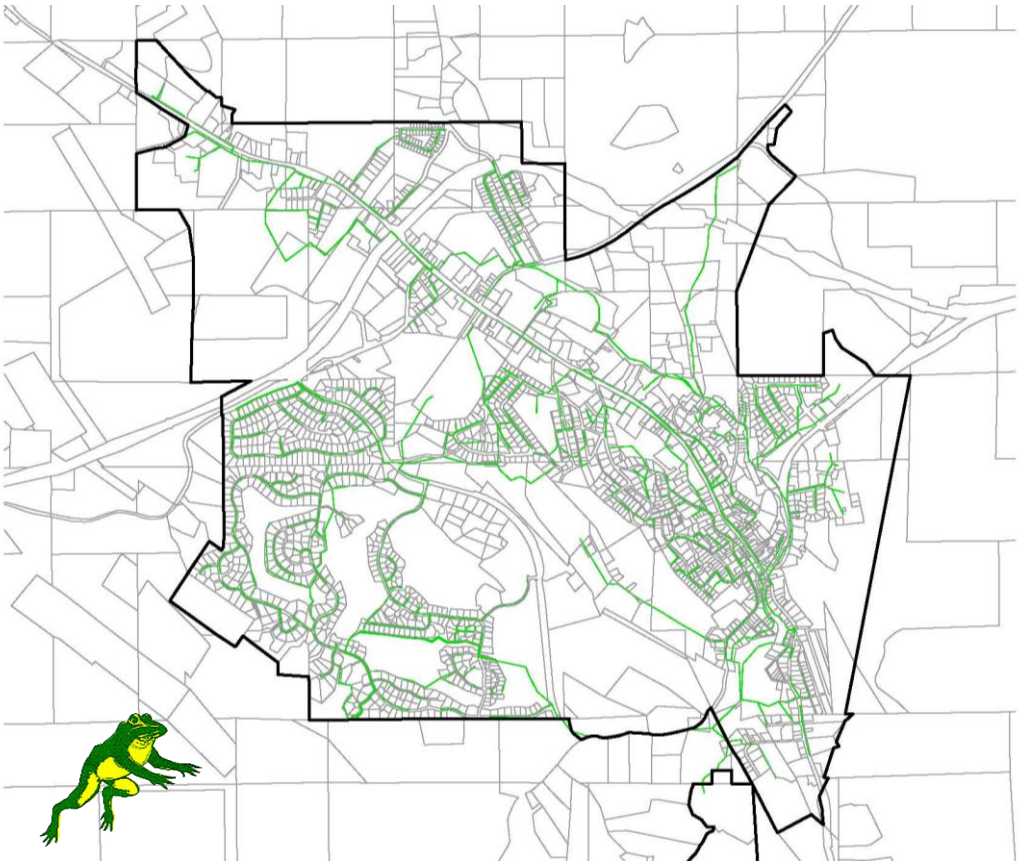
CITY OF ANGELS
WASTEWATER MASTER PLAN

VOLUME ONE



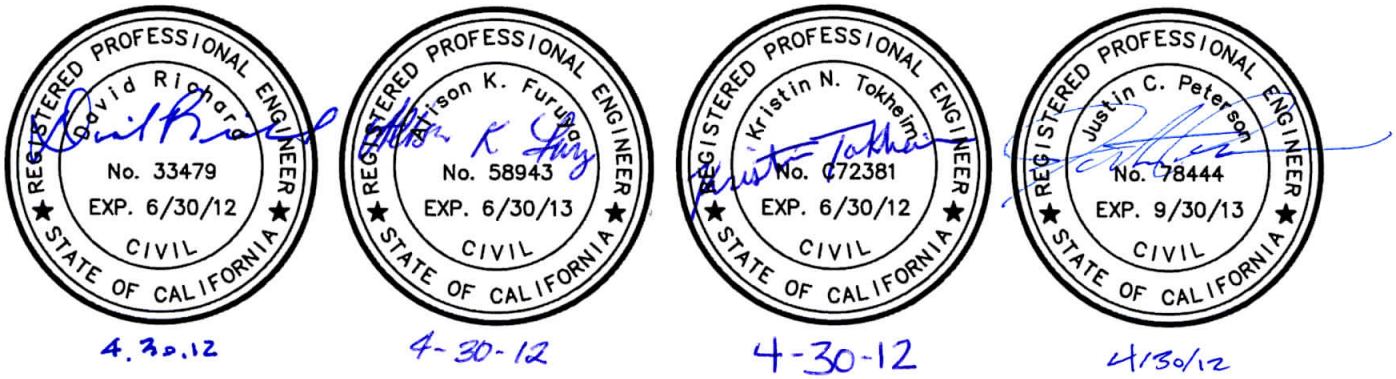
Funding Provided By:
State of California
Department of Housing and Community Development
Technical Assistance Grant 09TTAG-6496

APRIL 2012

NOLTE VERTICALFIVE

CITY OF ANGELS
WASTEWATER MASTER PLAN

VOLUME ONE



APRIL 2012

Submitted to:

City of Angels
584 South Main Street
Angels Camp, CA 95222

Prepared by:

Nolte Associates, Inc.
(a Nolte Vertical Five company)
1215 West Center Street, Suite 201
Manteca, CA 95337
(209) 239-9080 ▪ (209) 239-4166 (Fax)

Executive Summary

A Wastewater Master Plan (Master Plan) was prepared for the City of Angels (City) wastewater collection, treatment, and disposal system to ensure the City has adequate facilities to support future growth as defined in the recently adopted City of Angels 2020 General Plan (General Plan) [1]. The study area for the Master Plan is based on the current City limits from the General Plan [1] and does not include areas within the sphere of influence (SOI) beyond the City limits. Wastewater management for areas requiring annexation will be the subject of future technical studies. This Master Plan is partially funded by the State of California, Department of Housing and Community Development, Community Development Block Grant (CDBG) #09-PTAG-6496. Tasks completed as part of the Master Plan included:

1. A review of previous reports and studies completed within the last 23 years for the collection, treatment, and disposal facilities.

2. Site visits to the existing facilities and a review of available drawings and operational practices.

3. A review of the existing regulatory requirements for the wastewater facilities and a discussion of potential future requirements.

4. Development of design criteria.

5. Analysis of existing wastewater flow and potential impacts associated with legislated reductions in water use to estimated future flow projections.

6. Execution of six hydraulic model scenarios to identify existing and buildout capacity issues within the collection system and the potential impact of reduced inflow and infiltration (I/I).

7. Evaluation of wastewater treatment, storage, and disposal facilities.

8. An analysis of the existing City wastewater operational structure and survey of the operational structure for similar utilities.

9. Development and alternatives analysis of recommended improvements for the collection system, wastewater treatment, and disposal facilities.

10. Prioritization of recommended improvements to develop a short-term and long-term capital improvement plan (CIP).

11. Review of City wastewater budgets and comparison with projected CIP costs.

12. Identification of potential funding sources and preparation of a universal funding application.

From the review of existing operational practices and issues and evaluation of the capacities of the wastewater facilities, a short-term and long-term CIP was developed. The CIP was prioritized using a simplified Business Risk Exposure (BRE) model which considered the Consequence of Failure (CoF) and Probability of Failure (PoF) for the group of assets within each project. Projects with the greatest BRE rating (the product of the CoF and PoF factors) were assigned the highest priority and scheduled earlier in the CIP.

The total CIP cost was $11.3 million, with an average annualized cost of $570,000. Comparing the projected CIP costs to recent City wastewater revenues and the revenues and expenditures anticipated by the 2005 Wastewater Rate and Connection Fee Study Public Hearing presentation (2005 Wastewater Rate Study) [2] indicates that additional revenues will be needed to adequately fund the recommended CIP projects. Included as a recommended CIP projects are a connection fee study and a rate study to better assist with determining appropriate project financing.

CONTENTS

Page

Executive Summary ES-1

Chapter 1 Introduction 1–1

1.1 Background and Purpose 1–1
1.2 Scope of Master Plan 1–2

Chapter 2 Summary of Previous Reports 2–1

2.1 Previous Master Plan 2–1
2.2 I/I Study 2–1
2.3 Wastewater Collection System Improvements Study – 1998 2–1
2.4 Alternatives Analysis for North Angels Sewer Trunk Line – 2008 2–4
2.5 Downtown Wastewater Collection System Improvement Study – 2009 2–4
2.6 City of Angels Municipal Service Review – 2009 2–6
2.7 City of Angels Camp Sanitary Sewer Management Plan – 2009 2–7
2.8 City of Angels Draft System Evaluation & Capacity Assurance Plan – 2010 2–9

Chapter 3 Description of Existing Wastewater System 3–1

3.1 Sewer Collection System 3–1
3.2 Wastewater Treatment and Disposal Facilities 3–3
3.3 Overview of Collection System Operation and Maintenance Program 3–4
a. Maintenance Program Activities 3–4
b. Maintenance Issues to be Addressed 3–6
c. Historical and Current Maintenance Projects 3–8
d. Public Works Maintenance Schedule 3–10
3.4 Agreement with Calaveras County Water District 3–10

Chapter 4 Regulatory Setting 4–1

4.1 Wastewater Treatment Plant 4–1
a. Treatment Plant Waste Discharge Requirements 4–1
b. NPDES Permit 4–3
c. Reporting Requirements 4–4
4.2 Wastewater Collection System 4–9
4.3 Notice of Violation/Administrative Civil Liability Complaint 4–11

Chapter 5 Design Criteria 5-1

5.1 Study Area 5-1
5.2 Pump/Lift Stations 5-1
5.3 Conveyance Pipelines 5-2
a. Gravity Pipelines 5-2
b. Force Main Criteria 5-3
5.4 Wastewater Treatment Plant 5-3
5.5 Effluent Storage and Disposal Facilities 5-4

Chapter 6 Projected Wastewater Flows 6-1

6.1 Study Area 6-1
6.2 Land Use 6-6
a. Existing Areas 6-6
b. Future Areas 6-9
6.3 Analysis of Existing Dry Weather Flows 6-11
a. Wastewater Treatment Plant 6-11
b. Pump Stations and Six Mile Village 6-12
c. Summary of Existing Flows 6-12
d. Discussion of Service Area Population and Per Capita Factors 6-13
6.4 Development of Wastewater Generation Factors 6-14
a. Discussion of Equivalent Single Family Units for Land Use Categories 6-14
b. Development of WGF 6-19
c. Comparison of Estimated Flows Versus Actual Flows 6-22
d. Review of Recommended WGFs 6-23
6.5 Impacts of Water Conservation 6-25
6.6 Projection of Future Dry Weather Wastewater Flows 6-26
a. Projected Growth 6-27
b. Buildout Wastewater Flows 6-28
6.7 Conclusions 6-29

Chapter 7 Evaluation of Capacity of Wastewater Treatment, Storage, and Disposal Facilities 7-1

7.1 Identification of Needs at Wastewater Treatment and Disposal Facilities 7-1
7.2 Existing and Projected Flows 7-1
7.3 Historical Water Quality 7-4
a. Influent Water Quality 7-4
b. Effluent Water Quality for Land Discharge 7-5
c. Effluent Water Quality for Surface Water Discharge 7-6
7.4 Evaluation of Capacity of Treatment Facilities 7-7
a. Sequencing Batch Reactors 7-8
b. Intermediate Pumps 7-8
c. Continuous Backwash Filters 7-9
d. Ultraviolet Disinfection 7-11
e. Equalization Basin 7-12
f. Aerobic Digesters 7-15
g. Belt Filter Press 7-17
h. Sludge Drying Beds 7-19
7.5 Evaluation of Storage and Disposal Facilities Capacity 7-21
a. Description of Facilities 7-21
b. Existing and Projected Wastewater Flows and I/I 7-22
c. Precipitation 7-23
d. Evaporation/Evapotranspiration 7-24
e. Percolation and Reservoir Seepage 7-25
f. Angels Creek Flows 7-26
g. Summary of Water Balances 7-29

7.6 Conclusions 7-32

Chapter 8 Evaluation of Collection System Capacity 8-1

8.1 Summary of Wastewater Generation Factors 8-1
8.2 Summary of Average Dry Weather Flow 8-2
8.3 Development of Peak Wet Weather Flow Projections 8-3
a. Methodology for Estimating Peak Wet Weather Flow (PWWF) 8-4
b. Calculated Total Influent Flow from Collection System 8-4
c. Diurnal Peaking Factor 8-6
d. Inflow and Infiltration Allowance 8-6
8.4 Hydraulic Evaluation 8-9
a. Hydraulic Model Software 8-9
b. Hydraulic Model Inputs 8-10
c. Results of Capacity Evaluation 8-16
8.5 Results of Hydraulic Model 8-16
a. Gravity Sewer Hydraulic Deficiencies 8-17
b. Force Main Hydraulic Deficiencies 8-26
c. Pump Station Hydraulic Deficiencies 8-26
d. Recommended Capacity Improvements 8-27
8.6 I/I Reduction 8-30
8.7 Conclusions 8-36

Chapter 9 Evaluation of Operational Structure for Wastewater Management 9-1

9.1 Summary of Operational Structure of City Wastewater Facilities 9-1
a. Public Works Staff and Department Activities 9-1
b. Water and Sewer Operations 9-3
c. Operational Issues with Current Structure 9-3
9.2 Comparison to Similar Sized Communities 9-3
a. Summary of Organizational Structures 9-4
b. Trends in Organizational Structures 9-10
9.3 Regulatory Requirements Associated with Operation of Wastewater Facilities 9-13
9.4 Conclusions 9-14

Chapter 10 Recommended Improvements 10-1

10.1 Collection System Recommended Improvements and Alternatives Considerations 10-1
10.2 Wastewater Treatment Plant Recommended Improvements and Alternatives Considerations 10-6
10.3 Additional Recommended Projects 10-8
10.4 Prioritization of Recommended Improvements 10-8
10.5 Consequence of Failure 10-9
10.6 Probability of Failure 10-11
10.7 Business Risk Exposure Analysis and Results 10-12

Chapter 11 Probable Project Costs 11-1

11.1 Construction Cost Accuracy 11-1
11.2 Collection System Improvement Project Costs 11-1

a. Unit Piping Construction Costs 11-1
b. Improvement Project Costs 11-4
11.3 WWTP Improvement Project Costs 11-5
11.4 Master Plan and Rate Study Project Costs 11-6

Chapter 12 Capital Improvement Plan 12-1

12.1 Project Costs 12-1

Chapter 13 Improvement Project Funding 13-1

13.1 Historical City Wastewater Budget 13-1
13.2 Comparison of CIP with Historical Wastewater Capital Improvement Budgets and Sewer Rate Structure 13-2
13.3 Potential Funding Options and Sources 13-3
a. State Water Resources Control Board Wastewater Funding Programs 13-4
b. United States Department of Agriculture Rural Development 13-4

Chapter 14 References 14-1

APPENDICES

Appendix A WWTP Process Flow Diagram

Appendix B Wastewater Collection System Maintenance Program

Appendix C Summary of SSO Events

Appendix D WWTP Design Criteria

Appendix E Land Use Summary

Appendix F Treatment Plant Flow Summary, 2009-2011

Appendix G Pumping Station Flow Summary, 2010-2011

Appendix H Estimated Flows by Basin for Existing Areas

Appendix I Projected Growth and Wastewater Flows by Basin

Appendix J Buildout Flow Summary by Basin

Appendix K Phased Improvement Plan for Sprayfield Disposal System

Appendix L 2009-2011 Influent Water Quality for WWTP

Appendix M 2009-2011 Effluent Water Quality for WWTP

Appendix N Intermediate Pump Station Hydraulic Calculations

Appendix O Equalization Basin Capacity Analysis

Appendix P Existing and Projected I/I Flows

Appendix Q Water Balances for City of Angels Wastewater Management System

Appendix R Parcel Assignments for Hydraulic Model Loads

Appendix S	Peak Wet Weather Flow Calculations for Hydraulic Model Loads
Appendix T	Results of Hydraulic Model
Appendix U	CCR Title 23, Division 3, Chapter 26 - Classification of Wastewater Treatment Plants and Operator Certification
Appendix V	Agency Interview Questions, Responses, and Organizational Charts
Appendix W	Operator Certification Newsletters issued by Cal/EPA and the State Water Resources Control Board
Appendix X	Improvement Project CoF and PoF Ratings
Appendix Y	City of Angels 2010 Improvement Standards, Trench Detail SS-5
Appendix Z	Pipe Unit Cost Breakdown
Appendix AA	Collection System Improvement Project Costs
Appendix BB	Wastewater Treatment Plant Improvements Detailed Project Costs

LIST OF TABLES

Table 2-1 City of Angels Wastewater Master Plan Summary of Projects Recommended in 1998 Wastewater Collection System Improvements Study 2–2

Table 2-2 City of Angels Wastewater Master Plan Summary of Recommended Projects in 2009 Downtown Wastewater Collection System Improvement Study 2–6

Table 2-3 City of Angels Wastewater Master Plan Summary of Planned Projects Listed in City of Angels 2009 Sanitary Sewer Management Plan 2–9

Table 2-4 City of Angels Wastewater Master Plan Required Sewer Line Replacements Identified in City of Angels Draft System Evaluation and Capacity Assurance Plan 2–10

Table 3-1 City of Angels Wastewater Master Plan Summary of Wastewater Pump Stations 3–3

Table 4-1 City of Angels Wastewater Master Plan Summary of Land Discharge Effluent Limitations 4–2

Table 4-2 City of Angels Wastewater Master Plan Summary of Reclaimed Water Discharge Effluent Limitations 4–2

Table 4-3 City of Angels Wastewater Master Plan Summary of Effluent Discharge Specifications/Prohibitions for Land Discharge 4–2

Table 4-4 City of Angels Wastewater Master Plan Summary of Sludge Discharge Specifications/Prohibitions 4–3

Table 4-5 City of Angels Wastewater Master Plan Summary of Discharge to Angels Creek Effluent Limitations 4–4

Table 4-6 City of Angels Wastewater Master Plan Reporting Requirements 4–5

Table 4-7 City of Angels Wastewater Master Plan Mandatory Elements of Sewer System Management Plan 4–10

Table 4-8 City of Angels Wastewater Master Plan Proposed Sprayfield Improvement Projects 4–12

Table 5-1 City of Angels Wastewater Master Plan Maximum Desired Ratio of Normal Liquid Depth in Pipe to Pipe Diameter 5-3

Table 5-2 City of Angels Wastewater Master Plan Design Flows and Loadings for WWTP 5-4

Table 6-1 City of Angels Wastewater Master Plan Land Use Descriptions 6-6

Table 6-2 City of Angels Wastewater Master Plan Summary of Existing Land Uses by Basin 6-7

Table 6-3 City of Angels Wastewater Master Plan Summary of Buildout Land Uses by Total Acreage for Each Basin 6-9

Table 6-4 City of Angels Wastewater Master Plan Wastewater Treatment Plant Flow Data, 2009-2011 6-11

Table 6-5 City of Angels Wastewater Master Plan Pump Station and Six Mile Village Flow Data, 2010-2011 6-12

Table 6-6 City of Angels Wastewater Master Plan Methodology for Determining Wastewater Flow by Basin 6-13

Table 6-7 City of Angels Wastewater Master Plan ADWF Flows 6-13

Table 6-8 City of Angels Wastewater Master Plan Wastewater Flows Per Capita 6-14

Table 6-9 City of Angels Wastewater Master Plan California Department of Finance Data 6-14

Table 6-10 City of Angels Wastewater Master Plan ESU Conversion Factors for Developed Residential Parcels 6-15

Table 6-11 City of Angels Wastewater Master Plan ESU Conversion Factor for Worldmark Club 6-16

Table 6-12 City of Angels Wastewater Master Plan ESU Conversion Factors for Developed Commercial Parcels 6-16

Table 6-13 City of Angels Wastewater Master Plan Total Estimated Flow From Public Land Uses 6-17

Table 6-14 City of Angels Wastewater Master Plan Total Estimated Flow From Public Schools 6-18

Table 6-15 City of Angels Wastewater Master Plan Total Estimated Flow From Parks and Recreation Parcels 6-18

Table 6-16 City of Angels Wastewater Master Plan Total Estimated Flow From Golf Courses 6-18

Table 6-17 City of Angels Wastewater Master Plan Calculation of WGF 6-20

Table 6-18 City of Angels Wastewater Master Plan ESU Conversion Factor for Public Land Uses 6-21

Table 6-19 City of Angels Wastewater Master Plan Summary of ESU Conversion Factors 6-22

Table 6-20 City of Angels Wastewater Master Plan Comparison of Existing ESU and Projected Flow Summary by Basin Versus Actual Flows 6-23

Table 6-21 City of Angels Wastewater Master Plan Comparison of WGFs with Department of Finance Population Data 6-24

Table 6-22 City of Angels Wastewater Master Plan Historical Water Usage For Fixtures and Appliances 6-25

Table 6-23 City of Angels Wastewater Master Plan Water Use Considering New Water Conservation Legislation and Programs 6-26

Table 6-24 City of Angels Wastewater Master Plan Projected Population, Development, and Wastewater Flows by Basin 6-27

Table 6-25 City of Angels Wastewater Master Plan Projected Wastewater Flows With and Without Water Conservation 6-28

Table 6-26 City of Angels Wastewater Master Plan Buildout ESU and Projected Flow Summary by Basin (Without Conservation) 6-28

Table 6-27 City of Angels Wastewater Master Plan Estimated Reduction in Wastewater Flows from Water Conservation 6-29

Table 7-1 City of Angels Wastewater Master Plan Wastewater Treatment Plant Flow Data, 2009-2011 7-3

Table 7-2 City of Angels Wastewater Master Plan Projected Wastewater Flows for 10-Year, 20-Year, and Buildout Scenarios 7-4

Table 7-3 City of Angels Wastewater Master Plan Summary of Historical Influent BOD and TSS for WWTP 7-5

Table 7-4 City of Angels Wastewater Master Plan Summary of Historical Effluent Water Quality for WWTP and WDR Limitations for Land Discharge 7-6

Table 7-5 City of Angels Wastewater Master Plan Summary of Historical Effluent Water Quality for WWTP and NPDES Limitations for Discharge to Angels Creek 7-7

Table 7-6 City of Angels Wastewater Master Plan Sequencing Batch Reactors Operational Flow Ranges 7-8

Table 7-7 City of Angels Wastewater Master Plan Intermediate Pumps System Capacity and Operation Summary 7-9

Table 7-8 City of Angels Wastewater Master Plan Operational Requirements for Continuous Backwash Filters 7-10

Table 7-9 City of Angels Wastewater Master Plan Operational Guidelines for Continuous Backwash Filters 7-11

Table 7-10 City of Angels Wastewater Master Plan Summary of UV Disinfection System Capacity 7-12

Table 7-11 City of Angels Wastewater Master Plan Rainfall Recorded From March 18 – March 26, 2011 7-13

Table 7-12 City of Angels Wastewater Master Plan Projected I/I and Equalization Volume Required During Storm Event 7-15

Table 7-13 City of Angels Wastewater Master Plan Historical WAS Production from SBR System 7-16

Table 7-14 City of Angels Wastewater Master Plan Summary of Aerobic Digester System Capacity at Various Detention Times 7-17

Table 7-15 City of Angels Wastewater Master Plan Projected Performance for Belt Filter Press 7-18

Table 7-16 City of Angels Wastewater Master Plan Summary of Belt Filter Press System Operation and Sludge Production 7-19

Table 7-17 City of Angels Wastewater Master Plan Characteristics of Sludge Drying Beds and Covered Stockpile Area 7-20

Table 7-18 City of Angels Wastewater Master Plan Summary of Sludge Drying Beds and Covered Stockpile Area Capacity 7-21

Table 7-19 City of Angels Wastewater Master Plan Characteristics of City of Angels Treatment, Storage, and Disposal Facilities 7-22

Table 7-20 City of Angels Wastewater Master Plan Existing and Projected ADWF at City of Angels WWTP 7-22

Table 7-21 City of Angels Wastewater Master Plan Estimate of Existing I/I Flows to City of Angels WWTP 7-23

Table 7-22 City of Angels Wastewater Master Plan Monthly Precipitation for N-yr, 10-year, 25-year, and 100-year Conditions 7-24

Table 7-23 City of Angels Wastewater Master Plan Monthly Evaporation and Evapotranspiration for N-yr, 10-year, 25-year, and 100-year Conditions 7-25

Table 7-24 City of Angels Wastewater Master Plan Projected Seepage Rates for Holman Reservoir 7-26

Table 7-25 City of Angels Wastewater Master Plan Historical Stream Flows for Angels Creek Below Murphy's After Bay and Comparison with Precipitation Years 7-27

Table 7-26 City of Angels Wastewater Master Plan Projected N-yr and Dry Year Stream Flows for Angels Creek at WWTP Discharge Location 7-28

Table 7-27 City of Angels Wastewater Master Plan Angels Creek Stream Flows and Allowable Effluent Discharge Volumes 7-29

Table 7-28 City of Angels Wastewater Master Plan Summary of Water Balance Calculations for City of Angels Wastewater Management System 7-30

Table 8-1 City of Angels Wastewater Master Plan Summary of ESU Conversion Factors 8-2

Table 8-2 City of Angels Wastewater Master Plan Projected ADWF by Basin (Without Water Conservation) 8-3

Table 8-3 City of Angels Wastewater Master Plan Projected ADWF by Basin (With Water Conservation) 8-3

Table 8-4 City of Angels Wastewater Master Plan Wastewater Treatment Plant Flow Data During 2011 Peak Storm Event 8-8

Table 8-5 City of Angels Wastewater Master Plan Calculation of I/I Allowance 8-8

Table 8-6 City of Angels Wastewater Master Plan Summary of Wastewater Pump Stations 8-10

Table 8-7 City of Angels Wastewater Master Plan Summary of Force Mains 8-11

Table 8-8 City of Angels Wastewater Master Plan Applied Pipeline Friction Factors 8-11

Table 8-9 City of Angels Wastewater Master Plan Results of Flow Loading Scenarios 8-16

Table 8-10 City of Angels Wastewater Master Plan Summary of Difference Between Hydraulic Model and Recorded Flows 8-16

Table 8-11 City of Angels Wastewater Master Plan Hydraulically Limited Sewers Existing Wet Weather Loading (2011 Peak Storm) Scenario 8-18

Table 8-12 City of Angels Wastewater Master Plan Hydraulically Limited Sewers Buildout Wet Weather Loading (2011 Peak Storm) Scenario..... 8-19

Table 8-13 City of Angels Wastewater Master Plan Hydraulic Evaluation of Force Mains.... 8-26

Table 8-14 City of Angels Wastewater Master Plan Hydraulically Limited Pump Stations.... 8-27

Table 8-15 City of Angels Wastewater Master Plan Recommended Gravity Sewer Capacity Improvement Projects..... 8-28

Table 8-16 City of Angels Wastewater Master Plan Hydraulically Limited Sewers Buildout Wet Weather Loading (2011 Peak Storm with Reduced I/I) Scenario.... 8-31

Table 8-17 City of Angels Wastewater Master Plan Comparison of Recommended Capacity Improvements 8-34

Table 9-1 City of Angels Wastewater Master Plan Characteristics of Agency Wastewater Collections Organizational Structures 9-11

Table 9-2 City of Angels Wastewater Master Plan Characteristics of Agency Wastewater Treatment Organizational Structures 9-12

Table 10-1 City of Angels Wastewater Master Plan Recommended Collection System Hydraulic Capacity Improvements 10-5

Table 10-2 City of Angels Wastewater Master Plan Recommended Wastewater Treatment, Storage, and Disposal Facility Improvements..... 10-7

Table 10-3 City of Angels Wastewater Master Plan Consequence of Failure Factors..... 10-10

Table 10-4 City of Angels Wastewater Master Plan Probability of Failure Factors 10-11

Table 10-5 City of Angels Wastewater Master Plan Business Risk Exposure Scores 10-12

Table 11-1 City of Angels Wastewater Master Plan Unit Construction Costs for Excavation Work 11-2

Table 11-2 City of Angels Wastewater Master Plan Assumed Open Trench Dimensions 11-3

Table 11-3 City of Angels Wastewater Master Plan Assumed Installation Rate 11-3

Table 11-4 City of Angels Wastewater Master Plan PVC SDR 35 Pipe Material Costs 11-4

Table 11-5 City of Angels Wastewater Master Plan Unit Pipe Costs 11-4

Table 11-6 City of Angels Wastewater Master Plan Collection System Improvement Project Costs 11-5

Table 11-7 City of Angels Wastewater Master Plan WWTP Improvement Project Costs 11-6

Table 11-8 City of Angels Wastewater Master Plan Master Plan and Rate Study Project Costs 11-6

Table 12-1 City of Angels Wastewater Master Plan Short Term CIP for FY 2012-2013 through FY 2021-2022 12-2

Table 12-2 City of Angels Wastewater Master Plan Long-Term CIP for FY 2022-2023 through FY 2031-2032 12-3

Table 13-1 City of Angels Wastewater Master Plan City Wastewater Revenue and Expenditures 13-1

Table 13-2 City of Angels Wastewater Master Plan Sewer Capital Improvement and Capital Replacement Projects For FY 2011-12 13-2

Table 13-3 City of Angels Wastewater Master Plan 2005 Wastewater Rate Study Replacement and Depreciation Cost Expense Assumptions 13-3

LIST OF FIGURES

Figure 2-1 1998 Wastewater Collection System Improvement Study Projects 2–3
Figure 2-2 North Angels Sewer Trunk Line 2–5
Figure 2-3 Projects Listed in 2009 Sanitary Sewer Management Plan 2–8
Figure 3-1 City Pump Stations 3–2
Figure 3-2 Cleaning Frequency 3–5
Figure 3-3 Completed CCTV Work 3–7
Figure 3-4 Maintenance Issues Identified by City Staff 3–9
Figure 6-1 Limits of Existing Sewer Basins 6-2
Figure 6-2 Existing Sewer System Flow Schematic 6-3
Figure 6-3 Limits of Future Sewer Basins 6-4
Figure 6-4 Future Sewer System Flow Schematic 6-5
Figure 6-5 Existing Developed Land Uses 6-8
Figure 6-6 Buildout Land Uses 6-10
Figure 7-1 WWTP Flow Meters 7-2
Figure 8-1 WWTP Influent Flow Schematic 8-5
Figure 8-2 Average Daily Dry Weather Diurnal Flow Pattern at WWTP 8-7
Figure 8-3 Backbone of Existing System Hydraulic Model 8-12
Figure 8-4 Backbone of Future System Hydraulic Model 8-13
Figure 8-5 Developed and Undeveloped Parcels 8-15
Figure 8-6 Results of Hydraulic Model at Existing ADWF 8-22
Figure 8-7 Results of Hydraulic Model at Existing PWWF 8-23
Figure 8-8 Results of Hydraulic Model at Buildout ADWF 8-24
Figure 8-9 Results of Hydraulic Model at Buildout PWWF 8-25
Figure 8-10 Results of Hydraulic Model at Buildout PWWF (Reduced I/I) 8-33
Figure 9-1 Current Organizational Chart 9-2
Figure 10-1 Capital Improvement Plan Hydraulic Capacity Improvements - Phase 1 10-2
Figure 10-2 Capital Improvement Plan Hydraulic Capacity Improvements - Phase 2 10-3
Figure 10-3 Capital Improvement Plan Hydraulic Capacity Improvements - Phase 3 10-4
Figure 10-4 Business Risk Exposure Model 10-9

LIST OF ABBREVIATIONS

The following abbreviations are used in this report:

AACE	Association for the Advancement of Cost Engineering
ac	Acre
ac-ft	Acre-Feet
ACL	Administrative Civil Liability
ADWF	Average Dry Weather Flow
AWWA	American Water Works Association
BAE	Business Attraction/Expansion
BOD	Biochemical Oxygen Demand
BRE	Business Risk Exposure
Cal EMA	California Emergency Management Agency
CAO	Cleanup and Abatement Order
CC	Community Commercial
CCR	California Code of Regulations
CCTV	Closed-Circuit Television
CCWD	Calaveras County Water District
CDBG	Community Development Block Grant
CDPH	California Department of Public Health
cf	Cubic Foot
CFD	Community Facility District
cfs	Cubic Foot per Second
CIP	Capital Improvement Plan
cm	Centimeter
CO	Cleanout
CoF	Consequence of Failure
CPO	Chief Plant Operator
CWA	Clean Water Act
CWC	California Water Code
CWSRF	Clean Water State Revolving Fund
d/D	Liquid Depth in Pipe/Diameter Ratio
DPF	Diurnal Peaking Factor
DUNS	Data Universal Numbering System
EBMUD	East Bay Municipal Utilities District
EPA	United States Environmental Protection Agency
EQ	Equalization
ESFU	Equivalent Single-Family Unit
ESU	Equivalent Sewer Unit
ET	Evapotranspiration
FAAST	Financial Assistance Application Submittal Tool
fps	Feet per Second
ft	Feet or Foot
FTE	Full Time Equivalent
FY	Fiscal Year

LIST OF ABBREVIATIONS (Cont.)

gal/cf	Gallons per Cubic Foot
GCSD	Groveland Communities Service District
GHC	Greenhorn Creek
GIS	Geographical Information Systems
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
gpd/ac	Gallons per Day per Acre
gpd/du	Gallons per Day per Dwelling Unit
gpd/ESFU	Gallons per Day per Equivalent Single-Family Unit
gpd/ESU	Gallons per Day per Equivalent Sewer Unit
gpf	Gallons per Flush
gpm	Gallons per Minute
gpm/sf	Gallons per Minute per Square Foot
GWDR	General Waste Discharge Requirements Order No. 2006-0003-DWQ
HC	Historic Commercial
HDR	High Density Residential
HDR-WMC	Worldmark Club
hrs	Hours
I	Industrial
I/I	Inflow and Infiltration
in	Inch
Kc	Crop Coefficient
lbs	Pounds
LEED	Leadership in Energy and Environmental Design
lf	Lineal Foot
MDR	Medium Density Residential
MFP	Maximum Flow to Process
MG	Million Gallons
mgd	Million Gallons per Day
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MH	Manhole
MHI	Median Household Income
mJ	Millijoules
mL	Milliliter
mL/L	Milliliter per Liter
mph	Miles per Hour
MPN	Most Probable Number
MRP	Monitoring and Reporting Requirements
MSR	Municipal Service Review
ND	Non Detect
NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit

LIST OF ABBREVIATIONS (Cont.)

NWRI	National Water Research Institute
N-yr	Normal Year
OIT	Operator in Training
OCC	Office of Operator Certification
O&M	Operation and Maintenance
OS	Open Space
P	Public
PDWF	Peak Dry Weather Flow
PR-Golf	Golf Courses
PLSD	Private Lateral Sewage Discharges
PoF	Probability of Failure
POTW	Publically Owned Treatment Works
PPL	Project Priority List
PR	Parks and Recreation
P-SCH	Public Schools
Public Works	City Public Works Department
PVC	Polyvinyl Chloride
PWWF	Peak Wet Weather Flow
RE	Residential Estate
ROW	Right-of-Way
SB	Senate Bill
SBR	Sequencing Batch Reactor
SC	Shopping Commercial
SCADA	Supervisory Control and Data Acquisition
SCWG	Small Community Wastewater Grant
SDR	Standard Dimension Ratio
sf	Square Foot
SFR	Single Family Residential
SOI	Sphere of Influence
SP	Special Planning
SR	State Route
SRF	State Revolving Fund
SS	Suspended Solids
SSMP	Sanitary Sewer Management Plan
SSO	Sanitary Sewer Overflow
SWRCB	State Water Resources Control Board
TSS	Total Suspended Solids
TUD	Tuolumne Utilities District
µg/L	Micrograms per Liter
µmhos/cm	Micromhos per Centimeter
USDA	United States Department of Agriculture
UV	Ultraviolet
VFD	Variable Frequency Drive
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge

LIST OF ABBREVIATIONS (Cont.)

W&S	Water and Sewer
WDRs	Waste Discharge Requirements
WEP	Water and Environmental Programs
WGF	Wastewater Generation Factor
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1 Introduction

A Wastewater Master Plan (Master Plan) was prepared for the City of Angels (City) wastewater collection, treatment, and disposal system to ensure the City has adequate facilities to support future growth as defined in the recently adopted City of Angels 2020 General Plan (General Plan) [1]. The study area for the Master Plan is based on the current City limits from the General Plan [1] and does not include areas within the sphere of influence (SOI) beyond the City limits. Wastewater management for areas requiring annexation will be the subject of future technical studies. This Master Plan is partially funded by the State of California, Department of Housing and Community Development, Community Development Block Grant (CDBG) #09-PTAG-6496. Background information regarding wastewater management and tasks completed as part of the Master Plan are presented in this chapter.

1.1 Background and Purpose

The City desires a comprehensive Master Plan prepared for wastewater facilities. The required Master Plan includes the following items:

1. A summary and description of the wastewater system.

2. Projected wastewater flows for the 10 year and 20 year planning horizon.

3. An evaluation of the existing collection system and identification of hydraulic deficiencies with mitigation recommendations triggered by flow projections.

4. An evaluation of the existing wastewater treatment plant and disposal facilities; identifications of deficiencies with maintenance, and mitigation recommendations to optimize operations.

5. An analysis of available engineering and financial alternatives for maintenance and system improvements.

6. Cost estimates for required improvements to the collection system to ensure adequate capacity for both summer and winter flows to ensure overflow events do not occur.

7. Cost estimates for required improvements to the wastewater treatment plant and disposal facilities to ensure adequate capacity for growth projections.

8. A short and long-term Capital Improvement Plan (CIP) to address identified deficiencies including prioritization, alternatives analysis, and schedules. The CIP will include increases in pipe size, inflow and infiltration (I/I) reduction programs, increases in redundancy and pumping capacity, and storage, treatment/disposal facility modifications.

9. Recommendations for updates to the operational structure of the Wastewater Collection and Facility system.

10. Identification of regulatory concerns for the wastewater collection, treatment, and disposal facilities.

11. A universal funding application in support of the short-term components of the CIP, as required by the CDBG grant.

1.2 Scope of Master Plan

The following tasks were completed as part of the Master Plan:

1. A review of previous reports and studies completed within the last 23 years for the collection, treatment, and disposal facilities.

2. Site visits to the existing facilities and a review of available drawings and operational practices.

3. A review of the existing regulatory requirements for the wastewater facilities and a discussion of potential future requirements.

4. Development of design criteria.

5. Analysis of existing wastewater flow and potential impacts associated with legislated reductions in water use to estimated future flow projections.

6. Execution of six hydraulic model scenarios to identify existing and buildout capacity issues within the collection system and the potential impact of reduced I/I.

7. Evaluation of wastewater treatment, storage, and disposal facilities.

8. An analysis of the existing City wastewater operational structure and survey of the operational structure for similar utilities.

9. Development and alternatives analysis of recommended improvements for the collection system, wastewater treatment, and disposal facilities.

10. Prioritization of recommended improvements to develop a short-term and long-term CIP.

11. Review of City wastewater budgets and comparison with projected CIP costs.

12. Identification of potential funding sources and preparation of a funding application.

Each of these tasks is summarized in the following chapters.

2 Summary of Previous Reports

Previous reports prepared for the City are summarized in this chapter. Design criteria, constraints, and methodologies used for analyses in past reports were considered in developing the Master Plan. Recently completed projects were noted and recommended improvement projects were integrated into the Master Plan as appropriate.

For reference, generation rates and peaking factors from the City 1998 Improvement Standards [3] used for previous reports appear to remain unchanged in the City 2010 Improvement Standards [4].

2.1 Previous Master Plan

The 2002 Wastewater Master Plan was prepared for a planning period of 2001 through 2015. The 2002 Wastewater Master Plan included growth projections, proposed collection and treatment plant projects, and a financial analysis.

2.2 I/I Study

The City prepared an I/I study that is included as an Appendix to the Preliminary Engineering Reports for the Phase II and Phase III Wastewater Treatment Plant (WWTP) Improvement Projects [5, 6].

Several improvements have been completed to reduce I/I including the repair of sewer mains and manholes, disconnecting rain gutter/roof and basement drains from the sewer system, and enforcing the Angels Municipal Code [7] to require repairs to private sewer laterals by owners. In the study, the City identified various strategies for future I/I control. The most cost effective strategy identified by the City for continuing to reduce I/I is to mitigate the following sources:

1. Deteriorating manholes.
2. Defective cleanouts.
3. Leaking sewer mains and private laterals.
4. Roof leaders and storm drain cross connections to the sewer system.

2.3 Wastewater Collection System Improvements Study – 1998

The *Wastewater Collection System Improvements Study* [8] was prepared in 1998 to evaluate the condition of the existing wastewater collection facilities based on a review of maintenance records and input from maintenance personnel. Eleven prioritized projects were recommended including sewer main replacements, manhole replacements, and pump station rehabilitation. A short term and long term replacement schedule was developed based on funding availability through City monthly service fees and the State Small Community Wastewater Grant (SCWG) Program. A summary of the recommended projects in order of priority is provided in Table 2-1 and shown in Figure 2-1.

TABLE 2-1
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF PROJECTS RECOMMENDED IN
1998 WASTEWATER COLLECTION SYSTEM IMPROVEMENTS STUDY

Project Number	Description	Deficiency	Recommended Project	Estimated Completion Year	Completed?[a]
1	O'Conner Sewer, MH[b] 17-70 to MH 17-75-2	Substandard concrete main, multiple blockages and leaks	Replace main, reverse flow from MH 17-74 to 17-76-9A, abandon main from MH 17-70 to MH 17-74	1999/2000	Yes
2	Altaville Pump Station and Sewer Main, MH 95 to MH 98	Obsolete pump station and substandard main, multiple spills	Rehabilitate pump station and replace main from MH 95 to MH 97	1999/2000	Yes
3	Altaville Sewer, MH 98 to MH 101, MH 101-1 to MH 101-2	Substandard main, I/I	Replace main and manholes	2000/2001	Yes
4	Dogtown Road Sewer, MH 104-3 to MH 104-5	Substandard main, multiple blockages	Replace main and manholes	2001/2002	Yes
5	Gold Cliff Sewer, MH 17-65 to MH 17-69/70	Multiple blockages/ spills, MH spacing too great for cleaning equipment	Replace main and manholes, add two additional manholes	2005/2006	Partial – Manholes added
6	Bird Way Sewer, CO[c] 17-16-1A to MH 17-16-2	Substandard main, multiple blockages	Replace main and manholes	2006/2007	No
7	Miscellaneous Sewer Mains: CO 17-82 to MH 17-81, MH 17-45 to MH 17-46, MH 17-49-3 to MH 17-49-3B, MH 17-49-8 to Oak Ct.	Substandard main, multiple blockages	No cost effective repair at time of study, repair will depend on future development at Demarest St.	2006/2007	Partial: CO 17-82 to MH 17-81 completed. MH 17-45 to MH 17-46 replacement not yet needed
8	Peri Street Sewer, MH 77-24 to MH 77-29	Substandard main in drainage swale, I/I, multiple blockages	Replace main and manholes	-	Yes
9	Altaville Sewer, MH 98-4 to MH 98-5, and MH 102 to MH 103-4	Substandard main, I/I, multiple blockages	Replace main and manholes	2007/2008	Yes
10	San Joaquin Street Sewer, MH 17-82 to MH 17-84	Substandard main, multiple blockages	Replace main and manholes	2008/2009	Yes
11	Finnegan Lane Sewer, MH 17-2 to MH 17-5	Substandard main, multiple blockages	Replace main by pipe bursting, replace manholes	2008/2009	No[d]

[a] Per email correspondence with Weber, Ghio & Associates, Inc. [9]
[b] MH = manhole
[c] CO = cleanout
[d] Included in *City of Angels Draft System Evaluation & Capacity Assurance Plan* [10]

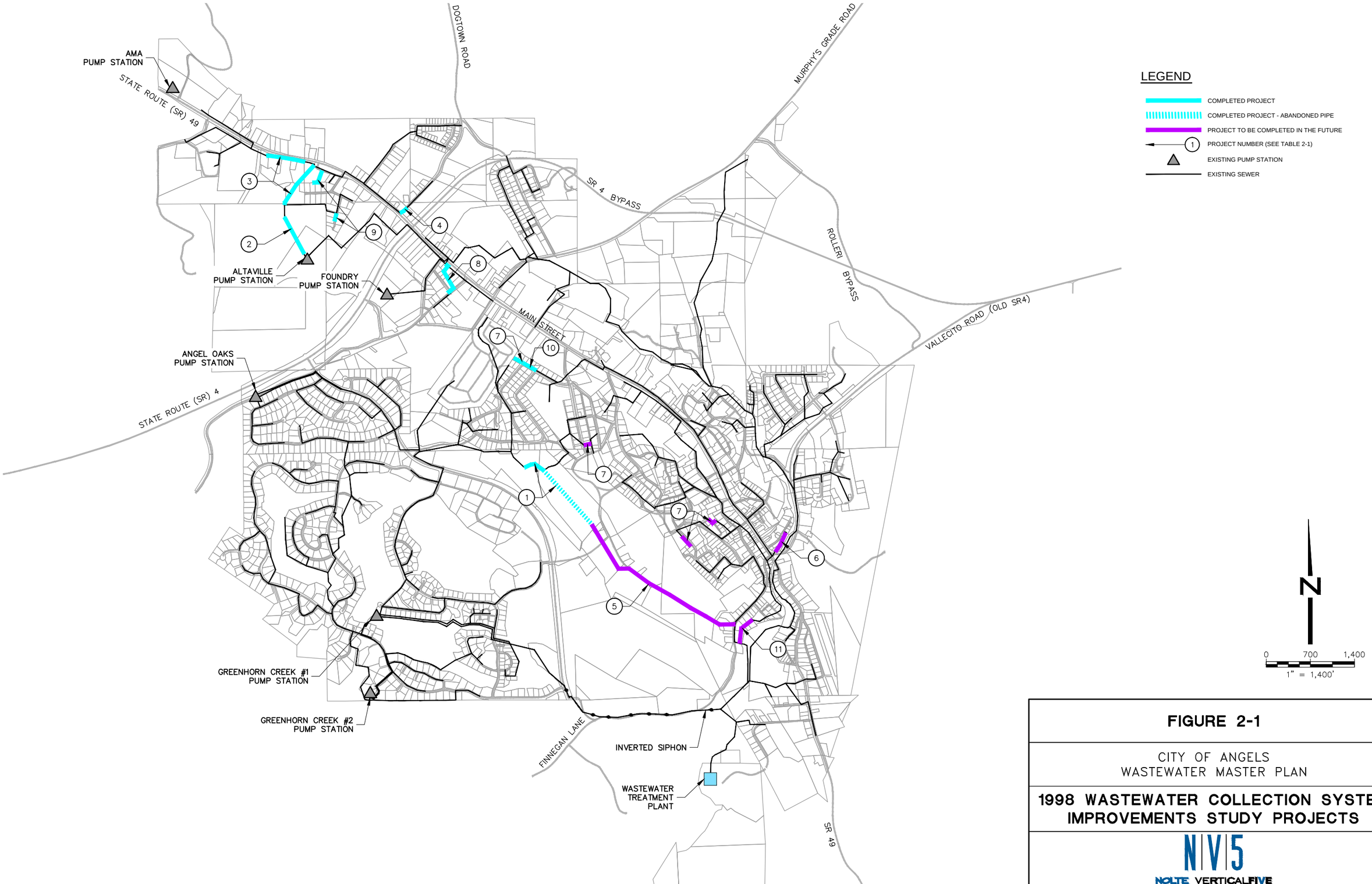


FIGURE 2-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

1998 WASTEWATER COLLECTION SYSTEM IMPROVEMENTS STUDY PROJECTS

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch2\Figure 2-1 1998 Study Projects.dwg KT 2/2/2012

2.4 Alternatives Analysis for North Angels Sewer Trunk Line – 2008

The *Alternatives Analysis for North Angels Sewer Trunk Line* [11] was prepared to evaluate alternatives for a new trunk sewer line to serve development in the western part of the City. Specifically, there was interest in commercial development near the Altaville Pump Station and additional development at the southern limit of Greenhorn Creek Road. For analysis purposes, the existing system was divided into Sheds A through V based on flow/topography. A count of all buildings was obtained from a GIS map, and flow per shed was calculated using generation rates and peaking factors from the City 1998 Improvement Standards [3]. I/I was assumed to be included in the average day generation rate and the peaking factors. To determine future flows, the General Plan [1] map was superimposed on the sewer shed map and buildout areas were measured and multiplied by the generation rate of 350 gallons per day per dwelling unit (gpd/du) using land use densities from the General Plan.

Pipe sizes were determined using Manning's equation and velocities were maintained less than 8 feet per second (fps), with the exception of pipe crests at Greenhorn Road with velocities in excess of 10 fps. Constraints noted for the design and construction of sewer lines in the City include significant vertical relief and an extensive amount of bedrock at shallow depths.

The recommended Alternative 2B for the North Angels Sewer Trunk Line has been approved by the City as shown in Figure 2-2. Alternative 2B requires the relocation of the Altaville Pump Station to the intersection of Angel Oaks Drive and State Route 4 (SR-4) to allow gravity support and provide more efficient development in the area. The abandoned pump station at Greenhorn Creek Road and Sierra Avenue would also be rebuilt. The proposed sewer main is approximately 2.5 miles long following the alignment of Angel Oaks Drive and Greenhorn Creek Road with pipe diameters ranging from 8-12 inches. Existing gravity sewer lines in Finnigan Lane up to the WWTP are recommended to be upgraded to 24-inch diameter.

2.5 Downtown Wastewater Collection System Improvement Study – 2009

The *Downtown Wastewater Collection System Improvement Study* [12] prepared in 2009 provides an analysis of the downtown sewer system and identifies sewer lines at capacity for existing and future flows. Sewer lines in the downtown collection system range from 6-inch to 10-inch diameter with some sections around 40 years old. Future flow projections reflect the buildout land use areas from the General Plan [1].

The City 1998 Improvement Standards [3] were used to estimate existing and future average daily flows and peak flows. The peaking factors are assumed to include I/I. The following design criteria were used for existing flows:

1. Existing residential parcel = 1 equivalent single family unit (ESFU)
2. Existing commercial parcel = 3 ESFUs
3. Existing school parcel = 6 ESFUs/acre (ac)

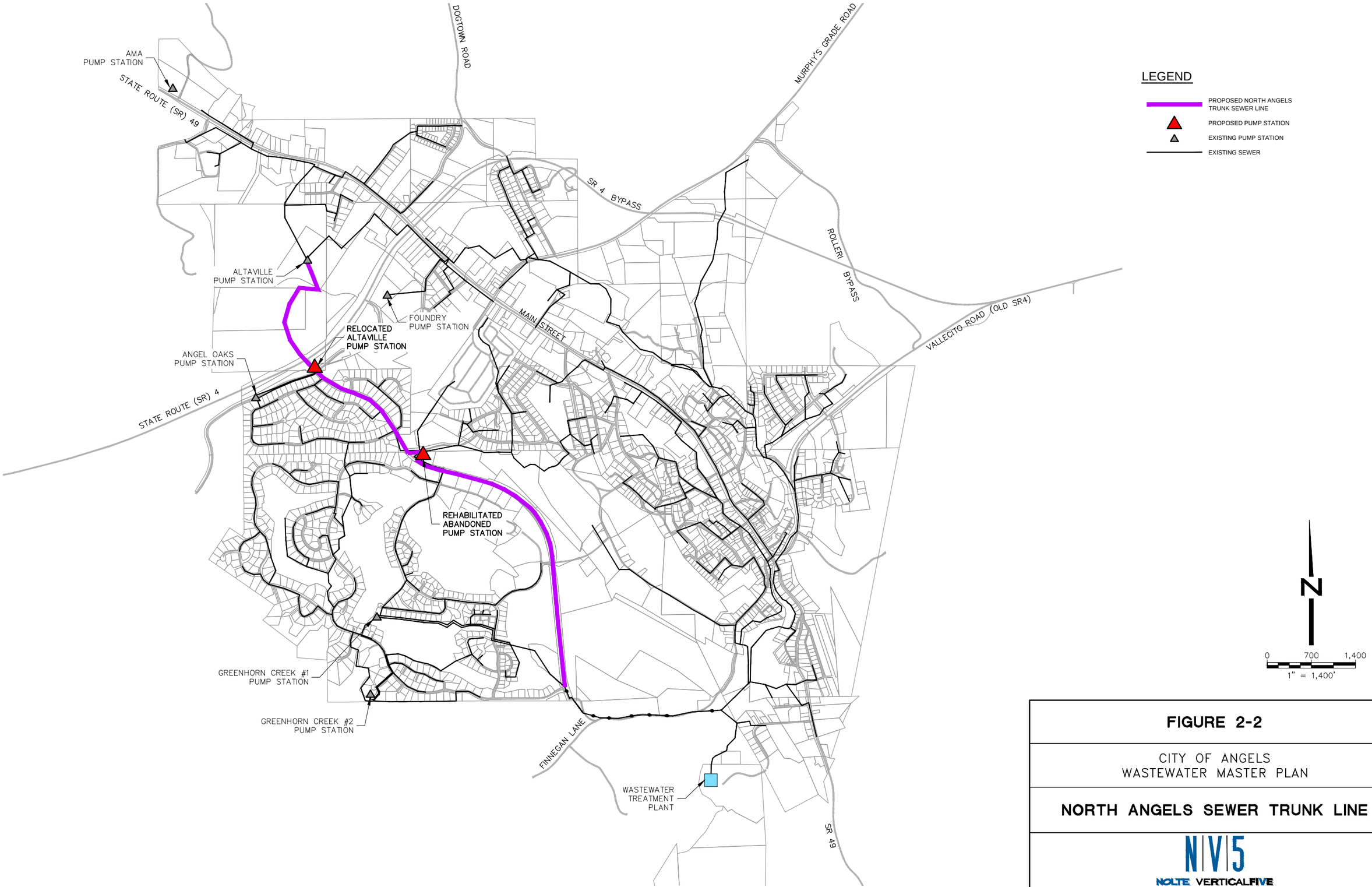


FIGURE 2-2

CITY OF ANGELS
WASTEWATER MASTER PLAN

NORTH ANGELS SEWER TRUNK LINE

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch2\Figure 2-2 North Angels Trunk.dwg KT 2/2/2012

The following design criteria were used for estimating flows for future development:

1. Single family residential (SFR) = 6 ESFUs/ac
2. High density residential (HDR) = 15 ESFUs/ac
3. Residential estate (RE) = 0.5 ESFUs/ac
4. Commercial = 15 ESFUs/ac
5. School = 6 ESFUs/ac

The United States Environmental Protection Agency (EPA) Storm Water Management Model 5 was used for a steady-state analysis of the system. The analysis revealed that the downtown collection system has sufficient capacity for existing flows but will require several sewer main replacements to handle future flows. The recommended funding in the study is a loan from the Clean Water State Revolving Fund (CWSRF) with repayment from new development connection fees. A list of the recommended sewer main replacements is provided in Table 2-2.

