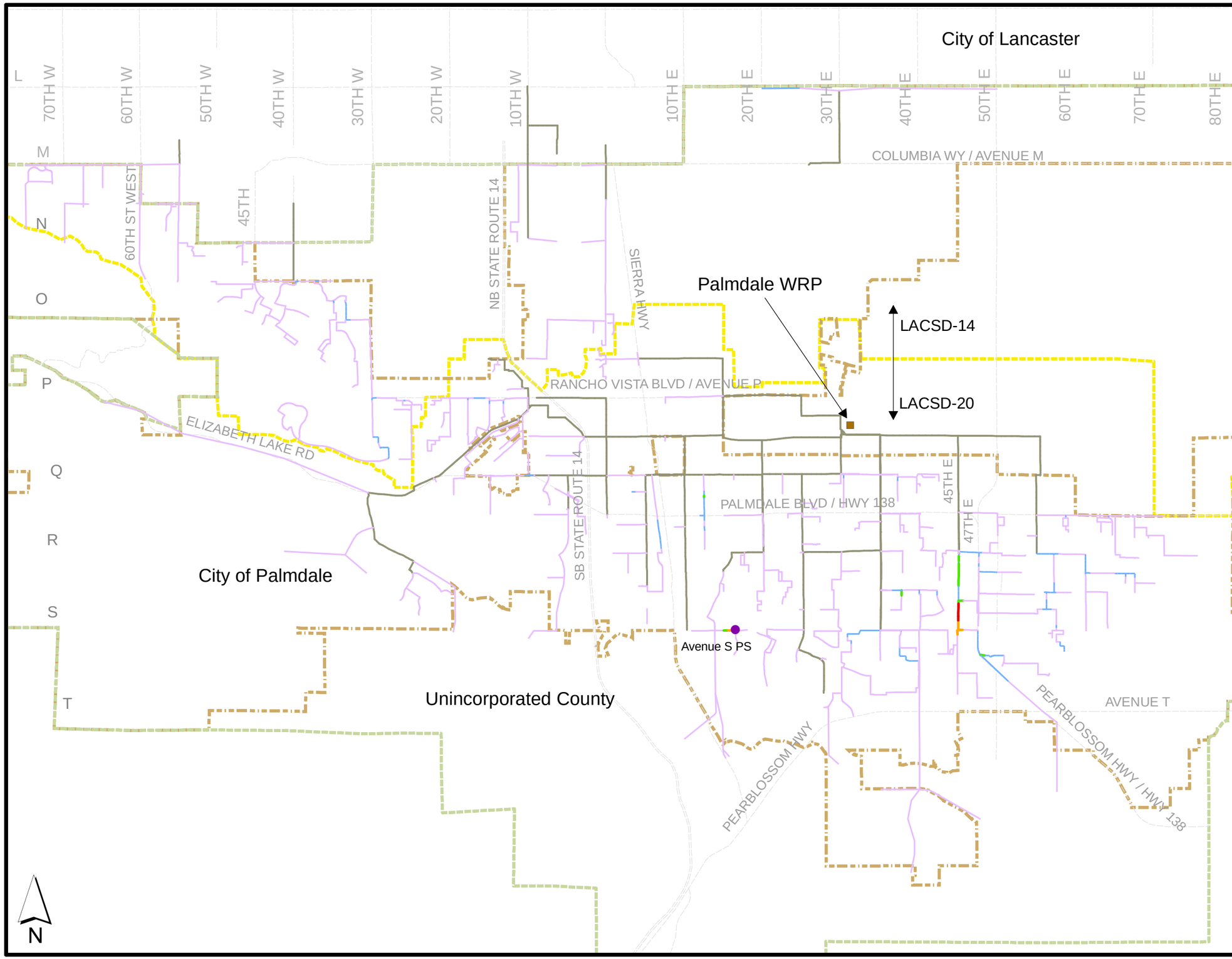
City of Palmdale
Sewer Master Plan

# Figure 5-7
# 2030 Dry Weather Capacity Without LACSD Trunks




## Legend

**Depth to Diameter**

- d/D < 50%
- 50% < d/D < 75%
- 75% < d/D < 100%
- Surcharging Due to Backwater
- Surcharging Due to Capacity Constraints

**Flood Volume (gal)**

- > 1,000,000
- 10,000 < Vol < 1,000,000
- 0 < Vol < 10,000

- Major Street
- Water Reclamation Plant
- Pump Station
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary

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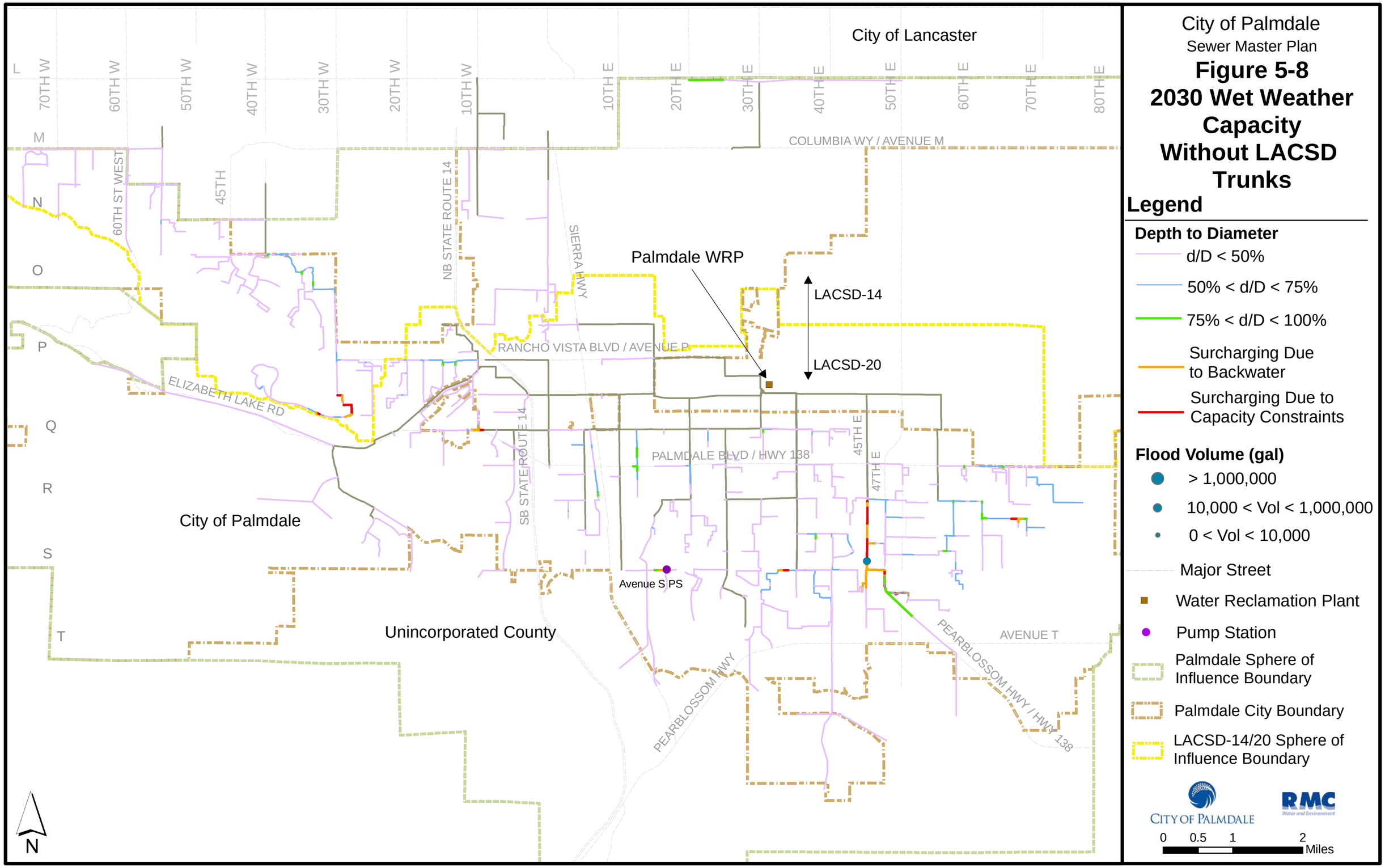
0 0.5 1 2 Miles


City of Palmdale
Sewer Master Plan
Figure 5-8
2030 Wet Weather Capacity Without LACSD Trunks
Legend
Depth to Diameter
d/D < 50%
50% < d/D < 75%
75% < d/D < 100%
Surcharging Due to Backwater
Surcharging Due to Capacity Constraints
Flood Volume (gal)
> 1,000,000
10,000 < Vol < 1,000,000
0 < Vol < 10,000
Major Street
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Palmdale Sphere of Influence Boundary
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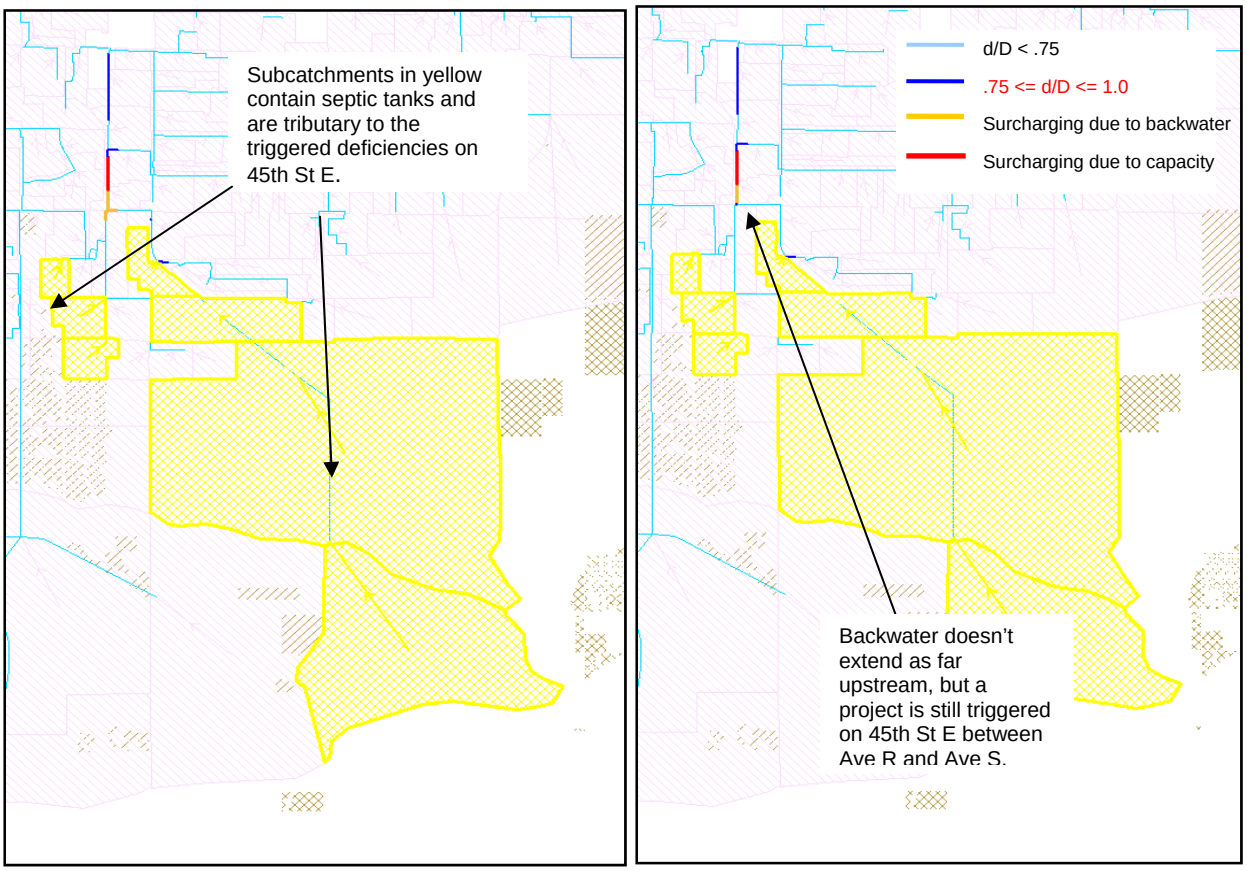
flow divided by pipe diameter) for 2006 and 2030 Peak DWF and WWF, both with (Figures 5-1 through 5-4) and without (Figures 5-5 through 5-8) the LACSD trunks. The following are the key findings:

- Under 2006 DWF conditions (Figure 5-1), the only sewers that exceed the 75 percent full criteria are trunk sewers (e.g., 45th St. E), as can be seen by comparison to Figure 5-5, where the trunk sewers have been removed from the analysis. At a few locations on the trunk sewers and at one location on a City sewer, a relatively high flow depth or minor surcharging occurs at a junction where a smaller pipe joins a larger pipe with matching inverts, resulting in a back up of flow from the larger pipe into the smaller pipe for a short distance. These situations are not considered to be capacity deficiencies.
- Under 2006 WWF conditions (Figure 5-2), some surcharging is apparent (red and orange lines), primarily on the trunks. On Figure 5-6, with the trunks removed, there are two short reaches of City sewers that are shown as surcharging, although the amount of surcharging is less than two feet and therefore not sufficient to trigger a capital improvement project. One of the major surcharging trunk sewers indicated in Figure 5-2 is the existing 18-inch sewer on Technology Drive/Ave. P-8 between Division St. and 15th St. E. That deficiency will be relieved by the construction of the new 42-inch Trunk A Relief Sewer which is currently underway. The new trunk sewer was added to the model in the 2030 DWF and WWF scenarios, and was determined to eliminate the projected surcharging in both cases (see Figures 5-3 and 5-4).
- Under 2030 DWF conditions (Figure 5-3), several additional trunk sewers are projected to surcharge, in particular the trunk sewers along 45th St. E (including a possible overflow) and 55th St. E., and the westbound trunk sewer on Ave. P-8 leading to the PWRP. With the trunk sewers removed (Figure 5-7), the only projected capacity deficiency in the City is the sewer along 45th St. E. between Ave. R and Ave. S.
- Under 2030 WWF conditions (Figure 5-4), the problems in trunk sewers along 45th St. E., 55th St. E., and Ave. P-8 become more severe, including additional projected overflows. Extensive surcharging in the Ave. Q trunk is also predicted. With the trunks removed (Figure 5-8), the previously identified deficiency along 45th St. E. between Ave. R and Ave. S is exacerbated, with a potential overflow. In addition, a second deficiency is projected due to development in Joshua Ranch, in the vicinity of 30th St. W. The problem sewer is a reach of 8-inch sewer with a relatively flat slope downstream of the canal crossing that would surcharge more than two feet above the crown of the pipe for about 1000 feet. Note that this deficiency is not projected to occur under DWF conditions, and is thus triggered by the I/I allowance of 666 gallons per day per acre. Since that I/I may or may not ever occur in reality, this should be considered a low priority unless monitoring indicates a real problem under wet weather flow conditions.
- Since flow in the 45th St. E. city sewer would be affected by 110 upstream septic tank conversions, an analysis was performed to determine if this future capacity deficiency is contingent on the assumption that all parcels on septic tanks would be sewered by 2030. Figure 5-9 shows in yellow those subcatchments that contain septic tanks and are tributary to triggered capacity deficiencies under 2030 DWF conditions. The scenario with full conversion of all septic tanks tributary to the deficient sewers is on the left and the scenario without conversion is on the right. It shows that although there are some minor differences in the extent of backwater, capacity-driven surcharging is still projected to occur in the 10” sewer on 45th St E between Ave R and Ave S even if no septic tanks are converted. Therefore, this capital improvement project is not dependent on the assumption of septic tank conversions.
- One additional potential capacity deficiency was initially identified in the vicinity of Essex Dr. and 47th St. E. This future deficiency, shown in Figure 5-10, can be averted by ensuring that one specific subcatchment (2099-0115) is sewered to the north rather than the west, as indicated in the figure. No new problems are caused as a result of re-directing flow to the north.




2030 DWF - Septic Tank Conversions Assumed

2030 DWF - Septic Tanks Remain

**Figure 5-9: Effect of Septic Tank Conversions on Capacity Deficiencies**

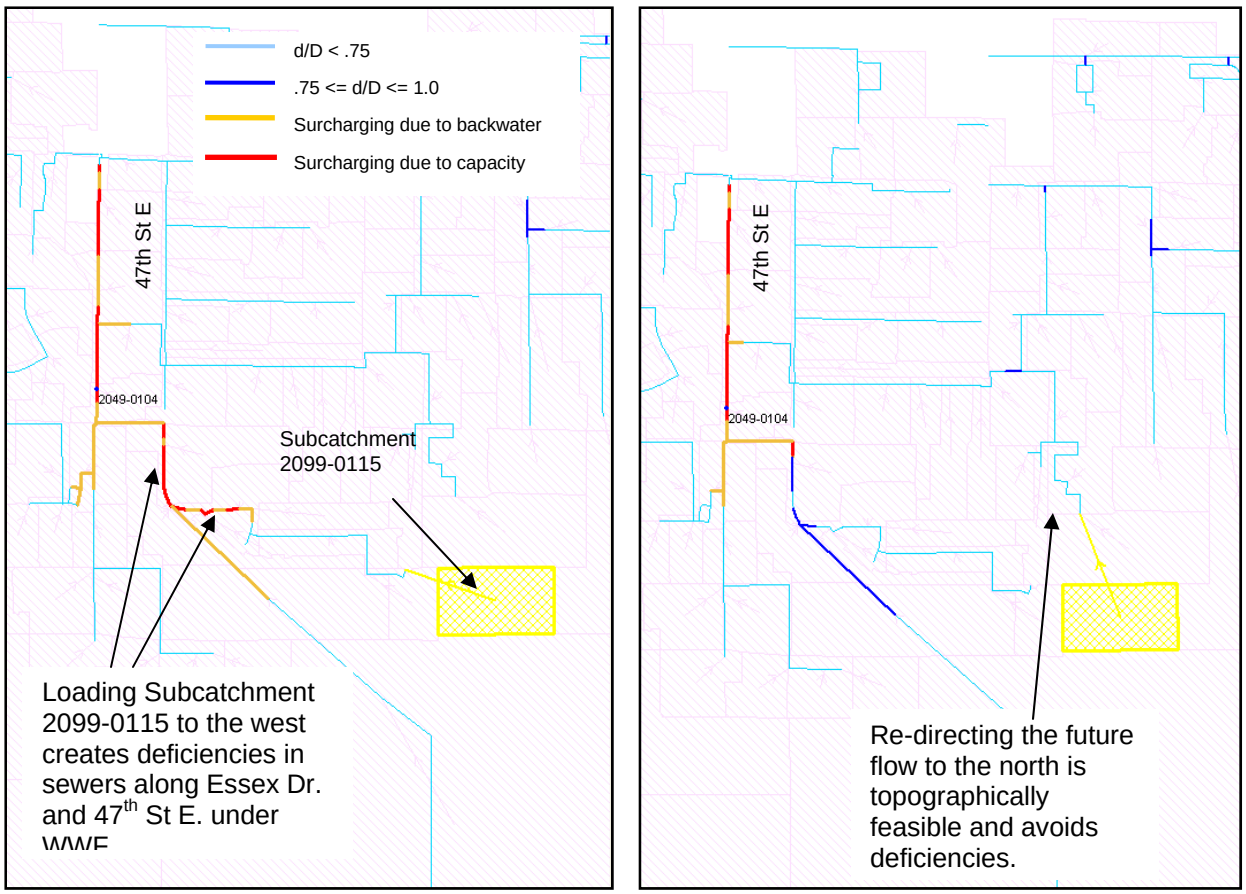
- The capacity of Pump Station S and its forcemain were found to be adequate for all future scenarios. The rated single pump capacity of Avenue S PS is .22 mgd. Even under the worst case scenario, Buildout WWF, the relief pump kicks on for just about half the time over the two day scenario. Incoming sewers to the PS do not back up and the pump station has adequate capacity during the Buildout WWF scenario.

## 5.3 Development of Solutions to Capacity Deficiencies

As described above, only two potential deficiencies on City sewers were identified in the hydraulic capacity analysis. In both cases, the deficiencies do not exist under existing (2006) DWF or WWF conditions, but are projected to occur due to future development. This section describes the development of solutions to these two deficiencies. Details of these projects, including plans, profiles, and cost estimates are presented.

### 5.3.1 Project 1: 45th St. E between Ave. R and Ave. S

The only reach of City sewer that exceeded the DWF trigger criteria was along 45th St E between Ave R and Ave S. Figure 5-11 shows the 2030 DWF deficiency along 45th St E. It is noteworthy that the current configuration of sewers in this area sends all flow from the 12-inch northbound sewer on 47th St. E to the west along Ave. S, and then north on 45th St. E. The diversion of flow at Manhole 2049-0910 was made



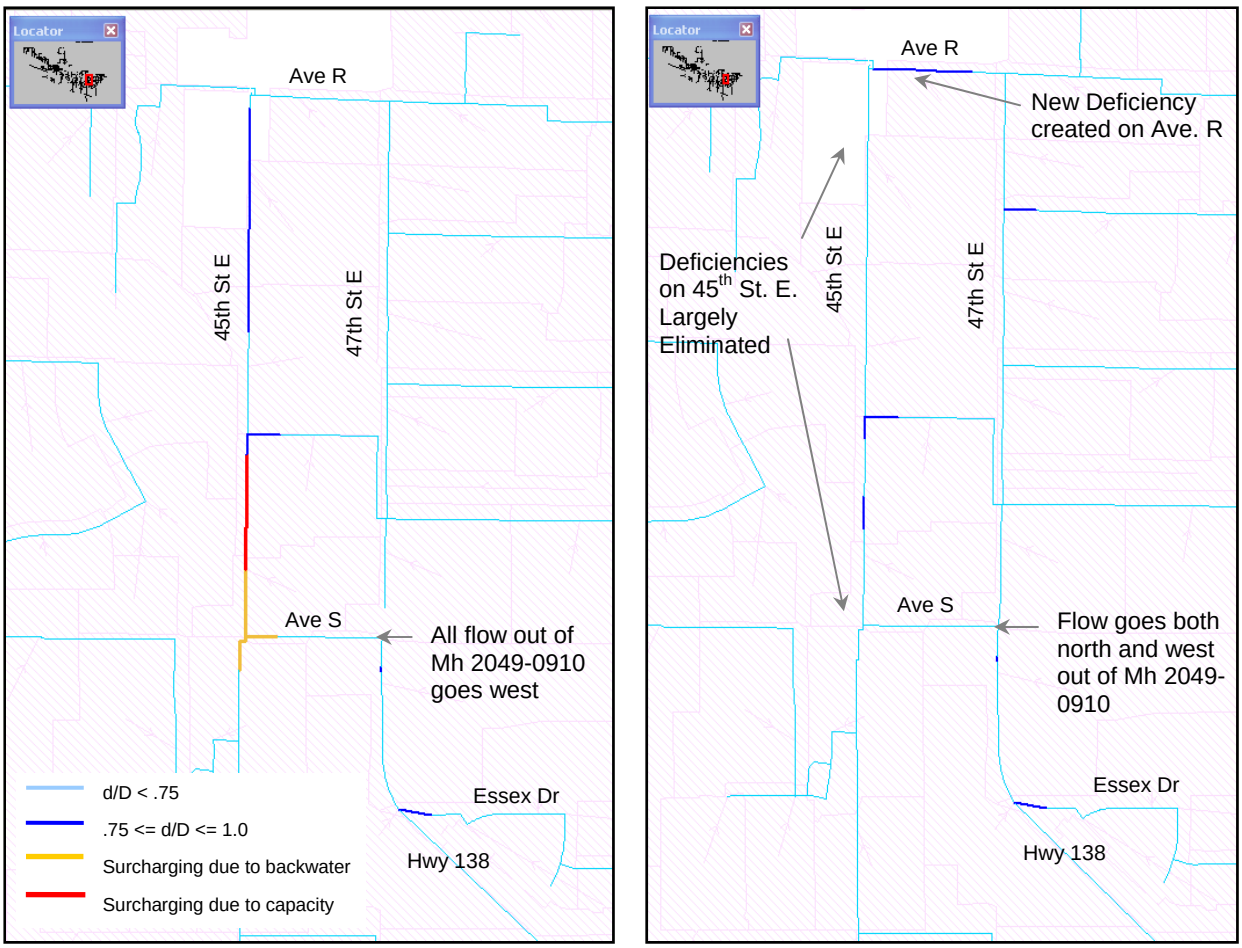

2030 WWF - Initial Model 2030 WWF – Re-directed Subcatchment 2099-0115

**Figure 5-10: Subcatchment 2099-0115 Loading to Avoid Future Deficiencies**

in the past to relieve the 12-inch sewer on Ave. R between 45th St. E. and 47th St. E. Re-connecting the sewer to 47th St. E. would divert flow away from the deficient sewer on 45th St. E., and more fully utilize capacity in the 47th St. E. sewer. This option was analyzed as an alternative to retaining the current configuration and upsizing the sewer on 45th St. E.

As shown on the right side of Figure 5-11, re-connecting the 47th St. E. sewer would eliminate the projected surcharging on the 45th St. E. sewer under 2030 DWF conditions. The 47th St. E. sewer could safely convey the increased flow to the north, but the sewer on Ave. R. would now exceed the trigger criteria (75 percent full) and would need to be relieved. Under 2030 WWF conditions, as shown in Figure 5-12, surcharging would occur under both alternatives, but the re-connection alternative would have a lower overall cost because the new sewers on 45th St. E. would be smaller and shorter in length, offsetting the additional sewer on Ave. R.

However, the re-connection alternative has some drawbacks. It would result in an undesirable situation in which the pipe sizes would actually decrease in a downstream direction from the existing 18-inch on Ave. S to a new 15-inch on 45th St. E., to the existing 12-inch on 45th St. E. The deficiency on Ave. R. would be triggered sooner, after only about 20 percent of the upstream development has occurred; under the alternative without re-connection, the deficiency on 45th St. E. would not be triggered until 60 percent of the development has occurred. In addition, the existing 12-inch sewer on 45th St. E. would eventually need to be replaced to handle the Buildout scenario flows.




2030 DWF – Current Sewer Configuration at Manhole 2040-0910

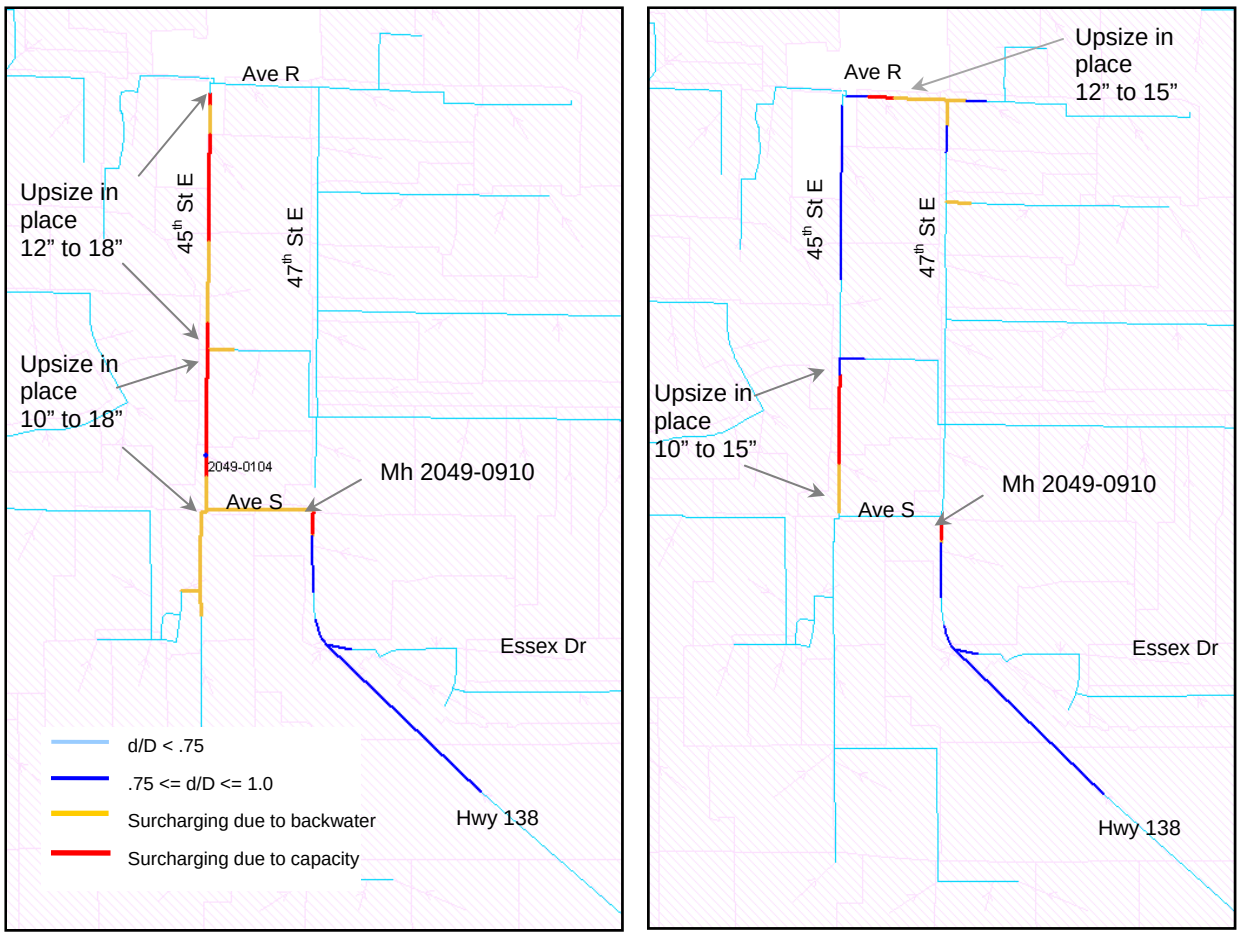
2030 DWF – Northbound 12" Sewer out of Manhole 2049-0910 Re-Connected

**Figure 5-11: 2030 DWF Deficiencies for Alternative Configurations at Manhole 2049-0910**

The alternative using the current configuration at Manhole 2049-0910 is recommended, as it would avoid the decreasing-diameter problem, could handle the projected Buildout flow scenario, and would not need to be built as soon as the alternative. Since the LACSD trunk sewer on 45th St. E. downstream of Ave. R will need relief in the future as well, the City should coordinate with LACSD on this improvement project.

### 5.3.2 Project 2: Joshua Ranch Sewer Near 30th St. W.

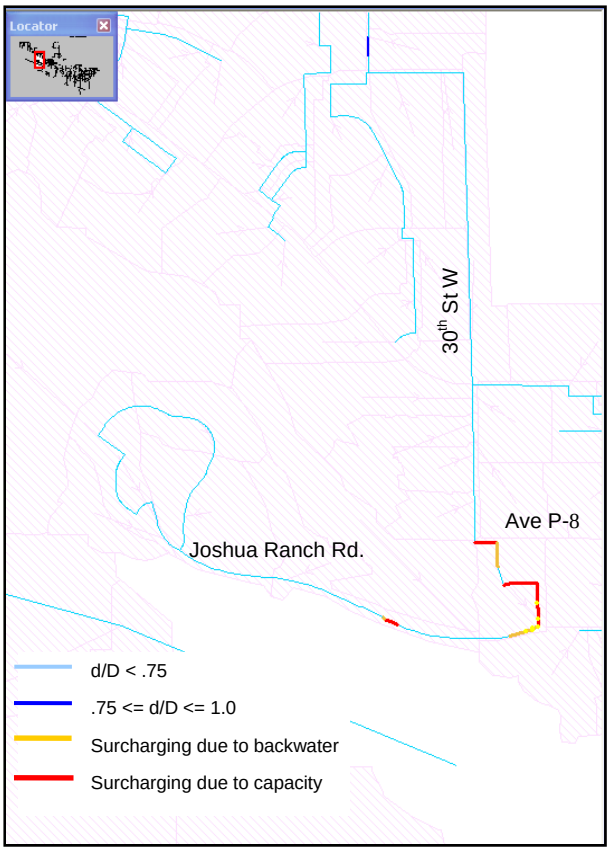
The capacity deficiency shown in Figure 5-8 in the 8-inch sewer from Joshua Ranch near 30th St. W. is projected to occur only under 2030 WWF. The potential solution shown in Figure 5-13 would be to upsize about 2,500 feet of existing 8-inch sewer to 10 inches. Because this project is not needed under projected DWF conditions, it may not be required unless monitoring during wet weather events in the future confirms the need for this project.



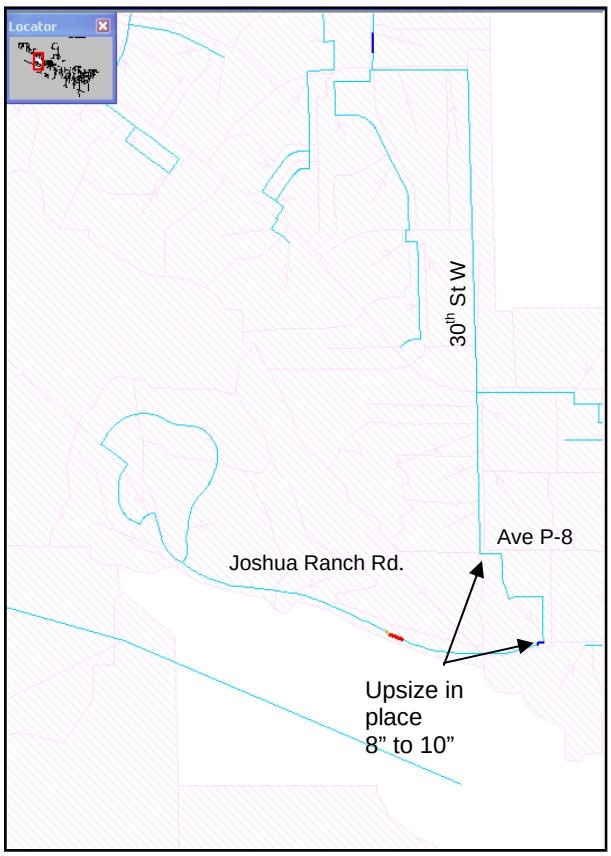

2030 WWF: Current Configuration at Manhole 2049-0910

2030 WWF: Northbound 12" Line out of Mh 2049-0910 Re-Connected

**Figure 5-12: Project 1: 45th St E between Ave R and Ave S – Alternatives With Different Configurations at Manhole 2049-0910**




2030 WWF: Surcharging Along Joshua Ranch Rd Sewer




2030 WWF Solution: Upsize in place sewer from 8" to 10"

**Figure 5-13: Project 2: Joshua Ranch Sewer Near 30th St. W.**

## 5.4 Capital Improvement Projects

This section discusses the capital improvement projects that are recommended based on the findings of the capacity analysis. Each project is documented with a general description, plan map, hydraulic profile, project details and considerations, and a planning-level capital cost estimate.

### 5.4.1 Sewer Sizing Criteria

New sewers required to relieve capacity deficiencies will be sized to handle the peak wet weather flow for the Buildout scenario at a depth of 75 percent of pipe diameter. For the purposes of this study, it was assumed that the existing deficient sewers would be replaced with larger sewers along the same alignment.

### 5.4.2 Cost Estimating Criteria

This section summarizes the methodology used to develop the base cost criteria for developing preliminary opinions of probable construction costs for the capital improvement projects. All costs presented in this section have been adjusted to an Engineering News Record (ENR) construction cost index of 9410, which represents the average 2008 ENR cost index for the Los Angeles Area. Planning level cost estimates were developed using the equation outlined in Table 5-1.

**Table 5-1: Project Cost Estimate Assumptions**

| Project Costs Equation | Assumptions |
|---|---|
| **Facility Raw Construction Cost**<br>(cost includes contractor overhead & profit)<br><br>+ Mobilization, Demobilization, Bonding, Insurance, Permits, Site security, Traffic Control, Staging area/Yard rental. | See Table 5-2<br><br>20% of Facility Raw Construction Cost |
| **=Construction Cost Sub-Total**<br><br>+ Pre-Design Construction Contingency | -<br><br>30% of Construction Cost Sub-Total |
| **= Total Construction Cost**<br><br>+ Engineering, Survey, Environmental, Construction management, Engineering services during construction, Legal, Administration, Financial | -<br><br>25% of Total Construction Cost |
| **= Total Capital Cost** | - |

Construction costs are for the installation of gravity sewer pipelines. The basis for these costs is described below. Baseline pipeline construction costs were developed for open cut gravity sewers. Unit cost criteria and cost factors were developed for each of the cost components shown in the equation above based on a combination of recent bid results, construction experience, and construction unit price guides (RS Means 2009). Raw construction costs were developed based on the unit costs presented in Table 5-2.

Baseline unit pipe construction costs were developed for gravity sewers ranging from 8 to 18 inches in diameter for four depth-of-cover ranges: less than 10 feet, 10 to 15 feet, 15 to 20 feet and greater than 20 feet. Pipe material was assumed to vitrified clay pipe (VCP).

**Table 5-2: Project Cost Estimate Assumptions**

| Item | Description/Assumptions | Unit Cost [1] |
|---|---|---|
| Open-Cut Gravity Sewers for Pipe Sizes in **paved roadway**:<br>8", 10", 12", 15", 18" DIA.<br>▪ <10' depth<br>▪ 10'-15' depth<br>▪ 15'-20' depth<br>▪ >20' depth | Assumes VCP for all pipe sizes; ¾ CY excavator with trench box; Additional shoring; Resurfacing; Hauling excess spoils; Saw-Cutting; Bedding/Backfill /Compaction. Assumes native soil for backfill outside pipe zone 12" above pipe outside diameter.<br>Does not include costs for: Traffic Control; Dewatering | -<br>-<br>-<br>$95 - $140 /LF (8"-18")<br>$125 - $175 /LF (8"-18")<br>$160 - $215 /LF (8"-18")<br>$220 - $280 /LF (8"-18") |
| Structures<br>▪ New Manhole; 15' depth<br>▪ New Manhole; >15' depth<br>▪ Connect to Existing Manhole<br>▪ Clean-Out | Assumes installation of a new Type I precast manhole 60" diameter.<br>Mainlines are new open-cut installation, the costs of clean-outs is negligible. | -<br>$8,500 /EA<br>$10,000 /EA<br>$1,000 /EA<br>$0 / EA |
| Lateral Service Connections | Assumes lateral connection on pipes up through 12" diameter (existing and new). Cost is for reconnecting lateral only and does not include replacing any lateral pipe. | $500 /EA |
| Demolition & Removal<br>▪ of Existing Pipe<br>▪ of Existing Manholes | Assumes selective demolition of small sewer pipe (up to 12") or large sewer pipe (up to 24") and selective demolition of precast manholes at 20' depth. | -<br>$25 - $35 /LF<br>$4,200 /EA |
| Land & Right-of-Way | Assumes all project facilities will be constructed in City right-of-way | $0 |
| Overhead & Profit | Already included in facility construction costs. | $0 |
| Bypass Pumping | Assumes equipment & labor for bypassing 200 LF of pipe for one day. | $30 /LF |
| Mobilization, Demobilization, Bonding, Insurance, Permits, Site security, Traffic Control, Staging area/Yard rental. | 20% of Facility Raw Construction Cost | 20% |
| Pre-Design Construction Contingency | 30% of Construction Cost Sub-Total | 30% |
| Engineering, Survey, Environmental, Construction management, Engineering services during construction, Legal, Administration, Financial | 25% of Total Construction Cost | 25% |

(1) Values have been rounded to nearest whole dollar value and are based on ENR Construction Cost Index 9410 (2008 Average).

The baseline pipe construction costs include the following assumptions:

- Vertical trench walls to reduce utility conflicts and construction impact.
- Trench box shoring is assumed for all construction alignments; however additional shoring is included due to the depth of the majority of the pipelines and uncertainty of utilities in the area. The specific type of shoring used will depend upon the trench depths, soil conditions, conflicting utilities, and groundwater levels. For purposes of this Master Plan, additional shoring is included at $4 to $5 per vertical square foot for solid shoring depending on trench depths.
- Select imported backfill in the pipe zone and native backfill above the pipe zone to the pavement structural base. It is assumed that the spoils may be hauled to local disposal site. Backfill would be compacted to 90 percent to within 2 feet of the ground surface. Pipe installation and trench detailed quantities are based on Los Angeles County Department of Public Works Standard Procedures for Processing Private Contract Sanitary Sewer Plans Manual (rev. 1987) and Standard Drawing S-21 Bedding for Sewer Pipe.
- An average construction installation, new alignment and rehabilitation, of 200 linear feet of pipe per day.
- Temporary pavement or trench plates to be placed over the excavated areas in traveled roadways at the end of each day.
- Sales tax of 9.25 percent on all raw materials.
- It was acknowledged that some projects involving upsizing of existing pipes could potentially be done less expensively and with less disruption by pipe bursting rather than removal and replacement of the existing pipe. However, because it is not known at the planning stage whether pipe bursting would be feasible based on site conditions, it was decided in conjunction with the City, to assume open-cut pipe replacement costs for all such projects.

A few specific construction assumptions of note include the following:

- **Lateral Service Connections:** It is assumed there will be lateral service connections on pipelines up through 12 inches in diameter based on knowledge of the City system and experience. A lump sum cost of $500 per lateral connection is assumed. This cost assumes only reconnection of the lateral; it does not include any replacement of the lateral pipeline. The number of laterals is estimated based on the number of parcels along the project reach.
- **Manholes:** It is assumed that new manholes will be constructed in place of rehabilitating existing manholes along capacity deficient sewer pipelines. Separate costs are provided for manhole demolition and removal of existing manholes and for constructing a new manhole in its place. Capacity deficient sewer pipelines that connect to only the upstream or downstream manholes, those manholes will not be removed. Costs for coring into the manhole for the upsized pipeline will be included.
- **Dewatering:** It is assumed dewatering will not be required for all alignments based on a typical groundwater depth of over 100 feet.
- **Bypass Pumping:** Bypass pumping will be required for all demolition of existing pipelines to reroute flow temporarily. A linear foot cost of $30 is assumed based on equipment and labor for 200 feet of bypass pumping a day.
- **Trenchless Construction:** Based on project locations it is assumed there will be no crossing of creeks, drainage channels, major arterials (including highways), and railroads that would require trenchless construction (bore-and-jack).

- **Geotechnical:** As the majority of the construction alignments are along existing alignments and/or along major roads, it is assumed no hard rock or cobbles will be encountered. For purposes of this Master Plan, there is no contingency for unexpected geologic conditions.

A standard cost estimating spreadsheet was developed and used for estimating the cost of all improvement projects. The spreadsheet also includes a summary description of the project, including location, proposed facilities, manhole references, project priority in terms of the trigger flow scenario, estimated cost, and a brief discussion of any project specific considerations, assumptions, and possible alternatives. Also included in the spreadsheet are the *Trench Section Quantity Calculations* used to calculate the linear foot cost per diameter pipe and depth of pipe.

### 5.4.3 Capital Improvement Project Descriptions

The locations of the two recommended capital improvement projects are shown in Figure 5-15. Descriptions of the projects are included at the end of this chapter. The first page of each project description consists of a summary project description and a breakdown of the project components and their estimated planning-level costs. The summary project description page is followed by plan and profile views. The plan views include the new pipe sizes and show all streets and sewers in the project vicinity. The existing pipe sizes are also indicated in parentheses. The profiles illustrate the invert and crown of the proposed sewer (pink lines), the ground surface (green line) based on rim elevations at all manholes, and the maximum hydraulic grade line (blue line). Key data below the profile are the diameter (width), upstream and downstream inverts above datum (us/ds inv (ft AD)), pfc (pipe full capacity), and volume, depth, flow, and velocity at the downstream (DS) section of each pipe. Profiles are provided for two scenarios. The first profile shows deficient pipe sections for the scenario that triggered the project (existing DWF/WWF, or 2030 DWF/WWF). The second profile shows the proposed project under peak Buildout wet weather flow.

Table 5-3 provides a summary of the projects, including the total estimated capital cost, the scenario that triggers the project, and information on the severity of the deficiency. That information includes the d/D ratio, the extent of surcharging above the pipe crown, and the freeboard (distance from maximum water level to the ground surface). In terms of priorities and scheduling, the following are the key considerations:

**Project 1 - 45th St. E. between Ave. R and Ave. S**: This project is not required under existing flow conditions. The sewer is projected to surcharge under 2030 DWF conditions, and potentially overflow under 2030 WWF conditions. The LACSD trunk sewer on 45th St. E. downstream of Ave. R is projected to reach its capacity sooner than the City's sewer. The projects on the trunk and on the City's sewer should be coordinated, with the City project following the trunk sewer project. Because the project is driven by future upstream development, the City should consider this when it establishes development conditions.

The project will be triggered when 60 percent of the incremental development between 2006 and 2030 occurs. This trigger condition corresponds to an increase of 3,544 in population and 981 in employment in the tributary area, which is shown in Figure 5-14. If growth were to occur uniformly over time, the deficiency would occur in 2020.

**Project 2 – Joshua Ranch Sewer Near 30th St. W.:** This project is not required under existing flow conditions or under 2030 dry weather flow conditions. It will only be needed if the estimated I/I from new development actually occurs. Because of the uncertainty in I/I estimates, it is not recommended that this project move forward until such time as flow or level monitoring confirms that I/I levels are actually sufficient to cause a capacity problem.

