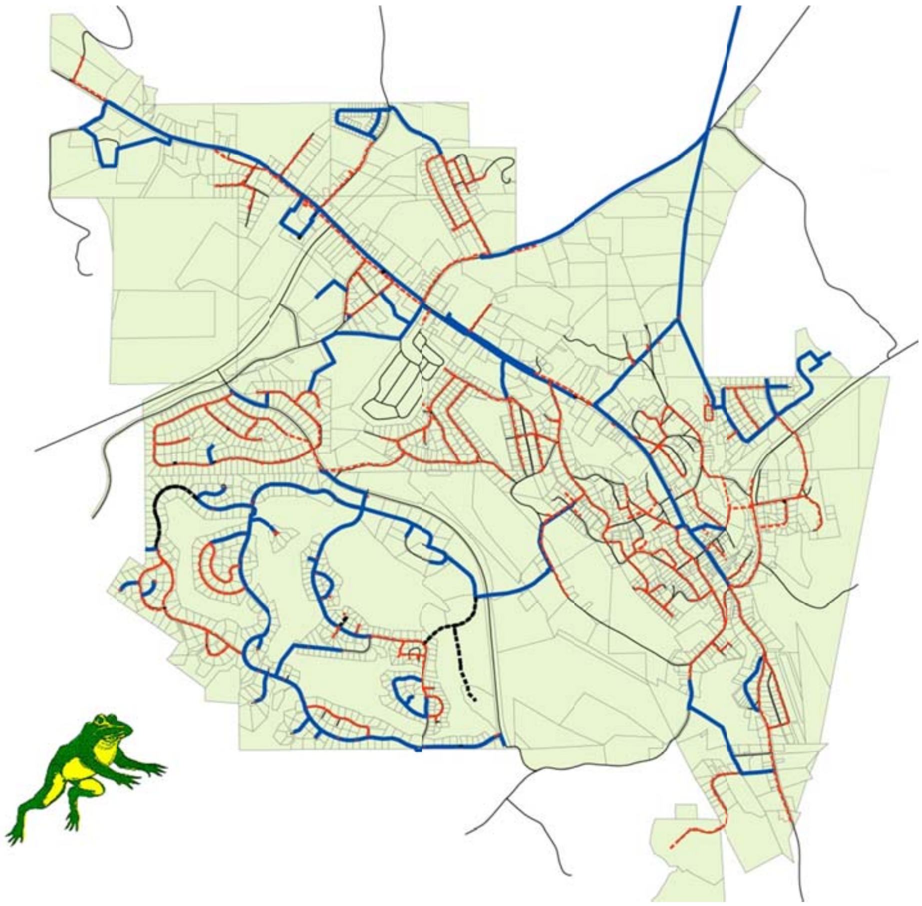
CITY OF ANGELS
WATER MASTER PLAN



July 2013

NV5

BEYOND ENGINEERING

CITY OF ANGELS
WATER MASTER PLAN

July 2013

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Executive Summary

A Water Master Plan (Master Plan) was prepared for the City of Angels (City) water supply, treatment, distribution, and storage systems 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 Master Plan includes an evaluation of existing facilities; an assessment of alternate water supplies; and an identification of recommended improvement projects for the water supply, treatment, distribution, and storage systems. 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. Water supply and delivery for areas requiring annexation will be the subject of future technical studies. Tasks completed as part of the Master Plan included:

1. A review of previous reports and studies completed for the water supply, treatment, distribution, and storage systems.

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

3. A review of the current and future regulatory requirements related to water supply.

4. Development of design criteria.

5. An analysis of existing water demands and calibration of a water demand factor based on actual usage to develop projected water demands.

6. An evaluation of water treatment, storage, and transmission facilities under projected water demands.

7. An evaluation of available water supplies under a range of delivery conditions and identification of alternate water supplies to help meet future demands and improve system reliability.

8. The execution of hydraulic model scenarios to identify existing and buildout capacity issues within the distribution system while assessing the impacts of potential improvements on system performance.

9. A prioritization of recommended improvements in support of the development of a short-term and long-term capital improvement plan (CIP).

A phased CIP was developed based on a review of applicable regulations, treatment plant performance, distribution system hydraulic capacity, and projected water demands. Projects within the treatment, supply, and storage CIP were prioritized based on the following, in descending order of importance:

1. Addressing regulatory concerns (Phase 1A)
2. Improving reliability by providing operational redundancy (Phase 1B)
3. Replacing aging infrastructure (Phase 1C)
4. Providing capacity for future development (Phase 2A)

The distribution system CIP was prioritized based on the following, in descending order of importance:

1. Providing required fire flow for existing demands (Phase 1A)
2. Meeting hydraulic performance criteria for existing demands (Phase 1B)
3. Providing required fire flow for future (buildout) demands (Phase 2A)
4. Meeting hydraulic performance criteria for future (buildout) demands (Phase 2B)

The total CIP cost is approximately $24.3 million, with an average annualized cost of $1.22 million. Comparing the projected CIP costs to recent City budgets (e.g., FY 2011-12 CIP budget for water of $260,000) indicates that additional revenues will be needed to adequately fund the recommended CIP projects. Included as recommended CIP projects are water rate and connection fee studies to better assist with determining appropriate project financing.

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APPENDICES

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LIST OF ABBREVIATIONS

The following abbreviations are used in this report:

AACE	Associated Advancement of Cost Engineering
ac	Acre
ADD	Average Day Demand
AF	Acre-Feet
AFY	Acre-Feet per Year
AMR	Automatic Meter Reading
ARV	Air Release Valve
AWWA	American Water Works Association
BAE	Business Attraction/Expansion
Cal ISO	California Independent System Operator
CC	Community Commercial
CCWC	Calaveras County Water Company
CCWD	Calaveras County Water District
CDPH	California Department of Public Health
cfs	Cubic Feet Per Second
CIP	Capital Improvement Plan
CWUA	Calaveras Water Users Association
DE	Dunn Environmental
DWR	Department of Water Resources
EA	Each
ENR	Engineering News Record
EPA	United States Environmental Protection Agency
EWU	Equivalent Water Unit
FERC	Federal Energy Regulatory Commission
fps	Feet per Second
ft	Feet or Foot
ft^2	Square Foot
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/EWU	Gallons per Day per Equivalent Water Unit
gpd/ft^2	Gallons per Day per Square Foot
gpm	Gallons per Minute
HC	Historic Commercial
HDR	High-Density Residential
HDR-WMC	Worldmark Club
I	Industrial
in	Inch
IWA	International Water Association
LF	Lineal Feet or Lineal Foot

LIST OF ABBREVIATIONS (Cont.)

LS	Lump Sum
MDD	Maximum Day Demand
MDR	Medium-Density Residential
MW	Megawatt
MG	Million Gallons
mgd	Million Gallons per Day
MSR	Municipal Service Review
NCPA	Northern California Power Agency
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OS	Open Space
P	Public
PG&E	Pacific Gas and Electric Company
PHD	Peak Hour Demand
PR-Golf	Golf Course
PR	Parks and Recreation
PRV	Pressure Reducing Valve
P-SCH	Public School
PVC	Polyvinyl Chloride
psi	Pounds per Square Inch
RE	Residential Estate
ROW	Right-of-Way
rpm	Revolutions per Minute
SC	Shopping Commercial
SF-CCI	San Francisco Construction Cost Index
SFR	Single-Family Residential
SOI	Sphere of Influence
SP	Special Planning
SR	State Route
SWRCB	State Water Resources Control Board
TDH	Total Dynamic Head
UGMC	Utica Gold Mining Company
UPA	Utica Power Authority
UPUD	Union Public Utility District
USGS	United States Geological Survey
UWC	Union Water Company
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

CONVERSION FACTORS

Volume

1 AF = 43,560 ft^3 = 325,851 gallons
1 ft^3 = 7.48 gallons
1 million gallons = 3.07 AF

Flow Rate

1 cfs = 450 gpm = 646,320 gallons/day
1,000 gpm = 2.23 cfs = 4.42 AF/day
1 mgd = 1,120 AFY = 3.07 AF/day
1 cfs for 24 hours = 1.983 AF
1 cfs for 30 days = 59.5 AF
1 cfs for 1 year = 724 AF

1 Introduction

A Water Master Plan (Master Plan) was prepared for the City of Angels (City) water supply, treatment, distribution, and storage systems 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 Master Plan includes an evaluation of existing facilities; an assessment of alternate water supplies; and an identification of recommended improvement projects for the water supply, treatment, distribution, and storage systems. 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. Water supply and delivery for areas requiring annexation will be the subject of future technical studies. Background information regarding water 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 water facilities. The required Master Plan includes the following items:

1. A summary and description of the water system.

2. Projected water demands for the 10-year and 20-year planning horizon.

3. An evaluation of the existing water distribution system and identification of hydraulic deficiencies with mitigation recommendations triggered by demand projections.