TABLE 2-2
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF RECOMMENDED PROJECTS IN
2009 DOWNTOWN WASTEWATER COLLECTION SYSTEM IMPROVEMENT STUDY

Pipe Segment[a] (MH to MH)	Existing Size (in)	Proposed Size (in)	Length (ft)
17-54 to 17-53	6	8	140
17-53 to 17-52	6	8	250
17-52 to 17-51	6	8	210
17-13 to 17-12	10	12	240
17-12 to 17-11	10	12	135
17-11 to 17-10	10	12	120
17-10 to 17-9	10	12	80
17-9 to 17-8	10	12	85
17-8 to 17-7	10	12	160
17-7 to 17-6	10	12	130
17-6 to 17-5	10	12	120
17-5 to 17-4	10	12	225
17-4 to 17-2	10	12	245

[a] All projects are included in *City of Angels Draft System Evaluation & Capacity Assurance Plan* [10]

2.6 City of Angels Municipal Service Review – 2009

The Municipal Service Review (MSR) [13] provides an assessment of the City's public services and facilities including wastewater collection, treatment, and disposal facilities.

Issues mentioned in the MSR include:

1. A shortfall in the collection of capital funds from the Greenhorn Creek and Angels Oaks Subdivisions is expected as new connections are made.

2. Portions of the wastewater collection system are failing in areas north of SR-4.

3. I/I is a continuing issue for the wastewater collection system.

4. Effluent storage capacity at the WWTP is insufficient for 100-year storm events. The lack of storage, however, has been mitigated with the addition of creek discharge under the National Pollutant Discharge Elimination System (NPDES) Permit No. CA0085201 [14] as part of the Phase III Improvements at the WWTP and is no longer an issue.

The MSR states that the City has established requirements for future annexations and developments so that property owners will pay their fair share of infrastructure development costs. The MSR also recommends the City become familiar with Community Facilities Districts (CFDs) and Mello-Roos bonds as a means for new development to pay infrastructure and operational costs.

2.7 City of Angels Camp Sanitary Sewer Management Plan – 2009

The *City of Angels Camp Sanitary Sewer Management Plan* (SSMP) [15] was prepared in compliance with requirements of the SWRCB. The SSMP reviews goals, organizational structure, legal authority (municipal code), operation and maintenance (O&M), emergency response, and the fats/oils/grease control program.

Recently completed projects listed in the SSMP include (see Figure 2-3):

1. Replacement of 12-inch diameter main line to WWTP with new 18-inch diameter main.

2. Replacement of 12-inch diameter Sand Flat Interceptor with new 15-inch diameter main.

3. Abandonment of Big Horn Pump Station and construction of new 8-inch diameter main.

4. Abandonment of Mark Twain Pump Station (gravity flow to Greenhorn Creek #1 Pump Station).

5. Rehabilitation of Altaville Pump Station (portion of Project #2 in Table 2-1).

6. Replacement of O’Conner sewer line (Project #1 in Table 2-1).

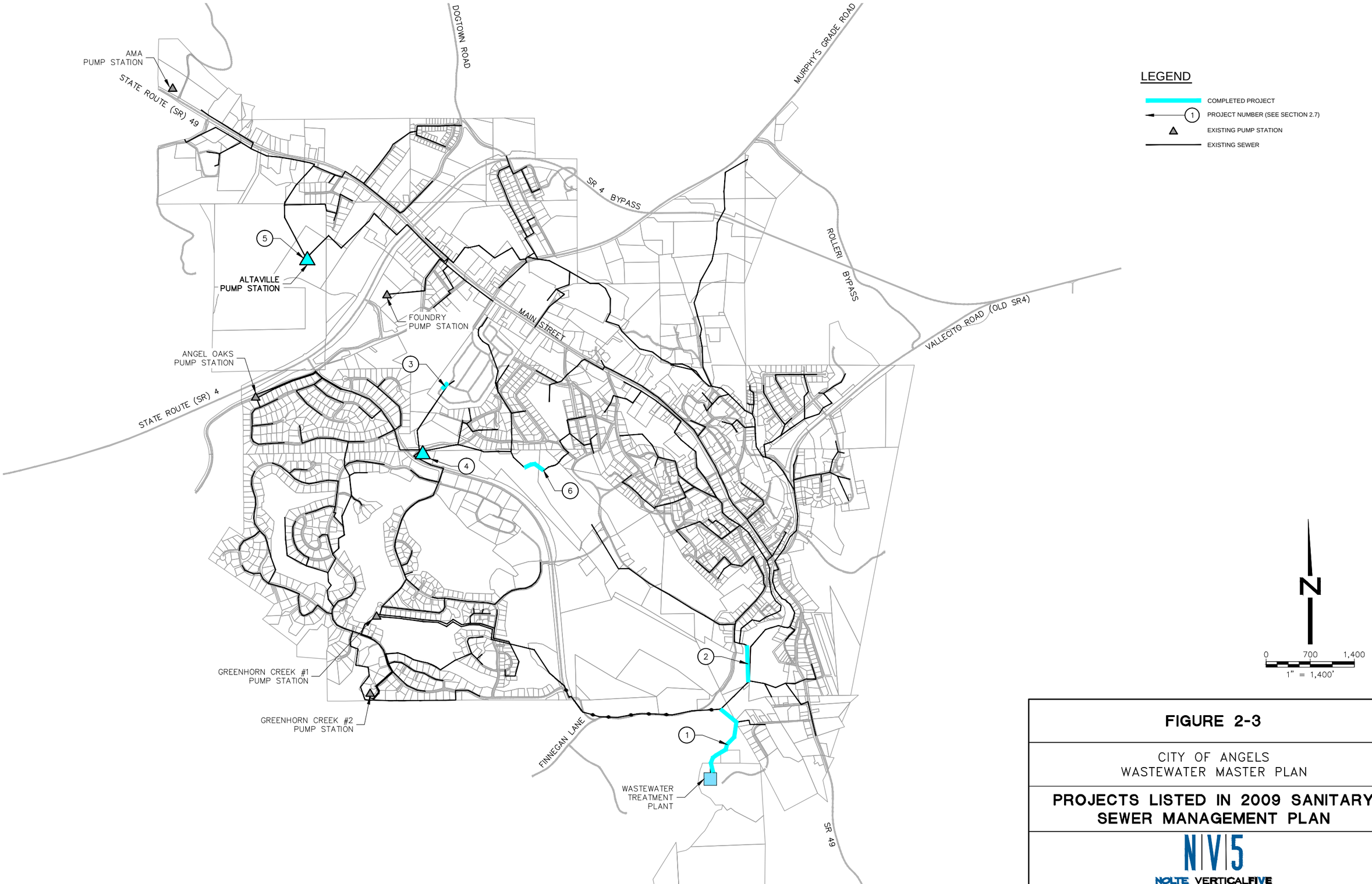


FIGURE 2-3

CITY OF ANGELS
WASTEWATER MASTER PLAN

PROJECTS LISTED IN 2009 SANITARY SEWER MANAGEMENT PLAN

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch2\Figure 2-3 2009 SSMP Projects.dwg KT 2/2/2012

Improvements listed in the SSMP for the 2009-2010 fiscal year are presented in Table 2-3. The focus of these improvements is to address I/I and access issues.

TABLE 2-3
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF PLANNED PROJECTS LISTED IN CITY OF ANGELS
2009 SANITARY SEWER MANAGEMENT PLAN

Pipe Segment (MH to MH)	Location	Completed?
17-70 to 17-65-1	Gold Cliff Road	No[a]
17-83 to 17-81	Amador Avenue	Yes – Sewer main rerouted from MH 17-83 to new MH 17-83-A and 17-79-A to existing MH 17-79
98-5 to 99	Wilson Way	Partial - Completed from 98-5 to 98[b]
103-1 to 103	North Baker	No[a]

[a] Still planned but not considered a high priority item [16].
[b] Pipe segment from MH 98 to MH 99 was likely not completed because it was already in good condition [16].

Goals identified in the SSMP include cost-effective minimization of I/I and a decrease in the occurrence and impact of SSOs.

2.8 City of Angels Draft System Evaluation & Capacity Assurance Plan – 2010

The *City of Angels Draft System Evaluation & Capacity Assurance Plan* (Draft Capacity Assurance Plan) [10] provides a computer model analysis of the City's existing wastewater collection system at existing and future flows and identifies components where flows exceed capacity under existing and future conditions. All existing manholes were surveyed for rim elevations and pipe inverts as part of study efforts. The existing collection system was divided into five basins. Existing flows were estimated by observing actual flow rates in the City. The following design criteria were used for existing flows:

1. Existing residential parcel = 1 ESFU
2. Existing residential = 6 ESFUs/ac
3. Existing commercial lot = 3 ESFUs (except Basin 5, commercial = 1 ESFU)
4. Existing commercial = 8 ESFUs/ac (except Basin 5, commercial = 4 ESFU/ac)
5. Existing school = 6 ESFUs/ac
6. Generation factors:
    a. Basin 1-4: 250 gallons per day per ESFU (gpd/ESFU)
    b. Basin 5: 200 gpd/ESFU
    c. WorldMark in Basin 2: 150 gpd/ESFU

For future flow analysis, it was assumed that the North Angels Sewer Trunk Line (Alternative 2B from *Alternatives Analysis for North Angels Sewer Trunk Line* [11]) as approved by City Council, would be active. Future flows were estimated based on build-out of future parcels with

land use densities as identified in the General Plan [1]. The City 1998 Improvement Standards [3] were used to estimate future average daily and peak flows. The peaking factors include I/I estimates. A sixth basin was added for the future flow analysis to account for the proposed North Angels Sewer Trunk Line.

Analysis of the system indicated that certain lines have flows exceeding capacity under existing conditions and several other lines will exceed capacity at future flows. Recommended sewer line replacements for existing and future conditions are presented in Table 2-4.

TABLE 2-4
CITY OF ANGELS WASTEWATER MASTER PLAN
REQUIRED SEWER LINE REPLACEMENTS IDENTIFIED IN CITY OF ANGELS DRAFT SYSTEM EVALUATION AND CAPACITY ASSURANCE PLAN

Pipe #	Pipe Segment (MH to MH)	Existing Size (in)	Pipe Size Required for Existing Flows (in)	Pipe Size Required for Future Flows (in)	Length (ft)
Basin 2					
P-342[a]	G-4 to G-3	8	10	-	257
P-450[a]	G-11 to G-10	8	10	-	351
P-514[a]	G-12 to G-11	8	10	-	230
Basin 3					
P-47	G-17-1 to G-17	6	-	8	71
P-219	G-27 to G-26	6	-	8	177
P-275	G-17-2 to G-17-1	6	-	8	211
P-311	G-26 to G-17-7	6	-	8	241
P-633	G-17 to PS#2	6	-	8	101
Basin 4					
P-82	101-4 to 101-3	6	-	8	99
P-227	101-3-1 to 101-3	6	-	8	183
P-459	101-6 to 101-5	6	-	8	384
P-474	101-5 to 101-4	6	-	8	462
P-76	101-1-1 to 101-1	6	-	10	95
P-257	101-1-1B to 101-1-1A	6	-	10	203
P-360	101-3 to 101-2	6	-	10	271
P-488	101-2 to 101-1-1B	6	-	10	219
P-691	101-1-1A to 101-1-1	6	-	10	183
P-53	101-1 to 101A	6	-	12	80
P-682	103 to 101	8	-	10	367
P-1	101A to 101	8	-	15	30
P-20	99 to 98	8	-	15	42
P-250	101 to 100-1	8	-	15	200

TABLE 2-4 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
REQUIRED SEWER LINE REPLACEMENTS IDENTIFIED IN CITY OF ANGELS
DRAFT SYSTEM EVALUATION AND CAPACITY ASSURANCE PLAN

Pipe #	Pipe Segment (MH to MH)	Existing Size (in)	Pipe Size Required for Existing Flows (in)	Pipe Size Required for Future Flows (in)	Length (ft)
P-270	100-1 to 100	8	-	15	209
P-437	100 to 99	8	-	15	332
P-242	98 to 97	10	-	15	196
P-460	97 to 96	10	-	15	387
P-668	96 to 95-6	10	-	15	388
Basin 5					
P-018	9-9 to 9-8	8	10	12	39
P-405	9-8 to 9-7	8	10	12	305
P-504	44-A-1 to 44-A	8	10	12	204
P-702	9-2 to 9-1	8	10	12	331
P-718	9-10 to 9-9	8	10	12	190
P-720	9-7 to 9-6	8	10	12	272
P-730	9-1 to 9	8	12	15	453
P-112	49 to 48	10	12	15	116
P-002	44-B to 44-A	10	12	18	38
P-007	45 to 44-B	10	12	18	37
P-038	44-A to 44	10	12	18	66
P-252	46 to 45	10	12	18	163
P-292	36 to 35	10	12	18	225
P-296	39 to 38	10	12	18	228
P-442	42 to 41	10	12	18	337
P-706	44 to 43	10	12	18	109
P-022	77-6-1 to 77-6	6	-	8	35
P-142[b]	17-54 to 17-53	6	-	8	140
P-330[b]	17-53 to 17-52	6	-	8	250
P-545[b]	17-52 to 17-51	6	-	8	210
P-608[c]	17-67 to 17-66-1	6	-	8	262
P-609[c]	17-66-1 to 17-66	6	-	8	265
P-610[c]	17-66 to 17-65Z	6	-	8	247
P-059	17-63 to 17-2	8	-	10	85
P-601	9-11 to 9-10	8	-	12	318
P-724	9-5 to 9-4	8	-	12	328

TABLE 2-4 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
REQUIRED SEWER LINE REPLACEMENTS IDENTIFIED IN CITY OF ANGELS
DRAFT SYSTEM EVALUATION AND CAPACITY ASSURANCE PLAN

Pipe #	Pipe Segment (MH to MH)	Existing Size (in)	Pipe Size Required for Existing Flows (in)	Pipe Size Required for Future Flows (in)	Length (ft)
P-726	9-4 to 9-3	8	-	12	278
P-728	9-3 to 9-2	8	-	12	267
P-722	9-6 to 9-5	8	-	12	285
P-013	77-23 to 79-8	10	-	12	33
P-019	56 to 55	10	-	12	41
P-027	62 to 61	10	-	12	55
P-056[b]	17-10 to 17-9	10	-	12	80
P-060[b]	17-9 to 17-8	10	-	12	85
P-067	77 to 76	10	-	12	84
P-081	67 to 66	10	-	12	99
P-093	60 to 59	10	-	12	107
P-099	63 to 62	10	-	12	110
P-105	48 to 47	10	-	12	113
P-110[b]	17-6 to 17-5	10	-	12	120
P-114[b]	17-11 to 17-10	10	-	12	120
P-125	72 to 71	10	-	12	127
P-128[b]	17-7 to 17-6	10	-	12	130
P-134[b]	17-12 to 17-11	10	-	12	135
P-140	59 to 58	10	-	12	136
P-159	73 to 72	10	-	12	144
P-168	57 to 56	10	-	12	148
P-172	54 to 53	10	-	12	150
P-193	58 to 57	10	-	12	159
P-198[b]	17-8 to 17-7	10	-	12	160
P-206	55 to 54	10	-	12	164
P-251	47 to 46	10	-	12	201
P-279	65 to 64	10	-	12	214
P-280	53 to 52	10	-	12	214
P-286[b]	17-5 to 17-4	10	-	12	225
P-290	70 to 69	10	-	12	222
P-315[b]	17-13 to 17-12	10	-	12	240
P-323[b]	17-4 to 17-2	10	-	12	245
P-359	76 to 75	10	-	12	270

TABLE 2-4 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
REQUIRED SEWER LINE REPLACEMENTS IDENTIFIED IN CITY OF ANGELS
DRAFT SYSTEM EVALUATION AND CAPACITY ASSURANCE PLAN

Pipe #	Pipe Segment (MH to MH)	Existing Size (in)	Pipe Size Required for Existing Flows (in)	Pipe Size Required for Future Flows (in)	Length (ft)
P-456	75 to 74	10	-	12	364
P-457	74 to 73	10	-	12	370
P-466	66 to 65	10	-	12	399
P-690	71 to 70	10	-	12	183
P-693	61 to 60	10	-	12	185
P-695	64 to 63	10	-	12	188
P-031	30 to 29	10	-	15	61
P-052	34 to 33	10	-	15	77
P-072	50 to 49	10	-	15	92
P-077	25 to 24-A	10	-	15	97
P-079	26 to 25	10	-	15	98
P-147	52 to 51	10	-	15	139
P-148	24-A to 24	10	-	15	139
P-153	51 to 50	10	-	15	141
P-180	29 to 26	10	-	15	155
P-187	32A to 31	10	-	15	157
P-197	33 to 32A	10	-	15	160
P-216	31 to 30	10	-	15	173
P-004	24 to 23	10	-	18	38
P-034	23 to 22	10	-	18	55
P-126	38 to 37	10	-	18	128
P-169	35 to 34	10	-	18	149
P-239	22 to 21	10	-	18	91
P-316	37 to 36	10	-	18	238
P-470	41 to 39	10	-	18	426
P-669	20 to 19	10	-	18	91
P-670	19 to 17	10	-	18	358
P-703	21 to 20	10	-	18	128
P-707	43 to 42	10	-	18	196
P-122	17-2 to 17-1	12	-	15	125
P-442	42 to 41	12	-	18	337
P-005	15 to 15A	12	-	21	43
P-383	16 to 15	12	-	21	279

TABLE 2-4 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
REQUIRED SEWER LINE REPLACEMENTS IDENTIFIED IN CITY OF ANGELS
DRAFT SYSTEM EVALUATION AND CAPACITY ASSURANCE PLAN

Pipe #	Pipe Segment (MH to MH)	Existing Size (in)	Pipe Size Required for Existing Flows (in)	Pipe Size Required for Future Flows (in)	Length (ft)
P-671	17 to 16	12	-	21	264
P-397	16B to 15A	15	-	21	306
P-373	10 to 9	15	-	24	280
P-440	15A to 10	15	-	24	321
P-591	9 to 8	18	-	24	324
P-595	8 to 7	18	-	24	240
P-596	7 to 6	18	-	24	165
P-597	6 to 5	18	-	24	83
P-598	5 to 4	18	-	24	184
P-599	4 to 3	18	-	24	63
P-600	3 to 2	18	-	24	98
P-683	2 to 1	18	-	24	254
Basin 6					
P-517	17-76-9 to 17-76-10	6	-	8	475
P-344	A-9 to A-10	6	-	12	257
P-386	A-8 to A-9	6	-	12	289
P-3	A-13 to G-16	8	-	12	15
P-409	A-12 to A-13	8	-	12	306
P-436	A-11 to A-12	8	-	12	332
P-458	A-10 to A-11	8	-	12	377

[a] Sewer lines require upsizing when North Angels Sewer Trunk Line is constructed [11].
[b] Included in *Downtown Wastewater Collection System Improvement Study* [12].
[c] Sewer lines also included in a rehabilitation project to address I/I problems.

3 Description of Existing Wastewater System

The City provides wastewater collection, treatment, and disposal services to an area of approximately 3.6 square miles in Angels Camp, California. A description of the existing system is provided in this chapter.

3.1 Sewer Collection System

The existing wastewater collection system serves approximately 1,600 meters (90% residential, 10% commercial) and is composed of six pump stations, 4.5 miles of force mains, and 22.5 miles of gravity sewers ranging in diameter from 4 to 18 inches. The wastewater collection system is essentially made up of three distinct sub-systems:

1. Altaville System: Predominately cement pipe ranging from 6-inch to 10-inch diameter.

2. Downtown System: Predominately asbestos cement pipe ranging from 6-inch to 10-inch diameter and up to approximately 40 years old.

3. Angel Oaks/Greenhorn System: Predominately polyvinyl chloride (PVC) pipe ranging from 6-inch to 10-inch diameter.

A schematic of the City pump stations and associated force mains is provided in Figure 3-1. A summary of the pump stations operated by the City is provided in Table 3-1.

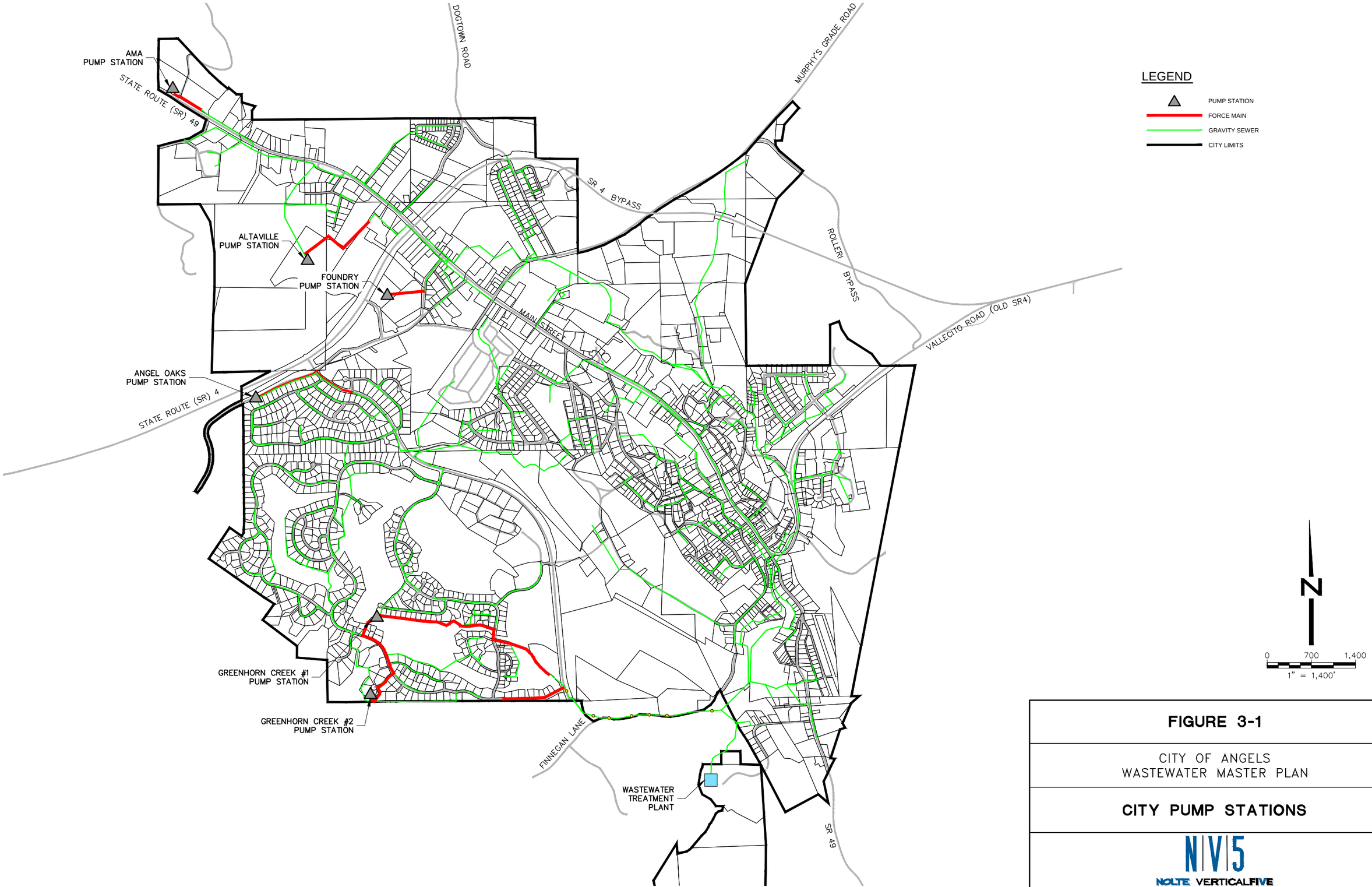


FIGURE 3-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

CITY PUMP STATIONS

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch3\Figure 3-1 Pump Stations.dwg KT 2/1/2012

TABLE 3-1
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF WASTEWATER PUMP STATIONS

Station	Location	Type	No. of Pumps	HP[a] (per pump)	Design Flow (gpm)[b]	Design Head (ft)	Pump Station Features[c]
AMA	Brunner Hill Dr.	Submersible	2	3	252	15.3	Local alarm only
Altaville	Wilson St.	Submersible	2[d]	25	500	93	Call-out alarms, backup generator
Foundry[e]	Foundry Ln.	Submersible	2	4	29	108	Site alarm only, backup generator at Foundry
Angel Oaks	Stockton Rd.	Submersible	2	10	150	75	Site alarm only
Greenhorn Creek #1	Spring House Rd.	Submersible	3	25	Pump 1: 525[f] Pump 2: 508[f] Pump 3: 518[f]	90	Call-out alarms, backup generator, control room
Greenhorn Creek #2	Raggio Ct.	Submersible	2	25	275	85	Call-out alarms, backup generator, control room

[a] HP = horsepower.
[b] gpm = gallons per minute
[c] In event of power failure, flows from pump stations without a backup generator would be handled with a pump truck.
[d] Space for a third pump is available in wet well.
[e] The Foundry Pump Station serves the Foundry, Police Station, and CDF.
[f] Results from a pump test performed on 3/27/2008.

3.2 Wastewater Treatment and Disposal Facilities

The WWTP and disposal facilities operate under NPDES Permit No. CA0085201 and Waste Discharge Requirements (WDRs) Order No. 98-110 issued by the Central Valley Region, California Regional Water Quality Control Board (Regional Board) [14, 17].

With Phase II and Phase III Improvements complete, the WWTP consists of a headworks, an equalization (EQ) basin, three sequencing batch reactors (SBRs), an intermediate storage basin, four filters (with two cells each), ultraviolet (UV) disinfection facilities, a diversion storage basin (formerly used as the chlorine contact basin), two aerobic digesters, a belt filter press, eight sludge drying beds, and a storage reservoir (Holman Reservoir). Holman Reservoir provides approximately 202 acre-feet (ac-ft) of storage for treated wastewater. A process flow diagram of the WWTP facilities is included in Appendix A.

Effluent from the WWTP is Title 22 tertiary disinfected recycled water as defined by the California Department of Public Health (CDPH). Recycled water is used for irrigation of a 136-ac sprayfield (61-ac available for disposal) adjacent to Holman Reservoir and 110-ac at

Greenhorn Creek Golf Course. The NPDES permit allows seasonal (winter) discharge to Angels Creek under specific conditions.

Phase II Improvements to the WWTP were completed in 2006 and included the lining and expansion of the EQ basin, an additional SBR, and installation of safety equipment. Phase II improvements increased the capacity of the WWTP to 0.6 million gallons per day (mgd) with a peak flow of 1.9 mgd.

Phase III Improvements to the WWTP were completed in November 2010 and included the addition of UV disinfection and stream discharge facilities. Prior to the completion of Phase III Improvements, the wastewater storage and disposal facilities had insufficient capacity for a 100-year storm event. The Regional Board issued Cleanup and Abatement Order (CAO) No. 5-01-535 on October 5, 2001 [18]. The CAO included requirements for the City to prepare water balances, capacity calculations, and a feasibility report identifying alternatives for addressing the lack of storage and disposal. The lack of sufficient storage and disposal facilities was mitigated with the construction of Phase III Improvements and the acquisition of a NPDES permit allowing seasonal discharge to Angels Creek.

In addition to the Phase III Improvements, the City has recently completed a project to improve solids handling including the addition of mechanical dewatering equipment (belt press) and the covering of a biosolids storage stockpile area.

3.3 Overview of Collection System Operation and Maintenance Program

The City Public Works Department (Public Works) consists of a six person crew that maintains the wastewater collection system, potable water system, roads, and parks. An overview of the maintenance program, maintenance issues, past/current projects, and scheduling of maintenance activities for the wastewater collection system is provided below reflecting information obtained during a field meeting with the Public Works Foreman [19].

a. Maintenance Program Activities

The City preventative O&M program consists of annual cleaning and inspection of the collection system with more routine cleaning of potential problem areas. Public Works maintains a binder for the inspection and cleaning of sewer lines and manholes that are part of the more routine maintenance program. The binder is divided by month and a log sheet for each sewer line is placed under as many months as determined necessary for cleaning frequency. Certain problem areas are cleaned on a monthly basis, especially sewer lines that are prone to grease accumulation or root problems. The dates of cleaning and conditions of the sewer lines are noted on each log sheet. Sewer lines are added and removed from the maintenance program at the discretion of Public Works. A list of the sewer lines that are in the maintenance program with cleaning frequencies is provided in Appendix B and displayed in Figure 3-2.

FIGURE 3-2

CITY OF ANGELS
WASTEWATER MASTER PLAN

CLEANING FREQUENCY

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch3\Figure 3-2 Cleaning Frequency.dwg JCP 2/1/2012

Pump stations are checked daily during the work week for proper operation and are jetted and cleaned once a month to prevent grease buildup. Grease buildup at the pump stations can interfere with proper operation of the floats which activate the submersible pumps. Pump run times are recorded daily from each pump station.

An 8-inch inverted siphon crossing Angels Creek (MH 9-1 to 9) is vacuumed out every two weeks for odor control and to limit the amount of grit transported to the WWTP.

Grease traps are required for commercial and industrial grease generators with quarterly inspections. During inspections, grease traps at each restaurant are tested for proper function and reports are prepared. Regular testing of the grease traps limits the amount of grease deposited into the collection system.

Closed-circuit television (CCTV) inspection of sewer lines began in August 2011. The CCTV inspection contractor makes a monthly visit for about two days at a time. The general intent is to televise known and suspected problem areas as a first priority whereas newer pipelines installed with the most recently constructed subdivisions are a last priority. The annual City budget for CCTV inspections is $25,000. Inspection ratings based on CCTV work to date as of January 2012 are presented in Figure 3-3.

The recent round of CCTV inspections was specified in an effort to coordinate sewer work with road repairs. The current methodology for scheduling CCTV inspections is to prioritize the work as follows: 1) televise areas where known/suspected sewer problems coincide with roads due for improvement within the next three years; and 2) televise areas where roads are due for improvement in the next three years but no known sewer problems exist with the caveat that television footage at this time will still be limited to "older" sewer lines [9]. Once the next sewer pipeline/road improvement projects are identified, the City will likely return to a CCTV inspection methodology of televising suspected problem areas as a first priority.

b. Maintenance Issues to be Addressed

There are significant access problems in the older parts of town with sewer lines running through backyards and under buildings. Some sections of pipe have been slip-lined including sewer lines below existing buildings in the downtown area with limited access. Limited access in these areas makes it difficult to perform maintenance work and operate CCTV equipment. There are also several sewer lines in the collection system with access problems due to blind tees.

During the CCTV work, a sewer line was found to have missing portions of pipe (MH 17-19 to 17-18). This sewer line replacement will be included in the CIP.

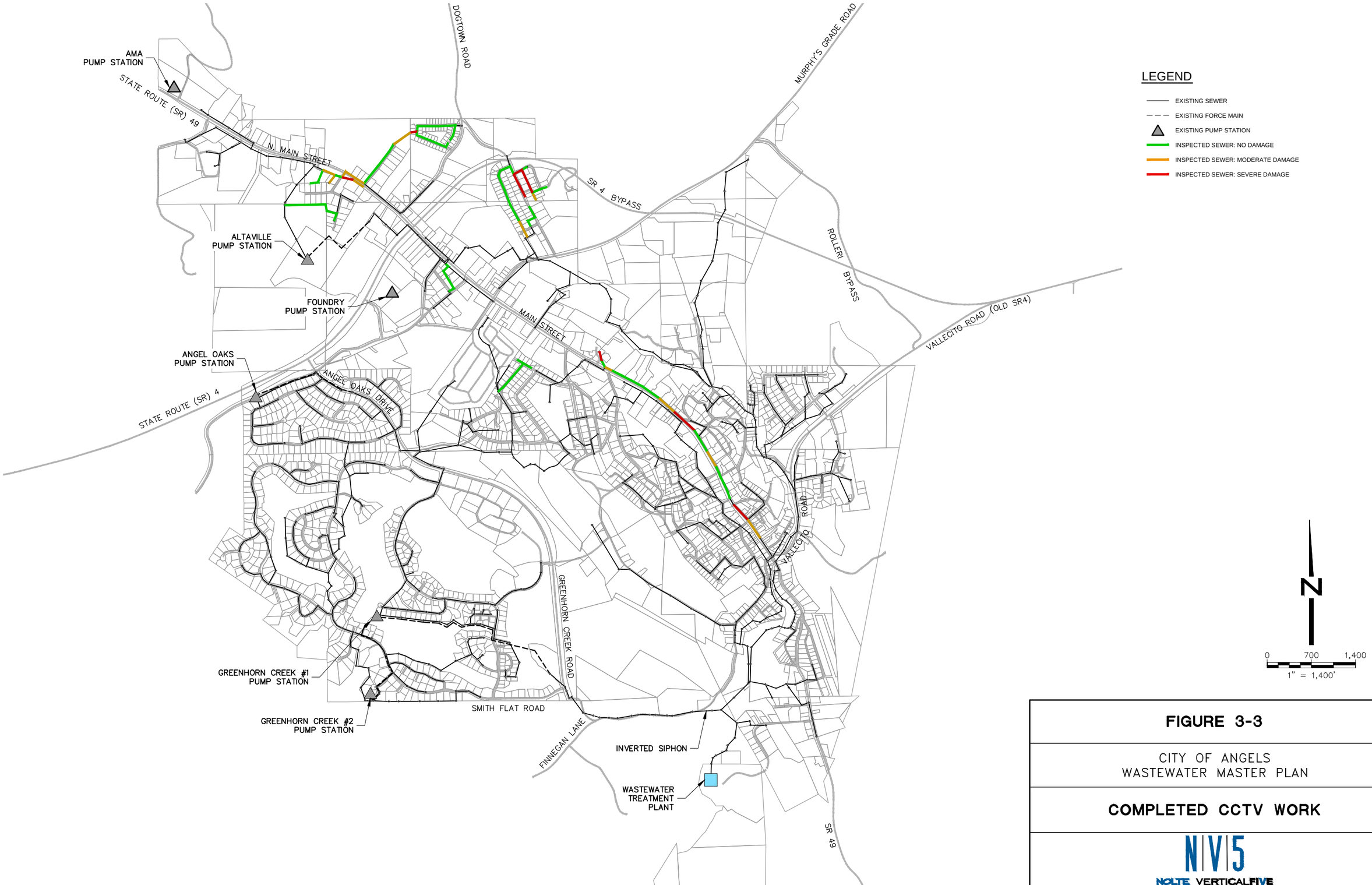


FIGURE 3-3

CITY OF ANGELS
WASTEWATER MASTER PLAN

COMPLETED CCTV WORK

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch3\Figure 3-3 Completed CCTV Work.dwg JCP 2/1/2012

Sanitary sewer overflows (SSOs) occur on occasion and are reported to the State Water Resources Control Board (SWRCB). SSOs near Angels Creek are of great concern and sewer lines at capacity in that area will be candidates for improvements in the CIP to avoid potential spills. A summary of recorded SSO events are provided in Appendix C. Anecdotal information for the sites of reported SSOs serves as the initial basis in the identification of potential system deficiencies. Discharges of treated effluent at the sprayfields are not included in Appendix C because these technically are not SSOs.

Maintenance issues identified by the Public Works Foreman are presented in Figure 3-4 [19].

In an effort to coordinate sewer repairs with road maintenance work, a list of priority areas for CCTV inspections were identified by the City Engineer in December 2011 [9]. The following roads scheduled for maintenance work within the next three years also have known sewer collection system problems:

1. Birds Way
2. Raspberry Lane
3. Gold Cliff Road (from Finnegan Lane)
4. Mark Twain Road (between Hillcrest Lane and Fairview Street)
5. Gold Cliff Road (at Stanislaus Avenue)
6. Bush Street extension (at Mark Twain Road, between Pacific Street and Main Street)

Other segments where road work is necessary but no known sewer collection system problems exist are as follows:

1. Booster Way
2. Stanislaus Street (between Main Street and Gold Cliff Road)
3. Hillcrest Lane (between West Street and Gold Cliff Road)
4. Finnegan Lane
5. Murphys Grade Road
6. Peri Street
7. Live Oak Drive

c. Historical and Current Maintenance Projects

The City has been proactive in resolving sources of I/I with sewer line replacement projects. There are I/I issues in the area served by the Greenhorn Creek #2 Pump Station that are currently being addressed by Public Works.

Approximately six months ago, a shutoff switch failed at the Greenhorn Creek #2 Pump Station and the pumps overheated. The shut off switch was subsequently replaced and future switch failures are being avoided with improved maintenance. At the Foundry Pump Station, the electrical panel was recently replaced after damage from flooding. The Foundry Pump Station is in the process of being rebuilt/re-plumbed and the drainage system was recently renovated to prevent future flooding.

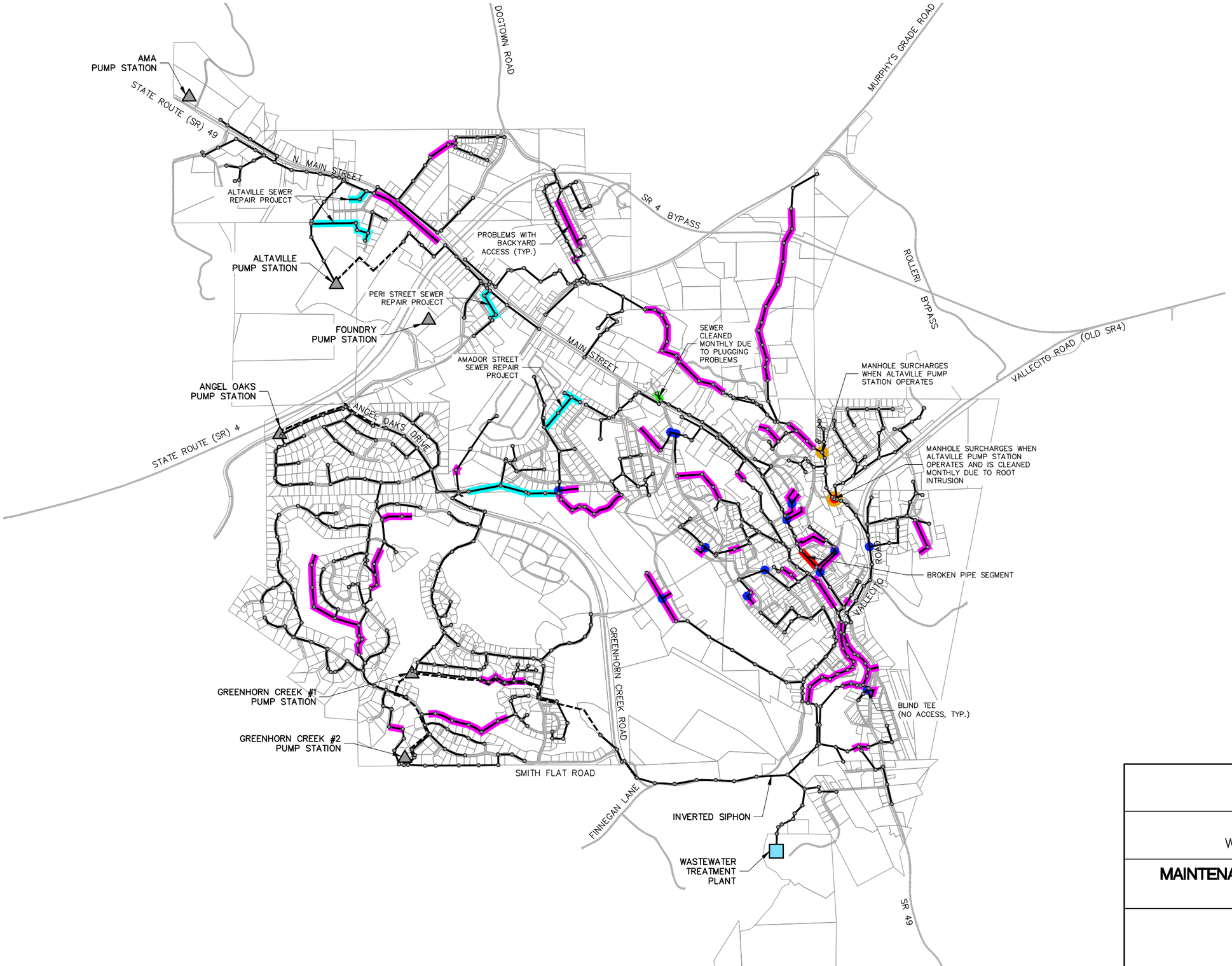


FIGURE 3-4

CITY OF ANGELS
WASTEWATER MASTER PLAN

MAINTENANCE ISSUES IDENTIFIED BY CITY STAFF

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch3\Figure 3-4 Maintenance Issues.dwg JCP/KT 4/18/2012

Corroded support crossbars at the AMA and Foundry Pump Station are scheduled to be replaced in the near future with stainless steel crossbars.

Public Works has responded to an odor issue and related customer complaints along Finnigan Lane and recently installed a scrubber which appears to have mitigated the problem.

d. Public Works Maintenance Schedule

The first two weeks of each month are used for cleaning of the sewer lines and manholes in the maintenance program. The third week of each month is used for reading water meters. The remainder of the month is used for repair of non-emergency items that were identified in the first few weeks. Park and roads are also maintained during the month. One crew member is on call 24 hours a day for a week long period and then rotated.

3.4 Agreement with Calaveras County Water District

The City has an agreement [20] with the Calaveras County Water District (CCWD) to accept sewer flows from Six Mile Village (community of Vallecito) under the following terms:

1. Effluent delivered shall have a biochemical oxygen demand (BOD_5) no greater than 210 milligrams per liter (mg/L).

2. Effluent quantity shall not exceed an average of 20,000 gallons per day (gpd) for any month.

3. If quantity is greater than 20,000 gpd for any month, the service charge shall be increased percentage-wise in direct proportion.

4. Service area in Six Mile Village is limited to 67 residential and 3 commercial lots.

5. CCWD will maintain their collection and pumping facilities.

Recent discussions with CCWD indicate that wastewater flows generated from future developments such as Mitchell Ranch and Coyote Creek will likely be delivered to the Vallecito/Douglas Flat Wastewater Treatment Plant. CCWD plans to continue sending flows from Six Mile Village to the City under the current agreement. Wastewater from Six Mile Village flows by gravity to MH 44-A-7. Monthly flow data provided by CCWD will be used when evaluating existing and future flows at the WWTP.

4 Regulatory Setting

The regulatory setting related to operation of the wastewater collection, treatment, and disposal systems is summarized in this chapter.

4.1 Wastewater Treatment Plant

The City WWTP is regulated by the Regional Board under Order No. R5-2009-0074, dated August 13, 2009, that amended Order No. R5-2007-0031 (NPDES Permit No. CA0085201) [14]. In addition, certain elements of WDRs Order No. 98-110, dated April 17, 1998, remain in effect [17]. Monitoring and reporting requirements (MRPs) for Greenhorn Creek Golf Course are regulated by Order No. 98-098 [21]. Effluent water quality limitations and performance requirements are defined as well as specific reporting provisions in the plant WDRs. A review of the WDRs and NPDES is provided below.

a. Treatment Plant Waste Discharge Requirements

Regional Board Order No. 98-110 [17] established discharge prohibitions, discharge specifications, reclamation specifications, sludge prohibitions, sludge discharge specifications, and groundwater limitations for wastewater treatment and disposal for the City WWTP. Regional Board Order No. R5-2007-0031 (2007 Order) [14] established effluent limitations for discharge to Angels Creek and surface water limitations.

The 2007 Order [14] describes the WWTP as having a design capacity, or maximum flow to process (MFP), of 1.9 mgd and consisting of: 1) mechanical screening; 2) biological treatment with nitrification/denitrification; 3) flow equalization; 4) chemical addition; 5) flocculation; 6) sand filtration; 7) disinfection; and 8) emergency storage. Treated wastewater is land applied through spray irrigation on approximately 61-ac of pastureland or used to irrigate the Greenhorn Creek Golf Course. Land discharge effluent limitations are provided in Table 4-1. Effluent limitations for reclaimed water used for irrigation of the golf course are provided in Table 4-2. Additional requirements are summarized in Table 4-3.

TABLE 4-1
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF LAND DISCHARGE EFFLUENT LIMITATIONS [17]

Parameter	Monthly Average Limit	Monthly Median Limit	Daily Maximum Limit
BOD_5	40 mg/L	--	80 mg/L
Settleable Solids	0.2 mL/L[a]	--	0.5 mL/L
Total Coliform Organisms	--	23 MPN[b]/100 mL[c]	230 MPN/100 mL

[a] mL/L = milliliter per liter.
[b] MPN = most probable number.
[c] mL = milliliter.

TABLE 4-2
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF RECLAIMED WATER DISCHARGE EFFLUENT LIMITATIONS [17]

Parameter	Monthly Average Limit	7-Day Median Limit	Daily Maximum Limit
BOD_5	30 mg/L	--	--
Turbidity	2.2 NTU[a]		5 NTU
Total Coliform Organisms		2.2 MPN/100 mL	23 MPN/100 mL

[a] NTU = nephelometric turbidity unit.

TABLE 4-3
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF EFFLUENT DISCHARGE SPECIFICATIONS/PROHIBITIONS FOR LAND DISCHARGE [17]

Specification	Requirement
Setbacks for spray irrigation areas	500 ft from domestic water wells; 100 ft from irrigation wells, food crops, and drainage courses; 50 ft from public roads and property lines
Dissolved oxygen level in ponds	Minimum of 1.0 mg/L for upper 1 ft zone of wastewater in ponds
Standing water	Applied irrigation water must infiltrate completely within 24 hours
Storage pond	Pond pH shall not be less than 6.5 or greater than 8.5
Freeboard	Pond freeboard shall not be less than 2.0 ft
Spray irrigation	Spray irrigation prohibited during periods of precipitation and for minimum of 24 hours after cessation of precipitation and when winds exceed 30 miles per hour (mph)
Storm water runoff	Storm water runoff from irrigation fields shall not be discharged to any surface drainage course within 24 hours of the last application of reclaimed water

Sludge from the treatment plant is aerobically digested and dewatered in sludge drying beds. WDRs Order No. 98-110 establishes sludge prohibitions and discharge specifications. Requirements are summarized in Table 4-4.

TABLE 4-4
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF SLUDGE DISCHARGE SPECIFICATIONS/PROHIBITIONS [17]

Specification	Requirement
Application	Biosolids shall not be applied to water saturated or frozen ground, during periods of rain or snow fall, or to land
Setbacks	10 ft from property lines; 50 ft from non-domestic supply wells and public roads; 100 ft from surface water; and 500 ft from domestic supply wells and residential buildings
Maximum constituent concentrations (mg/kg)[a]	Arsenic 75; Cadmium 85; Copper 4300; Lead 840; Mercury 57; Molybdenum 75; Nickel 420; Selenium 100; Zinc 7500

[a] mg/kg = milligram per kilogram.

b. NPDES Permit

Holman Reservoir provides 202 ac-ft, or 66 million gallons (MG), of storage capacity for reclaimed water not immediately disposed to the pastureland or Greenhorn Creek Golf Course. In 2007, NPDES Permit No. CA0085201 [14] was obtained for seasonal discharge to Angels Creek when flows exceed land disposal and storage capacity. Discharge to Angels Creek may only occur from November 15 to May 15 and when: 1) Angels Creek flow is a minimum 12 mgd and 2) the Angels Creek flow to effluent flow ratio is a minimum of 20:1. Additionally, discharge to Angels Creek is prohibited when Holman Reservoir has more than 20 MG of unused effluent capacity. Effluent water quality parameters for discharge to Angels Creek are summarized in Table 4-5. In addition, the following requirements must be met:

1. pH shall be a minimum of 6.5 and maximum of 8.0.

2. Average monthly percent removal of BOD_5 and total suspended solids (TSS) shall be a minimum of 85 percent.

3. Turbidity shall not exceed a daily average of 2 NTU, a value of 5 NTU more than 5% of the time within a 24-hour period and 10 NTU at any time.

4. Total coliform organisms shall not exceed 2.2 MPN/100mL as a 7-day median, 23 MPN/100mL more than once in a 30 day period or 240 MPN/100mL at any time.

5. Average daily discharge flow shall not exceed 1.9 mgd.

TABLE 4-5
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF DISCHARGE TO ANGELS CREEK EFFLUENT LIMITATIONS [14]

Parameter	Monthly Average Limit	Weekly Average Limit	Daily Maximum Limit
BOD_5	10 mg/L	15 mg/L	20 mg/L
Total Suspended Solids	10 mg/L	15 mg/L	20 mg/L
Electrical Conductivity	510 µmhos/cm[a]	-	-
Chlorine Residual	0.01 mg/L	-	0.02 mg/L
Settleable Solids	0.1 mL/L	-	0.2 mL/L
Ammonia (Total)	23 mg/L	-	56 mg/L
Bis(2-chloroethyl)ether	0.41 µg/L[b]	-	0.82 µg/L
Nitrate	10 mg/L	-	-
Nitrite	1.0 mg/L	-	-
Dichlorobromomethane	7.0 µg/L	-	14 µg/L
Copper	9.2 µg/L	-	18 µg/L
Lead	2.5 µg/L	-	4.9 µg/L
Zinc	133 µg/L	-	266 µg/L

[a] µmhos/cm = micromhos per centimeter.
[b] µg/L = micrograms per liter.

c. Reporting Requirements

A list of reports required for submission to the Regional Board by the current WDRs, NPDES, and MRPs are summarized in Table 4-6. Studies required by recently issued NPDES permits for other agencies that may also be required by the City under future permit renewals include:

1. Temperature Study: Evaluation to determine whether permitted conditions are protective of the aquatic life beneficial uses of the creek.

2. Creek pH Study: Evaluation of the natural background pH of the creek and the effect of the discharge.

3. Combination of WDRs and NPDES permit.

Additional monitoring programs, work plans, or reports would potentially be required in the event that the WWTP becomes non-compliant with any of the specified effluent limitations or operational prohibitions. The presence of springs at the sprayfields may become subject to future monitoring requirements as well.

TABLE 4-6
CITY OF ANGELS WASTEWATER MASTER PLAN
REPORTING REQUIREMENTS

Required Report	Required Report Content	Submitted to Regional Board?	Reference Section
WDRs Order No. 98-110 [17]			
Contingency Plan	Actions to be taken when effluent fails to meet required standards	Yes (*Title 22 Engineering Report*, Sept 2002 and May 2011)	Waste Discharge Requirements, pg. 11
Sludge Monitoring: Biosolids Pre-Application Report	1. Proposed loading rates and metal loading criteria 2. Proposed time schedule for application 3. Biosolids characteristics 4. Field characterization (crop types, tillage practices, erosion controls, distance to surface water/wells/etc.)	To be submitted when biosolids are applied to land	Monitoring & Reporting Program, pg. 3
Sludge Monitoring: Biosolids Post-Application Report	1. Volume and weight of biosolids applied 2. Location of application 3. Weight of wet sludge and dry sludge applied per ac 4. Metals and nitrogen applied per ac 5. Cumulative application of each constituent specified and comparison to allowable 6. Type of crops 7. A statement of compliance or non-compliance with site use restrictions	To be submitted when biosolids are applied to land	Monitoring & Reporting Program, pg. 3
Annual Land Management Report	Summary of land management operations for each season: 1. Total water application 2. Total volume of wastewater applied 3. Total nutrient loading 4. Amount of nutrients removed through harvest of the crop	No[a]	Monitoring & Reporting Program, pg. 4

TABLE 4-6 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
REPORTING REQUIREMENTS

Required Report	Required Report Content	Submitted to Regional Board?	Reference Section
Monthly and Annual Monitoring Reports	Influent, effluent, and storage pond monitoring results for specified constituents	Yes	Monitoring & Reporting Program, pg. 5
Plan for Preventing and Controlling Accidental Discharges	1. Possible sources of accidental loss or leakage of wastes 2. Effectiveness of present waste management procedures and identification of needed changes 3. Effectiveness of proposed changes in waste management strategies and implementation schedule	Yes (*Recycled Water Spill Assessment and Control Plan*, Jan 2011)	Standard Provisions & Reporting Requirements, pg. 3
Order No. R5-2009-0074 (NPDES Permit No. CA0085201) [14]			
Mixing Zone Study	Mixing zone study to evaluate available assimilative creek capacity	Yes (*Angels Creek Mixing Zone Stu*dy, Jan 2009)	Limitations & Discharge Requirements, pg. 17
Annual Salinity Evaluation and Minimization Plan	Address sources of salinity from the domestic wastewater treatment system	No[a]	Limitations & Discharge Requirements, pg. 17, 20 and Monitoring & Reporting Program, pg. E-12
Initial Investigative Toxicity Reduction Evaluation Work Plan	1. Description of evaluation techniques that will be used to identify causes and sources of effluent toxicity 2. Description of facility's methods to maximize treatment efficiency	To be submitted when toxicity triggers are exceeded	Limitations & Discharge Requirements, pg. 18
Pollutant Evaluation and Minimization Plan	Plan for minimization of ammonia, copper, lead, zinc, bis(2-chloroethyl)ether, and dichlorobromomethane	No[a]	Limitations & Discharge Requirements, pg. 20
Monthly, Quarterly, Semi-Annual, and Annual Monitoring Reports	Influent, effluent, creek, and municipal water supply monitoring results for specified constituents	Yes	Monitoring & Reporting Program, pg. E-1 – E-11

TABLE 4-6 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
REPORTING REQUIREMENTS

Required Report	Required Report Content	Submitted to Regional Board?	Reference Section
Annual Operations Report	1. Name, grades, and responsibilities of persons employed 2. Points of contact 3. Flow meter calibration information 4. Statement certifying current O&M manual and contingency plan	Yes	Monitoring & Reporting Program, pg. E-12
MRPs Order No. 98-098[b] (Greenhorn Creek Golf Course) [21]			
Monthly and Annual Monitoring Reports	Storage pond and reuse area monitoring results for specified constituents and inspections	Yes	Monitoring & Reporting Program, pg. 2-3, 5
Quarterly Groundwater Monitoring	Monitoring results of specified constituents and depth to groundwater	Yes	Monitoring & Reporting Program, pg. 3
Background Groundwater Quality Study Report	For each constituent: summary of monitoring data, concentrations in background monitoring wells, and comparison to that in wells used to monitor the facility	Yes	Monitoring & Reporting Program, pg. 6
CDPH Letter - Field Commissioning of UV Disinfection System, July 22, 2011 [22]			
Field Commissioning Results	Performance of UV disinfection system at several flows and UV transmittances	Yes (*City of Angels WWTP UV Disinfection System Field Commissioning Test Results*, May 2011)	-
Operations Plan	Operational limits and responses required for critical alarms	Yes	-

[a] Land Application Area Monitoring (appears to be similar to the Annual Land Management Report), Salinity Evaluation and Minimization Plans, and Pollutant Evaluation and Minimization Plans have also been required by the Regional Board under recently issued WDRs and NPDES permits for other facilities including the Plymouth Wastewater Treatment Facility, Sacramento Regional Wastewater Treatment Plant, Deer Creek Wastewater Treatment Plant, Bear Valley Wastewater Treatment Plant.