**Table 5-3: Capital Improvement Projects**

| Project ID | Location | US MH | DS MH | Project Type | Length | Existing Diameter | Required Diameter | Trigger Scenario | 2006 Worst Condition | 2030 Worst Condition | Freeboard at Trigger Scenario | Cost | Alternatives |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 45th St E from Ave R to Ave S | 2049-0933 | 2048-20-0732 | Upsize in place | 5,239' | 15, 12, 10 | 18 | 2030 DWF | d/D = .66 (WWF) | Overflows (WWF) | 4.4' | $2,685,000 | Re-connect the 12" northbound sewer out of manhole 2049-0910 (see details in text). |
| 2 | Parallels 30th St W between Ave P-8 and Joshua Ranch Rd. | 1883-0421 | 1833-0252 | Upsize in place | 2,477' | 8 | 10 | 2030 WWF | d/D= .39 (WWF) | 4.98' of surcharge (WWF) | 4.3' | $1,222,000 | Defer until wet weather monitoring confirms the need for the project. |

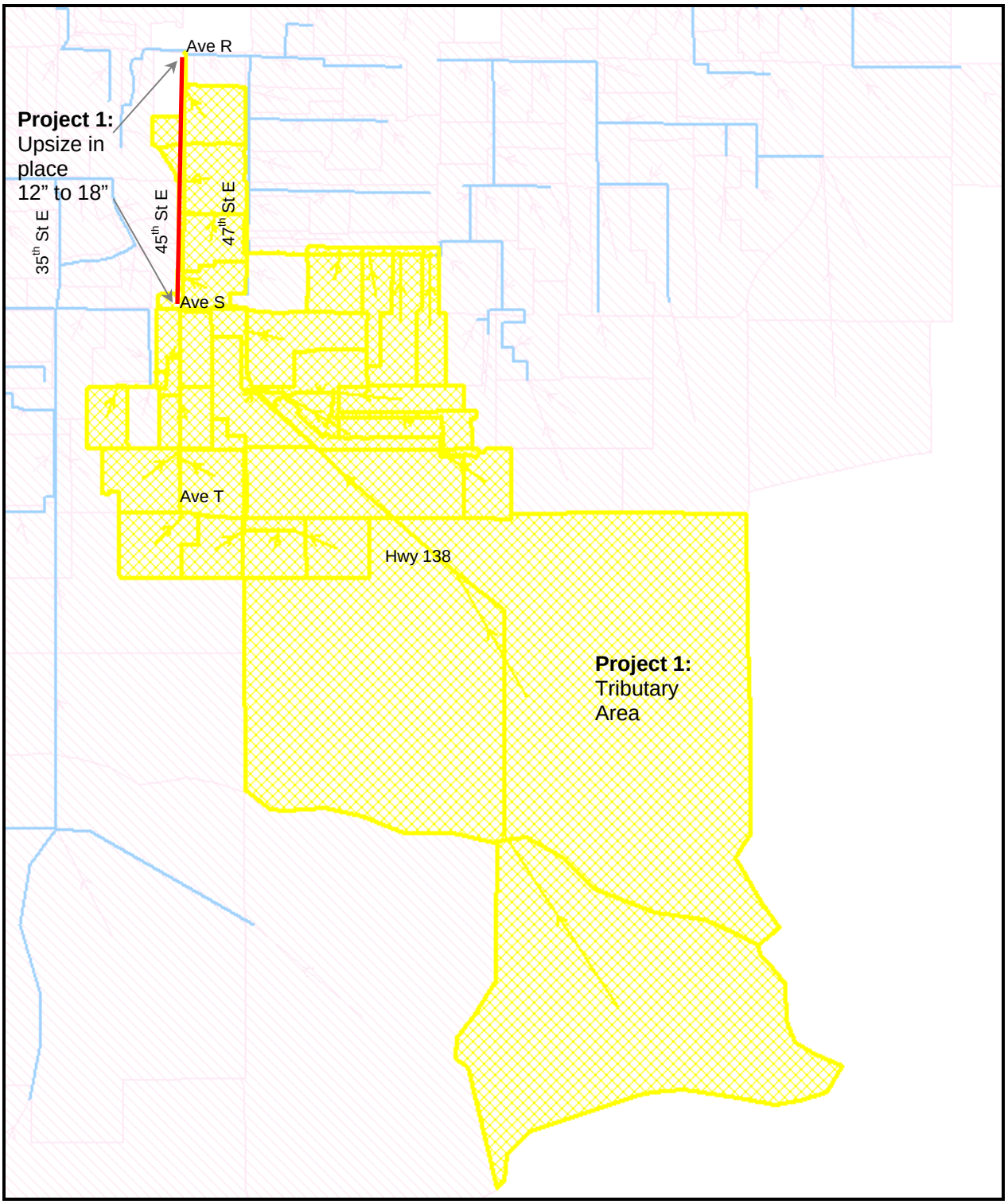



**Figure 5-14: Tributary Sewershed to Project 1: 45th St. E between Ave. R and Ave. S**

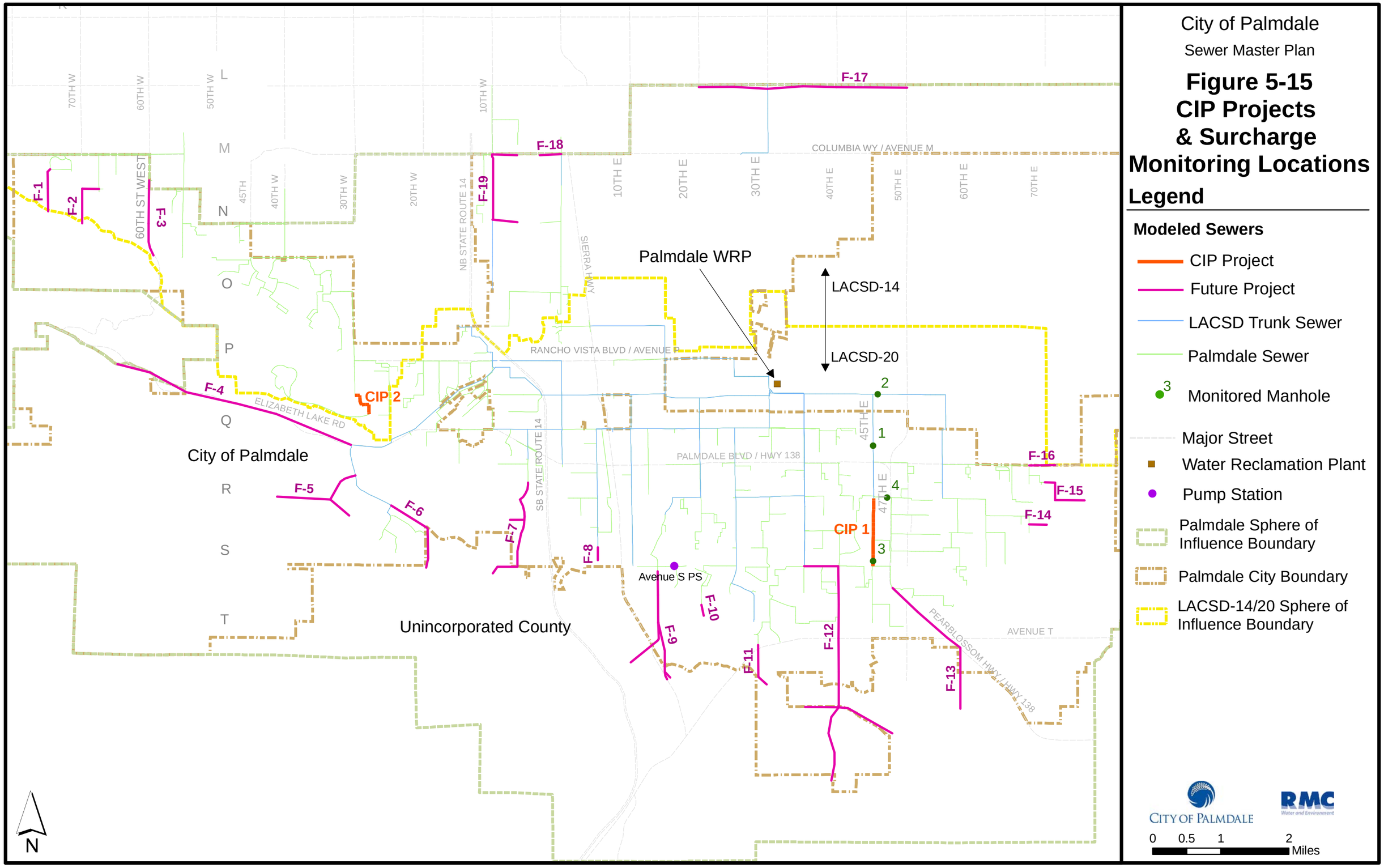
### 5.4.4 Future Development Sewer Costs

As mentioned earlier, the hydraulic model was extended to cover currently unsewered areas that are anticipated to be developed in the future. Of the approximately 36 miles of sewer added to the model, 28 were for sewers not yet built. Those sewers are shown in Figure 5-15. Based on the assumptions provided in Tables 5-1 and 5-2, planning-level capital cost estimates for major future extension were calculated and listed in Table 5-4. The city can use these cost estimates to help in current sewer connection fee evaluations as part of their capital program. The total cost for these 19 major future extension projects is approximately $54 million.

**Table 5-4: Future Development Sewer Project Costs**

| Project Id | Pipe Diameter (in) | Pipe Length (ft) | Average Pipe Depth (ft) | *Construction Cost Total [1] | *Total Capital Cost [2] |
|---|---|---|---|---|---|
| F-1 | 8 | 3,341 | 10-15 | $876,000 | $1,094,000 |
| F-2 | 8 | 3,986 | 10-15 | $1,045,000 | $1,306,000 |
| F-3 | 8 | 5,876 | 10-15 | $1,540,000 | $1,925,000 |
| F-4 | 24 | 6,263 | < 10 | $1,993,000 | $2,492,000 |
| F-4 | 21 | 10,383 | 10-15 | $3,677,000 | $4,596,000 |
| F-4 | 18 | 2,612 | 10-15 | $847,000 | $1,059,000 |
| F-5 | 10 | 1,909 | 10-15 | $500,000 | $625,000 |
| F-5 | 18 | 6,993 | 10-15 | $2,269,000 | $2,836,000 |
| F-6 | 8 | 6,386 | 15-20 | $2,002,000 | $2,503,000 |
| F-7 | 10 | 1,517 | > 20 | $620,000 | $775,000 |
| F-7 | 8 | 8,625 | 10-15 | $2,260,000 | $2,826,000 |
| F-8 | 8 | 1,000 | < 10 | $211,000 | $263,000 |
| F-9 | 10 | 3,949 | > 20 | $1,614,000 | $2,017,000 |
| F-9 | 10 | 9,245 | 10-15 | $2,423,000 | $3,028,000 |
| F-10 | 8 | 858 | 10-15 | $225,000 | $281,000 |
| F-11 | 8 | 3,355 | 10-15 | $879,000 | $1,099,000 |
| F-12 | 18 | 2,643 | 15-20 | $1,010,000 | $1,263,000 |
| F-12 | 15 | 2,962 | 15-20 | $878,000 | $1,097,000 |
| F-12 | 12 | 7,974 | 10-15 | $2,189,000 | $2,737,000 |
| F-12 | 10 | 13,252 | 10-15 | $3,473,000 | $4,341,000 |
| F-13 | 10 | 11,748 | 10-15 | $3,079,000 | $3,849,000 |
| F-14 | 8 | 1,374 | 10-15 | $360,000 | $450,000 |
| F-15 | 8 | 4,425 | 10-15 | $1,160,000 | $1,450,000 |
| F-16 | 10 | 2,019 | < 10 | $425,000 | $532,000 |
| F-17 | 10 | 16,158 | 10-15 | $4,235,000 | $5,293,000 |
| F-18 | 10 | 1,662 | < 10 | $350,000 | $438,000 |
| F-19 | 18 | 5,099 | 15-20 | $1,949,000 | $2,436,000 |
| F-19 | 10 | 3,875 | 10-15 | $1,016,000 | $1,270,000 |
| Total | | 149,488 | | $43,105,000 | $53,881,000 |

* Values are based on ENR Construction Cost Index 9410 (2008 Average)
1) Includes 20% Mobilization, Bonding, Insurance, Permits, Site Security, Traffic Control, and Staging Area Costs and 30% Pre-Design Construction Contingency
2) Includes 25% for Engineering, Survey, Envir., Const. Mgmt, Engr. Services During Const.,Legal, Administration, Financial


City of Palmdale
Sewer Master Plan
Figure 5-15
CIP Projects
& Surcharge
Monitoring Locations
Legend
Modeled Sewers
CIP Project
Future Project
LACSD Trunk Sewer
Palmdale Sewer
Monitored Manhole
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
Palmdale WRP
LACSD-14
LACSD-20
City of Palmdale
Unincorporated County
Avenue S PS
CIP 1
CIP 2
F-1
F-2
F-3
F-4
F-5
F-6
F-7
F-8
F-9
F-10
F-11
F-12
F-13
F-14
F-15
F-16
F-17
F-18
F-19
COLUMBIA WY / AVENUE M
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
PEARBLOSSOM HWY / HWY 138
AVENUE T
SIERRA HWY
NB STATE ROUTE 14
SB STATE ROUTE 14
70TH W
60TH W
50TH W
10TH W
60TH ST WEST
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Water and Environment
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### 5.4.5 Recommended Surcharge Monitoring Sites

Although no capacity deficiencies were identified under 2006 dry or wet weather conditions, it is possible that deficiencies could exist during wet weather conditions if the amount of I/I in a given area greatly exceeds the amount assumed in the analysis. To confirm that current wet weather flows do not create a significant risk of overflows, installation of passive surcharge monitors in selected key manholes is recommended. Passive surcharge monitors may consist of chalk or soluble paint marking or small cups in manholes that are checked after a major storm event to determine the highest water level that occurred during the event. It is a low-cost way to screen sites for surcharging, and is a cost-effective alternative to wet weather flow monitoring, particularly in dry climates where major rainfall events are rare and unpredictable, as in Palmdale. If surcharging is detected and determined not to be due to downstream obstructions or backwater, wet weather flow monitoring would be performed to determine the magnitude of I/I. Figure 5-15 shows recommended monitoring sites and Table 5-5 provides information on each site. In general, a site was chosen if it was predicted to surcharge or nearly surcharge under 2006 wet weather flow conditions, and prioritized based on the predicted distance of the water level to the ground.

The City needs to open and maintain communication with LACSD regarding potential surcharging in the LACSD trunks. The two agencies need to coordinate on surcharge monitoring as well as future capital improvement projects.

**Table 5-5: List of Ranked Surcharge Monitoring Sites**

| ID | MH | Jurisdiction | Comment |
|---|---|---|---|
| 1 | 2047-20-0332 | LACSD | Checks level in stretch of 45th St E trunk that is predicted to surcharge closest to ground level in 2006 wet weather. |
| 2 | 2047-20-0022 | LACSD | Checks level in trunk at 45th E and Ave P-12 intersection that is predicted to surcharge in 2006 wet weather, but less close to ground than site 1. |
| 3 | 2049-0103 | Palmdale | Monitors section of 10" City sewer on 45th E that is predicted to flow near 70% full in 2006 wet weather, and where future surcharging is predicted (CIP Project 1). |
| 4 | 2048-0078 | Palmdale | Monitors 12" City line on Ave R, where City staff has observed high water depths, and where 2006 wet weather flow is predicted to fill pipe to over 70%. |

RMC Water and Environment

**Project: City of Palmdale Sewer Master Plan**

**Aspect: Collection System Costs - CIP Project 1**

Date: September 18, 2009
Project No: 0200-003

Prepared by: C. Brothers & K. Erickson
Checked by: -
Check Date: -

| PROJECT DESCRIPTION | |
|---|---|
| PROJECT ID: …….. | 1 |
| FIRST PIPE ID: | 2049-0933.1 |
| LOCATION: …….. | The project is located along 45th St East from Ave R to Ave S. |
| BRIEF PROJECT DESCRIPTION: …… | The project consists of the upsize and replacement of 5,239-feet of 10,12, and 15-inch to 18-inch pipe. |
| PROJECT PRIORITY: …….. | 2030 DWF |
| ESTIMATED COST: …….. | $2,685,000 |
| COMMENTS: …….. | (i) Assumes existing alignment, open-cut, demolition of existing pipe. |
| ASSUMPTIONS: …….. | (i) Lateral service connections are estimated based on aerial imagery and parcel boundary shapefiles.<br>(ii) See GENERAL UNIT COST CRITERIA sheet for more cost assumptions. |
| ALTERNATIVES: …….. | Open the blocked 12" northbound sewer out of manhole 2049-0910. Project 1 would still be necessary, but could be delayed due to the increase in capacity made available by the unblocking of the northbound line. |

| U/S MANHOLE | | D/S MANHOLE | EXISTING DIAMETER (inches) | NEW DIAMETER (inches) | LENGTH (feet) | SLOPE (%) | PIPE DEPTH (feet) | MANHOLE UNIT COST ($/ea) | PIPE UNIT COST ($/lf) | TOTAL COST | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2049-0933 | to | 2049-0102 | 15 | 18 | 51.2 | 0.351 | 11 | $8,500 | $ 175 | $ 17,460 | NO LATERAL SERVICE CONNECTIONS |
| 2049-0102 | to | 2049-0357 | 15 | 18 | 138.4 | 0.484 | 10 | $8,500 | $ 140 | $ 27,876 | NO LATERAL SERVICE CONNECTIONS |
| 2049-0357 | to | 2049-0103 | 15 | 18 | 211.6 | 0.336 | 9 | $8,500 | $ 140 | $ 38,124 | NO LATERAL SERVICE CONNECTIONS |
| 2049-0103 | to | 2049-0104 | 10 | 18 | 267.6 | 1.159 | 8 | $8,500 | $ 140 | $ 45,964 | LATERAL SERVICE CONNECTIONS |
| 2049-0104 | to | 2048-0525 | 10 | 18 | 262.3 | 0.732 | 8 | $8,500 | $ 140 | $ 45,222 | LATERAL SERVICE CONNECTIONS |
| 2048-0525 | to | 2048-0526 | 10 | 18 | 308.2 | 0.74 | 9 | $8,500 | $ 140 | $ 51,648 | LATERAL SERVICE CONNECTIONS |
| 2048-0526 | to | 2048-0527 | 10 | 18 | 262 | 0.721 | 9 | $8,500 | $ 140 | $ 45,180 | LATERAL SERVICE CONNECTIONS |
| 2048-0527 | to | 2048-0528 | 10 | 18 | 300 | 0.83 | 8 | $8,500 | $ 140 | $ 50,500 | LATERAL SERVICE CONNECTIONS |
| 2048-0528 | to | 2048-0145 | 10 | 18 | 209.8 | 1.068 | 9 | $8,500 | $ 140 | $ 37,872 | LATERAL SERVICE CONNECTIONS |
| 2048-0145 | to | 2048-0144 | 12 | 18 | 330.4 | 0.666 | 9 | $8,500 | $ 140 | $ 54,756 | LATERAL SERVICE CONNECTIONS |
| 2048-0144 | to | 2048-0143 | 12 | 18 | 325 | 1.018 | 9 | $8,500 | $ 140 | $ 54,000 | LATERAL SERVICE CONNECTIONS |
| 2048-0143 | to | 2048-0444 | 12 | 18 | 11.6 | 0.688 | 10 | $8,500 | $ 140 | $ 10,124 | LATERAL SERVICE CONNECTIONS |
| 2048-0444 | to | 2048-0142 | 12 | 18 | 345 | 0.849 | 10 | $8,500 | $ 140 | $ 56,800 | LATERAL SERVICE CONNECTIONS |
| 2048-0142 | to | 2048-0063 | 12 | 18 | 350 | 0.857 | 8 | $8,500 | $ 140 | $ 57,500 | LATERAL SERVICE CONNECTIONS |
| 2048-0063 | to | 2048-0062 | 12 | 18 | 350 | 0.663 | 7 | $8,500 | $ 140 | $ 57,500 | LATERAL SERVICE CONNECTIONS |
| 2048-0062 | to | 2048-0061 | 12 | 18 | 315 | 0.663 | 9 | $8,500 | $ 140 | $ 52,600 | LATERAL SERVICE CONNECTIONS |
| 2048-0061 | to | 2048-0060 | 12 | 18 | 335 | 0.663 | 10 | $8,500 | $ 140 | $ 55,400 | LATERAL SERVICE CONNECTIONS |
| 2048-0060 | to | 2048-0059 | 12 | 18 | 226.3 | 0.641 | 10 | $8,500 | $ 140 | $ 40,182 | LATERAL SERVICE CONNECTIONS |
| 2048-0059 | to | 2048-0058 | 12 | 18 | 123.7 | 0.695 | 10 | $8,500 | $ 140 | $ 25,818 | LATERAL SERVICE CONNECTIONS |
| 2048-0058 | to | 2048-0057 | 12 | 18 | 350 | 0.86 | 10 | $8,500 | $ 140 | $ 57,500 | LATERAL SERVICE CONNECTIONS |
| 2048-0057 | to | 2048-20-0732 | 12 | 18 | 165.5 | 0.592 | 9 | $8,500 | $ 140 | $ 31,670 | LATERAL SERVICE CONNECTIONS |

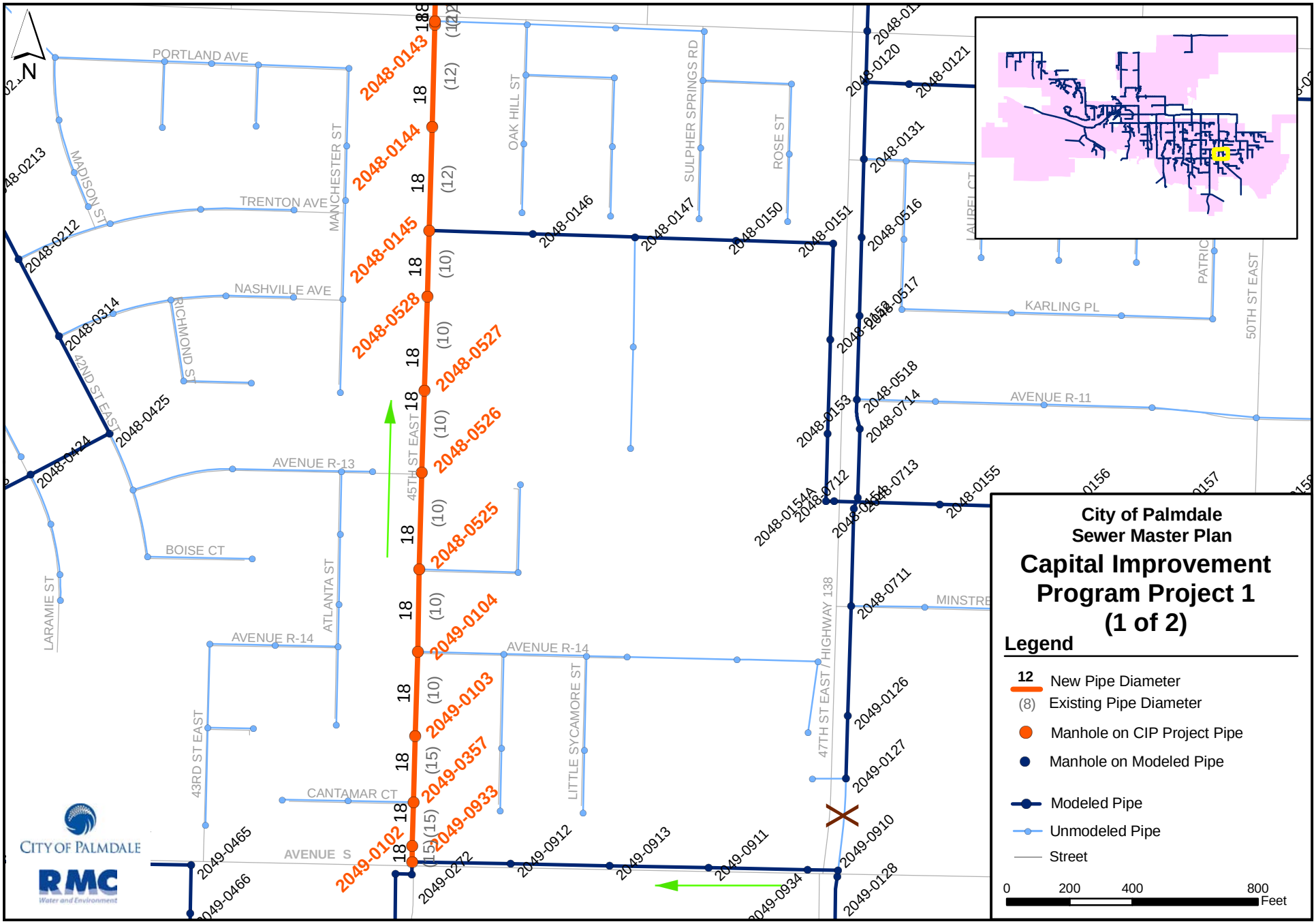
***Misc.***

| | | | | |
|---|---|---|---|---|
| Lateral Service Connections | 59 | EA | $ 500 | **$ 29,500** |
| Bypass Pumping | 5,239 | LF | $ 30 | **$ 157,148** |
| Demolition & Removal of Existing Pipe | 5,239 | LF | $ 35 | **$ 183,351** |
| Demolition & Removal of Existing Manhole | 22 | EA | $ 4,200 | **$ 92,400** |

| | | |
|---|---|---|
| | **FACILITY RAW CONSTRUCTION COST [1]** | **$ 1,377,000** |
| Mobilization, Demobilization, Bonding, Insurance, Permits, Site security, Traffic control, Staging area/Yard (20%) | | $ 275,400 |
| | **CONSTRUCTION COST SUB-TOTAL [1]** | **$ 1,652,000** |
| Pre-Design Construction Contingency (30%) | | $ 495,600 |
| | **CONSTRUCTION COST TOTAL [1]** | **$ 2,148,000** |
| Eng., Survey, Envi., Const. Mgmt, Engr. Services During Const.,Legal, Administration, Financial (25%) | | $ 537,000 |
| | **TOTAL CAPITAL COST [1]** | **$ 2,685,000** |

ENR CONSTRUCTION COST INDEX = 9410 (LOS ANGELES, 2008 Average)

Notes: (1) All costs are rounded up to the nearest thousand.


City of Palmdale
Sewer Master Plan
Capital Improvement Program Project 1 (1 of 2)
Legend
12 New Pipe Diameter
(8) Existing Pipe Diameter
Manhole on CIP Project Pipe
Manhole on Modeled Pipe
Modeled Pipe
Unmodeled Pipe
Street
0 200 400 800 Feet
N
PORTLAND AVE
TRENTON AVE
NASHVILLE AVE
AVENUE R-13
AVENUE R-14
AVENUE R-11
AVENUE S
KARLING PL
BOISE CT
CANTAMAR CT
MADISON ST
MANCHESTER ST
RICHMOND ST
42ND ST EAST
45TH ST EAST
43RD ST EAST
ATLANTA ST
LARAMIE ST
OAK HILL ST
SULPHER SPRINGS RD
ROSE ST
LITTLE SYCAMORE ST
47TH ST EAST / HIGHWAY 138
50TH ST EAST
2048-0143
2048-0144
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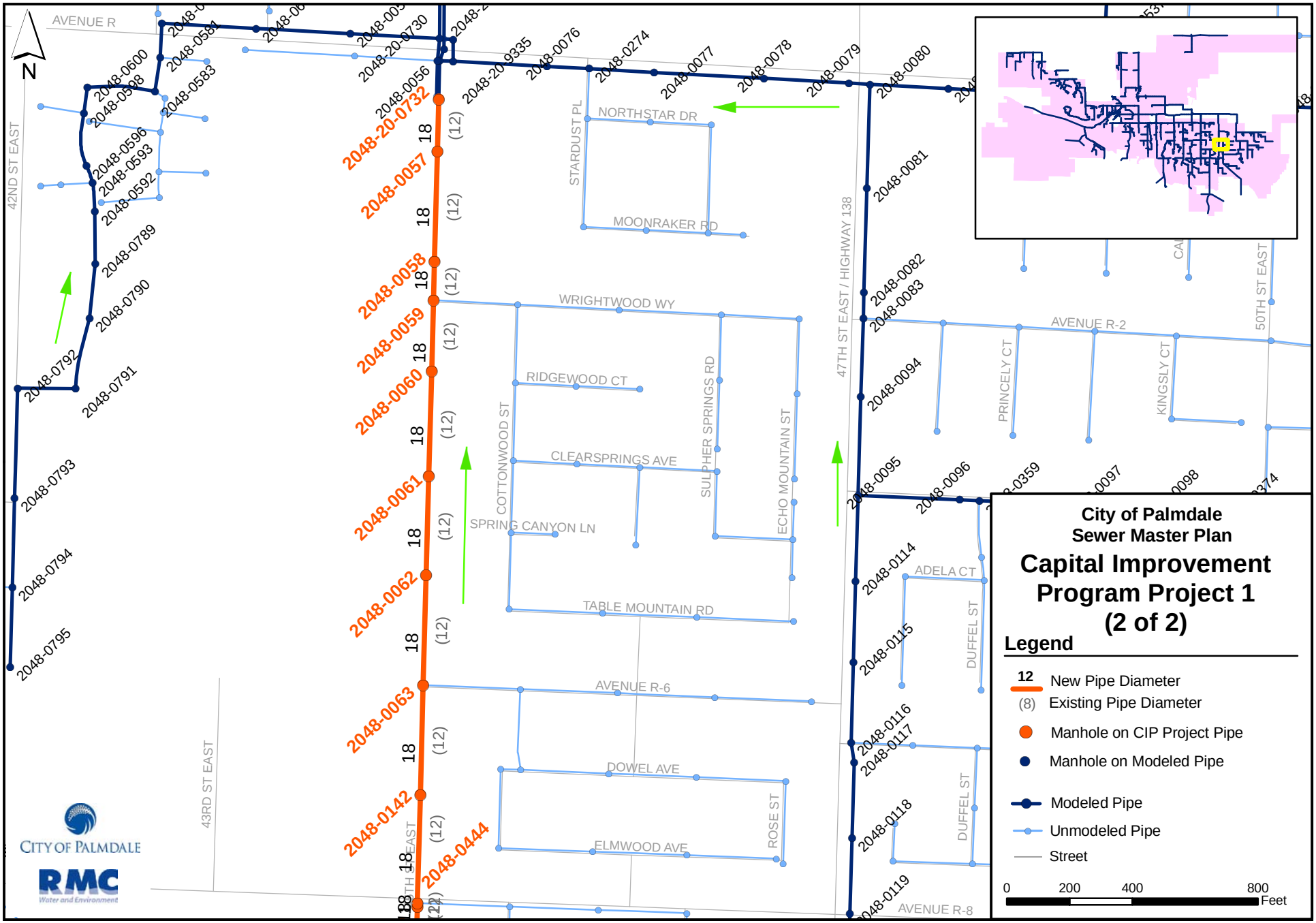
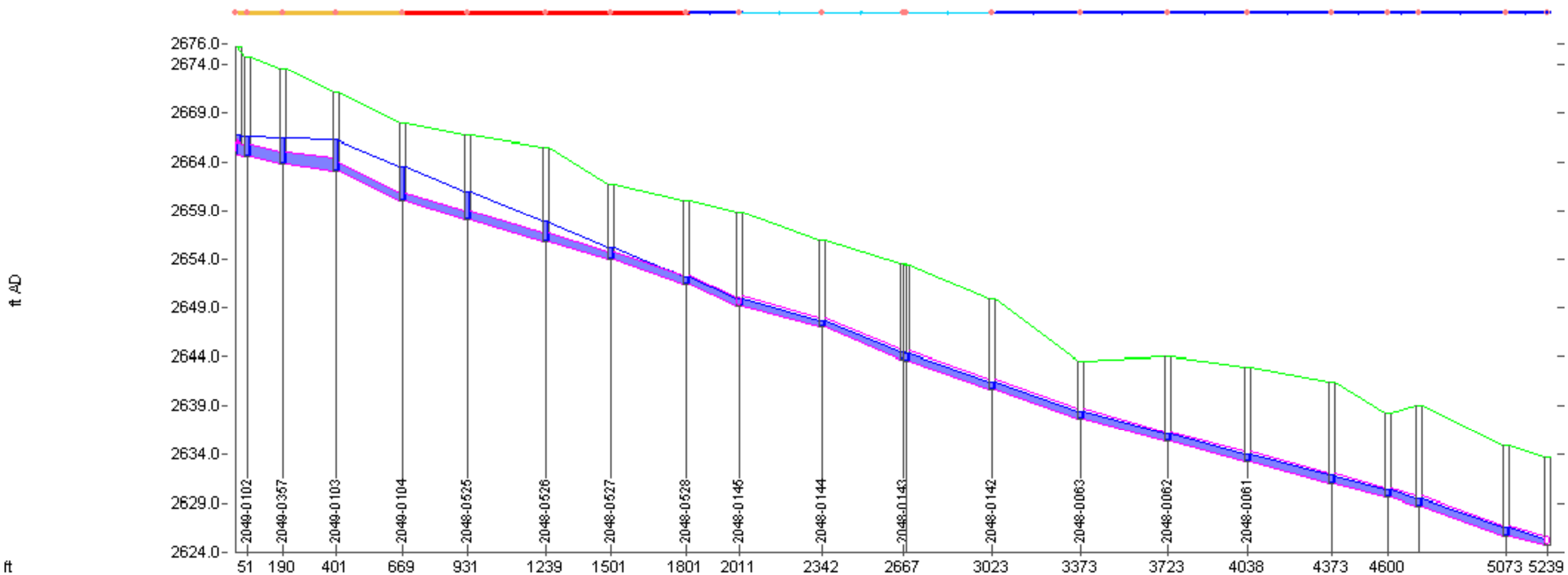

City of Palmdale
Sewer Master Plan
Capital Improvement Program Project 1 (2 of 2)
Legend
12 New Pipe Diameter
(8) Existing Pipe Diameter
Manhole on CIP Project Pipe
Manhole on Modeled Pipe
Modeled Pipe
Unmodeled Pipe
Street
0 200 400 800 Feet
N
AVENUE R
42ND ST EAST
43RD ST EAST
47TH ST EAST / HIGHWAY 138
50TH ST EAST
NORTHSTAR DR
STARDUST PL
MOONRAKER RD
WRIGHTWOOD WY
RIDGEWOOD CT
CLEARSPRINGS AVE
SPRING CANYON LN
COTTONWOOD ST
SULPHER SPRINGS RD
ECHO MOUNTAIN ST
TABLE MOUNTAIN RD
AVENUE R-2
PRINCELY CT
KINGSLY CT
ADELA CT
DUFFEL ST
AVENUE R-6
DOWEL AVE
ELMWOOD AVE
ROSE ST
AVENUE R-8
2048-20-0732
2048-0057
2048-0058
2048-0059
2048-0060
2048-0061
2048-0062
2048-0063
2048-0142
2048-0444
2048-0056
2048-20-9335
2048-0076
2048-0274
2048-0077
2048-0078
2048-0079
2048-0080
2048-0081
2048-0082
2048-0083
2048-0094
2048-0095
2048-0096
2048-0114
2048-0115
2048-0116
2048-0117
2048-0118
2048-0119
2048-0600
2048-0598
2048-0584
2048-0583
2048-0596
2048-0593
2048-0592
2048-0789
2048-0790
2048-0792
2048-0791
2048-0793
2048-0794
2048-0795
CITY OF PALMDALE
RMC Water and Environment

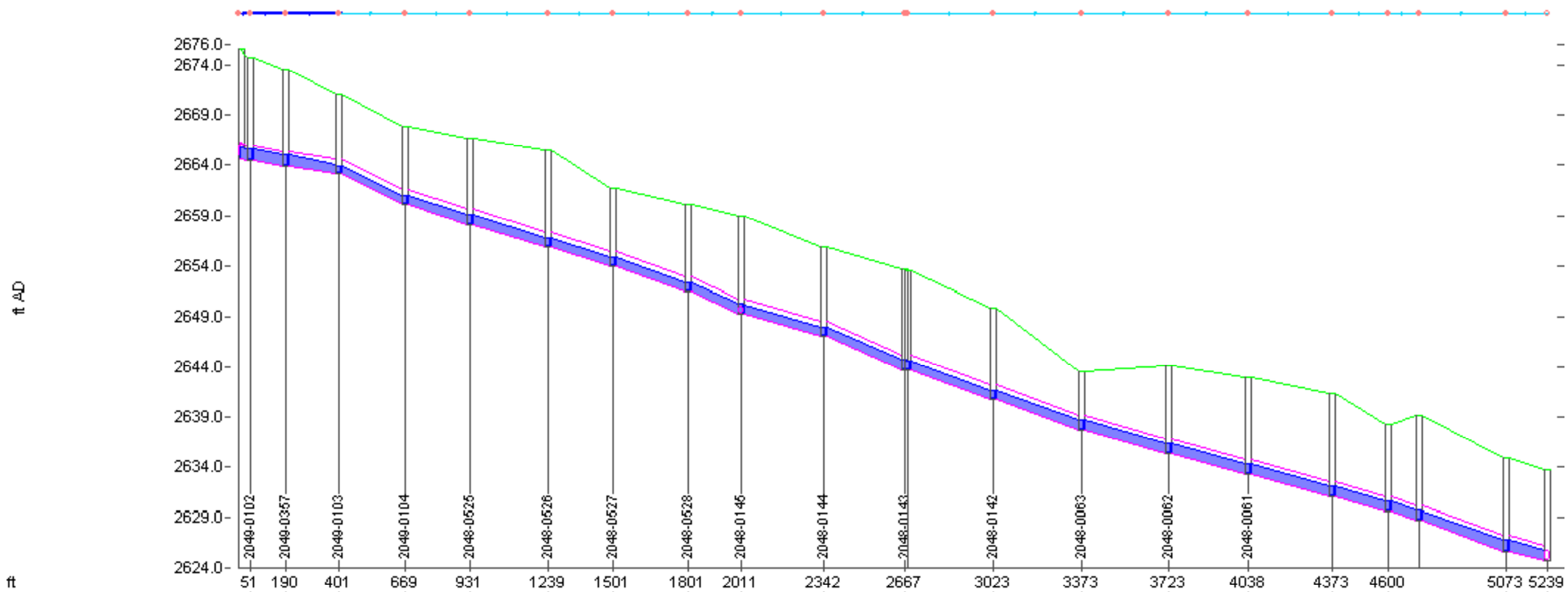
# CIP Project 1 – Deficiency (2030 DWF)




| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Shape ID | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | - | CIRC | CIRC |
| width (in) | 15.0 | 15.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 |
| us inv (ft AD) | - | - | 2663.140 | - | 2658.120 | - | 2653.950 | - | 2649.220 | 2647.020 | 2643.630 | 2640.700 | 2637.700 | 2635.380 | 2633.290 | - | - | 2628.760 | - |
| ds inv (ft AD) | - | - | 2660.040 | - | 2655.840 | - | 2651.460 | - | 2647.020 | 2643.710 | 2640.700 | 2637.700 | 2635.380 | 2633.290 | 2631.070 | - | - | 2625.750 | - |
| grad (%) | - | 0.336 | 1.159 | 0.732 | 0.740 | 0.721 | 0.830 | 1.068 | 0.666 | 1.018 | 0.849 | 0.857 | 0.663 | 0.663 | 0.663 | 0.641 | - | 0.860 | 0.592 |
| pfc (MGD) | 2.91 | 2.42 | 1.52 | 1.21 | 1.22 | 1.20 | 1.29 | 1.46 | 1.88 | 2.32 | 2.12 | 2.13 | 1.88 | 1.88 | 1.87 | 1.84 | 1.92 | 2.14 | 1.77 |
| DS Cumulative Flow (US Mgal) | 1.56 | 1.56 | 1.56 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.90 | 1.90 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.09 | 2.09 | 2.09 |
| DS Depth (ft) | - | 3.041 | 3.535 | 2.830 | 2.029 | 1.294 | 0.747 | 0.745 | 0.691 | 0.734 | 0.718 | 0.796 | 0.796 | 0.796 | 0.803 | 0.803 | - | 0.916 | 0.724 |
| DS Flow (MGD) | - | - | 1.35863 | 1.39283 | 1.39273 | 1.39270 | 1.39269 | - | 1.66203 | 1.66204 | 1.74882 | 1.74881 | 1.74881 | 1.74881 | 1.74880 | - | - | 1.82965 | - |
| DS Velocity (ft/s) | - | 3.357 | 3.702 | 3.813 | 3.767 | 4.029 | 4.469 | 4.204 | 4.445 | 4.197 | 4.540 | 4.096 | 4.098 | 4.094 | 4.028 | 4.048 | - | 3.900 | 4.646 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Node | - | - | - | - | - | - | - | - | - | - | - | - | 2048-0142 | 2048-0063 | - | - | - | - | - |
| ground (ft AD) | - | - | - | - | - | - | - | - | - | 2655.900 | - | - | 2649.900 | 2643.500 | 2644.100 | 2642.900 | - | - | - | - |
| level (ft AD) | - | - | - | - | - | - | - | - | - | 2647.671 | - | - | 2641.416 | 2638.495 | 2636.175 | 2634.085 | - | - | - | - |

# CIP Project 1 – Solution




| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Shape ID | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | - | CIRC | CIRC |
| width (in) | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 | 18.0 |
| us inv (ft AD) | - | - | 2663.140 | - | 2658.120 | - | 2653.950 | - | 2649.220 | 2647.020 | 2643.630 | 2640.700 | 2637.700 | 2635.380 | 2633.290 | - | - | 2628.760 | - |
| ds inv (ft AD) | - | - | 2660.040 | - | 2655.840 | - | 2651.460 | - | 2647.020 | 2643.710 | 2640.700 | 2637.700 | 2635.380 | 2633.290 | 2631.070 | - | - | 2625.750 | - |
| grad (%) | - | 0.336 | 1.159 | 0.732 | 0.740 | 0.721 | 0.830 | 1.068 | 0.666 | 1.018 | 0.849 | 0.857 | 0.663 | 0.663 | 0.663 | 0.641 | - | 0.860 | 0.592 |
| pfc (MGD) | 4.72 | 3.93 | 7.31 | 5.81 | 5.84 | 5.77 | 6.19 | 7.02 | 5.54 | 6.85 | 6.26 | 6.29 | 5.53 | 5.53 | 5.53 | 5.43 | 5.66 | 6.30 | 5.23 |
| DS Cumulative Flow (US Mgal) | 5.08 | 5.08 | 5.08 | 5.14 | 5.14 | 5.14 | 5.14 | 5.14 | 5.57 | 5.57 | 5.71 | 5.71 | 5.71 | 5.71 | 5.71 | 5.71 | 5.83 | 5.83 | 5.83 |
| DS Depth (ft) | - | 0.957 | 0.935 | 0.931 | 0.941 | 0.929 | 0.874 | 1.011 | 0.994 | 0.998 | 0.957 | 1.044 | 1.043 | 1.044 | 1.061 | 1.037 | - | 1.094 | 1.025 |
| DS Flow (MGD) | - | - | 3.94359 | 3.98670 | 3.98629 | 3.98595 | 3.98591 | - | 4.32420 | 4.32388 | 4.42249 | 4.42200 | 4.42057 | 4.41956 | 4.41866 | - | - | 4.50697 | - |
| DS Velocity (ft/s) | - | 5.130 | 5.309 | 5.398 | 5.335 | 5.404 | 5.773 | 4.870 | 5.384 | 5.355 | 5.799 | 5.272 | 5.273 | 5.269 | 5.187 | 5.286 | - | 5.050 | 5.420 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Node | - | - | - | - | - | - | - | - | - | - | - | 2048-0142 | 2048-0063 | - | - | - | - | - | - |
| ground (ft AD) | - | - | - | - | - | - | - | - | - | 2655.900 | - | 2649.900 | 2643.500 | 2644.100 | 2642.900 | - | - | - | - |
| level (ft AD) | - | - | - | - | - | - | - | - | - | 2647.908 | - | 2641.656 | 2638.742 | 2636.422 | 2634.333 | - | - | - | - |