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

5. An evaluation of supplemental water supply sources including emergency alternatives and secondary long-term alternatives with consideration for treatment and distribution requirements, costs, and constraints.

6. Cost estimates for required improvements to the distribution system and treatment facilities to ensure adequate capacity for both summer and winter demands with growth projections.

7. A short-term and long-term Capital Improvement Plan (CIP) to address identified deficiencies including prioritization, alternatives analysis, and schedules. The CIP will include establishment of connection fees based on growth projections.

8. Identification of any present and future regulatory concerns for the distribution system and treatment facilities.

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 for the water supply, treatment, distribution, and storage systems.

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

3. A review of the current and future regulatory requirements related to water supply.

4. Development of design criteria.

5. An analysis of existing water demands and calibration of a water demand factor based on actual usage to develop projected water demands.

6. An evaluation of water treatment, storage, and transmission facilities under projected water demands.

7. An evaluation of available water supplies under a range of delivery conditions and identification of alternate water supplies to help meet future demands and improve system reliability.

8. The execution of hydraulic model scenarios to identify existing and buildout capacity issues within the distribution system while assessing the impacts of potential improvements on system performance.

9. A prioritization of recommended improvements in support of the development of a short-term and long-term CIP.

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 analysis 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.

2.1 Agreement for Irrigation Water for Greenhorn Creek Golf Course – 1998

The second amended agreement dated July 1998 between the City of Angels and Greenhorn Creek Associates L.P. ensures that the City maintains a regular supply of water for irrigation of the Greenhorn Creek (GHC) Golf Course [2]. The agreement states the following in regards to untreated water from Angel's Creek:

> *The City shall make available up to 450 acre-feet (AF) of creek water from Angel's Creek for the Project's golf course irrigation at a minimum flow of 700 gallons per minute (gpm) up to a maximum rate of 1,400 gpm.*

The agreement also states that the golf course irrigation system must use recycled water from the City's wastewater treatment plant (WWTP) as follows:

> *At the time of installation and commencement of operation of the City's substantially new wastewater treatment facility, the golf course irrigation system shall be converted to use of treated wastewater as set forth herein. From that time forward, untreated creek water shall become a secondary source of irrigation, available during those times when sufficient treated wastewater is not available.*

2.2 Previous Water Master Plan – 2002

The 2002 Water Master Plan was prepared to support growth in the City and identify improvements and associated costs needed to meet future water demands through the year 2015. A number of projects were suggested to improve the distribution system and the water treatment plant (WTP) as discussed further below [3].

a. <u>Distribution System Projects</u>

The following five projects recommended in the 2002 Water Master Plan involved the replacement of old welded steel mains because they were undersized and/or had a high probability of failure:

1. State Route (SR) 49 Pipeline Replacement (from Stanislaus Street to Altaville Post Office)
2. SR-49 Pipeline Replacement (from Museum to Mark Twain Road)
3. Raspberry Lane Pipeline Replacement

4. Minna Street Pipeline Replacement
5. Church Street Pipeline Replacement

The following water main extensions were recommended to provide looped water mains, meet fire flow requirements, and increase flows to accommodate new connections to the existing system:

1. Finnegan Lane to Centennial Road Loop
2. Demarest-Monte Verde Street Loop
3. Lee Lane Water Pipeline

All pipeline improvements to the distribution system recommended in the 2002 Water Master Plan as outlined above have been completed with the exception of the SR-49 Pipeline Replacement (from Stanislaus Street to Altaville Post Office) which has been partially completed by private development.

In addition the construction of a second storage tank at Powder House Hill with a 2.0 million gallon (MG) capacity was suggested to meet the maximum day demand (MDD) on the system while the WTP is shut down for backwashing filters and removing sludge from the sedimentation basin. This project remains incomplete and is addressed later in this Master Plan.

b. <u>Water Treatment Plant Projects</u>

The 2002 Water Master Plan suggested that improvements be made to the existing sedimentation basin by installing a mechanical sludge collection system and tube settlers. Under the current configuration, the sedimentation basin has to be drained and hosed down to remove sludge. The installation of a mechanical sludge collection system would make continuous use of the sedimentation basin possible. Adding tube settlers to the outlet end of the sedimentation basin would allow for higher overflow rates due to the shallow settling depth.

Due to the lack of sludge processing capabilities, the 2002 Water Master Plan proposed the addition of two sludge dewatering basins to the WTP. The proposed sludge dewatering basins include access ramps to allow removal of dried sludge with mechanical equipment, a clarified water recovery system, and recycle pumps.

The addition of a fourth filter cell was also recommended to increase the capacity of the WTP by the year 2014.

All improvements to the WTP recommended in the 2002 Water Master Plan as outlined above have yet to be initiated and are addressed later in this Master Plan.

2.3 Municipal Service Review – 2009

The Municipal Service Review (MSR) provides an assessment of the City's public services and facilities including the water supply, treatment, distribution, and storage systems [4].

The MSR identified the following improvements based on previous studies to support projected population growth:

1. Addition of a fourth filter at the WTP to increase the capacity to 3.0 million gallons per day (mgd).
2. Construction of an additional 2.0 MG storage tank to provide the City with 4.0 MG of treated water each day.
3. Finding additional water supply sources to meet future water demands.

The MSR mentioned that the City's water supply is solely dependent on the Utica Power Authority (UPA) canal system for water delivery. Problems with the canal have severely disrupted the City's water supply in the past.

In addition, the MSR stated that various projects had been identified to replace old welded steel mains that have a high probability of failure or are undersized.

2.4 Memorandum on Continuance of 2002 Water Master Plan – 2011

An internal memorandum was prepared in January 2011 by the Senior Supervisor of Water/Wastewater Treatment with the recommendation to complete the existing 2002 Water Master Plan projects with the modifications listed below [5].

a. <u>Postpone Fourth Filter Cell</u>

It was suggested that the proposed fourth filter cell project at the WTP be postponed and included in a new master plan.

b. <u>Storage Tank at Powder House Hill</u>

The memorandum recommended that the proposed storage tank at Powder House Hill should instead be constructed on the site of the abandoned clearwell at the WTP to provide extra storage for the water system and allow maintenance on the existing storage tank without shutting down the water supply. A second pipeline from the WTP to the distribution system was also suggested to supply the City with water in the event that the existing pipeline fails.

c. <u>Sedimentation Basin</u>

As recommended in the 2002 Water Master Plan, it was suggested that the existing sedimentation basin be equipped with a sludge removal system to remove solids without decanting. A sludge handling facility was also recommended in the memorandum as in the 2002 Water Master Plan but with the clarification that the facility needs to be designed with the capacity to handle sludge from both the sedimentation basin and the filter backwash. In addition, it was suggested to begin plans for a second sedimentation basin to allow maintenance to the existing sedimentation basin without shutting down the WTP, to help reduce turbidity during storm events, and to prepare for future growth.