[b] Reports required by MRPs Order No. 98-098 are prepared and submitted under the direction of Greenhorn Creek Associates, L.P.

As noted in Table 4-6, the following studies required by the current WDRs and NPDES permit are also likely to be included in future permit renewals considering these studies are being required from other agencies:

1. Annual Land Management Report (aka Land Application Area Monitoring): Summary of land management operations including total wastewater volume applied, nutrient loading, and nutrient removal.

2. Salinity Evaluation and Minimization Plan: Address sources of salinity from the domestic wastewater treatment system and develop plan to minimize salinity.

3. Pollutant Evaluation and Minimization Plan: Address sources of specified toxins and develop plan to minimize the toxins.

The general concept and basic elements for the Salinity Evaluation and Minimization Plan and Pollutant Evaluation and Minimization Plan are outlined in the California Water Code (CWC) Section 13263.3(d)(3) as follows [23]:

> (3) The state board or a regional board may require a publically owned treatment works (POTW) to complete and implement a pollution prevention plan that includes all of the following:
>
> (A) An estimate of all of the sources of a pollutant contributing, or potentially contributing, to the loading of that pollutant in the treatment plant influent.
>
> (B) An analysis of the methods that could be used to prevent the discharge of the pollutants into the POTW, including application of local limits to industrial or commercial dischargers regarding pollution prevention techniques, public education and outreach, or other innovative and alternative approaches to reduce discharges of the pollutant to the POTW. The analysis also shall identify sources, or potential sources, not within the ability or authority of the POTW to control, such as pollutants in the potable water supply, airborne pollutants, pharmaceuticals, or pesticides, and estimate the magnitude of those sources, to the extent feasible.
>
> (C) An estimate of load reductions that may be attained through the methods identified in subparagraph (B).
>
> (D) A plan for monitoring the results of the pollution prevention program.
>
> (E) A description of the tasks, cost, and time required to investigate and implement various elements in the pollution prevention plan.

(F) A statement of the POTW's pollution prevention goals and strategies, including priorities for short-term and long-term action, and a description of the POTW's intended pollution prevention activities for the immediate future.

(G) A description of the POTW's existing pollution prevention programs.

(H) An analysis, to the extent feasible, of any adverse environmental impacts, including cross media impacts or substitute chemicals, that may result from the implementation of the pollution prevention program.

(I) An analysis, to the extent feasible, of the costs and benefits that may be incurred to implement the pollution prevention program.

The Regional Board is in the process of preparing more specific guidelines and examples to more clearly define expectations for the Salinity Evaluation and Minimization Plans and Pollutant Evaluation and Minimization Plans [24]. When preparing the Salinity Evaluation and Minimization Plan, it is recommended that the City include efforts to minimize salinity with the conversion from chlorine disinfection to UV disinfection at the WWTP.

4.2 Wastewater Collection System

The SWRCB General Waste Discharge Requirements Order No. 2006-0003-DWQ (GWDR) [25] requires that all sanitary sewer collection systems that have over one mile of sewer collection pipeline prepare a system-specific Sewer System Management Plan (aka SSMP). The GWDR prohibits sanitary sewer overflows (SSOs), defined as the discharge of untreated or partially untreated wastewater to waters of the United States, and calls for the owner/operator of the collection system to implement all feasible steps to eliminate SSOs. Mandatory elements of the SSMP are listed in Table 4-7. If a particular element is not applicable to the City collection system, the GWDR provides that the element may be waived. However, a description of why the element was waived must be included in the SSMP.

TABLE 4-7
CITY OF ANGELS WASTEWATER MASTER PLAN
MANDATORY ELEMENTS OF SEWER SYSTEM MANAGEMENT PLAN [25]

Item	Title	GWDR Section
1	Goals and Organization Structure	Section D.13.i & ii
2	Legal Authority	Section D.13.iii
3	O&M Plan	Section C.13.iv
4	Design and Performance	Section D.13.v
5	Overflow Emergency Response Program	Section D.13.vi
6	Fats, Oil, and Grease Control Program	Section D.13.vii
7	System Evaluation and Capacity Assurance Plan	Section D.13.viii
8	Monitoring, Measurement, and Program Modifications	Section D.13.ix
9	SSMP Program Audits	Section D.13.x
10	Communication Program	Section D.13.xi

The GWDR requires: 1) the City Council to approve the SSMP at a public meeting, and 2) the City's authorized representative to complete and mail a signed certification form (available in the SWRCB's Online SSO Database) to complete certification of the SSMP. The GWDR requires updates to the SSMP every five years and City Council approval/certification of any significant changes to the SSMP.

In September 2009, the SWRCB initiated a review and update of the GWDR. The process included public meetings and a workshop with regional water quality control boards represented. In March 2011, a "Notice of Opportunity to Comment" was issued by the SWRCB with draft changes to the GWDR along with a Staff Report [26] describing the proposed changes to the GWDR and public comments received. Proposed changes to the 2006 GWDR include:

1. A requirement for private lateral sewage discharges (PLSD) to also be reported when the City becomes aware of the PLSD. The 2006 GWDR provides for voluntary reporting of private lateral spills.

2. A change to notification requirements for SSOs that only the California Emergency Management Agency (Cal EMA) must be notified, eliminating duplicate notifications to local county health departments and the Regional Board. Additionally, notification may occur more than two hours after knowledge of the spill if the notification call would substantially impede cleanup of the spill.

3. A change to applicability criteria of the GWDR to include privately owned collection systems. Criteria are expanded to designate that the applicable systems have: 1) greater than one mile of sewer collection pipeline and 2) a system that collects and conveys more

than 25,000 gpd of untreated or partially treated wastewater to a publicly or privately owned treatment facility or sanitary sewer system. In addition, if an enrollee owns more than one sewer system that meets the criteria, and the systems are managed as separate districts, then each system must be enrolled separately. If an enrollee owns multiple systems and only one is over a mile in contiguous length, each system that is less than a mile in contiguous length must also be managed under a SSMP.

4. A revision to the definition of a SSO to be a discharge to "surface waters of the state" rather than "waters of the United States." The revision includes discharges to storm drain pipes tributary to "waters of the state," and not conveyed to a wastewater treatment plant.

5. Certain clarifications and revisions for the SSMP elements are proposed. These revisions include a change in the frequency of updating the document every two years, rather than every five years.

4.3 Notice of Violation/Administrative Civil Liability Complaint

A Notice of Violation (NOV) was issued by the Regional Board on December 2, 2010. The NOV [27] noted that between the months of September 2008 and April 2010, a cumulative flow of more than 3 MG of reclaimed water was spilled from the spray irrigation area. Reclaimed water from five of the six spills reported by the City reached surface water, which was a violation of WDRs Order No. 98-110. As required by the NOV, a Recycled Water Spill Assessment and Control Plan (Assessment) was submitted by the City Engineer in January 2011. The Assessment [28] cited "discovery delays" in response to spills, as a result of once daily sprayfield inspections by City WWTP staff. Proposed system improvements outlined in the Assessment and summarized in Table 4-8 include:

1. Upgrades to the Supervisory Control and Data Acquisition (SCADA) system to include sprayfield pumps, reservoir water levels, and flow monitoring.

2. A variable frequency drive (VFD) installed on the pump discharging to the sprayfields.

3. Installation of flow meters at the upper pump house, lower pump house, and Holman Reservoir.

4. Installation of a level sensor at the re-regulating reservoir.

5. Installation of a level sensor at the Holman Reservoir.

6. Miscellaneous mechanical upgrades to piping and valving.

TABLE 4-8
CITY OF ANGELS WASTEWATER MASTER PLAN
PROPOSED SPRAYFIELD IMPROVEMENT PROJECTS [29]

Phase	Project Description
I	Lower Pump House Rebuild: 1. Install meter for flow to re-regulate pond 2. Install meter for flow to and from Holman Reservoir 3. Install tee and valve for the emergency release for water from Holman Reservoir 4. Replace outdated split-case pump 5. Replace existing piping, valves, swing-check valves, and surge valve 6. Incorporate SCADA into electrical for flows, operations, and alarm settings a. Meter flows for Holman meter and flow alarms b. Meter flows for meter to re-regulating reservoir and flow alarms c. Holman level sensor and alarm d. Communications alarm between upper and lower pump houses e. Programmed shut-downs for alarms Upper Pump House Rebuild: 1. Install meter for flow to fields 2. Install VFD for upper pump to allow for soft starts and stops 3. Replace existing piping, valves, and swing-check valves 4. Incorporate sprayfield timers and sequences into SCADA to monitor operations better and allow for flow alarm shutdowns a. Install monitor at upper pump house to run fields from remote location 5. Establish radio signal communication between sprayfields and WWTP 6. Adapt sprayfield SCADA system and related pages into existing WWTP SCADA 7. Incorporate SCADA into electrical for flows, operations, and alarm settings a. Meter flows for re-regulating meter and flow alarms b. Re-regulating level sensor alarm c. Programmed shut-downs for alarms
II	Distribution System Upgrades: 1. Replace existing Schedule 40 piping with Class C900 PVC piping for force mains from lower pump house to upper pump house 2. Replace existing Schedule 40 piping with Class C900 PVC piping for force mains from upper pump house to each of the eight fields 3. Replace solenoid valves for all eight fields 4. Replace wooden boxes with reinforced concrete boxes 5. Install isolation valves
III	Re-grade all existing roads and install culverts where needed Re-grade drainage ditch and slide gate system around Holman Reservoir perimeter

The Assessment describes implementation of the improvements including a consultant's review of the sprayfield system, with construction of Phase I and II improvements anticipated by April 2013.

Following submission of the Assessment, two other discharges from the sprayfields to surface waters were reported by the City to the Regional Board. The discharges, which occurred January 14 and June 29, 2011, represented an estimated cumulative volume of 450,000 gallons. Based on these additional discharge violations, the Regional Board issued an administrative civil liability (ACL) complaint R5-2011-0589 to the City on September 6, 2011 [30]. The ACL compliant charged the City with civil liability in the amount of $125,000 for violations of WDRs Order No. 98-110 and Cleanup and Abatement Order 5-01-535. The City has waived their right to a hearing and is in negotiations with the Regional Board regarding the ACL.

5 Design Criteria

Design criteria used for evaluation of the wastewater collection, treatment, and disposal facilities are provided in this chapter.

5.1 Study Area

The study area for the Master Plan is based on the current City limits from the General Plan [1] which encompasses an area of approximately 2,280 ac. For master planning purposes, the study area does not extend beyond the current City limits. Land use information was provided by City staff.

5.2 Pump/Lift Stations

Pump stations and lift stations will be comparable in design, except pump stations will discharge to a force main and lift stations will discharge to a gravity sewer. Pump/lift stations will be evaluated based on the following criteria. Additional design criteria such as wet well sizing, flow metering, remote monitoring capabilities, and housing of electrical equipment in a building or weatherproof enclosure will be decided on a case-by-case basis.

1. Pump/lift stations sites will be sized to accommodate all pump/lift station equipment with sufficient access for maintenance vehicles and equipment (e.g., vactor truck or maintenance equipment).

2. Triplex stations will be used when necessary if a single pump capable of meeting the anticipated range of flows is not available.

3. Pump/lift stations will be furnished with submersible pumps and are to include the redundancy of one stand-by pump.

4. Each pump in a duplex pump/lift station will be designed to meet 100 percent of the peak wet weather flow (PWWF).

5. Triplex pump/lift stations are designed to meet 100 percent of the PWWF with the largest pump out of service.

6. Pump and impeller sizes will be selected with operating points within 60-115 percent of the pump's best efficiency point.

7. Pump drives will be either constant speed or VFD.

8. Static lift is calculated as the difference between the wet well invert and the upstream spring line of the sewer immediately downstream of the lift station.

9. An onsite emergency generator or a receptacle for connection to a portable emergency generator should be included.

10. Provide bypass capabilities with piping for the operation of a portable pump.

11. All wet wells will be lined.

12. Provide site lighting and water for wash down purposes.

5.3 Conveyance Pipelines

The use of gravity sewers for the collection system is the preferred method of conveyance. Although initially more expensive due to larger size and depth of installation, gravity sewers tend to have lower O&M costs and a reduced risk of failure. Pump stations, lift stations, and force mains will be selected for conditions where the topography, geology, or constraints in the existing system inhibits the use of gravity sewers. Design and evaluation criteria for gravity pipelines, gravity service area limits, and force mains are provided below.

a. Gravity Pipelines

The following criteria will be used in the design of gravity sewers:

1. New gravity sewer pipelines should be 8-inches or larger in nominal diameter. Terminal runs that have no potential for further extension, such as cul-de-sacs, may be 6-inch diameter. The City 2010 Improvement Standards [4] allow for additional sewer pipelines to be 6-inches in diameter; however, pipes of this size can be difficult to maintain.

2. The minimum depth of cover is 2.5 ft per City 2010 Improvement Standards [4].

3. The maximum depth of cover is 30 ft.

4. Manholes are assumed at maximum intervals of 300 ft per City 2010 Improvement Standards [4]. Manholes are also assumed at junctions, angle points, change in pipe diameter or gradient, and at the termination of sewer lines.

5. For analytical purposes, a Manning's "n" of 0.013 will be assumed for all new sewer pipelines. A Manning's "n" of 0.015 will be assumed for all existing sewer pipelines.

6. A minimum velocity of 2 fps should be maintained in gravity sewers when the pipe is half full per City 2010 Improvement Standards [4]. Maximum velocity should not exceed 10 fps at the design flow rate.

The primary evaluation criterion for hydraulic deficiency in gravity sewers is the liquid depth in pipe/diameter (d/D) ratio. New sewers are typically designed for d/D ratios ranging from 0.50 to

0.75, depending on diameter. Higher d/D ratios, up to 1.00, are accepted for existing sewers. For the purposes of the Master Plan, any gravity segment with a d/D ratio greater than 1.00 (100% full by depth) will be deemed hydraulically deficient. This designation is consistent with criteria used in previous studies. Proposed gravity sewers will be sized for a d/D ratio less than or equal to 0.75 (75% full by depth). The critical d/D ratios are summarized in Table 5-1.

TABLE 5-1
CITY OF ANGELS WASTEWATER MASTER PLAN
MAXIMUM DESIRED RATIO OF NORMAL
LIQUID DEPTH IN PIPE TO PIPE DIAMETER

Item	d/D Ratio
Existing gravity sewers	1.00
Proposed gravity sewers	0.75

b. Force Main Criteria

The following criteria will be used in the design of force mains:

1. The minimum depth of cover is 3 ft.
2. Velocities will range from 2-6 fps.
3. Force mains will be constructed of PVC, American Water Works Association (AWWA) C900/C905.
4. Air release valves will be provided at high points in the mains.

5.4 Wastewater Treatment Plant

A summary of the treatment plant design flow and loadings from the record drawings of the Phase III Improvement Project to the City WWTP [31] is presented in Table 5-2. Design criteria for individual processes are provided in Appendix D.

TABLE 5-2
CITY OF ANGELS WASTEWATER MASTER PLAN
DESIGN FLOWS AND LOADINGS FOR WWTP

Item	Value
Average Dry Weather Flow (ADWF), mgd	0.6
Peak Wet Weather Flow (PWWF), mgd	3.1
Maximum Flow to Process (MFP), mgd[a]	1.9
Influent BOD_5 at ADWF, mg/L	220
Influent Suspended Solids (SS) at ADWF, mg/L	220
Influent BOD_5 at MFP, mg/L	110

[a] Excess flows to be stored in equalization basin.

5.5 Effluent Storage and Disposal Facilities

The Regional Board requires storage and disposal facilities to be designed for 100-year annual precipitation in addition to the permitted plant flow [17]. This requirement is met by combination of existing storage reservoirs, irrigation of the City sprayfields and Greenhorn Creek golf course, and discharge to Angels Creek. Effluent limitations for spray irrigation of the 136-ac field (61-ac available for disposal) adjacent to Holman Reservoir and 110-ac at Greenhorn Creek golf course are established by WDRs Order No. 98-110 [17]. Effluent limitations for discharge to Angels Creek are established by NPDES Permit No. CA0085201 [14].

6 Projected Wastewater Flows

This chapter presents the development of appropriate wastewater generation factors (WGFs) for existing and future land uses to predict wastewater flows for 10-year and 20-year planning horizons and buildout conditions.

6.1 Study Area

Land use data for the City provided in geographic information systems (GIS) format were utilized for the development of this chapter. The furnished data encompassed a total area of approximately 2,280 ac within the City limits, including the WWTP.

The existing wastewater collection system is divided into five distinct sewer basins with pump stations conveying flow between basins. Limits of existing sewer basins, as established in the Draft Capacity Assurance Plan [10], are illustrated in Figure 6-1. An existing sewer system flow schematic is provided in Figure 6-2.

Analysis of buildout flows includes the addition of a sixth sewer basin, which will be created with the addition of the North Angels Sewer Trunk Line (Alternative 2B), as determined by the *Alternatives Analysis for North Angels Sewer Trunk Line* [11]. Existing Basin #2 will be subdivided to create Basin #6. Limits of future sewer basins are shown in Figure 6-3. A future sewer system flow schematic is provided in Figure 6-4.

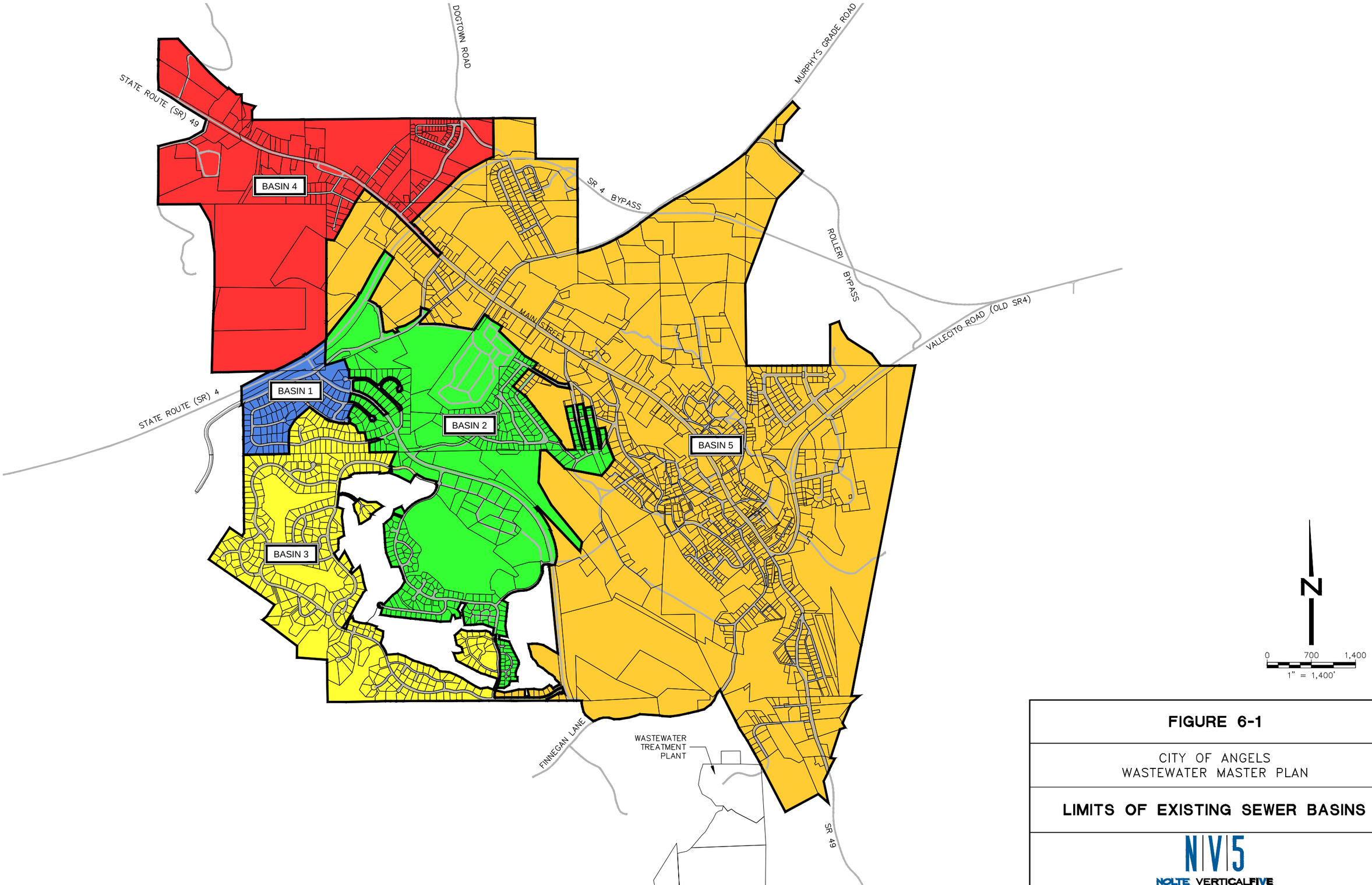


FIGURE 6-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

LIMITS OF EXISTING SEWER BASINS

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch6\Figure 6-1 Existing Basin.dwg JCP 2/1/2012

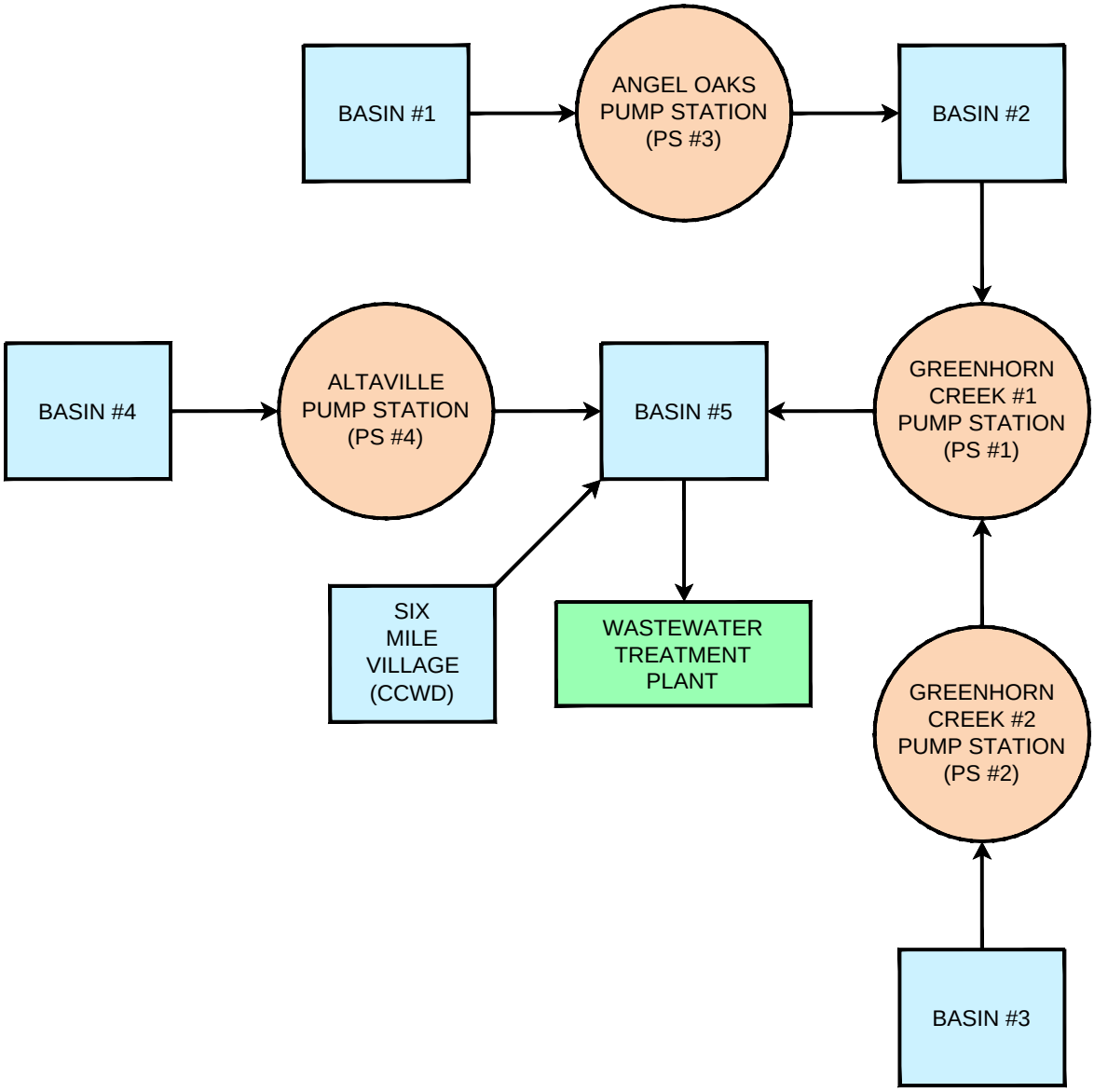


FIGURE 6-2

CITY OF ANGELS
WASTEWATER MASTER PLAN

EXISTING SEWER SYSTEM FLOW SCHEMATIC

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch6\Figure 6-2 Existing Schematic.dwg JCP 2/2/2012

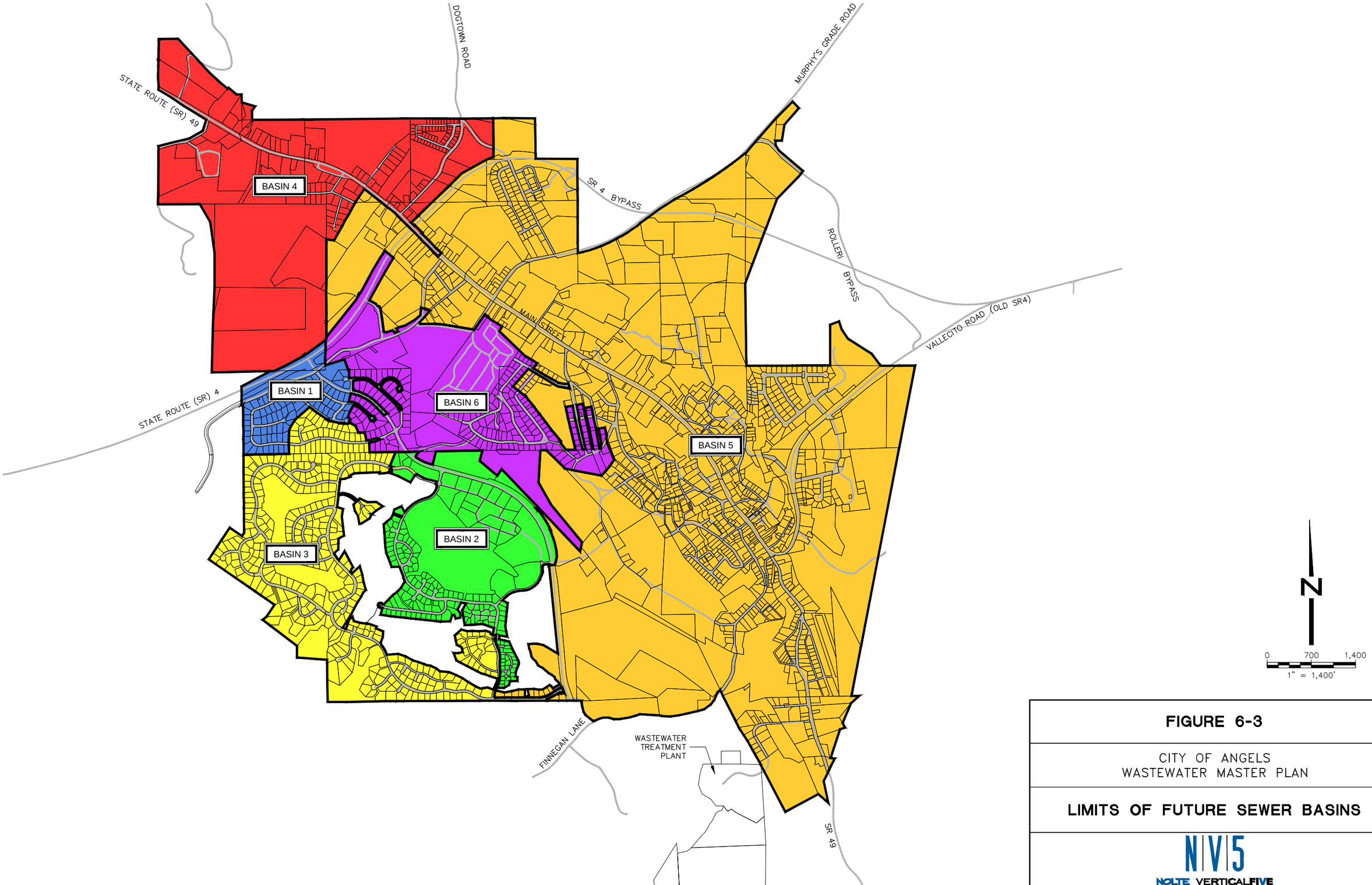


FIGURE 6-3

CITY OF ANGELS
WASTEWATER MASTER PLAN

LIMITS OF FUTURE SEWER BASINS

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch6\Figure 6-3 Future Basin.dwg JCP 2/1/2012

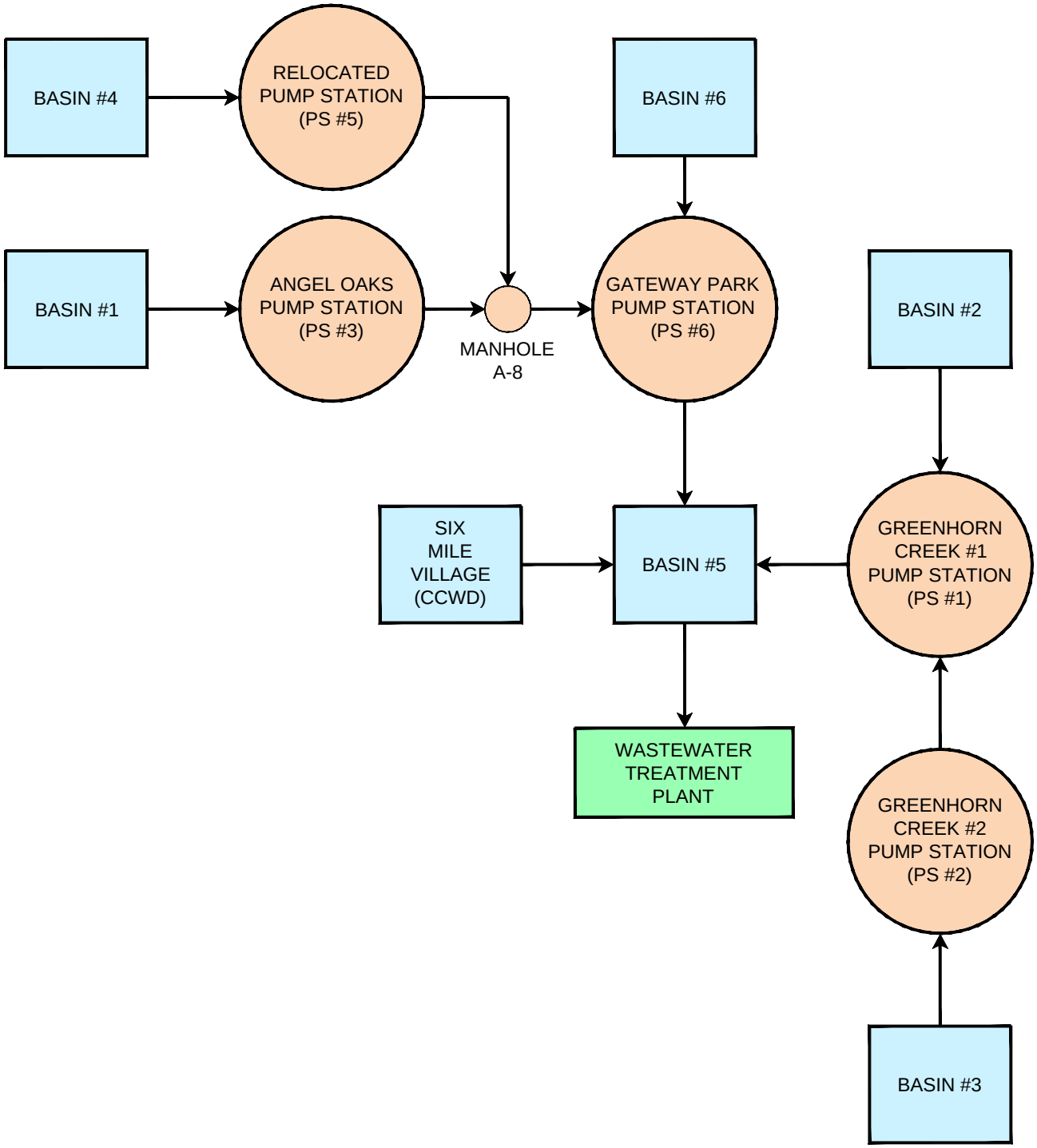


FIGURE 6-4

CITY OF ANGELS
WASTEWATER MASTER PLAN

FUTURE SEWER SYSTEM FLOW SCHEMATIC

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch6\Figure 6-4 Future Schematic.dwg JCP 1/27/2012

6.2 Land Use

City GIS data were analyzed to determine the distribution of land uses within each existing and future sewer basin. In addition to land uses based on the General Plan [1], data reviewed included the current GIS status of each parcel: developed, partially developed, or vacant. Land use descriptions are presented in Table 6-1.

TABLE 6-1
CITY OF ANGELS WASTEWATER MASTER PLAN
LAND USE DESCRIPTIONS

Land Use Code	Description
Residential	
HDR	High-Density Residential
MDR	Medium-Density Residential
RE	Residential Estates
SFR	Single-Family Residential
Commercial	
BAE	Business Attraction/Expansion
CC	Community Commercial
HC	Historic Commercial
SC	Shopping Commercial
Industrial	
I	Industrial
Public	
P	Public
P-SCH	Public School
PR	Parks and Recreation
PR-Golf	Golf Course
Other	
OS	Open Space
SP	Special Planning
ROW	Right-of-Way

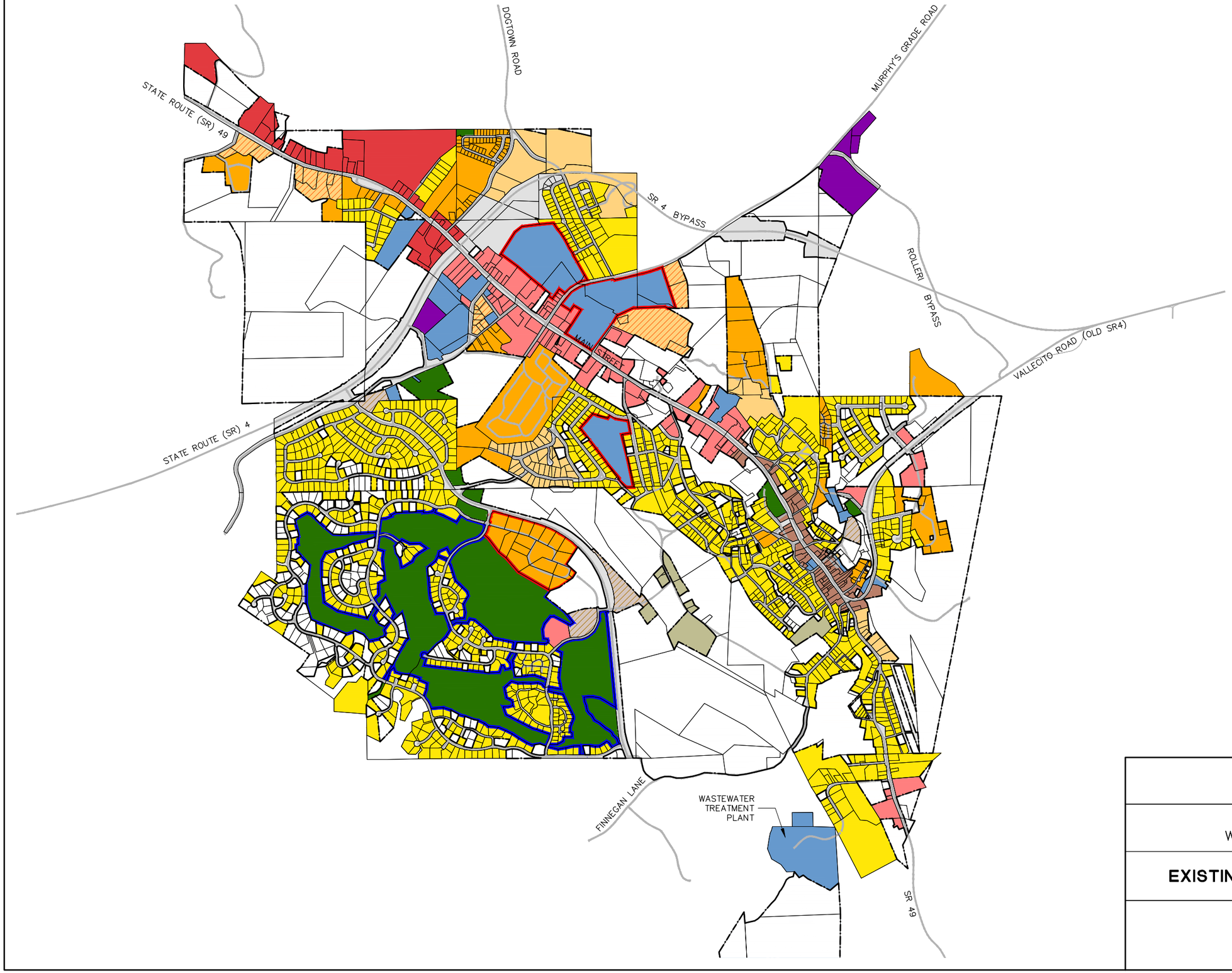
a. Existing Areas

Overall land use characteristics for existing basins were used to develop appropriate WGFs accounting for existing flows. A summary of land use, by basin, is presented in Table 6-2 and Figure 6-5. An expanded summary of existing land uses is provided in Appendix E. Table 6-2 summarizes land uses by acreage within each basin. Parcels designated as right-of-way and open space were assumed to generate minimal wastewater and are not included in the analysis of existing flows.

TABLE 6-2
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF EXISTING LAND USES BY BASIN

Use	Basin 1		Basin 2		Basin 3		Basin 4		Basin 5		Total	
	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac
Residential												
HDR	0	0.0	24	50.1	0	0.0	75	28.8	56	37.8	155	116.8
MDR	0	0.0	44	12.0	0	0.0	4	10.4	20	29.0	68	51.4
RE	0	0.0	0	0.0	0	0.0	0	0.0	10	13.5	10	13.5
SFR	83	24.0	269	68.2	222	81.9	30	12.2	587	186.4	1,191	372.7
Commercial												
BAE	0	0.0	0	0.0	0	0.0	8	9.8	14	18.4	22	28.2
CC	0	0.0	2	3.2	0	0.0	0	0.0	98	61.6	100	64.9
HC	0	0.0	0	0.0	0	0.0	0	0.0	79	15.9	79	15.9
SC	0	0.0	0	0.0	0	0.0	32	25.1	7	6.4	39	31.5
Industrial												
I	0	0.0	0	0.0	0	0.0	0	0.0	5	16.4	5	16.4
Public												
P	0	0.0	2	1.0	0	0.0	0	0.0	20	26.9	22	27.9
P-SCH	0	0.0	0	0.0	0	0.0	0	0.0	8	49.5	8	49.5
PR	0	0.0	4	9.7	1	0.4	1	0.6	3	6.9	9	17.5
PR-Golf	0	0.0	4	124.4	1	19.5	0	0.0	0	0.0	5	143.9
Other												
SP	1	1.7	1	3.3	0	0.0	0	0.0	2	6.2	4	11.2
OS	0	0.0	0	0.0	3	12.0	2	0.1	0	0.0	5	12.1
Total[a]	**84**	**25.7**	**350**	**271.9**	**227**	**113.7**	**152**	**87.0**	**909**	**475.0**	**1,722**	**973.4**

[a] Right of Way uses excluded.



LAND USE LEGEND

COMMERCIAL		
	BAE	BUSINESS ATTRACTION & EXPANSION
	CC	COMMUNITY COMMERCIAL
	HC	HISTORIC COMMERCIAL
	SC	SHOPPING COMMERCIAL
RESIDENTIAL		
	HDR	HIGH-DENSITY RESIDENTIAL
	MDR	MEDIUM-DENSITY RESIDENTIAL
	RE	RESIDENTIAL ESTATES
	SFR	SINGLE-FAMILY RESIDENTIAL
	HDR-WMC	WORLDMARK CLUB (HIGH-DENSITY)
INDUSTRIAL		
	I	INDUSTRIAL
PUBLIC		
	P	PUBLIC
	P-SCH	PUBLIC SCHOOL
	PR	PARKS & RECREATION
	PR-GOLF	GOLF COURSE
OTHER		
	OS	OPEN SPACE
	ROW	RIGHT-OF-WAY
	SP	SPECIAL PLANNING
	N/A	UNDEVELOPED PARCEL

N

0 700 1,400

1" = 1,400'

FIGURE 6-5

CITY OF ANGELS
WASTEWATER MASTER PLAN

EXISTING DEVELOPED LAND USES

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch6\Figure 6-5 Existing Use.dwg JCP 2/2/2012

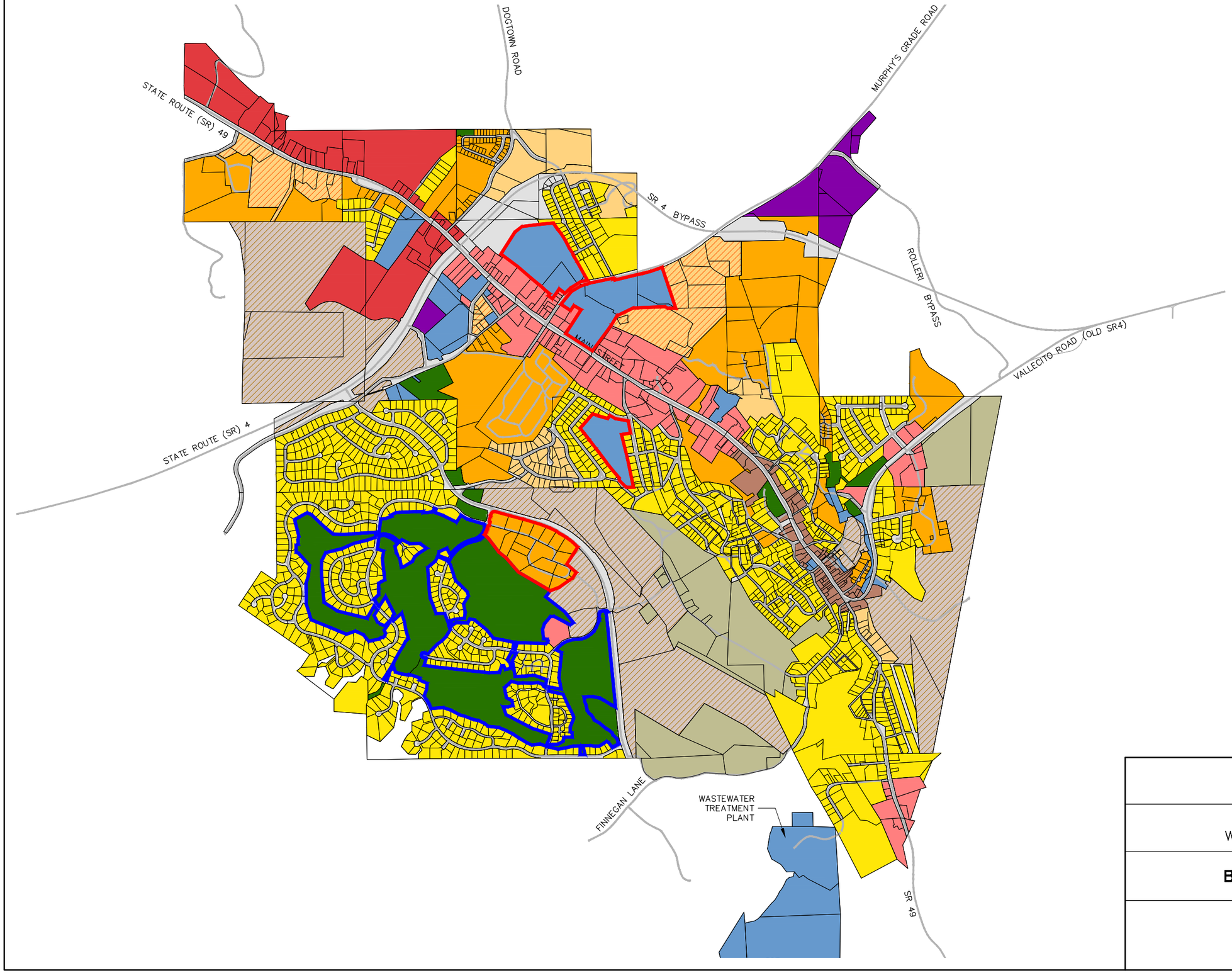
b. Future Areas

Land uses for parcels shown in the GIS files were used to estimate future flows. A summary of buildout land use, by basin, is presented in Table 6-3 and displayed in Figure 6-6. See Appendix E for an expanded summary of buildout land uses.

TABLE 6-3
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF BUILDOUT LAND USES BY TOTAL ACREAGE FOR EACH BASIN

Use	Basin 1		Basin 2		Basin 3		Basin 4		Basin 5		Basin 6		Total	
	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac	Parcels	Ac
Residential														
HDR	0	0.0	19	21.1	0	0.0	78	53.0	78	115.3	7	54.9	182	244.3
MDR	0	0.0	0	0.0	0	0.0	5	10.7	24	30.4	46	12.5	75	53.6
RE	0	0.0	0	0.0	0	0.0	0	0.0	26	125.8	0	0.0	26	125.8
SFR	86	24.9	147	32.4	364	133.7	30	12.2	690	259.1	156	44.5	1,473	506.8
Commercial														
BAE	0	0.0	0	0.0	0	0.0	10	20.2	21	39.1	0	0.0	31	59.3
CC	0	0.0	1	2.9	0	0.0	0	0.0	130	98.4	1	0.3	132	101.6
HC	0	0.0	0	0.0	0	0.0	0	0.0	85	20.6	0	0.0	85	20.6
SC	0	0.0	0	0.0	0	0.0	41	75.5	9	21.0	0	0.0	50	96.6
Industrial														
I	0	0.0	0	0.0	0	0.0	0	0.0	11	31.6	0	0.0	11	31.6
Public														
P	0	0.0	0	0.0	0	0.0	0	0.0	24	28.8	4	1.9	28	30.7
P-SCH	0	0.0	0	0.0	0	0.0	0	0.0	8	49.5	0	0.0	8	49.5
PR	0	0.0	1	1.8	1	0.4	1	0.6	4	11.1	3	7.9	10	21.8
PR-Golf	0	0.0	4	124.4	1	19.5	0	0.0	0	0.0	0	0.0	5	143.9
Other														
SP	5	4.2	4	21.6	0	0.0	4	93.8	18	154.2	5	23.4	36	297.2
OS	0	0.0	0	0.0	3	12.0	2	0.1	0	0.0	0	0.0	5	12.1
Total[a]	**91**	**29.1**	**176**	**204.1**	**369**	**165.5**	**171**	**266.0**	**1,128**	**985.0**	**222**	**145.6**	**2,157**	**1,795.4**

[a] Right of Way uses excluded.



LAND USE LEGEND

COMMERCIAL		
	BAE	BUSINESS ATTRACTION & EXPANSION
	CC	COMMUNITY COMMERCIAL
	HC	HISTORIC COMMERCIAL
	SC	SHOPPING COMMERCIAL
RESIDENTIAL		
	HDR	HIGH-DENSITY RESIDENTIAL
	MDR	MEDIUM-DENSITY RESIDENTIAL
	RE	RESIDENTIAL ESTATES
	SFR	SINGLE-FAMILY RESIDENTIAL
	HDR-WMC	WORLDMARK CLUB (HIGH-DENSITY)
INDUSTRIAL		
	I	INDUSTRIAL
PUBLIC		
	P	PUBLIC
	P-SCH	PUBLIC SCHOOL
	PR	PARKS & RECREATION
	PR-GOLF	GOLF COURSE
OTHER		
	OS	OPEN SPACE
	ROW	RIGHT-OF-WAY
	SP	SPECIAL PLANNING
	N/A	UNDEVELOPED PARCEL

N

0 700 1,400

1" = 1,400'

FIGURE 6-6

CITY OF ANGELS
WASTEWATER MASTER PLAN

BUILDOUT LAND USES

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch6\Figure 6-6 Buildout Use.dwg JCP 4/17/2012

6.3 Analysis of Existing Dry Weather Flows

Pump station and WWTP flow data were provided by the City and utilized to develop appropriate WGFs. Average Dry Weather Flow (ADWF) is typically predicted using land use information and corresponding WGFs. Sewer systems should be sized for hourly PWWF expected in the system, consisting of ADWF, a diurnal peaking factor (DPF), and I/I following a rainfall event.

Appropriate DPF and I/I allowances for the City wastewater collection system are discussed in Chapter 8.

a. Wastewater Treatment Plant

WWTP flow data were used to assess the overall average ADWF flows for the wastewater collection system. Total daily effluent flows for the WWTP from 2009 through 2011 were furnished by the City and reviewed for the months of June, July, and August to determine ADWF to the plant. A summary of WWTP effluent data used for flow analysis in provided in Table 6-4. Complete WWTP flow data are provided in Appendix F.

TABLE 6-4
CITY OF ANGELS WASTEWATER MASTER PLAN
WASTEWATER TREATMENT PLANT FLOW DATA, 2009-2011

Parameter	2009	2010	2011[a]	2009-2011 Average	Design Capacity[b]
ADWF, mgd[c]	0.346	0.373	0.353	0.357	0.600
Average Daily Flow for Max Month, mgd	0.521	0.620	0.748	0.630	-
Minimum Day, mgd[d]	0.004	0.123	0.148	0.092	-
Min Day/ADWF	0.012	0.330	0.420	0.254	-
95th Percentile, mgd	0.602	0.782	0.925	0.770	-
MFP	1.261	1.452	1.131	1.281	1.900

[a] Effluent flow data available from Jan - Aug for 2011.
[b] WWTP Record Drawings [31].
[c] ADWF for the months of Jun - Aug.
[d] Minimum day calculations exclude days with zero recorded flow.

The 2009-2011 average WWTP ADWF of 0.357 mgd is used in the Master Plan as an overall target value for WGF development and calibration. This figure includes flows from Six Mile Village.

b. Pump Stations and Six Mile Village

Pump run times for individual pump stations were used to estimate average flows for each basin or sewer shed. There are no flow meters at any of the pump stations. Pump run times and design points for the pumps at each pump station were used to estimate total daily pumped flow for each pump station. This method for estimating flow from the pump stations has several limitations, including the assumption that pumps are operating at their design point at all times.

The City also receives wastewater from Six Mile Village located to the northeast of Basin #5. Monthly flow data for Six Mile Village were provided by CCWD. Discussions with CCWD indicate that Six Mile Village is currently comprised of 64 residential lots. The service area of Six Mile Village is limited to 67 residential lots and 3 commercial lots. Buildout flows from Six Mile Village, discussed in Section 6.6b, will include an additional 3 residential lots and 3 commercial lots.

A summary of data used for flow analysis by basin is provided in Table 6-5. A complete summary of flow data, including pump run times and design points, is included in Appendix G.

TABLE 6-5
CITY OF ANGELS WASTEWATER MASTER PLAN
PUMP STATION AND SIX MILE VILLAGE FLOW DATA, 2010-2011

Description	ADWF (gpd)[a]	PDWF (gpd)[b]
Altaville Pump Station	45,098	189,000
Angel Oaks Pump Station	12,300	24,600
Greenhorn Creek #1 Pump Station (GHC #1)	160,855	318,990
Greenhorn Creek #2 Pump Station (GHC #2)	23,243	56,100
Six Mile Village[c]	8,975	20,194

[a] ADWF is average flow observed from June 1, 2011 through August 31, 2011.
[b] Peak dry weather flow (PDWF) is the maximum observed daily flow from January 1, 2011 through August 31, 2011.
[c] Flow data for Six Mile Village provided by CCWD.

c. Summary of Existing Flows

Flows for the WWTP, pump stations, and Six Mile Village were compared to determine the total average wastewater flow contributed by each basin under dry weather conditions. The methodology for determining individual basin flows is presented in Table 6-6.

TABLE 6-6
CITY OF ANGELS WASTEWATER MASTER PLAN
METHODOLOGY FOR DETERMINING WASTEWATER FLOW BY BASIN

Basin	Flow Estimate Calculation
Basin #1	= Angel Oaks Pump Station Flow
Basin #2	= (GHC#1 Pump Station) - (Angel Oaks Pump Station + GHC #2 Pump Station)
Basin #3	= GHC #2 Pump Station Flow
Basin #4	= Altaville Pump Station Flow
Basin #5	= (City Flow) - (GHC #1 Pump Station + Altaville Pump Station + Six Mile Village Flow)

Using existing land uses shown in Figure 6-5 and the flows and methodology presented in Tables 6-4, 6-5, and 6-6, ADWF flows were estimated for each basin. ADWF flows for each basin are presented in Table 6-7. The estimated City flow of 348,025 gpd (which excludes flows from Six Mile Village) presented below, will be used in subsequent calibrations of WGFs.