RMC
Water and Environment

**Project: City of Palmdale Sewer Master Plan**

**Aspect: Collection System Costs - CIP Project 2**

| | |
|---|---|
| Date: | September 18, 2009 |
| Project No: | 0200-003 |
| Prepared by: | C. Brothers & K. Erickson |
| Checked by: | - |
| Check Date: | - |

| PROJECT DESCRIPTION | |
|---|---|
| PROJECT ID: …….. | 2 |
| FIRST PIPE ID: | 1833-0421.1 |
| LOCATION: …….. | This project is located on Parallels 30th St W between Ave P-8 and Joshua Ranch Rd. |
| BRIEF PROJECT DESCRIPTION: …… | The project consists of the upsize and replacement of 2,477-feet of 8-inch to 10-inch pipe. |
| PROJECT PRIORITY: …….. | 2030 WWF |
| ESTIMATED COST: …….. | $1,222,000 |
| COMMENTS: …… | (i) Assumes existing alignment, open-cut, demolition of existing pipe. |
| ASSUMPTIONS: …… | (i) Lateral service connections are estimated based on aerial imagery and parcel boundary shapefiles.<br>(ii) See GENERAL UNIT COST CRITERIA sheet for more cost assumptions. |
| ALTERNATIVES: …….. | None |

| U/S MANHOLE | | D/S MANHOLE | EXISTING DIAMETER (inches) | NEW DIAMETER (inches) | LENGTH (feet) | SLOPE (%) | PIPE DEPTH (feet) | MANHOLE UNIT COST ($/ea) | PIPE UNIT COST ($/lf) | TOTAL COST | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1833-0421 | to | 1833-0266 | 8 | 10 | 138.9 | 0.439 | 11 | $8,500 | $ 130 | $ 26,557 | LATERAL SERVICE CONNECTIONS |
| 1833-0266 | to | 1833-0265 | 8 | 10 | 266 | 0.447 | 10 | $8,500 | $ 130 | $ 43,080 | LATERAL SERVICE CONNECTIONS |
| 1833-0265 | to | 1833-0264 | 8 | 10 | 344.4 | 0.439 | 13 | $8,500 | $ 130 | $ 53,272 | LATERAL SERVICE CONNECTIONS |
| 1833-0264 | to | 1833-0263 | 8 | 10 | 241.6 | 0.455 | 15 | $8,500 | $ 130 | $ 39,908 | LATERAL SERVICE CONNECTIONS |
| 1833-0263 | to | 1833-0262 | 8 | 10 | 192.9 | 0.441 | 15 | $8,500 | $ 130 | $ 33,577 | LATERAL SERVICE CONNECTIONS |
| 1833-0262 | to | 1833-0257 | 8 | 10 | 157 | 0.484 | 14 | $8,500 | $ 130 | $ 28,910 | LATERAL SERVICE CONNECTIONS |
| 1833-0257 | to | 1833-0256 | 8 | 10 | 322.1 | 1.13 | 11 | $8,500 | $ 130 | $ 50,373 | LATERAL SERVICE CONNECTIONS |
| 1833-0256 | to | 1833-0255 | 8 | 10 | 282.7 | 1.291 | 8 | $8,500 | $ 100 | $ 36,770 | LATERAL SERVICE CONNECTIONS |
| 1833-0255 | to | 1833-0254 | 8 | 10 | 153.7 | 0.807 | 8 | $8,500 | $ 100 | $ 23,870 | LATERAL SERVICE CONNECTIONS |
| 1833-0254 | to | 1833-0253 | 8 | 10 | 177.9 | 0.714 | 8 | $8,500 | $ 100 | $ 26,290 | LATERAL SERVICE CONNECTIONS |
| 1833-0253 | to | 1833-0252 | 8 | 10 | 199.6 | 0.681 | 9 | $8,500 | $ 100 | $ 28,460 | LATERAL SERVICE CONNECTIONS |

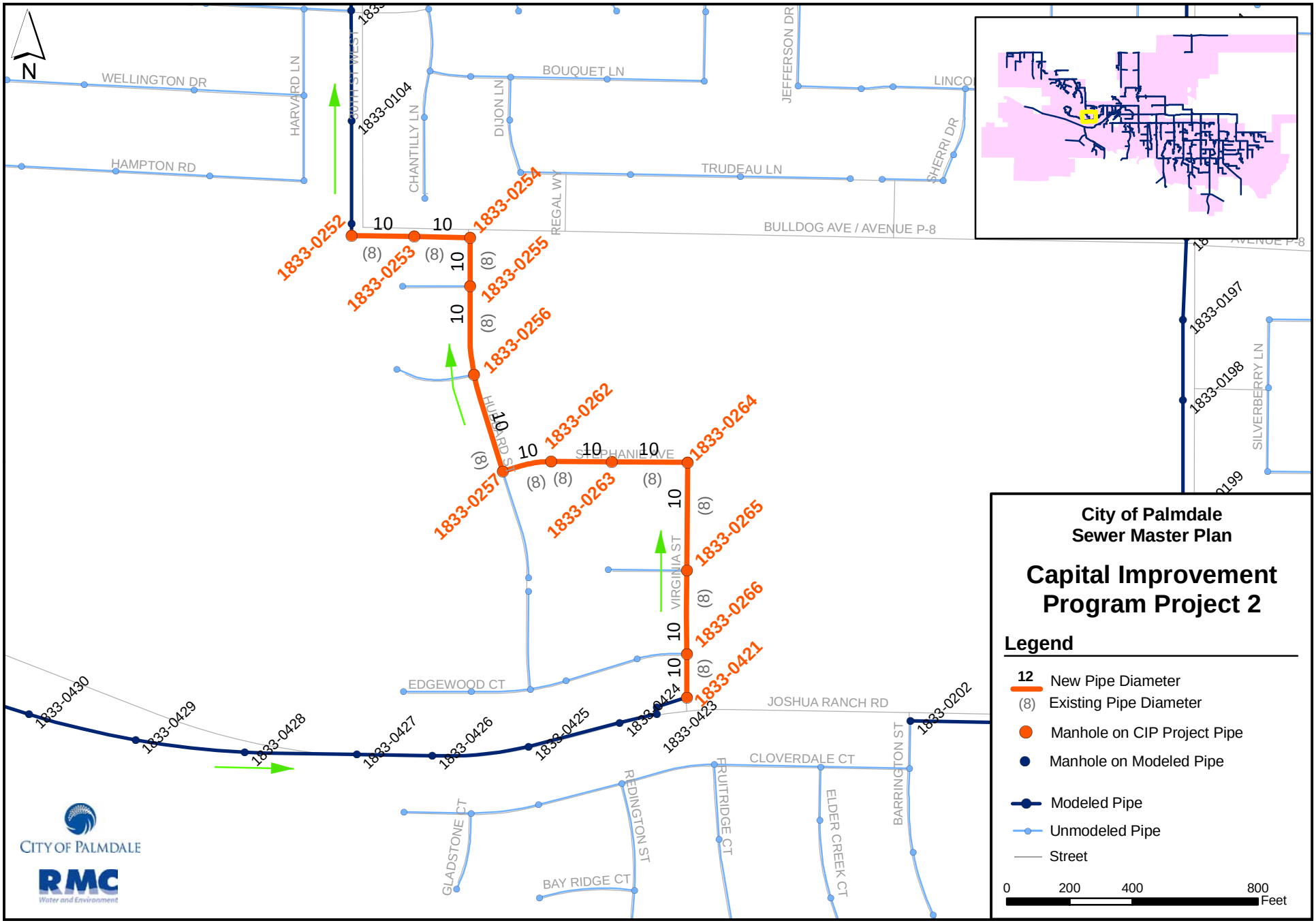
***Misc.***

| | | | | |
|---|---|---|---|---|
| Lateral Service Connections | 48 | EA | $ 500 | **$ 24,000** |
| Bypass Pumping | 2,477 | LF | $ 30 | **$ 74,299** |
| Demolition & Removal of Existing Pipe | 2,477 | LF | $ 35 | **$ 86,688** |
| Demolition & Removal of Existing Manhole | 12 | EA | $ 4,200 | **$ 50,400** |

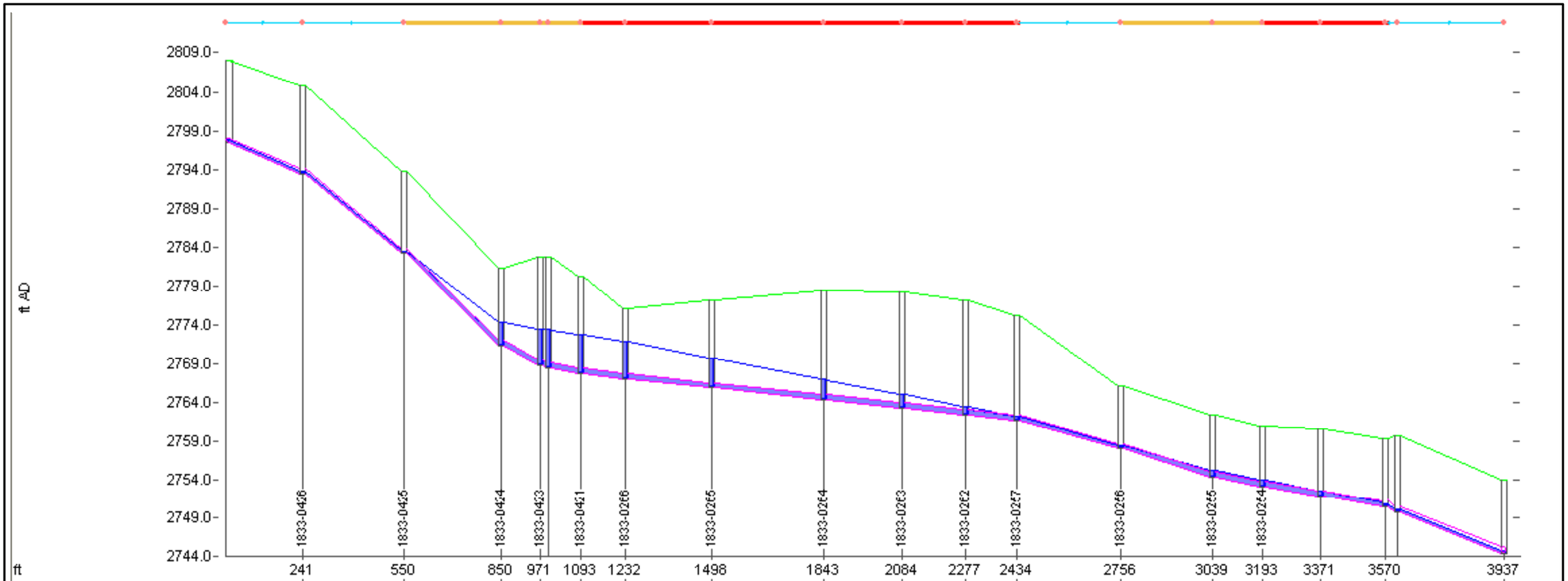
| | | |
|---|---|---|
| | **FACILITY RAW CONSTRUCTION COST [1]** | **$ 627,000** |
| Mobilization, Demobilization, Bonding, Insurance, Permits, Site security, Traffic control, Staging area/Yard (20%) | | $ 125,400 |
| | **CONSTRUCTION COST SUB-TOTAL [1]** | **$ 752,000** |
| Pre-Design Construction Contingency (30%) | | $ 225,600 |
| | **CONSTRUCTION COST TOTAL [1]** | **$ 978,000** |
| Eng., Survey, Envi., Const. Mgmt, Engr. Services During Const.,Legal, Administration, Financial (25%) | | $ 244,500 |
| | **TOTAL CAPITAL COST [1]** | **$ 1,222,000** |

ENR CONSTRUCTION COST INDEX = 9410 (LOS ANGELES, 2008 Average)

Notes: (1) All costs are rounded up to the nearest thousand.


City of Palmdale
Sewer Master Plan
Capital Improvement Program Project 2
Legend
12 New Pipe Diameter
(8) Existing Pipe Diameter
Manhole on CIP Project Pipe
Manhole on Modeled Pipe
Modeled Pipe
Unmodeled Pipe
Street
0 200 400 800 Feet
N
WELLINGTON DR
HAMPTON RD
HARVARD LN
BOUQUET LN
CHANTILLY LN
DIJON LN
JEFFERSON DR
TRUDEAU LN
SHERRI DR
REGAL WY
BULLDOG AVE / AVENUE P-8
HILLYARD ST
STEPHANIE AVE
VIRGINIA ST
EDGEWOOD CT
JOSHUA RANCH RD
CLOVERDALE CT
GLADSTONE CT
REDINGTON ST
BAY RIDGE CT
FRUITRIDGE CT
ELDER CREEK CT
BARRINGTON ST
SILVERBERRY LN
1833-0104
1833-0252
1833-0253
1833-0254
1833-0255
1833-0256
1833-0257
1833-0262
1833-0263
1833-0264
1833-0265
1833-0266
1833-0421
1833-0423
1833-0424
1833-0425
1833-0426
1833-0427
1833-0428
1833-0429
1833-0430
1833-0197
1833-0198
1833-0202
10
(8)
CITY OF PALMDALE
RMC
Water and Environment

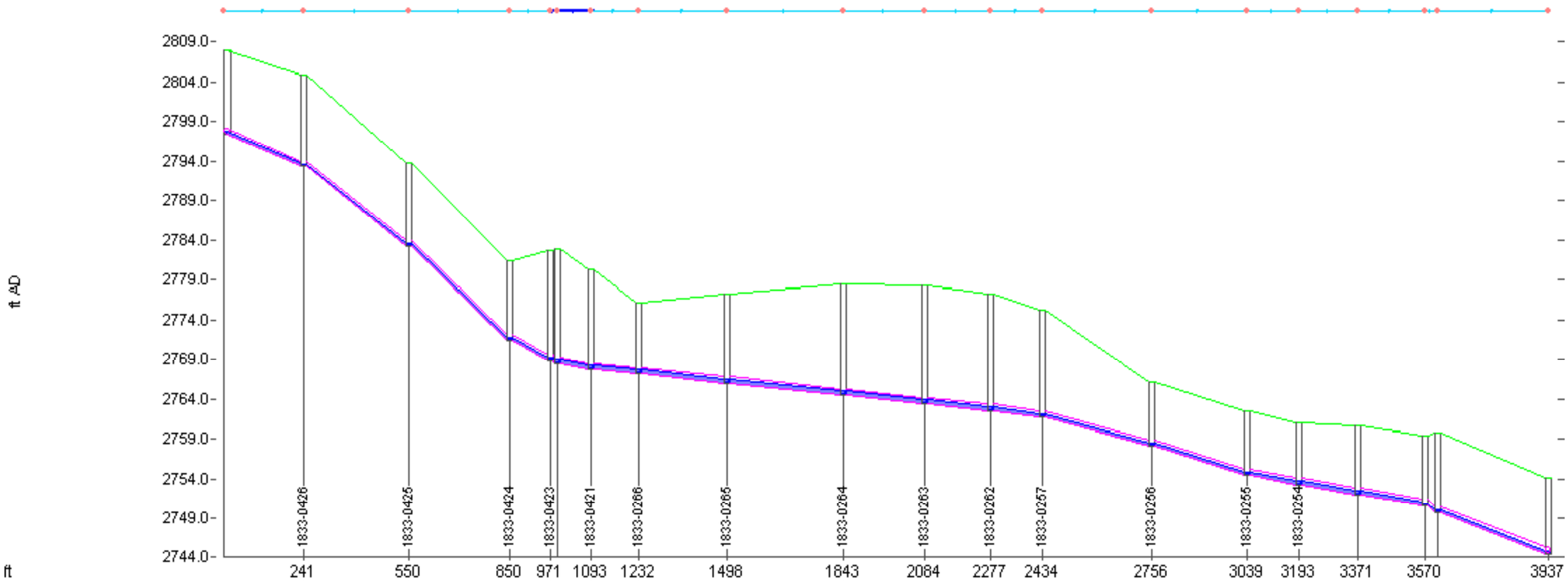
# CIP Project 2 – Deficiency (2030 WWF)




| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link | - | 1833-0426.1 | 1833-0425.1 | - | - | - | 1833-0266.1 | 1833-0265.1 | - | - | - | 1833-0257.1 | 1833-0256.1 | - | - | - | 1833-0105.1 |
| Shape ID | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC |
| width (in) | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 10.0 |
| us inv (ft AD) | 2797.470 | 2793.380 | 2783.210 | - | - | - | 2767.130 | 2765.940 | 2764.430 | 2763.330 | - | 2761.720 | 2758.080 | - | - | 2751.920 | 2749.710 |
| ds inv (ft AD) | 2793.380 | 2783.210 | 2771.420 | - | - | - | 2765.940 | 2764.430 | 2763.330 | 2762.480 | - | 2758.080 | 2754.430 | - | - | 2750.560 | 2744.520 |
| grad (%) | 1.698 | 3.290 | 3.929 | 2.121 | - | 0.439 | 0.447 | 0.439 | 0.455 | 0.441 | 0.484 | 1.130 | 1.291 | 0.807 | 0.714 | 0.681 | 1.572 |
| pfc (MGD) | 1.02 | 1.42 | 1.55 | 1.14 | 0.68 | 0.52 | 0.52 | 0.52 | 0.53 | 0.52 | 0.54 | 0.83 | 0.89 | 0.70 | 0.66 | 0.64 | 1.78 |
| DS Cumulative Flow (US Mgal) | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| DS Depth (ft) | 0.388 | 0.325 | 2.973 | 4.698 | - | 4.677 | 3.759 | 2.546 | 1.728 | 1.042 | 0.491 | 0.472 | 0.933 | 0.929 | 0.768 | 0.491 | 0.366 |
| DS Flow (MGD) | 0.63911 | 0.63907 | 0.63573 | - | - | - | 0.68198 | 0.68114 | 0.68088 | 0.68081 | - | 0.68079 | 0.67961 | - | 0.67929 | 0.67924 | 0.67923 |
| DS Velocity (ft/s) | 4.687 | 5.858 | 4.836 | 4.042 | - | 2.374 | 2.625 | 2.729 | 2.806 | 2.876 | 3.823 | 4.104 | 3.394 | 3.207 | 3.139 | 3.813 | 4.550 |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Node | - | 1833-0426 | 1833-0425 | - | - | - | - | - | 1833-0265 | 1833-0264 | - | - | 1833-0257 | 1833-0256 | - | - | - | - | - | - |
| ground (ft AD) | - | 2804.840 | 2793.800 | 2781.370 | - | - | - | - | 2777.140 | 2778.500 | 2778.300 | - | 2775.200 | 2766.130 | 2762.430 | - | - | - | - | - |
| level (ft AD) | - | 2793.705 | 2783.518 | 2774.391 | - | - | - | - | 2769.698 | 2766.974 | 2765.056 | - | 2762.203 | 2758.533 | 2755.360 | - | - | - | - | - |

# CIP Project 2 – Solution




| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Link | - | 1833-0426.1 | 1833-0425.1 | - | - | - | 1833-0266.1 | 1833-0265.1 | - | - | - | 1833-0257.1 | 1833-0256.1 | - | - | - | 1833-0105.1 |
| Shape ID | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC | CIRC |
| width (in) | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| us inv (ft AD) | 2797.470 | 2793.380 | 2783.210 | - | - | - | 2767.130 | 2765.940 | 2764.430 | 2763.330 | - | 2761.720 | 2758.080 | - | - | 2751.920 | 2749.710 |
| ds inv (ft AD) | 2793.380 | 2783.210 | 2771.420 | - | - | - | 2765.940 | 2764.430 | 2763.330 | 2762.480 | - | 2758.080 | 2754.430 | - | - | 2750.560 | 2744.520 |
| grad (%) | 1.698 | 3.290 | 3.929 | 2.121 | - | 0.439 | 0.447 | 0.439 | 0.455 | 0.441 | 0.484 | 1.130 | 1.291 | 0.807 | 0.714 | 0.681 | 1.572 |
| pfc (MGD) | 1.02 | 1.42 | 1.55 | 1.14 | 0.68 | 0.94 | 0.95 | 0.94 | 0.96 | 0.94 | 0.99 | 1.51 | 1.61 | 1.27 | 1.20 | 1.17 | 1.78 |
| DS Cumulative Flow (US Mgal) | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| DS Depth (ft) | 0.388 | 0.325 | 0.374 | 0.434 | - | 0.544 | 0.547 | 0.542 | 0.546 | 0.535 | 0.469 | 0.413 | 0.454 | 0.472 | 0.477 | 0.470 | 0.374 |
| DS Flow (MGD) | 0.63891 | 0.63887 | 0.63880 | - | - | - | 0.70505 | 0.70494 | 0.70490 | 0.70484 | - | 0.70476 | 0.70470 | - | 0.70462 | 0.70457 | 0.70452 |
| DS Velocity (ft/s) | 4.686 | 5.857 | 4.934 | 4.131 | - | 2.621 | 2.876 | 2.905 | 2.880 | 2.949 | 3.447 | 4.046 | 3.602 | 3.420 | 3.377 | 3.439 | 4.594 |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Node | - | 1833-0426 | 1833-0425 | - | - | - | - | - | 1833-0265 | 1833-0264 | - | - | 1833-0257 | 1833-0256 | - | - | - | - | - | - |
| ground (ft AD) | - | 2804.840 | 2793.800 | 2781.370 | - | - | - | - | 2777.140 | 2778.500 | 2778.300 | - | 2775.200 | 2766.130 | 2762.430 | - | - | - | - | - |
| level (ft AD) | - | 2793.705 | 2783.518 | 2771.793 | - | - | - | - | 2766.486 | 2764.971 | 2763.875 | - | 2762.133 | 2758.480 | 2754.884 | - | - | - | - | - |

# Chapter 6 Sewer System Repair/Renewal/Replacement Program

This chapter presents the City's near-term and long-term gravity sewer system repair, renewal, and replacement needs based on the characteristics of the City's sewer system and the results of the initial 62 miles of sewer video inspections performed. Also presented is a program for the on-going inspection, condition assessment, and repair/renewal/replacement of the City's sewers. Chapter 4 of the City's SSMP incorporates the program described in this chapter.

Sewer repairs, often referred to as point or spot repairs, consist of replacement or sectional lining of damaged pipe segments a few feet long that prevent a local failure. Repairs defer but do not eliminate the eventual need for more extensive renewal/replacement of the pipe. Renewal refers to manhole-to-manhole rehabilitation which can consist of pipe bursting or lining. Sewer replacement refers to excavation and removal (or abandonment) of an existing pipe and construction of a completely new replacement pipe. Renewal and replacement (but not repair) are both considered to result in a pipe with a new useful life and the retirement of the old asset (pipe) from the sanitary sewer asset database.

This chapter is divided into the following sections:

1. Sewer System Characteristics
2. Condition Assessment Methodology
3. Initial Inspection and Condition Assessment Program
4. Near-term Repair/Renewal/Replacement Program
5. Future Inspection Program
6. Long-term Renewal/Replacement Projections

## 6.1 Sewer System Characteristics

Chapter 1 of this report includes a description of the City's sewer system, including maps and tables of size and age characteristics. The City's sewer system consists of 396 miles of pipe and 8,441 manholes. About 99 percent of the gravity pipe is VCP and less than or equal to15 inches in diameter. The system is relatively new in that the oldest sewers were built in 1952, and over 85 percent of the system was built after 1980. Figure 6-1 shows the total length of sewer by year of construction. The City's two small pump stations and their force mains were not included in the repair/renewal/replacement evaluation.

Due to the relative uniformity of the City's sewer system in terms of pipe size and material, the year of construction is the most significant characteristic that can be used as an indicator of pipe condition and repair/renewal/replacement requirements. Besides the fact that older pipe has had a longer period in which to deteriorate, there are also differences in the pipe and joint materials that were commonly used during different historical periods in the evolution of clay sewer pipe. Based on information provided by the National Clay Pipe Institute[1], there have been three generations of clay sewer pipe:

- **Generation 1 -** Clay pipe manufactured before 1950 consists of short sections with joints every two to three feet. When compared with modern clay pipe, it has relatively thin walls and is only partially fired. This pipe is commonly referred to as "terra cotta" pipe. The joints are rigid and typically consist of cement mortar. The fragile nature of the pipes often resulted in damage during construction and subsequent damage from earth movement and loss of support due to migration of fine soil particles and nearby underground construction. The cement mortar joints tend to deteriorate over time due to corrosion and cracking due to soil movement and roots. Roots exploit the cracks and failed joints to gain access to water and nutrients and thereby cause further damage to the pipe.

[1] Adapted from National Clay Pipe Institute Chronology prepared by John Butler, dated August 23, 2005.

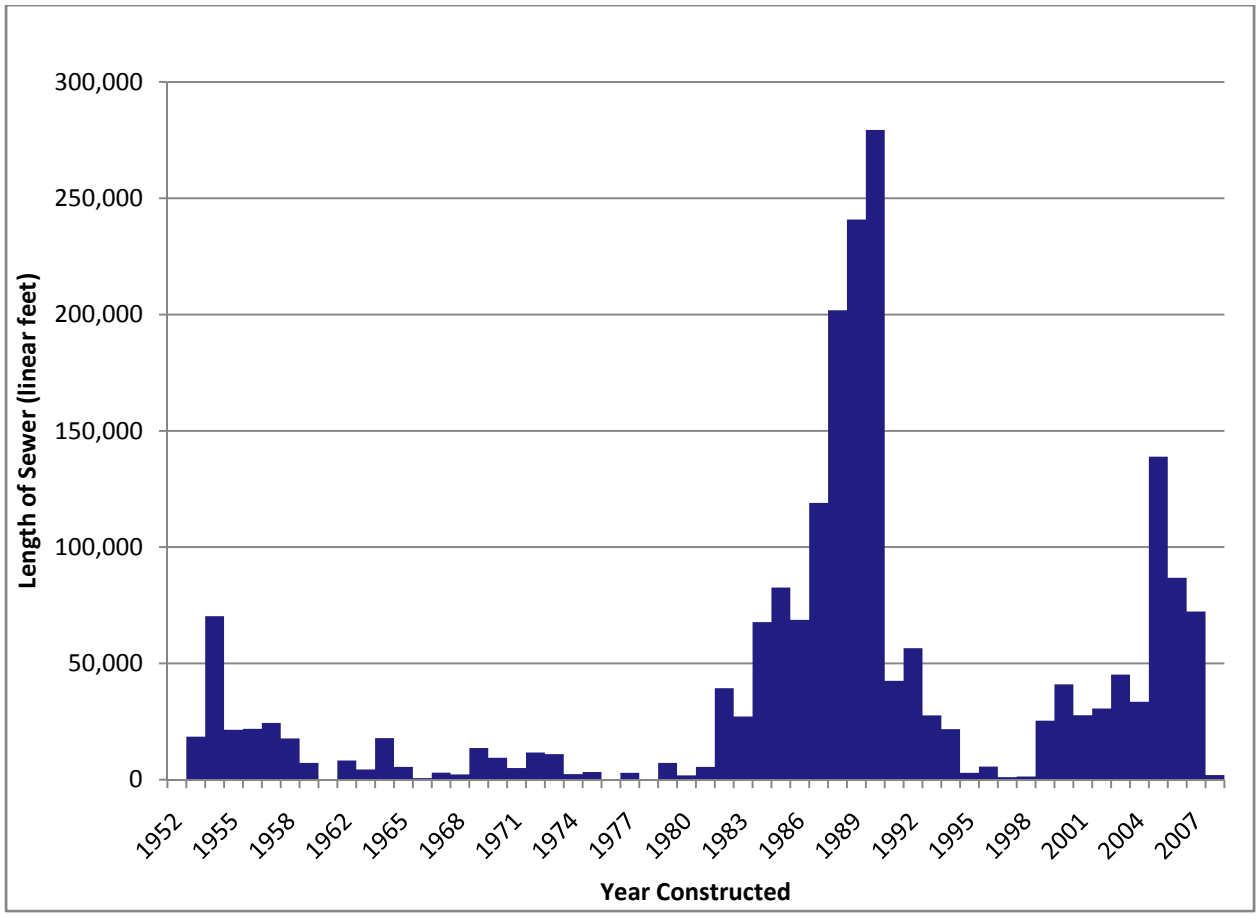



**Figure 6-1: Total Length of Gravity Sewers by Year of Construction**

- **Generation 2** - Clay pipe manufactured between 1950 and 1958 consists of longer sections with joints every five to six feet. The pipe walls are thicker and the clay is fired to a greater extent. This pipe is commonly referred to as "vitrified clay pipe". The joints are rigid and typically consist of cement mortar. Sewers of this generation are less susceptible to damage during construction, but they are problematic due to the durability of the joints, as described above for terra cotta pipe.
- **Generation 3** - Clay pipe manufactured after 1958 was also vitrified clay, but was designed with flexible joints made of polyvinyl chloride and, later, synthetic rubber (polyurethane). Sewers of this generation perform better than previous generations and are less susceptible to joint deterioration and root invasion. They are expected to have longer useful lives than pipes of previous generations (approximately 100 years vs 80 years).

The City has no Generation 1 sewers, and only about 9 percent are Generation 2 sewers, which are of some concern due to their rigid joints and the fact that those pipes are now over 50 years old. The Generation 3 sewers, which make up 91 percent of the City's system, would generally be expected to be in good condition and to remain so for many more years.

Although pipe material, clay pipe generation, and age are factors that are typically indicative of the condition and remaining useful life of sewers, actual current structural condition can only be determined through internal video inspections. Therefore, the near-term repair/renewal/replacement

recommendations are based primarily on video inspections and the analysis of initial inspection findings. The year of sewer construction has been used, however, for prioritizing future inspections, extrapolating the findings of initial inspections, and projecting long-term renewal/replacement needs.

## 6.2 Condition Assessment Methodology

Identifying and prioritizing near-term sewer repair/renewal/replacement projects requires obtaining accurate information on the structural condition of the sewer system. Current industry best practices for sewer system management call for conducting a baseline inspection of the entire system, typically over a 5- to 10-year period, as a basis for assessing its overall structural condition and identifying both short-term and long-term sewer repair/renewal/replacement needs. The results of the baseline inspection also serve to determine the frequency and priority for the next round of inspections, and provide data with which to assess long-term trends in sewer condition and to begin to develop actual service lives for the sewers based on actual conditions in Palmdale. Implementation of an effective condition assessment methodology, as described below, is important to ensure that sewer inspection data will achieve these objectives.

Video inspection using closed circuit television (CCTV) is the basic method used to assess gravity sewer condition. This section provides guidelines for video inspection and condition assessment, including establishing standardized observation codes, data documentation procedures, condition grading, and criteria for using the results to make repair/renewal/replacement decisions and establishing useful lives for the pipeline segments.

### 6.2.1 Video Inspection Specifications

Effective use of video inspection data requires that the data recorded be consistent, complete, and of high quality; and that it is captured in a format that can be readily accessed for analysis. Current industry best practice is to use Pipeline Assessment and Certification Program (PACP) standards developed by the National Association of Sewer Service Companies (NASSCO), which specifies observation codes and grades to be applied to all structural and maintenance-related defects. The City has adopted PACP standards and operator certification requirements for its video inspections. The City's Technical Provisions for CCTV Inspection Services are included as Appendix D.

### 6.2.2 Condition Grading and Rating

Under the PACP standard, all structural defects in any pipeline section are assigned a condition grade of 1 to 5. (PACP standards also cover maintenance defects which are used for maintenance planning purposes, but are not used in this condition assessment). The grades are defined generally as follows, although more specific definitions apply to each defect type:

- 5 – Immediate: Defects require immediate attention (likely to fail within 5 years).
- 4 – Poor: Severe defects that will become Grade 5 defects within the foreseeable future (likely to fail in 5 to 10 years).
- 3 – Fair: Moderate defects that will continue to deteriorate (may fail in 10 to 20 years).
- 2 – Good: Defects that have not begun to deteriorate (unlikely to fail for at least 20 years).
- 1 – Excellent: Minor defects (unlikely to fail in the foreseeable future).

The PACP standard defines failure as when the pipe can no longer convey the pipe design capacity. The implication is that such a failure will result in a sanitary sewer overflow (SSO) unless action is taken.

The grades for individual defects observed on a manhole-to-manhole pipe segment can be combined in various ways to determine an overall structural condition rating for the pipe. The PACP manual suggests

several formulas for this purpose, including summing the grades of all defects or averaging the grades. Some investigators divide the sum of the grades by the length of the pipe to get a per-foot grade density. While such formulas may be useful for screening pipes in terms of overall condition, they are not particularly useful for deciding which pipes require immediate attention. What is most important in such decisions is the presence of major defects (Grade 4 and 5 defects), and the number of such defects. For example, a single Grade 5 defect in a pipe requires action, while five Grade 1 defects do not, even though they both sum to 5. The number of Grade 4 or 5 defects is significant since it helps determine whether spot repair(s) or manhole-to-manhole rehabilitation (e.g., lining, pipe bursting) or replacement would be most appropriate.

Because it provides the best overall rating method for the purposes of decision making, the PACP Quick Structural Rating (QSR) is recommended as the City's primary rating system for condition assessment. This rating uses a four-digit code to indicate the number of defects having the two highest grades. For example, a QSR of 5132 indicates the worst defect was a Grade 5 defect (of which there was only one occurrence), and the next worst defect was Grade 3 (of which there were 2 occurrences). As another example, a QSR of 3412 indicates no Grade 4 or 5 defects, four Grade 3 defects, no Grade 2 defects, and two Grade 1 defects. Letters are used in cases where the number of defects is greater than 9 (e.g., 341B indicates more than 9 Grade 1 defects).

### 6.2.3 Repair/Renewal/Replacement Decision Criteria

The QSR provides the basic information needed to decide which repair/renewal/replacement action is appropriate, and/or when the pipe should be re-inspected. The recommended decision criteria and actions are illustration on Figure 6-2. Basically, if the worst structural defect is Grade 4 or higher, the pipe is scheduled for re-inspection only, with the timing based on condition. The better the condition (as indicated by the grade of the worst defect), the farther in the future the re-inspection can occur, since the risk of a failure prior to re-inspection is small. For pipes with one or more Grade 5 defects, a near-term action is required, generally within the next year, although some of the less severe defects could be deferred to a later year. For severe Grade 5 defects that have already failed or are judged to present an unacceptable risk of immediate failure, correction should be performed on an accelerated basis (immediately in the worst cases).

The decision on whether to implement a spot repair or a manhole-to-manhole rehabilitation or replacement is partly an economic decision (it is generally less costly to rehabilitate an entire pipe than to perform spot repairs if there are more than two repairs for every 100 feet of pipe), but may also involve a number of other considerations, including whether adjacent pipes need rehabilitation, whether the pipe needs additional capacity, and the specific nature of the defects. The logic in Figure 6-2 is recommended for use in budgetary planning, prior to performing more detailed assessments. It assumes that if spot repairs are performed, it would be cost-effective to repair the Grade 4 and 5 defects in any pipe section at the same time.

The decision on whether to use lining, pipe bursting, or replacement for manhole-to-manhole projects should be based on site-specific conditions. In general, lining and pipe bursting will be more economical than replacement and will likely be chosen in most cases. If properly installed, linings should have a similar service life as replacement (or pipe bursting), although the technology has not been in existence long enough to demonstrate a 100-year service life. The City may wish to inspect its initial lining projects more frequently than every 20 years to develop confidence in the continued use of this method.

Pipes requiring repair/renewal/replacement should be prioritized if the work will need to be performed over multiple years due to practical considerations and/or financial constraints. In setting priorities, the goal is to minimize risk. In this context, risk includes both the probability of a failure and the resultant impact of that failure. The probability of a failure is based on the number and severity of defects. The resultant impact of a failure is more subjective, and depends on the characteristics of the pipe and the land uses in the area. These characteristics include:

- Pipe size, as an indicator of flow rate. The failure of a large pipe (as opposed to a small pipe) that triggers a partial or total blockage is more likely to cause an overflow with a high impact.
- Traffic volume. A spill in a high-volume street or under a state highway will create a greater impact than one on a low-volume street.
- Proximity to open channels. A spill near an open channel is more likely to reach the channel before it can be contained in the street or in a storm drain.
- Sensitive land uses. Spills near schools, businesses, and environmentally sensitive habitats, for example, will have a greater impact than spills in a typical residential neighborhood.

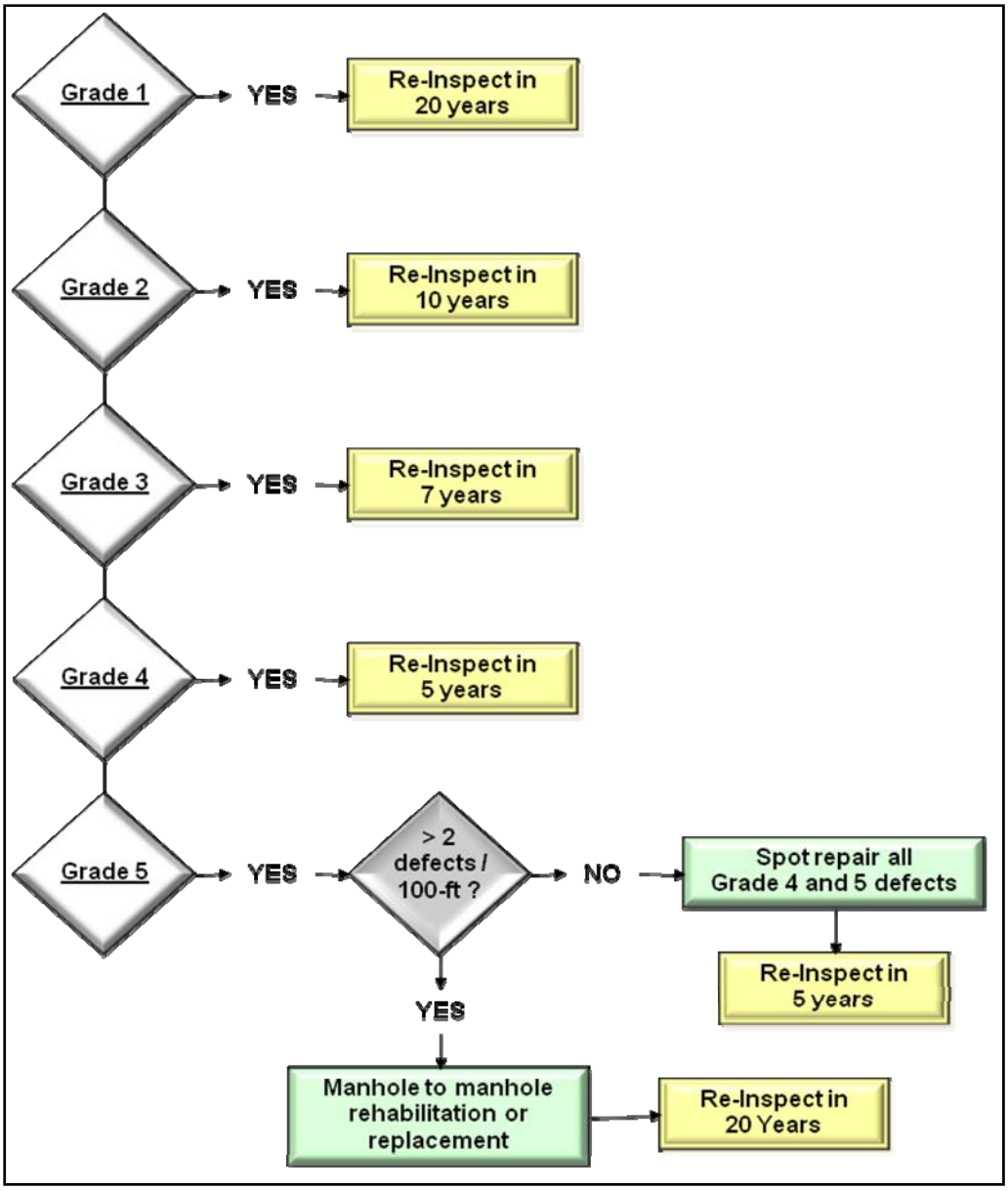



**Figure 6-2: Repair/Renewal/Replacement Decision Criteria Based on the Number and Grade of the Worst Observed Structural Defects**

Some agencies have assigned quantitative weights to these and other characteristics to compute impact scores which are combined with the probability scores to compute an overall risk score for each defective pipe. Such a quantitative approach may be justified to help prioritize a large number of defects that will be addressed over a multi-year period. In the City's case (as will be described later in this chapter), there are not enough defects to necessitate a quantitative prioritization process currently. However, the City should consider the potential impacts of each identified defect subjectively when prioritizing renewal/ replacement projects. The City should also maintain a database of pipe failures going forward to begin to develop a more localized philosophy for prioritization and to better understand the effects and methods of failure in local sewer pipelines.

## 6.3 Initial Inspection and Condition Assessment Program

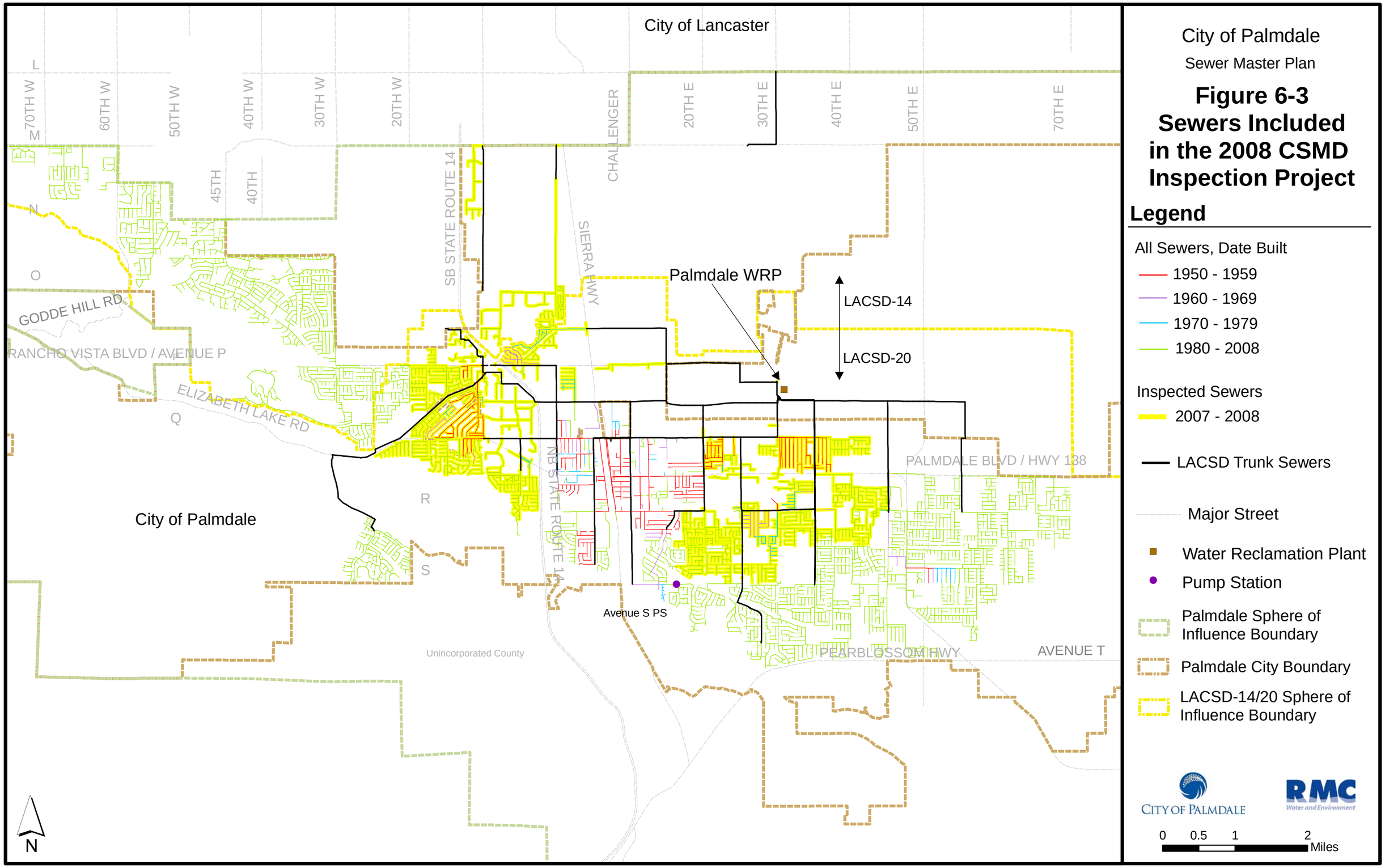
Approximately 62 miles of the City's sewer system were inspected by CSMD during 2008, using their accumulated capital outlay (ACO) funds. The inspected sewers are shown on Figure 6-3, which also indicates the decade of construction of all the sewers. It can be seen that the initial inspections included a sampling of pipes from various decades. Table 6-1 breaks down the 62 miles by decade of construction, indicating in the last column that the City's older pipes were well represented in the initial inspections; the percentage of pipes built in each of the decades of the 1950s, 1960s and 1970s that were inspected ranges from 25 to 30 percent. In addition, a large number of newer pipes built since 1980 were inspected. In all, 15.6 percent of the City's sewer system by length was inspected.

**Table 6-1: Maximum Structural Grades of Inspected Pipes**

| Year Constructed | 0 | 1 | 2 | 3 | 4 | 5 | Totals (ft) | Totals (miles) | % of Inspections | % of all pipes in age category |
|---|---|---|---|---|---|---|---|---|---|---|
| **1950-1959** | 20,148 | 2,890 | 6,613 | 13,167 | 5,480 | 0 | 48,297 | 9.1 | 14.8% | 26.6% |
| **1960-1969** | 13,782 | 350 | 309 | 0 | 0 | 0 | 14,441 | 2.7 | 4.4% | 25.8% |
| **1970-1979** | 14,632 | 774 | 0 | 0 | 280 | 0 | 15,686 | 3.0 | 4.8% | 29.3% |
| **1980-Present** | 238,117 | 4,473 | 3,392 | 804 | 1,112 | 206 | 248,103 | 47.0 | 76.0% | 13.8% |
| **Totals (ft)** | 286,680 | 8,487 | 10,313 | 13,971 | 6,872 | 206 | 326,528 | 61.8 | 100.0% | 15.6% |
| **Totals (miles)** | 54.3 | 1.6 | 2.0 | 2.6 | 1.3 | 0.0 | | | | |
| **% of all inspected pipe** | 87.8 | 2.6 | 3.2 | 4.3 | 2.1 | 0.1 | | | | |

Using the industry-standard PACP QSR Rating System, CSMD assigned all structural defects a condition grade from 1 to 5. RMC independently reviewed all pipes that had defects of Grade 4 or 5 and a random sampling of other pipes to verify the type and grade of each defect. Although the review confirmed the Grade 4 and 5 defects, it also identified two defects that had been assigned Grade 3 that were judged to actually be Grade 4 defects. Based on this finding, the independent review was expanded to include all pipes having Grade 3 defects, which encompassed 122 Grade 3 defects. The review identified 28 new Grade 4 defects that had originally been designated as Grade 3 or lower.

The adjusted results after independent review are shown in Table 6-1. The table shows the length of inspected pipe by the most severe defect observed, grouped by decade of construction. There was only a single Grade 5 defect found, and only 2.1 percent by length of the inspected sewers had one or more Grade 4 defects. This indicates that the City's gravity sewers are in very good condition. Also evident from the data is that the sewers built in the 1950s (Generation 2) are much more likely to have defects than newer sewers (Generation 3). For example, 11 percent of the inspected Generation 2 sewers by length had Grade 4 or 5 defects, compared with less than 1 percent of the Generation 3 sewers. Also, 37 percent of the Generation 2 sewers had Grade 3 defects, compared with less than 1 percent of Generation 3 sewers.