2.5 Angels Camp Water Audit – 2011

The 2011 Angels Camp Water Audit (2011 Water Audit) was prepared for the City to ensure compliance with regulations and to develop projects to equip the water system for the needs of current and future residents of the City. The proposed projects in the 2011 Water Audit fall into four categories as follows: 1) WTP; 2) Distribution System; 3) Water Quality Sampling; and 4) Administration and Planning. A summary of the recommended projects with the current status are provided in Table 2-1 [6].

TABLE 2-1
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF RECOMMENDED PROJECTS IN THE 2011 WATER AUDIT

Project Number	Project	Description	Rationale	Status
WTP Projects				
1	Construct Settling Ponds and Discharge Backwash Water Properly	Construct settling ponds. Recycle backwash water through headworks, obtain discharge permit, or discharge to wastewater system.	Required for regulatory compliance. Backwash water is currently being discharged without a permit.	Incomplete. Addressed in this Master Plan.
2	Implement Redundancy During Filter Backwash	Modify system so that at least one filter is on-line during backwashing.	Improves reliability. Allows water treatment to continue through backwash procedures, eliminating 2.75 hour shutdowns.	Incomplete. Addressed in this Master Plan.
3	Pursue Emergency Alternative Water Supply	Pursue alternative options for providing emergency water supply in event that flume system is damaged.	Necessary to provide redundancy if flume system is compromised.	Incomplete. Addressed in this Master Plan.
4	Construct Second Storage Tank	Construct a new 2.0 MG tank at one of three proposed locations.	Needed to meet future maximum day scenarios. Improve system reliability and security.	Incomplete. Addressed in this Master Plan.
5	Address Post-Storm Turbidity Shutdowns	Option A: Investigate whether second sedimentation basin would prevent shutdowns. Option B: Investigate feasibility of pre-filtration or other process to make high turbidity water usable.	Necessary to improve reliability after storms. If Option A is feasible, it would also improve redundancy.	Incomplete. Addressed in this Master Plan.
6	Add Fourth Filter	Add fourth mixed-media filter to provide additional capacity at WTP.	Provide additional redundancy. Needed to accommodate future growth.	Incomplete. Addressed in this Master Plan.

TABLE 2-1 (Cont.)
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF RECOMMENDED PROJECTS IN THE 2011 WATER AUDIT

Project Number	Project	Description	Rationale	Status
Distribution System Projects				
7	Complete an Inventory of the Distribution System	Complete an inventory of all pipes, valves, and hydrants within the system and incorporate into geographical information systems (GIS).	Necessary to allow the City to make accurate decisions in planning and construction. Needed to create hydraulic model.	Completed as part of this Master Plan. See Chapter 8.
8	Develop a Hydraulic Pipe Network Model	Develop a model of the system including the WTP, storage tank, and distribution system.	Can be used to analyze the system for compliance, make decisions, prioritize projects, and plan for future development.	Completed as part of this Master Plan. See Chapter 8.
9	Identify and Prioritize Infrastructure Upgrades using Hydraulic Model	Use the results of the model to identify and prioritize infrastructure upgrades.	Hydraulic model provides a tool for assessing system needs.	Completed as part of this Master Plan. See Chapter 8.
10	Assess Distribution System Compliance using Hydraulic Model	Use the results of the model to assess whether regulations are being met.	Provides a way for the City to demonstrate compliance with certain regulations.	Completed as part of this Master Plan. See Chapter 8.
11	Add Second Water Main from WTP to City	Add 18-inch pipeline parallel to the existing pipeline.	Necessary for redundancy and reliability. The existing pipeline is old and a major system weakness.	Incomplete. Addressed in this Master Plan.
12	Loop Dead Ends and Install Blowoff Assemblies	Where possible, loop dead ends. Otherwise install a blowoff assembly.	Will improve system reliability and water quality. Required for regulatory compliance.	Incomplete. Addressed in this Master Plan.

TABLE 2-1 (Cont.)
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF RECOMMENDED PROJECTS IN THE 2011 WATER AUDIT

Project Number	Project	Description	Rationale	Status
Water Quality Sampling Projects				
13	Update Bacterial Sampling Plan	Revise City's Bacterial Sampling Plan by 2012 (last updated in 2002).	State regulations require a minimum number of samples per month based on number of connections. Because the number of connections in the distribution system has increased, a minimum of six samples per month is now required rather than the five samples per month required in the 2002 plan. Regulations also require the plan be updated every 10 years.	Completed.
Administration and Planning Projects				
14	Develop City Planning Criteria in Next Water Master Plan	Incorporate all related water codes into a list of criteria for future planning.	Useful planning tool for assessing criteria for future infrastructure and existing deficiencies.	Completed as part of this Master Plan. See Chapter 4.
15	Submit Permit Amendment Following Major Upgrades at WTP	Submit application for a permit amendment following major improvements at the WTP.	Necessary for compliance with regulations.	Will be submitted concurrent with completion of design activities.
16	Update Operations and Maintenance Plan	Update the plan to reflect upgrades to the WTP.	Required by Water Supply Permit.	Completed by City Engineer in May 2012.
17	Pursue Shortage Plan with UPA	City should work with UPA to develop a plan to allocate water to all users during a drought.	Essential to securing a reliable water supply and the ability to meet maximum day scenarios at all times.	Ongoing.
18	Develop an Alternative Supply for GHC Development	Explore options for alternative supplies for GHC.	Necessary to ensure that the entire water supply allocation from UPA is available for the City.	Ongoing.
19	Staffing Level Recommendation	Hire one full-time and one part-time staff member.	Current staffing levels are below other comparable water purveyors by approximately 20 percent.	Under consideration.

2.6 Flow Meter Report – 2012

A flow meter report was prepared in April 2012 to address concerns that water is being lost in the distribution system [7]. Recommendations that were brought forward to reduce the difference between water produced and water metered are discussed below.

a. Account for Water Used at the Water Treatment Plant

There are two uses of process water at the WTP that should be accounted for in calculating the difference between water produced (from the combined filter effluent meter) and water metered (customer meters):

1. Process water for filter backwash.
2. Process water for sodium hypochlorite generation.

Accounting for the process water brings the average difference between water produced and water metered from 20 percent to 12 percent. The criticality of including process water in the analyses of unit capacities at the WTP is addressed in Chapter 7.

b. Replace Meter at the Storage Tank

There are a number of concerns with the age and calibration of the meter at the treated water storage tank (aka, the "town meter"). The flow meter report recommends replacing the 15-20 year old meter to increase the accuracy of measurements which may contribute to unaccounted-for water in the system. Replacement of the meter is anticipated in 2013.

c. Account for Age of Distribution System and Meters

The flow meter report presented two recommendations for accounting for the water lost due to aging pipes and customer meters:

1. Budget for leak checks by a leak detection contractor.
2. Replace all old meters and upgrade to an electronic meter reading system. Because old meters are worn, accuracy is problematic contributing to potential loss revenues. The electronic meter reading system will improve accuracy and reduce City labor costs.

The leak detection work, replacement of old meters, and upgrade to electronic meter reading system are incorporated into the recommended projects in Chapter 9.

2.7 Water Treatment Facilities Operations Plan – 2012

The Water Treatment Facilities Operations Plan (Operations Plan) provides detailed information on the operation of the City WTP [8]. The Operations Plan includes information on the following:

1. Detailed description of unit processes at the WTP.
2. Overview of start-up procedures.
3. Detailed standard operating procedures.
4. Abnormal conditions and troubleshooting.
5. Calibration and monitoring the plant.
6. Procedures for record keeping and reporting.
7. Maintenance of each of the WTP components.
8. Procedures in emergency situations.

2.8 List of Water Services or Mains to be Replaced

The City provided the following list of water services or mains to be replaced:

1. Replace water main and water services from 876 South Main Street to approximately 870 South Main Street.
2. Replace CLA-valve box on Mark Twain Road and Echo Street.
3. Replace fire hydrant (dresser) in front of Middleton's on North Main Street.
4. Replace blowoff valve on Bruntz Road.
5. Replace old steel pipelines on corner of Mark Twain Road.
6. Replace blowoff valve on 859 Gold Cliff Road.
7. Replace water services at dead end of Holley to Main.