TABLE 6-7
CITY OF ANGELS WASTEWATER MASTER PLAN
ADWF FLOWS

Basin	Existing Target ADWF (gpd)
Basin #1	12,300
Basin #2	125,311
Basin #3	23,243
Basin #4	45,098
Basin #5	142,073
City[a]	**348,025**

[a] City flow equals WWTP ADWF less Six Mile Village ADWF.

d. Discussion of Service Area Population and Per Capita Factors

For reference, City population data and existing development information are summarized in Table 6-8.

TABLE 6-8
CITY OF ANGELS WASTEWATER MASTER PLAN
WASTEWATER FLOWS PER CAPITA

Parameter	Value
Current Population (Capita)[a]	3,836
Total Residential Parcels[b]	1,424
Total Developed Area , All Uses (ac)[b]	973.4
City Wastewater Flow[c]	348,025 gpd

[a] April 2010 population estimate from Dept. of Finance, Table E-4 [32].
[b] Includes developed parcels only, see Table 6-2.
[c] See Table 6-7 (excludes flows from Six Mile Village).

California Department of Finance E-5 Population and Housing Estimates for Cities, Counties, and the State, 2011-2010, with 2000 Benchmark data (E-5 data) [33] is presented in Table 6-9.

TABLE 6-9
CITY OF ANGELS WASTEWATER MASTER PLAN
CALIFORNIA DEPARTMENT OF FINANCE DATA

Parameter	Value[a]
Total Housing Units	1,831
Total Occupied Housing Units	1,656
Vacancy Rate	9.56%
Persons per Household	2.14

[a] California Dept. of Finance, Table E-5 [31].

6.4 Development of Wastewater Generation Factors

City 2010 Improvement Standards [4] Section 14.04 identifies a design flow of 350 gpd/du. For the Master Plan, WGFs were developed on the basis of an equivalent sewer unit (ESU). This section describes the process for estimating appropriate conversion factors of ESU/parcel and ESU/ac for the different land uses and an appropriate gallons per day per ESU (gpd/ESU) WGF.

a. Discussion of Equivalent Single Family Units for Land Use Categories

For this analysis, existing and future land uses were multiplied by conversion factors (ESU/ac) to convert the land uses into ESU. Determination of ESU conversion factors for residential, commercial, public, and special planning land uses are discussed below.

Residential Land Use

During the review of the GIS data provided by the City, several large residential parcels were noted to be without clear delineation of individual parcel boundaries, resulting in a potential underestimation of ESU. A comparison of the total number of developed residential parcels from Table 6-2 and the number of housing units presented in the E-5 data (Table 6-9) support the concept that more than one housing unit may be present on some parcels. Examples of the large residential parcels may include mobile home parks, apartments, duplex and triplex units, and condominium complexes. After reviewing the parcel acreages from GIS, large residential parcels were considered to be those parcels with an area greater than 1 ac.

To estimate the appropriate housing density, the densities of existing developed typical parcels for each residential land use were calculated, assuming that each parcel represents one ESU. A summary of existing residential parcels and calculated development densities are presented in Table 6-10.

TABLE 6-10
CITY OF ANGELS WASTEWATER MASTER PLAN
ESU CONVERSION FACTORS FOR DEVELOPED RESIDENTIAL PARCELS

Use	'Counted' Parcels[a]			
	Total Parcels	Gross Area	Actual Density (parcels/ac)	Rounded Density (ESU/ac)[b]
HDR	112	21.9	5.1	5.0
MDR	59	18.2	3.2	3.0
RE	8	4.4	1.8	2.0
SFR	1165	310.3	3.8	4.0
Total	**1344**	**354.8**		

[a] Residential parcels with an area less than 1-ac are assessed on a 'count' basis.
[b] One 'counted' residential parcel = one ESU.

The density (rounded) of the counted parcels for each use, presented in Table 6-10, were used to estimate total residential ESUs for the City.

Consistent with the Draft Capacity Assurance Plan [10], Worldmark Club, a high-density resort condominium development, is assessed as a separate land use. Calculation of the development density for Worldmark Club (HDR-WMC) is provided in Table 6-11.

TABLE 6-11
CITY OF ANGELS WASTEWATER MASTER PLAN
ESU CONVERSION FACTOR FOR WORLDMARK CLUB

Parameter	Value
Residential Use Code	HDR-WMC
Approximate Total Units[a, b]	200
Gross Area (ac)	21.1
Density (ESU/ac)	9.5

[a] Estimated number of units from Draft Capacity Assurance Plan [10].
[b] Each unit assumed to equal one ESU.

Commercial Land Use

An ESU conversion factor for existing commercial parcels was developed using water meter connection data provided in the Preliminary Engineering Report for the recently completed WWTP Phase III Improvement Project [6]. Calculation of the commercial conversion factor is summarized in Table 6-12.

TABLE 6-12
CITY OF ANGELS WASTEWATER MASTER PLAN
ESU CONVERSION FACTORS FOR DEVELOPED COMMERCIAL PARCELS

Parameter	Value
Total Area (ac)[a]	140.5
Total Parcels[a]	240
Total Connections[b]	207
Average Commercial Density (Connections/ac)	1.5
ESU/Connection Ratio[b]	1.3
Conversion Factor (ESU/ac, rounded)	2.0

[a] Includes developed parcels only, see Table 6-2.
[b] Angels Camp Water Audit [34].

A uniform ESU conversion factor of 2.0 ESU/ac was applied to all existing commercial parcels for WGF development.

Industrial Land Use

A review of addresses for the five existing parcels listed as Industrial land uses included the Foundry, landscaping supply yards, a charter aircraft office, and a metal machining shop. None of these businesses are expected to produce a volume of wastewater significantly greater than a

typical commercial parcel. Therefore, a conversion factor of 2.0 ESU/ac was applied to all existing industrial parcels for WGF development.

Public Land Use

Public land uses include public (P), public schools (P-SCH), parks and recreation (PR), and golf courses (PR-Golf). Public (P) includes government buildings, transportation facilities, public utilities, special districts and similar uses. Due to the highly variable nature of wastewater generation for the public land uses, a different methodology for flow estimation was utilized. Total flows for public land uses were determined based on an estimated number of students, employees, or visitors for each use and published typical wastewater generation data. The total estimated flow from all various public land uses will be subtracted from the total City flow to estimate an appropriate gpd/ESU WGF. The WGF will then be applied to the estimated flow each type of public land use to determine an ESU/ac conversion.

Calculations for total flows from public land uses are provided in Table 6-13, 6-14, 6-15, and 6-16. Calculations of ESU conversion factors for public land uses are provided in Section 6.4b, below.

TABLE 6-13
CITY OF ANGELS WASTEWATER MASTER PLAN
TOTAL ESTIMATED FLOW FROM PUBLIC LAND USES

Parameter	Value
Total Area (ac)	27.9
Total Developed Public Parcels	22.0
Estimated Number of Employees per Parcel	50
Typical WGF (gpd/employee)[a]	13
Estimated Public ADWF (gpd)	14,300

[a] Metcalf and Eddy, Wastewater Engineering Treatment and Reuse [35].

TABLE 6-14
CITY OF ANGELS WASTEWATER MASTER PLAN
TOTAL ESTIMATED FLOW FROM PUBLIC SCHOOLS

Parameter	Value
Total Area (ac)[a]	49.5
Student Population[b]	2,008
Typical WGF (gpd/student)[c]	25
Estimated Public School ADWF (gpd)	50,200
Area-Based School Generation Rate (gpd/ac)[d]	1,013

[a] Includes Bret Harte High School, Mark Twain Union Elementary, and Mark Twain Community Day School.
[b] Local School Directory website [36].
[c] Metcalf and Eddy, Wastewater Engineering Treatment and Reuse [35].
[d] gpd/ac = gallons per day per ac.

TABLE 6-15
CITY OF ANGELS WASTEWATER MASTER PLAN
TOTAL ESTIMATED FLOW FROM PARKS AND RECREATION PARCELS

Parameter	Value
Total Area (ac)	17.5
Total Developed Parks and Recreation Parcels	9.0
Estimated Number of Visitors per Parcel per Day	100
Typical WGF (gpd/visitor)[a]	8
Estimated Parks and Recreation ADWF (gpd)	7,200

[a] Metcalf and Eddy, Wastewater Engineering Treatment and Reuse [35].

TABLE 6-16
CITY OF ANGELS WASTEWATER MASTER PLAN
TOTAL ESTIMATED FLOW FROM GOLF COURSES

Parameter	Value
Total Area (ac)	143.9
Number of Golf Courses	1.0
Estimated Number of Visitors per Course per Day	200
Typical WGF (gpd/visitor)[a]	100
Estimated Golf Course ADWF (gpd)	20,000

[a] Metcalf and Eddy, Wastewater Engineering Treatment and Reuse [35].

Special Planning Land Use

According to the General Plan [1], Special Planning land uses were applied to properties that have unique or unusual characteristics due to location or topography or to large tracts of land where the landowner has indicated plans for a mixed-use development with an integrated design. Special Planning land uses are also required to include a minimum of 25 percent open space. For the Master Plan, a conversion factor of 1.5 ESU/ac was used, which is based on the 2.0 ESU/ac conversion for commercial land uses and a 25 percent open space requirement.

b. Development of WGF

Using the ESU/ac conversion factors developed in Section 6.4a and estimated flow from public land uses, the estimated total wastewater flow from the City (presented in Table 6-7) was used to determine a WGF in terms of gpd/ESU. Table 6-17 summarizes the values used to estimate the appropriate WGF.

TABLE 6-17
CITY OF ANGELS WASTEWATER MASTER PLAN
CALCULATION OF WGF

Land Use	Total Developed Area (ac)	Density (ESU/ac)	Total ESU	
Land Uses				
Residential				
HDR	95.7	5.0	478	
MDR	51.4	3.0	154	
RE	13.5	2.0	27	
SFR	372.7	4.0	1,491	
HDR-WMC	21.1	9.5	200	
Commercial				
BAE	28.2	2.0	56	
CC	64.9	2.0	130	
HC	15.9	2.0	32	
SC	31.5	2.0	63	
Industrial				
I	16.4	2.0	33	
Other				
SP	11.2	1.5	17	
Total City Flow[a]			348,025	gpd
Flow Contribution from Public (P)			14,300	gpd
Flow Contribution from Public School Use (P-SCH)			50,200	gpd
Flow Contribution from Parks and Recreation (PR)			7,200	gpd
Flow Contribution from Golf Courses (PR-Golf)			20,000	gpd
Total City Flow less Flow from Public Land Uses			256,325	gpd
Total ESU			2,681	
WGF (gpd/ESU) (rounded)			**100**	

[a] See Table 6-7 (excludes flows from Six Mile Village).

A WGF of 100 gpd/ESU results from using the method described in this chapter.

An ESU conversion factor for public land uses was estimated using the 100 gpd/ESU WGF presented in Table 6-17 and the total estimated flows from Table 6-13 through 6-16. Calculations of the conversion factors are presented in Table 6-18.

TABLE 6-18
CITY OF ANGELS WASTEWATER MASTER PLAN
ESU CONVERSION FACTOR FOR PUBLIC LAND USES

Item	Public	Public School	Parks and Recreation	Golf Course
Abbreviation	P	P-SCH	PR	PR-Golf
Estimated Total ADWF Contribution (gpd)	14,300	50,200	7,200	20,000
Estimated WGF (gpd/ESU)	100	100	100	100
Total ESU	143	502	72	200
Total Area (ac)	27.9	49.5	17.5	143.9
Conversion Factor (ESU/ac) (rounded)	5.0	10	4.0	1.5

ESU conversion factors for all land uses are summarized in Table 6-19. Future ESU conversion factors for Residential Estate (RE) and Business Attraction/Expansion (BAE) are lower than existing ESU conversion factors. The existing ESU conversion factor for RE was based on an analysis of existing parcels size for areas with the RE land use designation, as shown in Table 6-10. The existing ESU conversion factor for BAE was based on an analysis of existing developed commercial parcel areas, as shown in Table 6-12. The future ESU conversion factors, including the factors for RE and BAE are from the General Plan [1].

TABLE 6-19
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF ESU CONVERSION FACTORS

Land Use	Existing[a] (ESU/ac)	Future[b] (ESU/ac)
Residential		
HDR	5.0	15.0
MDR	3.0	10.0
RE	2.0	0.5
SFR	4.0	6.0
HDR-WMC	9.5	9.5
Commercial		
BAE	2.0	1.0
CC	2.0	15.0
HC	2.0	15.0
SC	2.0	15.0
Industrial		
I	2.0	2.0
Public		
P	5.0	5.0
P-SCH	10.0	10.0
PR	4.0	4.0
PR-Golf	1.5	1.5
Other		
SP	1.5	1.5

[a] Existing conversion factors based on data presented in this chapter.
[b] Future conversion factors based on General Plan [1] densities.

c. Comparison of Estimated Flows Versus Actual Flows

A WGF of 100 gpd/ESU, along with the ESU conversions provided in Table 6-19, produces a total system flow of 360,100 gpd within approximately 3% of the "target" City Flow ADWF of 348,025 gpd (per Table 6-7).

Expanded calculations of total ESU by basin are included in Appendix E. A comparison of total estimated flows by basin to actual flows are presented in Table 6-20. A complete data summary of estimated flows for existing areas is provided in Appendix H.

TABLE 6-20
CITY OF ANGELS WASTEWATER MASTER PLAN
COMPARISON OF EXISTING ESU AND PROJECTED FLOW SUMMARY
BY BASIN VERSUS ACTUAL FLOWS

Basin	Total ESU[a]	WGF (gpd/ESU)	Estimated ADWF (gpd)	Actual ADWF (gpd)[b]	Percent Difference
Basin #1	99	100	9,900	12,300	-20%
Basin #2	896	100	89,600	125,311	-28%
Basin #3	358	100	35,800	23,243	54%
Basin #4	296	100	29,600	45,098	-34%
Basin #5	1,952	100	195,200	142,073	37%
City Flow	**3,601**	**100**	**360,100**	**348,025**	**3%**

[a] Total ESU includes Residential, Commercial, Industrial, Public, and Special Planning land uses, see Appendix E.
[b] From Table 6-7 (excludes flows from Six Mile Village).

Actual ADWF is based on pump run times for individual basins, WWTP flow meter data, and flow data for Six Mile Village provided by CCWD. City Flow excludes flows from Six Mile Village.

WWTP flow data (City Flow) presented in Table 6-4 is assumed to be more accurate than pump station flow data presented in Table 6-5, due to potential inaccuracies in correlating flow to pump run time. As such, the development of basin-specific WGFs was not considered practical.

In the future, flow monitoring, rather than estimation of flows using pump run times, would likely allow for better refinement of WGFs at individual basins.

d. Review of Recommended WGFs

City 2010 Improvement Standards identify a wastewater flow of 350 gpd/du, alternatively 100 gallons per capita per day (gpcd), to be used as the basis for sewer design [4]. Data presented in this chapter suggest that a WGF of 100 gpd/ESU may be applicable for planning purposes. Although the recommended WGF of 100 gpd/ESU may seem significantly lower than wastewater flow factors in the City 2010 Improvement Standards [4], it should be noted that the recommended WGF is based on an ESU, not per capita or per dwelling unit, and is to be used only with the ESU conversion factors presented in Table 6-19. The WGF of 100 gpd/ESU is designed to mimic ADWF observed at the WWTP for use with the hydraulic model presented in Chapter 8. For peak flows, the City 2010 Improvement Standards use the 350 gpd/du or 100 gpcd plus a peaking factor to calculate the total design flow [4]. In this Master Plan, however, a WGF plus a DPF and I/I allowance are used to calculate peak flows in Chapter 8 based on peak flows at the WWTP during rain events. The DPF and I/I allowance used in the Master Plan are significantly different than the peaking factor used in the City 2010 Improvement Standards [4].

Selection of a WGF is a critical part of the hydraulic evaluation of the collection system. Use of a higher than appropriate WGF will result in overestimation of flows, infrastructure oversizing, or scheduling WWTP and collection system projects to increase capacity earlier than necessary. Conversely the use of a lower than appropriate WGF could result in lower projections of ADWFs, infrastructure undersizing, and disconnects in scheduling appropriate WWTP and collection system projects addressing capacity issues.

Additional methods examined to validate the WGF of 100 gpd/ESU for use in the Master Plan were conducted. The City 2010 Improvement Standards [4] per capita WGF and typical per capita WGFs were compared with the per capita WGF calculated from projected City ADWF and Department of Finance population data for the City. Table 6-21 summarizes the results of this comparison.

TABLE 6-21
CITY OF ANGELS WASTEWATER MASTER PLAN
COMPARISON OF WGFS WITH DEPARTMENT OF FINANCE POPULATION DATA

Item	Value
City 2010 Improvement Standards, per Capita Wastewater Generation Rate [4]	100 gpcd
Typical per Capita WGF[a]	60 - 100 gpcd
Current Population[b]	3,836
Total Housing Units[c]	1,831 units
Percent Vacant Housing Units[c]	9.56%
City Population Density[c]	2.14 capita per housing unit
City Population Density Accounting for Vacant Housing Units	1.94 capita per housing unit
Projected ADWF, City Flow[d]	360,100 gpd
Projected per Capita WGF	94 gpcd

[a] Typical generation factors for one- to three-person households [35].
[b] April 2010 population estimate from Dept. of Finance, Table E-4 [32].
[c] California Dept. of Finance, Table E-5 [33].
[d] See Table 6-20.

Table 6-21 indicates that the projected per capita WGF of 94 gpcd is comparable with the City 2010 Improvement Standards [4] and typical per capita WGFs of 100 gpcd and 60-100 gpcd, respectively. Additionally, typical WGF per capita estimates and City population density data, with and without consideration for vacant homes, provide some further support for the use of the 100 gpd/ESU WGF.

6.5 Impacts of Water Conservation

With the adoption of Part 11 of the CCR Title 24 in January 2011, the State of California has adopted the nation's first "green" building code, commonly known as "CalGreen." The intent of CalGreen is to reduce water consumption, and thereby wastewater generation, by requiring future developments to implement water conservation measures.

When addressing residential water use, CalGreen 2010 requires a 20% reduction in indoor water use from the 2008 Title 24 baseline, through either prescriptive or performance methods. The prescriptive method requires installation of ultra-low flow fixtures for showerheads, bathroom and kitchen faucets, and toilets. The performance method requires a demonstrated 20 percent reduction in baseline water use, with options for compliance left to the builder. Historical water usage for fixtures and clothes washers are presented in Table 6-22.

TABLE 6-22
CITY OF ANGELS WASTEWATER MASTER PLAN
HISTORICAL WATER USAGE FOR FIXTURES AND APPLIANCES

Fixture/Appliance[a]	Year				
	1975	1980	1992	2008	2011[c]
Shower (gpm)	3.5	2.5	2.5	2.5	2.0
Toilets (gpf[b])	5.0	3.6	1.6	1.6	1.28
Faucets (gpm)	2.5	2.5	2.5	2.2	1.8
Clothes washers (gal/cf)[d]	15.0	15.0	15.0	8.5	6.0[e]

[a] *Water Use in the California Residential Home*, January 2010 [37].
[b] gpf = gallons per flush.
[c] CalGreen 2010 fixture rates for prescriptive method of compliance, effective January 2011.
[d] gal/cf = gallons per cubic foot.
[e] Regulated by CCR Title 20, Div 2, Ch 4, Article 4, Section 1605.3.

Other legislation and water conservation programs include the 20x2020 Water Conservation Plan, Leadership in Energy and Environmental Design (LEED), Senate Bill (SB) 407, and EPA WaterSense® Program, each of which have similar goals in water use reduction and efficiency to CalGreen.

The 20x2020 Water Conservation Plan (SB 7 legislation) requires a statewide 20 percent per capita reduction in urban water demands by 2020 while LEED has a prerequisite to reduce indoor water usage 20 percent beyond 1992 standards. SB 407 mandates retrofit of non-compliant plumbing fixtures in pre-1994 homes. Beginning in January 2014, all building alterations or improvements to single-family, multi-family, and commercial properties will require non-compliant fixtures to be replaced for final permit approval by local building departments. Starting in January 2017, a seller or transferor of a property must disclose to the purchaser the requirement for replacing plumbing fixtures. Furthermore, beginning in

January 2019, all non-compliant plumbing fixtures in multi-family and commercial properties must be replaced. The EPA WaterSense® program also requires a 20 percent reduction in water use. New homes may be labeled as EPA WaterSense® if specific criteria are met and the home is built by a WaterSense® building partner.

With the new CalGreen legislation and other water conservation programs, indoor water use, and subsequently, wastewater flow, is expected to decrease significantly for new residential development. Reduced indoor water use resulting from new water conservation legislation and programs is provided in Table 6-23.

TABLE 6-23
CITY OF ANGELS WASTEWATER MASTER PLAN
WATER USE CONSIDERING NEW WATER CONSERVATION LEGISLATION AND PROGRAMS

Legislation/Program	Expected Indoor Water Use, gpcd
CalGreen 2010	40.0[a]
EPA WaterSense® Program	39.5[b]
AWWA	43.5[c]

[a] *Water Use in the California Residential Home*, January 2010 [37].
[b] *Water-Efficient Single Family New Home Specification*, May 2008 [38].
[c] *Water Conservation Measurement Metrics Guidance Report*, January 2010 [39].

Based on new conservation legislation, a reduction in wastewater generation for future development can be anticipated and an adjusted wastewater generation rate may be applicable for future wastewater flow estimates. Using a mid-range per capita WGF of approximately 42 gpcd and estimated population density of 2.14 persons per household [33], a WGF of approximately 90 gpd/ESU may be more representative of wastewater flows from future development, assuming compliance with water conservation goals. The reduced WGF of 90 gpd/ESU will be used for flow calculations with water conservation and a WGF of 100 gpd/ESU will be used for flow calculations without water conservation.

6.6 Projection of Future Dry Weather Wastewater Flows

The General Plan [1] includes assumed densities (ESU/ac) for different land uses. For consistency with the General Plan [1], these densities, presented previously in Table 6-19, will be used with a WGF of 100 gpd/ESU to project future dry weather flows.

Future estimated flows and projected development are discussed below.

a. Projected Growth

California Department of Finance census data [32] and growth projections outlined in the General Plan [1] were utilized to project development and wastewater flows at 10-year and 20-year intervals.

In addition to baseline (existing) flows and ESUs, a baseline 2011 population of 3,919 was determined using the published 2010 census population of 3,836 and a mid-range annual growth rate of 2.16%. Average annual growth rates presented in the Land Use Element of the General Plan [1] vary from 1.80% to 2.52%. Observed growth rates from 2008-2010 have been significantly lower, ranging from 0.13% to 1.23%, as reported by the California Department of Finance.

The 2.16% average annual growth rate was applied uniformly to each sewer basin. Once the buildout ESU was reached in a particular basin, no further growth in that basin was assumed. Estimated City-wide population, development (ESUs), and wastewater flows for 10-year and 20-year projections are provided in Table 6-24. Expanded calculations for projected growth are provided in Appendix I.

TABLE 6-24
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED POPULATION, DEVELOPMENT, AND WASTEWATER FLOWS BY BASIN

Area	Base (Existing)		10-Year Projection		20-Year Projection	
	Percent Buildout[a]	ADWF (gpd)	Percent Buildout[a]	ADWF (gpd)	Percent Buildout[a]	ADWF (gpd)
Basin #1	92%	9,900	100%	10,800	100%	10,800
Basin #2, #6	65%	89,600	81%	110,947	100%	137,381
Basin #3	54%	35,800	66%	44,329	82%	54,891
Basin #4	23%	29,600	29%	36,652	35%	45,385
Basin #5	42%	195,200	51%	241,707	64%	299,294
City	**44%**	**360,100**	**55%**	**444,436**	**67%**	**547,750**
Population	**3,919**		**4,853**		**6,009**	

[a] Percent buildout based on existing or projected ESU relative to total buildout ESU.

Projected wastewater flows assuming water conservation at 10-year and 20-year planning horizons are provided in Table 6-25.

TABLE 6-25
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED WASTEWATER FLOWS WITH AND WITHOUT WATER CONSERVATION

Area	Estimated ADWF (gpd)					
	10-Year Projection			20-Year Projection		
	Without Conservation	With Conservation[a]	Percent Reduction	Without Conservation	With Conservation[a]	Percent Reduction
Basin #1	10,800	10,710	0.8%	10,800	10,710	0.8%
Basin #2, #6	110,947	108,813	1.9%	137,381	132,603	3.5%
Basin #3	44,329	43,476	1.9%	54,891	52,982	3.5%
Basin #4	36,652	35,947	1.9%	45,385	43,806	3.5%
Basin #5	241,707	237,056	1.9%	299,294	288,884	3.5%
City	**444,436**	**436,002**	**1.9%**	**547,750**	**528,985**	**3.4%**

[a] 'With Conservation' assumes a WGF of 90 gpd/ESU for parcels developed after 2011.

b. Buildout Wastewater Flows

Total ESU for buildout conditions were calculated based on information provided in Tables 6-3 and 6-19. Total future ESU and estimated buildout flows for each basin are presented in Table 6-26. A complete data summary of buildout flows is provided in Appendix I.

TABLE 6-26
CITY OF ANGELS WASTEWATER MASTER PLAN
BUILDOUT ESU AND PROJECTED FLOW SUMMARY
BY BASIN (WITHOUT CONSERVATION)

Basin	Total ESU	WGF (gpd/ESU)	Estimated Buildout ADWF (gpd)
Basin #1	108	100	10,800
Basin #2	573	100	57,300
Basin #3	669	100	66,900
Basin #4	1,286	100	128,600
Basin #5	4,703	100	470,300
Basin #6	803	100	80,300
City	**8,142**		**814,200**
Six Mile Village Flow[a]			**10,175**
Total Buildout WWTP Flow			**824,375**

[a] Buildout flow from Six Mile Village includes an additional 3 residential lots and 3 commercial lots at 100 gpd/ESU.

For comparison, buildout flow estimates using a reduced WGF, as discussed earlier, for future development are provided in Table 6-27. Although water use will begin to decrease for existing homes with the SB 407 legislation beginning in 2014, the timing and magnitude of long-term reductions are unknown. Water use for existing homes is assumed to remain constant in Table 6-27.

TABLE 6-27
CITY OF ANGELS WASTEWATER MASTER PLAN
ESTIMATED REDUCTION IN WASTEWATER FLOWS FROM WATER CONSERVATION

Basin	Existing Estimated ADWF (gpd)	Estimated Buildout ADWF (gpd)		Percent Reduction
		Recommended WGF[a]	Reduced WGF[b]	
Basin #1	9,900	10,800	10,710	0.8%
Basin #2, #6	89,600	137,600	133,520	3.0%
Basin #3	35,800	66,900	66,900	0.0%
Basin #4	29,600	128,600	123,600	3.9%
Basin #5	195,200	470,300	459,390	2.3%
WWTP (Total)	**360,100**	**814,200**	**794,120**	**2.5%**

[a] Based on recommended WGF of 100 gpd/ESU and Table 6-19 conversion factors.
[b] Based on reduced WGF of 90 gpd/ESU for parcels developed after 2011.

As shown in Table 6-27, recent legislative water conservation provisions may reduce ultimate flows to the WWTP by as much as 2.5%. Expanded calculations are provided in Appendix J.

6.7 Conclusions

Using historical treatment plant flow data and ESU estimates for the City, this chapter documents a recommended WGF of 100 gpd/ESU. The WGF will be used to project future ADWF and peak flows for evaluating collection system and WWTP capacity requirements. Using the recommended WGF, ADWF projections for 10-year, 20-year, and buildout scenarios were calculated and are summarized in Tables 6-24, 6-25, and 6-26. Minimal impacts from water conservation are anticipated. Further assessment of WGFs for existing and future development is provided in Chapter 8.

Critical assumptions which affect the calculated WGF values and future flow predictions include:

1. ESU densities used for particular land uses (e.g., the number of ESUs per ac); and

2. ESU relationships used for non-residential land uses.

Future activities which could provide data to increase the reliability of WGF estimates include:

1. Flow monitoring within each basin; and

2. A review of winter water use data for large residential parcels and non-residential land uses to determine appropriate relationships for ESUs/ac or ESUs/parcel.

7 Evaluation of Capacity of Wastewater Treatment, Storage, and Disposal Facilities

The purpose of this chapter is to evaluate the hydraulic and treatment capacity of the wastewater treatment, storage, and disposal facilities under existing and future flow scenarios.

7.1 Identification of Needs at Wastewater Treatment and Disposal Facilities

The following needs have been identified for the WWTP by the Plant Supervisor considering current operational practices [40]:

1. Construction of a grit chamber at the headworks.

2. Installation of a pre-filter turbidimeter to control chemical addition or automatic bypass of filters.

3. Stabilization of side slopes by gunite at the EQ basin. Construction of facilities for sludge removal and mitigation of short-circuiting issues.

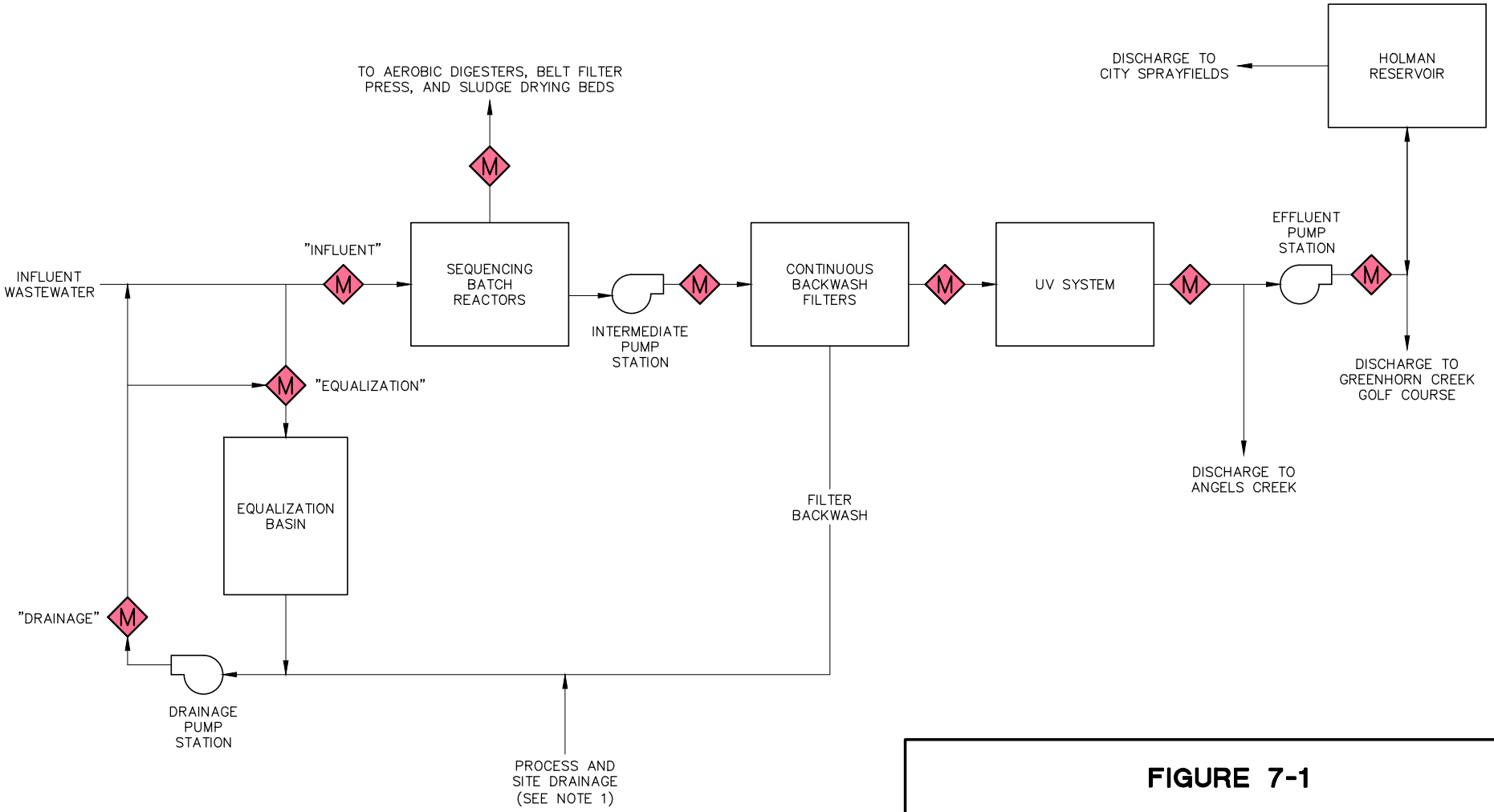
4. Construction of a large covered concrete surface to stockpile biosolids (potentially to Class A standards).

5. Modernization of personnel facilities including an office with a training classroom.

Regarding the effluent sprayfield, there are apparent deficiencies with the pumping, distribution, irrigation, and tailwater control components of the disposal system. Several violations to the WDRs have occurred as a result of these deficiencies including spills to surface water. The City has proposed to the Regional Board a phased plan to improve the performance and reliability of the sprayfield disposal system. A summary of the plan is included as Appendix K. Further assessment of sprayfield improvements will be the subject of a future evaluation.

7.2 Existing and Projected Flows

Daily influent and effluent flow data for the WWTP were provided by the City for January 2009 through August 2011. The daily influent flow data (aka “town influent”) is a SCADA calculation with the drainage pump station flow subtracted from the influent flow (after diversion to the EQ basin). The “town influent” flow data excludes flows from the EQ basin, plant drainage, and filter backwash. As such, the data does not provide an accurate representation of flows processed by the WWTP. Daily effluent flow data represents actual flows processed by the WWTP and can be used to determine the existing ADWF. A flow schematic depicting the location of flow meters at the WWTP is provided for reference in Figure 7-1. An influent flow meter prior to drainage pump station return flows and diversions to the EQ basin is recommended to measure total collection system flows into the WWTP.



LEGEND:

- TREATMENT PROCESS
- FLOW METER
- PUMP STATION

NOTES:

1. PROCESS AND SITE DRAINAGE INCLUDES INTERMEDIATE STORAGE BASIN DRAIN, UV SYSTEM DRAIN, AEROBIC DIGESTER DECANT, BELT FILTER PRESS DRAIN, SLUDGE DRYING BED DRAIN, EQUIPMENT OVERFLOWS, AND SITE STORM DRAINAGE.

FIGURE 7-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

WWTP FLOW METERS

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch7\Figure 7-1 WWTP Flow Meters.dwg KT 1/27/2012

A summary of effluent flows from 2009-2011 is provided in Table 7-1 and daily effluent flow data is included in Appendix F. The 2009-2011 average for ADWF is 0.357 mgd. The 2009-2011 average MFP (i.e., maximum equalized flow) is 1.281 mgd. Phase II and Phase III WWTP Improvements were designed for an ADWF of 0.6 mgd and a MFP of 1.9 mgd [31, 41].

TABLE 7-1
CITY OF ANGELS WASTEWATER MASTER PLAN
WASTEWATER TREATMENT PLANT FLOW DATA, 2009-2011

Parameter	2009	2010	2011[a]	2009-2011 Average	Design Capacity[b]
ADWF, mgd[c]	0.346	0.373	0.353	0.357	0.600
Average Daily Flow for Max Month, mgd	0.521	0.620	0.748	0.630	-
Minimum Day, mgd[d]	0.004	0.123	0.148	0.092	-
Min Day/ADWF	0.012	0.330	0.420	0.254	-
95th Percentile, mgd	0.602	0.782	0.925	0.770	-
MFP	1.261	1.452	1.131	1.281	1.900

[a] Effluent flow data available from Jan-Aug for 2011.
[b] Design capacity for Phase II and Phase III WWTP Improvements [31, 41].
[c] ADWF over the months of Jun-Aug.
[d] Minimum day excludes days with zero flow recorded.

WGFs for existing and future land uses were developed in Chapter 6 to predict future wastewater flows for 10-year and 20-year planning horizons. Using the recommended WGFs, ADWF projections for 10-year, 20-year, and buildout scenarios were calculated and are summarized in Table 7-2. Impacts of required water conservation measures are included for the buildout scenario. The effects of water conservation on ADWF projections for 10-year and 20-year planning horizons are minimal and not included as a flow scenario in Table 7-2.

TABLE 7-2
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED WASTEWATER FLOWS
FOR 10-YEAR, 20-YEAR, AND BUILDOUT SCENARIOS

Parameter	ADWF[a] (mgd)
10-Year Projection[b]	0.455
20-Year Projection[b]	0.558
Buildout Projection w/Conservation	0.804
Buildout Projection w/out Conservation	0.824

[a] Projected flows (including Six Mile Village) from Chapter 6
[b] Projected flows without water conservation.

7.3 Historical Water Quality

A review of historical influent and effluent water quality data from the WWTP compared to design criteria values and effluent limitations specified in the WDRs and the NPDES permit confirms consistent regulatory compliance. Influent and effluent water quality data from 2009-2011 are summarized in the following sections.

a. Influent Water Quality

Influent BOD_5 and TSS are sampled downstream of the drainage pump station return flows. Historical influent water quality data for BOD_5 and TSS are summarized in Table 7-3. Detailed influent water quality data provided by City staff are included in Appendix L.

Design loading values for Phase II and Phase III Improvements at the WWTP include a BOD_5 of 220 mg/L and TSS of 220 mg/L at ADWF [31, 41]. The average BOD_5 at ADWF from 2009-2011 was 226 mg/L which is in close proximity and confirms the validity of the design loading value of 220 mg/L. The average TSS at ADWF from 2009-2011 was 308 mg/L which is 40 percent higher than the design loading value of 220 mg/L and should be considered in the design of future treatment processes.

TABLE 7-3
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF HISTORICAL INFLUENT BOD AND TSS FOR WWTP

Year/Parameter	BOD_5 (mg/L)				TSS (mg/L)			
	Annual Average	Min	Max	Average at ADWF[a]	Annual Average	Min	Max	Average at ADWF[a]
2009[b]	233	97	544	257	281	114	860	374
2010	203	38	382	239	273	26	620	295
2011[c]	182	52	350	182	229	62	628	255
2009-2011 Average	206	62	425	226	261	67	703	308
WWTP Design Criteria[d]	-	-	-	220	-	-	-	220

[a] ADWF over the months of Jun-Aug.
[b] Annual average and max BOD_5 exclude 4/7/2009 with unusually high value of 945 mg/L.
[c] Data available from Jan-Aug for 2011.
[d] Design criteria for Phase II and Phase III WWTP Improvements [31, 41].

b. Effluent Water Quality for Land Discharge

Historical effluent water quality data and WDR limitations related to land disposal are summarized in Table 7-4. Daily effluent water quality data are provided in Appendix M. Historical data indicates that discharge limitations in the WDRs for irrigation of the City sprayfields and Greenhorn Creek Golf Course were achieved consistently from January 2009 through August 2011.

TABLE 7-4
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF HISTORICAL EFFLUENT WATER QUALITY FOR WWTP AND WDR LIMITATIONS FOR LAND DISCHARGE

	BOD_5 (mg/L)		Settleable Solids (mg/L)		Turbidity (NTU)		Total Coliform (MPN/100 mL)	
Year/Parameter	**Max Monthly Average**	**Max Day**	**Max Monthly Average**	**Max Day**	**Max Monthly Average**	**Max Day**	**Monthly Median**	**Max Day**
2009	6.4	10.0	0.1	0.1	1.6	5.0	2.0	11.0
2010	5.9	11.0	0.1	0.1	1.5	3.4	2.0	14.0
2011[a]	6.4	10.0	0.1	0.1	0.9	1.7	2.0	30.0[d]
WDRs for Land Discharge[b]	40.0	80.0	0.2	0.5	-	-	23.0	230.0
WDRs for Reclaimed Water Irrigation[c]	30.0	-	-	-	2.2	5.0	-	23.0

[a] Data available from Jan-Aug for 2011.
[b] Effluent limitations in WDRs for irrigation of City sprayfields [17].
[c] Effluent limitations in WDRs for reclaimed water irrigation at Greenhorn Creek Golf Course [17].
[d] Max day of 30.0 MPN/100mL occurred April 21, 2011 when effluent was discharged only to City sprayfields. Second greatest value for 2011 was 9.0 MPN/100mL which meets WDRs for both land discharge and reclaimed water irrigation.

c. Effluent Water Quality for Surface Water Discharge

The ability to discharge treated effluent to surface water was authorized by the Regional Board in March 2011 following completion of Phase III Improvements to the WWTP and the approval of a NPDES permit. For 2011, discharge to Angels Creek occurred from March 25-April 14. A summary of historical effluent water quality for March and April 2011 and NPDES limitations are provided in Table 7-5. Daily effluent water quality data is provided in Appendix M. Historical data indicates that NPDES limitations for discharge to Angels Creek were achieved for March and April 2011.

TABLE 7-5
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF HISTORICAL EFFLUENT WATER QUALITY FOR WWTP AND NPDES LIMITATIONS FOR DISCHARGE TO ANGELS CREEK

Parameter	March 2011[a]		April 2011[a]		NPDES Limitations[b]	
	Monthly Average	Daily Max	Monthly Average	Daily Max	Monthly Average	Daily Max
pH[c]	-	7.8	-	7.8	-	8.0
Total Coliform (MPN/100mL)	2.0[d]	4.0	2.0[d]	8.0	2.2[d]	23.0[e]
Turbidity (NTU)	-	1.6	-	1.2	-	2.0
BOD_5 (mg/L)	2.0	2.0	2.1	2.6	10.0	20.0
TSS (mg/L)	5.0	5.0	5.0	5.0	10.0	20.0
Electrical Conductivity (µmhos/cm)	305.0	-	420.0	-	510.0	-
Chlorine Residual (mg/L)[f]	-	-	-	-	0.01	0.02
Settleable Solids (mL/L)	0.1	0.1	0.1	0.1	0.1	0.2
Ammonia, Total (mg/L)	0.5	0.5	0.1	0.1	23.0	56.0
Bis(2-chloroethyl)ether (µg/L)	ND[g]	ND	ND	ND	0.41	0.82
Nitrate (mg/L)	3.9	-	2.4	-	10.0	-
Nitrite (mg/L)	0.1	-	0.1	-	1.0	-
Dichlorobromomethane (µg/L)	ND	ND	ND	ND	7.0	14.0
Copper (µg/L)	6.0	6.2	2.7	2.7	9.2	18.0
Lead (µg/L)	ND	ND	ND	ND	2.5	4.9
Zinc (µg/L)	22.0	23.0	41.0	41.0	133.0	266.0

[a] Discharge to Angels Creek occurred March 25-April 14.
[b] NPDES limitations for effluent water quality for discharge to Angels Creek [14].
[c] NPDES permit requires minimum pH of 6.5 [14]. Daily minimum was 7.2 for March 2011 and 7.0 for April 2011.
[d] 7-day median [14].
[e] Total coliform shall not exceed 23.0 MPN/100mL more than once in a 30 day period or 240.0 MPN/100mL at any time [14].
[f] UV disinfection is used at WWTP.
[g] ND = non detect.

7.4 Evaluation of Capacity of Treatment Facilities

A review of the unit treatment processes at the WWTP for both hydraulic and treatment capacity and operational recommendations is provided below.

a. Sequencing Batch Reactors

Influent wastewater flows are directed to the SBR system following headworks screening. The SBR system consists of three basins, each with an active volume of approximately 0.251 MG [42]. The equipment in Basins 1 and 2 is CASS™ SBR technology provided by Aquatech/AECOM. The equipment in Basin 3 is furnished by Sanitaire/ITT Industries. Operational guidelines provided by Sanitaire designate a normal cycle as four hours in duration and a storm cycle as three hours in duration [42]. Sanitaire recommends initiation of the storm cycle when overall flows to the SBR system exceed 1.0 mgd [42]. The SBR system was designed for an ADWF of 0.6 mgd and a MFP of 1.9 mgd. For reference, the 20-year ADWF projection for the WWTP is 0.4 mgd (see Table 7-2). Under low flows, one or two basins can be removed from service for efficiency and economy in operation. Recommendations for operational flow ranges are provided in Table 7-6.

TABLE 7-6
CITY OF ANGELS WASTEWATER MASTER PLAN
SEQUENCING BATCH REACTORS OPERATIONAL FLOW RANGES

	Flow (mgd)[a]	
No. of Basins in Operation	**Low Flow**	**MFP**
1 Basin	-	0.67
2 Basins	0.40	1.34
3 Basins	0.60	2.01

[a] Flow ranges based on minimum and maximum hydraulic retention times of 9 and 30 hours, respectively, as listed in design criteria in the Phase II and Phase III WWTP Improvements Record Drawings [31,41]. Typical hydraulic retention times range from 15-40 hours per *Wastewater Engineering Treatment and Reuse*, Metcalf and Eddy [35].

The SBR system has sufficient capacity for 10-year and 20-year ADWF projections with one basin out of service for redundancy. The MFP that can be handled with one basin out of service is 1.34 mgd. Operating at the MFP of 1.9 mgd requires all three basins to be in service. The SBR system is limited by the capacity of the continuous backwash filters at 1.3 mgd under current operational experience (see Table 7-8).

The SBR system was designed to achieve a maximum effluent TSS of 10.0 mg/L [42]. Historical TSS data available on the SBR decant have demonstrated that the SBR system is consistently meeting the performance objective of 10 mg/L.

b. Intermediate Pumps

The intermediate pumping station transfers wastewater from the SBR system to the continuous backwash filters. The intermediate pumping station consists of four Floway vertical turbine pumps.

Each pump motor is equipped with a VFD. A summary of the intermediate pumping system capacity and operational recommendations is presented in Table 7-7. Pump performance curves and system curve calculations are provided in Appendix N.

TABLE 7-7
CITY OF ANGELS WASTEWATER MASTER PLAN
INTERMEDIATE PUMPS SYSTEM CAPACITY AND OPERATION SUMMARY

Parameter	Value
Number of Pumps	3 duty, 1 standby
Capacity of each Pump	445 gpm at 16 ft total dynamic head
Total Capacity[a]	1,275 gpm (1.84 mgd)
Flow Range for 1 Pump Operating	0-470 gpm (0-0.68 mgd)
Flow Range for 2 Pumps Operating	470-890 gpm (0.68-1.28 mgd)
Flow Range for 3 Pumps Operating	890-1,275 gpm (1.28-1.84 mgd)

[a] Total capacity with three pumps in parallel is estimated based on Floway pump curve and projected system curve (see Appendix N) [5, 6, 41].

The total capacity of the intermediate pumping station based on the projected system curve is 1.84 mgd which is slightly less than the MFP of 1.9 mgd.

c. Continuous Backwash Filters

Filtration is achieved at the WWTP with four DynaSand® Filters (with two filter cells each) manufactured by Parkson. The DynaSand® Filters are deep bed, upflow, granular media filters with continuous backwash. Minimum and maximum filter loading rates recommended by Parkson and required for Title 22 wastewater reuse facilities are 2.5 and 5.0 gallons per minute per square foot (gpm/sf), respectively [44, 45]. A loading rate of 5.0 gpm/sf corresponds to a filtration capacity of 2.2 mgd with one filter out of service. However, based on operational experience during high flows, the maximum desirable loading rate is limited to 3.0 gpm/sf, which corresponds to a filtration capacity of only 1.3 mgd with one filter out of service. The operators have experienced significant sand washout at loading rates greater than 3.0 gpm/sf. The operational limitations are likely a result of clogging which is sometimes experienced with DynaSand® Filters. Parkson recommends using a compressed air lance to loosen the clogged sand and then adjusting the airlift rates to restore filtration capacity [44]. Air-lancing has already been performed at the WWTP when necessary to unplug the filters but has not been used as a method for increasing filtration capacity. A summary of operational requirements for the continuous backwash filters is provided in Table 7-8.

TABLE 7-8
CITY OF ANGELS WASTEWATER MASTER PLAN
OPERATIONAL REQUIREMENTS FOR CONTINUOUS BACKWASH FILTERS

Parameter	Value
Number of Filters	4
Area per Filter, sf[a]	100
Typical Backwash Rates, gpm/filter[b]	14-28
Minimum Design Loading Rate, gpm/sf [b]	2.5
Maximum Design Loading Rate, gpm/sf [c]	5.0
Maximum Loading Rate from Operational Experience, gpm/sf [d]	3.0
Minimum Design Flow per Filter (at loading rate of 2.5 gpm/sf), mgd	0.360
Maximum Design Flow per Filter (at loading rate of 5.0 gpm/sf), mgd	0.720
Maximum Flow per Filter from Operational Experience (at loading rate of 3.0 gpm/sf), mgd	0.432
Maximum Filtration Capacity at Design Loading (5.0 gpm/sf), mgd[e]	2.2
Maximum Filtration Capacity from Operational Experience (3.0 gpm/sf), mgd[e]	1.3

[a] sf = square foot.
[b] Recommendation for Parkson DynaSand® filters [44].
[c] Maximum loading rate for Title 22 wastewater reuse facility [45].
[d] Maximum loading rate from operational experience to prevent sand washout is 1,200 gpm with all filters in operation [46].
[e] Maximum capacity with one filter out of service.

Guidelines for operation of the filters at incremental flow rates are provided in Table 7-9. Under current operational conditions, filtration capacity is limited to 1.3 mgd which is significantly lower than the design MFP of 1.9 mgd. As noted however in Table 7-1, the MFP for the period of 2009-2011 was 1.281 mgd, just within the operational capacity of the filters. Some filtration capacity may be restored with reduction of the sand clogging and adjustment of the airlift. According to Parkson, filters that are removed from service for an extended time should be disinfected and drained to prevent additional clogging [44].

TABLE 7-9
CITY OF ANGELS WASTEWATER MASTER PLAN
OPERATIONAL GUIDELINES FOR CONTINUOUS BACKWASH FILTERS

Daily Flow (mgd)	Recommended Number of Filters in Operation[a]		
	Minimum		Maximum
	Loading Rate of 3.0 gpm/sf	Loading Rate of 5.0 gpm/sf	Loading Rate of 2.5 gpm/sf
0.1	1	1	-
0.2	1	1	-
0.3	1	1	-
0.4	1	1	1
0.5	1	1	1
0.6	1	1	1
0.7	2	1	1
0.8	2	1	2
0.9	2	1	2
1.0	2	1	2
1.1	3	2	3
1.2	3	2	3
1.3	3	2	3

[a] Filters should be capable of operating with one filter out of service for redundancy.

Parkson recommends an influent TSS concentration less than 20 mg/L to the continuous backwash filters [44]. A TSS above 20 mg/L may require chemical addition and a maximum TSS of 50-70 mg/L should not be exceeded [44]. As mentioned previously, historical TSS data available on the SBR decant (i.e. the continuous backwash filter influent) indicate that a performance objective for the SBRs of 10 mg/L is consistently being met. Peroxide is currently injected into the continuous backwash filter influent for algae control. A polymer is also added to the influent as a filter aid. Sodium hypochlorite addition is being considered during the summer months (when a chlorine residual is allowed) for improved algae control.

d. Ultraviolet Disinfection

The UV disinfection system was designed in accordance with National Water Research Institute (NWRI) guidelines to deliver a dose of 100 millijoules per square centimeter (mJ/cm^2) at a UV transmittance greater than or equal to 55 percent. A capacity summary for the UV disinfection system is presented in Table 7-10.

TABLE 7-10
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF UV DISINFECTION SYSTEM CAPACITY

Parameter	Value
Number of Channels	2
Number of Banks per Channel	3
Number of Standby Banks Per Channel[a]	1
Minimum flow, mgd[b]	0.4
Maximum flow, mgd[c]	1.9

[a] System is capable of delivering the design dose at maximum flow (1.9 mgd) with one bank per channel out of service [47]. With one standby bank per channel, applicable NWRI guidelines for reliability are satisfied [48].
[b] Minimum validated flow through a single channel.
[c] Two channels operating at the maximum validated flow (660 gpm).

The UV disinfection system appears to have sufficient capacity for 10-year and 20-year flow projections up to the MFP of 1.9 mgd.

e. Equalization Basin

The 3.0 MG EQ basin was designed as temporary storage for influent wastewater flows in excess of the MFP of 1.9 mgd. Excess wastewater is diverted to the EQ basin and cycled through the plant drainage pump station. The plant drainage pump station also collects flows from process drains/overflows, filter backwash, and storm water runoff. During a storm with sustained peak flows, wastewater continuously cycles through the EQ basin and plant drainage pump station until the influent wastewater flow drops below the desired flow regulated by the influent control valve. Although the design MFP is 1.9 mgd, the influent wastewater flow is currently limited to approximately 1.15-1.30 mgd (800-900 gpm) for sustained periods of time up to 1.73 mgd (1,200 gpm) for shorter spans of time with all filters in operation to prevent washout of sand [46].

Limited flow metering capabilities make it difficult to evaluate the effectiveness of the EQ basin. Wastewater flows out of the EQ basin are unmetered (see Figure 7-1) and as a result the storage in the EQ basin during a storm is unknown. One method of determining storage volumes during peak flows is to estimate the portion of plant drainage pump station flows that originate from "base drainage" flow (i.e. process/site drainage and filter backwash) so that flows out of the EQ basin can then be calculated. An analysis of dry weather flows when EQ basin flows are minimal provides a good basis for estimating a base drainage flow.

For dry weather flows in July 2011, the drainage flows were approximately 28 percent of influent wastewater flows on average (see Table O-1, Appendix O). Parkson estimates filter backwash rates at 14-28 gpm per filter which equates to approximately 5-10 percent of the influent

wastewater flows [44]. Draining of process equipment for cleaning in the summer months may result in a higher than expected base drainage flow; therefore, 20 percent of influent flow is conservatively assumed from drainage during winter months. The largest series of storm events recorded during 2011 was from March 18-26 with a total rainfall of 5.85 inches. A summary of the rainfall recorded during this time period is provided in Table 7-11. An analysis of hourly EQ basin storage volumes during and after the storm event is provided in Table O-2 in Appendix O. The maximum EQ basin storage volume resulting from the storm was 1.85 MG on March 27 which is 61 percent of the basin capacity. Anecdotal information by plant staff indicates that the EQ basin is typically less than half full during peak storm events.