City of Palmdale
Sewer Master Plan
Figure 6-3
Sewers Included in the 2008 CSMD Inspection Project
Legend
All Sewers, Date Built
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 2008
Inspected Sewers
2007 - 2008
LACSD Trunk Sewers
Major Street
Water Reclamation Plant
Pump Station
Palmdale Sphere of Influence Boundary
Palmdale City Boundary
LACSD-14/20 Sphere of Influence Boundary
City of Lancaster
City of Palmdale
Unincorporated County
Palmdale WRP
LACSD-14
LACSD-20
Avenue S PS
GODDE HILL RD
RANCHO VISTA BLVD / AVENUE P
ELIZABETH LAKE RD
PALMDALE BLVD / HWY 138
PEARBLOSSOM HWY
AVENUE T
SB STATE ROUTE 14
NB STATE ROUTE 14
SIERRA HWY
CHALLENGER
70TH W
60TH W
50TH W
40TH W
30TH W
20TH W
20TH E
30TH E
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0 0.5 1 2 Miles
CITY OF PALMDALE
RMC Water and Environment

This finding suggests that the Generation 2 sewers will comprise the first major wave of repair/renewal/replacement projects for the City when they deteriorate further.

The findings from the initial inspections were extrapolated to entire system in Table 6-2, under the assumption that all pipes built in a decade are in similar condition as the inspected pipes built in that decade. Because the initial inspections included a good sampling of pipes built in all decades, the results of the extrapolation should be reasonably indicative of the overall condition of the City's system. The actual footage of sewers with Grade 4 and 5 defects that will be found after completion of inspection of the entire system, however, is likely to differ somewhat from the extrapolated footage because variables other than decade of construction can affect structural condition, including the quality of the original materials and construction as well as site-specific conditions.

**Table 6-2: Structural Grades for Entire System (Extrapolated)**

| Year Constructed | 0 | 1 | 2 | 3 | 4 | 5 | Totals (ft) | Totals (miles) | % of System |
|---|---|---|---|---|---|---|---|---|---|
| 1950-1959 | 75,849 | 10,881 | 24,894 | 49,568 | 20,629 | 0 | 181,821 | 34.4 | 8.7% |
| 1960-1969 | 53,379 | 1,356 | 1,197 | 0 | 0 | 0 | 55,931 | 10.6 | 2.7% |
| 1970-1979 | 49,922 | 2,640 | 0 | 0 | 956 | 0 | 53,517 | 10.1 | 2.6% |
| 1980-Present | 1,724,795 | 32,398 | 24,568 | 5,821 | 8,055 | 1,489 | 1,797,126 | 340.4 | 86.1% |
| Totals (ft) | 1,903,945 | 47,274 | 50,658 | 55,390 | 29,640 | 1,489 | 2,088,395 | 395.5 | 100.0% |
| Totals (miles) | 360.6 | 9.0 | 9.6 | 10.5 | 5.6 | 0.3 | | | |
| % of all pipe | 91.2 | 2.3 | 2.4 | 2.7 | 1.4 | 0.1 | | | |

Note that the extrapolation suggests that the system is in better condition overall than the sewers that were included in the initial inspections. This is due to the over-representation of older sewers in the initial inspections; 14.8 percent of the initial inspections were on Generation 2 sewers, which represent only 8.7 percent of the whole system. As a result, although some 6.5 percent of the inspected sewers had Grade 3 or worse defects, only 4.2 percent of the overall system is expected to have such defects. A remarkable 91.2 percent of the system is expected to have no structural defects at all.

## 6.4 Near-Term Repair/Renewal/Replacement Program

The pipes which had Grade 4 or 5 structural defects are listed in Table 6-3, with details on the pipe itself and the number and type of defects found, including the QSR. In all, there is one pipe with a Grade 5 defect and 26 pipes with one or more Grade 4 defects.

Table 6-3 includes a recommendation based on the methodology described in Section 6.2 and a review of the videos. For seven of the pipes, there is also a CSMD recommendation/status shown in bold. Those pipes, which were the only pipes in which CSMD had originally identified Grade 4 or 5 defects, had been referred to CSMD staff by the City for possible correction using ACO funds. As indicated, CSMD lined three of the pipes and has scheduled a fourth to be lined. The other three were judged by CSMD to not pose an immediate risk of failure and were recommended for re-inspection in 10 years. Note that the criteria used by CSMD for recommending repair/rehabilitation/replacement or re-inspection intervals are not known. It is noteworthy that the density of defects is low, as shown in the table. There is typically only one Grade 4/5 defect per pipe, and the density per 100 feet is well under the criteria of 2 that has been recommended, as shown in Figure 6-2. Thus, spot repairs would generally have been recommended rather than manhole-to-manhole rehabilitation or replacement if the Grade 4 defects had actually been critical Grade 5 defects.

**Table 6-3: Summary of Grade 4 and Grade 5 Defects from Initial Inspections**

| Upstream Manhole ID | Downstream Manhole ID | Location | Diam. (in) | Length (ft) | QSR | No of Grade 5 Defects | No of Grade 4 Defects | Grade 4/5 Defects per 100 ft | Year Built | Major Defects | Status/ Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994-0027 | 1994-0028 | SWEETBRIER ST | 8 | 205 | 4124 | 0 | 1 | 0.49 | 1954 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0066 | 1994-0068 | 22ND ST E | 8 | 133 | 4100 | 0 | 1 | 0.75 | 1954 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0072 | 1994-0071 | PUERTA AVE | 8 | 295 | 4232 | 0 | 2 | 0.68 | 1954 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0075 | 1994-0074 | PUERTA AVE | 8 | 280 | 4232 | 0 | 2 | 0.71 | 1954 | Fracture Longitudinal | Re-inspect in 5 years |
| 1994-0114 | 1994-0113 | ALLEY | 8 | 300 | 4111 | 0 | 1 | 0.33 | 1953 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0122 | 1994-0123 | FRONTIER AV | 8 | 300 | 4121 | 0 | 1 | 0.33 | 1953 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0123 | 1994-0124 | FRONTIER AV | 8 | 300 | 4131 | 0 | 1 | 0.33 | 1953 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0128 | 1994-0127 | 31ST ST E | 8 | 302 | 4131 | 0 | 1 | 0.33 | 1953 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0129 | 1994-0128 | 31ST ST E | 8 | 325 | 4132 | 0 | 1 | 0.31 | 1953 | Fracture Multiple | **Lined by CSMD** |
| 1994-0130 | 1994-0129 | 31ST ST E | 8 | 300 | 4112 | 0 | 1 | 0.33 | 1953 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0142 | 1994-0143 | GLENBUSH AV | 8 | 328 | 4131 | 0 | 1 | 0.30 | 1954 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0154 | 1994-0168 | POND AV | 8 | 300 | 4121 | 0 | 1 | 0.33 | 1956 | Fracture Multiple | Re-inspect in 5 years |
| 1994-0170 | 1994-0168 | POND AV | 8 | 22 | 4100 | 0 | 1 | 4.46 | 1955 | Fracture Multiple | **Lined by CSMD** |
| 1994-0179 | 1994-0183 | AVE Q-4 | 8 | 300 | 4232 | 0 | 2 | 0.67 | 1955 | Fracture Multiple | **Lined by CSMD** |
| 1995-0350 | 1995-0345 | AVE R-6 | 8 | 280 | 4100 | 0 | 1 | 0.36 | 1970 | Fracture Multiple | **To be lined by CSMD** |
| 1995-0448 | 1994-0153 | 32ND ST E | 8 | 305 | 4200 | 0 | 2 | 0.66 | 1956 | Fracture Multiple | Re-inspect in 5 years |
| 1995-0455 | 1995-0463 | AVE R-3 | 8 | 115 | 4100 | 0 | 1 | 0.87 | 1982 | Fracture Multiple | **Re-inspect in 5 years CSMD: 10 years** |
| 1995-0563 | 1995-0508 | APRICOT DR | 8 | 206 | 5100 | 1 | 0 | 0.49 | 1988 | Broken Soil Visible | **Re-inspect in 2 years CSMD: 10 years** |
| 1996-0034 | 1996-0033 | 29TH PL E | 10 | 300 | 4100 | 0 | 1 | 0.33 | 1982 | Fracture Multiple | Re-inspect in 5 years |
| 2047-0008 | 2047-0007 | 35TH ST E | 8 | 188 | 4131 | 0 | 1 | 0.53 | 1956 | Fracture Multiple | Re-inspect in 5 years |
| 2047-0023 | 2047-0022 | 36TH ST E | 8 | 300 | 4121 | 0 | 1 | 0.33 | 1955 | Fracture Multiple | Re-inspect in 5 years |
| 2047-0032 | 2047-0033 | LANDON AVE | 8 | 345 | 433B | 0 | 3 | 0.87 | 1955 | Broken | Re-inspect in 5 years |
| 2047-0033 | 2047-0034 | LANDON AVE | 8 | 300 | 4131 | 0 | 1 | 0.33 | 1955 | Fracture Multiple | Re-inspect in 5 years |
| 2048-0001 | 2047-0028 | LANDON AV | 8 | 350 | 4100 | 0 | 1 | 0.29 | 1956 | Fracture Multiple | Re-inspect in 5 years |
| 2048-0346 | 2048-0347 | JANUS DR | 8 | 348 | 4100 | 0 | 1 | 0.29 | 1987 | Broken | **Re-inspect in 5 years CSMD: 10 years** |
| 2048-0382 | 2048-20-0663 | PALMDALE BVLD | 15 | 377 | 4131 | 0 | 1 | 0.27 | 1988 | Fracture Multiple | Re-inspect in 5 years |
| 2048-0383 | 2048-0382 | PALMDALE BVLD | 15 | 350 | 4121 | 0 | 1 | 0.29 | 1988 | Fracture Multiple | Re-inspect in 5 years |

The recommendation for all the Grade 4 defects is to re-inspect the pipe in 5 years, with the exception of those that CSMD has lined or plan to line. With respect to the single Grade 5 defect found, CSMD recommended only re-inspection in 10 years because the defect is near the upstream terminus of a line and there are no connections upstream of the defect and therefore no flow in the pipe at that location. A failure would thus not result in a spill. Due to these extenuating circumstances, we concur that a repair is not needed at this time, but recommend a re-inspection and re-assessment in 2 years rather than 10 years since a failure could still have impacts even if an SSO does not occur.

In conclusion, there are no pipes recommended for repair/renewal/replacement at this time based on the assessment of the initial 62 miles of inspections.

## 6.5 Future Inspection Program

An additional 54 miles of sewer video inspections were performed by CSMD in 2009, and the results are expected to be provided to the City by mid-2009. The findings from these inspections should be assessed using the methodologies presented in this chapter. The remaining 280 miles of sewer should be inspected over the next ten years. Re-inspections should proceed based on the observed structural conditions as described in Section 6.2 and Figure 6-2. It is noted that the City will need to perform additional video inspections for other purposes, such as investigating blockages and SSOs and spot checking the quality of sewer cleaning.

In scheduling the remaining inspections, priority should be given to older sewers (due to the higher likelihood of structural defects) and larger sewers (due to their higher impact of failure). In addition, sewers with known maintenance problems should also be inspected sooner, as that will help the City better understand the nature of the problems in those pipes and will provide information that will allow the City to refine its maintenance program. It is also likely that structural problems in those sewers may be contributing to high maintenance in some cases, and correcting those structural problems may also lessen maintenance requirements.

Based on those considerations, all of the City's uninspected sewers have been placed in four priority categories as defined below and shown in Figure 6-4 (and included in a GIS database for future use by the City).

- Priority 1 (17.4 miles): CSMD maintenance hot spots and all pipes 15 inches in diameter or larger
- Priority 2 (46.0 miles): Sewers that were requested for cleaning by CSMD crews since 2005
- Priority 3 (14.5 miles): All other sewers built before 1970
- Priority 4 (202.3 miles): All other sewers built after 1970
- Inspected Sewers (115.3 miles): Pipes already inspected by CSMD in 2008 and 2009

Since it is expected that any major defects that may exist in the system will be found in the Priority 1, 2, and 3 sewers, the City should plan to complete those 78 miles of inspections within the next two to three years.

In addition to first-time inspections, the City should plan to re-inspect sewers based on the recommended frequencies from Figure 6-2. Although the annual amount of re-inspection will depend on the conditions found in the initial and subsequent inspections, a long-term estimate based on the conditions observed to-date is about 22 miles per year. Because the system is in very good condition, a high percentage of the pipes will be on a 20-year cycle, and those re-inspections account for about 18.5 miles per year out of the 22 miles total. The annual re-inspection mileage can be expected to increase gradually over time as new sewers are built and as existing sewers deteriorate and require more frequent inspections.

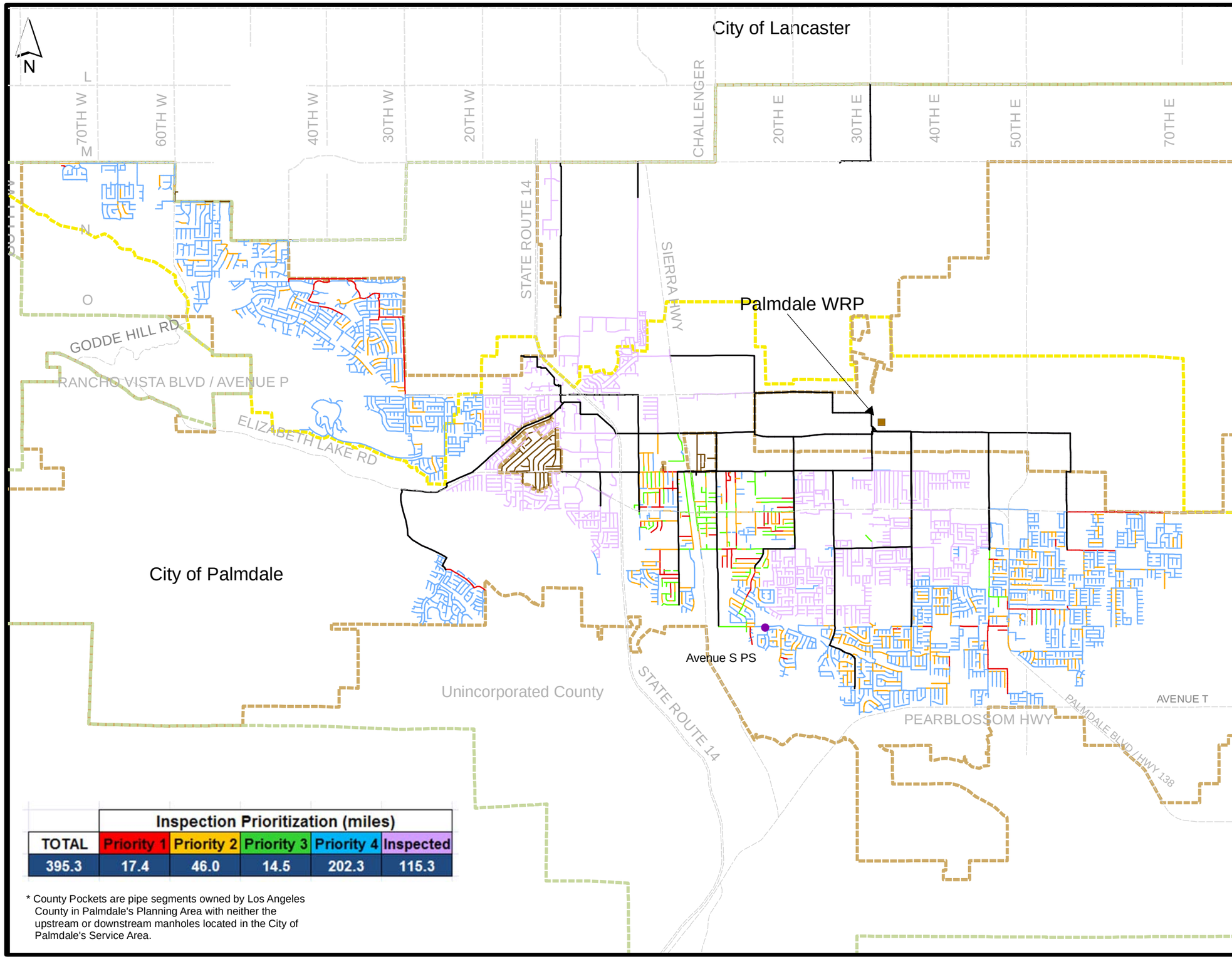
## 6.6 Long-Term Renewal/Replacement Projections

The inspection and assessment methods described above are appropriate for making near-term repair/renewal/replacement decisions based on the observed structural condition. Over the long-term, the condition of all sewers will degrade and eventually they will need to be renewed or replaced. This section provides estimates of long-term renewal and replacement budgetary needs based on the footage of City sewers built in various years, assumptions on sewer service lives, and unit costs for renewal/replacement.

City of Palmdale

Sewer Master Plan

# Figure 6-4
# CCTV Inspection Prioritization




| | Inspection Prioritization (miles) | | | | |
|---|---|---|---|---|---|
| TOTAL | Priority 1 | Priority 2 | Priority 3 | Priority 4 | Inspected |
| 395.3 | 17.4 | 46.0 | 14.5 | 202.3 | 115.3 |

* County Pockets are pipe segments owned by Los Angeles County in Palmdale's Planning Area with neither the upstream or downstream manholes located in the City of Palmdale's Service Area.

## Legend

**Pipe Inspection Priority**

- Priority 1 - Hot Spots & >15" DIA. Pipes
- Priority 2 - Requested Cleaning Pipes
- Priority 3 - Pre-1970 Const. Pipes
- Priority 4 - Post-1970 Const. Pipes
- Inspected Pipes
- LACSD Trunk Sewers
- Other Agency Sewer and County Pockets *
- Water Reclamation Plant
- Pump Station
- Palmdale Sphere of Influence Boundary
- Palmdale City Boundary
- LACSD-14/20 Sphere of Influence Boundary

CITY OF PALMDALE

RMC Water and Environment

0 0.5 1 2 Miles

### 6.6.1 Sewer Service Life

The basis for projecting long-term renewal/replacement needs is the estimated service lives (useful lives) of the sewers. For the purposes of this study, service life is considered to be the age at which deterioration and defect accumulation result in a decision to perform a corrective action on the sewer in the form of a manhole-to-manhole renewal or replacement project. Spot repairs are not considered in this long-term projection, although they will be performed on many pipes to avoid premature failures and extend service lives.

Service life varies by pipe material, and the values in Table 6-4 are considered to be conservative estimates for common pipe materials. Since the City's system is almost 99 percent clay pipe, only the last two values in the table are significant (80 or 100 years).

**Table 6-4: Assumed Average Service Life of Sewer Pipe Materials**

| Pipe Material | Average Service Life (yrs) |
|---|---|
| Cast Iron (CIP) | 50 |
| Ductile Iron (DIP) | 50 |
| Polyvinyl Chloride (PVC) | 90 |
| Reinforced Concrete (RCP) | 50 |
| Vitrified Clay (pre-1959) | 80 |
| Vitrified Clay (post-1959) | 100 |

The actual service life of any given pipe will vary from the average value shown in Table 6-4. Some pipes will fail before the average service life is reached while others will fail long after. To reflect this fact, the probability of early or late failure has been included in this projection, as depicted in the curve on Figure 6-5. In this probability curve, 5 percent of the pipes are assumed to fail 30 years early or late, 10 percent are assumed to fail 20 years early or late, 20 percent are assumed to fail 10 years early or late, and 30 percent are assumed to fail when they reach their average service life. For example, sewers built in 1955 would be expected to fail in 2035, but some may fail as early as 2005 or as late as 2065.

The actual service life and the failure probability curve for the City's sewers is in fact unknown since there have been no failures to-date and the oldest sewers are just now reaching the early failure points based on these assumptions. Over the long term, the City should be able to refine these assumptions as failures occur from the failure database they will be establishing with this program. Although some cities with older sewers have begun to refine their service life assumptions based on observed failure rates, the transferability of such data to other cities is questionable unless location and sewer characteristics are very similar. The City should develop a philosophy and tracking mechanism to begin the process of defining the useful lives of its collection system pipes based upon materials, maintenance results, repair results and pipe system environment. This can be accomplished by tracking actual dates of failure by pipe segment, results of repairs and their effect on extending useful lives. This data should be maintained in a database to facilitate future analysis.

The term "failure" as used here to describe the end of a sewer's service life is somewhat different than the definition provided in the PACP standard and used earlier in this chapter: when the pipe can no longer convey the pipe design capacity. In the case of the latter, a point repair is a viable option to address an actual or imminent failure. In fact, point repairs may be performed to defer manhole-to-manhole projects, and thus extend service lives. This long-term projection does not attempt to quantify the cost and life-extending effect of point repairs, but simply assigns services lives and costs to perform manhole-to-manhole renewal/replacement projects. The City should budget for spot repairs as part of its annual O&M budget. A reasonable estimate for the next few years is 20-30 point repairs at a unit cost of $5,000.

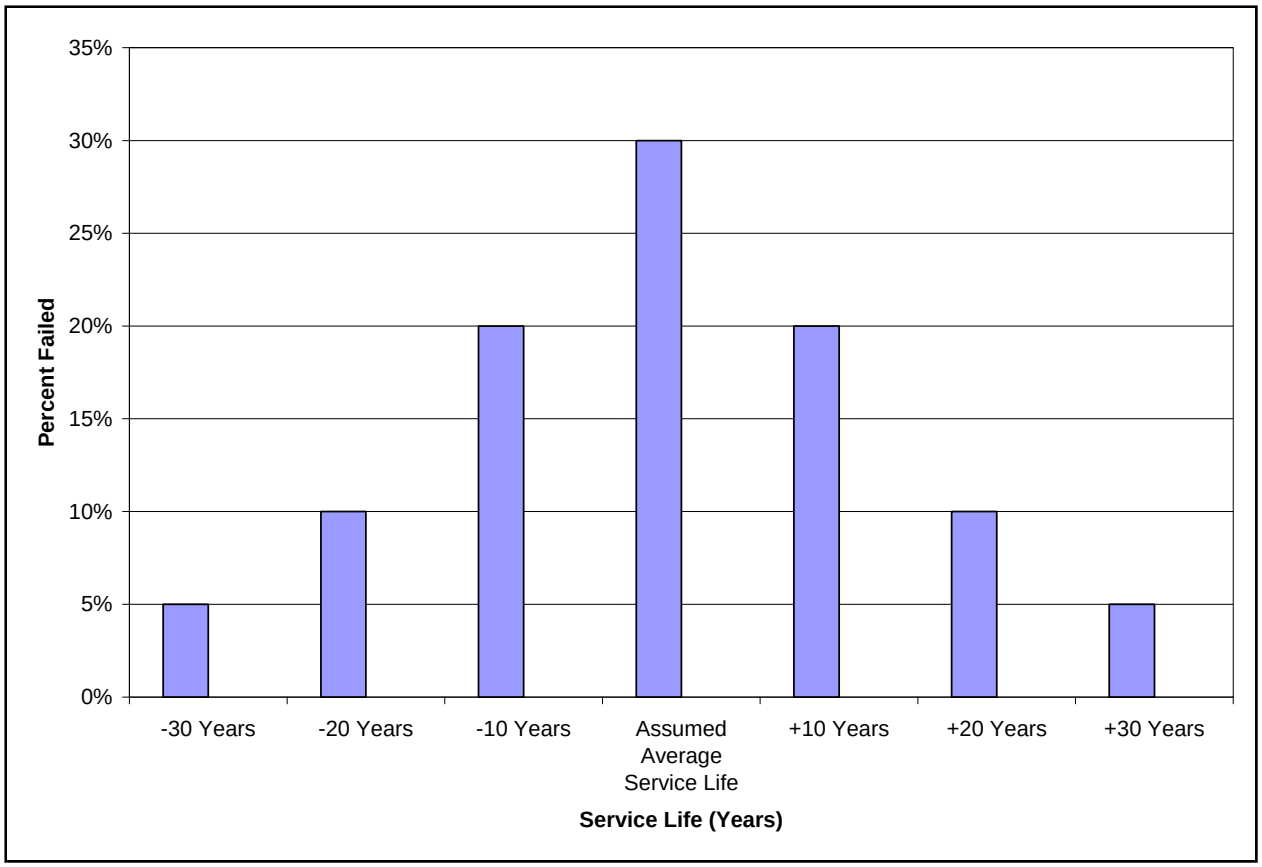



**Figure 6-5: Assumed Sewer Failure Probability Curve**

### 6.6.2 Long-term Renewal/Replacement Projection

This long-term renewal/replacement projection analysis estimates the length of sewer that will fail each year in the future, based on the characteristics of the sewers (diameter, length, material, and year of construction of each manhole-to-manhole pipe) and the assumptions on service life and failure probability curves described above. The cost associated with renewal/replacement of failed sewers is estimated based on unit costs and assumptions as to the methods that will be used. These assumptions include:

1. At the end of the useful life, the pipe will be either lined or replaced by pipe bursting or open-cut replacement. This analysis does not consider the service life and replacement of the new sewer.
2. The percentage of pipes that are lined, pipe burst, or replaced will vary by diameter. These percentages are defined in Table 6-5. Lining and pipe bursting are considered to be cost-effective alternatives to open cut replacement in most situations, and are therefore assumed to be used 70 to 80 percent of the time.
3. The unit cost per foot of renewal/replacement will vary by diameter, assuming typical pipe depths. These construction costs, including manhole replacement, are also shown in Table 6-5. These costs exclude any costs for renewal/replacement of privately-owned laterals (neither upper nor lower laterals) but does include the cost of reconnection of all existing laterals identified during construction.
4. A 6-inch or smaller pipe will be replaced with an 8-inch diameter pipe (a minor issue due to very little 6-inch pipe in the City).

**Table 6-5: Allocation and Unit Construction Costs of Renewal/Replacement Methods**

| Diameter | Lining Rehabilitation | | Pipe Bursting | | Open Cut Replacement | |
|---|---|---|---|---|---|---|
| (in) | Percent | $/LF | Percent | $/LF | Percent | $/LF |
| 8* | - | | 80 | 160 | 20 | 235 |
| 10 | - | | 70 | 165 | 30 | 240 |
| 12 | - | | 70 | 170 | 30 | 245 |
| 14 | 70 | 250 | - | | 30 | 310 |
| 15 | 70 | 250 | - | | 30 | 310 |
| 16 | 70 | 270 | - | | 30 | 335 |
| 18 | 70 | 270 | - | | 30 | 335 |
| 20 | 80 | 290 | - | | 20 | 360 |
| 21 | 80 | 290 | - | | 20 | 360 |
| 24 | 80 | 310 | - | | 20 | 385 |
| 27 | 80 | 330 | - | | 20 | 410 |

Note: Costs include mobilization, demobilization, excavation, backfill, shoring, pavement, lateral reconnection (without lateral replacement) on 12-inch and smaller pipes, traffic control, dewatering, bypass pumping, manhole replacement, and all other costs associated with pipe construction. Costs are in 2008 dollars, ENR Construction Cost Index 9410.
* All pipe smaller than 8 inches in diameter will be replaced with 8-inch pipe.

Using these assumptions, estimates of the long-term renewal/replacement needs for the City's sewer system are presented in Figures 6-6 and 6-7. Figure 6-6 shows the projected length of pipe failure in each year. Figure 6-6 shows the resulting annual and cumulative capital cost for renewal/replacement of failed pipes. The capital cost includes an allowance of 25 percent over the construction costs listed in Table 6-5 for engineering and other administrative and legal costs.

The main conclusions from this long-term renewal/replacement analysis are:

- The oldest sewers in the City have not yet reached their estimated average service life, but some early failures should have started to occur by 2003. The initial video inspections performed to-date did not find any widespread failures, but a few pipes were determined by CSMD to warrant lining. If more Grade 5 defects are found in future inspections, spot repairs of isolated defects will likely be adequate to defer the need for extensive manhole-to-manhole renewal/replacement for several years. The City should budget for up to 30 spot repairs per year, and include $150,000 in its annual O&M budget for that purpose.
- The estimated annual capital costs for renewal/replacement (excluding repairs) over the next 50+ years (2010 to 2060) averages about $1.2 million (all costs are in 2008 dollars). In the first decade (2010 to 2019, including pre-2010 backlog), the annual cost is about $0.6 million. The cost rises to $0.8 million in the following decade, and then remains at about $1.5 million for the following three decades. By 2060, almost all of the 34 miles of the City's Generation 2 sewers (built before 1959) will be over 100 years old and will have been renewed/replaced based on the assumptions in this analysis. A total of 52 miles of sewer would have been renewed/replaced at a total cost of $61 million.
- The actual costs the City can expect to incur over the next 50 years are highly sensitive to the service life assumptions for Generation 2 sewers and the effectiveness of ongoing maintenance and spot repairs in extending those service lives.

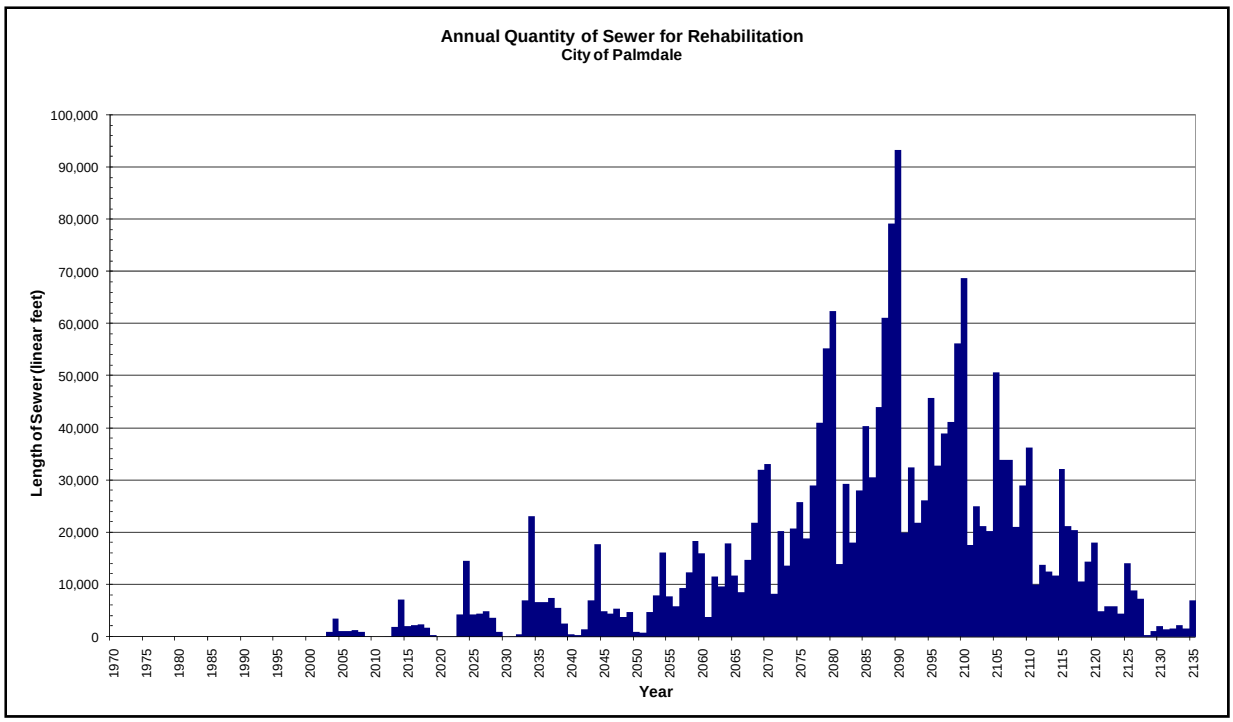



**Figure 6-6: Projected Length of Sewer Failures**

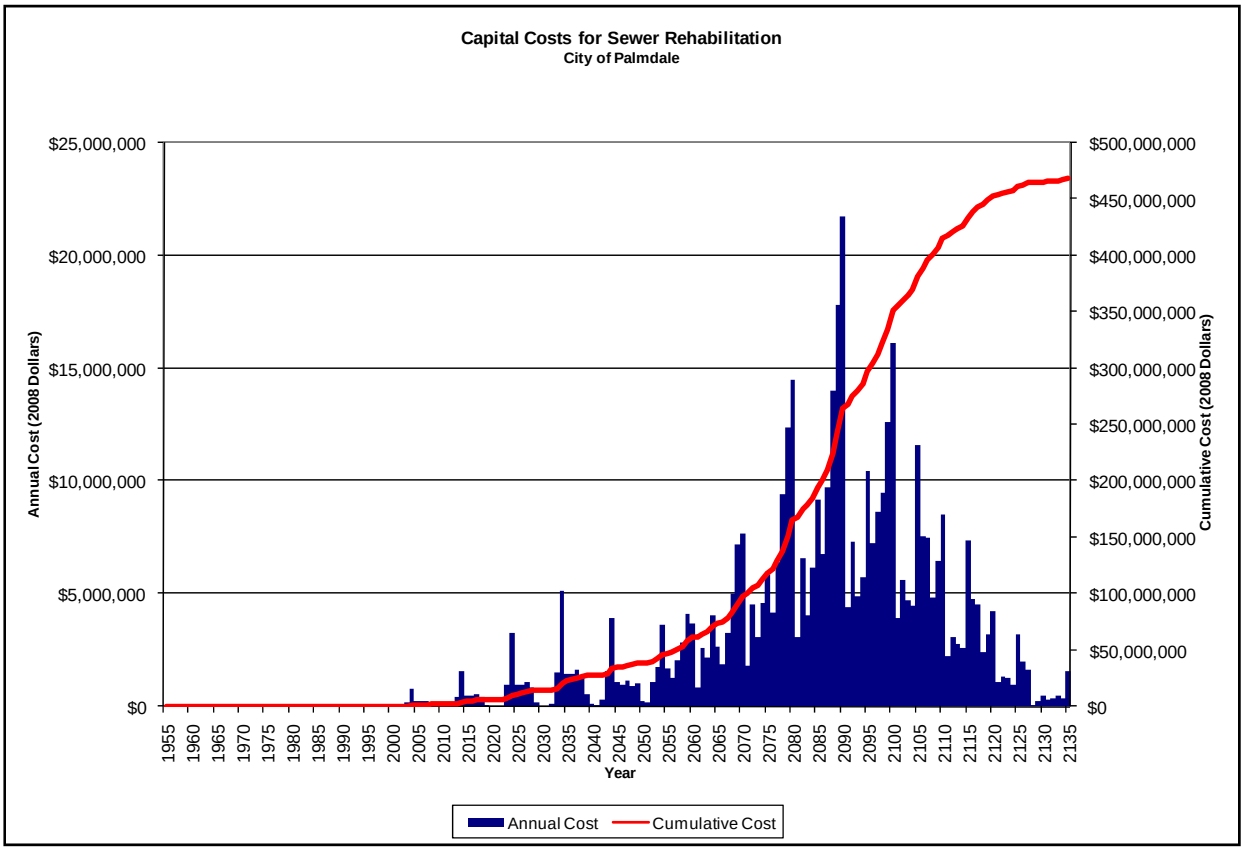



**Figure 6-7: Projected Annual and Cumulative Capital Costs for Sewer Renewal/Replacement**

- A prudent approach for the City at this time would be to establish an annual repair/renewal/replacement budget of $0.6 to $1.2 million (in addition to the cost of inspection/assessment), and to periodically reassess this budget based on observed conditions from the ongoing video inspection program as well as actual costs for renewal/replacement work performed. These funds should be collected and deposited in a sinking fund each year irrespective of the actual construction done, to be available in years when costs exceed sewer service revenue. The funds should be earmarked as available only for repair/renewal/replacement and not for normal operating expenses or other non-sewer related city operating costs. The City Council should formalize this process through a written policy statement or ordinance provision establishing the sanitary sewer replacement sinking fund to protect the accumulated reserves and to define the needs and allowable uses for the funds now and into the future.

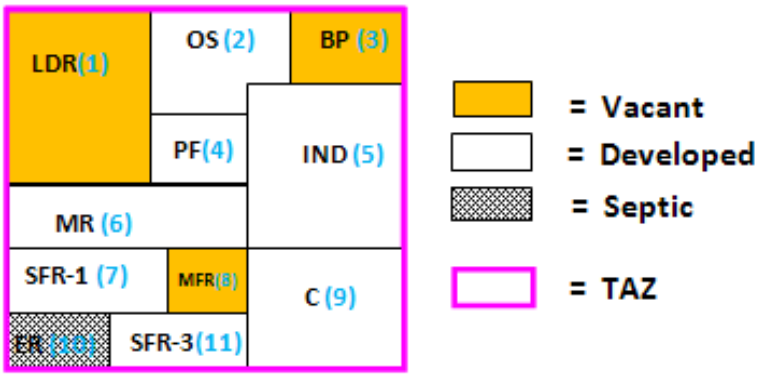
# Appendix A - Landuse and Population Geoprocessing Methodology

This appendix illustrates the steps involved in calculating existing and future residential and non-residential flows. The examples shown cover the 2006, 2030, and Buildout scenario processes.

## 2006 Scenario

The example TAZ below shows developed, vacant, and septic parcels grouped by zoning category, the result of intersecting the TAZ, zoning, parcel, and developed area GIS files. There are 11 parcel groups (blue IDs), of which 8 are developed (one of which is on septic) and 3 are vacant.

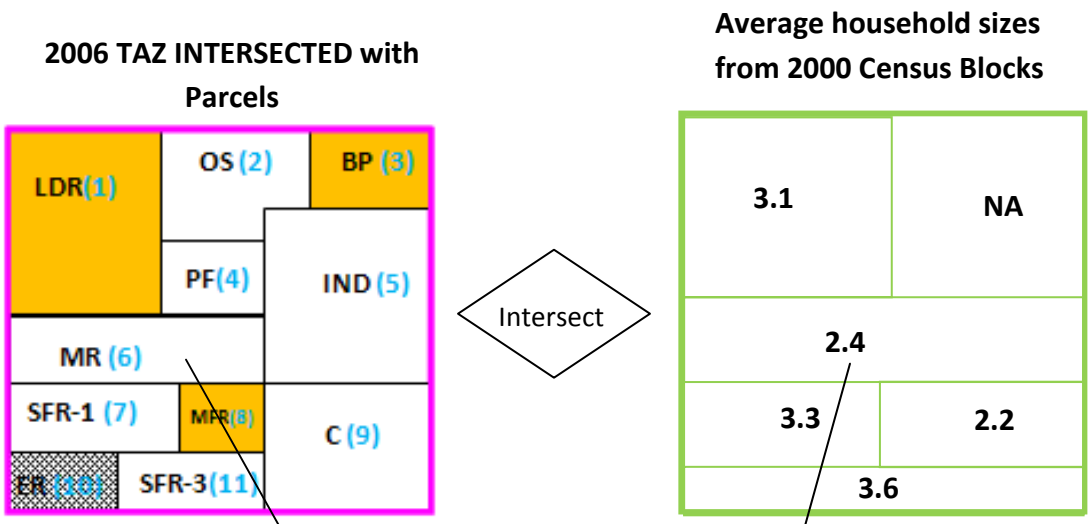
**2006 TAZ INTERSECTED with Parcels**




The single family (SF) and multi-family (MF) residential units specified by the City in the TAZ database were distributed to developed parcels. The table below shows the distribution process. For example, the 100 MF units in this TAZ are distributed to parcel group 6, which consists of 40 acres. Since only one developed MF group is present, all 100 units go to parcel group 6. The 289 SF units are distributed to parcel groups 7, 10, and 11. More units are distributed to group 11 (161 units) than to group 7 (119 units) because its general planning category had a higher density (3.4 vs. 2.5 du/ac). Note that units are not distributed to vacant or non-residential parcels. Septic units are not included in the 2006 model. Employee counts are distributed by simple area weighting to only industrial, commercial or public facility parcels. In this example, employee counts do not get distributed to opens space (OS) landuse.

| TAZ Fields | | | | | Parcel / Landuse Fields | | | | | | Calculation Fields | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAZ Id | SF Units | MF Units | R (Retail Employees | NR (Non-Retail Employees | Parcel Grp Id | General Plan Category | Developed or Vacant in 2006 | TAZ Land Use Type | Average Density (du/acre) | Parcel Group Area (acres) | Area * Density | Sum (Area * Density: MF,SF); (Area: R, NR) | Distributed Resi-dential Units | Distributed Employees |
| 930 | 289 | 100 | 400 | 54 | (2) | OS | Developed | NR | NA | 20 | NA | NA | NA | NA |
| | | | | | (4) | PF | Developed | NR | NA | 15 | NA | 55 | NA | 15 |
| | | | | | (5) | IND | Developed | NR | NA | 40 | NA | 55 | NA | 39 |
| | | | | | (6) | MR | Developed | MF | 10 | 40 | 400 | 400 | 100 | NA |
| | | | | | (7) | SFR-1 | Developed | SF | 2.5 | 30 | 75 | 183 | 119 | NA |
| | | | | | (9) | C | Developed | R | NA | 40 | NA | 40 | NA | 400 |
| | | | | | (10) | ER | Septic | SF | .4 | 15 | 6 | 183 | 9 | NA |
| | | | | | (11) | SFR-3 | Developed | SF | 3.4 | 30 | 102 | 183 | 161 | NA |

The distributed residential units are multiplied by the average household size to get the population. The average household size for each parcel is estimated by intersection with the 2000 Census block data.

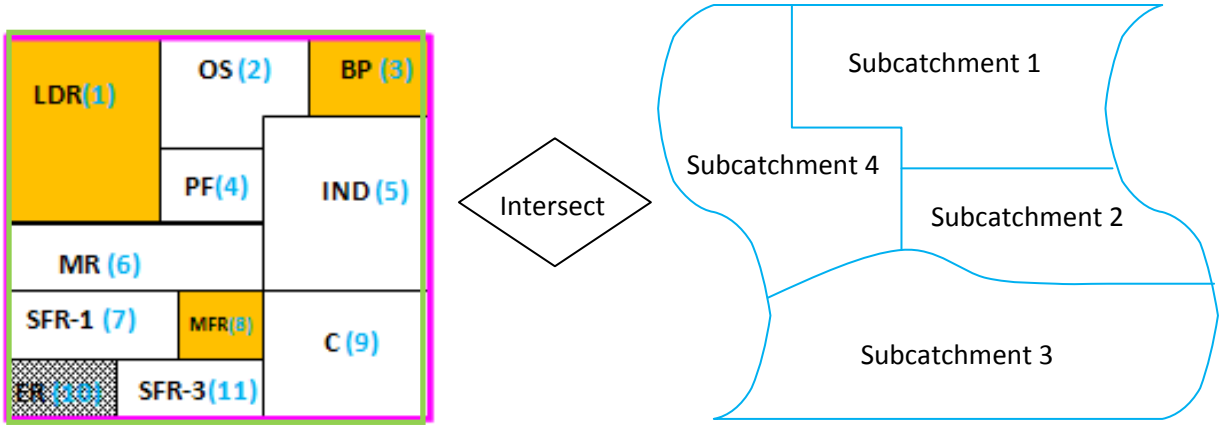



| Parcel Group Id | Residential Units | Census Block Average Household Size | 2006 Population |
|---|---|---|---|
| (2) | NA | NA | NA |
| (4) | NA | NA | NA |
| (5) | NA | NA | NA |
| (6) | 100 | 2.4 | 240 |
| (7) | 119 | 2.2 | 262 |
| (9) | NA | NA | NA |
| (10) | 9 | 3.6 | 32 |
| (11) | 161 | 3.6 | 580 |

For simplicity in this example, the entire parcel group is indicated as having a single average household size. The computations, however, are performed at the individual parcel level – different parcels in the same parcel group (in the same TAZ and having the same zoning category) could have different household sizes if they are in different census blocks.

Flows from non-residential areas were based on the area-weighted distribution of the retail and non-retail employee counts. The flow is based on the employee count and the gallons per employee flow rate developed during calibration.

The final step is to distribute and aggregate the parcel populations (and the non-residential employee counts) to subcatchments by intersection with the subcatchment boundary file. Area-weighting is used in cases where a parcel lies partially in two or more subcatchments.

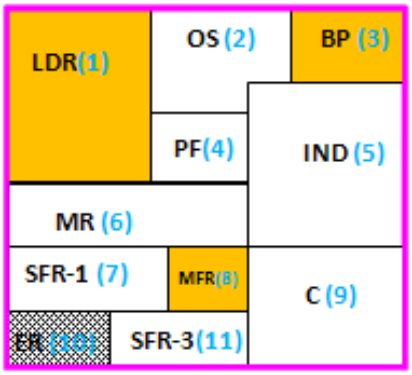


## 2030 Scenario

For the 2030 Scenario, the incremental housing units and employee counts specified in the TAZ database are distributed to the vacant parcels. Then, the incremental populations and employment counts areas are added to the 2006 Scenario values and aggregated to the subcatchments as shown for the 2006 Scenario above. Any population in septic areas is also added to the 2006 Scenario values.

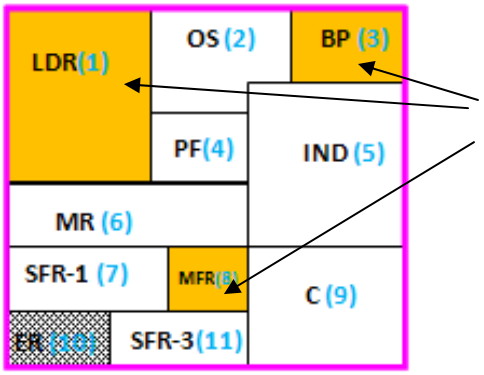
In this example, the 2006 TAZ data did not include any Special Trip Generators, but the 2030 data did for the specific automobile showroom parcels within the Business Park (group 3). The Special Trip Generators' exact locations are generally indicated in the Special Trip Generator table. This allows the Special Trip Generator employees to be loaded to the exact parcel that they are located in and then added to any retail or non-retail employees already within that parcel. For this example, 50 Special Trip Generator employees are added to the 46 employees located within parcel group 3. A total of 96 employees are aggregated to subcatchment 1 from parcel group 3.