Recently completed water main replacements include:

1. Pipeline on Hillside Court (replaced and upgraded to 6-inch pipeline with a dry barrel hydrant on the end of the pipeline).

3 Description of Existing Water System

The City's existing water system consists of raw water supply, treatment, storage, and distribution facilities. Each of the existing system components is described in this chapter. The existing water system facilities are shown in Figure 3-1.

3.1 Raw Water Delivery System

The raw water source for the City is surface water from the North Fork of the Stanislaus River and multiple tributaries. Raw water is delivered to the City via a flume and canal system. The City has contractual rights for up to 1,600 acre-feet per year (AFY) of water through a series of agreements with Pacific Gas and Electric Company (PG&E). An overview of the raw water delivery system is provided below and described in greater detail in Chapter 6.

Water on the North Fork of the Stanislaus River is stored in four upper reservoirs (Alpine, Union, Utica, and Spicer Meadow). Water released from these upper reservoirs continues downstream along the North Fork of the Stanislaus River to a diversion ditch known as the Upper Utica Canal. From the Upper Utica Canal, water is diverted to the Collierville Tunnel and then to Hunter's Reservoir through the Tunnel Tap. From Hunter's Reservoir, water is released into the Lower Utica Canal, also known as the flume, which is owned and operated by UPA. The Lower Utica Canal is used for hydroelectric generation and for water deliveries to the City, the town of Murphys, and to other private users. Following Murphys, the water enters Angels Creek and is diverted into Angels Ditch. Water in Angels Ditch travels to Ross Reservoir which has a capacity of up to 100 AF and represents a 30-day emergency supply for the City according to the 2011 Water Audit [6]. Below Ross Reservoir, water travels to the Angels Forebay where the City diverts water to the WTP. Unused water discharges to Angels Creek after the Angels powerhouse.

An agreement between Greenhorn Creek Associates L.P. and the City allows the GHC Golf Course to divert up to 450 AFY of surface water from Angels Creek [2]. The agreement states that surface water from Angels Creek should be a secondary source to recycled water from the City's WWTP, when available. Diversions from Angels Creek to GHC Golf Course count as part of the City's annual allocation of 1,600 AFY.

3.2 Water Treatment Plant

The City acquired the WTP from PG&E in 1984. The WTP is equipped for conventional filtration treatment and disinfection with sodium hypochlorite solution. An overview of the WTP is provided below and described in more detail in Chapter 7.

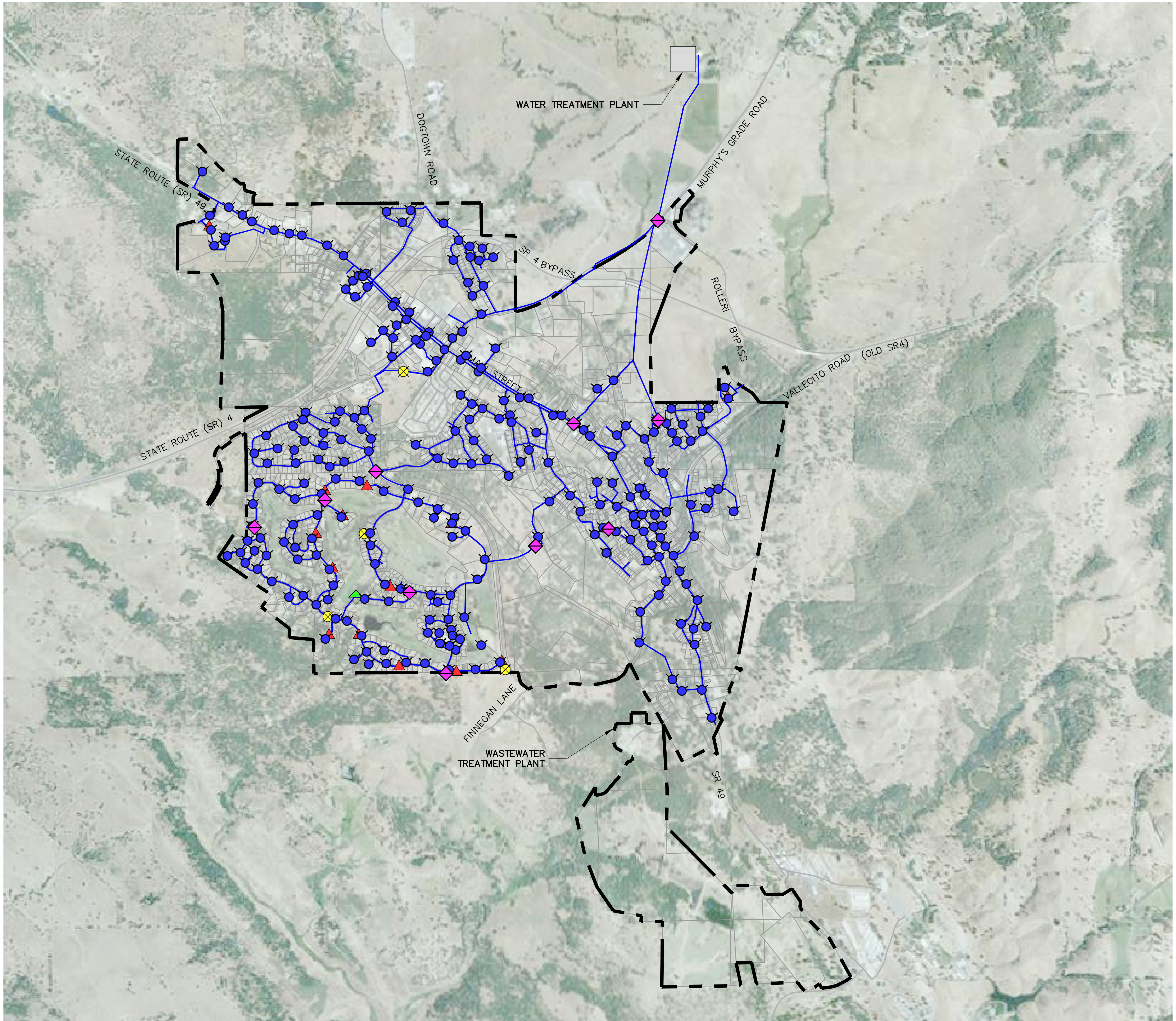

FIGURE 3-1

CITY OF ANGELS
WATER MASTER PLAN

EXISTING WATER SYSTEM

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Raw water is received at the WTP from the Angels Forebay. WTP facilities include a four-stage flocculation basin, a sedimentation basin, four filter-feed pumps in parallel, three pressure filters, a sodium hypochlorite disinfection system with an on-site generator, a 2.5 MG treated water storage tank, and a 3,508 foot (ft) transmission main that delivers water from the storage tank to the City's distribution system by gravity. Filter backwash water and water from sedimentation basin cleaning is discharged into a stock pond on a neighboring ranch. Chemical addition at the WTP includes: 1) aluminum-based coagulant injected into raw water between the Angels Forebay and the flocculation basin; 2) sodium hypochlorite injected prior to flocculation basin and pressure filters; 3) caustic soda injected prior to pressure filters; and 4) zinc orthophosphate injected prior to treated water storage tank.

The total plant capacity is 2.0 mgd with one pressure filter out of service. Installation of a fourth filter is under consideration by the City, and if constructed would bring the total plant capacity to 3.1 mgd with one filter out of service.