TABLE 7-11
CITY OF ANGELS WASTEWATER MASTER PLAN
RAINFALL RECORDED FROM MARCH 18 – MARCH 26, 2011

Date	Recorded Rainfall (in)[a]
March 18	0.64
March 19	0.29
March 20	0.98
March 21	0.70
March 22	0.29
March 23	0.41
March 24	1.27
March 25	0.03
March 26	1.24
Total	5.85

[a] Rainfall recorded at Greenhorn Creek Weather Station [49].

Estimating the required EQ basin volume for future influent wastewater flows was approximated using the following process:

1. Estimate total incoming flow to the WWTP using the following relationship and hourly flow data provided by the City.

$$Q_{SS} = Q_{influent} + Q_{eq} - Q_{dr}$$

Where:

Q_{SS}	=	incoming flow from the collection system
$Q_{influent}$	=	flow measured by the "Influent" flow meter located downstream of the flow diversion to the EQ Basin
Q_{eq}	=	flow measured by the "Equalization" flow meter located on the inlet line to the EQ Basin
Q_{dr}	=	flow measured by the "Drainage" pump station flow meter

2. Review the calculated total incoming flow (Q_{SS}) data during storm events to determine peak flows.

3. Estimate the I/I contribution by subtracting the ADWF of 0.357 mgd from the Q_{ss}.

4. Estimate the wastewater stored in the EQ basin during the storm event by subtracting the MFP from the Q_{SS}, when Q_{SS} is larger than the MFP.

5. Totalize the I/I contribution during the period when equalization storage is required.

6. Project future I/I contributions during a similar storm event by multiplying the 2011 I/I contribution with the ratio of the projected service area and existing service area. I/I rates can be estimated using several methods including service area size, number of connections, or length of pipe within collection system. For this method, the assumption is that the rate of I/I is proportional to service area.

7. Sum the applicable future ADWF with the projected future I/I contribution during a significant storm event to project future flows.

8. Subtract the observed allowable MFP (1.3 mgd) from the projected future flows to estimate the amount of flow that needs to be stored ($Q_{storage}$).

9. Sum the volume to be stored (the product of $Q_{storage}$ and the appropriate time increment) over the appropriate period to project future storage requirements.

Table 7-12 summarizes the projected equalization storage requirements for existing and future flows using a storm event from the month of March 2011. The month of March 2011 was equivalent to a 50-year wet weather month. Calculations are further detailed in Table O-3 of Appendix O.

TABLE 7-12
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED I/I AND EQUALIZATION VOLUME REQUIRED DURING STORM EVENT

Item	ADWF (mgd)	Period when Storage is Required and Accumulating (hrs)[a]	Projected Total I/I during Period[b] (MG)	Projected Total Incoming Flow (MG)	Projected Available Treatment Capacity[c] (MG)	Projected Equalization Volume Required (MG)
Existing (Year 2011)	0.357	31	2.08	2.55	1.70	0.85
10-Year Projection	0.455	31	2.58	3.07	1.70	1.37
20-Year Projection	0.558	31	3.19	3.71	1.70	2.01

[a] hrs = hours.

[b] Projected total I/I when maximum storage required is calculated assuming a direct relationship between I/I and service area. The measured total I/I in 2011 during the storm event under which the maximum equalization storage was required occurred between 3/20/2011 6:00 am to 3/21/2011 12:00 pm and was 2.08 MG. The estimated existing service area was 991 ac. Estimated service areas for the 10-year and 20-year projections are 1,228 and 1,520 ac, respectively.

[c] Projected available treatment capacity assumes a MFP of 1.3 mgd and a period of 31 hours.

Using the method described above, the EQ basin appears to have sufficient capacity for 10-year and 20-year flow projections, despite using a lower than designed MFP of 1.3 mgd.

f. Aerobic Digesters

The aerobic digesters provide stabilization of waste activated sludge (WAS) from the SBRs. Two basins, each with a volume of 125,000 gallons are used by plant staff [31, 41]. A summary of WAS production from 2009-2011 is presented in Table 7-13. Average WAS production has decreased from 17,605 gpd in 2009 to 7,953 gpd in 2011. The significant decrease in WAS production is due to an improvement in the operational strategy for sludge wasting as well as the addition of hydrated lime to the influent which has helped with settling (i.e., thicker WAS and less wasting).

TABLE 7-13
CITY OF ANGELS WASTEWATER MASTER PLAN
HISTORICAL WAS PRODUCTION FROM SBR SYSTEM

Month	Monthly WAS Production (gal)		
	2009	2010	2011
January	643,000	600,000	310,000
February	569,000	460,000	352,000
March	690,000	607,000	299,000
April	454,000	617,000	322,000
May	511,000	661,000	303,000
June	507,000	556,000	196,000
July	519,000	258,000	168,000
August	529,000	217,000	184,000
September	462,000	273,000	164,000
October	312,000	187,000	273,000
November	302,000	205,000	110,000
December	928,000	259,000	222,000
Average WAS Production, gpd	17,605	13,425	7,953
Average WAS Production, lbs[a]/day[b]	1,248	952	564
WWTP ADWF, gpd	346,454	373,022	352,500
Ratio WAS Flow/WWTP ADWF	0.051	0.036	0.023

[a] lbs = pounds.
[b] Based on WAS concentration of 8,500 mg/L from Operational Description for SBR System by Sanitaire [42].

A summary of the aerobic digester system capacity under various operational assumptions is presented in Table 7-14. The total maximum WAS capacity with two aerobic digester basins in service ranges from 15,625-20,833 gpd depending on the hydraulic detention time. Assuming a WAS concentration of 8,500 mg/L [42], the maximum solids loading to the aerobic digesters is 0.03 lbs of volatile solids/ft^3/day which meets the criteria of 0.10-0.20 lbs of volatile solids/ft^3/day [50]. The Plant Supervisor confirmed that WAS concentrations typically range from 8,400-10,500 mg/L [40].

TABLE 7-14
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF AEROBIC DIGESTER SYSTEM CAPACITY AT VARIOUS DETENTION TIMES

Parameter	Hydraulic Detention Time, days[a]	
	12	16
Solids Loading Criteria, lbs volatile solids/ft^3/day[b]	0.10	0.20
Maximum WAS Flow Capacity per Basin, gpd	10,417	7,813
Total Maximum WAS Flow Capacity (2 Basins), gpd	20,833	15,625
Solids Loading at Maximum WAS Flow, lbs volatile solids/ft^3/day[c]	0.03	0.03
Maximum WWTP Flow Capacity w/Ratio of 0.023 WAS Flow/WWTP ADWF, gpd[d]	923,344	692,508

[a] Recommended hydraulic detention time for aerobic digestion of WAS per *Small and Decentralized Wastewater Management Systems* [50].

[b] Recommended solids loading criteria for aerobic digestion of WAS per *Small and Decentralized Wastewater Management Systems* [50].

[c] Based on WAS concentration of 8,500 mg/L from *Operational Description for SBR System* by Sanitaire [42] and assuming 78 percent of solids are volatile based on operational input [40].

[d] Using current ratio of WAS Flow/WWTP ADWF from 2011 WAS production data (See Table 7-13).

The aerobic digesters appear to have sufficient capacity for 10-year and 20-year ADWF projections considering current operational practices. Historical WAS production data indicate that WAS flows per WWTP ADWF have decreased from 2009 to 2011. If future WAS production is similar to the 2009 data (ratio of 0.023 WAS Flow/WWTP ADWF), the aerobic digesters will be at capacity in the year 2017.

g. Belt Filter Press

The belt filter press has been in operation for less than a year and is operated when the aerobic digester effluent contains approximately 2.5 percent solids. Recommended operational information is limited to projected performance data provided by Charter Machine Company, the manufacturer of the Tower Press™, as outlined in Table 7-15. The Plant Supervisor confirmed that a percent solids of 12-18 is typically achieved with the belt filter press which is consistent with the projected performance data [40].

TABLE 7-15
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED PERFORMANCE FOR BELT FILTER PRESS

Parameter	Belt Filter Press[a]	
	Value	Average
Dry Feed Solids, %	1-2	1.5
Filtrate Capture, %	98	98
Cake Solids, %	14-19	16.5
Polymer Consumption, lbs/ton of dry solids	10-14	12
Throughput, lbs dry solids/hr	750	750
Throughput, gpm	100	100

[a] Projected performance for Tower Press ™ TP12.43 by Charter Machine Company [51].

A summary of the belt filter press system operation and sludge production for existing and future conditions is presented in Table 7-16. The belt filter press appears to have sufficient capacity for 10-year and 20-year WAS flow projections.

TABLE 7-16
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF BELT FILTER PRESS SYSTEM OPERATION AND SLUDGE PRODUCTION

Parameter	Projection		
	Existing (2011)	10-Year	20-Year
WAS Flow to Aerobic Digesters, gpd[a]	7,953	10,266	12,590
WAS TSS, mg/L[b]	9,450	9,450	9,450
WAS Volatile Suspended Solids (VSS), mg/L[b]	7,350	7,350	7,350
Total Solids Loading to Digester, lbs/day	627	809	992
Volatile Solids Loading to Digester, lbs/day	488	629	772
Nonvolatile Solids Loading to Digester, lbs/day	139	180	221
Reduction in VSS, %[c]	40	40	40
Volatile Solids Remaining after Digestion, lbs/day	293	378	463
Solids Loading to Belt Filter Press, lbs/day	432	557	684
Solids to be Dewatered (12 day detention time), lbs	5,182	6,689	8,203
Solids to be Dewatered (16 day detention time), lbs	6,909	8,918	10,937
Operational Time of Belt Filter Press to Process Sludge (12 day detention time)[d]	7	9	11
Operational Time of Belt Filter Press to Process Sludge (16 day detention time)[d]	9	12	15
Average Operational Time of Belt Filter Press, hrs/day (5 days a week)[d]	0.8	1.0	1.3
Sludge Production, tons/year[e]	110	142	174

[a] 10-year and 20-year WAS flows projected using current ratio of WAS Flow/WWTP ADWF from 2011 WAS production data (see Table 7-13).

[b] Information obtained during WWTP site visit [40].

[c] Reduction of VSS during aerobic digestion ranges from 38-50 percent per *Wastewater Engineering Treatment and Reuse*, Metcalf and Eddy [35].

[d] Assuming a throughput of 750 lbs of dry solids/hr from projected performance for Tower Press™ TP12.43 by Charter Machine Company (see Table 7-15) [51].

[e] Assuming cake solids of 62 percent is obtained from sludge drying beds as determined from known sludge disposal of 110 tons for 2011 [46].

h. Sludge Drying Beds

Dewatered sludge (cake) from the belt filter press is stockpiled in a covered sludge storage area and then dewatered further in the sludge drying beds to increase percent solids before final disposal. At the WWTP, sludge is typically stored from November to May and "worked" from June to September. During "working" of the sludge, the goal is to achieve 85-95 percent solids

[40]. Characteristics of the sludge drying beds and covered stockpile areas at the WWTP are provided in Table 7-17.

TABLE 7-17
CITY OF ANGELS WASTEWATER MASTER PLAN
CHARACTERISTICS OF SLUDGE DRYING BEDS AND COVERED STOCKPILE AREA

Parameter	Sludge Drying Beds	Covered Stockpile Area
Number of Beds/Stockpile Area	6	2
Area per Bed/Stockpile Area, sf	800	800
Total Area, sf	4,800	1,600
Sidewall Height, ft	2	2
Stockpile Volume Available, cf[a]	-	3,200

[a] cf = cubic foot.

The paved area required for sludge drying can be determined using an equation from *Small and Decentralized Wastewater Management Systems* [50] as follows:

$$A = \frac{1.04S\left(\frac{1-s_d}{s_d} - \frac{1-s_e}{s_e}\right) + PAF}{k_e E_p F}$$

Where:

A = required sludge drying bed area, sf

S = annual sludge production, lbs dry solids/year

s_d = % solids of sludge out of belt filter press, 16.5% (see Table 7-15)

s_e = % solids of sludge for final disposal, 62% (see Table 7-16)

P = annual precipitation, 2.72 ft/yr (see Table 7-22)

F = conversion factor, 62.4 lb/ft^3

k_e = reduction factor for sludge vs. free water surface, 0.6

E_p = free water pan evaporation rate, 5.97 ft/yr (see Table 7-23)

Sludge drying areas and stockpile volumes required for existing and future conditions are presented in Table 7-18. The required sludge drying areas for 10-year and 20-year projections as well as for existing conditions suggest that significantly more square footage would be useful. In addition, the covered stockpile areas have insufficient capacity for current and projected volumes

of sludge to be held before disposal. The large gap between existing versus required sludge drying and stockpile areas is apparent in the current operational strategy. Under existing operations, sludge is being stored in the stockpile area before reaching a desirable percent solids. In addition, plant personnel have resorted to working sludge in the bottom of the EQ basin during the summer months as a supplement to the lack of area in the existing sludge drying beds. Based on industry accepted parameters and anecdotal evidence, the need for additional sludge drying beds and covered stockpile areas is warranted.

TABLE 7-18
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF SLUDGE DRYING BEDS AND COVERED STOCKPILE AREA CAPACITY

Parameter	Projection		
	Existing (2011)	10-year	20-year
Sludge Production, tons dry solids/year[a]	110	142	174
Total Required Sludge Drying Area, sf[b]	18,923	24,426	29,955
Sludge Loading Rate, lbs solids/sf/year	11.6	11.6	11.6
Total Stockpile Volume Required, cf/year	6,481	8,365	10,259

[a] Sludge disposal in May 2011 was 110 tons (see Table 7-16) [46].
[b] Required sludge drying area determined using recommended parameters from *Small and Decentralized Wastewater Management Systems* [50].

7.5 Evaluation of Storage and Disposal Facilities Capacity

The Regional Board requires WWTP storage and disposal facilities be designed for 100-year annual precipitation [17]. Annual 100-year precipitation is the depth of rainfall that is expected to occur within a year, on the average, once every hundred years. Various combinations of storage and disposal facilities can be used to meet this regulatory requirement.

Water balance calculations were prepared to evaluate the storage and disposal facilities capacity at existing, 10-year, 20-year, and buildout flow projections under various precipitation conditions. Inflows and outflows to the treatment, storage, and disposal facilities were evaluated on a monthly basis and the effects of seasonal variations were incorporated into the water balances. Inflows include the influent wastewater flow (ADWF), I/I, and precipitation. Outflows include water surface evaporation, reservoir seepage, soil percolation and evapotranspiration (ET) at the land disposal areas, and discharge to Angels Creek.

a. Description of Facilities

A summary of the treatment, storage, and disposal facility characteristics as applicable to the water balances is provided in Table 7-19. A polynomial curve was developed to represent the

water surface area of Holman Reservoir as a function of storage volume based on values used in previous water balances in the WWTP *Preliminary Engineering Reports* [5, 6].

TABLE 7-19
CITY OF ANGELS WASTEWATER MASTER PLAN
CHARACTERISTICS OF CITY OF ANGELS
TREATMENT, STORAGE, AND DISPOSAL FACILITIES

Facility	Area (ac)[a]	Max Volume (MG)[a]
WWTP Surface Water Area	0.5	-
WWTP Land Drainage Area	0.8	-
Holman Reservoir	11.6[b]	66.0
Holman Reservoir Catchment Area	14.5[c]	-
City Sprayfields	61.0	-
Greenhorn Creek Golf Course	110.0	-

[a] Area and volume information from WWTP *Preliminary Engineering Reports* [5, 6].
[b] Water surface area at maximum storage volume.
[c] Includes maximum water surface area and land drainage area for Holman Reservoir.

b. Existing and Projected Wastewater Flows and I/I

Total influent flow to the WWTP is the sum of the ADWF and I/I. Existing and projected ADWFs for use in the water balance calculations are summarized in Table 7-20.

TABLE 7-20
CITY OF ANGELS WASTEWATER MASTER PLAN
EXISTING AND PROJECTED ADWF AT CITY OF ANGELS WWTP

Parameter	ADWF (gpd)
Existing	0.357[a]
10-Year Projection	0.455[b]
20-Year Projection	0.558[b]
Buildout Projection with Conservation	0.804[b]
Buildout Projection without Conservation	0.824[b]

[a] See Table 7-1.
[b] See Table 7-2.

Monthly I/I was estimated by subtracting ADWF from monthly average WWTP flows from 2009-2011. An estimate of existing I/I flows is provided in Table 7-21. I/I flows are projected to increase proportionally with increasing wastewater flows and precipitation. Estimated monthly I/I

flows for existing, 10-year, 20-year, and buildout scenarios under various precipitation conditions are included in Appendix P.

TABLE 7-21
CITY OF ANGELS WASTEWATER MASTER PLAN
ESTIMATE OF EXISTING I/I FLOWS TO CITY OF ANGELS WWTP

Month	Monthly Average Effluent (mgd)				ADWF[a] (mgd)	I/I[b] (mgd)
	2009	2010	2011	2009-2011 Average		
Oct	0.325	0.339	-	0.332	0.357	0.000
Nov	0.296	0.426	-	0.361	0.357	0.004
Dec	0.403	0.620	-	0.511	0.357	0.154
Jan	0.381	0.496	0.508	0.462	0.357	0.104
Feb	0.521	0.472	0.518	0.504	0.357	0.147
Mar	0.464	0.449	0.748	0.553	0.357	0.196
Apr	0.356	0.471	0.420	0.416	0.357	0.059
May	0.394	0.375	0.368	0.379	0.357	0.022
Jun	0.347	0.416	0.369	0.378	0.357	0.000
Jul	0.361	0.376	0.362	0.366	0.357	0.000
Aug	0.332	0.328	0.327	0.329	0.357	0.000
Sep	0.291	0.302	-	0.296	0.357	0.000

[a] ADWF represents daily effluent flow for Jun-Aug from 2009-2011 (see Table 7-1).
[b] I/I calculated by subtracting ADWF from monthly average effluent from 2009-2011. I/I of zero assumed for months included in ADWF calculation (Jun-Aug) and for months with a calculated I/I value less than zero.

c. Precipitation

Historical precipitation records were used to determine average monthly precipitation for normal year (N-yr), wet year (10-year and 25-year), and 100-year conditions as summarized in Table 7-22. The method for projecting monthly precipitation for the various conditions was consistent with previous studies [5, 6]. A runoff coefficient of 0.9 was used to estimate the runoff from the land catchment area at the WWTP that is collected at the drainage pump station [5, 6]. Similarly, a runoff coefficient of 0.9 was applied for rainfall collected by the land catchment area surrounding Holman Reservoir [5, 6].

TABLE 7-22
CITY OF ANGELS WASTEWATER MASTER PLAN
MONTHLY PRECIPITATION FOR N-YR, 10-YEAR, 25-YEAR, AND 100-YEAR CONDITIONS

Month	Average Monthly Precipitation (in)			
	N-yr[a]	10-year[b]	25-year[c]	100-year[d]
Oct	1.72	2.41	2.72	3.11
Nov	3.48	4.87	5.50	6.30
Dec	5.27	7.38	8.33	9.54
Jan	6.18	8.66	9.77	11.19
Feb	5.65	7.91	8.93	10.23
Mar	5.45	7.63	8.61	9.86
Apr	2.72	3.81	4.30	4.93
May	1.32	1.85	2.08	2.39
Jun	0.30	0.43	0.48	0.55
Jul	0.03	0.04	0.05	0.05
Aug	0.07	0.10	0.11	0.13
Sep	0.44	0.61	0.69	0.79
Total	32.64	45.69	51.56	59.07

[a] Average monthly precipitation from 1888-2011 for Department of Water Resources (DWR) Station #B40 835300 in Sonora [52].

[b] N-yr precipitation for Station #B40 835300 in Sonora multiplied by ratio of 10-year/N-yr from DWR Station #B30 020900 in Angels Camp (ratio of 1.41) [5, 6].

[c] N-yr precipitation for Sonora Station #B40 835300 in Sonora multiplied by ratio of 25-year/N-yr from DWR Station #B30 020900 in Angels Camp (ratio of 1.58) [5, 6].

[d] N-yr precipitation for Sonora Station #B40 835300 in Sonora multiplied by ratio of 100-year/N-yr from DWR Station #B30 020900 in Angels Camp (ratio of 1.81) [5, 6].

d. Evaporation/Evapotranspiration

Historical Class A pan evaporation records were used to determine average monthly evaporation and crop ET for N-yr, 10-year, 25-year, and 100-year precipitation conditions as summarized in Table 7-23. A pan factor of 0.8 was used to convert average monthly pan evaporation to water surface evaporation [5, 6]. Pan evaporation data can also be used to estimate ET using a crop coefficient (Kc). A Kc value of 0.8 for cool season turf grass was used to convert average monthly pan evaporation to ET for the City sprayfields and Greenhorn Creek Golf Course [53]. For 100-year precipitation conditions, evaporation/ET is assumed to decrease to 76 percent of N-yr and wet year evaporation/ET from October through April as a result of increased rainfall [5, 6].

TABLE 7-23
CITY OF ANGELS WASTEWATER MASTER PLAN
MONTHLY EVAPORATION AND EVAPOTRANSPIRATION
FOR N-YR, 10-YEAR, 25-YEAR, AND 100-YEAR CONDITIONS

Month	1992-2005 Pan Evaporation (in)[a]	N-yr, 10-year, 25-year Evaporation/ET (in)[b]	100-year Evaporation/ET (in)[c]
Oct	5.52	4.42	3.36
Nov	2.23	1.78	1.36
Dec	1.19	0.95	0.72
Jan	1.30	1.04	0.79
Feb	1.83	1.46	1.11
Mar	3.46	2.77	2.10
Apr	5.25	4.20	3.19
May	7.94	6.35	6.35
Jun	10.23	8.18	8.18
Jul	12.23	9.78	9.78
Aug	11.72	9.38	9.38
Sep	8.71	6.97	6.97
Total	71.61	57.29	53.30

[a] Class A pan evaporation values from Western Regional Climate Center, New Melones Dam HQ [54].
[b] Pan/Kc factor of 0.8 applied for conversion to free water surface evaporation and cool season turf grass ET [5, 6, 53].
[c] Assume 76 percent of N-yr evaporation/ET for Oct-Apr to account for decrease in evaporation/ET during precipitation [5, 6].

e. Percolation and Reservoir Seepage

Although infiltration testing has not been performed for the land disposal areas or Holman Reservoir, a conservative percolation rate can be assumed for use in the water balance calculations. For land disposal, a clean water percolation rate of 0.04 inch per hour (in/hr) for sandy clay loam with a percolation safety factor of 10 percent (i.e., 10 percent of percolation rate is applied in calculations) is assumed, consistent with the assumption in previous reports [5, 6].

For seepage in Holman Reservoir, a seasonal reduction is applied to account for rising groundwater elevations. Reservoir seepage rates are then reduced by 50 percent for SS accumulation at the bottom of the reservoir. Monthly reservoir seepage rates are presented in Table 7-24.

TABLE 7-24
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED SEEPAGE RATES FOR HOLMAN RESERVOIR

Month	Days Per Month	Unadjusted Seepage Rate[a] (in/hr)	Seepage Rate w/Safety Factor[b] (in/mo)	Seasonally Adjusted Seepage Rate[c] (in/mo)	Reservoir Seepage Rate[d] (ft/mo)
Oct	31	0.04	3.00	3.00	0.13
Nov	30	0.04	3.00	2.00	0.08
Dec	31	0.04	3.00	0.50	0.02
Jan	31	0.04	3.00	0.00	0.00
Feb	28	0.04	3.00	0.00	0.00
Mar	31	0.04	3.00	0.10	0.00
Apr	30	0.04	3.00	1.00	0.04
May	31	0.04	3.00	2.00	0.08
Jun	30	0.04	3.00	3.00	0.13
Jul	30	0.04	3.00	3.00	0.13
Aug	31	0.04	3.00	3.00	0.13
Sep	30	0.04	3.00	3.00	0.13

[a] Clean water percolation rates for sandy clay loam [5, 6].
[b] Safety factor of 10% for leaching rate [5, 6].
[c] Seasonal reduction to account for saturation of shallow soil and rising water table elevations during precipitation [5, 6].
[d] Reduction of 50% to account for SS accumulation on the bottom of the reservoir [5, 6].

f. Angels Creek Flows

The amount of treated effluent that can be discharged to Angels Creek is dependent on several factors, including background flows in the creek. Stream flows for Angels Creek at the WWTP discharge location were available from May 2010 through September 2011 from the Utica Power Authority [55]. Rainfall from October 2010 through September 2011 totaled 48.61 inches which is comparable to a 10-year precipitation condition as shown in Table 7-22. Stream flows for N-yr precipitation and dry year conditions were projected by analyzing trends from a gage further upstream with additional historical data. Historical stream flows from the upstream gage (Angels Creek below Murphy's After Bay) and a comparison with precipitation conditions are presented in Table 7-25.

TABLE 7-25
CITY OF ANGELS WASTEWATER MASTER PLAN
HISTORICAL STREAM FLOWS FOR ANGELS CREEK BELOW MURPHY'S AFTER BAY AND COMPARISON WITH PRECIPITATION YEARS

Month	Stream Flows (cfs)[a, b]					N-yr as % of 10-yr[c]	Dry Year as % of 10-yr[d]
	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010		
Oct	30.0	22.1	14.2	30.0	19.4	64	47
Nov	19.4	14.8	11.7	16.0	11.5	59	60
Dec	25.3	20.3	14.9	24.0	20.0	79	59
Jan	24.7	21.0	16.0	31.0	20.0	81	65
Feb	24.1	22.0	16.0	31.0	20.0	83	66
Mar	25.9	23.1	16.0	31.0	20.0	77	62
Apr	34.1	33.9	16.1	31.0	20.0	59	47
May	40.3	18.8	30.0	31.1	37.5	93	74
Jun	37.6	18.8	30.0	31.0	39.0	104	80
Jul	32.0	19.0	29.3	31.0	37.6	117	92
Aug	32.0	19.0	30.0	31.0	37.0	116	94
Sep	32.0	19.0	30.0	31.0	37.0	116	94
Average (cfs)	29.8	21.0	21.2	29.1	26.6	89	71
Precipitation (in)[e]	47.6	24.8	24.0	26.6	32.5	-	-
Equivalent Precipitation Year[f]	10-yr	Dry	Dry	N-yr	N-yr	-	-

[a] cfs = cubic foot per second.
[b] Stream flows for Angels Creek below Murphy's After Bay – Station 11298650 [56].
[c] Stream flows in 2009-2010 as a percent of stream flows in 2005-2006.
[d] Stream flows in 2007-2008 as a percent of stream flows in 2005-2006.
[e] Annual precipitation from DWR Station #B40 835300 in Sonora [52].
[f] Equivalent precipitation year when compared with N-yr, 10-year, 25-year, and 100-year data from Station B40 835300 in Sonora and B30 020900 in Angels Camp (see Table 7-22).

A summary of projected stream flows for Angels Creek at the WWTP discharge location under N-yr precipitation and dry year conditions is presented in Table 7-26.

TABLE 7-26
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED N-YR AND DRY YEAR STREAM FLOWS
FOR ANGELS CREEK AT WWTP DISCHARGE LOCATION

Month	Historical Average Monthly Stream Flows[a] (cfs)		Projected N-yr Stream Flows[b] (cfs)	Projected Dry Year Stream Flows[c] (cfs)
	2009-2010	2010-2011		
Oct	-	16	15.1	11.4
Nov	-	27	25.5	19.3
Dec	-	67	62.6	47.4
Jan	-	51	47.5	36.1
Feb	-	54	50.3	38.1
Mar	-	79.0	74.1	56.2
Apr	57	58	56.7	41.1
May	43	47	43.3	33.4
Jun	33	44	33.1	31.0
Jul	26	31	25.8	22.2
Aug	26	28	25.5	19.8
Sep	28.0	29	28.0	20.6
Average (cfs)	35.4	44.2	40.6	31.4
Precipitation (in)[d]	32.5	48.6	-	-
Equivalent Precipitation Year[e]	N-yr	10-year	-	-

[a] Average stream flows provided by Utica Power Authority for Angels Creek at WWTP discharge location [55].
[b] Projected N-yr year stream flows assuming N-yr flows are 89% of 2010-2011 (10-year) stream flows (see Table 7-25).
[c] Projected dry year stream flows assuming dry year flows are 71% of 2010-2011 (10-year) stream flows (see Table 7-25).
[d] Annual precipitation from DWR Station #B40 835300 in Sonora [52].
[e] Equivalent precipitation year when compared with N-yr, 10-year, 25-year, and 100-year data from Station B40 835300 in Sonora and B30 020900 in Angels Camp (See Table 7-22).

A summary of the relationship between stream flows and discharge limits to Angels Creek is provided in Table 7-27. In addition to the stream flow restrictions noted in Table 7-27 and the effluent water quality requirements outlined in Table 7-5, discharge to Angels Creek is also prohibited when Holman Reservoir has more than 20 MG unused storage capacity [14].

TABLE 7-27
CITY OF ANGELS WASTEWATER MASTER PLAN
ANGELS CREEK STREAM FLOWS AND ALLOWABLE EFFLUENT DISCHARGE VOLUMES

Month	Available Days for Discharge[a]	Projected N-yr Stream Flows					Projected Dry Year Stream Flows				
		Average Stream Flow[b]		Discharge Limit[c]	Allowable Discharge Volume		Average Stream Flow[b]		Discharge Limit[c]	Allowable Discharge Volume	
		(cfs)	(mgd)	(mgd)	(MG)	(ac-ft)	(cfs)	(mgd)	(mgd)	(MG)	(ac-ft)
Oct	0	15.1	9.8	0	0	0	11.4	7.4	0	0	0
Nov	16	25.5	16.5	0.8	13.2	40.5	19.3	12.5	0.6	10.0	40.5
Dec	31	62.6	40.4	1.9	58.9	180.7	47.4	30.7	1.5	47.5	180.7
Jan	31	47.5	30.7	1.5	47.6	146.2	36.1	23.3	1.2	36.1	146.2
Feb	28	50.3	32.5	1.6	45.5	139.6	38.1	24.6	1.2	34.5	139.6
Mar	31	74.1	47.9	1.9	58.9	180.7	56.2	36.3	1.8	56.3	180.7
Apr	30	56.7	36.6	1.8	54.9	168.6	41.1	26.6	1.3	39.9	168.6
May	15	43.3	28.0	1.4	21.0	64.5	33.4	21.6	1.1	16.2	64.5
Jun	0	33.1	21.4	0	0	0	31.0	20.0	0	0	0
Jul	0	25.8	16.7	0	0	0	22.2	14.4	0	0	0
Aug	0	25.5	16.5	0	0	0	19.8	12.8	0	0	0
Sep	0	28.0	18.1	0	0	0	20.6	13.3	0	0	0

[a] NPDES permit restricts effluent discharge to Angels Creek from November 15 to May 15 [14].
[b] See Table 7-26.
[c] NPDES permit restricts Angels Creek flow to effluent flow ratio at 20:1 and maximum average daily discharge of 1.9 mgd. Discharge to Angels Creek is prohibited when stream flows are less than 12 mgd (18.6 cfs) [14].

g. Summary of Water Balances

A summary of the water balance calculations for existing, 10-year, 20-year, and buildout flow scenarios under various precipitation conditions is provided in Table 7-28. Detailed water balance calculations are included in Appendix Q. For land disposal, treated effluent was first applied to the City sprayfields up to the allowable disposal capacity with any remaining effluent then routed to Greenhorn Creek Golf Course for irrigation. In essence, the minimum quantity of treated effluent anticipated for delivery to Greenhorn Creek Golf Course if irrigation of the City sprayfields is maximized first is presented in Table 7-28. For the purpose of the water balance calculations, N-yr stream flows were assumed for N-yr, 10-year, 25-year, and 100-year precipitation conditions. A water balance calculation was also performed for the buildout flow scenario with dry year stream flows and is included in Table 7-28.

TABLE 7-28
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF WATER BALANCE CALCULATIONS FOR CITY OF ANGELS WASTEWATER MANAGEMENT SYSTEM

Flow Scenarios and Precipitation Year	Annual Volume Disposed				Remaining Capacity				Additional Storage or Disposal Required?
	Irrigation		Creek Discharge (ac-ft)	Total (ac-ft)	Irrigation		Creek Discharge (ac-ft)	Total (ac-ft)	
	City Sprayfields (ac-ft)	GHC[a] (ac-ft)			City Sprayfields (ac-ft)	GHC[a] (ac-ft)			
Existing Flows									
N-yr Precip	255	207	22	484	77	391	467	935	No
10-year Precip	235	209	81	525	76	350	554	980	No
25-year Precip	241	204	98	542	64	345	538	946	No
100-year Precip	229	194	146	569	57	322	489	868	No
Projected 10-Year Flows									
N-year Precip	282	245	83	610	50	353	552	955	No
10-year Precip	284	221	152	657	26	338	483	848	No
25-year Precip	279	220	179	678	25	328	521	874	No
100-year Precip	262	216	231	708	24	300	468	793	No
Projected 20-Year Flows									
N-year Precip	322	273	147	741	10	325	489	824	No
10-year Precip	300	263	234	797	10	296	647	953	No
25-year Precip	294	263	264	821	10	286	617	912	No
100-year Precip	276	249	330	855	10	266	550	827	No

TABLE 7-28 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF WATER BALANCE CALCULATIONS FOR CITY OF ANGELS WASTEWATER MANAGEMENT SYSTEM

Flow Scenarios and Precipitation Year	Annual Volume Disposed				Remaining Capacity				Additional Storage or Disposal Required?
	Irrigation		Creek Discharge (ac-ft)	Total (ac-ft)	Irrigation		Creek Discharge (ac-ft)	Total (ac-ft)	
	City Sprayfields (ac-ft)	GHC[a] (ac-ft)			City Sprayfields (ac-ft)	GHC[a] (ac-ft)			
Projected Buildout Flows w/Conservation									
N-yr Precip	332	405	320	1,057	0	194	560	754	No
10-year Precip	310	383	437	1,131	0	176	443	620	No
25-year Precip	304	379	479	1,162	0	170	402	571	No
100-year Precip	286	355	566	1,206	0	161	315	476	No
Projected Buildout Flows w/out Conservation									
N-yr Precip	332	416	335	1,082	0	183	546	729	No
10-year Precip	310	393	455	1,158	0	167	426	592	No
25-year Precip	304	388	497	1,190	0	160	383	544	No
100-year Precip	286	364	585	1,235	0	152	295	447	No
Projected Buildout Flows w/out Conservation - Dry Year Stream Flows									
N-yr Precip	332	416	335	1,082	0	183	373	556	No

[a] Greenhorn Creek Golf Course.

Water balance results reveal that the storage and disposal facilities have sufficient capacity through buildout flow projections under 100-year precipitation conditions. The storage and disposal facilities are also sufficient for buildout flow projections under dry year stream flows. No additional storage or disposal facilities are required for the projected flow scenarios. The ultimate capacity for the existing storage and disposal facilities is 0.85 mgd ADWF (with N-yr stream flows) with the limiting factor being the storage capacity of Holman Reservoir. The full capacity of the City sprayfields will be utilized under buildout flow projections for all precipitation conditions.

7.6 Conclusions

The following unit process capacities have been evaluated and are considered sufficient for 10-year and 20-year ADWF and MFP projections:

1. SBR System
2. Intermediate Pumps
3. Continuous Backwash Filters
4. UV Disinfection
5. EQ Basin
6. Aerobic Digesters
7. Belt Filter Press

In terms of process or hydraulic bottle necks:

1. The continuous backwash filters are limited to 1.3 mgd with one filter out of service. This may be partially mitigated with maintenance to loosen the clogged sand and adjustment of airlift rates.

2. The next most limiting process is the intermediate pump station which has a maximum capacity of 1.84 mgd, slightly below the design MFP of 1.9 mgd.

3. The EQ basin appears to have sufficient capacity to offset the hydraulic limitations of the continuous backwash filters and intermediate pump station.

4. The need for additional sludge drying beds and covered stockpile areas is warranted.

The current storage and disposal facilities appear to have sufficient capacity for flows beyond buildout projections. The maximum capacity of the storage and disposal facilities is 0.85 mgd ADWF.

The following needs have been identified considering current operational practices:

1. Construction of a grit chamber at the headworks.

2. Installation of a pre-filter turbidimeter to control chemical addition or automatic bypass of filters.

3. Stabilization of side slopes by gunite at the EQ basin. Construction of facilities for sludge removal and mitigation of short-circuiting issues.

4. Construction of a large covered concrete surface to stockpile biosolids (potentially to Class A standards).

5. Modernization of personnel facilities including an office with a training classroom.

6. Installation of an influent flow meter for total collection system flows into the WWTP.

8 Evaluation of Collection System Capacity

The purpose of this chapter is to discuss peaking factors and I/I allowances for the existing collection system and to execute a hydraulic model for various flow scenarios using these factors for current, 10-year, 20-year, and buildout planning horizons. The results of the model scenarios will be used to develop recommended capacity improvement projects for the collection system.

8.1 Summary of Wastewater Generation Factors

WGFs are used to estimate an appropriate flow per unit for application to the projected collection system service area to predict future wastewater flows. The development of WGFs for the City was described in Chapter 6 with comparison of ADWF data from the WWTP with existing ESUs served by the collection system. In Chapter 6, a WGF of 100 gpd/ESU was recommended in combination with the conversion factors presented in Table 8-1 for estimating ESUs per acre for various land uses. Although the recommended WGF of 100 gpd/ESU may seem significantly lower than wastewater flow factors in the City 2010 Improvement Standards [4], it should be noted that the recommended WGF is based on an ESU, not per capita or per dwelling unit. The ESU per acre conversion factors in Table 8-1 were based on GIS data for existing developed parcels, typical wastewater generation rates for different types of facilities, and land use densities presented in the General Plan [1]. Additionally, a reduced WGF of 90 gpd/ESU was considered for future developments to account for impacts associated with water conservation legislation.

TABLE 8-1
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF ESU CONVERSION FACTORS

Land Use	ESU/ac	
	Existing[a]	Future[b]
Residential		
HDR	5.0	15.0
MDR	3.0	10.0
RE	2.0	0.5
SFR	4.0	6.0
Commercial		
BAE	2.0	1.0
CC	2.0	15.0
HC	2.0	15.0
SC	2.0	15.0
Industrial		
I	2.0	2.0
Public		
P	5.0	5.0
P-SCH	10.0	10.0
PR	4.0	4.0
PR-Golf	1.5	1.5
Other		
SP	1.5	1.5

[a] Existing conversion factors based on data presented in Chapter 6.
[b] Future conversion factors based on General Plan [1] densities.

8.2 Summary of Average Dry Weather Flow

The WGFs were applied to existing and future land uses within each basin to estimate the ADWF for current, 10-year, 20-year, and buildout scenarios, with and without water conservation. To predict future scenarios, an average annual growth rate of 2.16 percent was used (equivalent to the midpoint of the 1.80 to 2.52 percent range in annual growth rates presented in the Land Use Element of the General Plan [1]). The 2.16 percent average annual growth rate was applied uniformly to each sewer basin. Once the buildout ESU was reached in a particular basin, no further growth in that basin was assumed. Estimated ADWFs for current, 10-year, 20-year, and buildout projections with and without water conservation are summarized in Tables 8-2 and 8-3.

TABLE 8-2
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED ADWF BY BASIN
(WITHOUT WATER CONSERVATION)

Area	ADWF (gpd)			
	Current	10-Year Projection	20-Year Projection	Buildout Projection
Basin #1	9,900	10,800	10,800	10,800
Basin #2, #6	89,600	110,947	137,381	137,600
Basin #3	35,800	44,329	54,891	66,900
Basin #4	29,600	36,652	45,385	128,600
Basin #5	195,200	241,707	299,294	470,300
City	**360,100**	**444,436**	**547,750**	**814,200**

TABLE 8-3
CITY OF ANGELS WASTEWATER MASTER PLAN
PROJECTED ADWF BY BASIN
(WITH WATER CONSERVATION)

Area	ADWF (gpd)		
	10-Year Projection	20-Year Projection	Buildout Projection
Basin #1	10,710	10,710	10,710
Basin #2, #6	108,813	132,603	133,520
Basin #3	43,476	52,982	66,900
Basin #4	35,947	43,806	123,600
Basin #5	237,056	288,884	459,390
City	**436,002**	**528,985**	**794,120**

Because water conservation is projected to result in a minimal reduction of overall future wastewater generation (ranging from 0.4 to 5 percent for the different planning horizons), the WGF of 100 gpd/ESU was used for hydraulic modeling and analysis purposes, for both existing and proposed land uses.

8.3 Development of Peak Wet Weather Flow Projections

PWWF is typically defined as the average hour peak flow measured during a storm event. The sewers within the collection system should be sized to accommodate the projected PWWF without surcharging. The PWWF is a combination of the wastewater flow contributed during dry weather conditions (PDWF) and I/I. I/I consists of several components, but in general is flow into the collection system which is in direct response to rainfall that occurs within a service

area. Infiltration is defined as storm water flows that enter the sewer system through defects in pipelines, manholes, and joints. Infiltration opportunities include pipeline cracks, misaligned joints, and root penetrations. Inflow is defined as storm water that enters the collection system via a direct connection to the system. Inflow opportunities include roof drain and downspout connections, leaky manhole covers, and illegal storm drain connections.

The method used for projecting PWWF within the collection system is described in the following sections.

a. Methodology for Estimating Peak Wet Weather Flow (PWWF)

The following method was used to estimate PWWFs within the system:

1. Establish the boundaries for areas, referred to as sheds, which will flow to a particular manhole.

2. Obtain land use information for each shed from the GIS data provided by the City.

3. Multiply land use areas within each shed by the corresponding WGF and ESU conversion factor to obtain the projected ADWF for each shed.

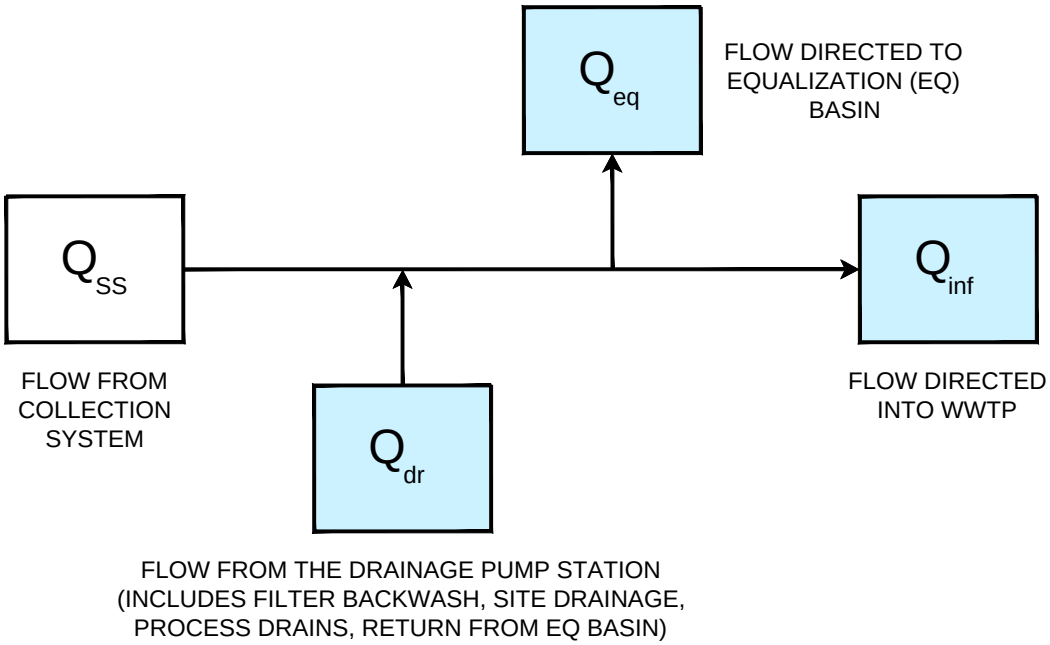
4. Estimate PDWF by multiplying the projected ADWF with the DPF.

5. Estimate the I/I for each shed by multiplying the total shed acreage with the I/I rate or allowance.

6. Sum PDWF and I/I to obtain PWWF. PWWF is the flow used to check the sizing of the sewers.

b. Calculated Total Influent Flow from Collection System

Total influent wastewater from the collection system is not measured directly at the WWTP. However, wastewater entering the treatment plant, wastewater directed to the EQ basin, and wastewater from the drainage pump station are measured by flow meters. Figure 8-1 illustrates the relationship between these four parameters.



LEGEND

FLOW IS MEASURED WITH FLOW METER

FIGURE 8-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

WWTP INFLUENT FLOW SCHEMATIC

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-1 WWTPSchematic.dwg JCP 3/9/2012

Using the following equation, total influent wastewater from the collection system was calculated from the hourly average data provided by the City. Hourly average data was available for the period from March 1 to August 15, 2011.

$$Q_{SS} = Q_{inf} + Q_{eq} - Q_{dr}$$

Where:

Q_{SS} = incoming flow from the collection system

Q_{inf} = flow measured by the "Influent" flow meter located downstream of the flow diversion to the EQ Basin. This is the flow that is directed into the treatment plant.

Q_{eq} = flow measured by the "Equalization" flow meter located on the line to the EQ Basin

Q_{dr} = flow measured by the "Drainage" pump station flow meter

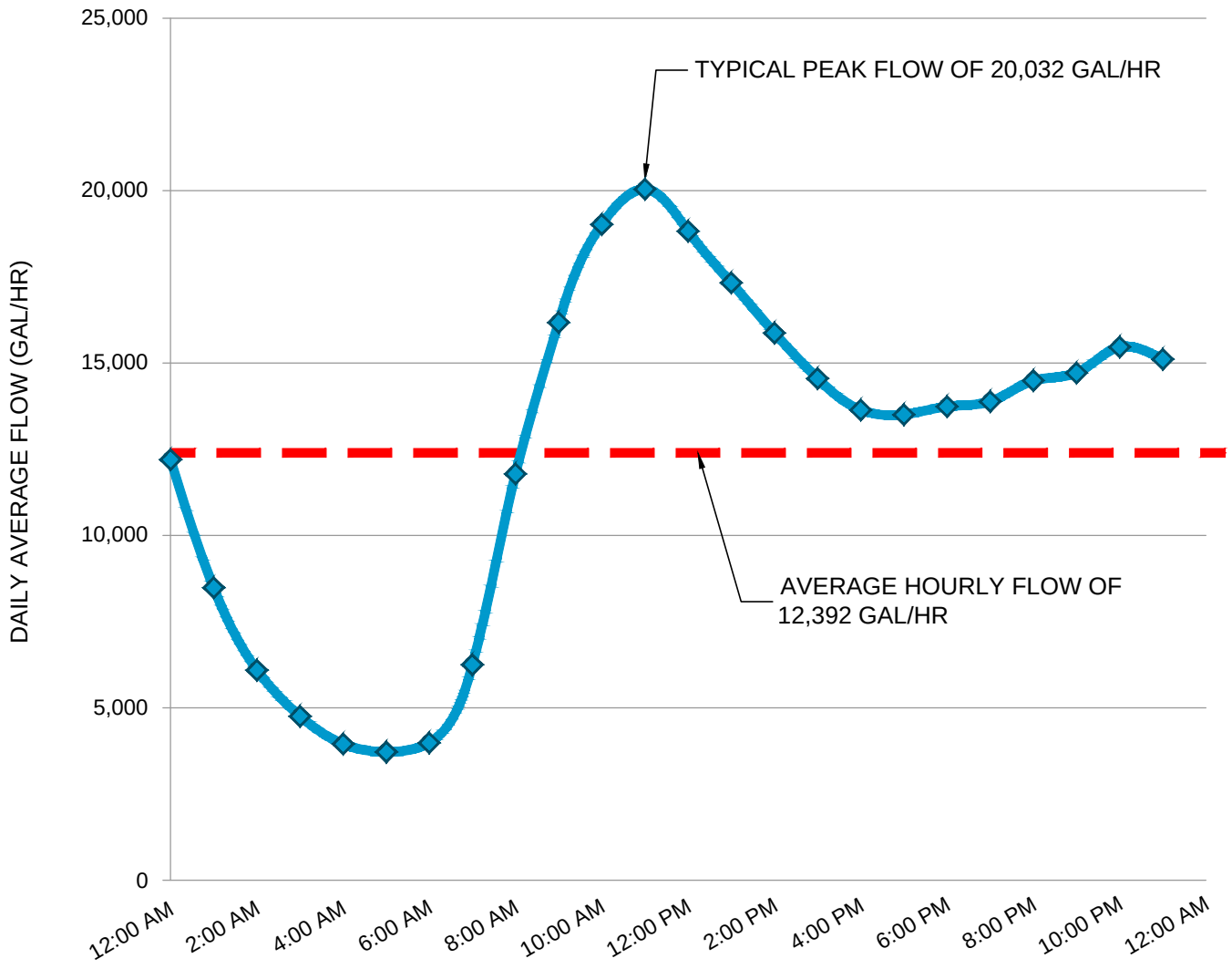
c. Diurnal Peaking Factor

As described in Section 8.3, PWWF is a combination of factors, including the DPF. Typical wastewater flows vary throughout the day, exhibiting peaks during the late morning and early evening, with the lowest flow occurring in the early morning. Flow for the City follows this pattern, as shown in Figure 8-2. Figure 8-2 presents the average hourly flow pattern recorded for the period from June 1 to August 31, 2011.

The City 2010 Improvement Standards Drawing SS-7 [4] provides a peaking factor curve to calculate the ratio of peak hour flow to ADWF. However, similar to the analysis of available data for developing a recommended WGF for use in the Master Plan, a recommended DPF was developed based on the review of historical wastewater flow data during dry weather conditions (June 1 to August 31). The data indicate that a DPF of 1.35 is appropriate for use. This diurnal peak flow tends to occur between 10:00 am to 11:00 am.

d. Inflow and Infiltration Allowance

An I/I allowance is added to the peak hourly dry weather flow to estimate the PWWF expected during a design storm event. Design storm events are based on a frequency of occurrence and length of storm. For wastewater collection systems, a 10-year, 24-hour storm event is a common design storm and was selected for use in this hydraulic evaluation for the City. A review of the National Oceanic and Atmospheric Administration (NOAA) Precipitation-Frequency Atlas of the Western United States [57] indicates total precipitation of 4-4.5 inches for a 10-year, 24-hour storm event.



LEGEND

TOTAL CALCULATED COLLECTION SYSTEM FLOW

DAILY AVERAGE FLOW

FIGURE 8-2

CITY OF ANGELS
WASTEWATER MASTER PLAN

AVERAGE DAILY DRY WEATHER DIURNAL FLOW PATTERN AT WWTP

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-2 DiurnalPattern.dwg JCP 2/2/2012

Precipitation records from the Greenhorn Creek weather station were reviewed and hourly WWTP flow data were used to correlate incoming flows to rainfall events. The month of March 2011 was equivalent to a 50-year wet weather month. The WWTP peak calculated flow of 2.89 mgd from the collection system occurred on March 20, 2011, at 10:00 am. A total rainfall of 0.98 inches was measured that day. Although this amount of rainfall is significantly less than a 10-year, 24-hour storm, data for a larger storm event were not available and four of the five days preceding this day also had rainfall. For this evaluation, wastewater flows recorded during the March 20, 2011, storm event were used to develop an initial I/I allowance and are summarized in Table 8-4.

TABLE 8-4
CITY OF ANGELS WASTEWATER MASTER PLAN
WASTEWATER TREATMENT PLANT FLOW DATA
DURING 2011 PEAK STORM EVENT

Date and Time	Precipitation (in)	Equalization Basin Flow (mgd)	WWTP Influent Flow (mgd)	Drainage Flow (mgd)	Total Collection System Flow (mgd)
March 20, 2011, 10:00 am	0.98	2.14	1.07	0.32	2.89

I/I allowances can be estimated using a variety of methods. If sufficient data is available throughout the collection system, a peaking factor curve, similar to the peaking curve in the City 2010 Improvement Standards [4], relating PWWF to ADWF can be developed and applied. Other methods include adding an I/I allowance based on area served or per inch diameter and length of pipe. Depending on the availability of data, the allowances can be adjusted for particular basins. Because flow for the basins is not monitored, one I/I allowance for the entire City was developed using the hourly flow data at the WWTP. The estimated I/I allowance is 2,300 gpd/ac for a design storm event. Table 8-5 summarizes the method used for calculating this allowance. For reference, typical I/I allowances range from 20-3,000 gpd/ac [58].

TABLE 8-5
CITY OF ANGELS WASTEWATER MASTER PLAN
CALCULATION OF I/I ALLOWANCE

Calibration Storm Event, Date and Time	Total Collection System Flow (mgd)	Diurnally Adjusted Dry Weather Flow (mgd)[a]	I/I Contribution (mgd)	Total Service Area (ac)[b]	I/I Allowance (gpd/ac)
March 20, 2011, 10:00 am	2.89	0.47	2.42	1052.1	2,300

[a] ADWF used was 0.36 mgd (the 2009-2011 ADWF average) and 0.009 mgd (the ADWF for Six-Mile Village). The ratio of ADWF at 10:00 am to ADWF is 1.28 per Figure 8-2.

[b] Total service area includes 991.4 ac for the City and 60.7 ac for Six-Mile Village.

8.4 Hydraulic Evaluation

The method for calculating PWWF was used to develop flow estimates for input into the existing hydraulic model for the City collection system. This section describes the hydraulic modeling software used, the hydraulic model inputs, flow loading scenarios modeled, and the results of the hydraulic model. The hydraulic modeling assumes the collection system pipes are in good condition (i.e., the modeling results do not account for pipe deficiencies such as cracks and root intrusions or changes in slope).

a. Hydraulic Model Software

The software used to model the existing collection system was Bentley Haestad, SewerCAD (Version 8i), consistent with the software used for the Draft Capacity Assurance Plan [10]. SewerCAD can analyze the performance of a collection system under various flow conditions such as dry weather, wet weather, steady-state, or unsteady-state. For the hydraulic evaluation of the City collection system, a steady-state model using calculated PWWF was conducted.

Information on pipes, manholes, force mains, pump stations, and outfalls is input into the program. Additionally, the user selects the flow analysis method to be used in the model. Once that information has been input, information regarding wastewater flow is added. SewerCAD can accept manually input flows or can estimate expected flows using WGFs included in the software program. SewerCAD also contains DPF curves and I/I rates which can be used for unsteady-state and wet weather flow analysis. Using the physical information for a collection system, model scenarios can be executed for various flow conditions.