**2030 TAZ INTERSECTED with Parcels**




| TAZ Incremental Units 2006- 2030 | | | | | | Parcel / Landuse Fields | | | | | | Calculation Fields | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAZ Id | SF Units | MF Units | R (Retail Employees) | NR (Non-Retail Employees | STGs | Parcel Grp Id | General Plan Category | Developed or Vacant in 2006 | TAZ Land Use Type | Average Density (du/acre) | Parcel Group Area (acres) | Area * Density | Sum (Area * Density: MF,SF); (Area: R, NR) | Distributed Resi-dential Units | Distributed Employees |
| 930 | 78 | 160 | 0 | 46 | 50 | (1) | LDR | Vacant | SF | 1 | 50 | 50 | 50 | 78 | NA |
| | | | | | | (3) | BP | Vacant | NR | NA | 15 | NA | 15 | NA | 46 |
| | | | | | | (3) | BP | Vacant | NR | NA | 15 | NA | NA | NA | 50 |
| | | | | | | (8) | MFR | Vacant | MF | 16 | 30 | 480 | 480 | 160 | NA |

## Buildout Scenario




*Buildout residential units and employee counts specified for each TAZ are distributed to all vacant parcels.*

For the Buildout Scenario, the incremental housing units and employee counts specified in the TAZ database are distributed to the vacant parcels. Then, the incremental populations and employment counts areas are added to the 2006 Scenario values and aggregated to the subcatchments as shown for the 2006 Scenario above. Any population in septic areas is also added to the 2006 Scenario values.

The Buildout Scenario takes the total number of incremental housing units specified in the TAZ database and distributes them to every vacant parcel within the TAZ based on the average general plan densities. This approach assumes that almost all of the existing areas are built out already and new growth within the City's core would likely go into any existing vacant areas. The table below shows the results of the distribution process.

Buildout non-residential flows are computed assuming development of the entire area of all vacant non-residential parcels. The total number of retail employee and non-retail employee counts specified in the TAZ database is distributed to vacant retail and non-retail designated parcels. Special Trip Generators are added just as they were for the 2030 scenario.

| TAZ Incremental Units 2006- Buildout | | | | | | Parcel / Landuse Fields | | | | | | Calculation Fields | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAZ Id | SF Units | MF Units | R (Retail Employees) | NR (Non-Retail Employees | STGs | Parcel Grp Id | General Plan Category | Developed or Vacant in 2006 | TAZ Land Use Type | Average Density (du/acre) | Parcel Group Area (acres) | Area * Density | Sum (Area * Density: MF,SF); (Area: R, NR) | Distributed Resi-dential Units | Distributed Employees |
| 930 | 100 | 160 | 0 | 120 | 50 | (1) | LDR | Vacant | SF | 1 | 50 | 50 | 50 | 100 | NA |
| | | | | | | (3) | BP | Vacant | NR | NA | 15 | NA | 15 | NA | 120 |
| | | | | | | (3) | BP | Vacant | NR | NA | 15 | NA | NA | NA | 50 |
| | | | | | | (8) | MFR | Vacant | MF | 16 | 30 | 480 | 480 | 160 | NA |

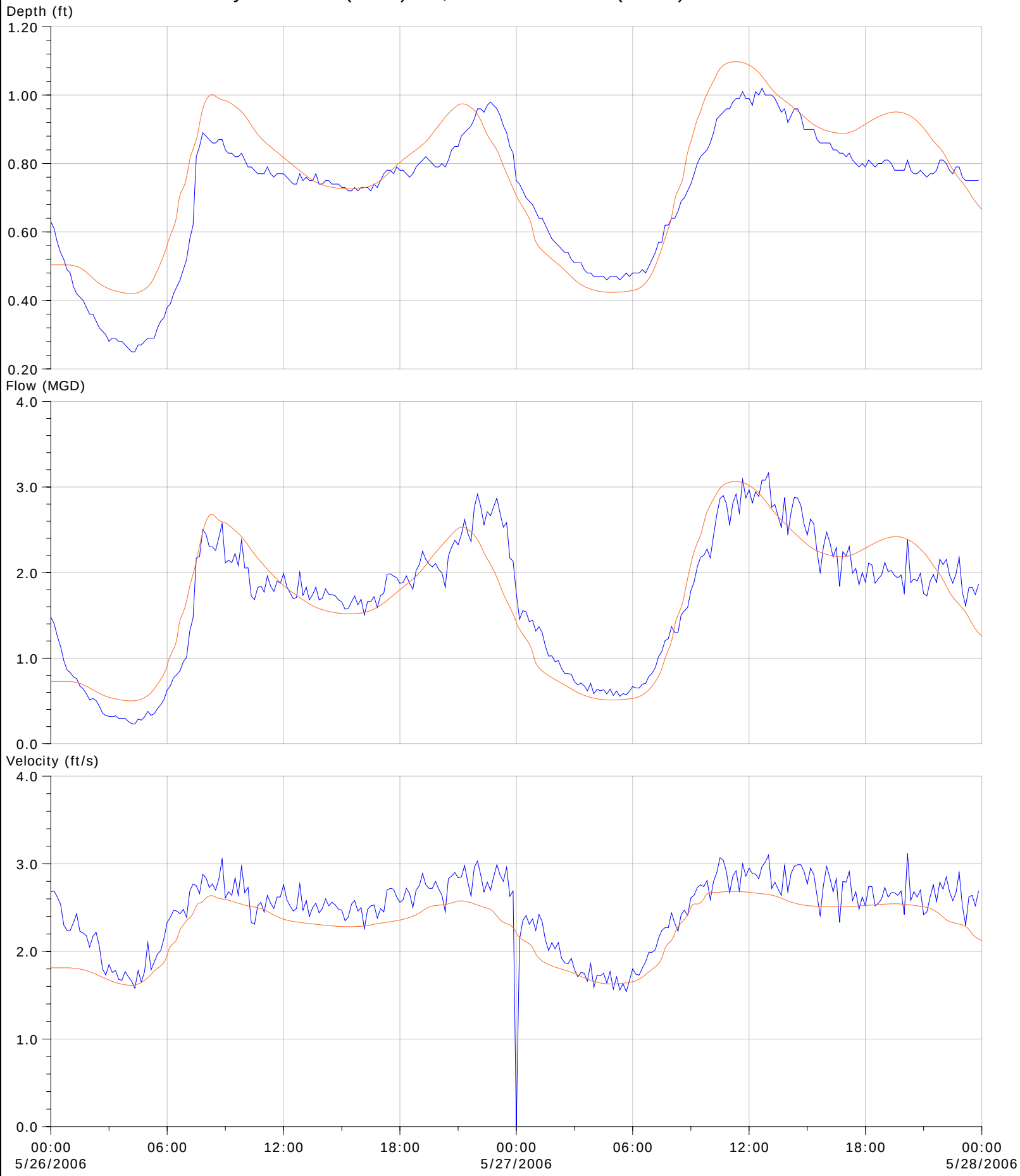
# Appendix B - Dry Weather Calibration Summary Table

| Flow Survey | Calibration Usable | Meter ADWF (MGD) | Model ADWF (MGD) | ADWF % Diff | Wkday Meter ADWF | Wkday Model ADWF | Wkday ADWF % Diff | Wkday Meter PDWF | Wkday Model PDWF | Wkday PDWF % Diff | Wknd Meter ADWF | Wknd Model ADWF | Wkend ADWF % Diff | Wknd Meter PDWF | Wknd Model PDWF | Wknd PDWF % Diff | < 20% Diff | < 10% Diff | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | Y | 1.70 | 1.70 | 0.40 | 1.60 | 1.62 | 1.07 | 2.92 | 2.68 | -8.13 | 1.79 | 1.79 | -0.20 | 3.16 | 3.06 | -3.17 | Y | Y | |
| 103 | Y | 0.06 | 0.08 | 32.40 | 0.07 | 0.08 | 10.35 | 0.15 | 0.14 | -4.14 | 0.05 | 0.08 | 65.15 | 0.09 | 0.14 | 47.90 | Y | N | |
| 123 | Y | 0.05 | 0.06 | 20.18 | 0.05 | 0.06 | 31.05 | 0.09 | 0.09 | 1.93 | 0.06 | 0.06 | 11.27 | 0.11 | 0.11 | -1.81 | N | N | |
| 146 | Y | 0.37 | 0.41 | 12.64 | 0.36 | 0.41 | 14.17 | 0.58 | 0.78 | 35.25 | 0.37 | 0.41 | 11.15 | 0.65 | 0.70 | 8.00 | Y | N | |
| 157 | Y | 0.15 | 0.17 | 10.30 | 0.13 | 0.17 | 28.12 | 0.27 | 0.32 | 19.55 | 0.18 | 0.17 | -3.09 | 0.28 | 0.29 | 3.71 | N | N | |
| 163 | Y | 0.11 | 0.09 | -10.59 | 0.11 | 0.09 | -12.67 | 0.25 | 0.16 | -36.56 | 0.10 | 0.09 | -8.40 | 0.25 | 0.16 | -36.19 | Y | N | Reviewed tributary area and it looks ok, added .08 MGD as missing TQ to SC 1942-20-0167A. |
| 173 | Y | 0.09 | 0.08 | -9.55 | 0.09 | 0.08 | -9.03 | 0.25 | 0.16 | -38.44 | 0.09 | 0.08 | -10.05 | 0.24 | 0.14 | -44.35 | Y | Y | Add 10 gpcd |
| 198 | Y | 0.56 | 0.55 | -2.79 | 0.66 | 0.55 | -17.38 | 1.16 | 0.86 | -25.96 | 0.46 | 0.55 | 18.08 | 1.11 | 0.91 | -17.38 | Y | N | |
| 207 | Y | 0.42 | 0.34 | -18.84 | 0.42 | 0.34 | -18.90 | 0.60 | 0.50 | -15.98 | 0.42 | 0.34 | -18.79 | 0.69 | 0.54 | -22.12 | Y | N | Added .1 MGD (.05 as missing TQ and .05 as missing base flow to SC 1995-20-0211). Although there appears to be no cross-connection flows between the two parallel lines, the total volume modeled at 207 and 269 matches the total metered flow. |
| 213 | Y | 0.26 | 0.21 | -20.61 | 0.26 | 0.21 | -19.09 | 0.41 | 0.32 | -20.96 | 0.27 | 0.21 | -22.08 | 0.49 | 0.35 | -28.71 | Y | N | Added .01 MGD (.05 as missing TQ and .05 as missing Add. DWF from school) |
| 254 | Y | 0.30 | 0.36 | 19.15 | 0.30 | 0.36 | 22.16 | 0.44 | 0.56 | 28.00 | 0.31 | 0.36 | 16.27 | 0.59 | 0.59 | 1.48 | N | N | |
| 263 | Y | 0.17 | 0.17 | -0.25 | 0.17 | 0.17 | -0.34 | 0.29 | 0.26 | -8.38 | 0.17 | 0.17 | -0.17 | 0.32 | 0.28 | -13.67 | Y | Y | |
| 269 | Y | 0.82 | 0.90 | 9.66 | 0.78 | 0.90 | 14.69 | 1.52 | 1.41 | -7.82 | 0.85 | 0.89 | 5.06 | 1.53 | 1.47 | -4.09 | Y | N | |
| 284 | Y | 0.55 | 0.56 | 2.89 | 0.55 | 0.56 | 2.86 | 1.04 | 0.88 | -14.73 | 0.55 | 0.56 | 2.92 | 0.98 | 0.92 | -6.23 | Y | Y | Bump to Residential per capita flow to 70 gpcd |
| 310 | Y | 0.38 | 0.44 | 14.18 | 0.37 | 0.44 | 19.45 | 0.67 | 0.69 | 2.18 | 0.40 | 0.44 | 9.35 | 0.73 | 0.73 | 0.39 | Y | N | Added .1 ADWF / Changed all prfiles to Adj Wkday / Wkend but maintained gpcd |
| 333 | Y | 1.25 | 1.17 | -6.15 | 1.24 | 1.10 | -11.44 | 2.03 | 2.06 | 1.33 | 1.26 | 1.24 | -0.93 | 2.07 | 2.17 | 5.08 | Y | N | |
| 339 | Y | 0.67 | 0.67 | -0.44 | 0.62 | 0.63 | 1.88 | 1.31 | 1.11 | -15.66 | 0.72 | 0.70 | -2.45 | 1.53 | 1.14 | -25.47 | Y | Y | |
| 356 | Y | 0.57 | 0.54 | -5.05 | 0.57 | 0.54 | -4.55 | 0.98 | 0.85 | -13.26 | 0.57 | 0.54 | -5.55 | 1.07 | 0.89 | -16.62 | Y | Y | |
| 362 | Y | 0.41 | 0.42 | 1.87 | 0.44 | 0.42 | -5.27 | 0.70 | 0.66 | -5.58 | 0.38 | 0.42 | 10.19 | 0.85 | 0.69 | -18.65 | Y | Y | |
| 388 | Y | 0.33 | 0.37 | 13.40 | 0.32 | 0.37 | 17.60 | 0.70 | 0.59 | -16.39 | 0.34 | 0.37 | 9.48 | 0.64 | 0.61 | -3.39 | Y | N | |
| 418 | Y | 0.11 | 0.14 | 21.86 | 0.12 | 0.14 | 17.73 | 0.21 | 0.21 | -3.38 | 0.11 | 0.14 | 26.31 | 0.18 | 0.23 | 25.38 | Y | N | |
| 461 | Y | 0.37 | 0.35 | -4.67 | 0.35 | 0.35 | -0.14 | 0.67 | 0.56 | -16.78 | 0.39 | 0.35 | -8.82 | 0.88 | 0.59 | -32.81 | Y | Y | |
| 470 | Y | 0.24 | 0.24 | 1.34 | 0.24 | 0.24 | 1.99 | 0.43 | 0.39 | -9.36 | 0.24 | 0.24 | 0.69 | 0.41 | 0.40 | -0.70 | Y | Y | Added .05 MGD to rest of Gross metershed (minus school parcel) to account for missing residential flows. Rasing gpcd will not improve enough. |
| 479 | Y | 0.07 | 0.07 | 6.97 | 0.06 | 0.07 | 16.90 | 0.14 | 0.13 | -6.85 | 0.07 | 0.07 | -1.40 | 0.20 | 0.12 | -38.78 | Y | N | Added .05 to SC 1996-20-0478 to account for School flows |
| 535 | Y | 0.74 | 0.62 | -16.72 | 0.72 | 0.62 | -14.42 | 1.00 | 0.94 | -6.63 | 0.76 | 0.62 | -18.91 | 1.14 | 0.98 | -13.89 | Y | N | Add +.5' to USIE at 1941-0381.1 and 1941-0529.1 to better match the flow distributions. and see what happens. Added .05 MGD as BQ to SC 1941-0133 and SC1941-0112 - Palmdale Transit Village flow. |
| 544 | Y | 0.65 | 0.80 | 22.45 | 0.66 | 0.79 | 20.28 | 1.16 | 1.18 | 1.75 | 0.65 | 0.81 | 24.64 | 1.49 | 1.25 | -16.34 | N | N | |
| 549 | Y | 1.37 | 1.27 | -7.00 | 1.26 | 1.27 | 0.64 | 2.39 | 2.32 | -2.86 | 1.48 | 1.28 | -13.50 | 2.75 | 2.15 | -21.75 | Y | Y | Raised per capita flow rates by 10 gpcd for all subcatchments that weren't already at max rates. |
| 563 | Y | 0.11 | 0.11 | 0.10 | 0.10 | 0.11 | 9.45 | 0.18 | 0.19 | 9.92 | 0.13 | 0.12 | -7.22 | 0.25 | 0.21 | -16.06 | Y | Y | Checked meter data, and it appears to start 2.5-3 hours later than most meters. Shifted TQ profile by 3 hours to the right. |
| 628 | Y | 0.13 | 0.12 | -10.82 | 0.12 | 0.12 | -6.58 | 0.26 | 0.17 | -35.01 | 0.14 | 0.12 | -14.66 | 0.35 | 0.16 | -53.05 | Y | Y | Obviously missing flow. Distributed .1 MG over all Net 628 Metersheds by area. |
| 640 | Y | 0.18 | 0.33 | 80.78 | 0.18 | 0.33 | 76.96 | 0.52 | 0.60 | 15.90 | 0.18 | 0.33 | 84.76 | 0.54 | 0.55 | 1.75 | N | N | May still be an issue along Palm/Lan border as far as flow distribution. Lowered gpcd of all 70/80 SCs to 60 gpcd. |
| 671 | Y | 1.30 | 1.05 | -19.58 | 1.29 | 1.05 | -18.72 | 2.00 | 1.80 | -10.15 | 1.32 | 1.05 | -20.41 | 2.16 | 1.75 | -18.76 | Y | N | Upstream flow diversion makes this calibraiton harder to achieve, so raised 12" line's invert +.5'. |
| 676 | Y | 0.06 | 0.05 | -21.85 | 0.07 | 0.05 | -28.75 | 0.10 | 0.08 | -24.34 | 0.06 | 0.05 | -13.45 | 0.10 | 0.08 | -20.17 | N | N | |
| 684 | Y | 0.57 | 0.59 | 2.15 | 0.53 | 0.59 | 10.54 | 0.89 | 1.04 | 17.04 | 0.62 | 0.59 | -5.05 | 1.03 | 0.99 | -4.41 | Y | N | Upstream flow diversion makes this calibraiton harder to achieve, so raised 12" line's invert +.5'. |
| 706 | Y | 0.07 | 0.07 | 1.50 | 0.09 | 0.07 | -14.56 | 0.19 | 0.13 | -31.02 | 0.06 | 0.07 | 25.12 | 0.10 | 0.13 | 29.78 | Y | N | |

# Appendix C - Dry Weather Calibration Plots

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

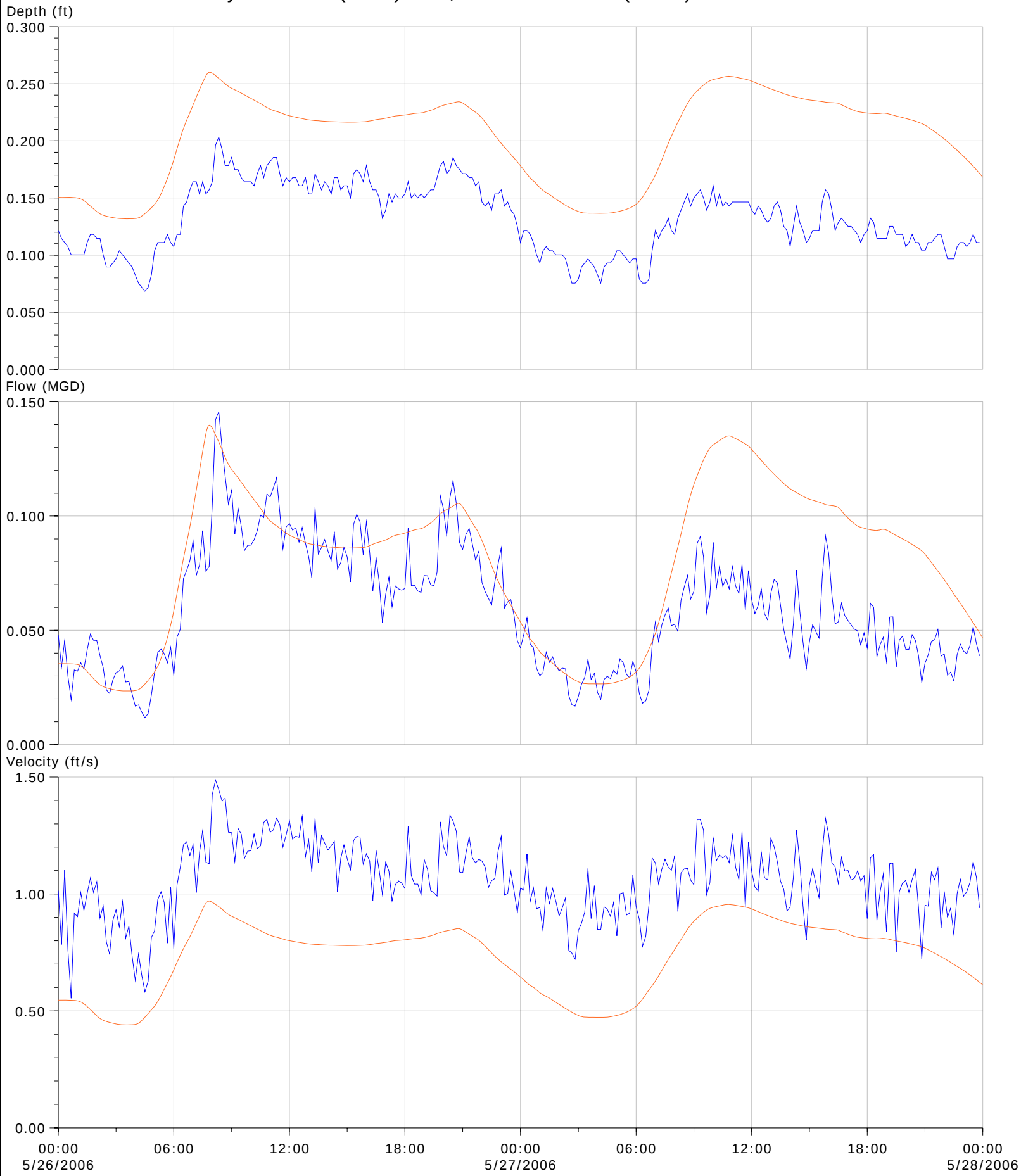
# Flow Survey Location (Obs.) 14, Model Location (Pred.) D/S 2047-20-0015.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.250 | 1.020 | 0.229 | 3.164 | 3.384 | 0.000 | 3.120 |
| DWF Model | 0.420 | 1.098 | 0.500 | 3.064 | 3.411 | 1.612 | 2.685 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

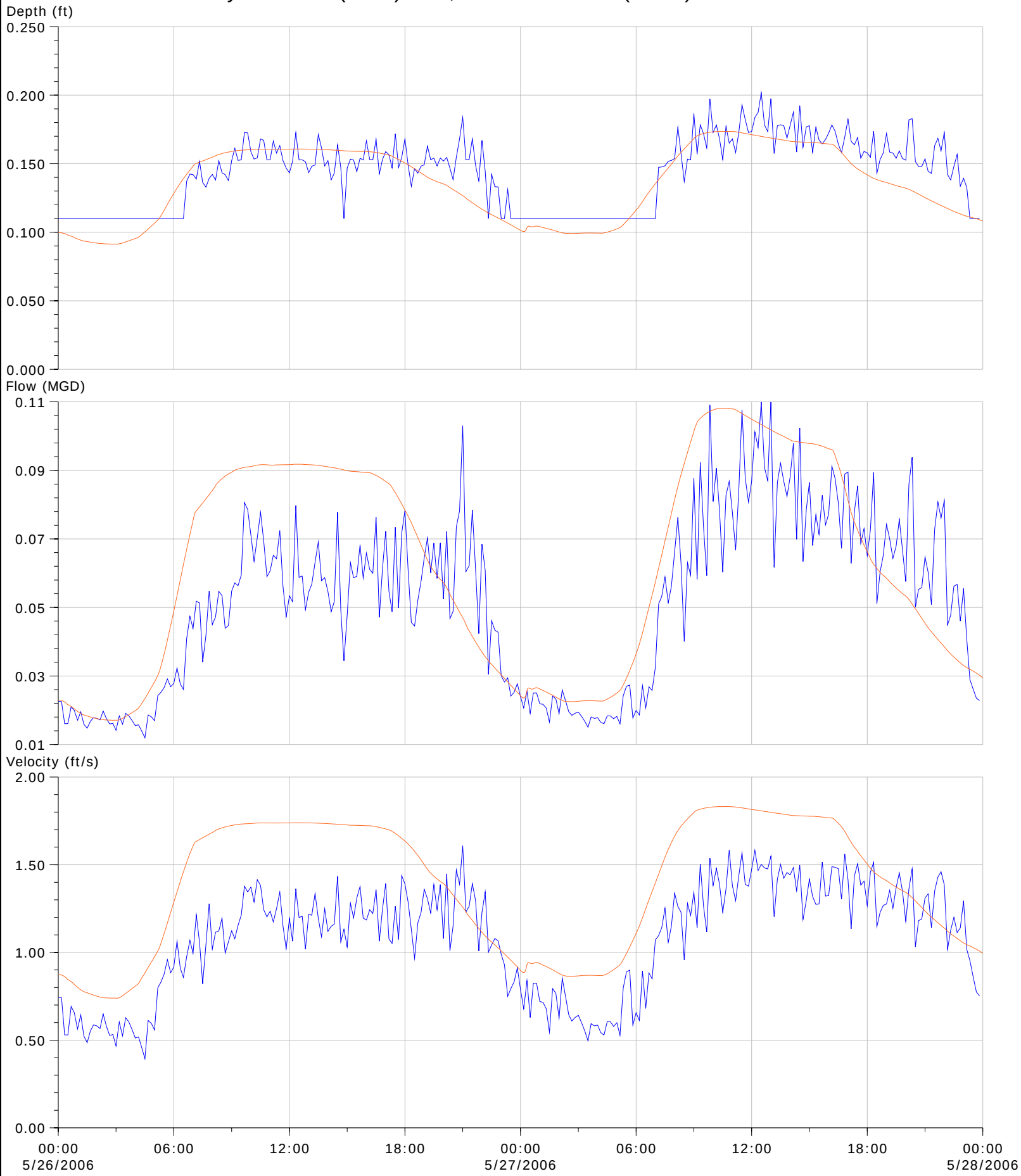
# Flow Survey Location (Obs.) 103, Model Location (Pred.) D/S 1940-20-0104.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.068 | 0.203 | 0.012 | 0.146 | 0.119 | 0.554 | 1.487 |
| DWF Model | 0.132 | 0.260 | 0.023 | 0.140 | 0.159 | 0.440 | 0.969 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

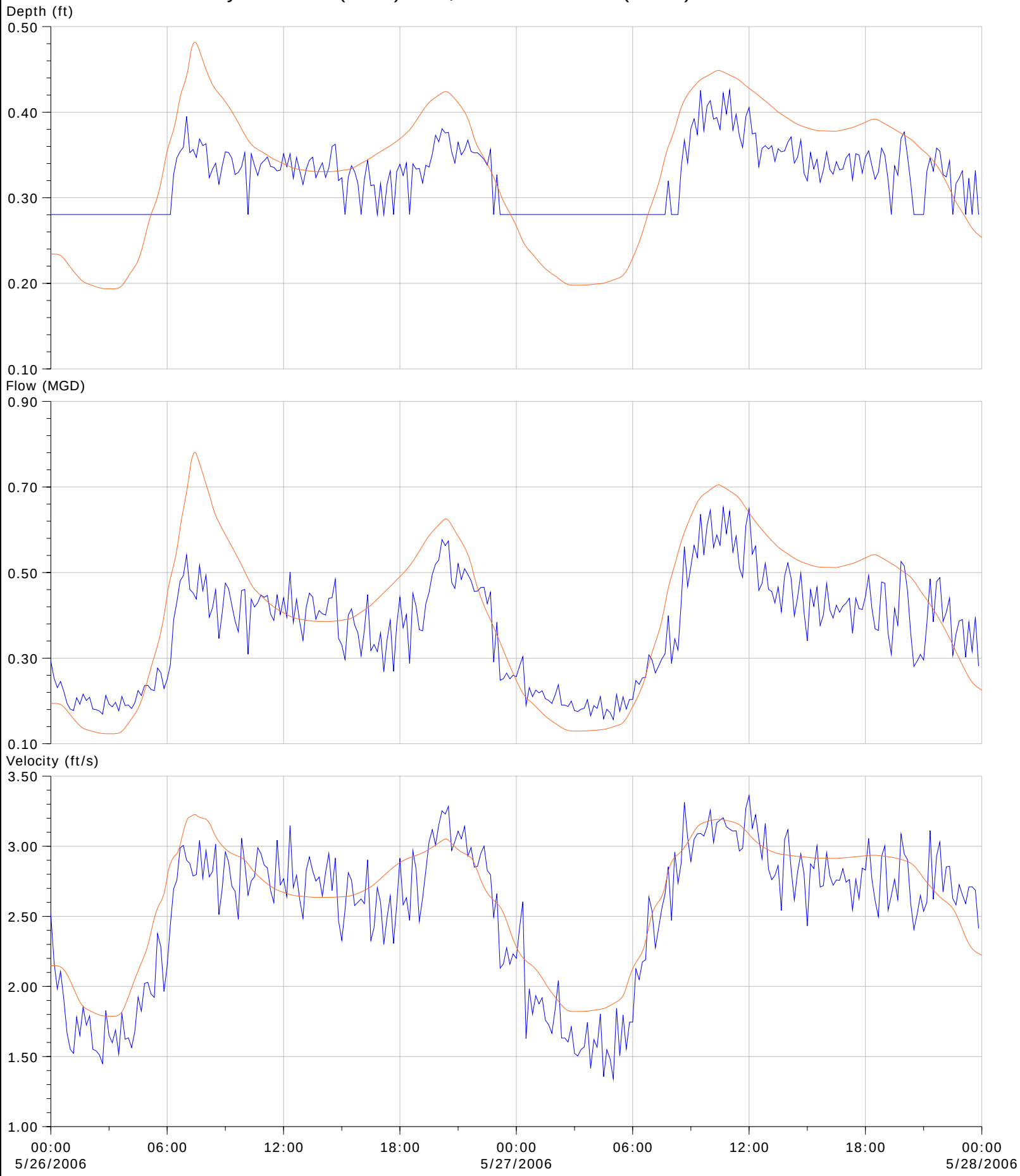
# Flow Survey Location (Obs.) 123, Model Location (Pred.) D/S 1941-20-0124.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.110 | 0.202 | 0.012 | 0.110 | 0.103 | 0.394 | 1.608 |
| DWF Model | 0.091 | 0.174 | 0.017 | 0.108 | 0.124 | 0.739 | 1.832 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

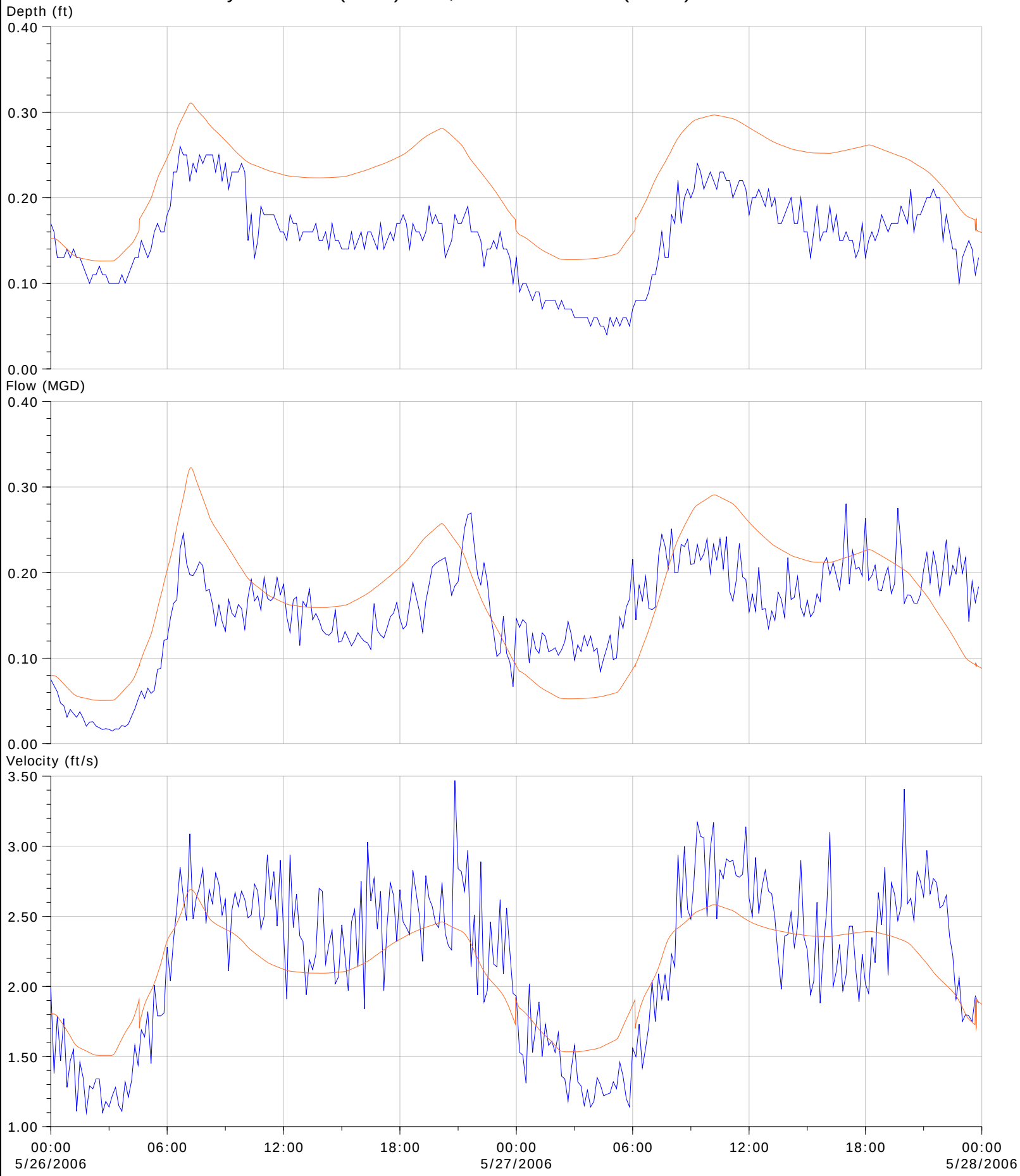
# Flow Survey Location (Obs.) 146, Model Location (Pred.) D/S 1941-20-0147.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.280 | 0.426 | 0.156 | 0.652 | 0.732 | 1.341 | 3.362 |
| DWF Model | 0.194 | 0.482 | 0.123 | 0.781 | 0.827 | 1.788 | 3.227 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

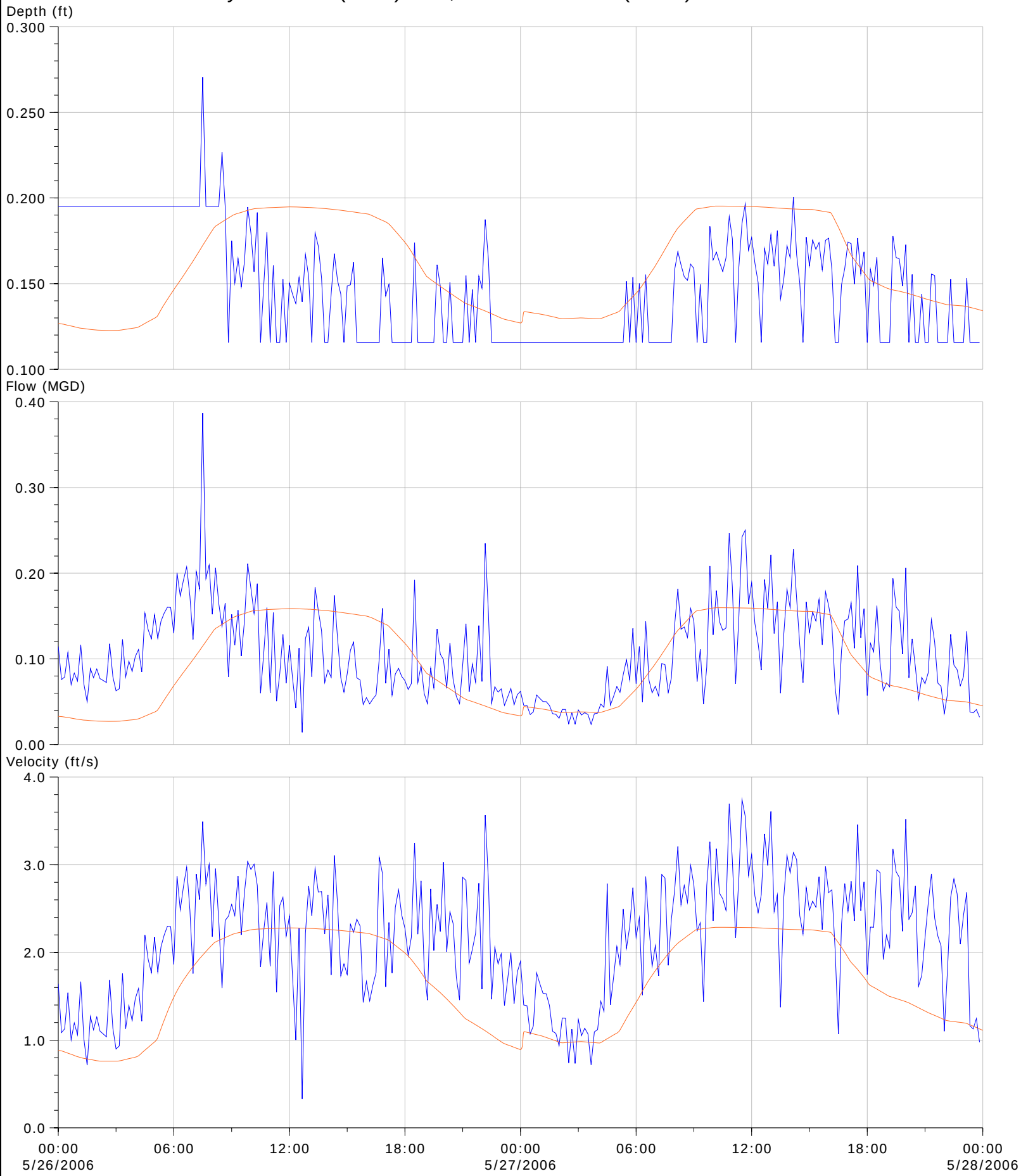
# Flow Survey Location (Obs.) 157, Model Location (Pred.) D/S 1887-20-0158.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.040 | 0.260 | 0.015 | 0.280 | 0.308 | 1.100 | 3.470 |
| DWF Model | 0.126 | 0.311 | 0.051 | 0.322 | 0.341 | 1.508 | 2.692 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

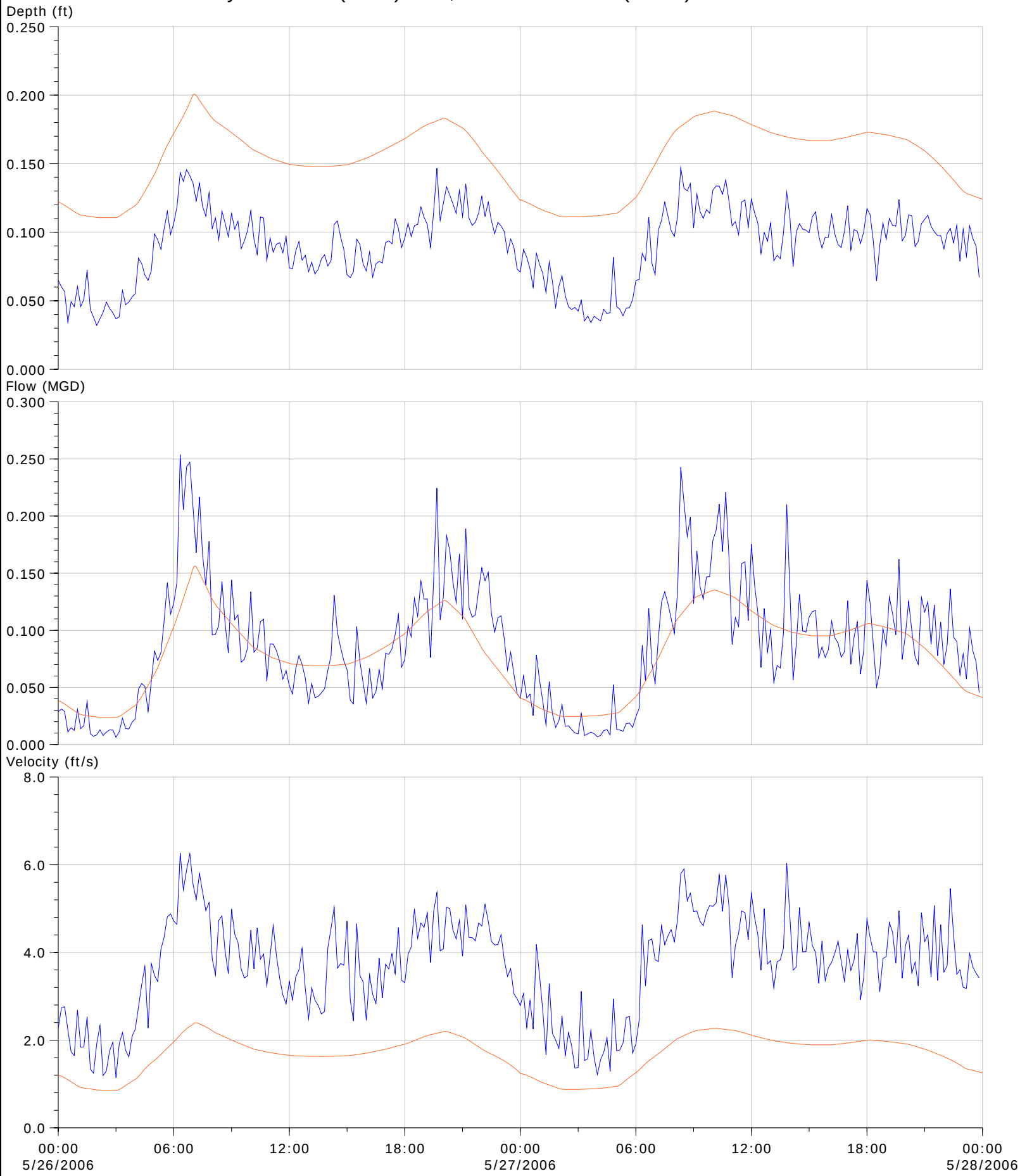
# Flow Survey Location (Obs.) 163, Model Location (Pred.) D/S 1941-20-0164.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.116 | 0.270 | 0.014 | 0.387 | 0.211 | 0.330 | 3.743 |
| DWF Model | 0.123 | 0.195 | 0.027 | 0.160 | 0.189 | 0.760 | 2.287 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

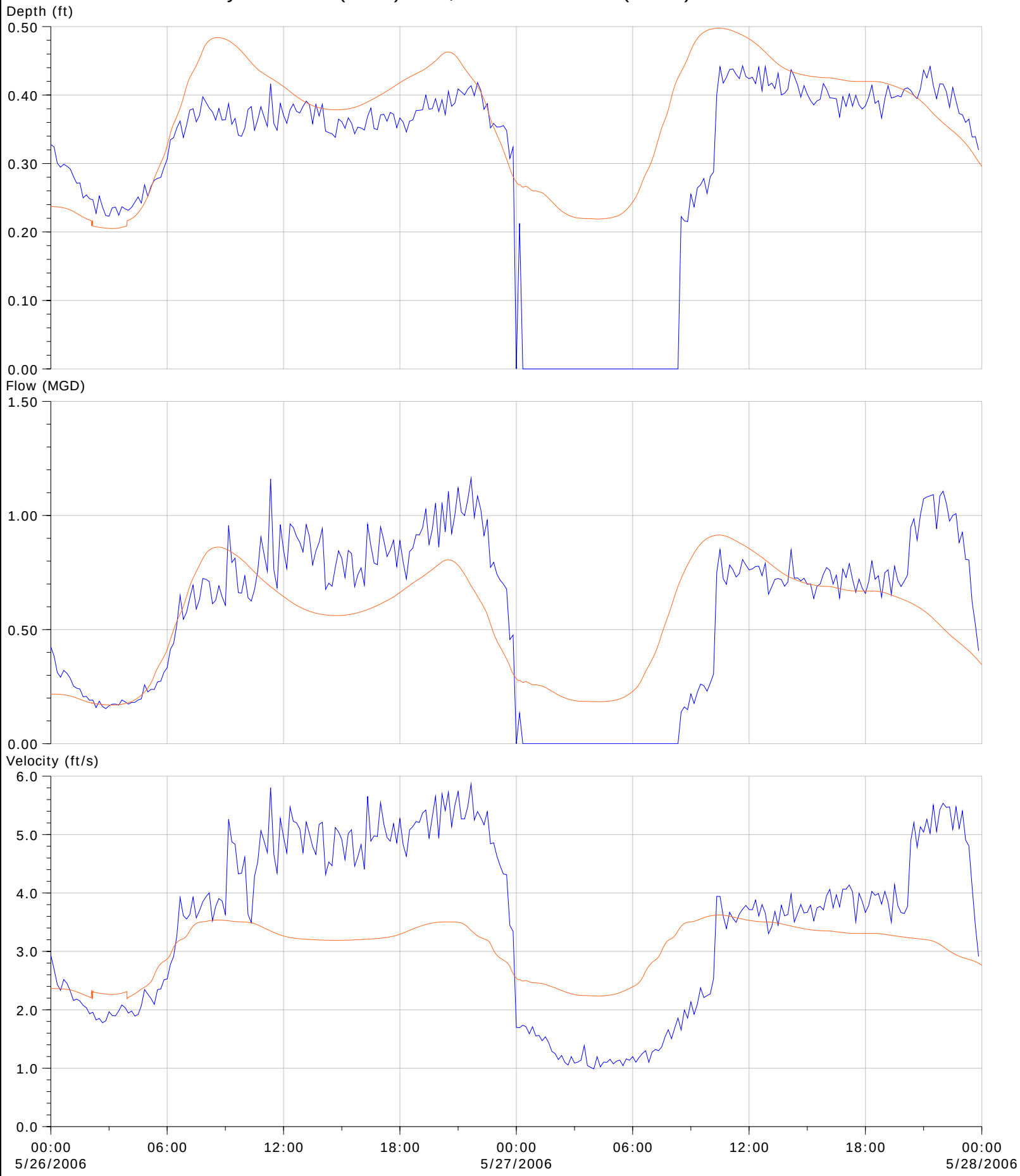
# Flow Survey Location (Obs.) 173, Model Location (Pred.) D/S 1888-20-0174.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.032 | 0.147 | 0.006 | 0.254 | 0.175 | 1.143 | 6.270 |
| DWF Model | 0.111 | 0.201 | 0.024 | 0.156 | 0.159 | 0.855 | 2.395 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