3.3 Distribution System

The existing water distribution is separated into five pressure zones: Zones A – E. Pressure zones are described further in Chapter 8. The entire distribution system is fed by gravity from the 2.5 MG treated water storage tank at the WTP. The system serves 1,769 metered connections (approximately 85 percent residential). Pipelines range from 2-inch to 14-inch diameter. Distribution system features include fire hydrants (including wharf head style hydrants), air release valves (ARVs), blowoff valves, pressure relief valves (PRVs), and a surge valve. Pipe materials include American Water Works Association (AWWA) C900 polyvinyl chloride (PVC) in newer areas (less than 20 years old) and asbestos cement, spiral weld steel, ductile iron, or galvanized steel in older areas.

4 Applicable Regulations and Design Criteria

A review of applicable regulations and the development of appropriate design criteria for the water system are provided in this chapter.

4.1 Source Capacity

An agreement between Calaveras County Water District (CCWD) and Northern California Power Agency (NCPA) provides a schedule of 'Maximum Delivery' volumes of water from the North Fork of the Stanislaus River (through the Tunnel Tap) and Mill Creek deliveries into Hunter's Reservoir for use by UPA [9]. This agreement is based on the Department of Water Resources (DWR) May 1 forecast of 'total runoff' and is comprised of six steps of decreased water allocations. There are uncertainties of delivery volumes during very dry years, and it is necessary to firm-up water allocations and agreements between CCWD, NCPA, and UPA.

In addition to securing a firm allocation of source water, a goal of City officials is to augment the surface water supply with groundwater. Because of the 2001 Darby Fire that destroyed a section of the wooden flume delivery system, more importance has been placed on locating a well to provide a supplemental water supply.

The City's water supply capacity will be evaluated based upon criteria within the California Waterworks Standards [10]. Specifically, the following requirements apply:

1. At all times, the water system's source(s) should have the capacity to meet the MDD.

2. The water system should be able to meet four hours of peak hour demand (PHD) with source capacity, storage capacity, and/or emergency source connections.

3. Both the MDD and PHD requirements should be met in the water system as a whole and in each individual pressure zone.

4. The source capacity of a surface water supply should be the lowest anticipated daily yield based on adequately supported and documented data.

5. The source capacity of a purchased water connection between two public water systems should be included in the total source capacity of the purchaser if the purchaser has sufficient storage or standby source capacity to meet user requirements during reasonably foreseeable shutdowns by the supplier.

4.2 Treatment Plant

In general, although improvements may be needed to increase reliability and properly dispose of process residuals [6], the City WTP complies with applicable California drinking water regulations. In addition, recent California Department of Public Health (CDPH) correspondence indicates that the City is in compliance with the federal Long Term 2 Enhanced Surface Water Treatment Rule (no further action required) and has made significant progress toward complying with the federal Stage 2 Disinfectants and Disinfection Byproducts Rule [11].

The WTP will be evaluated based upon design criteria, reliability requirements, and recycling provisions within the California surface water treatment regulations [12]. The evaluation and subsequent design will focus upon the following specific requirements:

1. Standby replacement equipment should be available to assure continuous operation and control of unit processes for coagulation, filtration, and disinfection.

2. The plant should be equipped with filter units which provide redundant capacity when filters are out of service for backwash or maintenance.

3. Solids removal treatment should be provided for recycle flows (if City chooses to recycle process water at the WTP).

4. Recycle flows should be returned to the headworks of the WTP (if City chooses to recycle process water at the WTP).

In addition, new recycling facilities within the WTP will be designed in accordance with United States Environmental Protection Agency (EPA) technical guidance [13] and the California Cryptosporidium Action Plan [14]. The following criteria will be used:

1. Recycle flow should be less than or equal to 10 percent of the plant influent flow.

2. Raw water and recycle flows should be controlled to avoid hydraulic surges. Equalization should be provided for recycle flows.

3. The recycled water treatment process should be selected and designed to achieve turbidities of less than 2.0 Nephelometric Turbidity Units (NTU).

4.3 Storage Capacity

A 2.5 MG tank located at the WTP is the only existing storage tank within the City water system. In a 2011 memorandum [15], CDPH staff commented on the reliability of the City water system and, specifically, the storage tank and the transmission pipeline from the WTP into the City. To avoid service interruptions, the memorandum stated that “the City needs one more storage tank and a transmission main to store and carry treated water from the water treatment plant to the distribution system. The second storage tank and the new transmission main will operate in parallel to the existing domestic water supply system that comprises of a 2.5 MG storage tank and a 14-inch transmission main.”

Storage capacity within the City water system will be evaluated based upon the California Waterworks Standards [10], the City of Angels 2010 Improvement Standards [16], and operation and maintenance considerations. The following criteria will be applied:

1. The system should be able to meet four hours of PHD with source capacity, storage capacity, and/or emergency source connections.

2. Storage capacity should be sufficient to satisfy demands during reasonably foreseeable shutdowns of the wooden flume system that conveys water to the City from the North Fork of the Stanislaus River.

3. Storage capacity should be greater than or equal to the sum of the required fire storage, operational (system peaking) storage, and emergency storage. Fire storage requirements are calculated based on the flows and durations presented in Table 4-1 from City Resolution 21-78. Operational storage is equal to 20 percent of the MDD. Emergency storage is equal to four hours of MDD.

4. City staff should have the ability to remove a tank from service for repairs, inspection, maintenance, cleaning, and re-coating without causing service interruptions.

TABLE 4-1
CITY OF ANGELS WATER MASTER PLAN
FIRE FLOW REQUIREMENTS

Land Use Category	Fire Flow[a] (gpm)	Duration[a] (hrs)
Rural residential (<2 lots/acre)	500	2
Single family residential (<2 lots/acre)	500	2
Single family residential (≥3 lots/acre)	750	2
Multiple residential up to a fourplex; neighborhood businesses of one story	750	2
Multiple residential units of >4 units, one and two story; light commercial and light industrial	1,500	2
Multiple residential, three stories; heavy commercial, and heavy industrial	2,000	2

[a] Fire flows and durations established in City Resolution 21-78.

4.4 Distribution System

The City distribution system includes five pressure zones, and all of the pressure zones receive water by gravity from the WTP. Certain pressure zones contain piping that has been in use for more than 50 years, and pipe sizes range from 2-inch to 14-inch. Some pipe sizes are unknown.

As part of the master planning process, a computer model of the distribution system was developed. Computer simulations were used to evaluate the distribution system and identify necessary improvement projects. Evaluation and design criteria are summarized in Table 4-2.

TABLE 4-2
CITY OF ANGELS WATER MASTER PLAN
DISTRIBUTION SYSTEM EVALUATION AND DESIGN CRITERIA

Criteria	Value	Source
Minimum pressure – ADD[a]	40 psi[b]	2010 Improvement Standards [16]
Minimum pressure – MDD	35 psi	Typical design standard
Minimum pressure – PHD	20 psi	California Waterworks Standards [10]
Minimum pressure – fire flow plus MDD	20 psi	2010 Improvement Standards [16], California Waterworks Standards [10]
Maximum pressure at service connection	150 psi (PRV required at 80 psi)	2010 Improvement Standards [16]
Maximum velocity	8 fps[c] (typical) 12 fps (short durations)	Typical design standards
Maximum head loss gradient	10 ft per 1,000 ft	Typical design standard
Minimum main size	4-inches	California Waterworks Standards [10]

[a] ADD = average day demand
[b] psi = pounds per square inch
[c] fps = feet per second

5 Existing and Projected Water Demands

The purpose of this chapter is to develop an appropriate water demand factor for existing and future land uses to predict future water demands for the 10-year and 20-year planning horizons as well as for buildout conditions.

5.1 Study Area

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 SOI beyond the City limits. Water supplies for areas requiring annexation will be the subject of future technical studies. Land use data for the City provided in GIS format were utilized for the development of this chapter. The furnished data encompassed a total area of approximately 2,280 acres (ac) within the City limits (see Figure 3-1).

5.2 Land Use

City GIS data were analyzed to determine the distribution of existing and future land uses within the study area. 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 5-1.