The sewer model uses the Manning equation to calculate gravity sewer flow capacities. The Manning's "n" value (coefficient of friction) can be varied based on pipe material and age. The Manning equation to calculate velocity is presented below for reference.

Manning Equation: $$V = \frac{1.486 \times R^{2/3} \times S^{1/2}}{n}$$

Where:
- V = velocity, fps
- n = Manning's coefficient of friction
- R = hydraulic radius, ft
- S = slope of pipe, ft/ft

The sewer model uses the Hazen-Williams equation for calculating headloss in force mains. The "C" values (roughness coefficient) can be varied based on pipe material and age. For reference, the Hazen-Williams equation is presented below.

Hazen-Williams Equation: $$V = 1.32 \times C \times R^{0.63} \times S^{0.54}$$

Where: V = velocity, fps
C = Hazen-Williams' roughness coefficient
R = hydraulic radius, ft
S = slope of energy grade line, ft/ft

b. Hydraulic Model Inputs

Inputs into the hydraulic model included physical data for the collection system, friction coefficients, and flow loads. The following sections describe these inputs.

Physical Data

The City provided the electronic SewerCAD files for the existing hydraulic model. The electronic files included approximate pipe locations, lengths, sizes, and inverts at manholes for pipes within the collection system ranging from 6-inches to 18-inches in diameter.

Existing pump stations and force mains were added to the hydraulic model to analyze the system as a whole. The previous hydraulic model analyzed the basins separately. Information pertaining to the pump stations and force mains are summarized in Tables 8-6 (also identified as Table 3-1 in Chapter 3) and 8-7.

TABLE 8-6
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF WASTEWATER PUMP STATIONS

Station	Location	Type	No. of Pumps	HP (per pump)	Design Flow (gpm)	Design Head (ft)	Pump Station Features[a]
AMA	Brunner Hill Dr.	Submersible	2	3	252	15.3	Local alarm only
Altaville	Wilson St.	Submersible	2[b]	25	500	93	Call-out alarms, backup generator
Foundry[c]	Foundry Ln.	Submersible	2	4	29	108	Site alarm only, backup generator at Foundry
Angel Oaks	Stockton Rd.	Submersible	2	10	150	75	Site alarm only
Greenhorn Creek #1	Spring House Rd.	Submersible	3	25	Pump 1: 525[d] Pump 2: 508[d] Pump 3: 518[d]	90	Call-out alarms, backup generator, control room
Greenhorn Creek #2	Raggio Ct.	Submersible	2	25	275	85	Call-out alarms, backup generator, control room

[a] In event of power failure, flows from pump stations without a backup generator would be handled by a pump truck.
[b] Space for a third pump is available in wet well.
[c] The Foundry Pump Station serves the Foundry, Police Station, and CDF.
[d] Results from a pump test performed on 3/27/2008.

TABLE 8-7
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF FORCE MAINS

Force Main	Diameter (in)	Length (ft)
Altaville	6	1,367
Angel Oaks	4	1,708
Greenhorn Creek #1	8	3,152
Greenhorn Creek #2	6	1,850
Future PS #5	8[a]	713
Future PS #6	8[a]	1,819

[a] Recommended force main diameter for adequate capacity under existing and buildout PWWF conditions.

Figures 8-3 and 8-4 illustrate the physical backbone of the hydraulic model for existing and future conditions. The future backbone reflects recommendations from the *Alternatives Analysis for North Angels Sewer Trunk Line* [11]. If the recommendations from the *Alternatives Analysis for North Angels Sewer Trunk Line* are not constructed, the hydraulic model scenarios for future conditions presented in this Master Plan may not be valid and additional model scenarios should be executed using a physical backbone which is representative of the anticipated future conditions. Proposed improvements downstream of the North Angels Sewer Trunk Line would likely be downsized if the sewer line and "triggering" development are deferred.

Friction Factors

Friction coefficients used in the model are presented in Table 8-8.

TABLE 8-8
CITY OF ANGELS WASTEWATER MASTER PLAN
APPLIED PIPELINE FRICTION FACTORS

Pipe Category	Friction Coefficient
Gravity Mains (Manning, n)	
Existing Sewers	0.013
Proposed Sewer	0.015
Force Mains (Hazen-Williams, C)	130

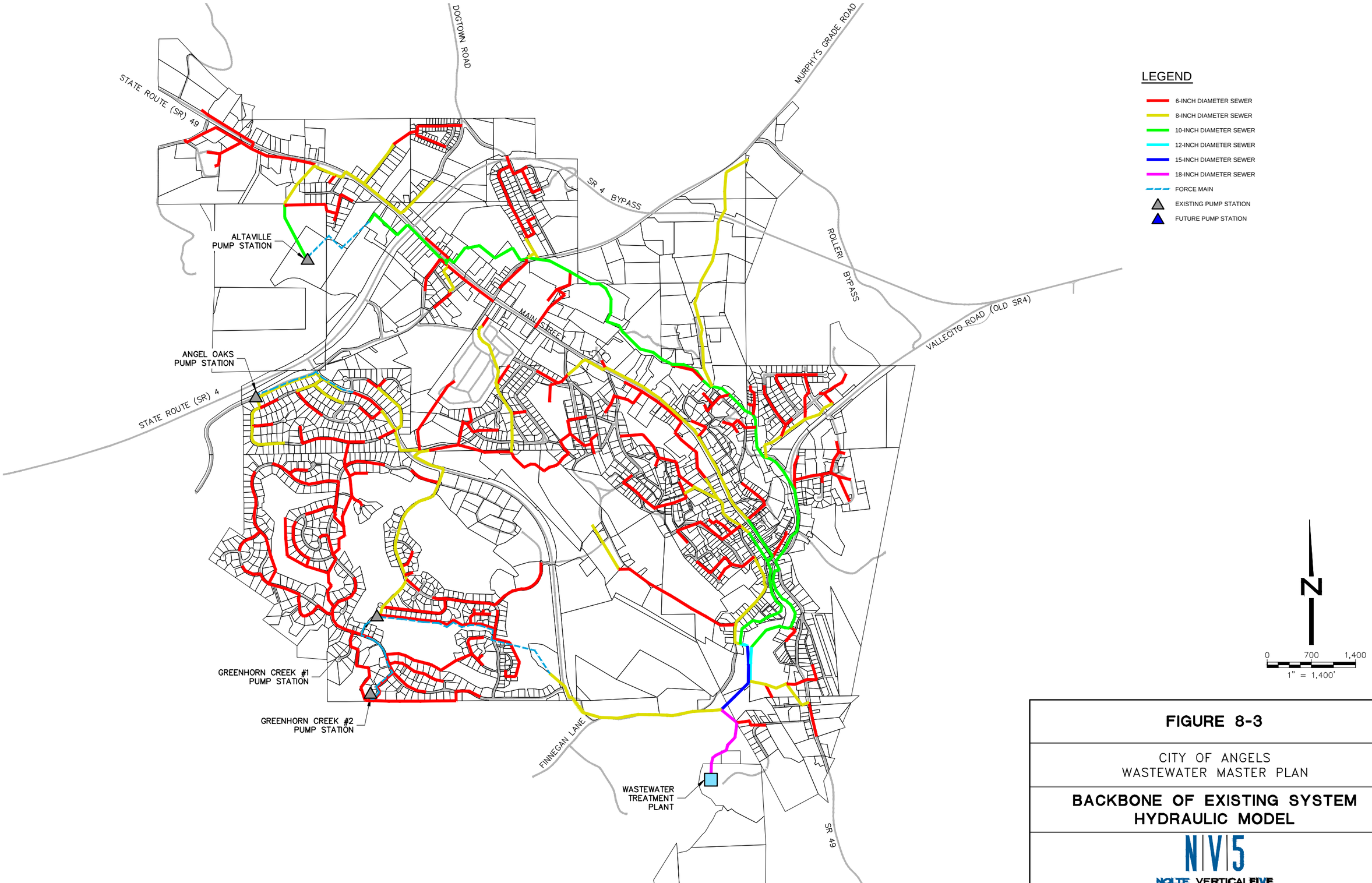


FIGURE 8-3

CITY OF ANGELS
WASTEWATER MASTER PLAN

BACKBONE OF EXISTING SYSTEM HYDRAULIC MODEL

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-3 ExistingBackbone.dwg JCP 2/1/2012

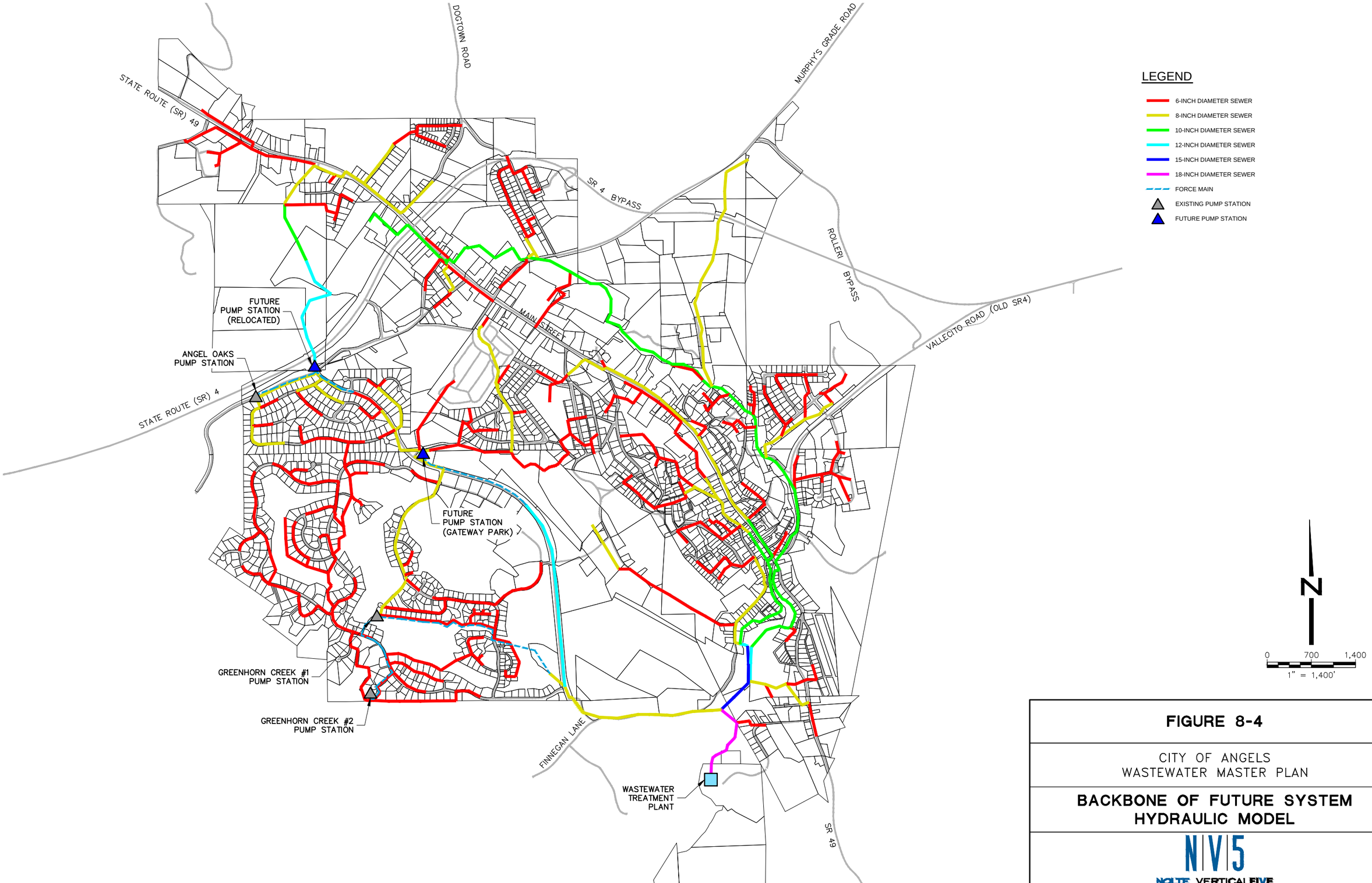


FIGURE 8-4

CITY OF ANGELS
WASTEWATER MASTER PLAN

BACKBONE OF FUTURE SYSTEM HYDRAULIC MODEL

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-4 FutureBackbone.dwg JCP 3/12/2012

Flow Loads

PWWF wastewater loads for parcels were assigned to particular manholes within the hydraulic model based on GIS data provided by the City. Maps illustrating the parcel assignments are provided in Appendix R. PWWF calculations assigned to the manholes are provided in Appendix S.

Flow Loading Scenarios

Four flow loading scenarios were developed for the hydraulic model: 1) Existing Dry Weather Loading; 2) Existing Wet Weather Loading (for 2011 Peak Storm); 3) Buildout Dry Weather Loading; 4) Buildout Wet Weather Loading (for 2011 Peak Storm). Each scenario is described in further detail below. All scenarios were executed as steady-state.

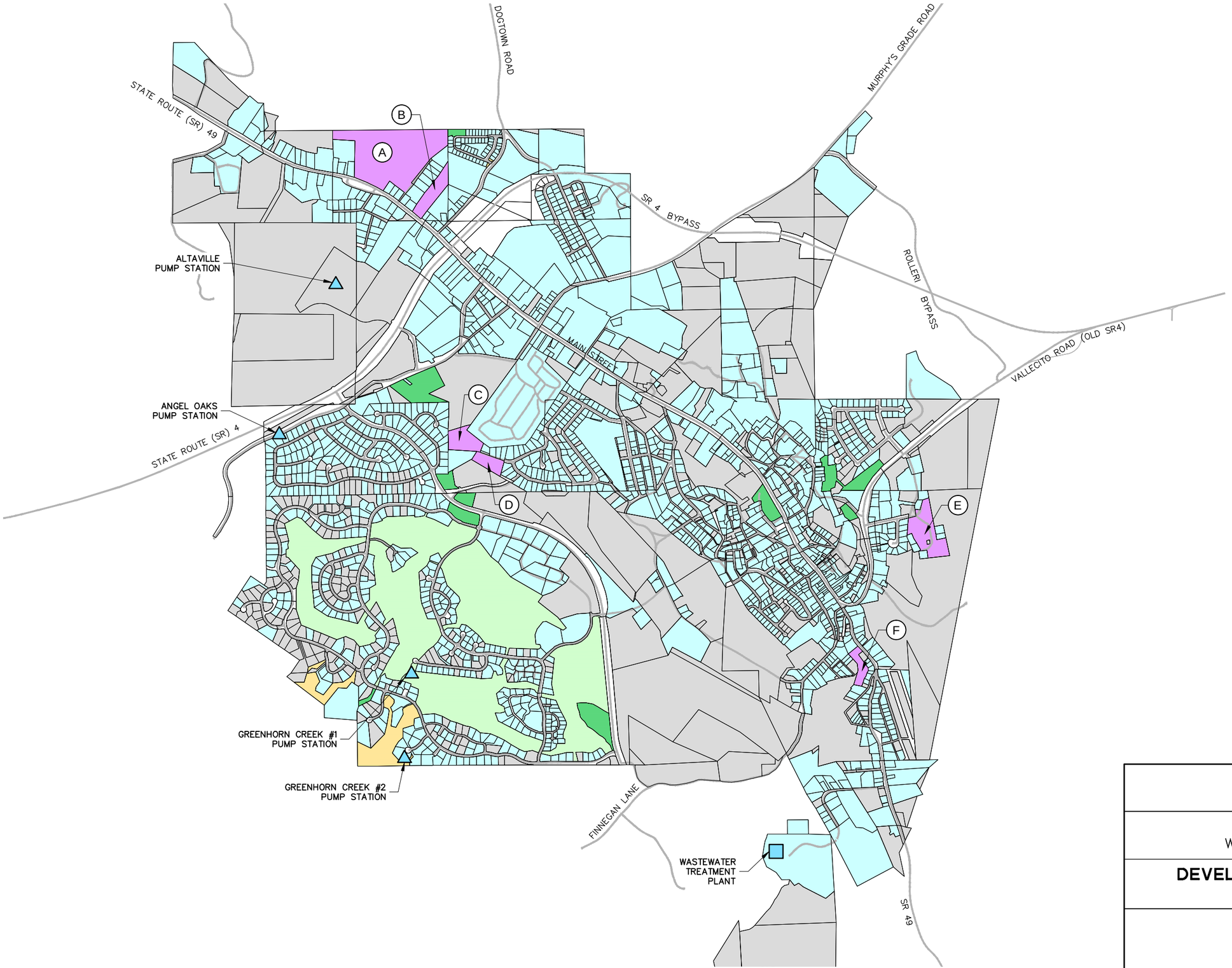
1. Existing Dry Weather Loading – This flow scenario consists of wastewater loading for developed parcels based on land use information provided by the City and WGFs presented in Chapter 6. No diurnal peaking or I/I allowance is considered.

2. Existing Wet Weather Loading (for 2011 Peak Storm) – This flow scenario consists of wastewater loading for developed parcels based on land use information provided by the City, WGFs presented in Chapter 6, a DPF of 1.35, and an I/I allowance of 2,300 gpd/ac, as presented in Table 8-5.

3. Buildout Dry Weather Loading – This flow scenario consists of wastewater loading for developed and undeveloped parcels based on land use information provided by the City and WGFs presented in Chapter 6. No diurnal peaking or I/I allowance is considered.

4. Buildout Wet Weather Loading (for 2011 Peak Storm) – This flow scenario consists of wastewater loading for developed and undeveloped parcels based on land use information provided by the City, WGFs presented in Chapter 6, a DPF of 1.35, and an I/I allowance of 2,300 gpd/ac, as presented in Table 8-5.

Flow loading scenarios for 10-year and 20-year growth projections were not conducted at this time. To simulate these scenarios, areas where growth occurs during the applicable time period would need to be assumed, which is beyond the scope of this Master Plan. Figure 8-5 presents a summary of developed and undeveloped parcels within the City limits, for reference. As development occurs, the hydraulic model can be executed in the future with the addition of projected wastewater loads from the appropriate parcels to determine the timing of recommended improvements envisioned in the buildout scenario.



LEGEND

- DEVELOPED PARCEL
- PARTIALLY DEVELOPED PARCEL
- VACANT PARCEL
- GOLF COURSE
- PARK
- OPEN SPACE
- RIGHT-OF-WAY
- EXISTING PUMP STATION

NOTE:

1. PARTIALLY DEVELOPED PARCELS IDENTIFIED BASED ON A REVIEW OF CITY GIS DATA AND AERIAL IMAGERY. TOTAL ESFU FOR PARTIALY DEVELOPED PARCELS IS PRORATED BY THE APPROXIMATE PERCENTAGE OF DEVELOPMENT.

PARTIAL DEVELOPMENT KEY

- (A) SHOPPING COMMERCIAL (SC), 10% DEVELOPED
- (B) HIGH-DENSITY RESIDENTIAL (HDR), 30% DEVELOPED
- (C) HIGH-DENSITY RESIDENTIAL (HDR), 30% DEVELOPED
- (D) HIGH-DENSITY RESIDENTIAL (HDR), 30% DEVELOPED
- (E) HIGH-DENSITY RESIDENTIAL (HDR), 10% DEVELOPED
- (F) SINGLE-FAMILY RESIDENTIAL (SFR), 10% DEVELOPED

N

0 700 1,400

1" = 1,400'

FIGURE 8-5

CITY OF ANGELS
WASTEWATER MASTER PLAN

DEVELOPED AND UNDEVELOPED PARCELS

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-5 DevelopedParcels.dwg JCP 2/1/2012

c. Results of Capacity Evaluation

Results for the four flow loading scenarios are summarized in Table 8-9. Complete model results are presented in Appendix T.

For reference, the calculated PWWF for the current collection system using WWTP data was 2.88 mgd for a storm similar to the 2011 peak storm event. A summary of the differences associated with the flow loading scenarios and measured data for existing conditions is presented in Table 8-10. Peak model flows were within +/- 3 percent of the measured flow data.

TABLE 8-9
CITY OF ANGELS WASTEWATER MASTER PLAN
RESULTS OF FLOW LOADING SCENARIOS

Scenario	Modeled Flow to WWTP (mgd)
Existing Dry Weather Flow	0.37
Existing Wet Weather Loading (2011 Peak Storm)	2.88
Buildout Dry Weather Flow	0.82
Buildout Wet Weather Loading (2011 Peak Storm)	5.38

TABLE 8-10
CITY OF ANGELS WASTEWATER MASTER PLAN
SUMMARY OF DIFFERENCE BETWEEN HYDRAULIC MODEL AND RECORDED FLOWS

Scenario	Recorded Flow (mgd)	Modeled Flow to WWTP (mgd)	Percent Difference
Existing Dry Weather Flow	0.36	0.37	3.4%
Existing Wet Weather Loading (2011 Peak Storm)	2.89	2.88	-0.5%

8.5 Results of Hydraulic Model

The following section discusses the hydraulic deficiencies identified by the computer simulation model. Deficiencies include gravity segments with excessive d/D ratios, surcharging manholes, force mains with excessive peak velocities, and pump stations with insufficient capacities.

a. Gravity Sewer Hydraulic Deficiencies

Gravity sewers are considered hydraulically deficient (i.e., surcharged) if the projected d/D exceeds 1.00 for existing gravity sewers and 0.75 for proposed gravity sewers, as described in the Chapter 5. Gravity sewers identified as hydraulically deficient under the Existing Wet Weather Loading (2011 Peak Storm) and Buildout Wet Weather Loading (2011 Peak Storm) scenario are summarized in Tables 8-11 and 8-12. Figures 8-6 through 8-9 present the d/D ranges for pipes within the collection system hydraulic model for the Existing Dry Weather Flow, Existing Wet Weather Loading (2011 Peak Storm), Buildout Dry Weather Flow, and Buildout Wet Weather Loading (2011 Peak Storm) scenarios. Pipes with d/D ratios that exceed 1.00 are considered surcharged and pipes with d/D ratios between 0.75 and 1.00 have limited capacity. Pipes with d/D ratios less than 0.75 have sufficient capacity. Figures 8-6 and 8-8 illustrate that the existing collection system has sufficient capacity to accommodate existing and buildout ADWFs. Pipes P-730 and P-731 are shown in red, indicating that these pipes have a d/D ratio equal to or greater than 1.00; however, these pipes are an inverted siphon.

TABLE 8-11
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED SEWERS
EXISTING WET WEATHER LOADING (2011 PEAK STORM) SCENARIO

Pipe Label[a]	Length (ft)	Dia. (in)	Upstream			Downstream		
			Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]
P-18	39	8	9-9	0.00	4.01	9-8	0.12	7.06
P-2	38	10	44-B	3.75	5.42	44-A	1.10	2.67
P-251	201	10	47	3.12	3.65	46	5.32	6.70
P-252	163	10	46	5.32	6.70	45	3.17	4.76
P-292	225	10	36	7.81	9.11	35	4.85	5.55
P-296	228	10	39	6.09	7.68	38	6.99	7.60
P-316	238	10	37	7.09	7.70	36	7.81	9.11
P-38	66	10	44-A	1.10	2.67	44	6.48	7.75
P-383	279	12	16	5.99	7.25	15	3.35	4.28
P-405	305	8	9-8	0.12	7.06	9-7	5.32	8.31
P-442	337	10	42	3.03	4.78	41	4.82	5.43
P-470	426	10	41	4.82	5.43	39	6.09	7.68
P-504	204	8	44-A-1	5.67	6.38	44-A	1.10	2.67
P-601	318	8	9-11	0.76	4.68	9-10	1.16	4.53
P-671	264	12	17	4.68	5.80	16	5.99	7.25
P-7	37	10	45	3.17	4.76	44-B	3.75	5.42
P-702	331	8	9-2	0.00	4.87	9-1	0.00	6.58
P-706	109	10	44	6.48	7.75	43	10.52	11.11
P-707	195.9	10	43	10.52	11.11	42	3.03	4.78
P-718	71	8	9-10	1.16	4.53	T-1	1.79	6.45
P-719	119	8	T-1	1.79	6.45	9-9	0.00	4.01
P-720	169	8	9-7	5.32	8.31	T-2	8.34	8.95
P-724	225	8	9-5	3.81	4.42	T-4	6.23	7.60
P-725	103	8	T-4	6.23	7.60	9-4	3.03	3.64
P-726	182	8	9-4	3.03	3.64	T-5	3.19	4.21
P-727	96	8	T-5	3.19	4.21	9-3	2.50	4.07
P-728	185	8	9-3	2.50	4.07	T-6	1.19	3.58
P-729	82	8	T-6	1.19	3.58	9-2	0.00	4.87
P-730	307	8	9-1	0.00	6.58	T-7	2.53	26.08
P-731	146	8	T-7	2.53	26.08	9	4.48	5.40

[a] Pipe labels correlate to the pipe designations in the SewerCAD database.

[b] "T-" prefix indicates a point of change in slope and not an actual manhole

[c] Manhole depth is the distance from manhole rim to bottom

TABLE 8-12
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED SEWERS
BUILDOUT WET WEATHER LOADING (2011 PEAK STORM) SCENARIO

			Upstream			Downstream		
Pipe Label[a]	Length (ft)	Dia. (in)	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]
P-1	26	8	101A	3.29	4.18	101	3.17	4.15
P-122	125	12	17-2	0.00	1.57	17-1	0.82	4.95
P-126	128	10	38	4.01	7.60	37	4.61	7.70
P-148	139	10	24-A	0.16	2.90	24	3.73	5.30
P-169	149	10	35	3.60	5.55	34	4.94	5.66
P-18	39	8	9-9	0.00	4.01	9-8	0.00	7.06
P-180	155	10	29	0.00	4.20	26	0.00	4.00
P-187	157	10	32A	2.79	4.25	31	0.00	3.20
P-197	160	10	33	2.48	3.20	32A	2.79	4.25
P-2	38	10	44-B	2.56	5.42	44-A	0.00	2.67
P-203	163	6	41-1	2.85	3.17	41	0.10	5.43
P-216	173	10	31	0.00	3.20	30	0.00	3.91
P-219	177	6	G-27	2.37	4.33	G-26	7.66	9.14
P-239	91	10	22	3.27	4.00	21	1.15	2.90
P-250	200	8	101	3.17	4.15	100-1	2.96	4.12
P-251	201	10	47	3.06	3.65	46	3.70	6.70
P-252	163	10	46	3.70	6.70	45	1.91	4.76
P-257	203	6	101-1-1B	4.66	4.98	101-1-1A	3.86	4.74
P-270	209	8	100-1	2.96	4.12	100	2.59	3.64
P-275	211	6	G-17-2	1.28	3.54	G-17-1	2.22	3.56
P-287	221	6	G-17-3	3.13	3.52	G-17-2	1.28	3.54
P-29	60	6	G-18	4.31	4.48	G-17	3.06	4.32
P-292	225	10	36	4.85	9.11	35	3.60	5.55
P-296	228	10	39	1.47	7.68	38	4.01	7.60
P-31	61	10	30	0.00	3.91	29	0.00	4.20
P-311	241	6	G-26	7.66	9.14	G-17-7	11.36	11.74
P-316	238	10	37	4.61	7.70	36	4.85	9.11
P-323	242	10	17-4	4.54	4.93	17-2	0.00	1.57
P-34	55	10	23	3.75	5.00	22	3.27	4.00
P-344	257	6	A-9	4.08	4.57	A-10	4.24	4.80
P-353	297	8	A-11-1	0.93	5.39	A-11	7.82	13.75
P-367	300	6	G-28	6.51	6.88	G-27	2.37	4.33
P-369	293	8	A-11-2	7.24	10.25	A-11-1	0.93	5.39
P-373	280	15	10	0.00	4.90	9	0.16	5.40
P-376	283	15	17-1	0.82	4.95	16B	1.23	6.25

TABLE 8-12 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED SEWER
BUILDOUT WET WEATHER LOADING (2011 PEAK STORM) SCENARIO

			Upstream			Downstream		
Pipe Label[a]	Length (ft)	Dia. (in)	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]
P-38	66	10	44-A	0.00	2.67	44	3.98	7.75
P-383	279	12	16	1.65	7.25	15	0.00	4.28
P-386	289	6	A-8	0.00	4.55	A-9	4.08	4.57
P-397	306	15	16B	1.23	6.25	15A	0.00	5.61
P-399	297	8	A-11-3	5.93	6.05	A-11-2	7.24	10.25
P-4	38	10	24	3.73	5.30	23	3.75	5.00
P-405	305	8	9-8	0.00	7.06	9-7	0.00	8.31
P-409	306	8	A-12	1.88	5.69	A-13	2.58	3.18
P-416	311	6	G-25	4.05	4.08	G-26	7.66	9.14
P-436	332	8	A-11	7.82	13.75	A-12	1.88	5.69
P-437	332	8	100	2.59	3.64	99	4.52	5.14
P-440	321	15	15A	0.00	5.61	10	0.00	4.90
P-442	337	10	42	0.00	4.78	41	0.10	5.43
P-458	377	8	A-10	4.24	4.80	A-11	7.82	13.75
P-47	71	6	G-17-1	2.22	3.56	G-17	3.06	4.32
P-470	426	10	41	0.10	5.43	39	1.47	7.68
P-5	43	12	15	0.00	4.28	15A	0.00	5.61
P-501	213	8	44-A-4	5.83	6.51	44-A-3	4.08	5.30
P-502	178	8	44-A-3	4.08	5.30	44-A-2	6.73	8.29
P-503	124	8	44-A-2	6.73	8.29	44-A-1	4.46	6.38
P-504	204	8	44-A-1	4.46	6.38	44-A	0.00	2.67
P-505	189	6	44-9	10.04	10.12	44-A-3	4.08	5.30
P-53	79	6	101-1	3.64	4.92	101A	3.29	4.18
P-586	238	6	15-1-1	4.79	4.83	15-1	3.76	5.36
P-587	244	8	15-1	3.76	5.36	15	0.00	4.28
P-589	182	8	15-2	2.68	2.89	15-1	3.76	5.36
P-59	85	8	17-63	4.49	4.76	17-2	0.00	1.57
P-591	324	18	9	0.16	5.40	8	0.23	4.65
P-594	204	6	7-1	2.87	3.02	8	0.23	4.65
P-595	240	18	8	0.23	4.65	7	0.84	4.64
P-596	165	18	7	0.84	4.64	6	1.44	4.71
P-597	83	18	6	1.44	4.71	5	1.64	4.61
P-598	184	18	5	1.64	4.61	4	2.17	4.62
P-599	63	18	4	2.17	4.62	3	2.18	4.64
P-600	98	18	3	2.18	4.64	2	3.68	5.64

TABLE 8-12 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED SEWER
BUILDOUT WET WEATHER LOADING (2011 PEAK STORM) SCENARIO

Pipe Label[a]	Length (ft)	Dia. (in)	Upstream			Downstream		
			Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]
P-601	318	8	9-11	0.70	4.68	9-10	0.00	4.53
P-633	101	6	G-17	3.06	4.32	PS2	-	-
P-651	286	6	A-15	7.27	7.33	A-11	7.82	13.75
P-669	91	10	20	3.67	4.40	19	0.00	3.10
P-670	358	10	19	0.00	3.10	17	0.00	5.80
P-671	264	12	17	0.00	5.80	16	1.65	7.25
P-683	254	18	2	3.68	5.64	Outfall	-	-
P-691	183	6	101-1-1A	3.86	4.74	101-1-1	3.74	4.73
P-7	37	10	45	1.91	4.76	44-B	2.56	5.42
P-702	331	8	9-2	0.00	4.87	9-1	0.00	6.58
P-703	128	10	21	1.15	2.90	20	3.67	4.40
P-706	109	10	44	3.98	7.75	43	8.30	11.11
P-707	195.9	10	43	8.30	11.11	42	0.00	4.78
P-718	71	8	9-10	0.00	4.53	T-1	0.00	6.45
P-719	119	8	T-1	0.00	6.45	9-9	0.00	4.01
P-72	92	10	50	3.03	3.90	49	2.97	3.93
P-720	169	8	9-7	0.00	8.31	T-2	8.29	8.95
P-721	103	8	T-2	8.29	8.95	9-6	0.00	5.09
P-722	150	8	9-6	0.00	5.09	T-3	0.00	5.19
P-723	135	8	T-3	0.00	5.19	9-5	0.00	4.42
P-724	225	8	9-5	0.00	4.42	T-4	0.00	7.60
P-725	103	8	T-4	0.00	7.60	9-4	0.00	3.64
P-726	182	8	9-4	0.00	3.64	T-5	0.00	4.21
P-727	96	8	T-5	0.00	4.21	9-3	0.00	4.07
P-728	185	8	9-3	0.00	4.07	T-6	0.00	3.58
P-729	82	8	T-6	0.00	3.58	9-2	0.00	4.87
P-730	307	8	9-1	0.00	6.58	T-7	0.00	26.08
P-731	146	8	T-7	0.00	26.08	9	0.16	5.40
P-76	95	6	101-1-1	3.74	4.73	101-1	3.64	4.92
P-77	97	10	25	1.49	4.90	24-A	0.16	2.90
P-79	98	10	26	0.00	4.00	25	1.49	4.90
(F) P-717[d]	420	12	(F) 9-12	8.39	9.00	41162	0.00	4.53

[a] Pipe labels correlate to the pipe designations in the SewerCAD database.
[b] "T-" prefix indicates a point of change in slope and not an actual manhole
[c] Manhole depth is the distance from manhole rim to bottom.
[d] Pipe (F) P-717 is a proposed (future) pipe included under the North Angels Sewer Trunk Line Project.

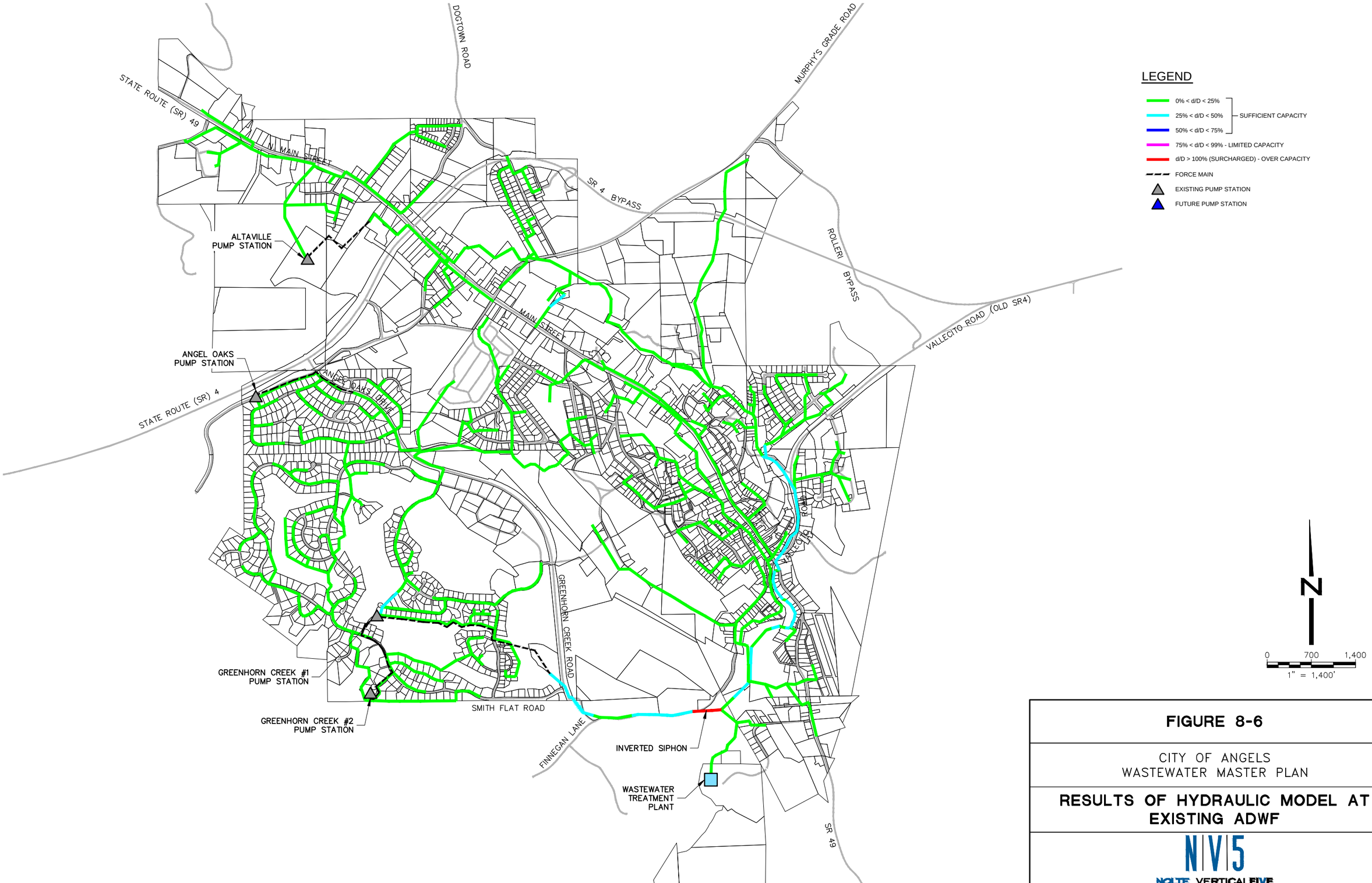


FIGURE 8-6

CITY OF ANGELS
WASTEWATER MASTER PLAN

RESULTS OF HYDRAULIC MODEL AT EXISTING ADWF

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-6 ExistingADWF.dwg JCP 2/1/2012

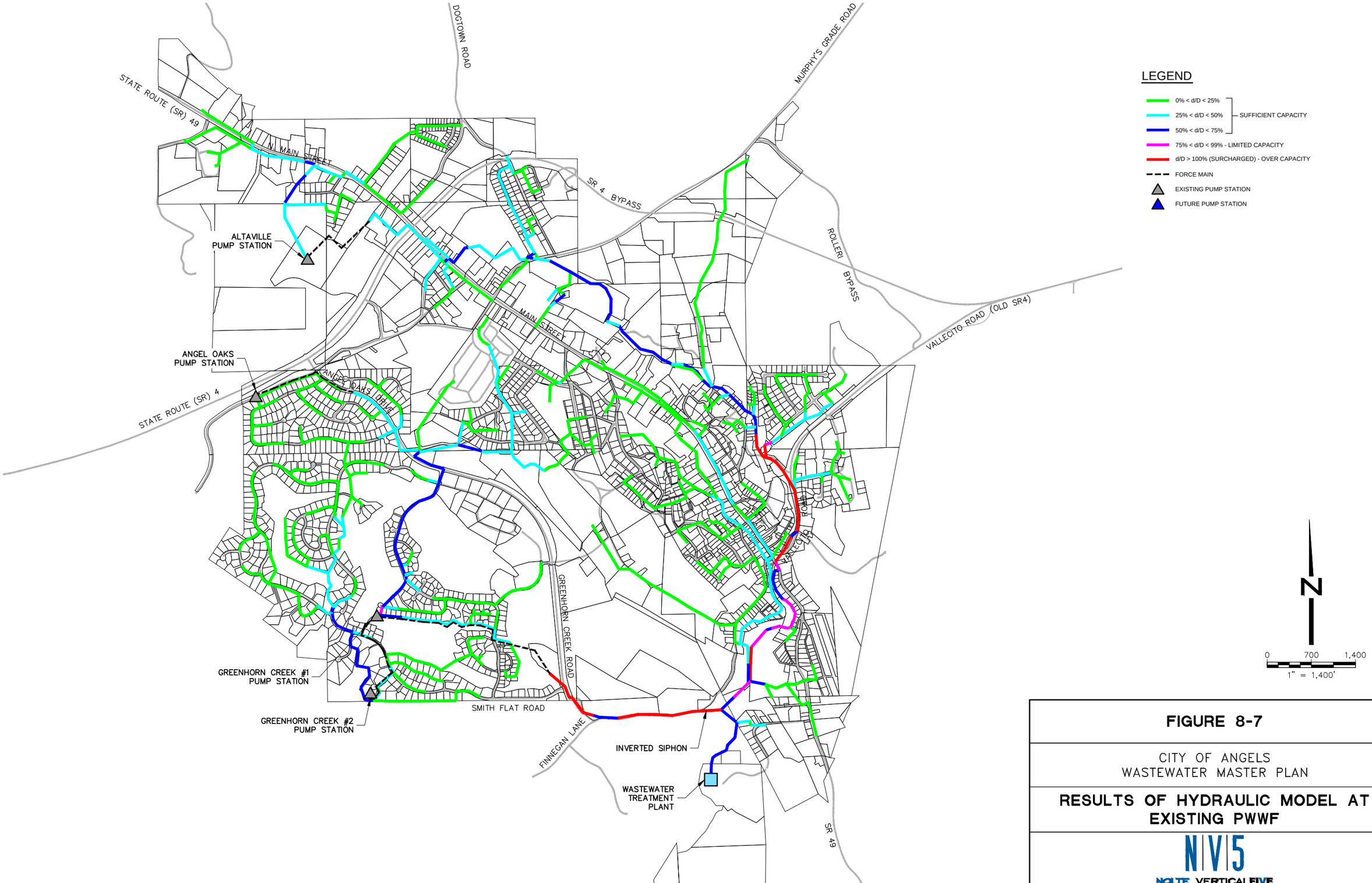


FIGURE 8-7

CITY OF ANGELS
WASTEWATER MASTER PLAN

RESULTS OF HYDRAULIC MODEL AT EXISTING PWWF

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-7 ExistingPWWF.dwg JCP 3/6/2012

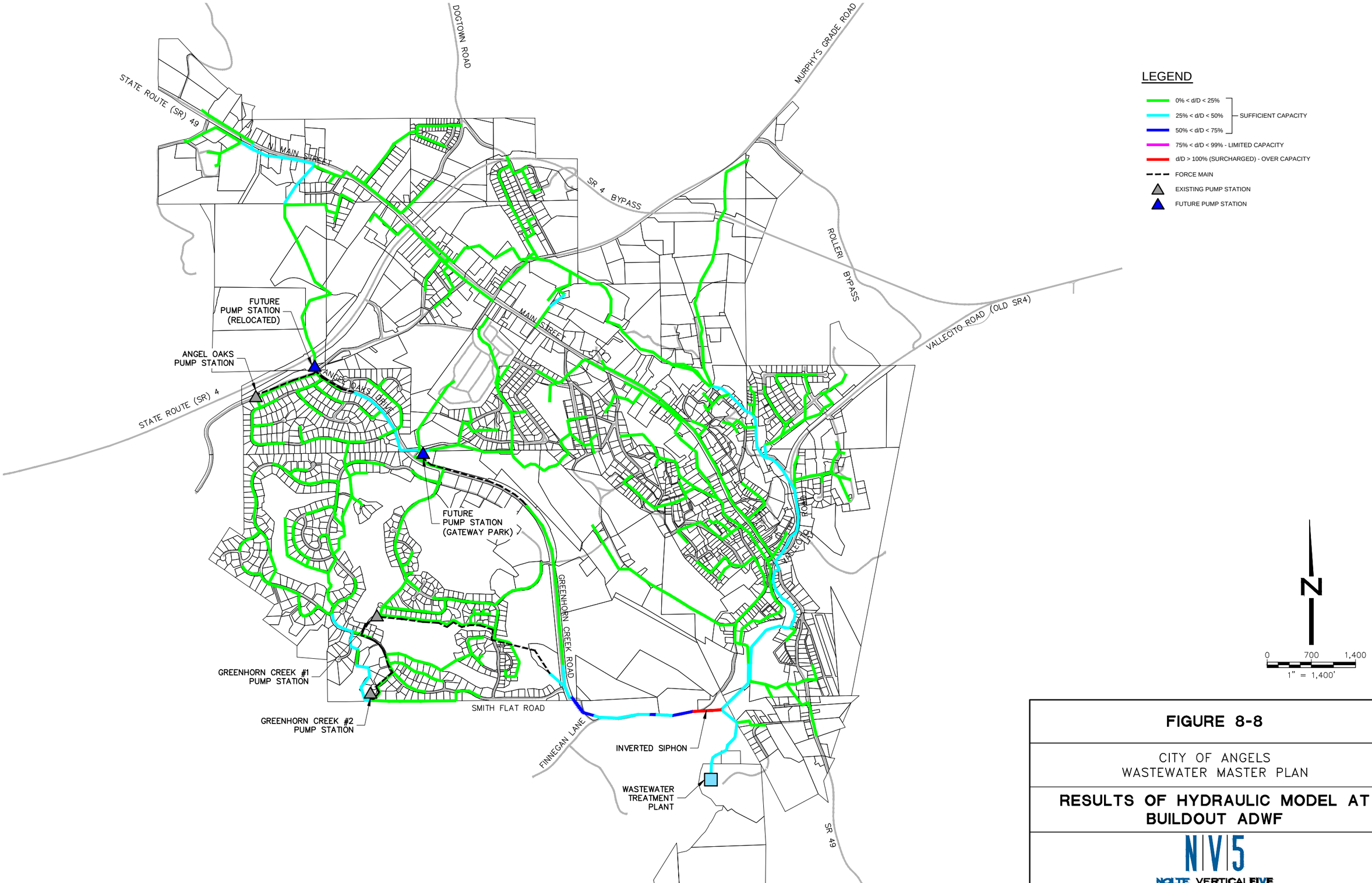


FIGURE 8-8

CITY OF ANGELS
WASTEWATER MASTER PLAN

RESULTS OF HYDRAULIC MODEL AT BUILDOUT ADWF

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-8 BuildoutADWF.dwg JCP 3/6/2012

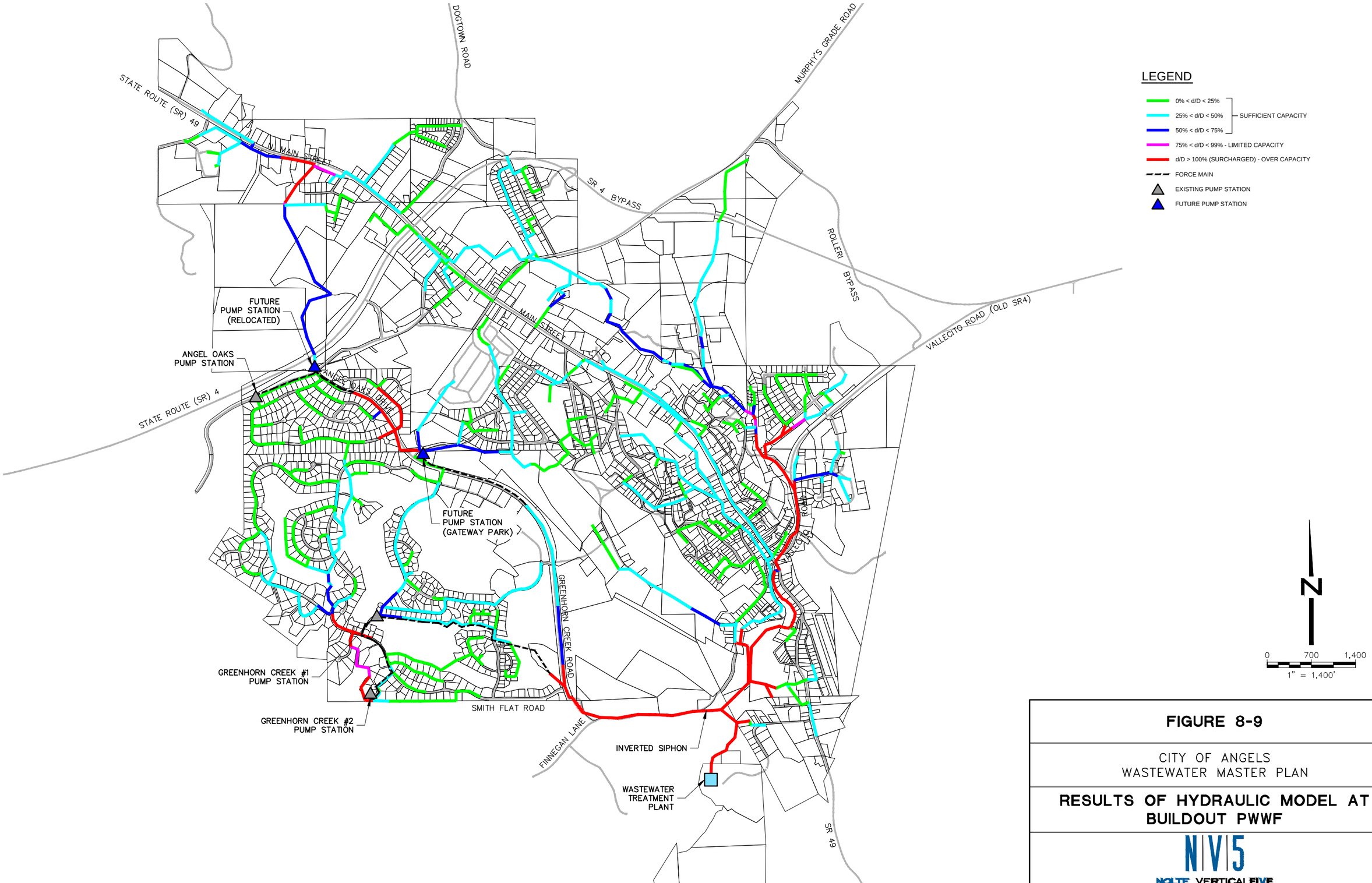


FIGURE 8-9

CITY OF ANGELS
WASTEWATER MASTER PLAN

RESULTS OF HYDRAULIC MODEL AT BUILDOUT PWWF

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-9 BuildoutPWWF.dwg JCP 4/17/2012

b. Force Main Hydraulic Deficiencies

Force mains are considered hydraulically deficient if velocities exceed 6 fps, as described in Chapter 5. The force mains appear to be sufficiently sized for existing and buildout PWWFs as summarized in Table 8-13.

TABLE 8-13
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULIC EVALUATION OF FORCE MAINS

Force Main	Force Main Diameter (in)	Existing Wet Weather Loading PWWF (gpd)	Buildout Wet Weather Loading PWWF (gpd)	Velocity for Existing Wet Weather Loading PWWF (fps)	Velocity for Buildout Wet Weather Loading PWWF (fps)
Altaville	6	240,125	-	1.9	-
Angel Oaks	4	72,525	81,449	1.3	1.4
Greenhorn Creek #1	8	1,128,816	1,017,861[a]	5.0	4.5
Greenhorn Creek #2	6	309,933	471,005	2.4	3.7
Future PS #5	8[b]	-	785,530[a]	-	3.5
Future PS #6	8[b]	-	1,309,955[a]	-	5.8

[a] Assuming construction of North Angels Sewer Trunk Line.

[b] The force mains for Future PS #5 and Future PS #6 should be 8 in diameter for sufficient capacity at buildout PWWF.

c. Pump Station Hydraulic Deficiencies

Pump stations are considered hydraulically deficient if the PWWF cannot be conveyed with the largest pump out of service, as described in Chapter 5. No pump stations appear to be hydraulically deficient for the Existing Dry Weather Flow and Buildout Dry Weather Flow scenarios. However, Greenhorn Creek #1 Pump Station is undersized for existing and buildout PWWFs as summarized in Table 8-14. Classics on the Ridge subdivision is required to upsize the Greenhorn Creek #1 Pump Station as part of their conditions of approval [9].

TABLE 8-14
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED PUMP STATIONS

Hydraulically Limited Pump Station	Existing Pump Station Capacity (gpm)	Existing Wet Weather Loading PWWF (gpm)	Buildout Wet Weather Loading PWWF (gpm)
Greenhorn Creek #1	650[a]	784	707

[a] Capacity of Pumps 1 and 2 in parallel (with 10-3/8 inch diameter impellers installed in 2008 [16]).

d. Recommended Capacity Improvements

Using the results of the hydraulic model, a list of recommended capacity improvements for the gravity sewers within the collection system was compiled and is presented in Table 8-15. The list includes information on capacity of the existing infrastructure for reference as a "trigger point" for determining the timing for the improvement.