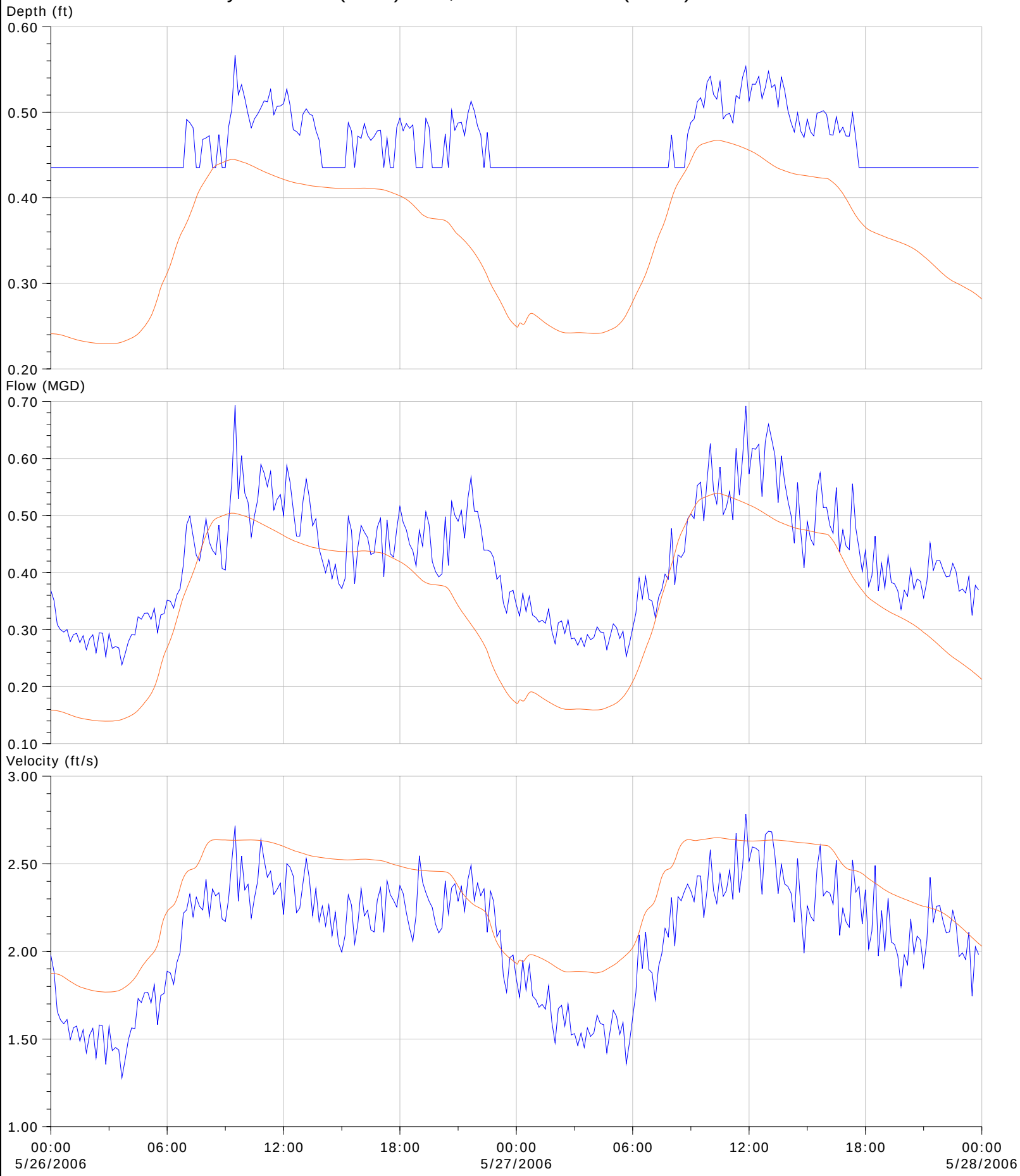
# Flow Survey Location (Obs.) 198, Model Location (Pred.) D/S 1994-20-0199.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.000 | 0.443 | 0.000 | 1.164 | 1.121 | 0.989 | 5.869 |
| DWF Model | 0.205 | 0.498 | 0.170 | 0.914 | 1.093 | 2.190 | 3.623 |

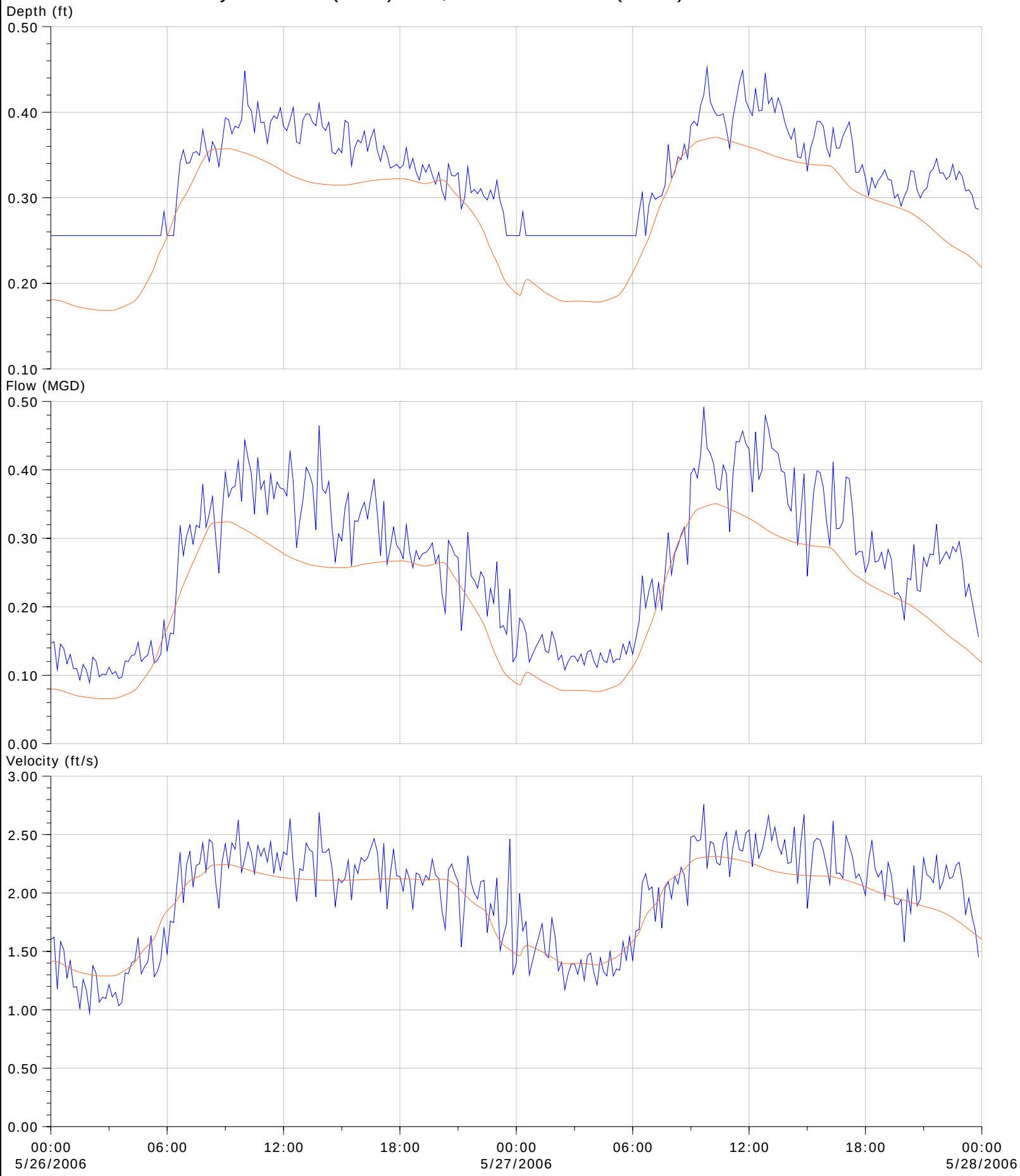
Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 207, Model Location (Pred.) D/S 1994-20-0208.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.435 | 0.567 | 0.238 | 0.694 | 0.840 | 1.278 | 2.783 |
| DWF Model | 0.229 | 0.467 | 0.140 | 0.539 | 0.684 | 1.768 | 2.650 |

# Flow Survey Location (Obs.) 213, Model Location (Pred.) D/S 1995-20-0213A.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.256 | 0.452 | 0.089 | 0.492 | 0.528 | 0.971 | 2.758 |
| DWF Model | 0.169 | 0.371 | 0.066 | 0.351 | 0.420 | 1.289 | 2.313 |

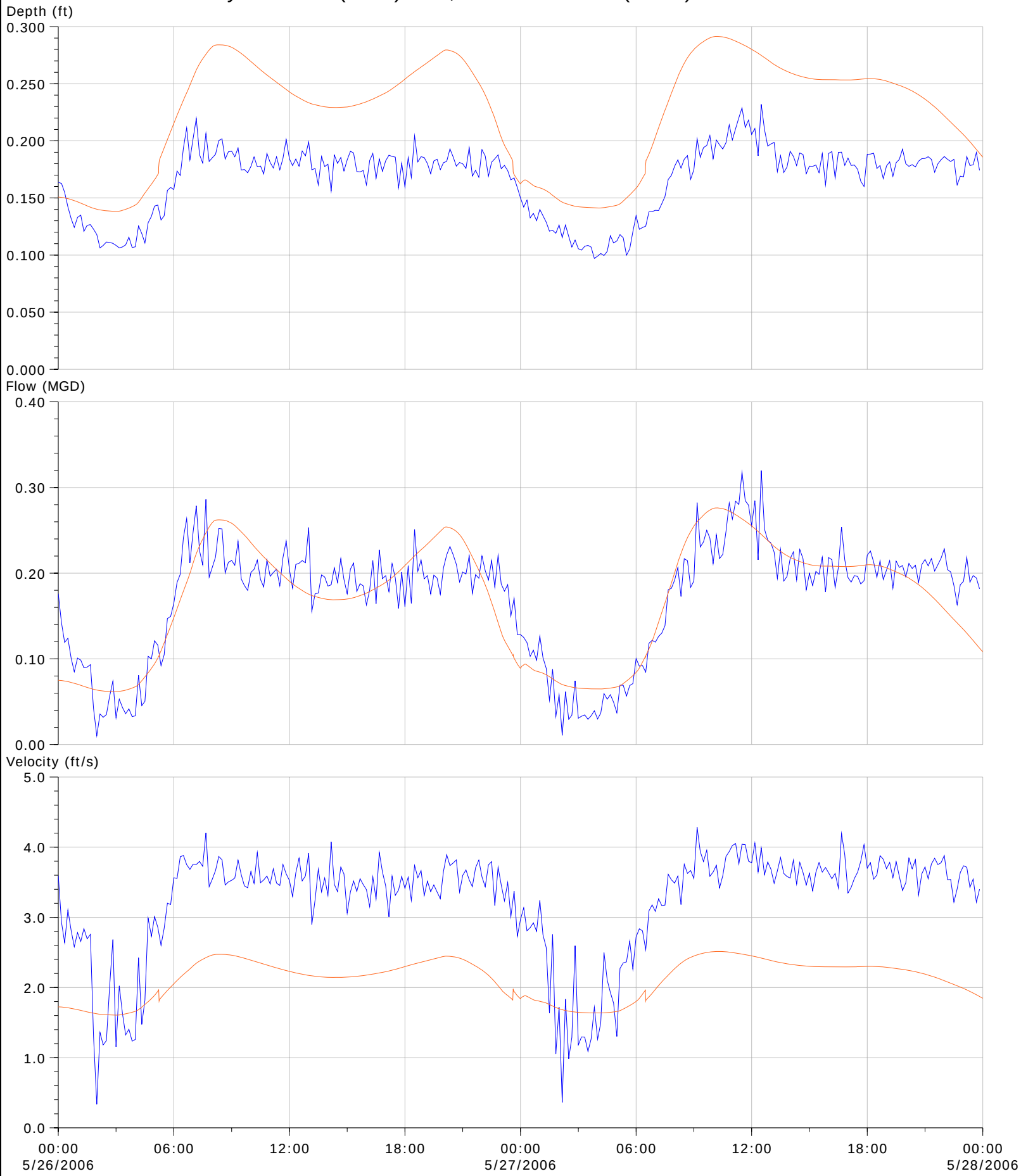
Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 254, Model Location (Pred.) D/S 1995-20-0255.1

| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.151 | 0.411 | 0.075 | 0.586 | 0.607 | 1.181 | 3.182 |
| DWF Model | 0.201 | 0.428 | 0.125 | 0.594 | 0.726 | 1.721 | 2.869 |

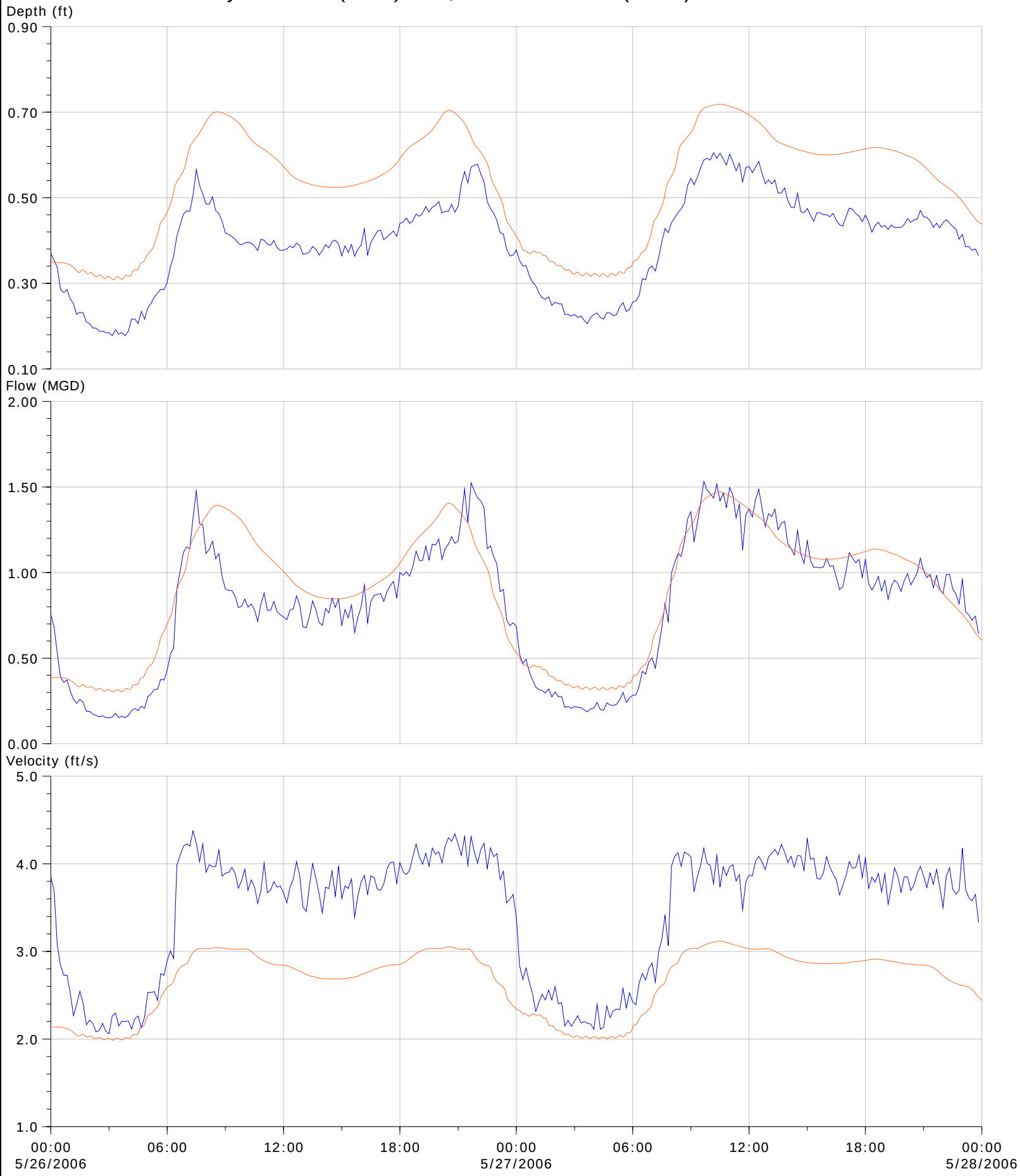
Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 263, Model Location (Pred.) D/S 1995-20-0264.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.097 | 0.232 | 0.010 | 0.320 | 0.341 | 0.337 | 4.283 |
| DWF Model | 0.138 | 0.291 | 0.062 | 0.276 | 0.341 | 1.606 | 2.514 |

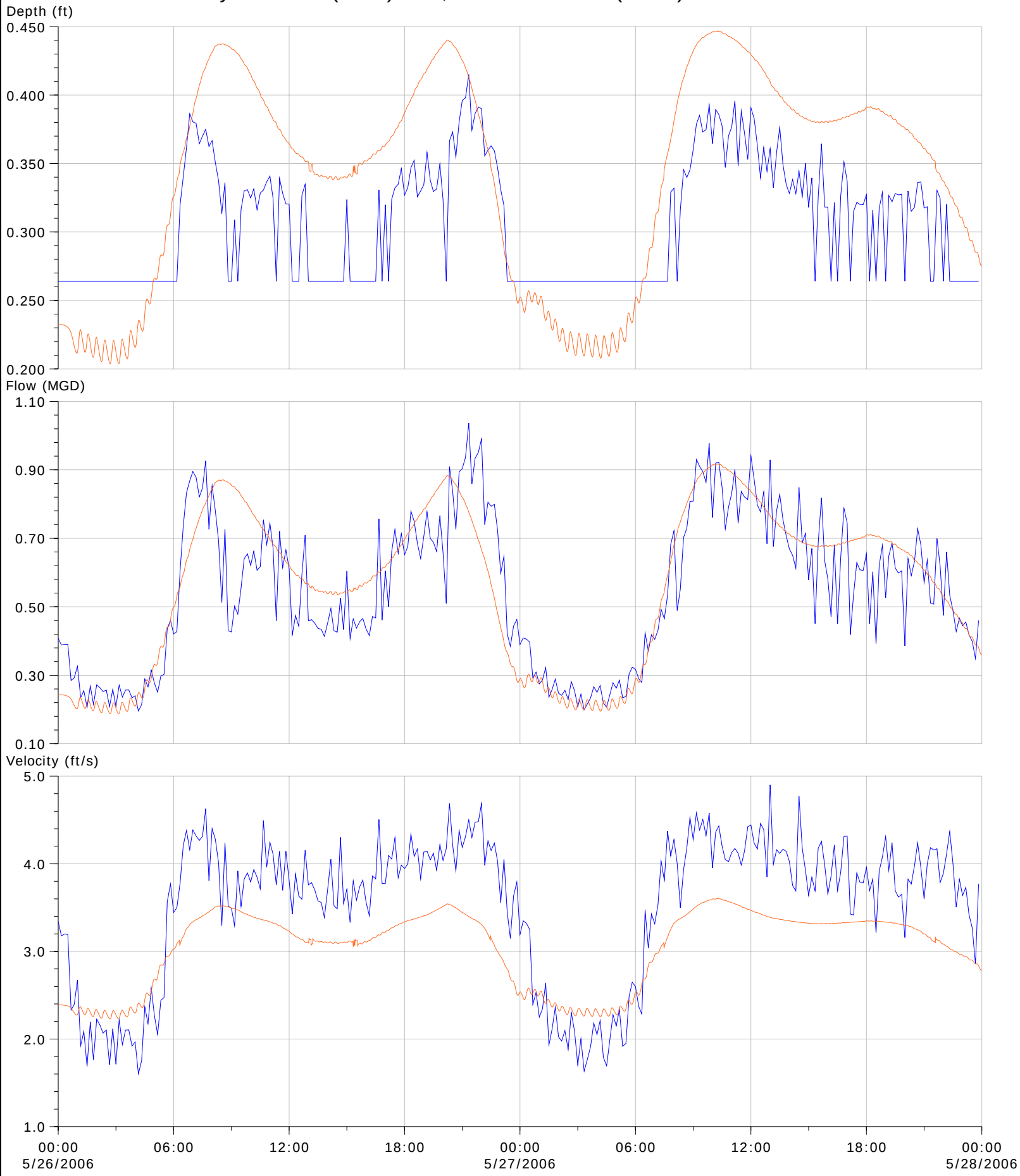
# Flow Survey Location (Obs.) 269, Model Location (Pred.) D/S 1994-20-0270.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.178 | 0.605 | 0.150 | 1.533 | 1.627 | 2.059 | 4.376 |
| DWF Model | 0.308 | 0.718 | 0.302 | 1.470 | 1.791 | 1.988 | 3.117 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

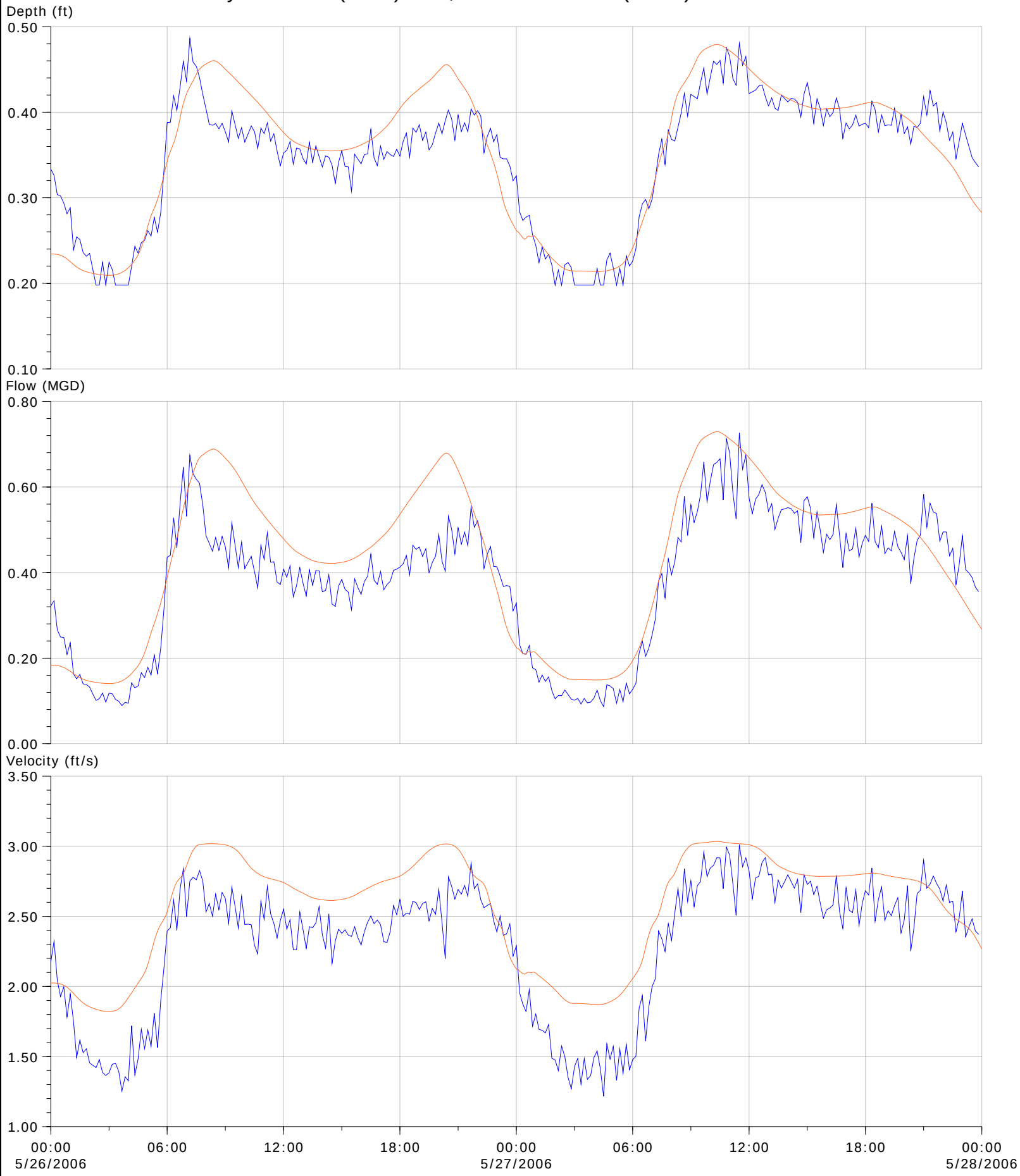
# Flow Survey Location (Obs.) 284, Model Location (Pred.) D/S 1995-20-0284A.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.264 | 0.415 | 0.196 | 1.036 | 1.094 | 1.602 | 4.901 |
| DWF Model | 0.204 | 0.447 | 0.188 | 0.917 | 1.129 | 2.228 | 3.603 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

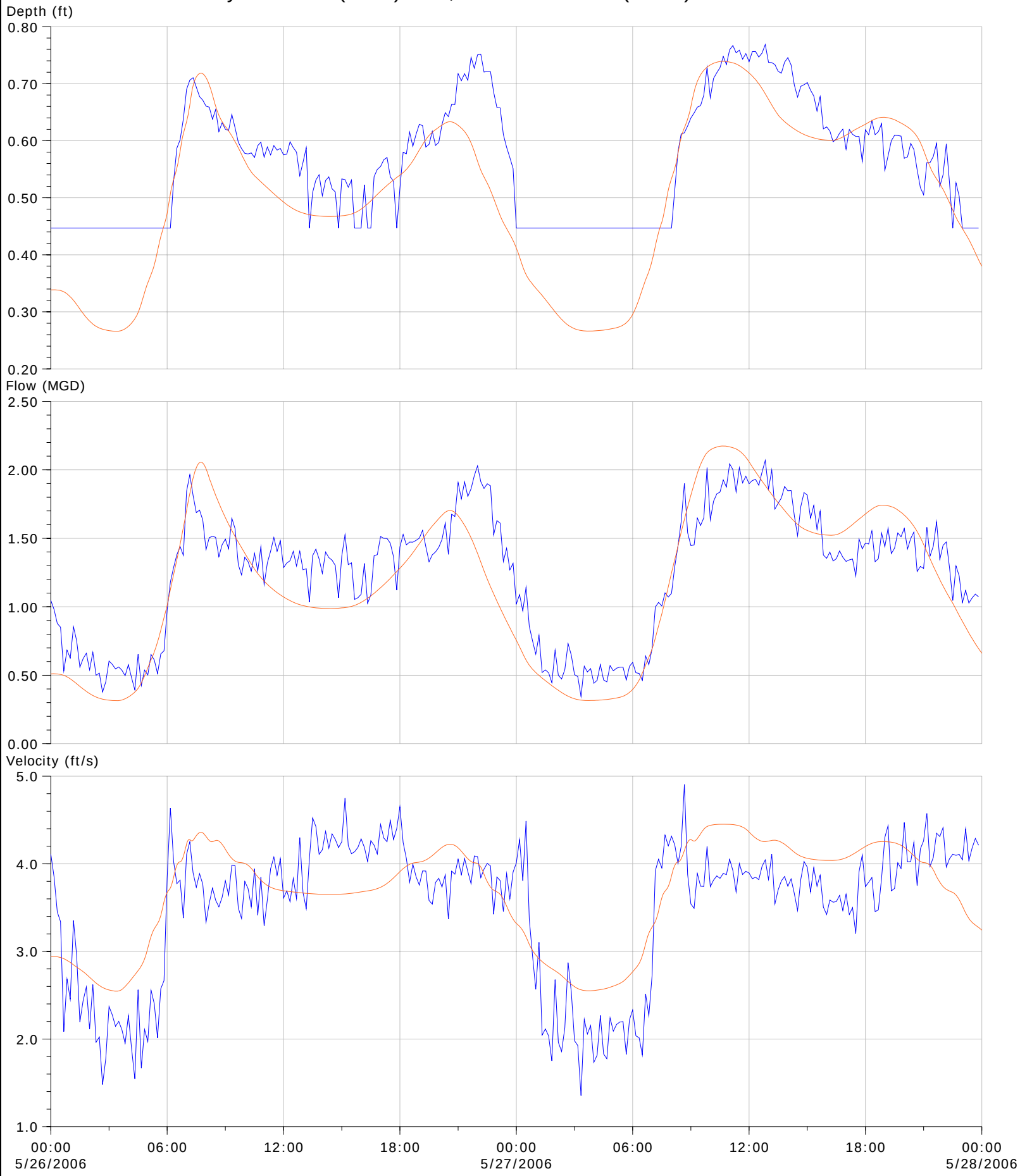
# Flow Survey Location (Obs.) 310, Model Location (Pred.) D/S 1995-20-0311.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.198 | 0.486 | 0.087 | 0.726 | 0.764 | 1.216 | 3.012 |
| DWF Model | 0.209 | 0.479 | 0.141 | 0.729 | 0.875 | 1.822 | 3.035 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

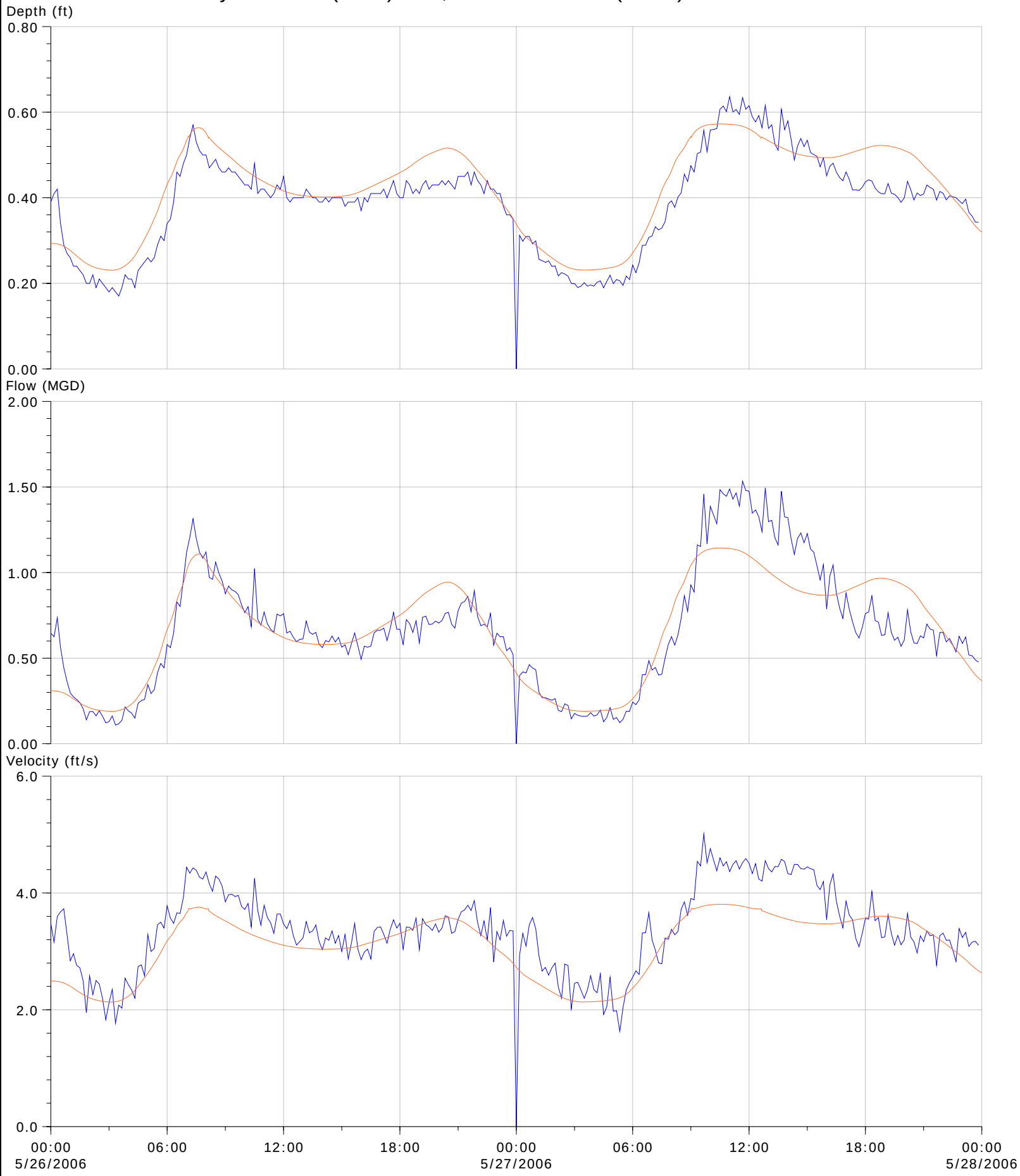
# Flow Survey Location (Obs.) 333, Model Location (Pred.) D/S 2047-20-0334.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.447 | 0.769 | 0.345 | 2.069 | 2.490 | 1.355 | 4.905 |
| DWF Model | 0.266 | 0.739 | 0.314 | 2.174 | 2.345 | 2.546 | 4.452 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

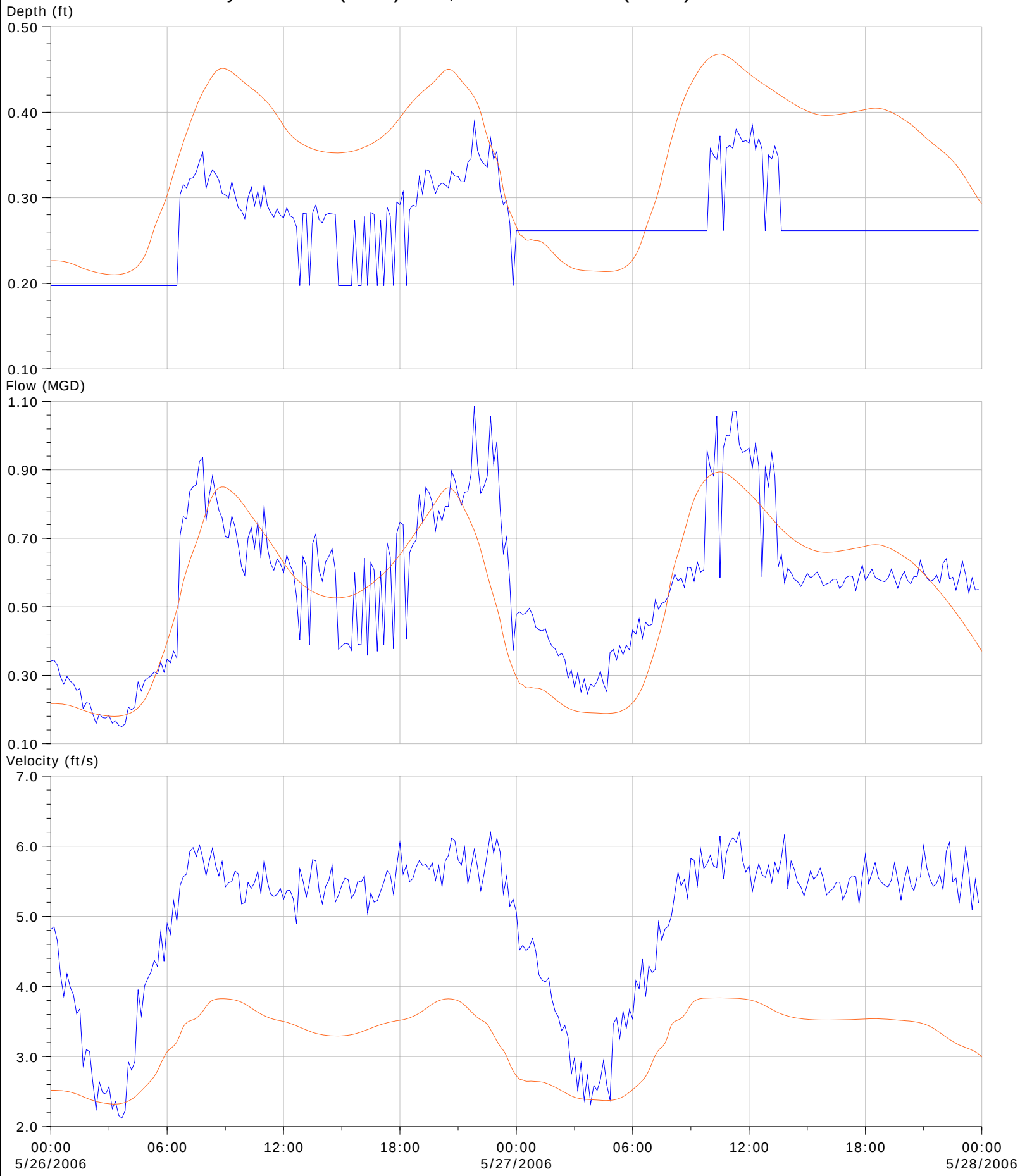
# Flow Survey Location (Obs.) 339, Model Location (Pred.) D/S 2048-20-0339A.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.000 | 0.636 | 0.000 | 1.534 | 1.334 | 0.000 | 5.012 |
| DWF Model | 0.231 | 0.572 | 0.189 | 1.144 | 1.333 | 2.132 | 3.807 |

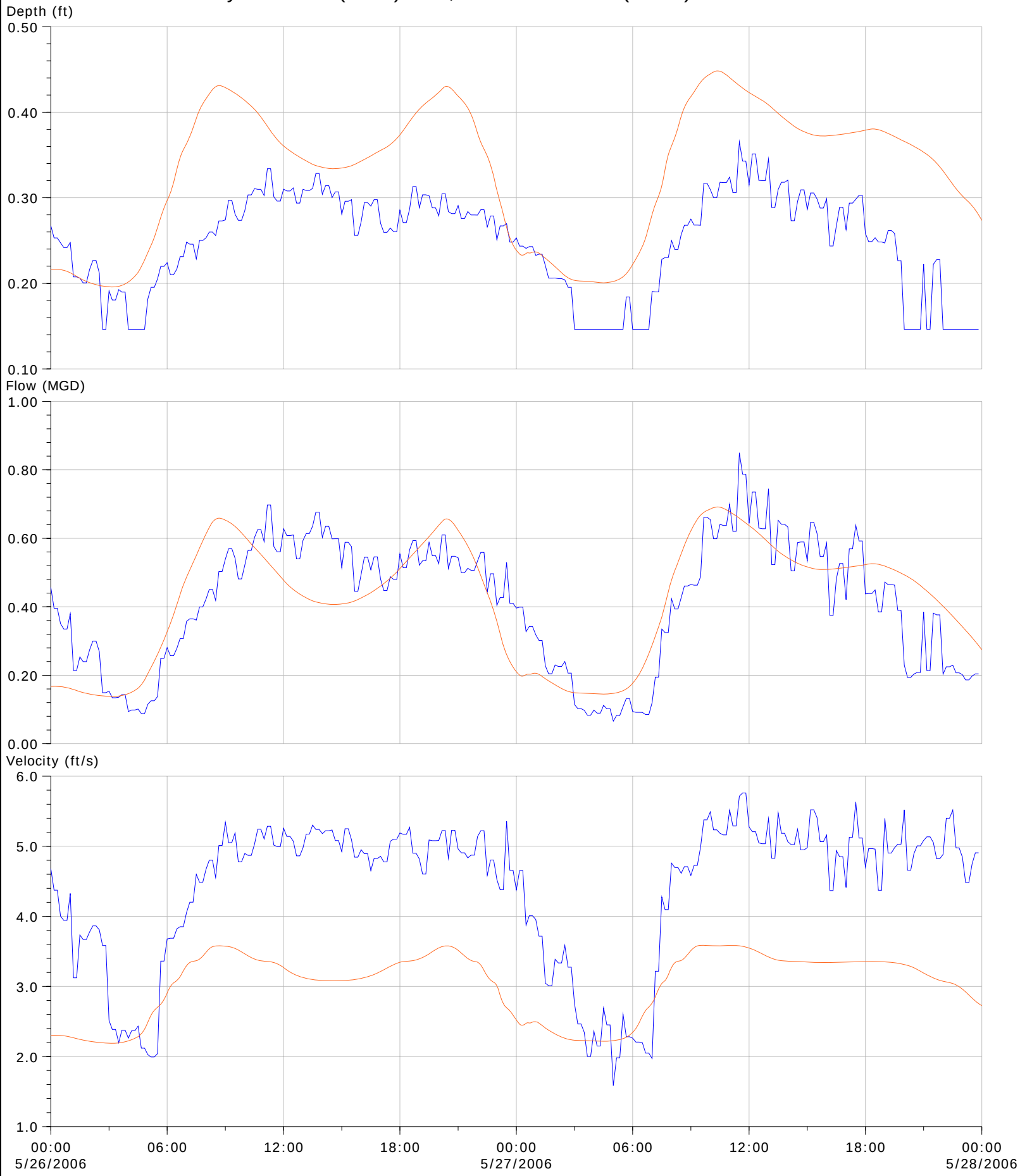
Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 356, Model Location (Pred.) D/S 2098-20-0357.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.197 | 0.388 | 0.150 | 1.086 | 1.137 | 2.121 | 6.197 |
| DWF Model | 0.210 | 0.468 | 0.180 | 0.894 | 1.083 | 2.321 | 3.837 |

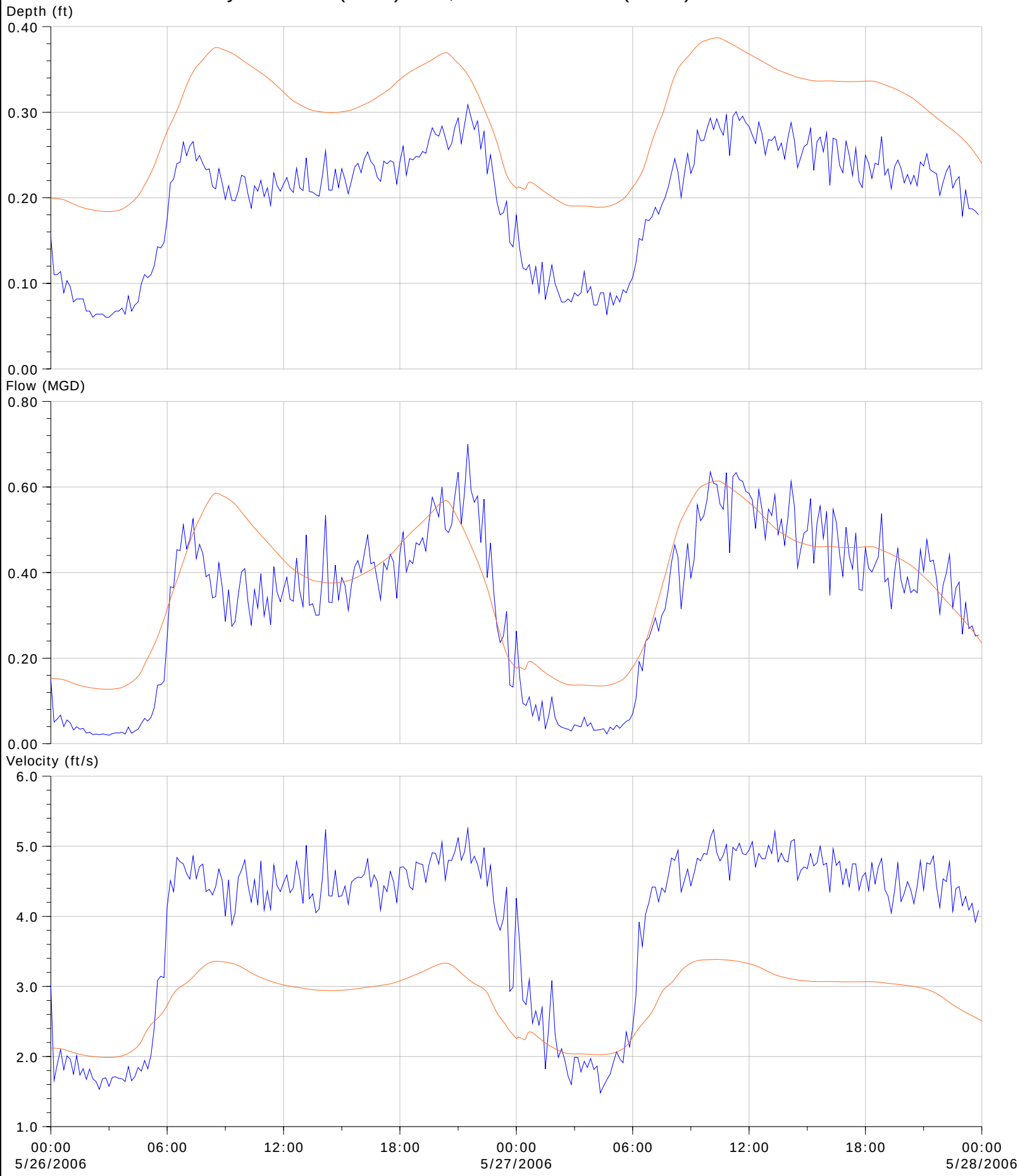
# Flow Survey Location (Obs.) 362, Model Location (Pred.) D/S 2098-20-0363.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.146 | 0.365 | 0.066 | 0.850 | 0.818 | 1.585 | 5.760 |
| DWF Model | 0.196 | 0.448 | 0.138 | 0.692 | 0.836 | 2.189 | 3.587 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