TABLE 5-1
CITY OF ANGELS WATER MASTER PLAN
LAND USE DESCRIPTIONS

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

a. Existing Areas

Overall land use characteristics were used to develop an appropriate water demand factor reflecting historical water demands. A summary of existing developed land uses (including partially developed areas) is presented in Table 5-2 and Figure 5-1. Parcels designated as ROW and OS were assumed to have no water demands and were excluded from the analysis of existing demands.

TABLE 5-2
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF EXISTING LAND USES

Land Use	Number of Parcels[a]	Total Developed Area[a] (ac)
Residential		
HDR	128	80
MDR	68	51
RE	10	14
SFR	1,190	372
HDR-WMC	19	21
Commercial		
BAE	21	26
CC	101	65
HC	79	16
SC	39	32
Industrial		
I	5	16
Public		
P	22	28
P (WWTP)	2	18
P-SCH	8	50
PR	9	18
PR-Golf	5	144
Other		
SP	1	4
OS	5	12
ROW	154	216
Total	**1,866**	**1,183**

[a] Includes partially-developed land uses.

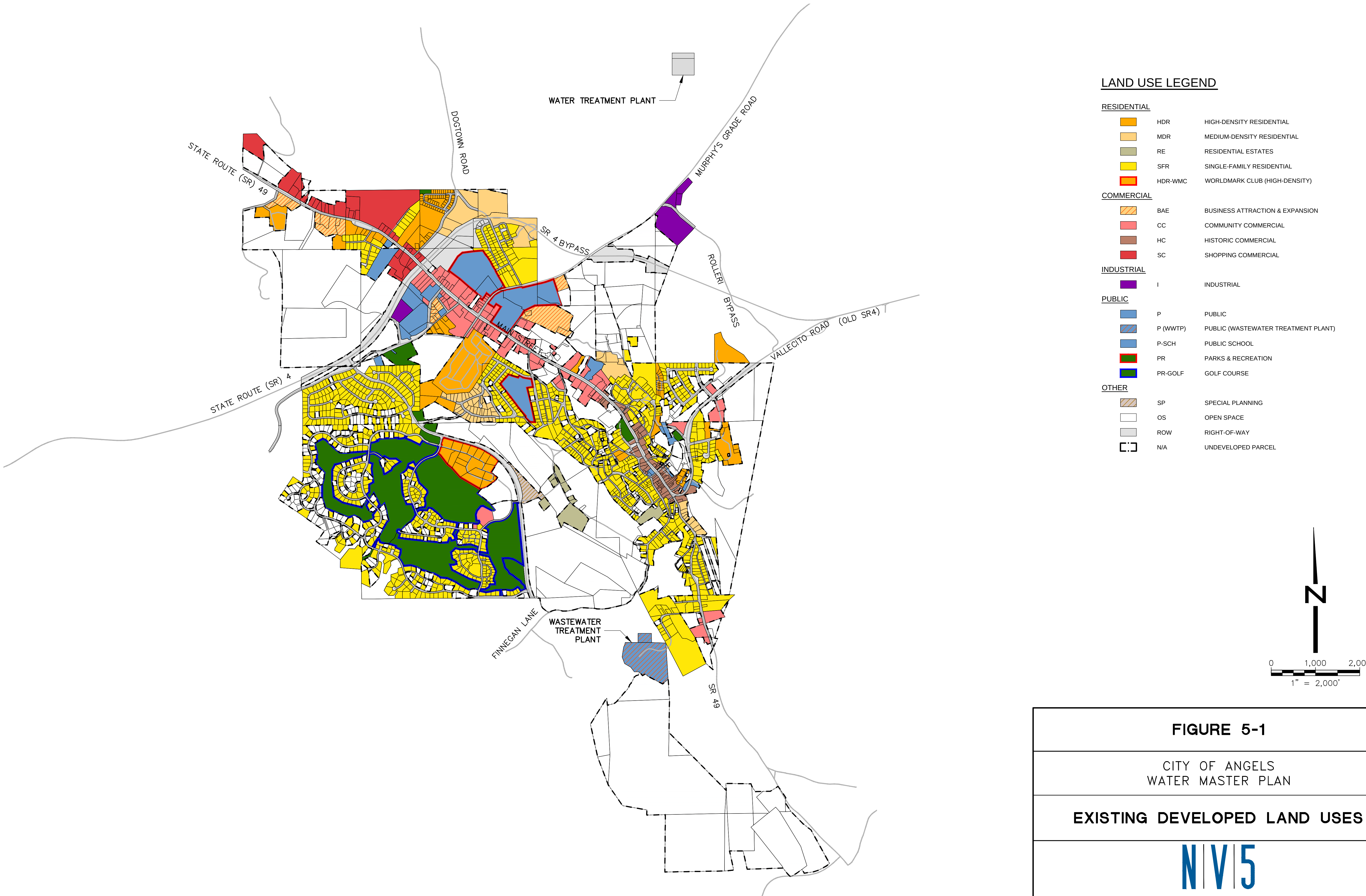


FIGURE 5-1

CITY OF ANGELS
WATER MASTER PLAN

EXISTING DEVELOPED LAND USES

NV5
BEYOND ENGINEERING

n:\mtb020401\Cadd\ET_WaterMP\final\5-1 Existing Use.dwg JCP/KT 2/6/2013

b. Future Areas

Land uses for parcels shown in the GIS files were used to estimate future water demands. A summary of buildout land use is presented in Table 5-3 and displayed in Figure 5-2.

TABLE 5-3
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF BUILDOUT LAND USES

Land Use	Number of Parcels[a]	Total Buildout Area[a] (ac)
Residential		
HDR	163	223
MDR	75	54
RE	26	126
SFR	1,472	507
HDR-WMC	19	21
Commercial		
BAE	31	59
CC	133	102
HC	85	21
SC	50	97
Industrial		
I	11	32
Public		
P	28	31
P (WWTP)	19	266
P-SCH	8	50
PR	10	22
PR-Golf	5	144
Other		
SP	36	297
OS	5	12
ROW	154	216
Total	**2,330**	**2,280**

[a] Includes developed, partially developed, and vacant land uses.