TABLE 8-15
CITY OF ANGELS WASTEWATER MASTER PLAN
RECOMMENDED GRAVITY SEWER CAPACITY IMPROVEMENT PROJECTS

Pipe Label[a]	Upstream Manhole[b]	Downstream Manhole[b]	Location	Existing Dia. (in)	Proposed Dia. (in)	Capacity of Existing Sewer (gpd)	Required Buildout Capacity (gpd)
P-126	38	37	Vallecito Road	10	12	1,470,274	1,717,447
P-148	24-A	24	South Main Street	10	12	1,158,238	1,740,452
P-169	35	34	South Main Street	10	12	1,177,306	1,722,828
P-18	9-9	9-8	Greenhorn Creek Rd.	8	12	829,528	2,510,109
P-180	29	26	South Main Street	10	12	1,286,776	1,732,079
P-2	44-B	44-A	Bret Harte Drive	10	15	562,662	1,132,455
P-219	G-27	G-26	Smith Flat Road	6	8	288,463	344,982
P-275	G-17-2	G-17-1	Smith Flat Road	6	8	295,386	380,437
P-292	36	35	Vallecito Road	10	12	953,395	1,722,828
P-296	39	38	Vallecito Road	10	15	801,231	1,715,851
P-31	30	29	South Main Street	10	12	1,319,887	1,732,079
P-311	G-26	G-17-7	Smith Flat Road	6	8	256,952	351,189
P-316	37	36	Vallecito Road	10	12	1,987,750	1,720,595
P-34	23	22	South Main Street	10	12	1,161,404	1,749,147
P-344	A-9	A-10	Angel Oaks Drive	6	8	963,694	899,389
P-373	10	9	Finnegan Lane	15	18	1,411,356	2,724,545
P-38	44-A	44	Booster Way	10	15	603,785	1,411,978
P-383	16	15	South Main Street	12	15	914,404	1,832,326
P-386	A-8	A-9	Angel Oaks Drive	6	8	710,689	899,389
P-4	24	23	South Main Street	10	12	1,171,275	1,749,147
P-405	9-8	9-7	Greenhorn Creek Rd.	8	15	740,223	2,511,551
P-409	A-12	A-13	Angel Oaks Drive	8	10	566,486	977,816
P-436	A-11	A-12	Angel Oaks Drive	8	10	753,438	977,816
P-437	100	99	North Main Street	8	10	350,837	452,785
P-440	15A	10	Finnegan Lane	15	18	1,864,138	2,710,272
P-442	42	41	Booster Way	10	12	819,951	1,421,615
P-5	15	15A	Finnegan Lane	12	15	1,216,383	1,969,014
P-504	44-A-1	44-A	Suzanne Drive	8	10	549,519	278,303
P-53	101-1	101A	North Main Street	6	8	99,938	274,795
P-591	9	8	WWTP Influent	18	21	4,079,538	5,319,510
P-595	8	7	WWTP Influent	18	21	4,110,799	5,381,732
P-596	7	6	WWTP Influent	18	21	3,774,276	5,381,732
P-597	6	5	WWTP Influent	18	21	3,495,126	5,381,732

TABLE 8-15 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
RECOMMENDED GRAVITY SEWER CAPACITY IMPROVEMENT PROJECTS

Pipe Label[a]	Upstream Manhole[b]	Downstream Manhole[b]	Location	Existing Dia. (in)	Proposed Dia. (in)	Capacity of Existing Sewer (gpd)	Required Buildout Capacity (gpd)
P-598	5	4	WWTP Influent	18	21	4,003,793	5,381,732
P-599	4	3	WWTP Influent	18	21	5,409,414	5,381,732
P-600	3	2	WWTP Influent	18	21	2,375,572	5,382,044
P-601	9-11	9-10	Greenhorn Creek Rd.	8	10	1,104,465	1,055,636
P-633	G-17	PS2	Smith Flat Road	6	8	344,213	471,003
P-670	19	17	South Main Street	10	12	1,576,935	1,755,385
P-671	17	16	South Main Street	12	15	1,329,392	1,832,326
P-683	2	Outfall	WWTP Influent	18	21	4,063,445	5,382,044
P-7	45	44-B	Bret Harte Drive	10	12	1,140,430	1,132,455
P-702	9-2	9-1	Finnegan Lane	8	15	1,049,721	2,578,269
P-703	21	20	South Main Street	10	12	1,251,581	1,755,385
P-706	44	43	Booster Way	10	12	488,948	1,411,978
P-718	9-10	T-1	Greenhorn Creek Rd.	8	10	1,564,698	2,510,109
P-719	T-1	9-9	Greenhorn Creek Rd.	8	12	1,002,286	2,510,109
P-72	50	49	Bret Harte Drive	10	12	1,190,218	1,107,087
P-720	9-7	T-2	Finnegan Lane	8	15	700,589	2,552,014
P-721	T-2	9-6	Finnegan Lane	8	10	3,117,259	2,552,014
P-722	9-6	T-3	Finnegan Lane	8	10	2,476,237	2,552,014
P-723	T-3	9-5	Finnegan Lane	8	10	2,256,484	2,552,014
P-724	9-5	T-4	Finnegan Lane	8	12	1,977,099	2,552,014
P-725	T-4	9-4	Finnegan Lane	8	12	951,841	2,552,014
P-726	9-4	T-5	Finnegan Lane	8	12	1,636,345	2,552,014
P-727	T-5	9-3	Finnegan Lane	8	12	1,297,551	2,552,014
P-728	9-3	T-6	Finnegan Lane	8	12	1,268,414	2,578,269
P-729	T-6	9-2	Finnegan Lane	8	12	1,784,235	2,578,269
P-730	9-1	T-7	Finnegan Lane	8	18	2,047,431	2,594,965
P-731[c]	T-7	9	Finnegan Lane	8	18	-3,131,395	2,594,965
P-77	25	24-A	South Main Street	10	12	1,277,884	1,739,625
P-79	26	25	South Main Street	10	12	1,230,458	1,735,895

[a] Pipe labels correlate to the pipe designations in the SewerCAD database.
[b] "T-" prefix indicates a point of change in slope and not an actual manhole
[c] Pipe 731 shown with negative capacity due to upward slope of pipe; pipe is inverted siphon.

Capacity improvement for all pipes identified as hydraulically limited may not be required, as increasing the capacity of downstream pipes in strategic locations will alleviate backwater effects on upstream pipes. Capacity improvements are required for approximately 62 pipelines out of a total of 102 pipelines identified as hydraulically limited for Buildout PWWF conditions.

No capacity improvements for force mains appear to be necessary. However, Greenhorn Creek #1 Pump Station appears to be undersized for existing and buildout PWWF conditions and is required to be upsized by Classics on The Ridge subdivision as part of their conditions of approval [9].

8.6 I/I Reduction

Because the hydraulic deficiencies within the gravity sewers are mainly attributed to I/I contributions, another potential method for addressing hydraulic deficiencies is to reduce I/I. However, reducing I/I is often a difficult task because the locations and causes of the I/I within the collection system must be pinpointed. The City has been performing extensive CCTV inspection of sewers and manholes to identify sources of I/I and plans to regularly implement sewer improvement projects to reduce I/I. However, to estimate the potential benefits associated with reduced I/I, a hydraulic scenario using a reduced I/I allowance for Buildout Wet Weather Loading conditions was conducted. This flow scenario was similar to Scenario 4 (described in Section 8.4b), with a 30 percent reduction in I/I allowance (I/I allowance of 1,610 gpd/ac).

Table 8-16 and Figure 8-10 summarize the pipelines with flows at or above capacity for the Buildout Wet Weather Loading (2011 Peak Storm with Reduced I/I) scenario. The hydraulic model indicates that with a reduction in I/I, approximately 9,720 feet of pipe will be at capacity. This is approximately 9,530 fewer feet of pipe at capacity as compared to the model simulation with no reduction in I/I (with approximately 19,252 feet of pipe at capacity).

TABLE 8-16
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED SEWERS
BUILDOUT WET WEATHER LOADING (2011 PEAK STORM WITH REDUCED I/I) SCENARIO

			Upstream			Downstream		
Pipe Label[a]	Length (ft)	Dia. (in)	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]
P-148	139	10	24-A	1.68	2.90	24	4.40	5.30
P-18	39	8	9-9	0.00	4.01	9-8	0.00	7.06
P-180	155	10	29	2.68	4.20	26	2.57	4.00
P-2	38	10	44-B	3.84	5.42	44-A	1.18	2.67
P-216	173	10	31	2.56	3.20	30	2.38	3.91
P-251	201	10	47	3.13	3.65	46	5.47	6.70
P-252	163	10	46	5.47	6.70	45	3.27	4.76
P-292	225	10	36	7.20	9.11	35	4.60	5.55
P-296	228	10	39	5.70	7.68	38	6.96	7.60
P-31	61	10	30	2.38	3.91	29	2.68	4.20
P-316	238	10	37	7.06	7.70	36	7.20	9.11
P-353	297	8	A-11-1	5.16	5.39	A-11	12.04	13.75
P-38	66	10	44-A	1.18	2.67	44	6.53	7.75
P-383	279	12	16	5.05	7.25	15	2.69	4.28
P-4	38	10	24	4.40	5.30	23	4.18	5.00
P-405	305	8	9-8	0.00	7.06	9-7	0.00	8.31
P-409	306	8	A-12	3.93	5.69	A-13	2.64	3.18
P-436	332	8	A-11	12.04	13.75	A-12	3.93	5.69
P-440	321	15	15A	4.08	5.61	10	3.53	4.90
P-442	337	10	42	3.18	4.78	41	4.79	5.43
P-458	377	8	A-10	4.31	4.80	A-11	12.04	13.75
P-470	426	10	41	4.79	5.43	39	5.70	7.68
P-5	43	12	15	2.69	4.28	15A	4.08	5.61
P-504	204	8	44-A-1	5.75	6.38	44-A	1.18	2.67
P-587	244	8	15-1	5.18	5.36	15	2.69	4.28
P-601	318	8	9-11	3.25	4.68	9-10	0.00	4.53
P-651	286	6	A-15	7.28	7.33	A-11	12.04	13.75
P-670	358	10	19	2.14	3.10	17	3.49	5.80
P-671	264	12	17	3.49	5.80	16	5.05	7.25
P-7	37	10	45	3.27	4.76	44-B	3.84	5.42
P-702	331	8	9-2	0.00	4.87	9-1	0.00	6.58
P-706	109	10	44	6.53	7.75	43	10.53	11.11
P-707	195.9	10	43	10.53	11.11	42	3.18	4.78
P-718	71	8	9-10	0.00	4.53	T-1	0.00	6.45

TABLE 8-16 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
HYDRAULICALLY LIMITED SEWERS
BUILDOUT WET WEATHER LOADING (2011 PEAK STORM WITH REDUCED I/I) SCENARIO

			Upstream			Downstream		
Pipe Label[a]	Length (ft)	Dia. (in)	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]	Manhole[b]	Liquid Level Distance From Rim (ft)	Manhole Depth (ft)[c]
P-719	119	8	T-1	0.00	6.45	9-9	0.00	4.01
P-720	169	8	9-7	0.00	8.31	T-2	8.29	8.95
P-722	150	8	9-6	4.43	5.09	T-3	3.78	5.19
P-723	135	8	T-3	3.78	5.19	9-5	0.00	4.42
P-724	225	8	9-5	0.00	4.42	T-4	0.00	7.60
P-725	103	8	T-4	0.00	7.60	9-4	0.00	3.64
P-726	182	8	9-4	0.00	3.64	T-5	0.00	4.21
P-727	96	8	T-5	0.00	4.21	9-3	0.00	4.07
P-728	185	8	9-3	0.00	4.07	T-6	0.00	3.58
P-729	82	8	T-6	0.00	3.58	9-2	0.00	4.87
P-730	307	8	9-1	0.00	6.58	T-7	0.00	26.08
P-731	146	8	T-7	0.00	26.08	9	4.18	5.40
P-77	97	10	25	3.61	4.90	24-A	1.68	2.90
P-79	98	10	26	2.57	4.00	25	3.61	4.90
(F) P-717[d]	420	12	(F) 9-12	8.47	9.00	9-10	0.00	4.53

[a] Pipe labels correlate to the pipe designations in the SewerCAD database.
[b] "T-" prefix indicates a point of change in slope and not an actual manhole
[c] Manhole depth is the distance from manhole rim to bottom.
[d] Pipe (F) P-717 is a proposed (future) pipe included under the North Angels Sewer Trunk Line Project.

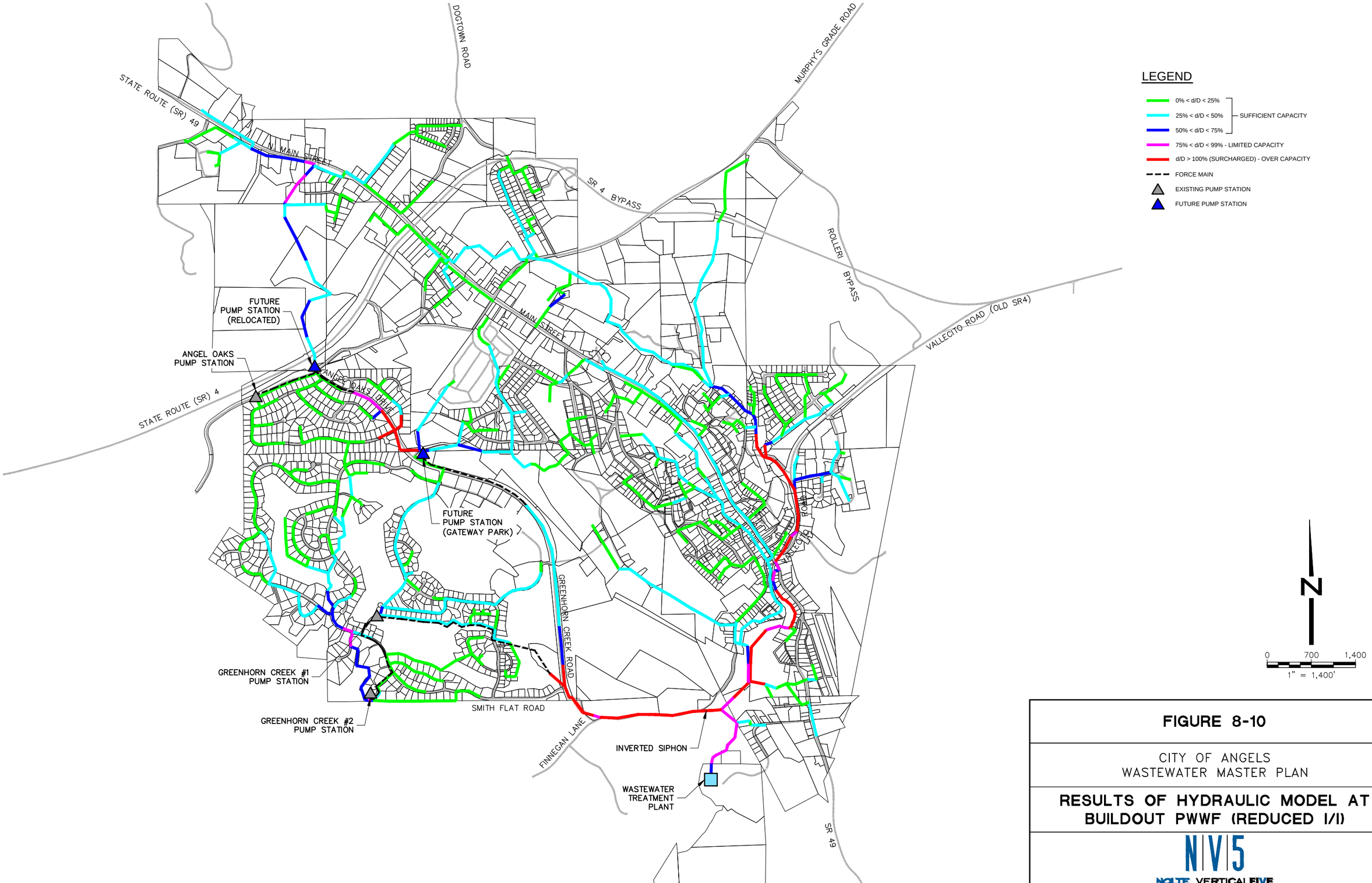


FIGURE 8-10

CITY OF ANGELS
WASTEWATER MASTER PLAN

RESULTS OF HYDRAULIC MODEL AT BUILDOUT PWWF (REDUCED I/I)

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch8\Figure 8-10 ReducedPWWF.dwg JCP 3/6/2012

A comparison of capacity improvements required for buildout design conditions (2011 Peak Storm) versus the reduced I/I scenario is provided in Table 8-17. Also included is a summary of capacity improvements required to address hydraulic deficiencies for existing PWWF conditions.

TABLE 8-17
CITY OF ANGELS WASTEWATER MASTER PLAN
COMPARISON OF RECOMMENDED CAPACITY IMPROVEMENTS

Pipe Label[a]	Location	Length (ft)	Existing Dia. (in)	Proposed Diameter (in)		
				Existing PWWF	Reduced I/I, Buildout PWWF	Buildout PWWF
P-126	Vallecito Road	128	10	-	-	12
P-148	South Main Street	139	10	-	12	12
P-169	South Main Street	149	10	-	-	12
P-18	Greenhorn Creek Rd.	39	8	10	12	12
P-180	South Main Street	155	10	-	-	12
P-2	Bret Harte Drive	38	10	12	12	15
P-219	Smith Flat Road	177	6	-	-	8
P-275	Smith Flat Road	211	6	-	-	8
P-292	Vallecito Road	225	10	12	12	12
P-296	Vallecito Road	228	10	12	12	15
P-31	South Main Street	61	10	-	-	12
P-311	Smith Flat Road	241	6	-	-	8
P-316	Vallecito Road	238	10	-	-	12
P-34	South Main Street	55	10	-	-	12
P-344	Angel Oaks Drive	257	6	-	-	8
P-373	Finnegan Lane	280	15	-	-	18
P-38	Booster Way	66	10	12	12	15
P-383	South Main Street	279	12	15	15	15
P-386	Angel Oaks Drive	289	6	-	-	8
P-4	South Main Street	38	10	-	12	12
P-405	Greenhorn Creek Rd.	305	8	10	12	15
P-409	Angel Oaks Drive	306	8	-	10	10
P-436	Angel Oaks Drive	332	8	-	-	10
P-437	North Main Street	332	8	-	-	10
P-440	Finnegan Lane	321	15	-	18	18
P-442	Booster Way	337	10	12	12	12
P-5	Finnegan Lane	43	12	-	15	15
P-504	Suzanne Drive	204	8	-	-	10
P-53	North Main Street	79	6	-	-	8

TABLE 8-17 (Cont.)
CITY OF ANGELS WASTEWATER MASTER PLAN
COMPARISON OF RECOMMENDED CAPACITY IMPROVEMENTS

Pipe Label[a]	Location	Length (ft)	Existing Dia. (in)	Proposed Diameter (in)		
				Existing PWWF	Reduced I/I, Buildout PWWF	Buildout PWWF
P-591	WWTP Influent	324	18	-	-	21
P-595	WWTP Influent	240	18	-	-	21
P-596	WWTP Influent	165	18	-	-	21
P-597	WWTP Influent	83	18	-	-	21
P-598	WWTP Influent	184	18	-	-	21
P-599	WWTP Influent	63	18	-	-	21
P-600	WWTP Influent	98	18	-	-	21
P-601	Greenhorn Creek Rd.	318	8	-	-	10
P-633	Smith Flat Road	101	6	-	-	8
P-670	South Main Street	358	10	-	-	12
P-671	South Main Street	264	12	-	-	15
P-683	WWTP Influent	254	18	-	-	21
P-7	Bret Harte Drive	37	10	12	12	12
P-702	Finnegan Lane	331	8	10	12	15
P-703	South Main Street	128	10	-	-	12
P-706	Booster Way	109	10	12	12	12
P-718	Greenhorn Creek Rd.	71	8	10	10	10
P-719	Greenhorn Creek Rd.	119	8	10	10	12
P-72	Bret Harte Drive	92	10	-	-	12
P-720	Finnegan Lane	169	8	10	12	15
P-721	Finnegan Lane	103	8	-	10	10
P-722	Finnegan Lane	150	8	-	10	10
P-723	Finnegan Lane	135	8	-	10	10
P-724	Finnegan Lane	225	8	10	12	12
P-725	Finnegan Lane	103	8	10	12	12
P-726	Finnegan Lane	182	8	-	10	12
P-727	Finnegan Lane	96	8	-	10	12
P-728	Finnegan Lane	185	8	-	10	12
P-729	Finnegan Lane	82	8	10	10	12
P-730	Finnegan Lane	307	8	12	15	18
P-731	Finnegan Lane	146	8	12	15	18
P-77	South Main Street	97	10	-	-	12
P-79	South Main Street	98	10	-	-	12

[a] Pipe labels correlate to the pipe designations in the SewerCAD database.
[b] Pipes with "-" given for proposed diameter do not require upsizing for that particular scenario.

8.7 Conclusions

The results of this evaluation of collection system capacity indicated that there are several sewers within the existing collection system that operate at or above capacity during peak wet weather conditions. These sewers are summarized in Tables 8-11 to 8-17. Despite a potential reduction in I/I, the majority of these sewers will experience flows at or above capacity under buildout conditions, further supporting the need for upsizing these pipelines in near term projects. Proposed sizing considers projected buildout PWWFs to ensure that these pipes will have sufficient capacity for future conditions and no additional capacity upgrades will be necessary.

The evaluation also indicates that there is one pump station which appears to be undersized for existing and buildout PWWF conditions as summarized in Table 8-14. All existing force mains appear to have sufficient capacity for existing and buildout PWWF conditions.

Further consideration for the appropriate timing and necessity of these upgrades is provided with development of the CIP in Chapter 10.

As recommended in Chapter 6, a flow monitoring study for each of the basins may provide additional useful data for assisting with locating potential sources of I/I, in addition to the other I/I mitigation activities currently being undertaken by the City. This evaluation used an average I/I allowance for the entire collection system. Results from a flow monitoring study would provide a method for evaluating I/I in each basin. Further discussion of flow monitoring and I/I identification and reduction is provided in Chapter 10.

9 Evaluation of Operational Structure for Wastewater Management

A review of the current operational and organizational structure for the City wastewater treatment and collection systems is presented in this chapter. This structure is compared to structures for other similar communities and agencies, particularly in view of typical regulatory requirements.

9.1 Summary of Operational Structure of City Wastewater Facilities

The City wastewater facilities are currently operated under two separate departments, Public Works and Water and Sewer (W&S). Public Works consists of a six-person crew that maintains the wastewater collection system, water distribution system, roads, parks, and provides assistance for City events. W&S consists of a six-person crew that operates and maintains the WWTP and Water Treatment Plant (WTP). Figure 9-1 illustrates the organizational structure for the two departments.

a. Public Works Staff and Department Activities

The six-person Public Works crew divides their manpower between wastewater collection, water distribution, street, parks, and City events on a weekly interval. If an emergency arises, the crew is shifted based on need. The Public Works foreman is the supervisor for the remaining five crew members. The foreman also spends a significant amount of time in the field assisting crew members. Because of the problems of maintaining an older collection system, the staff is periodically shorthanded during sewer repairs, when a minimum of two maintenance personnel are needed. An overview of the maintenance program, issues, and scheduling of maintenance activities for Public Works is provided in Section 3.3.

Staff for Public Works is listed below:

1. Jon Kitchell, Distribution & Collections Operator II
2. Roger Moore, Distribution & Collections Operator II
3. David Porovich, Equipment Operator I
4. Joe Kitchell, Equipment Operator I
5. Brent Huse, Service Maintenance
6. Jeremy Wood, Equipment Operator II

CITY COUNCIL

CITY ENGINEER

CITY ADMINISTRATOR

CITY ATTORNEY

PUBLIC WORKS

PUBLIC WORKS FOREMAN

ASSISTANT PUBLIC WORKS FOREMAN

Supports Foreman in a supervisory level and assists crew in duties

PUBLIC WORKS CREW

Provides maintenance to sewer collection and water systems, roads, parks and support for City events (Staff - 4)

WATER AND SEWER OPERATIONS

WATER/WASTEWATER TREATMENT SENIOR SUPERVISOR

WATER AND SEWER OPERATORS

Provides support to Water and Wastewater Treatment Operations (Staff - 5)

FIGURE 9-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

CURRENT ORGANIZATIONAL CHART

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch9\Figure 9-1 Org Chart.dwg JCP 1/27/2012

b. Water and Sewer Operations

The six person W&S crew consists of operators and maintenance staff who are responsible for operating the WWTP, including the disposal system, and WTP. To be an operator in this department, an individual must have and maintain current wastewater and water operator certifications with the State of California. Additionally, because the WWTP is a Class IV wastewater treatment plant, the designated Chief Plant Operator (CPO) must possess a valid operator certificate of a grade at least equivalent to the class of the plant operated per Section 3680, Chapter 26, Title 23 of the California Code of Regulations (CCR) (see Appendix U). In addition, 50 percent of the operators shall possess at least Grade II certificates or operator in training (OIT) certificates at the Grade II or higher level.

Staff for W&S is listed below along with specific wastewater treatment plant operator grade:

1. Garett Walker, Senior Supervisor Water/Wastewater Treatment, Grade IV
2. Russ Albert, Plant Operator, Grade III
3. Chris O'Flinn, Plant Operator, Grade III
4. John Souza, Plant Operator, OIT
5. Michael Kennedy, Plant Operator, Grade II
6. Michael Scadden, Plant Operator, Grade II

c. Operational Issues with Current Structure

Issues with the current operational structure for management of the wastewater facilities include:

1. The various responsibilities of Public Works often result in a shortage of staff when emergencies arise.

2. Dual certified operators (wastewater treatment and water treatment) are required for W&S which limits the number of qualified applicants who can be hired by the City.

3. The current operational structure for W&S appears to be deficient in meeting the requirements of the State of California for designation of a person as a CPO. Further discussion of this requirement is found in Section 9.3.

4. The separation of the management of the wastewater collection system and WWTP hinders coordination of interrelated work between the two groups.

9.2 Comparison to Similar Sized Communities

To assist in the evaluation of the City wastewater facility operational structure, a review of other wastewater collection and treatment facility organizational structures was undertaken. Responses from nine agencies are summarized below and detailed in Appendix V. Also located

in Appendix V are organizational charts for the staffing at the eight agencies. Agencies were selected based on size or geographic service area.

a. Summary of Organizational Structures

The agencies contacted were:

1. City of Ripon
2. City of Riverbank
3. Tuolumne Utilities District (TUD)
4. City of Plymouth
5. Calaveras County Water District (CCWD)
6. East Bay Municipal Utilities District (EBMUD) – Pardee Section
7. City of Galt
8. Groveland Communities Service District (GCSD)

Responses from each agency are summarized in further detail below.

City of Ripon

The City of Ripon has a population of 14,738, with approximately 4,800 sewer connections and a wastewater treatment plant which receives an average flow of 1.0 mgd. According to the Public Works Director, the Ripon Public Works Department has a total staff of 28 and is divided into eight divisions. The Wastewater Division consists of five staff members who are responsible for maintaining the forty miles of sewers, thirty miles of storm drain lines, six wastewater pump stations, three storm water pump stations, and the wastewater treatment plant. All five of the staff members of the Wastewater Division hold a wastewater treatment operator license. Employees within Public Works assist other divisions if needed.

The wastewater treatment plant consists of 15 acres of treatment ponds and 40 acres of disposal ponds. Minimal operator time is required for observation and maintenance. The plant is permitted to treat up to 1.8 mgd of influent; current flows are 1.2 mgd. Only one full-time operator is needed to operate the plant. On average, a treatment plant operator will spend approximately two hours at the plant per day collecting samples and completing daily activities and will then support staff in other areas such as wastewater collections. Wastewater collections system maintenance is completed monthly and emergency collection system issues are rare.

Staff within the Wastewater Division report directly to the Public Works Director. The Public Works Director serves as the chief operator of the Wastewater Treatment System. This structure apparently works well with the community; however, in the future the city may be required to upgrade their treatment system which would necessitate additional staff.

City of Riverbank

The City of Riverbank has a population of approximately 23,000, with 8,000 sewer connections. The city wastewater treatment plant and collection system are operated under the Development Services Department. The sewer collection system is operated under Public Works. The wastewater treatment plant is operated under a separate division.

The wastewater treatment plant currently treats 2 mgd through a series of aerated ponds and percolation ponds. Staff consists of three operators, including the wastewater treatment plant supervisor. Staffing levels are considered minimum because of the size of the facility and equipment inventory. In the past, the wastewater treatment plant operated with only two operators, but relieving vacation, holidays, and sick times proved problematic. Currently, the three operators on staff provide coverage for vacations, sick days, and on-call rotations. Ideally, an additional operator would add a degree of cushion, but at this time the city does not plan to budget for any additional staff. All three operators hold multiple certifications in areas such as water treatment, collections, and pesticide application (useful for weed abatement at the wastewater treatment plant).

Public Works is responsible for the maintenance of 100 miles of sewers, nine storm basins, several wastewater lift stations, streets, and the storm drain system. Public Works has a total staff of seven, including the Public Works Supervisor. The city has an aggressive maintenance schedule and has routine cleaning schedules for all the sewer mains.

Tuolumne Utilities District (TUD)

TUD is a water and wastewater utility serving nearly 44,000 residents in the cities of Sonora, Twain Harte, Columbia, and a portion of Jamestown within Tuolumne County. The TUD wastewater system serves approximately 12,030 single family equivalent sewer connections and treats a combined wastewater flow of 1.8 mgd.

TUD operates the Sonora Regional Wastewater Treatment Facility and the Twain Harte Wastewater Treatment Plant. Each facility treats a daily flow of 1.6 mgd and 0.15 mgd, respectively. TUD maintains approximately 140 miles of gravity feed and force main sewer lines and 29 lift stations throughout the service area. The collection system spans a 27 mile radius. Wastewater collection and treatment operate under one group within the Operations Division. The Wastewater Superintendent is responsible for the TUD wastewater treatment system and collection system operations.

The Wastewater Superintendent has a staff of eight. There are three wastewater treatment plant operators that oversee the Sonora Regional Wastewater Treatment Facility and Twain Harte Wastewater Treatment Plant. There is seven-day coverage of the wastewater treatment plants with overlaps in the middle of the week for routine maintenance procedures. There are five

maintenance workers that oversee the collection system and lift stations. Regular maintenance activities include cleaning and monitoring of the facilities.

Management of the Operations Division is as follows:

1. The plant operators and collection system teams have their daily duties and routines and report to the Wastewater Superintendent/Chief Operator.

2. The Wastewater Superintendent/Chief Operator oversees treatment and collection teams and has daily regulatory compliance duties. The Wastewater Superintendent/Chief Operator reports to the Operations Manager.

3. The Operations Manager oversees wastewater, water, maintenance/construction, and raw water distribution and reports to the General Manager.

Any required construction maintenance activities, such as cutting through asphalt for a sewer line repair, is accomplished by the Maintenance/Construction Department, which has separate teams for wastewater and water.

Overall, the Wastewater Superintendent considers that the operation is efficient and that staffing levels are optimum. The staff maintains contact with other departments as well as outside districts to improve services in the general area.

City of Plymouth

The City of Plymouth serves a population of 1,000, with approximately 550 sewer connections. The City has approximately seven miles of sewer lines and an aerated-pond type wastewater treatment plant which receives an average daily flow is 0.14 mgd. The Public Works department is responsible for the wastewater collection facilities, wastewater treatment plant, water distribution facilities, streets, and parks and recreation.

There is minimal full time staff within the Public Works department. The Public Works Director works half time. Two full-time and one part-time maintenance worker are responsible for the maintenance of the wastewater collection system, water distribution system, streets, and buildings, with the approximate equivalent of 1.5 full-time equivalent (FTE) workers assigned specifically to the collection system. The wastewater treatment plant has one full time operator and two part-time operators.

Considering the size and area, staffing is sufficient for the current responsibilities. An additional maintenance worker would be useful when other areas such as water distribution need more support; however, additional staffing is not being considered at this time.

Calaveras County Water District (CCWD)

CCWD serves a population of 12,586, with approximately 4,609 sewer connections within their district. CCWD owns and operates wastewater collection and treatment facilities, water distribution and treatment facilities, and hydroelectric facilities. The CCWD service area includes the communities of Arnold, Copperopolis, West Point, Jenny Lind, and Sheep Ranch and consists of a collection system of approximately 100 miles of gravity lines, 30 miles of force mains, 1,670 maintenance manholes, and 49 lift stations.

CCWD operates twelve wastewater treatment plants, with flows ranging from 15,000 to 100,000 gpd. Wastewater treatment and water treatment facilities are operated under the Water and Wastewater Operations division. A senior supervisor for the Water and Wastewater Operations division oversees the wastewater treatment and water treatment operators. There are approximately eight plant operators and two journey level operators that are equally divided into water and wastewater treatment. Some of the operators are certified in both water and wastewater treatment; however, their duties are only within one area. The two journey level operators are training for their certification in wastewater and water treatment.

The Distribution and Collections division maintains and operates the water distribution and wastewater collection systems. A senior supervisor for the Distribution and Collections division oversees the distribution and collection systems staff. There are six distribution workers, three meter readers, five collection system workers, and two mechanics.

East Bay Municipal Utilities District (EBMUD) – Pardee Section

The EBMUD, Pardee Section (Pardee Section), oversees wastewater and water service for the Pardee Lake Recreation Area, Pardee Center, Camanche South Shore Recreation Area, and Camanche North Shore Recreation Area located in Amador County. The areas include approximately 761 equivalent sewer connections which are used on a seasonal basis. Sewer connections include residential, campground restrooms, and RV facility hookups.

A total of four wastewater treatment plants, four water treatment plants, eleven sewer lift stations, 25 miles of gravity sewers, and three miles of force mains are managed by the Pardee Section. The Camanche North Shore wastewater treatment plant is a 0.20 mgd facultative pond system. The Camanche South Shore wastewater treatment plant has a capacity of 0.70 mgd and is a package secondary treatment system with sprayfield disposal. Pardee Recreational Area also has sprayfield disposal.

The Assistant Superintendent at Pardee Center oversees operations of the wastewater treatment plants, water treatment plants, collection systems, and hydroelectric and water transmission lines at Pardee Lake. The Assistant Superintendent reports to the Pardee Area Superintendent. The Pardee Section has a total staff of 17 operators and maintenance crew for the facilities in the area (five operators and twelve maintenance specialists). The Water Quality Control Supervisor is

responsible for the day to day operations of the collection system, wastewater treatment facilities, and water treatment facilities, as well as certain maintenance efforts for the raw water transmission line.

There are a total of five operators that are simultaneously certified in wastewater treatment, water treatment, and water distribution. These five operators share duties in wastewater and water treatment weekly. Staff estimates their time at approximately 60% in water treatment operations and 40% in wastewater treatment operations.

There are a total of twelve maintenance specialists that oversee collection issues and conduct preventative maintenance on the collection system, wastewater treatment plants, water treatment plants, and hydropower facilities. Four of the maintenance specialists are designated specifically to wastewater operations. According to the Water Quality Control Supervisor, operations run smoothly with this organizational structure.

City of Galt

The City of Galt serves a population of 24,000, with approximately 7,200 sewer connections. Wastewater collection and wastewater treatment operate under separate divisions. Wastewater collections operation is under the Streets Division and wastewater treatment is operated under the Utilities Division. There are approximately 78 miles of sewers and a recently upgraded tertiary treatment plant with UV disinfection maintained by the City of Galt. The wastewater treatment plant is designed for a capacity is 3.0 mgd, with a current daily flow of 2.4 mgd. Both the Streets Division and Utilities Division report to the Public Works Director.

The Streets Superintendent oversees the Streets Division. The Streets Division is responsible for the O&M of streets, storm drainage facilities, water distribution system maintenance and repair, and wastewater collection system maintenance and repair. Typical functions are street sweeping, street patching, street sign maintenance (replacement), catch basin repair, storm drain repair, drainage ditch maintenance and repair, water service replacement and repair, and wastewater mainline cleaning and repair. Collection system issues are identified for quarterly cleaning.

A senior field supervisor who reports to the Streets Superintendent oversees the wastewater collection, water distribution, and storm drain systems. There is a staff of thirteen that are responsible for maintenance of the streets, collection system, distribution system, storm drains, signs and markings, and buildings. Typically, there is a two-man crew assigned daily to each of the six areas with adjustments as needed.

The Utilities Superintendent oversees the Utilities Division. The Utilities Division is responsible for the O&M of the wastewater treatment plant and reclamation facility, thirteen collection system lift stations, drinking water wells, and drinking water treatment systems. Treated wastewater is reclaimed for irrigation of crops during the dry season of May through October and discharged to Laguna Creek during the wet season of November through April. The Utilities

Division is divided into Wastewater Services and Water Services sections. A wastewater plant supervisor oversees the Wastewater Services section. In addition to the wastewater plant supervisor, the Wastewater Services section has five operators and two maintenance workers. The city is actively pursuing a dual certification program with the majority of operators to be dual certified in wastewater and water treatment within the next six months.

Groveland Community Services District (GCSD)

GCSD serves a population of 3,400. GCSD currently has approximately 1,600 sewer connections and manages 35 miles of gravity sewer lines, seven miles of force mains, 16 lift stations, and a wastewater treatment plant. GCSD also manages a water treatment and distribution system. The wastewater treatment plant has a permitted capacity of 0.4 mgd with an ADWF of 0.16 mgd. The plant is an activated sludge plant with tertiary treatment capabilities. Treated effluent is disposed of on sprayfields and conveyed to the Pine Mountain Lake Golf Course.

The water and wastewater systems are managed under the O&M department. The O&M Manager overseas the Treatment section and Collections and Distribution section. The Collections and Distribution section consists of the systems supervisor, the Maintenance Mechanical Systems group, and the Collection/Distribution Systems group. The total size of the Collections and Distribution section is a staff of eight, including the systems supervisor. Within the section, are two maintenance mechanics (under the Maintenance Mechanical Systems group) and five collection/distribution operators (under the Collection/Distributions Systems group). Staff in the Collection/Distribution Systems group is dual certified in water distribution and wastewater collection. Staff in the Collections and Distribution section allocates approximately 45 percent of their time to the distribution system, 45 percent to the collection system, and 10 percent to ground maintenance and maintaining one park.

The Treatment section is responsible for the operation of the water treatment plant and wastewater treatment plant. An operations supervisor/CPO oversees the Water/Wastewater Treatment Operations group. The Treatment section has a staff of six, including the operations supervisor/CPO. One operator is stationed at the wastewater treatment full time, three operators are stationed at the water treatment plant, and the remaining operator is responsible for miscellaneous duties such as checking on spray fields, golf course irrigation, and delivering samples to the main office for outside laboratory testing. One operator is on-call for both systems, on a rotational basis.

This organizational system apparently works well. Currently the staffing levels are good and seasonal staff have not been needed for the past two years. Because the Treatment section group has several operators that are certified in wastewater collection and water distribution, staff from the Treatment section have been able to assist the Collections and Distribution section when needed.

b. Trends in Organizational Structures

Tables 9-1 and 9-2 summarize characteristics of the wastewater collection system and wastewater treatment organizational structures for the eight agencies contacted. For agencies that have a department with shared responsibilities (i.e., staff are responsible for other areas in addition to wastewater collection or treatment), the staff FTE dedicated to wastewater collection or wastewater treatment was approximated based on analysis of typical responsibilities. Tables 9-1 and 9-2 are provided for comparison purposes only. Operational needs vary depending on the type of treatment process, level of treatment, type of disposal, and other system characteristics. In particular, different treatment technologies require varying levels of operational attention. The treatment process at the City WWTP is one of the more labor intensive treatment trains and would be expected to require more operator attention for maintaining such processes as the flow equalization facilities, SBRs, and UV system. Additionally, the terrain and layout of the collection system present challenges which may also warrant more collection system staff than other agencies.

TABLE 9-1
CITY OF ANGELS WASTEWATER MASTER PLAN
CHARACTERISTICS OF AGENCY WASTEWATER COLLECTIONS ORGANIZATIONAL STRUCTURES[a]

Community	No. of Sewer Connections	Miles of Sewer	Wastewater Pump Stations	Are Wastewater Collections and Treatment Managed Together?	Do Collections Staff have Responsibilities Not Related to Wastewater?	No. of Staff Dedicated to Wastewater Collection (FTE)[b]	Wastewater Collections Staff per Length of Sewer (FTE/mile of Sewer)	Wastewater Collections Staff per Wastewater Pump Station (FTE/pump Station)
City of Angels	1,600	22.5	6	No	Yes	2	0.088	0.33
City of Ripon	4,800	40	6	Yes	No	3	0.075	0.50
City of Riverbank	8,000	100	9	No	Yes	2.8	0.028	0.31
TUD	12,030	140	29	Yes	No	5.5	0.039	0.19
City of Plymouth	550	7	0	No	Yes	1.5	0.214	0
CCWD	4,609	130	49	No	Yes	5.5	0.042	0.11
EBMUD – Pardee Section[c]	761	28	11	Yes	Yes	4	0.143	0.36
City of Galt	7,200	78	12	No	Yes	2	0.026	0.17
GCSD	1,600	35	16	No	Yes	3.6	0.103	0.23

[a] Information provided in table is for comparison purposes only. Different treatment technologies require varying levels of operational attention. Operational needs vary depending on the type of treatment process, level of treatment, type of disposal, and other system characteristics.

[b] FTE = Full time equivalent. Includes direct supervisors.

[c] East Bay Municipal Utilities District - Pardee Center is a seasonal facility with certain recreational areas closed November through March.

TABLE 9-2
CITY OF ANGELS WASTEWATER MASTER PLAN
CHARACTERISTICS OF AGENCY WASTEWATER TREATMENT ORGANIZATIONAL STRUCTURES[a]

Community	Average Daily Flow to Wastewater Treatment Plant(s) (mgd)	Level of Treatment	Disposal System	Class of Wastewater Treatment Plant(s)	Do Treatment Staff have Responsibilities Not Related to Wastewater?	Are Staff Required to be Dual Certified?[b]	No. of Staff Dedicated to Wastewater Treatment (FTE)[c]	Wastewater Treatment Plant Staff per Wastewater Flow (FTE/mgd)
City of Angels	0.36	Tertiary	Sprayfield/Surface discharge	IV	Yes	Yes	3.6[e]	10
City of Ripon	1.2	Secondary	Percolation	II	No	No	1	1.0
City of Riverbank	2.0	Secondary	Percolation	III	No	No	3	1.5
TUD	1.8	Varies	Varies	II and III	No	No	3.5	2.0
City of Plymouth	0.14	Secondary	Sprayfield	I	Yes	No	1.8	12.5
CCWD	Not available	Varies	Varies	Not available	Yes	No	5.5	-
EBMUD - Pardee Section[d]	1.3	Secondary	Varies	I and II	Yes	Yes	2	1.5
City of Galt	2.4	Tertiary	Irrigation/Surface discharge	IV	Yes	No	8	3.3
GCSD	0.16	Secondary	Sprayfield	II	Yes	Yes	2	12.5

[a] Information provided in table is for comparison purposes only. Different treatment technologies require varying levels of operational attention. Operational needs vary depending on the type of treatment process, level of treatment, type of disposal, and other system characteristics.
[b] Dual certified = certified in water treatment and wastewater treatment.
[c] FTE = Full time equivalent. Includes direct supervisors.
[d] East Bay Municipal Utilities District - Pardee Center is a seasonal facility with certain recreational areas closed November through March.
[e] FTE estimate from Angels Camp Water Audit [34].

The responses from the eight agencies contacted indicate the following:

1. Organizational structures for wastewater management vary. The structures for the agencies contacted aligned within the following categories:

    a. Wastewater treatment and collections under one group/division (City of Ripon, TUD)

    b. Wastewater treatment and collections under separate groups with collections staff also responsible for one or more other tasks such as park maintenance, street sweeping and maintenance, assistance with city events, water distribution, and storm drain maintenance (City of Riverbank, City of Plymouth, CCWD, GCSD, City of Galt, EBMUD)

2. Most agencies had staff designated specifically for water treatment or wastewater treatment. Only two of the eight agencies (GCSD, EBMUD) contacted had shared water treatment and wastewater treatment duties, similar to the City structure.

3. Most of the agencies contacted had a supervisor assigned for overseeing collections staff who was not involved in regular field work and/or a director/supervisor who reports to the city administrator (such as a Public Works Director).

4. Staffing ratios for the operation of wastewater collection systems (in terms of the ratio of FTE/mile of sewer) is approximately 0.088 for the City, as compared to ratios ranging from 0.026 to 0.214 for the other agencies contacted. Agencies with higher ratios (GCSD, EBMUD, City of Plymouth) have more staff per mile of sewer and had the same or less sewer connections.

5. Staffing ratios for the operation of wastewater treatment systems (in terms of the ratio of FTE/mgd wastewater flow) is approximately 10 for the City, as compared to ratios ranging from 1.0 to 12.5 for the other agencies contacted. Agencies with higher ratios (GCSD, City of Plymouth) have more staff per wastewater flow and receive less wastewater than the City.

9.3 Regulatory Requirements Associated with Operation of Wastewater Facilities

State of California regulations pertaining to the classification of wastewater treatment plants and operator certification are found in Sections 3670-3719.19, Chapter 26, Title 23 of the CCR (see Appendix U). The SWRCB Office of Operator Certification (OOC) is responsible for ensuring that wastewater treatment plants operate in accordance to these regulations. A newsletter is published regularly by the OCC containing articles of interest to certified operators and highlights enforcement actions taken throughout the State. Copies of several newsletters are provided in Appendix W.

The regulations include definitions and requirements for the grade classification of operators of wastewater treatment plants. The following position definitions are contained in the regulations:

1. Chief Plant Operator: a Supervisor who is certified as an Operator and who is responsible for the overall operation of a wastewater treatment plant.

2. Operator: any person operating a wastewater treatment plant and who occupies a position and performs duties for which the OOC requires an Operator certificate.

3. Operator-in-Training: any person who operates a wastewater treatment plant under the direct supervision of a certified Operator while gaining experience to qualify for an Operator certificate.

4. Shift Supervisor: a certified Operator who oversees and directs the operation or a phase of the operation of a wastewater treatment plant during a specific work period and who reports to a Supervisor or a Chief Plant Operator.

5. Supervisor: a certified Operator who oversees and directs the operation of a wastewater treatment plant during a specific work period and who reports to a Chief Plant Operator.

The position of particular responsibility is the CPO. According to the definition of a CPO, the CPO is responsible for the overall operation of the wastewater treatment plant. Under this definition and as described in the OOC newsletters, CPO responsibilities include the achievement of the goals of the SWRCB certification program, such as signing documents for examinations and certificates for operators working under the CPO. Because of the importance of the position, Section 3676, Chapter 26, Title 23 of the CCR requires that agencies notify the OOC in writing within 30 calendar days of a change in the employment of the person designated as the CPO.

9.4 Conclusions

From this review of organizational structures for other communities and regulatory requirements, the following conclusions for addressing existing issues with the current City operation structure are offered:

1. Shortage of Public Works staff during emergencies could be addressed by the addition of staff or assistance from other departments. Higher FTE/mile of sewer ratios for other agencies of similar size or less offer support for the addition of staff.

2. Specifically assigning operators to water treatment or wastewater treatment would eliminate the need for dual certified operators. Most of the other agencies contacted had separate staff for each type of treatment.

3. A review of regulatory requirements indicates that a CPO must be designated for the WWTP and that there are specific responsibilities for the CPO. The job description for the position to serve as the CPO should include these responsibilities.

4. Several agencies contacted had a common supervisor overseeing wastewater collections and wastewater treatment, who then reported to the City Administrator or General Manager. Addition of a supervisor for Public Works and W&S may improve overall management of the wastewater facilities for the City.

10 Recommended Improvements

Improvements for the collection system and WWTP described in Chapters 7 and 8 are assembled into recommended projects in this chapter. Additional projects previously planned by the City are also described. The recommended improvements are then prioritized considering asset management principles.

10.1 Collection System Recommended Improvements and Alternatives Considerations

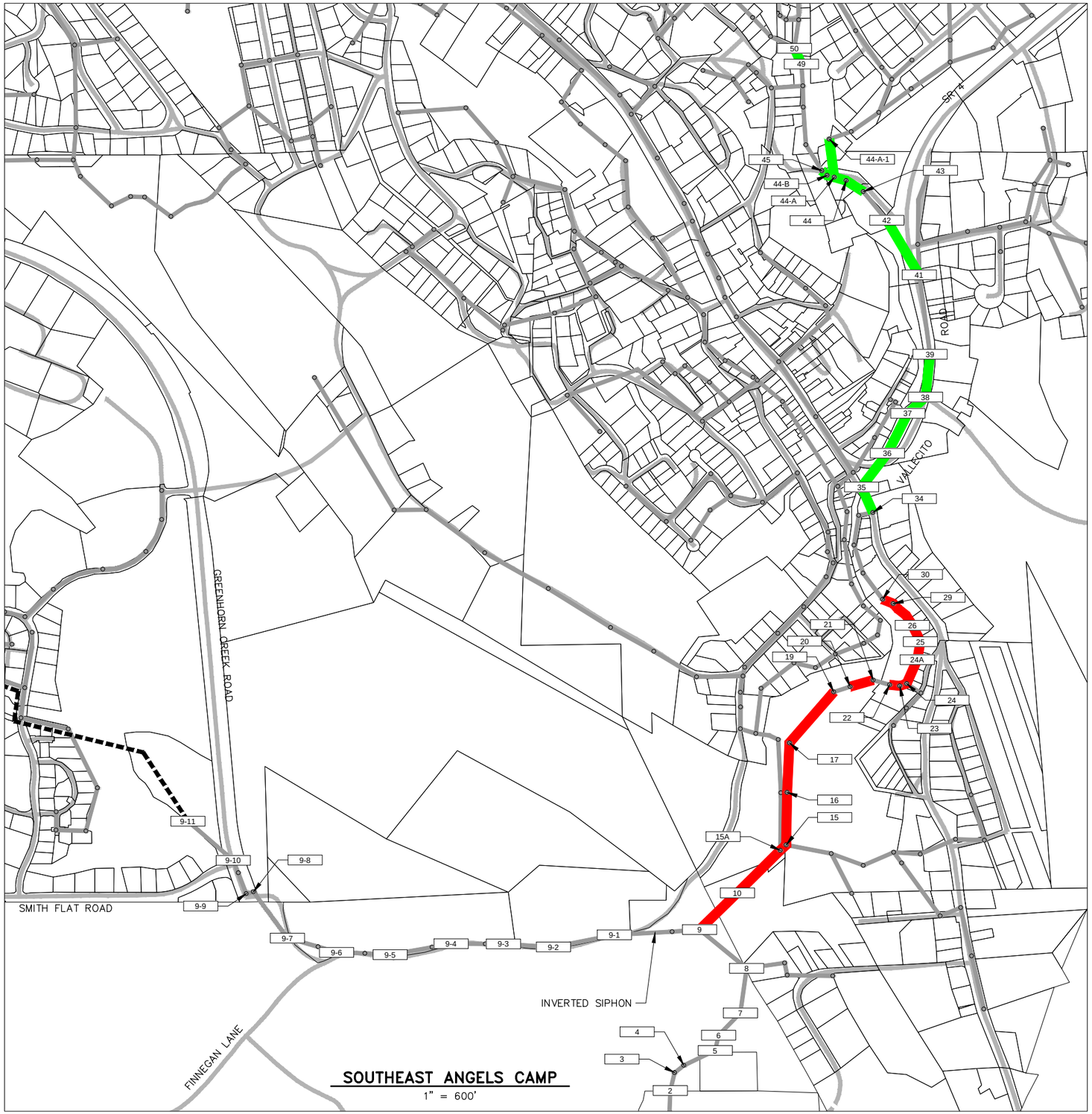
The evaluation of collection system capacity revealed several pipe segments within the network receiving flows in excess of the pipe capacity. These segments are recommended for upsizing. An alternative scenario to upsizing the pipes was conducted by reviewing potential impacts associated with an I/I reduction of 30 percent for the projected buildout flow. An I/I reduction of 30 percent was not considered as an alternative mitigating existing PWWF hydraulic deficiencies because I/I reduction measures typically require a significant effort to identify sources of I/I and to implement improvements which result in noticeable wet weather flow reductions. Addressing existing hydraulic issues is viewed as a higher priority than directing resources towards I/I reduction in the short term because of the unknown timing/magnitude of the success of reduction efforts. I/I reduction is considered a long-term objective that will reduce infrastructure sizing for buildout conditions.

The evaluation of the collection system capacity also indicated that Greenhorn Creek #1 Pump Station appears to be undersized for existing and buildout PWWF conditions. It is assumed that Greenhorn Creek #1 Pump Station will be upsized by Classics on The Ridge subdivision as part of their conditions of approval [9] and as such, will not be included in the recommended projects in this chapter.

Segments recommended for upsizing were predominately grouped into the following three phases:

- Phase 1 - segments that are at or exceed capacity of the existing PWWF scenario
- Phase 2 - segments that are at or exceed capacity of the existing PWWF and the reduced I/I Buildout PWWF scenario
- Phase 3 - segments that are at or exceed capacity of the Buildout PWWF scenario

The recommended increase in size of the pipelines under any of the phases corresponds to the size required to convey Buildout PWWF, so as to avoid the need for a second upsizing project in the future. Overall, hydraulic capacity improvements were grouped into five separate projects. Figures 10-1 through 10-3 and Table 10-1 summarize these projects.