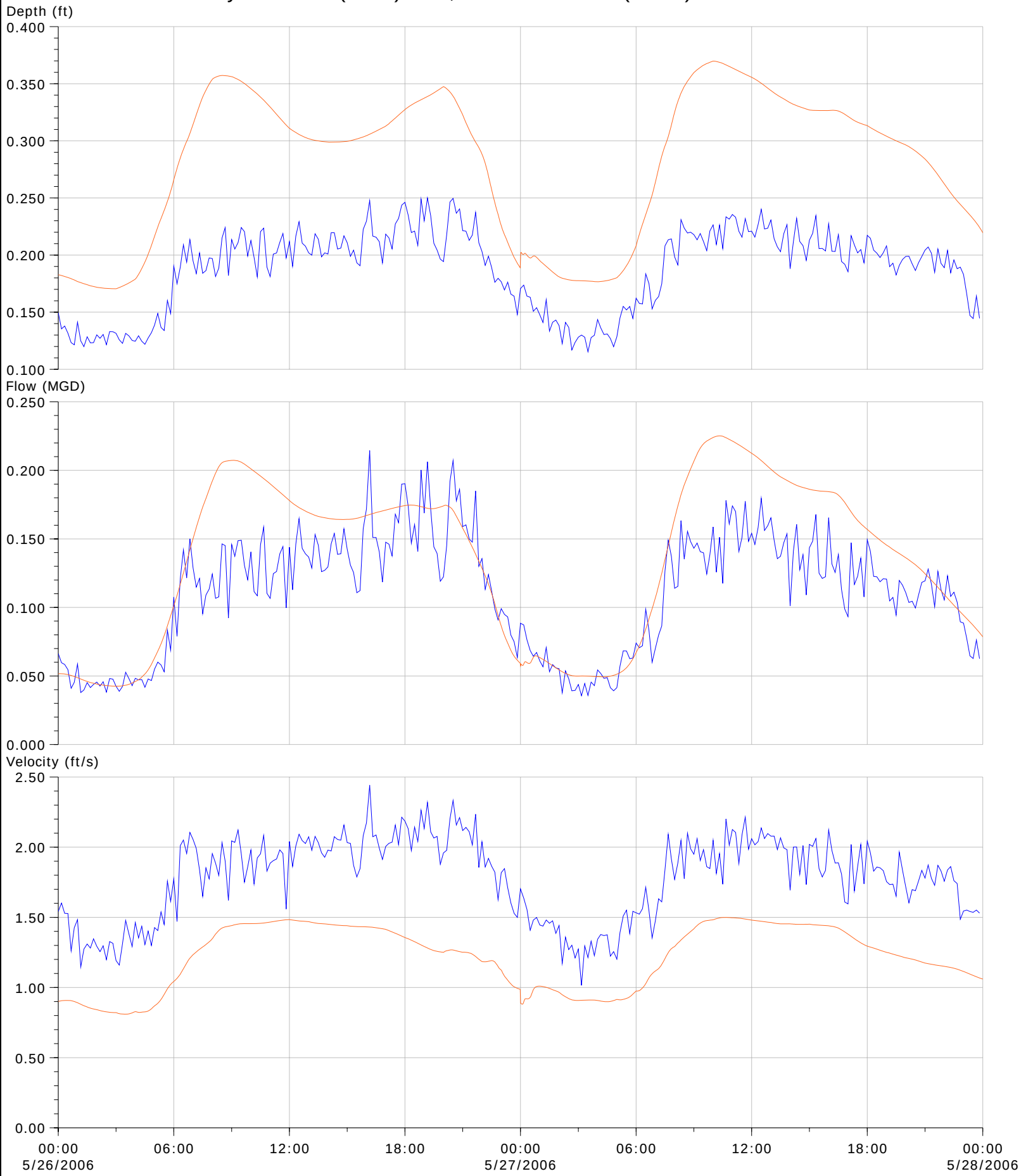
# Flow Survey Location (Obs.) 388, Model Location (Pred.) D/S 1941-20-0389.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.060 | 0.309 | 0.020 | 0.700 | 0.658 | 1.482 | 5.253 |
| DWF Model | 0.184 | 0.387 | 0.127 | 0.614 | 0.748 | 1.988 | 3.385 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

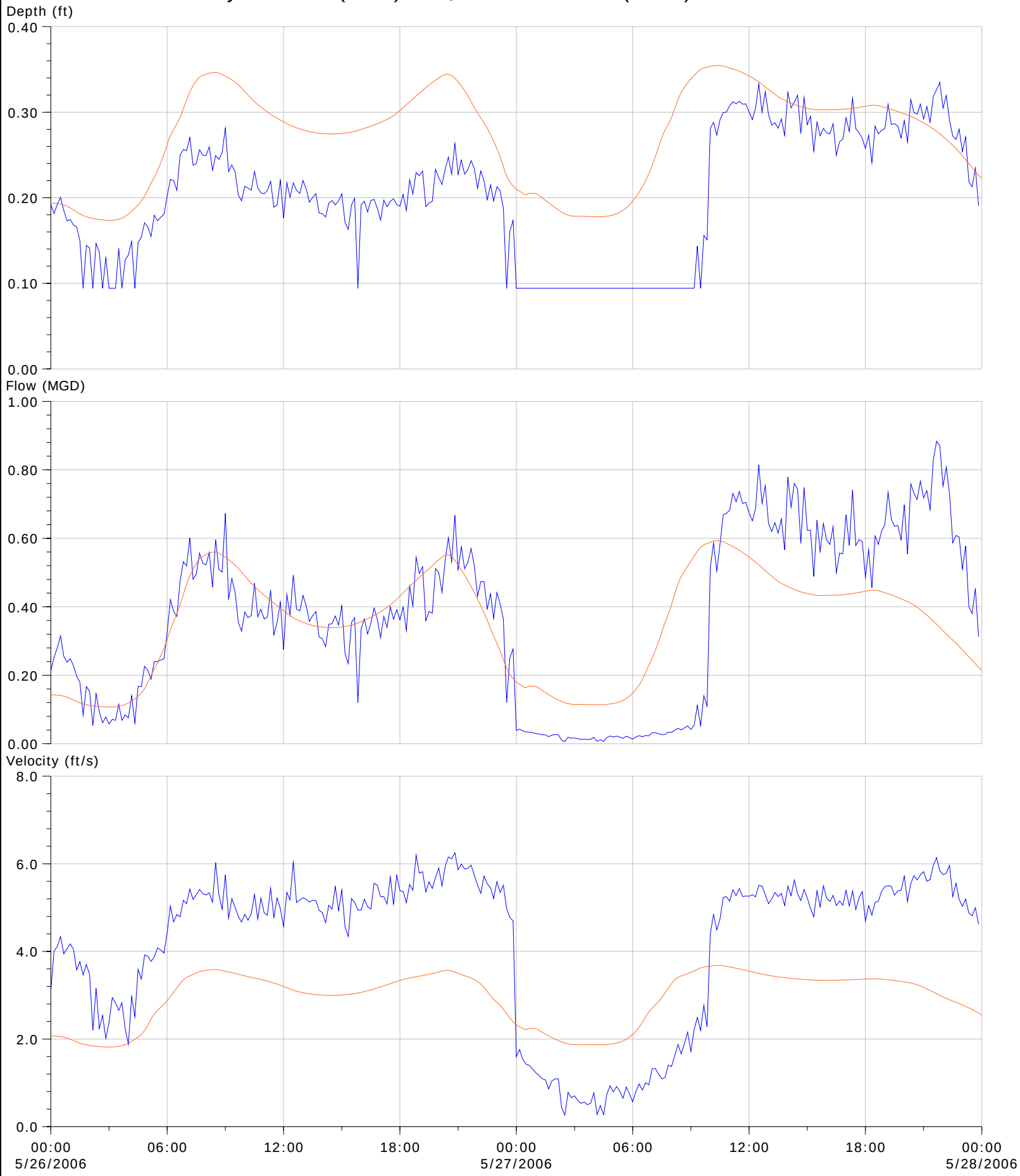
# Flow Survey Location (Obs.) 418, Model Location (Pred.) D/S 1941-20-0419.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.115 | 0.250 | 0.036 | 0.214 | 0.222 | 1.015 | 2.442 |
| DWF Model | 0.171 | 0.370 | 0.043 | 0.225 | 0.271 | 0.810 | 1.500 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

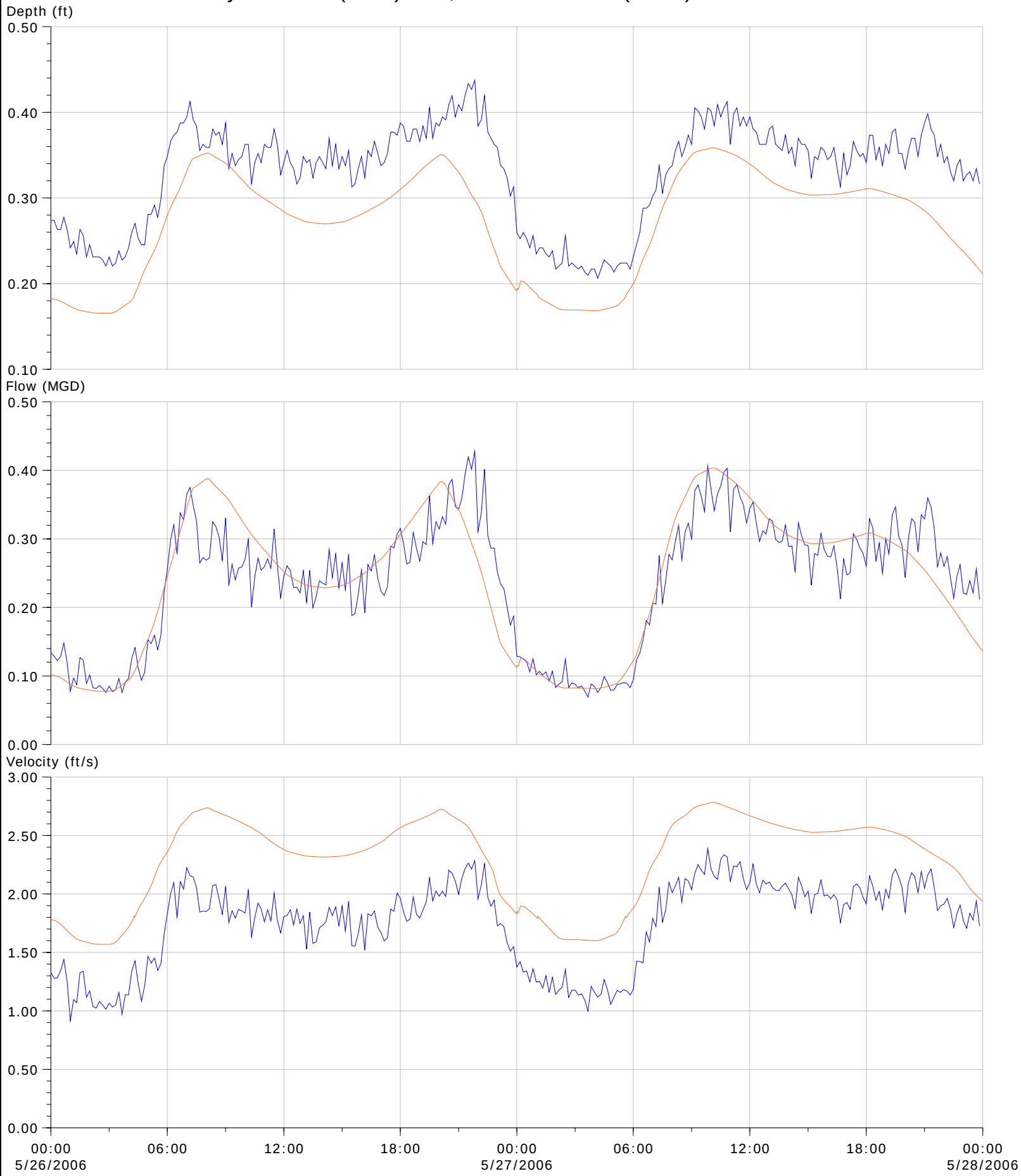
# Flow Survey Location (Obs.) 461, Model Location (Pred.) D/S 1995-20-0462.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.094 | 0.335 | 0.006 | 0.883 | 0.738 | 0.261 | 6.251 |
| DWF Model | 0.174 | 0.355 | 0.107 | 0.594 | 0.705 | 1.816 | 3.682 |

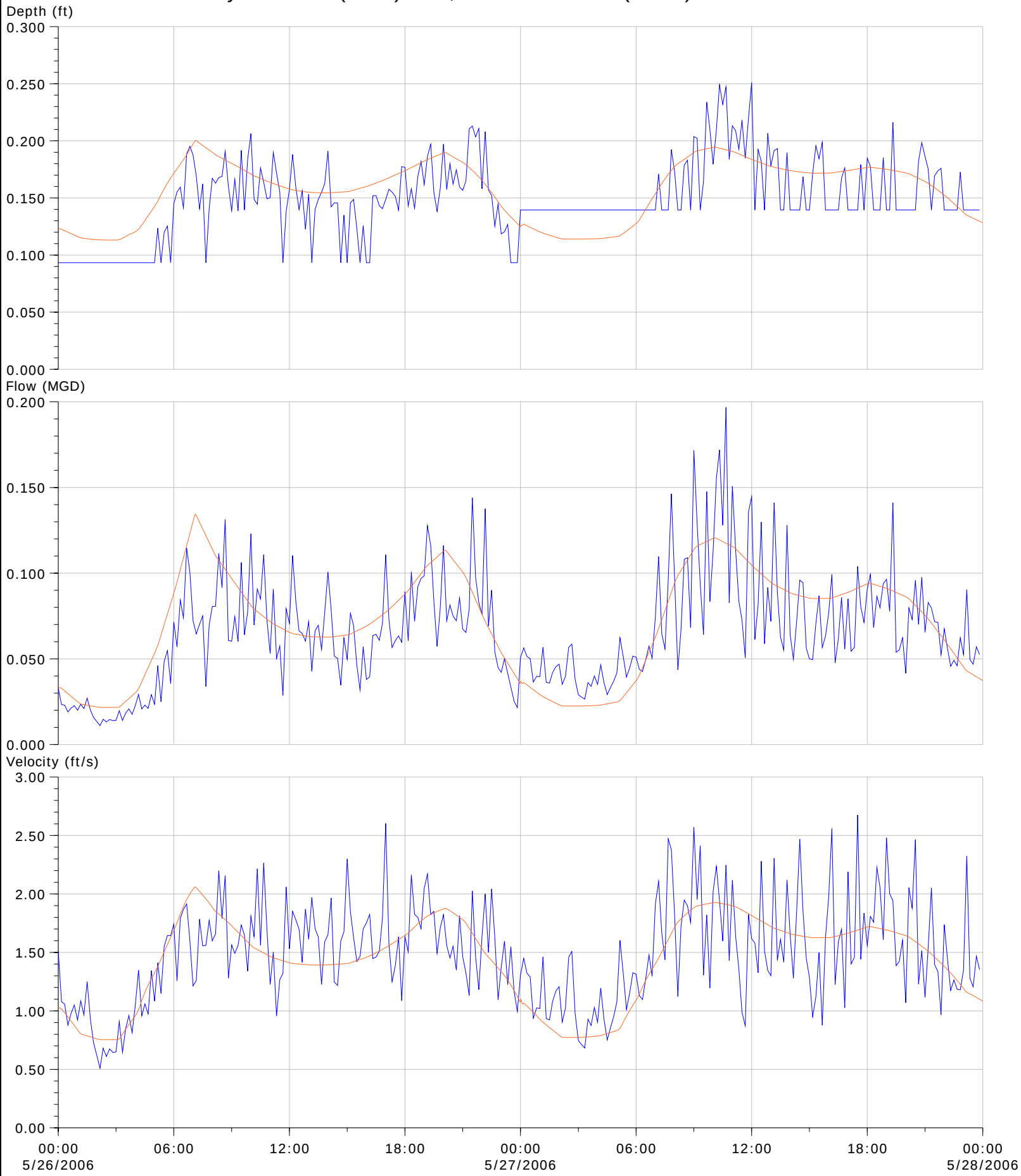
Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 470, Model Location (Pred.) D/S 1996-20-0471.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.206 | 0.437 | 0.069 | 0.428 | 0.477 | 0.915 | 2.390 |
| DWF Model | 0.166 | 0.359 | 0.078 | 0.404 | 0.484 | 1.569 | 2.784 |

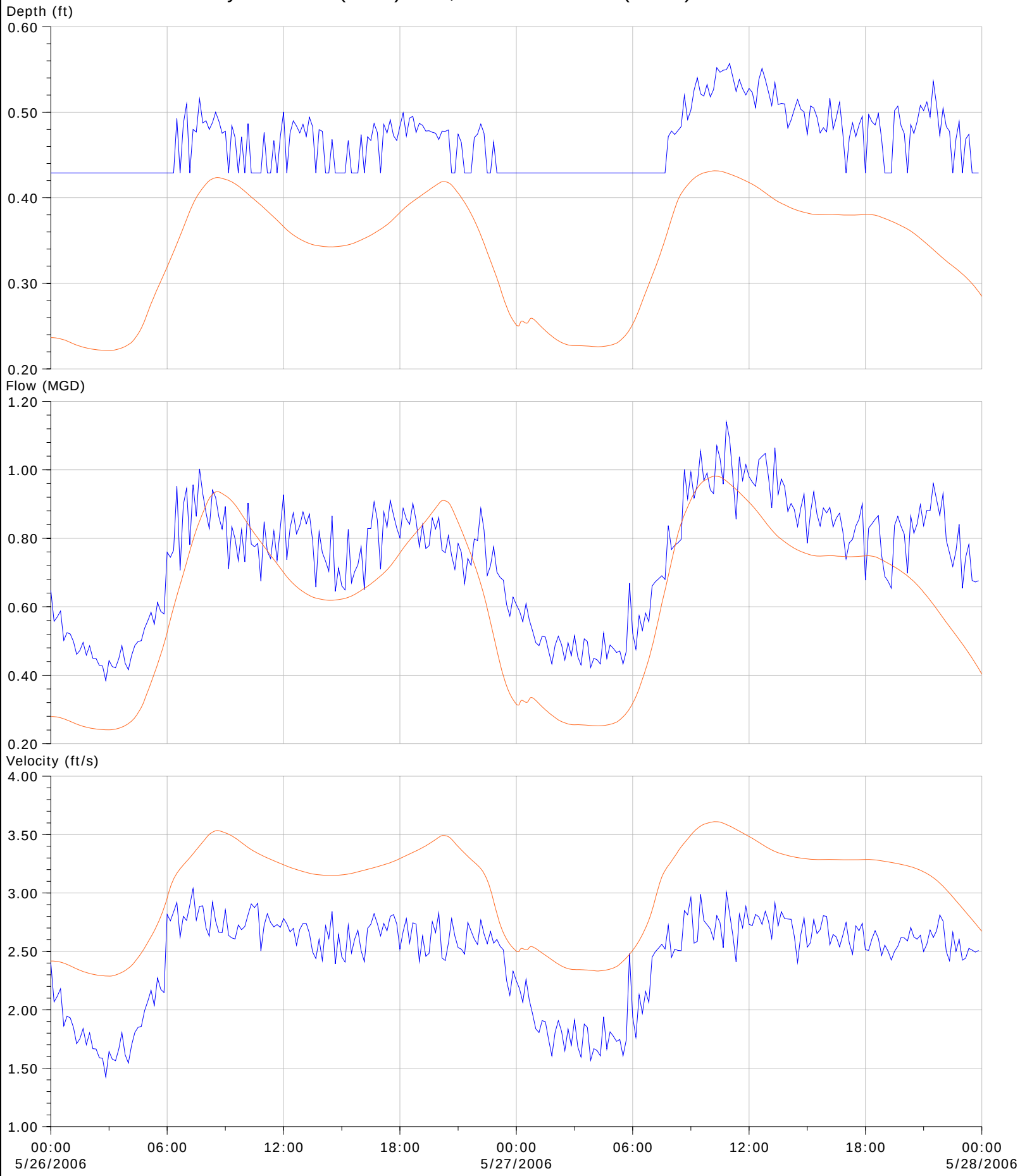
# Flow Survey Location (Obs.) 479, Model Location (Pred.) D/S 1996-20-0480.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.093 | 0.251 | 0.011 | 0.197 | 0.132 | 0.510 | 2.675 |
| DWF Model | 0.113 | 0.200 | 0.022 | 0.134 | 0.142 | 0.754 | 2.060 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

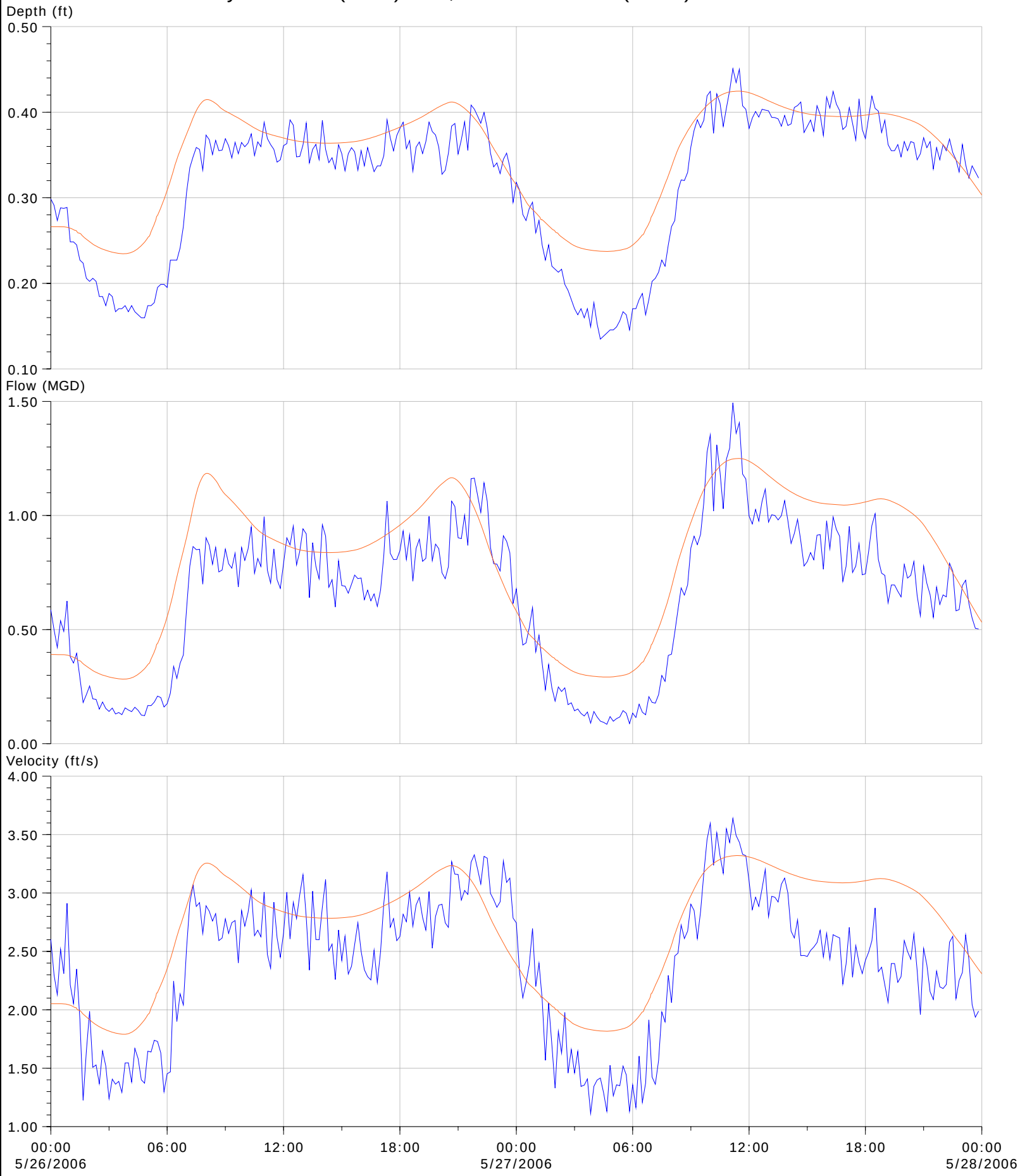
# Flow Survey Location (Obs.) 535, Model Location (Pred.) U/S 1941-20-8307.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.429 | 0.557 | 0.384 | 1.140 | 1.475 | 1.425 | 3.037 |
| DWF Model | 0.222 | 0.432 | 0.240 | 0.982 | 1.233 | 2.289 | 3.611 |

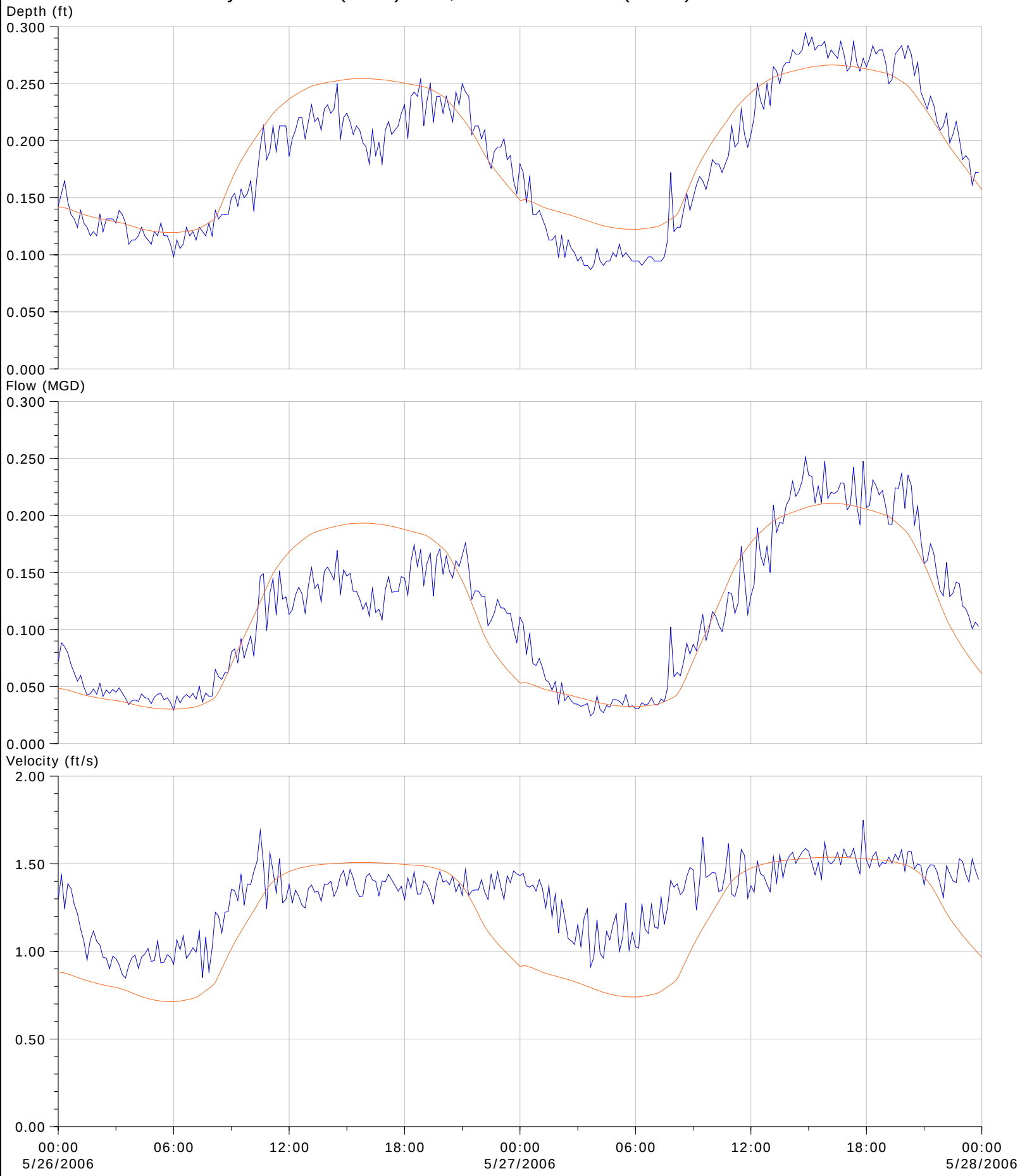
Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 544, Model Location (Pred.) D/S 1887-20-0545.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.135 | 0.451 | 0.085 | 1.494 | 1.302 | 1.113 | 3.639 |
| DWF Model | 0.234 | 0.425 | 0.283 | 1.250 | 1.600 | 1.790 | 3.320 |

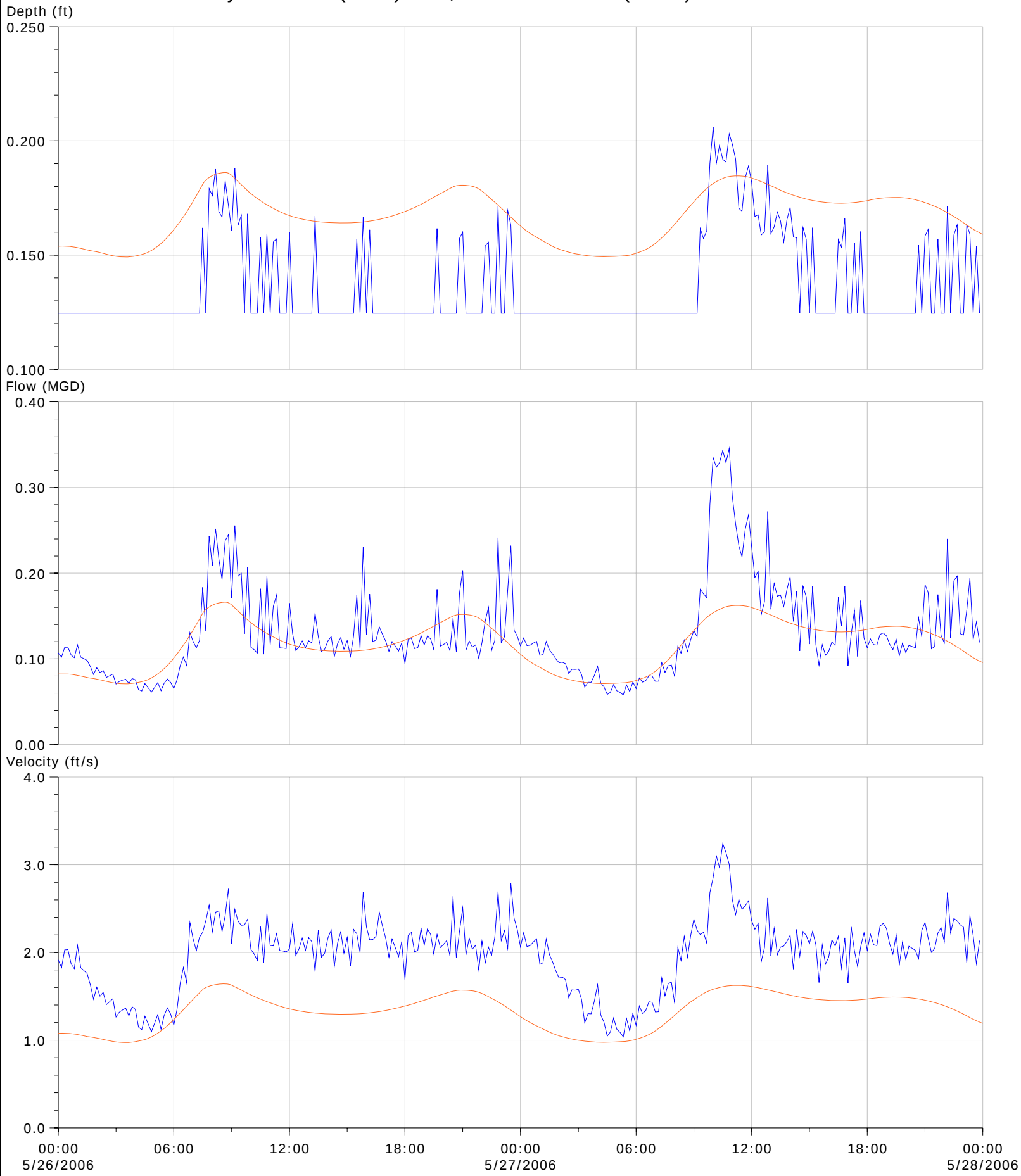
# Flow Survey Location (Obs.) 563, Model Location (Pred.) U/S 1886-20-0563.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.087 | 0.294 | 0.024 | 0.251 | 0.228 | 0.848 | 1.751 |
| DWF Model | 0.120 | 0.266 | 0.030 | 0.211 | 0.229 | 0.713 | 1.538 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

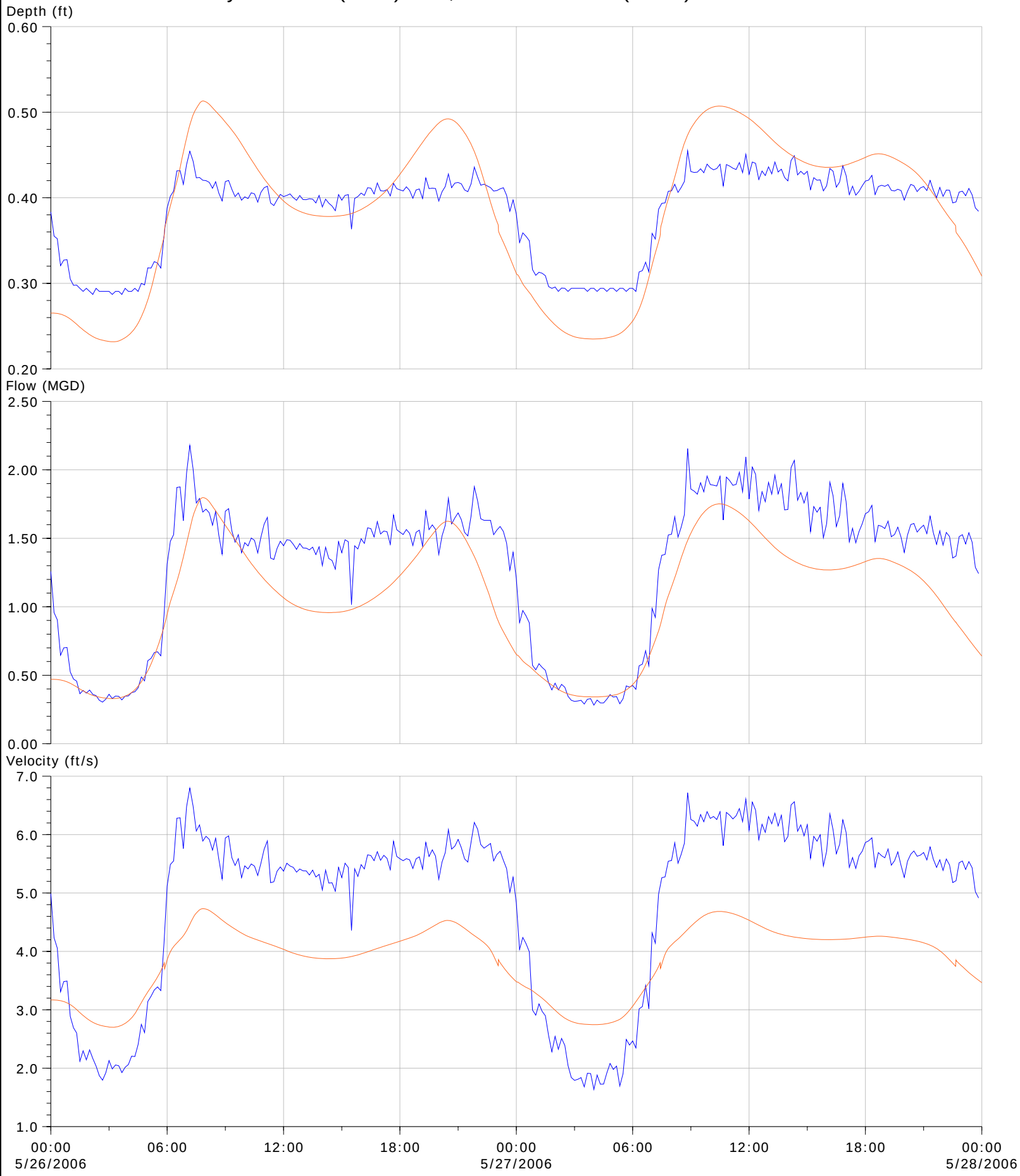
# Flow Survey Location (Obs.) 628, Model Location (Pred.) D/S 1887-20-9003.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.125 | 0.206 | 0.058 | 0.346 | 0.262 | 1.038 | 3.241 |
| DWF Model | 0.149 | 0.186 | 0.071 | 0.166 | 0.234 | 0.972 | 1.642 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

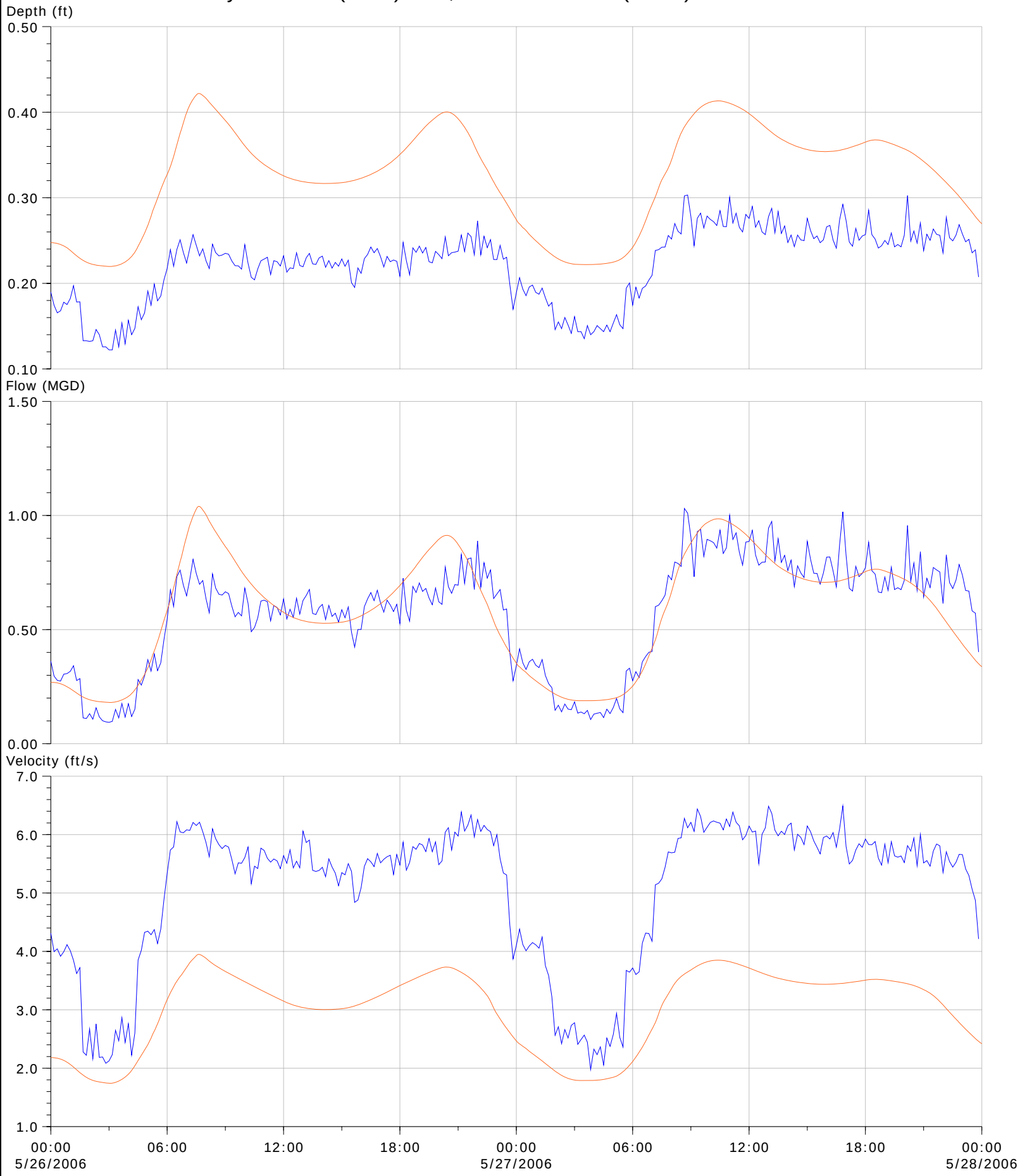
# Flow Survey Location (Obs.) 671, Model Location (Pred.) D/S 2048-20-0672.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.287 | 0.455 | 0.282 | 2.178 | 2.596 | 1.636 | 6.796 |
| DWF Model | 0.232 | 0.513 | 0.329 | 1.797 | 2.095 | 2.701 | 4.732 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

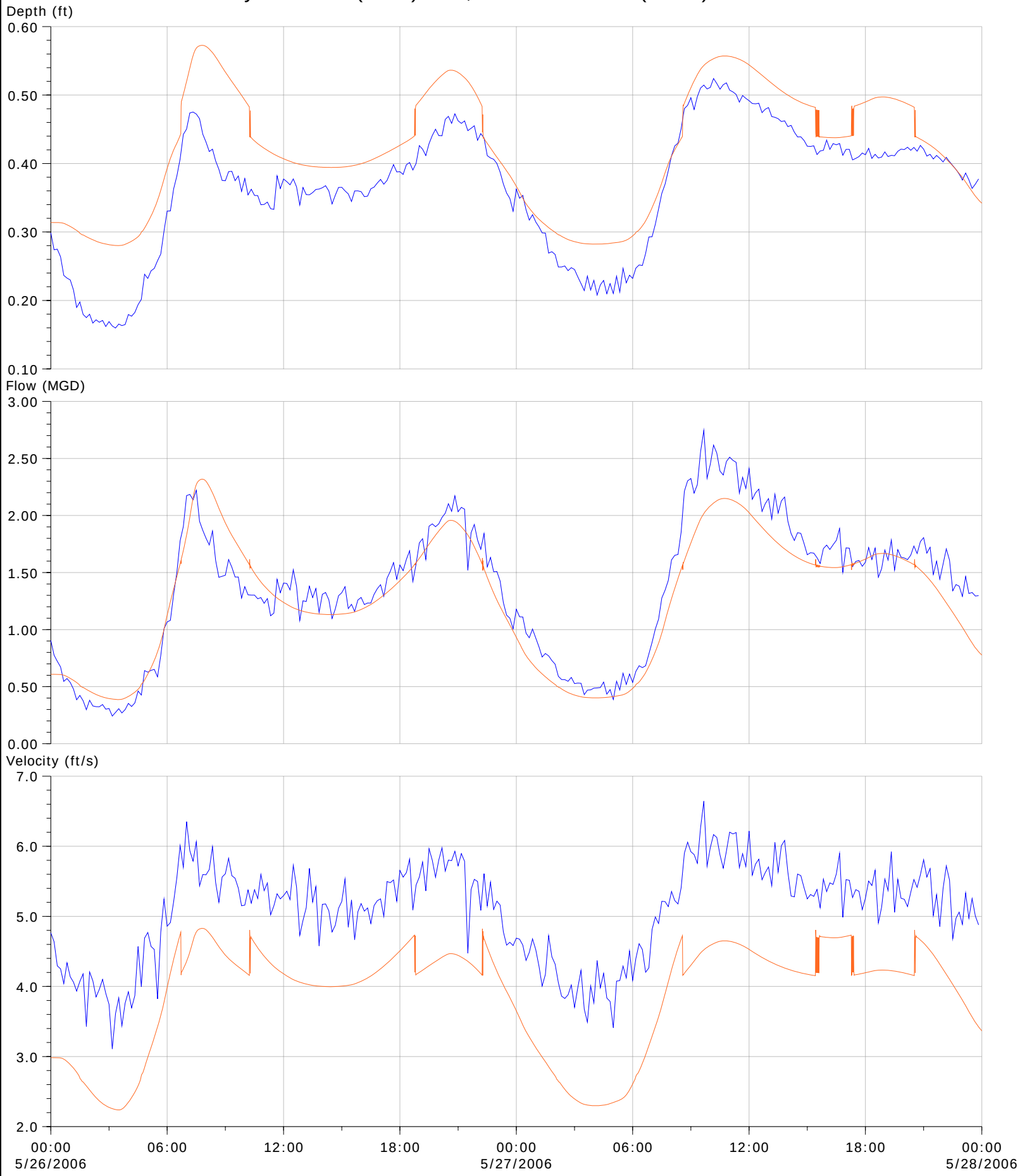
# Flow Survey Location (Obs.) 684, Model Location (Pred.) D/S 2049-20-0685.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.122 | 0.303 | 0.093 | 1.031 | 1.144 | 1.978 | 6.489 |
| DWF Model | 0.220 | 0.422 | 0.181 | 1.040 | 1.172 | 1.742 | 3.949 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