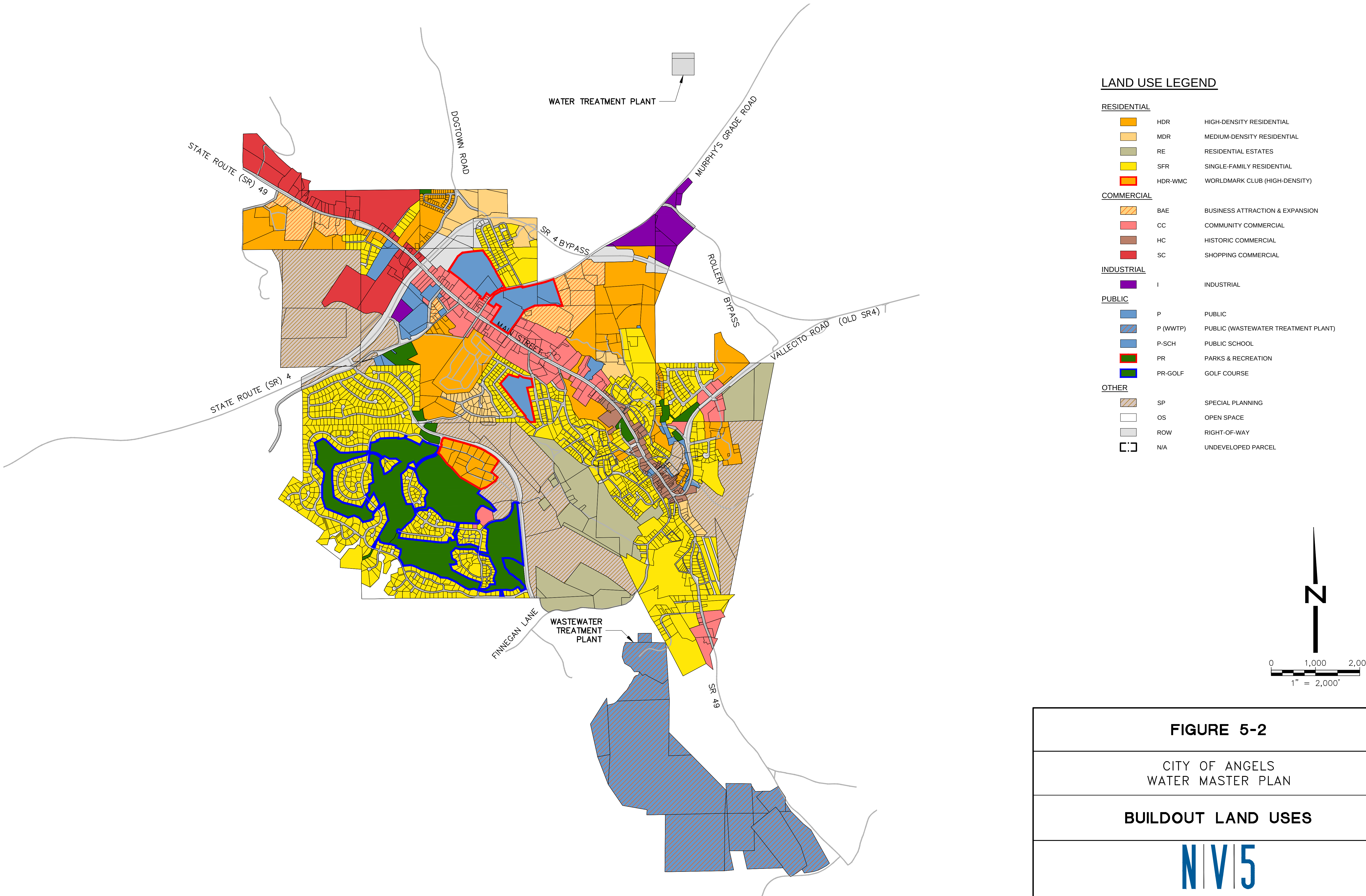


FIGURE 5-2

CITY OF ANGELS
WATER MASTER PLAN

BUILDOUT LAND USES

NV5
BEYOND ENGINEERING

5.3 Analysis of Existing Water Demands

Historical water production and consumption data were analyzed to determine non-revenue water (i.e., system losses), peaking factors, an appropriate water demand factor, and other parameters to estimate and allocate existing and projected future water demands. Water production data are based on influent flow meter records of raw water delivered to the WTP. Consumption data were compiled from customer billing records based on water meter readings.

The GHC Golf Course meets its irrigation demands with a combination of direct diversions of surface waters from Angels Creek and seasonal use of recycled water from the WWTP. Although the GHC Golf Course does not receive finished waters produced by the WTP, the diversions from Angels Creek are included as part of the City's annual deliveries of surface water from UPA. GHC Golf Course irrigation demands are not a component of the historical water production from the WTP and metered City water usage data but were evaluated separately for inclusion in future water requirements for the City.

a. Water Production

Water production data are based on influent flow meter (aka, upper plant meter) records of raw water delivered to the WTP. The influent flow meter is located upstream of the plant headworks. Historical monthly water production data for the City WTP are presented in Table 5-4. As shown in Table 5-4, the annual production at the WTP from 2007 to 2011 ranged from 275 MG to 339 MG, corresponding to an average day production of 0.75 mgd and 0.93 mgd, respectively. The 2007-2012 average annual production is 314 MG and corresponds to an average day production of 0.86 mgd. The 2007-2012 average day production of 0.86 mgd is used in this chapter as an overall target value for water demand factor development and calibration.

TABLE 5-4
CITY OF ANGELS WATER MASTER PLAN
HISTORICAL MONTHLY WATER PRODUCTION,
WATER TREATMENT PLANT, 2007-2012

Month	Monthly Production[a] (MG)						2007-2012 Average (MG)
	2007	2008	2009	2010	2011	2012	
Jan	16.2	16.5	13.4	13.8	13.0	18.2	15.2
Feb	14.4	14.8	11.4	11.7	11.9	16.7	13.5
Mar	18.4	18.3	14.1	14.3	13.9	15.8	15.8
Apr	20.8	26.5	21.3	13.9	16.1	18.3	19.5
May	30.5	32.8	30.3	20.2	26.7	34.2	29.1
Jun	38.3	38.3	32.4	31.2	32.2	38.7	35.2
Jul	46.1	44.3	42.0	40.8	46.0	42.8	43.7
Aug	47.3	47.5	40.7	40.1	47.3	-	44.6
Sep	36.4	37.4	35.1	34.2	41.8	-	37.0
Oct	26.6	28.5	25.0	25.8	27.2	-	26.6
Nov	20.6	18.3	18.4	15.4	18.4	-	18.2
Dec	16.3	15.6	15.0	13.2	17.8	-	15.6
Total	**332**	**339**	**299**	**275**	**313**	**-**	**314**
Total (AF)	1,018	1,039	918	843	959	-	963
Average Day (mgd)	0.91	0.93	0.82	0.75	0.86	-	0.86

[a] The monthly production data is from the WTP influent flow meter (upper plant meter).

Water production data based on the WTP influent flow meter as presented in Table 5-4 are useful for evaluations of available water supply and distribution system performance. However, it should be noted that the WTP influent flow meter does not account for water used in various unit processes at the plant. Process water is drawn from the storage tank outlet to generate sodium hypochlorite solution and represents a significant demand at the WTP. Process water is included in the projected demands for evaluation of the WTP unit processes in Chapter 7.

b. <u>2012 Water Production Trends</u>

Trends in water production for the beginning of 2012 show significant increases as compared to 2011 and more closely represent trends in the dry-years of 2008 and 2009. As shown in Table 5-5, monthly water production in 2012 is up to 40 percent higher than the monthly production in 2011. The apparent increasing water production trends in 2012 may be related to: 1) increased irrigation resulting from a relatively dry winter; and 2) changes in the City water rate structure (the addition of 1,000 cubic feet to the monthly base rate). Because the apparent increase in plant production in 2012 may represent a long-term trend, average water production rates for 2007-2012 (as shown in Table 5-4) will serve as the “starting point” for demand projections.

TABLE 5-5
CITY OF ANGELS WATER MASTER PLAN
2012 MONTHLY WATER PRODUCTION,
WATER TREATMENT PLANT, JANUARY-JULY

Month	2012 Monthly Production (MG)	Percent Increase from 2011[a]
Jan	18.2	40%
Feb	16.7	40%
Mar	15.8	14%
Apr	18.3	13%
May	34.2	28%
Jun	38.7	20%
Jul	42.8	-7%

[a] Per Table 5-4.

c. Metered Water Usage

The City's water system serves a population of approximately 3,836 people [17, 18] through 1,769 service connections. The number of metered service connections by user type as reported to DWR for 2011 is presented in Table 5-6. In addition to the metered service connections, the City reports an additional 350 unmetered connections for fire hydrants and other fire service related connections [6].

TABLE 5-6
CITY OF ANGELS WATER MASTER PLAN
METERED WATER SERVICE CONNECTIONS BY USER TYPE FOR 2011

User Type	Number of Metered Connections
Single Family Residential	1,469
Multi-Family Residential[a]	33
Commercial/Institutional[b]	211
Industrial	3
Landscape Irrigation[c]	47
Other[d]	3
Agricultural Irrigation[e]	3
Total	**1,769**

[a] "Multi-Family Residential" includes condominiums, apartment complexes, and mobile home parks.

[b] "Commercial" includes general businesses, restaurants, hotels/motels, markets, laundromats, and car washes. The GHC Timeshare has 7 commercial accounts for their restaurant, pools, restrooms, spa lockers, and a lift station. "Institutional" includes schools, City buildings (such as City Hall, the Firehouse, and the Police Department), City parks, and process water for the WTP and WWTP [19].