SOUTHEAST ANGELS CAMP
1" = 600'

LEGEND

- SEWER REPLACED UNDER PHASE 1 IMPROVEMENTS - EAST TRUNK SEWER
- SEWER REPLACED UNDER PHASE 1 IMPROVEMENTS - VALLECITO ROAD
- EXISTING SEWER WITH SUFFICIENT CAPACITY
- FORCE MAIN
- EXISTING PUMP STATION
- 15-1-1 MANHOLE 15-1-1

N

0 300 600
1" = 600'

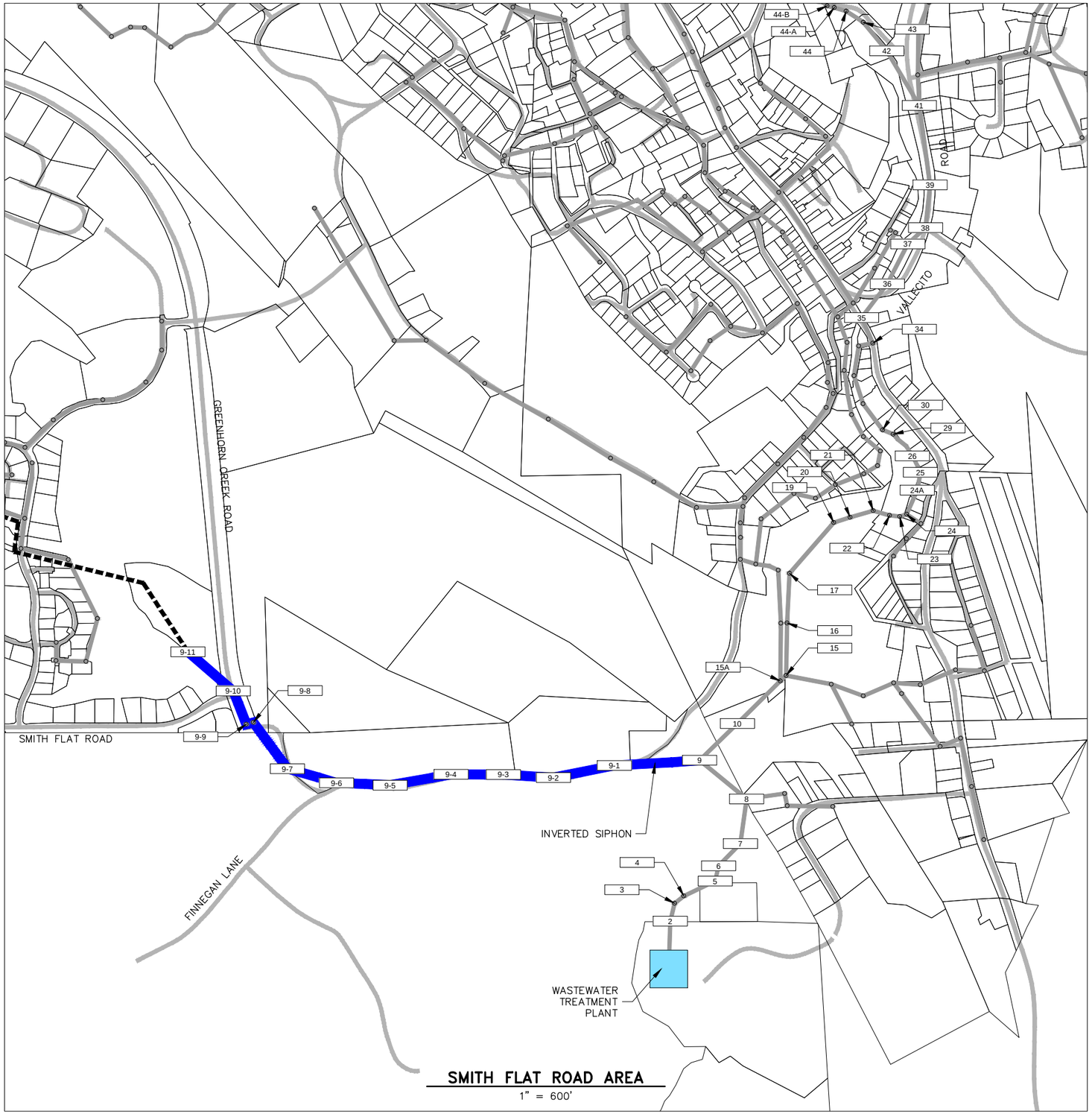
FIGURE 10-1

CITY OF ANGELS
WASTEWATER MASTER PLAN

CAPITAL IMPROVEMENT PLAN
HYDRAULIC CAPACITY IMPROVEMENTS - PHASE 1

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch10\Figure 10-1 Phase 1 Improvement.dwg JCP 3/5/2012



LEGEND

- SEWER REPLACED UNDER PHASE 2 IMPROVEMENTS - WEST TRUNK SEWER
- EXISTING SEWER WITH SUFFICIENT CAPACITY
- FORCE MAIN
- EXISTING PUMP STATION
- 15-1-1 MANHOLE 15-1-1

N

0 300 600

1" = 600'

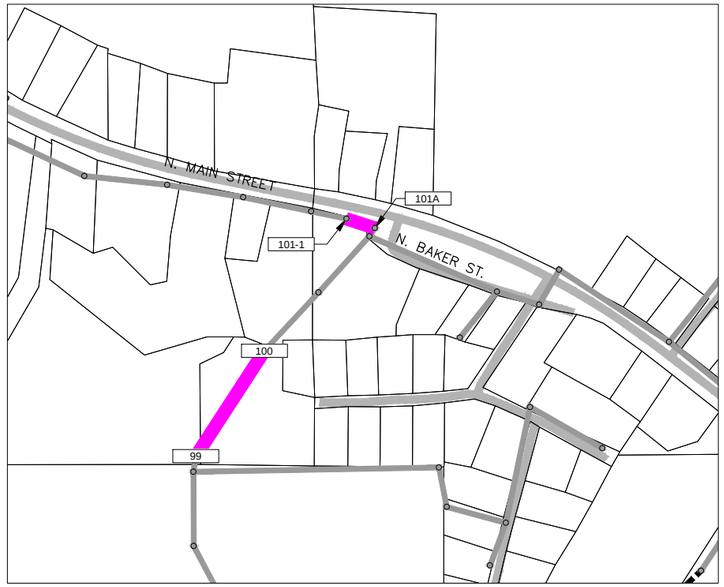
FIGURE 10-2

CITY OF ANGELS
WASTEWATER MASTER PLAN

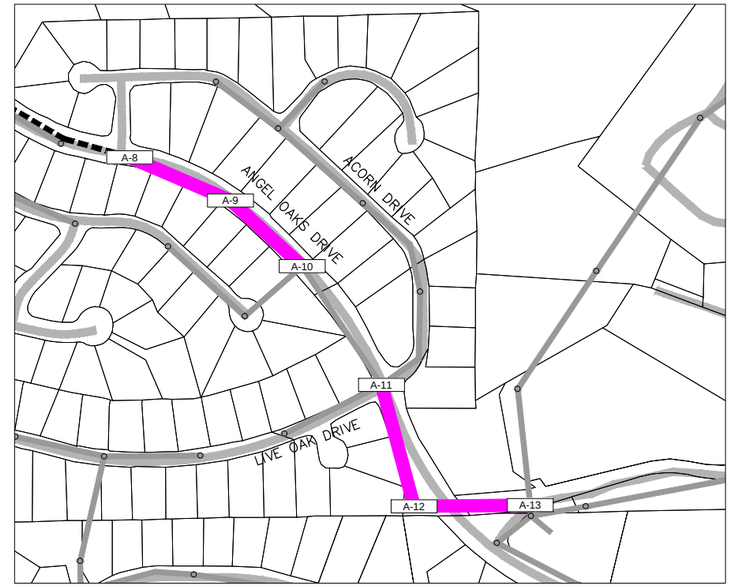
CAPITAL IMPROVEMENT PLAN
HYDRAULIC CAPACITY IMPROVEMENTS - PHASE 2

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

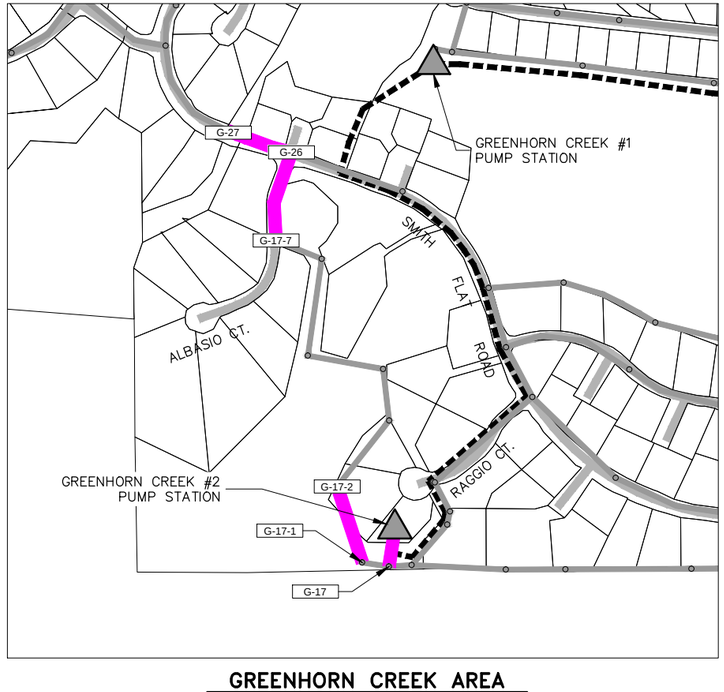
N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch10\Figure 10-2 Phase 2 Improvement.dwg JCP 3/5/2012



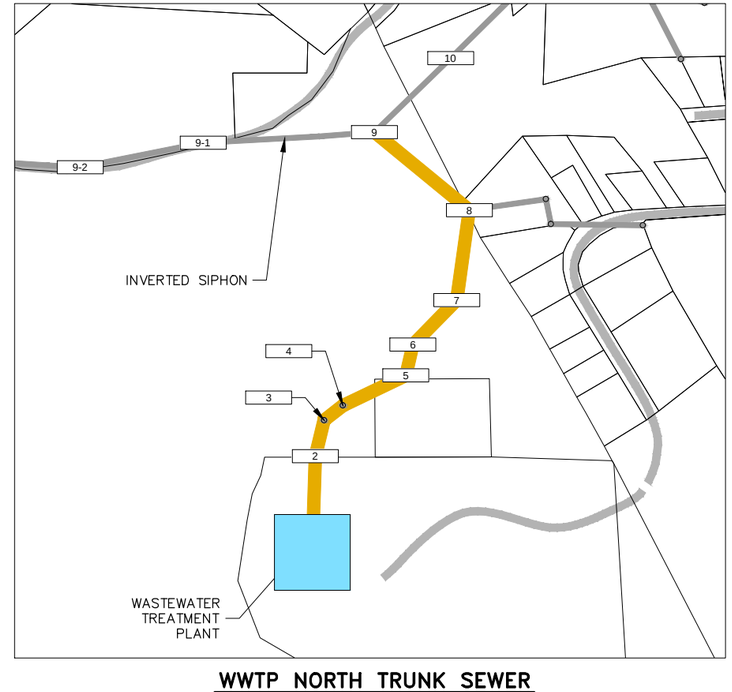
NORTH MAIN STREET AREA
1" = 400'



ANGEL OAKS DRIVE AREA
1" = 400'



GREENHORN CREEK AREA
1" = 400'



WWTP NORTH TRUNK SEWER
1" = 400'

LEGEND

- SEWER REPLACED UNDER PHASE 3 IMPROVEMENTS - WWTP NORTH TRUNK SEWER
- SEWER REPLACED UNDER PHASE 3 IMPROVEMENTS - MAIN STREET, ANGEL OAKS DRIVE, AND GREENHORN CREEK AREA
- EXISTING SEWER WITH SUFFICIENT CAPACITY
- FORCE MAIN
- EXISTING PUMP STATION
- 15-1-1 MANHOLE 15-1-1

N

0 200 400
1" = 400'

FIGURE 10-3

CITY OF ANGELS
WASTEWATER MASTER PLAN

CAPITAL IMPROVEMENT PLAN
HYDRAULIC CAPACITY IMPROVEMENTS - PHASE 3

NOLTE VERTICALFIVE
NOLTE ASSOCIATES, INC.

N:\MTB020400\Cadd\ET_WW Master Plan\final\Ch10\Figure 10-3 Phase 3 Improvements.dwg JCP 3/5/2012

TABLE 10-1
CITY OF ANGELS WASTEWATER MASTER PLAN
RECOMMENDED COLLECTION SYSTEM HYDRAULIC CAPACITY IMPROVEMENTS

Improvement Phase	Project Description	Pipe Segments Included in Project
Phase 1 – Mitigation of Existing Surcharged Sewers	East Trunk Sewer	From Manhole 30 to Manhole 9
	Vallecito Road	From Manhole 50 to Manhole 34
Phase 2 – Mitigation of Buildout Surcharged Sewers with reduced I/I	West Trunk Sewer	Manhole 9-11 to Manhole 9
Phase 3 – Mitigation of Buildout Surcharged Sewers	WWTP North Trunk Sewer	Manhole 9 to WWTP
	Main Street, Angel Oaks Drive, Greenhorn Creek area	Manhole 101-1 to Manhole 101-A
		Manhole 100 to Manhole 99
		Manhole A-8 to Manhole A-10
		Manhole A-11 to Manhole A-13
		Manhole G-27 to Manhole G-17-7
		Manhole G-17 to Greenhorn Creek #2 Pump Station

To also address I/I, as well as further refine these projects, two additional types of assignments are recommended:

1. As discussed in Chapters 6 and 8, a flow monitoring study will provide useful data for further calibration of the hydraulic model and potential identification of areas with high I/I. Additionally, the flow monitoring study could include recommendations for addressing discrepancies between the observed flows at the WWTP and the City 2010 Improvement Standards [4] for wastewater generation. Although the analyses included in Chapters 6 and 8 regarding WGFs and I/I allowances were conducted for the purpose of developing inputs for the hydraulic model, the results indicate that further investigation of the City 2010 Improvement Standards [4] for wastewater design flow may be warranted. City 2010 Improvement Standards include the use of an average flow of 100 gpcd or 350 gpd/du for design of sewers with peak flows calculated using the factors from the peaking factor curve (City 2010 Improvement Standards Drawing SS-7 [4]). The peaking factor curve includes peaking factors ranging from 4.0 to 2.5 (approximately), with the peaking factor diminishing as average daily project flows increase. Peaking factors observed at the WWTP have been significantly higher (a peak flow of 2.89 mgd was observed at the WWTP in March 2011, as compared to a 2009-2011 averaged WWTP ADWF of 0.357 mgd, results in a peaking factor of 8.1). Additionally, the 2009-2011 averaged WWTP ADWF indicates that average dry weather flow contributions are lower than 350 gpd/du.

2. As mentioned in Chapter 3, the City regularly schedules CCTV inspections of sewer lines. These inspections have resulted in the identification of several lines with significant defects (such as cracks or breaks). These lines will be scheduled for repair as part of regular proposed improvement projects. In addition to maintaining the condition of the collection system, these improvement projects will also assist with reducing I/I. Because the CCTV work is ongoing, it is assumed in this Master Plan that rehabilitation projects resulting from the inspections would be regularly scheduled every other year. Based on the current results, a length of 2,500 lf of pipe, with an average diameter of 8 inches, and a depth of 5-10 ft was assumed for replacement/rehabilitation every other year.

10.2 Wastewater Treatment Plant Recommended Improvements and Alternatives Considerations

Although the evaluation of the wastewater treatment, storage, and disposal facilities revealed that the majority of the process facilities at the treatment plant have sufficient capacity to accommodate 10-year and 20-year flow projections, several improvements to address existing operational difficulties, regulatory concerns, and aging facilities are recommended. These improvement projects are summarized in Table 10-2.

TABLE 10-2
CITY OF ANGELS WASTEWATER MASTER PLAN
RECOMMENDED WASTEWATER TREATMENT, STORAGE, AND DISPOSAL FACILITY IMPROVEMENTS

Improvement Project	Project Description
Grit Chamber at Headworks	Construction of a grit chamber at the headworks.
Pre-Filter Turbidimeter	Installation of a pre-filter turbidimeter to control chemical addition or automatic bypass of filters.
Gunite Side Slopes at EQ Basin	Stabilization of side slopes by gunite at the EQ basin.
Concrete Partition Walls at EQ Basin	Mitigation of short circuiting issues at the EQ basin with the addition of concrete partition walls.
Sludge Removal Facilities at EQ Basin	Construction of a concrete bottom at the EQ basin for drying and "working" of sludge.
Conversion of Existing Sludge Drying Beds to Stockpile Areas	Construction of a large covered concrete surface to stockpile biosolids (potentially to Class A standards) by adding covers to the existing sludge drying beds.
Office Building with Training Classroom	Modernization of personnel facilities including an office with a training classroom.
Influent Flow Meter and Vault	Installation of an influent flow meter for total collection system flows into the WWTP.
Sprayfield Improvements – Phase I	Rebuild of lower and upper pump house equipment and addition of SCADA.
Sprayfield Improvements – Phase II	Upgrades to the distribution system.
Sprayfield Improvements – Phase III	Grading improvements of existing roads, culverts, ditches and slide gate system.

10.3 Additional Recommended Projects

In addition to the improvement projects recommended to address the collection system and WWTP, there are several general projects which would be useful to program into the City CIP which are related to periodically assessing the wastewater facilities. These general projects include:

1. Wastewater Master Plan (or Asset Management Plan)

2. Wastewater Rate and Connection Fee Study

Wastewater Master Plans and Rate and Connection Fee Studies are updated periodically to re-assess the wastewater facilities and to ensure that adequate funding is available to meet General Plan objectives, regulatory requirements, and maintenance needs. In recent years, asset management plans have provided similar guidance as a master plan document and may be prepared in lieu of or in conjunction with a master plan document. Although a larger undertaking, asset management plans offer the advantage of better estimating costs for maintaining equipment because the plans include creation of an asset inventory and projections for remaining useful life of equipment. Ideally, these documents are prepared following each General Plan update which typically occurs every 5-10 years. This Master Plan programs updates of the Wastewater Master Plan and Rate and Connection Fee Study once every eight years.

10.4 Prioritization of Recommended Improvements

To prioritize the recommend improvements, a simplified asset management type Business Risk Exposure (BRE) method was developed. A BRE model considers the Consequence of Failure (CoF) and the Probability of Failure (PoF). Assets with high combined PoF and CoF scores are given priority for improvement. An example of the outputs from a BRE model, illustrating the method for addressing the model results, is shown in Figure 10-4.

Initial rating systems for establishing the CoF and PoF of an asset or group of assets are described in the following sections.

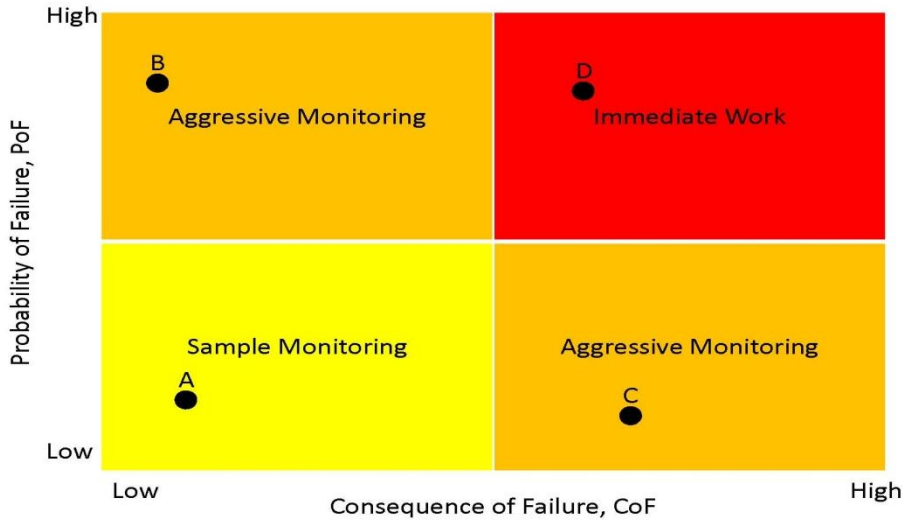


Figure 10-4 Business Risk Exposure Model

10.5 Consequence of Failure

CoF represents the consequence of failure and is one of the two metrics which were used for determining the priority of improvement projects. High CoF ratings reflect assets which have a higher consequence of failure; for example, assets which serve a large number of customers or which have a higher potential for adversely affecting the environment if they failed.

The following factors were used for rating the CoF of an improvement project.

1. Wastewater flow conveyed or processed – This factor is related to maintaining wastewater service to the largest number of customers by correlating wastewater flow to the number of customers served.

2. Potential monetary and social costs of failure – This factor considers the potential monetary and social costs associated with failure of the asset or group of assets included in an improvement project.

3. Environmental Impact – This factor considers the environmental impact that failure of the asset or group of assets included in an improvement project may have. For example, if an element is located near a water body such as Angels Creek, a drainage channel, stream, or wetland, a SSO or discharge of partially treated wastewater would be more challenging to contain and could have a more significant impact on the environment than if the discharge occurred in an isolated area.

4. Ease of Repair – This factor relates to construction constraints which could adversely impact the City's ability to repair the asset or group of assets within an improvement

project. A rating for this factor is assigned to assets which are located in easements, along streets or intersections with high traffic volume, have critical crossings with flood control channels or streets, or are near major or critical utilities.

A rating for each of the above four factors was assigned to each improvement project. Rating values for each category are shown in Table 10-3 below. The resultant CoF score will influence priorities by focusing activities on the assets with the highest consequence of failure.

TABLE 10-3
CITY OF ANGELS WASTEWATER MASTER PLAN
CONSEQUENCE OF FAILURE FACTORS

Category	Description	Rating
Wastewater flow conveyed or processed	Conveys more than 80% of the total City flow	5
	Conveys between 40-80% of the total City flow	3
	Conveys less than 40% of the total City flow	1
Potential monetary and social costs for failure	Failure would be costly to the City and would result in regulatory fines if not done expeditiously	5
	Failure of asset(s) would be more than cost for a planned repair, but would not result in regulatory fines	3
	Failure of asset(s) would be a minor burden to the City or the community	1
	Improvement project adds a new element to the wastewater system, therefore no costs are associated with failure of asset(s)	0
Environmental Impact	Improvement project is located near a river or creek	5
	Improvement project is located near a drainage channel, stream, or wetland	3
	Improvement project is not located near a river, creek, drainage channel, stream, or wetland	0
Ease of Repair	Flood control channel or creek crossing nearby which would make repairs difficult	5
	Improvement project is located along a major traffic thoroughfare	5
	Major buried utilities are in the area of the improvement project	3
	Major overhead utilities are in the area of the improvement project	1
	Improvement project is located outside of Right of Way (e.g. private property with no easement)	1
	Improvement project is located within public Right of Way with no major utility conflicts	0

The individual ratings are summed to determine an overall CoF rating for the assets affected by each improvement project. The maximum total CoF rating is 20.

10.6 Probability of Failure

The PoF is an estimate on when an asset or group of assets may fail with regard to the function of the asset or group of assets. Although PoF cannot be determined with certainty, PoF can be estimated based on various sources such as industry standards, age, condition assessment data, O&M records, and condition assessment records. In the case of this Master Plan, PoF factors were developed to determine the degree to which a potential "failure mode" would be addressed by an improvement project. The rating system considers hydraulic capacity, regulatory compliance, safety, and O&M requirements and is presented in Table 10-4. Other PoF factors may be developed or used in the future to re-evaluate the prioritization of improvement projects. Unlike the CoF factors which were additive, the PoF factor assigned to a particular asset will be the highest categorical rating assigned. The category with the highest rating indicates the likeliest mode of failure for an asset. The highest PoF rating is 20, corresponding to the highest CoF factor which can be assigned.

TABLE 10-4
CITY OF ANGELS WASTEWATER MASTER PLAN
PROBABILITY OF FAILURE FACTORS

Category	Description	Rating
Hydraulic/ Treatment Capacity	Improvement project does not address hydraulic or treatment capacity issues	0
	Improvement project is needed to address buildout PWWF hydraulic or treatment deficiency	2
	Improvement project is needed to address reduced I/I buildout PWWF hydraulic or treatment deficiency	5
	Improvement project addresses an existing PWWF hydraulic or treatment deficiency	15
	Improvement project is needed to address critical existing PWWF hydraulic or treatment deficiency (such as surcharging or manholes with water level within 1 ft of manhole rim)	20
Regulatory Compliance	Improvement not required based on existing regulations	0
	Improvement anticipated to be required based on known potential upcoming regulations	10
	Improvement required to meet existing regulatory requirements	20
Safety	Improvement is not related to safety issues	0
	Improvement will improve safety for staff	10
	Improvement addresses a critical safety issue	20
O&M Requirements	Improvement project does not address an O&M issue	0
	Improvement project will result in reduced O&M requirements	10
	Improvement project addresses a critical or time consuming O&M issue	20

10.7 Business Risk Exposure Analysis and Results

Once CoF and PoF scores were assigned, the product of the two scores was used to formulate the BRE score associated with an improvement project. Projects with the highest BRE score will be those which present the greatest benefit to the City. The CoF, PoF, and resulting BRE scores developed as part of this Master Plan are summarized in Table 10-5. A detailed breakdown of the ratings is provided in Appendix X.

Scores were not assigned to preparation of master plans and rate study documents because these documents should be prepared on a regular basis, approximately every 5-10 years.

TABLE 10-5
CITY OF ANGELS WASTEWATER MASTER PLAN
BUSINESS RISK EXPOSURE SCORES

Project Rank	Wastewater System	Improvement Project	CoF	PoF	BRE (CoF x PoF)
1	Collection System	Phase 1 – Mitigation of Existing Surcharged Sewers, Vallecito Road	16	20	320
2	Sprayfields	Sprayfield Improvements – Phase I	15	20	300
3	Sprayfields	Sprayfield Improvements – Phase II	15	20	300
4	Sprayfields	Sprayfield Improvements – Phase III	15	20	300
5	Collection System	Phase 1 – Mitigation of Existing Surcharged Sewers, East Trunk Sewer	12	20	240
6	Collection System	Flow monitoring evaluation	10	15	150
7	WWTP	Sludge Removal Facilities at EQ Basin	5	20	100
8	WWTP	Gunite Side Slopes at EQ Basin	5	20	100
9	WWTP	Conversion of Existing Sludge Drying Beds to Stockpile Areas	5	20	100
10	WWTP	Concrete Partition Walls at EQ Basin	5	20	100
11	WWTP	Pre-filter turbidimeter	5	20	100
12	Collection System	Phase 2 –Mitigation of Buildout Surcharged Sewers with reduced I/I, West Trunk Sewer	4	20	80
13	WWTP	Grit Chamber at Headworks	5	10	50
14	WWTP	Office Building with Training Classroom	5	10	50
15	Collection System	Phase 3 – Mitigation of Buildout Surcharged Sewers, WWTP North Trunk Sewer	14	2	28
16	Collection System	Phase 3 – Mitigation of Buildout Surcharged Sewers, Greenhorn Creek Area, North Main Street, Angel Oaks Drive	5	2	10
17	WWTP	Influent Flow Meter and Vault	5	0	0

11 Probable Project Costs

Project costs were developed for the recommended improvement projects. The basis for the costs are described below.

11.1 Construction Cost Accuracy

The opinions of construction costs presented in this Master Plan are based on quotations from previous projects and similar project bid results. The opinions were prepared for general planning purposes and have an expected accuracy within +50 to -30 percent, based on definitions by the Association for the Advancement of Cost Engineering (AACE). The costs are based on an Engineering News Record San Francisco Construction Cost Index of 10208 (January 2012).

11.2 Collection System Improvement Project Costs

Collection system improvement project costs are composed of construction costs, plus contingencies for engineering, construction management, and administration. As an initial step, unit costs for length of installed pipe were developed. The unit costs were separated based on pipe size and depth installed. The unit costs for pipe reflect installation and assume conventional pipe installation by means of open cut, unless otherwise noted. Capital costs may be lower if trenchless technology construction methods are employed.

a. Unit Piping Construction Costs

Costs for conventional open cut construction were separated into twelve categories. Unit costs assumed for each of these categories are presented in Table 11-1.

TABLE 11-1
CITY OF ANGELS WASTEWATER MASTER PLAN
UNIT CONSTRUCTION COSTS FOR EXCAVATION WORK

Category	Unit Cost ($)	Unit
Excavation	2	cy
Pipe Bedding	10	cy
Class IV Backfill	100	cy
Compaction	5	cy
Shoring	2	lf[c]
Pavement removal and replacement	10	sf
Installation[a]	3,000	day
Site preparation	2	lf
Utility and traffic control	5	lf
Permit compliance and public coordination	4	lf
Connections and improvements to existing structures/utilities[b]	40	lf
Protection of existing structure/utilities	4	lf

[a] Installation costs include labor and equipment (materials excluded),
[b] Unit costs for connections and improvements to existing structures/utilities includes rehabilitation of manholes, re-establishment of manhole connections, and reconstruction/reconnection of laterals.
[c] lf = lineal foot.

The unit costs for each category are based on a review of recent bid results for the City and nearby communities and other pipeline installation work. Quantities and materials assumed for the unit costs were based on the City 2010 Improvement Standards Trench Detail (SS-5) [4]. The standard trench details require Class IV slurry cement as the backfill material for roadway trenches and Class I backfill for pipe bedding material, with limits of the pipe bedding installation extending from 1 ft depth above the pipe to 6 inches below the pipe depth. City 2010 Improvement Standards [4] trench detail is included as Appendix Y.

The excavation costs were multiplied by the appropriate units based on probable trench dimensions. The assumptions used for the width and depth for a conventional open cut trench are shown in Table 11-2.

TABLE 11-2
CITY OF ANGELS WASTEWATER MASTER PLAN
ASSUMED OPEN TRENCH DIMENSIONS

Description	Trench Dimension (ft)		
	0-5 ft Depth	5-10 ft Depth	10-15 ft Depth
Trench width - added to pipe diameter	1	1	2
Trench surface width - added to pipe diameter[a]	2	2	4
Depth[b]	5.5	10.5	15.5

[a] Trench surface width used to estimate pavement removal and replacement.

[b] Depth includes an additional 6-inches for bedding in accordance with City 2010 Improvement Standards [4].

Installation costs were based on an installation rate (lf of pipe installed per day) for the diameter and depth of the pipe. Table 11-3 lists the installation rate assumptions used for developing overall pipe installation costs.

TABLE 11-3
CITY OF ANGELS WASTEWATER MASTER PLAN
ASSUMED INSTALLATION RATE

Pipe Diameter (inches)	Installation Rate (lf/day)		
	0-5 ft Depth	5-10 ft Depth	10-15 ft Depth
15 and less	225	200	150
18 through 24	200	175	125

Unit costs for piping materials are summarized in Table 11-4. Unit costs reflect quotations from local vendors in November 2011 for PVC standard dimension ratio (SDR) 35 pipe.

TABLE 11-4
CITY OF ANGELS WASTEWATER MASTER PLAN
PVC SDR 35 PIPE MATERIAL COSTS

Pipe Diameter (inches)	Cost per lf ($)
8	6
10	10
12	14
15	20
18	29
21	41
24	50

Using the unit costs for the components associated with the installation of piping described previously, total costs for piping construction were developed. These final costs are summarized in Table 11-5. A complete breakdown of pipe costs is presented in Appendix Z. These costs per lf will be used for developing construction costs for recommended collection system improvement projects including costs for connecting to structures/utilities such as manholes and laterals. Because of the system connection costs, these unit costs are noticeably higher than typical individual bid line item for installation of pipe.

TABLE 11-5
CITY OF ANGELS WASTEWATER MASTER PLAN
UNIT PIPE COSTS

Pipe Diameter (inches)	Pipe Material	Cost per lf ($)		
		0-5 ft depth	5-10 ft depth	10-15 ft depth
8	PVC	129	174	302
10	PVC	136	185	316
12	PVC	140	194	328
15	PVC	149	212	348
18	PVC	160	228	374
21	PVC	171	245	396
24	PVC	180	260	415

b. Improvement Project Costs

Using the unit piping construction costs, collection system improvement construction costs were estimated by multiplying the length of pipe included in the project with the unit cost per lf, for

piping within the appropriate size and depth category. Additionally, total construction costs include a 20 percent contingency. A 25 percent contingency for engineering, construction management, and administration was then added to the total construction cost to obtain a project cost estimate. Construction costs and project costs are summarized in Table 11-6. A more detailed breakdown for the construction costs is provided in Appendix AA.

TABLE 11-6
CITY OF ANGELS WASTEWATER MASTER PLAN
COLLECTION SYSTEM IMPROVEMENT PROJECT COSTS[a]

Improvement Project	Construction Cost[b], $	Project Cost[c], $
Flow Monitoring Study	Not Applicable	45,000
Phase 1 – Mitigation of Existing Surcharged Sewers, Vallecito Road	390,000	485,000
Phase 1 – Mitigation of Existing Surcharged Sewers, East Trunk Sewer	480,000	600,000
Phase 2 – Mitigation of Buildout Surcharged Sewers with reduced I/I, West Trunk Sewer	740,000	930,000
Phase 3 – Mitigation of Buildout Surcharged Sewers, WWTP North Trunk Sewer	290,000	360,000
Phase 3 – Mitigation of Buildout Surcharged Sewers, Main Street, Angel Oaks Drive, Greenhorn Creek area	450,000	560,000
Total	**2,350,000**	**2,980,000**

[a] Project costs for replacement/rehabilitation projects scheduled every other year are not included in table. Costs for replacement/rehabilitation projects scheduled every other year are estimated to be $522,000 (construction costs, includes 20% contingency) and $655,000 (project cost), per project.

[b] Construction costs include a 20% contingency.

[c] Project costs include a 25% contingency for engineering, construction management, and administration., except for the Flow Monitoring Study. Flow Monitoring Study is based upon a consultant fee estimate.

11.3 WWTP Improvement Project Costs

WWTP improvement project costs are composed of construction costs plus contingencies for engineering, construction management, and administration. Because of the diversity of the projects, construction cost estimates were prepared for each individual project. A detailed breakdown of the construction cost estimates are provided in Appendix BB and summarized in Table 11-7. The construction cost estimates include a 20 percent contingency. To obtain the project costs, a 25 percent contingency for engineering, construction management, and administration was added.

TABLE 11-7
CITY OF ANGELS WASTEWATER MASTER PLAN
WWTP IMPROVEMENT PROJECT COSTS

WWTP Improvement Project	Construction Cost[a], $	Project Cost[b], $
Grit Chamber at Headworks	71,000	89,000
Pre-Filter Turbidimeter	5,000	6,000
Gunite Side Slopes at EQ Basin	110,000	138,000
Concrete Partition Walls at EQ Basin	12,000	15,000
Sludge Removal Facilities at EQ Basin	468,000	585,000
Conversion of Existing Sludge Drying Beds to Stockpile Areas[c]	31,000	39,000
Office Building with Training Classroom	240,000	300,000
Influent Flow Meter and Vault	46,000	58,000
Sprayfield Improvements - Phase I	252,000	315,000
Sprayfield Improvements - Phase II	399,000	499,000
Sprayfield Improvements - Phase III	279,000	349,000
Total	1,913,000	2,393,000

[a] Construction costs include a 20% contingency, with exception of Sprayfield Improvements which include a 15% contingency based on preliminary engineer's estimate.

[b] Project costs include a 25% contingency for engineering, construction management, and administration.

[c] Construction and project costs are for the conversion of two sludge drying units into stockpile areas (each sludge drying unit consists of two 800 sf sludge drying beds).

11.4 Master Plan and Rate Study Project Costs

Project costs for preparing a wastewater master plan and wastewater rate and connection fee study were estimated based on the cost associated with preparation of this Master Plan and recent costs for similar studies for other agencies of similar size. Project costs are summarized in Table 11-8.

TABLE 11-8
CITY OF ANGELS WASTEWATER MASTER PLAN
MASTER PLAN AND RATE STUDY PROJECT COSTS

Document	Project Cost ($)
Wastewater Master Plan	100,000
Wastewater Rate and Connection Fee Study	40,000

12 Capital Improvement Plan

This chapter summarizes recommended CIP projects developed from the hydraulic and existing condition evaluations for future implementation. Projects are separated into a short term (within the next ten years) and long term (10-20 years out) plans.

12.1 Project Costs

Chapter 10 summarized recommendations regarding collection system and WWTP improvements including rationale for prioritized improvements. Collection system improvements addressed existing and projected hydraulic capacity issues and replacement/rehabilitation of sewers with deficiencies. WWTP improvements addressed regulatory issues, aging facilities, and operational difficulties. Based on the results of the analysis, short-term (from Fiscal Year (FY) 2012-2013 to FY 2021-2022) and long-term (from FY 2022-2023 to FY 2031-2032) CIP projects are presented in Tables 12-1 and 12-2. For projects which include a design component, 10 percent of the project costs were allocated to the FY prior to construction (the recommended project year) to account for costs associated with development and design of a project. As was described in Chapter 11, project costs include a 25 percent contingency for engineering, construction management, and administration.

TABLE 12-1
CITY OF ANGELS WASTEWATER MASTER PLAN
SHORT TERM CIP
FOR FY 2012-2013 THROUGH FY 2021-2022

		Project Cost Allocation, $ Fiscal Year										
Project	**Recommended Project Fiscal Year**	**FY2012-2013**	**FY2013-2014**	**FY2014-2015**	**FY2015-2016**	**FY2016-2017**	**FY2017-2018**	**FY2018-2019**	**FY2019-2020**	**FY2020-2021**	**FY2021-2022**	**Project Total**
Sprayfield Improvements – Phase I	2011-2012											
Sprayfield Improvements – Phase II	2012-2013	499,000										499,000
Sprayfield Improvements – Phase III	2012-2013	349,000										349,000
Sewer Rehabilitation/Replacement Project	Every other year		50,000	605,000	50,000	605,000	50,000	605,000	50,000	605,000	50,000	2,670,000
Phase 1 – Mitigation of Existing Surcharged Sewers, Vallecito Road	2013-2014	40,000	445,000									485,000
Phase 1 – Mitigation of Existing Surcharged Sewers, East Trunk Sewer	2015-2016			50,000	550,000							600,000
Flow monitoring evaluation	2016-2017				45,000							45,000
Sludge Removal Facilities at EQ Basin	2017-2018					50,000	535,000					585,000
Gunite Side Slopes at EQ Basin	2017-2018					20,000	118,000					138,000
Conversion of Existing Sludge Drying Beds to Stockpile Areas	2017-2018					4,000	35,000					39,000
Concrete Partition Walls at EQ Basin	2017-2018					2,000	13,000					15,000
Pre-filter turbidimeter	2017-2018					1,000	5,000					6,000
Phase 2 –Mitigation of Buildout Surcharged Sewers with reduced I/I, West Trunk Sewer	2019-2020							80,000	850,000			930,000
Grit Chamber at Headworks	2021-2022									10,000	79,000	89,000
Office Building with Training Classroom	2021-2022									30,000	270,000	300,000
Wastewater Master Plan	2019-2020								100,000			100,000
Wastewater Rate and Connection Fee Study	2012-2013, 2020-2021	40,000								40,000		80,000
	Fiscal Year Total	928,000	495,000	655,000	645,000	682,000	756,000	685,000	1,000,000	685,000	399,000	

TABLE 12-2
CITY OF ANGELS WASTEWATER MASTER PLAN
LONG-TERM CIP
FOR FY 2022-2023 THROUGH FY 2031-2032

		Project Cost Allocation, $ Fiscal Year										
Project	**Recommended Project Fiscal Year**	**FY2022-2023**	**FY2023-2024**	**FY2024-2025**	**FY2025-2026**	**FY2026-2027**	**FY2027-2028**	**FY2028-2029**	**FY2029-2030**	**FY2030-2031**	**FY2031-2032**	**Project Total**
Sewer Rehabilitation/Replacement Project	Every other year	605,000	50,000	605,000	50,000	605,000	50,000	605,000	50,000	605,000	50,000	3,275,000
Phase 3 – Mitigation of Buildout Surcharged Sewers, WWTP North Trunk Sewer	2023-2024	30,000	330,000									360,000
Phase 3 – Mitigation of Buildout Surcharged Sewers, Greenhorn Creek Area, North Main Street, Angel Oaks Drive				50,000	510,000							560,000
Influent Flow Meter and Vault					10,000	48,000						58,000
Wastewater Master Plan	2027-2028						100,000					100,000
Wastewater Rate and Connection Fee Study	2028-2029							40,000				40,000
	Fiscal Year Total	635,000	380,000	655,000	570,000	653,000	150,000	645,000	50,000	605,000	50,000	

13 Improvement Project Funding

This chapter discusses recent City budgets for capital improvements to the wastewater facilities and compares the projected costs for the improvements recommended in this Master Plan. Additionally, potential funding sources are described and financing strategies are presented.

13.1 Historical City Wastewater Budget

Adopted City budgets for the three most recent years were reviewed to collect data regarding historical City expenditures on capital improvements to the wastewater collection system and WWTP. In general, the City budgets separate wastewater into four different funds: Sewer O&M, Sewer Capital Improvements, Sewer Capital Replacement, and Sewer Debt Service. Projected budget revenues and expenditures for FY 2011-12 are summarized in Table 13-1.

TABLE 13-1
CITY OF ANGELS WASTEWATER MASTER PLAN
CITY WASTEWATER REVENUE AND EXPENDITURES

Revenue or Expense	Fund	FY 2011-12 (Adopted Budget) ($)
Revenue	Sewer O&M	1,630,000
Revenue	Capital Improvement	296,025
Revenue	Capital Replacement	549,840
Revenue	Debt Service	130,000
	Subtotal	2,605,965
Expense	Sewer O&M	2,084,355
Expense	Capital Improvement	795,840
Expense	Capital Replacement	708,000
Expense	Debt Service	552,840
	Subtotal	4,141,035
	Net Change	**(1,535,070)**

Projects budgeted for the Sewer Capital Improvement and Capital Replacement funds for the last three fiscal years are summarized in Table 13-2. Descriptions of the projects are also provided.

TABLE 13-2
CITY OF ANGELS WASTEWATER MASTER PLAN
SEWER CAPITAL IMPROVEMENT AND CAPITAL REPLACEMENT PROJECTS
FOR FY 2011-12

Fund	Project	Project Description	Budget ($)
Capital Improvement	Sprayfield Improvements Phase 1, engineering and construction	Improvements to Lower and Upper Pump Houses to address regulatory issues	315,000
	Sewer Master Plan	Preparation of a Sewer Master Plan to evaluate wastewater facilities	100,000
	SSMP	Update of the existing SSMP to address regulatory requirements	25,000
	Transfer to Debt Service	Payment for debts incurred for previous wastewater improvements	355,840
Capital Replacement	2010 Sewer Rehabilitation Project, engineering and construction	Projected remaining costs for completion of sewer rehabilitation project which began construction in 2011.	188,000
	2012 Sewer Rehabilitation Project, engineering and construction	Rehabilitation of sewers with significant defect identified during recent CCTV work.	450,000
	Finnegan Lane Sewer Mitigation	Research funding options to address odors at the inverted siphon crossing under Angels Creek on Finnegan Lane. Conduct a limited flood plain study and coordinate with property owners to determine the feasibility of the project. Installation of a scrubber to remove odors.	70,000

13.2 Comparison of CIP with Historical Wastewater Capital Improvement Budgets and Sewer Rate Structure

Based on the review of historical budgets, projects from the recommended CIP in this Master Plan would typically fall under the Capital Improvement or Capital Replacement fund. Information provided from the 2005 Wastewater Rate Study [2] indicates that expenses for replacement costs and depreciation were budgeted as presented in Table 13-3.

TABLE 13-3
CITY OF ANGELS WASTEWATER MASTER PLAN
2005 WASTEWATER RATE STUDY
REPLACEMENT AND DEPRECIATION COST EXPENSE ASSUMPTIONS

Expense Category	Assumed Annual Cost for 2005 Rate Structure ($)
Wastewater Treatment Facilities Replacement Costs	112,500
Collection System Replacement Costs	52,000
Depreciation	130,000
Total	**294,500**

Definitions for replacement costs and depreciation were as follows:

1. Replacement costs: Expenditures required for a facility to operate for its design life. Based upon 5 year planning cycle (i.e., pumps, motors, equipment, vehicles, radios, etc.).

2. Depreciation: Costs of depreciation of items not designated in replacement cost revenue and connection fee revenue.

Based on Tables 12-1 and 12-2, annualized CIP costs for Capital Improvement and Capital Replacement projects are approximately $700,000 for the next ten years. Recent City budgets, planned improvements at the sprayfields to address regulatory concerns and improve operations, and the additional recommended CIP from this Master Plan indicate that assumptions from the 2005 Wastewater Rate Study [2] should be revisited to better align projected costs for managing the wastewater facilities and City revenue for the wastewater funds. Pursuit of outside funding sources may assist with providing capital to implement improvements while minimizing the fiscal impact to the City. Potential funding options and sources are discussed in the next section.

Additionally, according to an Independent Auditor's Report and Financial Statements [59] an interfund transfer from the Water Fund to the Sewer Fund of $1,105,000 occurred in June 2011. The loan is to be repaid in annual installments of $200,000 plus interest at 2 percent per annum. Consideration for repayment of this transfer should be addressed in a rate study. Information from the 2005 Wastewater Rate Study [2] assumed an annual debt service expense of $195,680.

13.3 Potential Funding Options and Sources

Several government agencies offer funding assistance for wastewater improvement projects. Funding assistance packages may include conventional borrowing at low interest rates or a loan/grant package. The two major funding sources for wastewater improvement projects are through programs administered by the SWRCB or United States Department of Agriculture (USDA). The programs offered by these two agencies are described in further detail.

a. State Water Resources Control Board Wastewater Funding Programs

The SWRCB administers two programs for funding construction of publicly owned wastewater treatment and collection facilities: the SCWG Program and the Clean Water State Revolving Fund (SRF). The SCWG is funding through State of California Propositions 40 and 50 and provides grant assistance for construction of publicly owned wastewater treatment and collection facilities. Grants are available for small communities with financial hardships. Communities must comply with population restrictions (< 20,000 people) and annual Median Household Income (MHI) restrictions (< $37,995) to qualify for funding. Funding is available for up to $2 million per project. Unfortunately, the SCWG is currently not soliciting new projects due to lack of funding.

The SRF loan program was established as part of the Federal Water Pollution Act (Clean Water Act or CWA). The program is funded by federal grants, state funds, and revenue bonds. The purpose of the SRF is to implement the CWA and various state laws by providing financial assistance for the construction of facilities or implementation of measures necessary to address water quality problems and to prevent pollution of waters of the state. The SRF loan program provides low-interest loan funding for construction of publicly-owned wastewater treatment facilities, local sewers, sewer interceptors, water reclamation facilities, as well as nonpoint source pollution control projects. Loans are available for up to $25 million per municipality per year with a 20 year term and an interest rate equal to ½ the most recent state general obligation bond rate. The first step in the process for applying for SRF financing is to file a SWRCB on-line Financial Assistance Application Submittal Tool (FAAST) application by completing a Project Priority List (PPL) questionnaire. However, the solicitation for the PPL questionnaire is currently closed for the FAAST application. An alternative approach for placement on the PPL is to complete a SWRCB CWSRF Financial Assistance application.

b. United States Department of Agriculture Rural Development

The USDA Rural Development Water and Environmental Programs (WEP) provides loans, grants, and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in rural areas, cities, and towns of 10,000 or less. Public bodies, non-profit organizations and recognized Indian tribes may qualify for assistance. To qualify, applicants must be unable to obtain financing from other sources at rates and terms they can afford and/or their own resources. Funds can be used for construction, land acquisition, legal fees, engineering fees, capitalized interest, contingencies, and any other cost that is determined by Rural Development to be necessary for the completion of the project. Projects must be primarily for the benefit of rural users.

The rates that are used to calculate the loans are subject to change quarterly. Loans are made based on the applicant's authority and the life expectancy of the system's project, which may be up to a maximum of 40 years.

To apply for the program, the following materials should be submitted: an application form SF 424.2, two copies of a Preliminary Engineering Report, Environmental Report, population and median household income of the area to be served, current audits or financial information for the past three years, evidence of outstanding indebtness, organizational documents, the applicant's IRS tax identification number, a Data Universal Numbering System (DUNS) number, a proposed operating budget, and some certification forms. The loan program is based on repayment ability. The loans are calculated on similar systems rates, median household income, financial status of the system, and outstanding indebtedness. There are some systems that qualify for grant funding; however, grant funding availability is limited. Funding contributions from the agency applying show ownership in the projects and are often recommended. The agency contributions are the first money spent on any project. Applications are accepted at any time through the USDA Rural Development State and Area offices.

14 References

[1] Angels Camp 2020 General Plan, adopted 3 February 2009.

[2] City of Angels 2005 Wastewater Rate and Connection Fee Study Public Hearing Presentation, 20 June 2006.

[3] City of Angels 1998 Improvement Standards, *Sewer Design Standards*. <http://www.angelscamp.gov/docs/street-standards.pdf>

[4] City of Angels 2010 Improvement Standards, City Council Resolution 10-42, *Design Standards – Sanitary Sewer*. <http://www.angelscamp.gov/docs/Improvement-Standards-2010.pdf>

[5] *Preliminary Engineering Report for City of Angels Wastewater Treatment Plant Improvement Project Phase II*, February 2003.

[6] *Preliminary Engineering Report for City of Angels Wastewater Treatment Plant Improvement Project Phase III*, 2009.

[7] Angels Municipal Code, 15 March 2011. <http://www.codepublishing.com/CA/angels/>

[8] *City of Angels Wastewater Collection System Improvements Study*, Prepared by Weber, Ghio & Associates, Inc., October 1998.

[9] Email correspondence with Vanessa Apodaca, Weber, Ghio & Associates, Inc., 7 October 2011, 19 January 2012, and 28 February 2012.

[10] *City of Angels Draft System Evaluation & Capacity Assurance Plan*, Prepared by Weber, Ghio & Associates, Inc., April 2010.

[11] *Alternatives Analysis for North Angels Sewer Trunk Line*, Prepared by Willdan Engineering, May 2008.

[12] *Downtown Wastewater Collection System Improvement Study*, Prepared by Weber, Ghio & Associates, Inc., March 2009.

[13] *City of Angels Municipal Service Review*, Prepared by LAFCO of Calaveras County, adopted December 2009.

[14] California Regional Water Quality Control Board, Central Valley Region, Order No. R5-2009-0074, *Amending Waste Discharge Requirements Order No. 2007-0031 (NPDES Permit No. CA0085201) for City of Angels Wastewater Treatment Plant, Calaveras County*, 13 August 2009.

[15] *City of Angels Camp Sanitary Sewer Management Plan*, Prepared October 2009.

[16] Telephone communication with City of Angels Public Works Foreman Jon Kitchell, 13 October 2011 and 29 February 2012.

[17] California Regional Water Quality Control Board, Central Valley Region, Order No. 98-110, *Waste Discharge Requirements for City of Angels Wastewater Treatment Plant, Calaveras County*, 17 April 1998.

[18] California Regional Water Quality Control Board, Central Valley Region, *Cleanup and Abatement Order No. 5-01-535*, 5 October 2001.

[19] Meeting with City of Angels Public Works Foreman Jon Kitchell, 26 September 2011.

[20] Agreement between City of Angels and Calaveras County Water District to Receive Sewage Effluent for Six Mile Village, 12 December 1985.

[21] California Regional Water Quality Control Board, Central Valley Region, *Revised Monitoring and Reporting Program No. 98-098, for Greenhorn Creek Associates, L.P. and City of Angels, Calaveras County*, 3 May 2007.

[22] Letter from CDPH to Mary Boyd with the Central Valley Regional Water Quality Control Board: *City of Angels WWTP Field Commissioning Test Results Wedeco (TAK 55HP Low-Pressure High-Output) UV Disinfection System)*, July 22, 2011.

[23] *Pollution Prevention Plans*, California Water Code Section 13263.3(d)(3).

[24] Email correspondence and telephone communication with Jim Martin, California Regional Water Quality Control Board Regional Board, Central Valley Region, Rancho Cordova, 16 February 2012.

[25] California State Water Resources Control Board, Order No. 2006-0003-DWQ, *General Waste Discharge Requirements for Sanitary Sewer Systems*, 26 May 2006.

[26] California State Water Resources Control Board, *Staff Report Water Quality Order No. 2011-XXXX-DWQ, Statewide General Waste Discharge Requirements for Sanitary Sewer Systems*, 22 March 2011.

[27] California Regional Water Quality Control Board, Central Valley Region, 2 December 2010, *Notice of Violation and Water Code Section 13267 Order for Technical Report, City of Angels Wastewater Treatment Facility, Calaveras County*.

[28] City of Angels, January 2011, *Recycled Water Spill Assessment and Control Plan for City of Angels Sprayfields*.

[29] Proposed Sprayfield Improvements identified in 30 June 2011 correspondence to the Regional Water Quality Control Board.

[30] California Regional Water Quality Control Board, Central Valley Region, *Administrative Civil Liability Complaint, City of Angels Wastewater Treatment Facility, Calaveras County*, 6 September 2011.

[31] City of Angels Wastewater Treatment Plant Phase III Improvements – Record Drawings, Prepared by ECO:Logic, April 2011.

[32] E-4 Population Estimates for Cities, Counties, and the State, 2001-2010 with 2000 & 2010 Census Counts, prepared by California Department of Finance, August 2011.

[33] E-5 Population and Housing Estimates for Cities, Counties, and the State, 2001-2010, with 2000 Benchmark, prepared by California Department of Finance, January 2010.

[34] *Angels Camp Water Audit*, Prepared by Stetson Engineers, Inc. July 22, 2011.

[35] Wastewater Engineering Treatment and Reuse, Metcalf and Eddy, Fourth Edition, 2003

[36] *Ratings and Map of Public and Private Schools*, Local School Directory, November 2011. <http://www.localschooldirectory.com/city-schools/Angels-Camp/CA>

[37] *Water Use in the California Residential Home*, prepared by ConSol, January 2010.

[38] *Water-Efficient Single Family New Home Specification Supporting Statement*, United States Environmental Protection Agency – Water Sense, May 2008. <http://www.epa.gov/WaterSense/docs/home_suppstat508.pdf>

[39] *Water Conservation Measurement Metrics Guidance Report*, American Water Works Association – Water Conservation Division, January 2010. <http://www.awwa.org/files/Publications/Streamlines/2010/030210/AWWA%20Metrics%20Guidance%20Report%20Jan-22-2010%20Final%20_3_.pdf>

[40] Email correspondence and site visit with Garett Walker, WWTP Supervisor, City of Angels, 29 July 2011, 14 October 2011, 30 December 2011.

[41] City of Angels Wastewater Treatment Plant 0.6 MGD Expansion – Record Drawings, Prepared by Lee & Ro, Inc., February 2004.

[42] *Operational Description – Sequencing Batch Reactor System, NIT Process, Angels Camp WWTP*, Prepared by Sanitaire, September 2005.

[43] Operations and Maintenance Manual for City of Angels Wastewater Treatment Plant, Improvement Project SCG #602-010, prepared by Lee & Ro, Inc.

[44] Email correspondence and telephone communication with Steve Young, Parkson Corporation, 4 November 2011, 14 November 2011, 7 December 2011, and 20 December 2011.

[45] *Treatment Technology Report for Recycled Water*, California Department of Public Health, January 2007.

[46] Telephone communication with Garett Walker, WWTP Supervisor, City of Angels, 10 November 2011.

[47] *City of Angels Wastewater Treatment Facility Title 22 Engineering Report*, Weber, Ghio & Associates, May 2011.

[48] *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse*, Second Edition, National Water Research Institute, May 2003.

[49] Daily Precipitation Data for Greenhorn Creek Weather Station in Angels Camp, California, Weather Underground, December 2011. <http://www.wunderground.com/cgi-bin/findweather/getForecast?query=95221&sp=KCAANGEL4>

[50] Small and Decentralized Wastewater Management Systems, Crites and Tchobanoglous, 1998.

[51] *Projected Performance for Tower Press™ Belt Filter Press Model TP12.43*, Provided by Charter Machine Company, November 2011.

[52] Monthly Precipitation Data for DWR Station #B40 835300 in Sonora, California Department of Water Resources, December 2011. <ftp://ftp.water.ca.gov/users/dfmhydro/Monthly%20Historical%20Rain/M%20Rain%20B/>

[53] *A Guide to Estimating Irrigation Water Needs of Local Plantings in California*, Prepared by University of California Cooperative Extension for California Department of Water Resources, August 2000.

[54] Monthly Average Pan Evaporation for New Melones HQ Station, Western Regional Climate Center, November 2011. <http://www.wrcc.dri.edu/htmlfiles/westevap.final.html>

[55] Stream Flows for Angels Creek – Gage 126, Utica Power Authority, December 2011.

[56] Stream Flows for Angels Creek below Murphys After Bay - Station 11298650, U.S. Geological Survey - National Water Information System: Web Interface, December 2011. <http://waterdata.usgs.gov/nwis/dv/?referred_module=sw&site_no=11298650>

[57] National Oceanographic and Atmospheric Organization, Precipitation Frequency Atlas of the Western United States, Volume XI – California, released 1973.

[58] Wastewater Engineering, Treatment, Disposal, and Reuse, Metcalf & Eddy, Inc., 1991.

[59] *City of Angels Independent Auditor's Report and Financial Statements*, prepared by Bryant L. Jolley Certified Public Accountants, 30 June 2011.