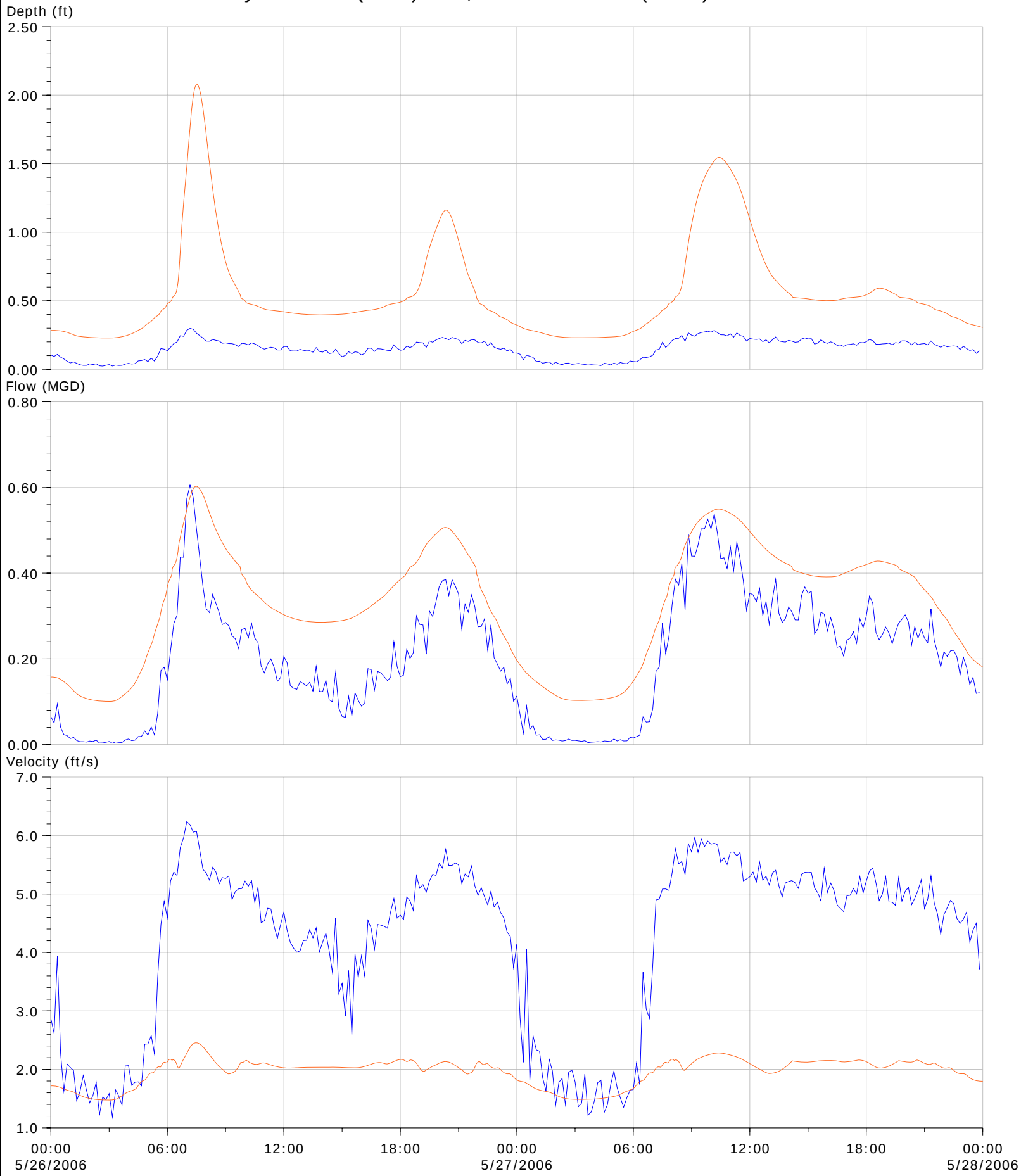
# Flow Survey Location (Obs.) 549, Model Location (Pred.) D/S 1776-0351.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.160 | 0.524 | 0.242 | 2.746 | 2.727 | 3.108 | 6.643 |
| DWF Model | 0.280 | 0.573 | 0.387 | 2.318 | 2.544 | 2.238 | 4.829 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

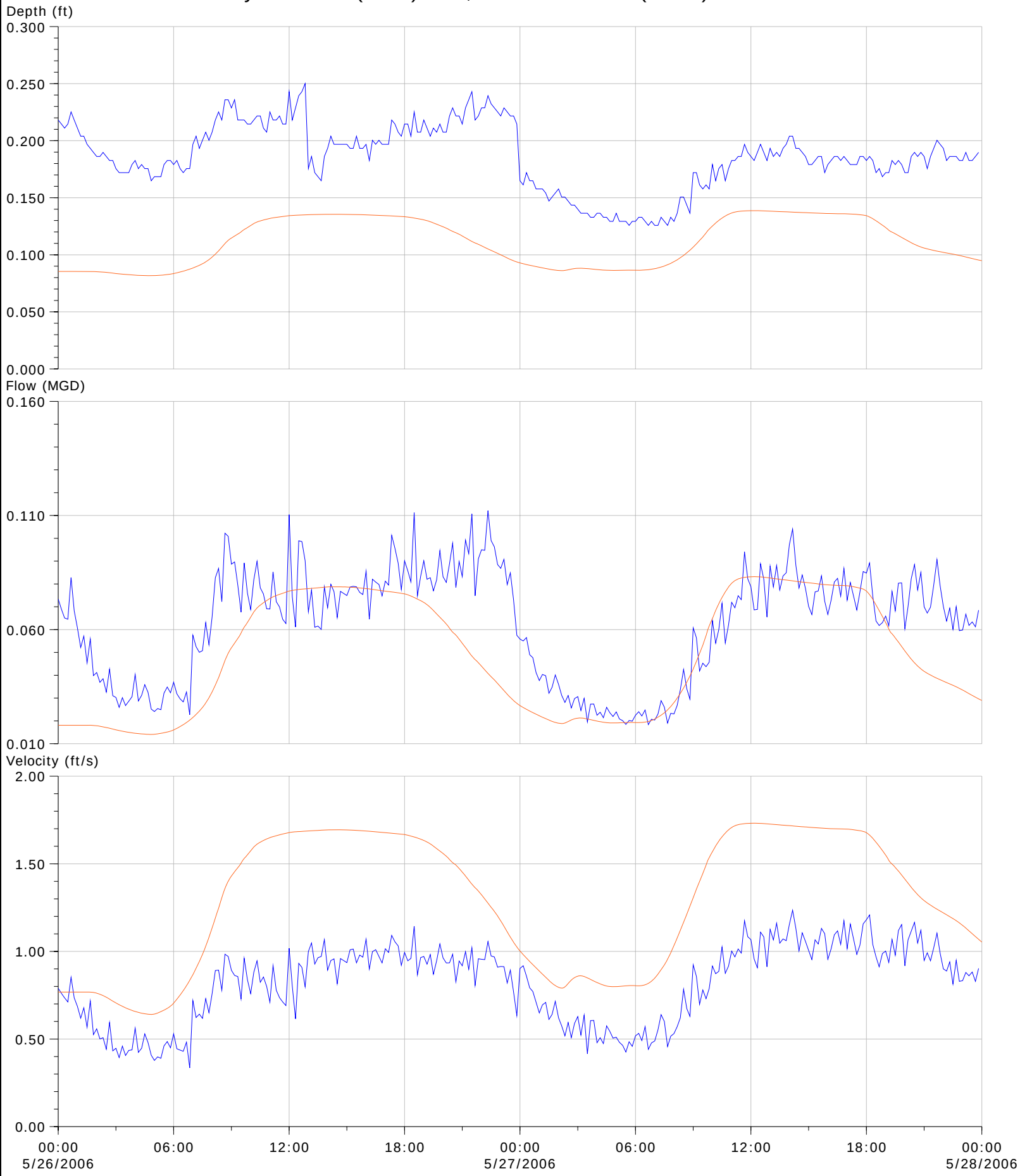
# Flow Survey Location (Obs.) 640, Model Location (Pred.) D/S 1775-0527.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.024 | 0.299 | 0.003 | 0.606 | 0.405 | 1.188 | 6.238 |
| DWF Model | 0.228 | 2.079 | 0.101 | 0.603 | 0.651 | 1.476 | 2.454 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 676, Model Location (Pred.) D/S 1938-0629.1




| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.126 | 0.250 | 0.018 | 0.112 | 0.125 | 0.335 | 1.235 |
| DWF Model | 0.082 | 0.139 | 0.014 | 0.083 | 0.098 | 0.640 | 1.731 |

Flow Survey: >Catchment Group>Flow Survey Group>Palmdale DWF Q (11/3/2008 4:20:57 PM)
Sim: >Catchment Group>Run Group>DWF_CAL_0005_010709>DWF (1/7/2009 11:47:40 AM)
Graph Template: >Catchment Group>Graph Template Group>DWF CAL Graph Template (11/19/2008 6:24:26 PM)

# Flow Survey Location (Obs.) 706, Model Location (Pred.) D/S 1884-0155.1

| | Depth (ft) | | Flow (MGD) | | | Velocity (ft/s) | |
|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Volume (US Mgal) | Min | Max |
| Meter | 0.104 | 0.192 | 0.005 | 0.188 | 0.145 | 0.151 | 2.763 |
| DWF Model | 0.091 | 0.173 | 0.021 | 0.130 | 0.147 | 0.892 | 2.205 |

# Appendix D - Technical Provisions Sanitary Sewer Condition Assessment and CCTV Inspection Services

# TECHNICAL PROVISIONS
# CITY OF PALMDALE
# SANITARY SEWER CONDITION ASSESSMENT
# AND CCTV INSPECTON SERVICES

## PART 1 RESPONSIBILITIES OF AND TASKS TO BE PERFORMED BY THE CONTRACTOR

A. Contractor shall perform the services described in these Technical Provisions.

B. Contractor shall perform such work with a degree of skill and diligence normally employed by Contractor performing the same or similar services.

C. Contractor shall furnish all labor, tools, equipment, materials, traffic control, safety requirements, inspection repots, reports and supplies required for the performance of the Sewer Condition Assessment and Closed Circuit-Television Inspection (CCTV), clearing of sewer lines requested by the City, and emergency response as specified hereinafter.

D. In the event CCTV inspection cannot be performed due to major debris accumulation and/or blockage, the Contractor may be directed to perform cleaning activities prior to inspection.

E. Contractor shall provide corrective services in thirty days without charge to the City for services, which fail to meet the standards and the specific guarantee requirements set forth in these Technical Provisions, and are reported to Contractor in writing. Should the Contractor fail or refuse to perform promptly its obligations under this warranty, the City may render or undertake the performance thereof and the Contractor shall be liable for any expenses thereby incurred.

## PART 2 GENERAL REQUIREMENTS

A. Contractor should take notice that inspection operations shall not result in the interruption of sewage service to any customer in the City. Sewage must be controlled within the pipeline at all times.

B. Contractor shall maintain proper license by the State of California to perform the required services during the period of this agreement.

C. Contractor shall provide an electronic copy of all field inspection and cleaning to be entered into the City's computer in a format acceptable to the City. For the purpose of backup, a paper copy of the completed log sheets will be kept by the contractor

D. Contractor shall reseal all manholes encountered that were sealed for the control of odors or entry of extraneous water.

E. Contractor shall notify and request the City for assistance, if needed, in connection with removal, dismantling, and replacements of any special equipment such as cameras or cleaning equipment within the manhole (MH) structures.

F. Contractor shall provide video identifying the pipe segment by manhole number and the street location. The narration shall identify all connections, general conditions of the sewer, problem areas, location of all connections or problem areas by linear footage, and observations concerning the condition of the pipe joints. Records of the daily work, inspection, logs and the video records (including but is not limited to: DVDs and/or hard drives) and/or electronic video formats capable of playing on a computer (Windows XP based computer) shall be prepared and forwarded to the City on a weekly basis. The video records become the property of the City. VHS tapes will not be accepted.

G. Contractor shall not remove any trees, plants, shrubs, or ornamental vegetation without the prior written consent of the City.

H. Contractor shall obtain all necessary permits and observe all standard rules of safety for pedestrian and traffic control in accordance with local laws and accepted practice. Additionally, the contractor shall demonstrate knowledge of current safety requirements for confined space entry. Additionally, Contractor shall comply with all Federal, State, and Local safety regulations and Cal-OSHA requirements.

I. Contractor shall progress with the work in an orderly manner at appropriate times not to interfere excessively with the normal routine of the neighborhood. A schedule of work shall be submitted to the City for review and approval prior to setting up for work.

J. Contractor shall be in full charge and be responsible for the job site, the scope of work of this Contract, and subject to the directions of the City's Project Manager or City staff in charge.

K. Contractor shall observe and comply with all Federal, State, and local laws, ordinances, codes, orders, and regulations, which in any manner affect the conduct of work, specifically as it relates to sewage spills.

L. Contractor shall be responsible for obtaining the "Encroachment Permit" required by the California Department of Transportation (Cal Trans) and/or Los Angeles County when performing work on any State or County highway. Contractor is also responsible for obtaining all applicable permits and paying permit fees for work within Caltrans and/or Los Angeles County rights-of-way.

M. Contractor shall respond to requests from the City to assess the sewer condition under emergency situations. Extra time spent by the Contractor due

to standby or coordination with the City staff shall be compensated by the agreed upon unit costs in Exhibit B, Price List.

N. For emergency situations, Contractor shall respond to a special request issued by the City within 24 hours for CCTV inspection. The Contractor shall have full time personnel experienced in CCTV/Video-tape review readily available within the time limits noted above upon an emergency notification.

O. Contractor must be prepared to perform sewer condition assessment services immediately upon execution of the agreement by the City or on July 1, 2009 whichever is the later date. Contractor is required to assume liability for all associated performance damages as specified.

P. In the event CCTV inspection cannot be performed due to major debris accumulation and/or blockage, the Contactor shall notify the City immediately. The City may require the Contractor to clean the sewer until blockage or sewer surcharge is relieved. Roots, grease, oil, sediment, or solids shall be removed to permit the visual review and recording of the inside wall of the sewer line. The contractor when directed by the City shall carry out hydraulic flushing and cleaning of the sewers prior to CCTV inspection. The CCTV inspection of this segment of sewer line may be re-scheduled.

## PART 3 NO GUARANTEE OF MINIMUM AMOUNT OF WORK

The City is not obligated to any minimum or maximum quantities under the contract. Nothing in this document or elsewhere in the contract documents shall be construed as obligating the City to do so.

## PART 4 SEWER CONDITION ASSESSMENT

### 4.1 CCTV Inspection

A. Contractor shall make a video recording of the television inspection and supply one copy to the City. The video recordings shall be in color and give clear video/pictures of conditions of pipelines requiring cleaning and any other structural problems. The recording(s) deemed unacceptable by the City shall be reproduced at no cost to the City. All data and video recording will become the sole property of the City without restrictions of future use, duplication, modification, and dissemination. Contractor shall have no vested rights to the completed work and may not sell or reuse it without the City's permission. The project data furnished to the Contractor for use in rendering project services shall remain the property of the City and shall be returned on termination of the agreement. Contractor may not distribute, sell or otherwise use data without permission of the City.

B. Contractor shall create pipeline reports, containing the measurement of faults and other features inside the pipeline. This includes measurements of pipe

size, laterals, water levels and other features, as well as automatic analysis of pipe ovality and pipe available capacity up to 30 times per second.

C. The camera shall be moved through the line in either direction at a uniform rate stopping when necessary to ensure proper documentation of the sewer's condition but in no case shall the television camera be pulled at a speed greater than thirty feet per minute (30 fpm).

D. As the camera approaches a lateral connection or substantial defect, the camera progress shall be halted and the camera lens panned to further view the lateral pipe and connection (including looking up the lateral) or defect to thoroughly evaluate its condition.

E. Manual winches, power winches, TV cable powered rewind or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the line. !f during the inspection operation the television camera will not pass through the entire manhole section, Contractor shall re-set his equipment in a manner so that the inspection can be performed from the opposite maintenance hole. If again, the camera fails to pass through the entire section, Contractor shall notify the City immediately.

F. If during the television inspection Contractor encounters a condition where public safety is threatened (such as, but not limited to, a pipe hole, pipe collapse, stoppage, blockage and/or eminent sewer spill) City Project Manager shall be notified immediately. Furthermore, CONTRACTOR shall provide a videotape copy of the section of line containing the condition within 24 hours to City.

G. If during the television Inspection, the camera is jammed inside the sewer and can not be retrieved, the contractor shall not excavate the pipe to retrieve it. Contractor shall inform the City immediately for assistance, but it is Contractor's responsibility to remove the camera and ensure that the sewer is not damaged.

H. Whenever non-remote powered and controlled winches are used to pull the television camera through the line, telephone, radios or other suitable means of communication shall be set up between the two manholes of the section being inspected to ensure that adequate communications exists between members of the crew.

4.2 Operators

All closed-circuit television (CCTV) operators shall be certified by the National Association of Sewer Service Companies (NASSCO) by passing the Pipeline Assessment and Certification Program (PACP). The methodology of evaluation, data collection, and reporting criteria used for the NASSCO certification shall be practiced for all CCTV inspections. No work under this Contract shall be performed by non-NASSCO certified operators. Contractor shall provide the Project Manager with copies of its CCTV operators' NASSCO certifications when requested.

4.3 Pre-Inspection Cleaning (Item No. 3 on Price List (Exhibit B)

All sewer pipelines to be inspected shall be sufficiently cleaned by the Contractor within 72 hours prior to CCTV inspection to provide clear examination of the pipe's interior and to provide sufficient opening for the camera to pass through the pipe. The Contractor shall be careful not to damage any pipes, including the plastic liners, if any.

Cleaning methods shall be employed to sufficiently clean the pipe so the camera can pass and fully ascertain and document the structural integrity and operational condition of the pipe. Any costs associated with CCTV work that is necessitated by the Contractor's failure to sufficiently clean the main line shall be borne by the Contractor.

All sludge, dirt, sand, rocks, grease, roots, and other solid or semisolid material resulting from the cleaning operations shall be removed and hauled away from the downstream manhole of the section being cleaned. Passing material from sewer section to sewer section shall not be permitted. The Contractor shall be responsible for removing all solid and semisolid materials from the cleaning operation from the work site no less often than at the end of each workday. Materials, which accumulate during the workday, shall be placed in totally enclosed and watertight containers. Handling, transport, and disposal of materials shall be in full compliance with all applicable Federal, State, and local requirements.

The Contractors shall verify the manhole locations and information provided by the Project Manager prior to the CCTV inspections. The Contractor shall notify Project Manager of any discrepancies.

4.4 CCTV Equipment

A. The Contractor’s CCTV equipment shall include video cameras, a video monitor cable, power sources, and all equipment necessary to perform a CCTV inspection as outlined in this Technical Specifications.

B. The cameras shall meet Cal-OSHA requirements for operating in the sanitary sewer environment.

C. The cameras shall have Pan-and-Tilt capabilities, and shall have a minimum of 360 x 270 degree rotation and illumination sensitivity shall be three lux or less and provide a minimum of 460 lines of resolution. The focal distance shall be adjustable through a range from 25 mm (1 inch) to infinity.

D. During CCTV inspection, lighting intensity shall be adjusted to minimize glare. Lighting and picture quality shall be adjusted to provide a clear, in-focus picture of the entire periphery of the pipeline for all conditions encountered.

E. All camera systems shall be able to navigate around minor objects, roots, and debris. The system used to move the camera through the pipe shall not obstruct the camera's view or interfere with proper documentation of the sewer conditions.

F. The camera cable shall be retracted to remove slack and to ensure an accurate footage reading.

G. The distance shall be measured between the exit of the start manhole and the entrance of the finish manhole for a true measurement of the length of the pipe segment, as required by PACP. It shall be recorded in standard units and the video display readout shall display units to one-tenth of a foot.

H. The cable footage-counter shall be accurate to plus or minus 2 feet per 1,000 feet. The Contractor shall calibrate their measuring device monthly with a known distance prior to starting the inspection and recording process.

I. Video inspection and reporting shall be submitted in a NASSCO-compatible format.

J. The camera lens shall be kept clear of condensation and debris during the CCTV inspection.

K. A Nationally Recognized Testing Laboratory must approve all electrical equipment, including CCTV cameras, for use in a Hazardous location and wet environments. This equipment must be approved for use in Class I, Division I, Group 0 Hazardous Locations as defined by the National Fire Protection Association (NFPA) Code 820-1999.

L. Contractor shall have the ability to communicate with its crew at all times (i.e.. cellular phone, radio, etc.)

M. Contractor shall have replacement equipment available within twenty-four (24) hours in the event of equipment breakdown.

4.5 Software Requirements

The Contractor shall perform all CCTV inspections using the WinCan V7 software in the PACP module. WinCan America Inc., can be contacted at (505) 341-0109. It is intended that the Contractor shall make a continuous digital recording of the complete pipe inspection. The recording shall also be used as a permanent record of defects. Unless directed otherwise by the City, the recording shall be MPEG 4. The Contractor shall pause the digital recording at any time there is a delay in the inspection and restart the digital video recording in the same digital file. The pause shall in no way affect, freeze, or interrupt the reply of the video and shall not close the video file during the inspection. The Contractor shall store a single video file for each pipeline inspected. The recorded files shall have a resolution of 352 by 240 pixels and an interlaced

frame rate of a minimum of 24 frames per second. The naming of the video file shall be automatic, consisting of the "FROM MANHOLE" ID, "TO MANHOLE" ID, and the eight-digit inspection date, as shown in the following example, or as specified by the City:

1813-0001_1813-0002_20050101
(FromMH_ ToMH_ YYYYMMDD)

All pictures shall be recorded as a JPEG image. For each picture, indexing shall exist as a separate text file of the observation noted. The data shall be time coded using the elapsed time from the video file. This shall allow the user in WinCan to use the indexing feature and go to that defect with a click instead of fast forwarding or rewinding. All pictures shall have the same file name as the pipeline video plus the footage where the picture is taken, as shown in the following example, or as specified by the City:

i. 1813-0001_1813-0002_20050101_125
ii. (FromMH_ ToMH_ YYYYMMDD_Footage)
iii. CCTV Time
iv. City Name .
v. Street Name ·
vi. Upstream Manhole ID ·
vii. Downstream Manhole ID .
viii. Direction of Survey - Upstream/Downstream .
ix. Pipe Diameter .
x. Pipe Material
xi. Pipe Length, ft (Est.)
xii. Weather .
xiii. Location Code (Ground Cover)

Separate video and data files shall be created for each sewer line segment. In case of reverse setup, such inspection shall be stored in a separate video and data files. If an undocumented manhole is discovered during the inspection, then a separate inspection shall be started for the additional pipe segment. The City will provide the Contractor with a list of unused manhole IDs for naming the undocumented manholes.

4.6 Video

A. The Contractor shall make a continuous color digital recording in MPEG 4 format for each pipe segment inspected, unless specified by City.

B. Video files shall have a minimum resolution of 352 x 240 pixels and an interlaced frame rate at a minimum of 24 frames per second.

C. Video inspection will not exceed a traverse rate of 30 feet per minute.

D. The Contractor shall pause the digital recording at any time there is a delay in the inspection and restart the digital video recording in the same digital file. The pause shall in no way affect, freeze, or interrupt the replay of the video and shall not close the video file during the inspection.

E. Each pipe segment (manhole to manhole) shall be identified with an initial text screen and completed in accordance with PACP's CCTV inspection form header Instructions and shall be as follows:

| Line | Number & Description |
|---|---|
| Line 1: | Surveyed By |
| Line 2: | Street |
| Line 3: | Location Code* |
| Line 4: | Weather* |
| Line 5: | Direction of Survey (upstream/downstream) |
| Line 6: | Use of sewer* |
| Line 7: | Pipe Material |
| Line 8: | Pipe Diameter/Height |
| Line 9: | Pipe Length (on plans) |
| Line 10: | Start Manhole Number |
| Line 11: | End Manhole Number |
| Line 12: | Pipe ID (PSR or MMS #) |
| Line 13: | Inspection Time/Date |

F. Line items noted with an asterisk (*) are optional depending on the line capacity of the text overlay equipment.

G. This data must completely match the data entered in the database header information.

H. The Contractor shall provide a sample submittal of the CCTV video output, inspection log, digital photos, and inspection evaluation database, after completing approximately 1 to 2 days of CCTV inspection. City staff shall determine the typical video quality, quality of cleaning of the pipe, and judgment exercised on the evaluation of pipe condition. This submittal shall note any changes to the Specifications listed regarding video format, compression or other conditions for review and approval by the City.

I. The initial text screen shall appear no more than 15 seconds at the beginning of the video footage, and shall appear before the 360 degree pan of the starting manhole.

J. During the CCTV inspection, the video shall show the following text at all times:

| Line Number | Description |
|---|---|
| Line 1: | City |

Line 2: Street/ Start Manhole Number/ Direction of Inspection/ End Manhole Number
Line 3: Pipe Material / Pipe Size
Line 4: Inspection Time/Date/Running Total

K. During the CCTV inspection, the camera shall stop at all defects and significant observations to ensure a clear and focused view of the pipe condition and shall rotate the camera head at the defect to allow for adequate evaluation at a later time.

L. The video recording shall include on-screen observation text for every observation recorded in the database, including AMH, in addition to the text in Section J above

M. The naming of the video file shall consist of the “FROM MANHOLE STATION NUMBER”, “TO MANHOLE STATION NUMBER”, and the eight digit inspection date, as shown in the following example, or as pre-approved by City:

1884-0021_1844-0035_20050101.mp4
(FromMHStation_ToMHStation_YYYYMMDD)

Note: “Manhole Station Number” may consist of survey station numbers as indicated on the design plans.

## 4.8 Photographs

B. Digital photographs in JPEG format shall be made of all recorded defect observations. These photographs will be computer generated with the use of the inspection reporting system software.

C. JPEG images shall be captured at a minimum resolution of 640x480 pixels.

D. At a minimum, all photographs shall be named consisting of the following descriptions: “FROM MANHOLE STATION NUMBER”, “TO MANHOLE STATION NUMBER”, eight digit inspection date, and the defect 'station' location along the pipe. It is in the Contractor's discretion as to additional data information that may be needed in the naming of the files to make each file unique within the file naming constraints of their inspection software.

1844-0021
-1844-0035_20050101_125_A.jpg
(FromMHStation_ToMHStation_YYYYMMDD_Defect Position_UniqueData)

E. Any additional information shall be included after the mandatory info specified above. The naming convention shall be consistent throughout the project.

F. A minimum of TWO photographs of each defect shall be taken, one with a perspective view and one with a close-up view.

G. ONE photograph is required for each lateral connection looking directly at the connection and each AMH observation from the bottom of the manhole looking up.

4.9 Additional Inspection Procedures

A. A full 360 degree pan of all manholes is required. This video footage shall occur at the beginning of each pipe segment survey inspection from the bottom of the manhole panning up the manhole shaft. The Contractor shall cover the manhole opening to prevent too much light from entering the structure and to ensure a clear and focused view of the manhole interior. In instances when the manhole is the terminating manhole, then the pan shall occur at the end of the pipe segment survey inspection.

B. Video footage shall be taken centered on the pipe with the water level running horizontally. The camera shall run along the invert of the pipe and not at its side, unless it is passing a point obstacle. If extended driving on the side of the pipe is required, then either the pipe needs a more thorough cleaning or an observation should be noted from the PACP codes describing the nature of the obstacle.

C. Obstructions may be encountered during the course of the CCTV inspection that prevent the travel of the camera. In instances when obstructions are not passable, the Contractor shall withdraw the equipment and begin a CCTV inspection from the opposite end of the sewer reach.

D. If a particular line is inspected more than once, then the Contractor shall include all versions of the inspections in the database. The MGO observation shall be used on all inspections except at the first occurrence. The Contractor shall provide an explanation for the additional inspections in the Remarks section.

4.95 Special Conditions

EXCESSIVE DEPTH OF FLOW:

A. Maximum depth of flow for CCTV inspections shall be 25 percent of the pipe diameter. If the depth of flow is greater, then the CCTV inspection shall be performed during the low flow periods between the hours of 10:00 p.m. to 6:00 a.m.

B. The Contractor shall pay special attention to all local jurisdiction rules and regulations, especially regarding activities during off-peak hours.

C. If the flow is still above 25 percent on the return trip, then the Contractor can use a flow-controlling mechanism (i.e. flow reducer) to control the flow

and proceed with the inspection. After the initial screen and AMH observation, the MGO observation shall be used to note the reason for the return to this location and indicate the use of such flow-controlling equipment, in the appropriate box in the section header information screen.

D. The Contractor shall include the original inspection in the final submittal even with high flow conditions.

E. If the Contractor encounters a surcharging manhole (whereas the flow at the manhole is at least 50 percent of the sewer pipe diameter), then the Contractor shall immediately notify the Public Works Maintenance at (661) 267-5338.

## PART 5 SUBMITTALS AND DELIVERABLES AND REVIEW

### 5.1 Submittal

The Submittal will consist of:

A. An external hard drive (provided by the contractor at contractor's expense) or DVD(s) containing the database, video, and photo files.

B. A printed Report in a hardcover white clear view 3-ring binder labeled as described in Section 5.2 containing the following information:

a. Footage calibration report for each camera used.

b. PACP Certificate copies of all operators.

c. Summary table of all pipeline segments inspected with the following fields in the order listed:

Column 1: Date of Inspection
Column 2: Start Manhole
Column 3: Stop Manhole
Column 4: Total Pipe Length (per as-built plan)
Column 5: Televised Length
Column 6: Quick Maintenance Rating (per PACP)
Column 7: Quick Structure Rating (per PACP)
Column 8: Section Number

(*NOTE: The table shall be sorted by StartManhole)

d. An observation table of all pipeline segments inspected with the following fields in the order listed:

Column 1: Section Number
Column 2: Position of Defect
Column 3: Observation Code (per PACP)

Column 4: Observation Description (per PACP)
Column 5: Structural Grade (per PACP)
Column 6: O&M Grade (per PACP)

(*NOTE: The table shall be sorted by Section Number)

5.2 Deliverables

A. All video recording, image files, and databases shall be submitted in a digital format approved by Public Works and electronically stored in a WinCan V7, PACP database format, for proper data management. All video recording, image files, databases, and reports shall be generated using the Win Can V7 software. The digital CCTV inspections shall be submitted on an external hard drive with USB 2.0 connection. All submittals shall become the property of the City.

B. DVD's or External hard drive(s), binder cover and binder spine label shall include the following information on computer-generated labels:

1. City of Palmdale Collection System Division

2. General Contractor Name and Sub-contractor Name

3. Project Name and City Agreement No.

4. Start Date of CCTV Inspections (e.g. MM/DD/YYYY)

5. Finish Date of CCTV Inspections (e.g. MM/DD/YYYY)

C. All files included as part of the deliverables shall be contained within one single folder on the DVD or hard drive and labeled with the project name and the date as:

Y0TV0708A_20071220_Submittal (ProjectName_YYYYMMDD_SubmitalName)

An executive summary for the CCTV Inspection shall be provided in a format acceptable to the City and shall be provided within one (1) week from the completion of the inspection.

Contractor shall also submit the contractor's written report in digitized form. Contractor shall record in color videotape of the data on the television monitor, a digital video disc (DVD) as required by the City. Said copy shall be provided to the City within one (1) week after the job is assigned. If requested by the City, the Contractor shall have the ability to provide copies of said DVD recordings within 24 hour of the assignment. Contractor shall have all DVDs and necessary playback equipment readily accessible for review by the City during the life of the contract. The DVDs shall give clear pictures of conditions of pipelines requiring

cleaning and any other structural problems. DVD(s) deemed unacceptable by the City shall be reproduced at no cost to the City.

DVD shall include the following information:

Visual
- Manhole ID numbers
- Pipe Material
- Date of TV Inspection
- Current distance along reach (tape counter footage) and
- Printed labels on DVD container and tape cartridge with location information, date format information, and other descriptive information

Inspection Report of the CCTV project shall be submitted in a three-ring hardcover notebook that includes the following:

- Brief summary of work performed
- Footage calibration report for each camera ·
- Summary list of all pipeline segments inspected ·
- Pipe graphic reports (log sheets) of each segment
- Sewer maps and plans provided by the City to the Contractor for purposes of the inspection
- External hard drive (USB 2.0) containing electronic files of all video recordings, images, and databases of inspection data

The Project Inspection Report for each segment shall be as specified above and the database shall contain at least the fields listed below or as specified by the City. All fields shall be completed in accordance with PACP procedures:

- Surveyed by - Operator Name
- PACP Certification Number
- System Owner · Survey Customer (City of Palmdale - Sewer Maintenance).
- Contract Number
- Pipe ID
- CCTV Date
- CCTV Time ·
- Street Name and Number
- City Name
- Further Location Details - nearest cross street name
- Upstream Manhole ID ·
- Downstream Manhole ID ·
- Direction of Survey - Upstream/Downstream
- Pipe Diameter
- Pipe Shape

- Pipe Material
- Lining Method - if applicable
- Total Length of Pipe - as specified on plans
- Total Length Survey
- DVD/Media Number - use the Work Order Number
- Pre-cleaning
- Weather
- Location Code
- Pipe - slope, if inclinometer surveys requested
- Pipe - drop (total invert elevation change, if inclinometer surveys requested)
- Water Level (initial depth of water surface to invert)
- Water Mark (depth of high water mark to invert)
- Observation descriptions
- Observation - JPEG image (each)
- Observation - footage (each)
- Observation - clock position (each)
- Observation - PACP defect code (each)
- Observation - comments (each, if any)
- Schematic of pipeline showing laterals and observations
- Photographs of major defects or typical pipe condition

Video or DVD. and written reports shall be submitted to.

City of Palmdale
Director of Public Works
Public Works Department
38250 N. Sierra Highway
Palmdale, CA 93550

5.3 Review

A. The video recordings, photographs, and data shall be reviewed by the CITY for focus, lighting, clarity of view, and technical quality.

B. Videos or photographs recorded while a camera has flipped over in the process of traveling or the viewing of laterals, obstructions, or defects are blocked by cables, skids or other equipment will not be accepted.

C. Shape, focus, proper lighting, and clear, distortion-free viewing during the camera operations shall be maintained. Failure to maintain these conditions will result in the rejection of the video and/or photographs by the CITY.

D. Videos or photographs recorded showing steam, inadequate lighting, or other poor image quality will be cause for rejection by CITY.

E. Any reach of sewer where recording quality, inspection, and/or report is not acceptable to CITY according to this Technical Specifications shall be re-televised, or data modified at no additional cost to the City.

## PART 6 ADDITIONAL RESPONSIBILITIES OF THE CONRACTOR

A. In the event of any Contractor-related overflow or interruption/backup of customer service, the Contractor shall immediately notify the Public Works Maintenance Division at (661) 267-5338, and shall contain and eliminate the overflow. The contract shall also immediately notify the Project Manager.

B. The Contractor shall be responsible for any fines levied by others, reimbursement of any agency incurred costs, damage, cleanup, restoration of flow, and any disruption of service costs to customers as a result of the Contractor's work. This is in addition to any and all costs incurred by the customer. City reserves the right to deduct any costs resulting from the above by reducing the amounts from the next invoice owed to the contractor or by direct billing to the contractor which shall be paid no later than thirty (30) days following invoice date.

C. The Contractor shall respect the rights of property owners, and not enter upon private property without obtaining permission from the owner of the property.

D. For manholes located on easements of private property, the Contractor shall provide the property owner with 24-hour advanced notice for easement access prior to entering the property, unless the property owner provides immediate permission (Note: renters cannot provide access).

E. Be responsible for placing proper traffic warning devices to protect the specific jobsite, and to prevent accidents or personal injury to the public. The Contractor shall provide police protection and/or flagger for safe traffic control. Some line sections will be located in heavy traffic areas.

## PART 7 EMERGENCY NOTIFICATION

A. Contractor shall immediately notify the City whenever a surcharged sewer or a partial or total pipe blockage is discovered. Contractor shall contact the CITY at (661) 267-5338 during normal work hours Monday through Friday, except holidays, or the City's emergency phone number at (661) 267-5338 at all other times. Contractor shall indicate the location, nature of the problem, and when the problem was first detected. Contractor may continue working, but shall stay onsite or nearby until City forces arrive, unless otherwise instructed by City representatives.

## PART 8 SAFETY

A. Contractor shall comply with all Federal. State, and local safety regulations and all applicable Cal-OSHA requirements. If confined space entry into a live sewer is necessary, the City requires continuous ventilation and monitoring of the manhole atmosphere for hydrogen sulfide, combustibles, and oxygen concentration during manhole entry. Contractor is required to operate and maintain his or her safety equipment and is responsible for all safety training for his or her crew. Contractor shall never leave an open manhole unattended.

B. All equipment must be removed from the sewer at the end of each work session. Contractor shall perform all work in the safest possible manner. The City may make unannounced inspections to ensure compliance with safety requirements. If Contractor is deemed to be working in an unsafe manner by the City, the Contract may be terminated.

## PART 9 TRAFFIC CONROL AND PUBLIC CONVENIENCE & SAFETY

### 9.1 Traffic and Access

A. Traffic control shall be established by Contractor and shall conform to requirements of the current "**California Manual of Uniform Traffic Control Devices** as amended by the **2003 California Supplement".** There are a number of sewer lines that are heavy in the heavy traffic areas and will require the use of arrow board(s) and an extensive traffic control set up. When major traffic control setup is required, City Traffic Engineer may require the submittal of a traffic control plans. Such plan shall address the specific manner in which vehicle and pedestrian access and safety will be maintained during maintenance work. In addition, Caltrans may require major traffic control setup and submittal of traffic control plans for work within Caltrans right-of-way. Contractor is responsible for paying all permits fees, including preparation of traffic control plans required by Caltrans or City Traffic Engineer.

B. If the Contractor is required to submit traffic control plans, or if the Contractor proposes revised plans, all traffic protection and control plans shall be prepared by a California Registered Civil Engineer and submitted to the City's representative (or Caltrans – for all work within Caltrans R/W) for review and approval twenty (20) days prior to the beginning of such operations. No work shall begin until traffic protection and control plans have been approved by the City and the Caltrans Inspector.

C. The Contractor shall give 48-hour notice to affected property owner prior to blocking any driveway or entering onto a private easement. The Contractor shall provide adequate access at all times to City, County and Caltrans Maintenance staff and their representatives during contract work hours. Contractor shall daily clean-up the work area prior to leaving the work site, to allow City, County and Caltrans Maintenance staff and their representatives to have safe and convenient access during non-contract work hours.

D. Contractor shall be responsible for obtaining the "Encroachment Permit" required by the California Department of Transportation (Caltrans) or Los Angeles County when performing work on any State Highway and/or County Streets. The Contractor shall obtain, at no cost to the City, the required permits, licenses or rights of entry authorizing the Contractor to perform said work for the City

9.2 Traffic Access - Street Closures, Detours, Barricades

A. The Contractor shall provide and install barricades, delineators, warning devices and construction signs in accordance with the plans and the **California Manual of Uniform Traffic Control Devices** as amended by the **2003 California Supplement**. During adverse weather or unusual traffic or working conditions additional traffic devices shall be placed as directed by the Director of Public Works. All traffic signs and devices shall conform to the current State of California, Department of Transportation, Manual of Warning Signs, Lights, and Devices for Use in Performance of Work upon Highways, unless otherwise approved by the Director of Public Works.

B. The Contractor shall not close any street within the City of Palmdale without first obtaining the approval of the Director of Public Works. Barricading, traffic control and detour diagrams in connection with street closures shall be submitted by the Contractor as required by the Director of Public Works.

C. Should the Contractor fail to furnish a sufficient number of traffic and/or pedestrian safety devices, the City will place such necessary items and the Contractor shall be liable to the City for providing such devices in accordance with the following provisions:

1. For placing of barricades - $5.00 per barricade for the first day or any part thereof and $2.00 per barricade per day for each day thereafter or any part thereof.

2. For flashers - $2.50 per flasher for the first day or any part thereof and $1.00 per flasher per day for each day thereafter or any part thereof.

3. For traffic cones - $1.00 per cone for each day or any part thereof.

4. In the event that the services of the City are required between the hours of 3:30 P.M. and 7:00 A.M., during the normal week or at any time on Saturday, Sunday, or a City holiday, there shall be an additional charge to the above set forth minimums of $100.00 for each service trip required.

D. Contractor shall relocate, preserve and maintain the visibility of all existing signs within the project limits which affect the flow of traffic, as directed by the Director of Public Works. Any signs which are damaged or found to be

missing during the course of construction shall be replaced by the Contractor at his expense as directed by the Director of Public Works. All other signs that interfere with the course of work and are not necessary for the safe flow of traffic shall be covered over by the Contractor.

E. All open trenches within barricaded areas are to be covered with plywood during non-working hours. Steel plates are required when traffic is to be maintained. All work shall be per Cal-OSHA and City requirements.

F. All intersections shall remain open at all times to all traffic movement with turn pockets unless otherwise approved by the City.

9.3 Safety Orders

A. The Contractor is hereby advised of the provisions of Section 6705 of the California Labor Code which pertain to trench excavation:

B. Public works involving an estimated expenditure in excess of twenty-five thousand dollars ($25,000) for the excavation of any trench or trenches five feet or more in depth, shall require the submission by the contractor, and acceptance by the awarding body or by a registered civil or structural engineer, employed by the awarding body, to whom authority to accept has been delegated, in advance of excavation, of a detailed plan showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches. If such plan varies from the shoring system standards, the plan shall be prepared by a registered civil or structural engineer.

Nothing in Section 6705 shall be deemed to allow the use of a shoring, sloping, or protective system less effective than that required by the Construction Safety Orders.

Nothing in Section 6705 shall be construed to impose tort liability on the City or any of its employees.

9.4 Emergency Provisions

A. Unusual conditions may arise on the work which will require that immediate and unusual provision be made to protect the public from danger or loss or damage to life and property, due directly or indirectly to the prosecution of the work, and it is part of the service required of the Contractor to make such provisions and to furnish such protection.

B. Whenever, in the opinion of the City, an emergency exists of which the City is aware and against which the Contractor has not taken sufficient precaution for the safety of the public or the protection of utilities or of adjacent structures or property which may be injured by the progress of

construction; and whenever, in the opinion of the City, immediate action shall be considered necessary in order to protect public or private personnel or property interests, or prevent likely loss of human life or damage on account of the operations under the Contract, then in that event the City may provide suitable protection to said interests by causing such work to be done and material to be furnished, as in the opinion of the City may seem reasonable and necessary, all at the expense of the Contractor.

## PART 10 MEASUREMENT AND PAYMENT

A. Measurement and payment for CCTV and condition assessment inspection of existing sanitary sewer pipelines and manholes shall be at the unit price per linear foot, regardless of diameter, for such inspection as determined in the City geographic information system unless the contractor can show that the measurement differs significantly by measurement along the horizontal centerline of the existing pipe from the downstream edge of the manhole to the outlet edge of the next upstream manhole, and in accordance with the requirements of these Contract Documents. CCTV Inspections and condition assessment shall include approximately 28 to 30 miles of system-wide inspection (more or less), and approximately 20 miles (more or less) as-needed inspections, which include post blockage responses, sewer referrals from the cleaning by either CSMD or sewer cleaning contractor, quality control and hot spot inspections. CCTV inspection of post blockage responses, quality control and hot spot inspections <u>shall be performed within 24 hours of notification from the City</u>.
The Contractor's failure to timely respond shall result in a two-hundred dollar ($250.00) penalty per incident.

B. Payment shall be made at the unit price per linear foot, regardless of pipeline diameter, indicated in the Proposal for which price shall constitute full compensation for furnishing all materials, labor, permits, traffic control set up (heavy and light traffic areas), tools and equipment for video inspection/taping of the existing sanitary sewer pipelines and manholes including, but not limited to, Sections 5.1 – 5.3, submittals, deliverables, and review of these technical specifications, permitting, safety requirements, reports, DVD discs, hard drive, and all other incidental work not specifically described in any other item of the specifications, complete-in-place, as specified and/or shown.

C. Compensation for all traffic control requirements, including scheduling, posting signs, notifications, permits, traffic control plans, fees, traffic control and emergency provisions shall be included in the item no. 1 of Exhibit B (Price List), and no additional compensation shall be allowed therefore. Contractor is also responsible for obtaining all applicable permits and paying permit fees for work within Caltrans rights-of-way.

D. In general, the actual length video inspection should be used for invoicing purposes. The actual length is the distance that the Contractor was able to video inspect in lineal feet from the inside face of the upstream wall of the downstream manhole, where the cleaning equipment was placed into the pipe, to the farthest point along the pipe segment that cleaning was conducted with a maximum length being up to the inside face of the upstream wall of the upstream manhole.

E. If a clean pipe is only able to be partially inspected due to an obstruction, the Contractor shall immediately alert the City.

F. If the Contractor chooses not video inspect the full length of pipe, the City may choose to use its crews to video the pipe. In this case, the Contractor shall not be able to invoice for this pipe.

G. If the obstruction is found to be a physical defect which did not allow the video inspection to take place, then the Contractor may invoice for the amount actually video taped by the Contractor.

H. For pipes that are able to be video taped in their entirety, the invoiced length will be compared to the GIS length to look for inconsistencies. Also, City representatives will be inspecting work sites and measurement techniques during this project.

I. Compensation for all debris removed from a pipeline segment shall include the cost of removal, transportation, reporting and tip fees associated with the complete removal and legal disposal of all material in compliance with all standards and requirements for debris disposal. The above items (A thru I) shall be included in the item 1 on Exhibit B (Price List).

J. Payment for hydraulic flushing and cleaning prior to CCTV inspection shall include water, water meter, traffic control, safety requirements, hauling disposal of materials, dump fees, all materials, labor, permits, tools and equipment, and shall be included in the unit price per linear foot of sewer lines flushed and cleaned, per item no. 2 of Exhibit B (Price List). This task is done only when requested by the City.

** END **