[c] "Landscape Irrigation" represents areas where the meter is used strictly for landscaping and includes subdivision and business landscaping, but excludes City parks. The GHC Timeshare has 3 landscape irrigation accounts [19].

[d] "Other" includes construction meters.

[e] "Agricultural Irrigation" represents areas for crops and raising cattle/animals [19].

Historical metered water usage by user type is presented in Table 5-7. As shown in Table 5-7, the metered water usage from 2007 to 2011 ranged from 260 MG to 325 MG. The 2007-2011 average annual water usage is 293 MG which corresponds to an ADD of 0.80 mgd.

TABLE 5-7
CITY OF ANGELS WATER MASTER PLAN
HISTORICAL METED WATER USAGE BY USER TYPE, 2007-2011

	Metered Water Usage (MG)					2007-2011 Average (MG)	Percent of Total
User Type	**2007**	**2008**	**2009**	**2010**	**2011**		
Single Family Residential	203.0	202.0	187.8	165.9	169.8	185.7	63%
Multi-Family Residential	17.0	19.0	15.7	14.5	12.0	15.6	5%
Commercial/Institutional	81.0	81.0	71.7	67.3	62.8	72.8	25%
Industrial	2.0	2.0	1.7	0.9	0.6	1.4	0.5%
Landscape Irrigation	16.0	16.0	13.8	13.3	13.3	14.5	5%
Other	2.0	1.0	0.8	0.4	0.1	0.8	0.3%
Agricultural Irrigation	3.0	3.0	3.1	2.2	1.9	2.6	0.9%
Total	**325**	**323**	**294**	**264**	**260**	**293**	**100%**
Total (AF)	997	991	904	811	799	901	-
Average Day (mgd)	0.89	0.88	0.81	0.72	0.71	0.80	-

d. Non-Revenue Water

Non-revenue water (aka, unaccounted-for water) is the distributed volume of water that is not reflected in customer billings. Non-revenue water as defined by AWWA is the sum of unbilled authorized consumption (water for firefighting, flushing, etc.) plus apparent losses (customer meter inaccuracies, unauthorized consumption, and systematic data handling errors) plus real losses (system leakage and storage tank overflows) [20]. Non-revenue water for the City also includes system losses at the WTP from process water including filter backwashing and equipment wash-downs (i.e., unrecovered or non-recycled water).

Non-revenue water from 2007 through 2011 is presented in Table 5-8. As shown in Table 5-8, the 2007-2011 average for non-revenue water is 6.1 percent of the total water produced. The high percentage of non-revenue water in 2011 of 16.9 percent may be due to the installation of a new influent flow meter at the WTP in February 2011 [21]. Although losses of less than 10 percent are typically an indicator of good water system performance, AWWA recommends against gauging water losses as a percentage total production [20]. For a more meaningful assessment of the system's water losses and the effect on City revenues, AWWA recommends the International Water Association (IWA)/AWWA Water Audit Method [20]. The IWA/AWWA Water Audit Method relies upon the quantification of water volumes, costs, and system characteristics as input to several performance indicators to reveal water loss standing rather than relying on a single, simplistic percentage of unaccounted-for water [20]. However, for the purpose of this Master Plan, the 2007-2011 average for non-revenue water of 6.1 percent will be used as an adjustment to account for non-revenue water demands in Section 5.3-e, Per Capita Water Demands.

TABLE 5-8
CITY OF ANGELS WATER MASTER PLAN
NON-REVENUE WATER, 2007-2011

Parameter	2007	2008	2009	2010	2011	2007-2011 Average
Total Annual Production[a] (MG)	332	339	299	275	313	312
Total Annual Metered Usage[b] (MG)	325	323	294	264	260	293
Non-Revenue Water (MG)	7	16	5	11	53	19
Non-Revenue Water (%)	2.1%	4.7%	1.7%	4.0%	16.9%	6.1%

[a] See Table 5-4.

[b] See Table 5-7.

e. Per Capita Water Demands

City population data and per-capita water demands based on existing water production and customer billing records are summarized in Table 5-9. As shown in Table 5-9, the total residential water demand adjusted to account for non-revenue water demand is 586,000 gpd. The adjusted total residential water demand divided by the current City population of 3,836 results in an average per capita water demand of 153 gallons per capita per day (gpcd). For comparison, City 2010 Improvement Standards Section 16.06.01 [16] identifies a design per capita demand of 150 gpcd, within 2 percent of the calculated demand of 153 gpcd. The adjusted total residential water demand of 586,000 gpd will be used as a target value for validation of the water demand factor determined in Section 5.5, Development of Water Demand Factor.

TABLE 5-9
CITY OF ANGELS WATER MASTER PLAN
EXISTING PER CAPITA WATER DEMAND

Parameter	Value
Current Population (Capita)[a]	3,836
Total Residential Water Demand (gpd)[b,c]	552,000
Adjusted Total Residential Water Demand (gpd)[d]	586,000
Average Per Capita Water Demand (gpcd)	153

[a] April 2010 population estimate from Dept. of Finance, Table E-4 [17, 18].

[b] 2007-2011 average metered water usage for single-family and multi-family residential calculated from values in Table 5-7 (excludes non-residential water usage).

[c] gpd = gallons per day

[d] Total residential demand including allowance for non-revenue water demand (assume average non-revenue demand of 6.1% per Table 5-8).

f. Greenhorn Creek Golf Course Irrigation Demands

As discussed previously, GHC Golf Course meets its irrigation demands with a combination of surface waters from Angels Creek and recycled water from the WWTP. Irrigation with recycled water began in April 2009 [21]. Historical surface water deliveries for irrigation of GHC Golf Course are summarized in Table 5-10. As shown in Table 5-10, the average annual surface water delivery for GHC Golf Course is 55.0 MG (169 AF).

TABLE 5-10
CITY OF ANGELS WATER MASTER PLAN
HISTORICAL SURFACE WATER DELIVERIES FOR IRRIGATION OF GHC GOLF COURSE, 2009-2011

	Monthly Irrigation with Surface Water (MG)			2009-2011 Average
Month	**2009**	**2010**	**2011**	**(MG)**
Apr	0.0	0.0	4.5	1.5
May	0.0	1.7	10.5	4.1
Jun	9.4	10.1	13.1	10.9
Jul	17.2	13.1	14.8	15.0
Aug	14.6	17.1	5.3	12.3
Sep	9.4	12.7	7.6	9.9
Oct	3.9	0.0	0.0	1.3
Total	**54.4**	**54.7**	**55.8**	**55.0**
Total (AF)	167	168	171	169
Average Day (mgd)	0.15	0.15	0.15	0.15

In addition to the 55.0 MG (169 AF) of creek water, the average delivery of recycled water for the years 2009-2011 was 31.0 MG (95 AF) for a total irrigation demand of 86.0 MG (264 AF). In 2012, 53.6 MG (165 AF) of creek water and 50.1 MG (154 AF) of recycled water was delivered to GHC Golf Course for a total irrigation demand of 104 MG (319 AF).

An agreement between the City and Greenhorn Creek Associates L.P. allows up to 147 MG/year (450 AFY) of Angels Creek surface water for irrigation of the GHC Golf Course [2]. In a worst case scenario, if the WWTP failed to produce recycled water meeting Title 22 Standards, GHC Golf Course would be entitled to take their entire supply from Angels Creek. . Historically, the largest irrigation demand recorded for GHC Golf Course occurred in 2012. The combined surface water diversion and recycled water delivery for golf course irrigation in 2012 was 104 MG (319 AFY). For future water demand projections, the annual irrigation demand for GHC Golf Course is assumed at this maximum historical value.

5.4 Peaking Factors

Peaking factors are used to calculate the water demands expected under varying demand conditions greater than average annual demands. The resulting demand conditions are used in the hydraulic analysis of the distribution system. Typical peaking factors necessary for the hydraulic evaluation and sizing of improvements include the ratio of MDD to ADD and the ratio of PHD to MDD. Peaking factors are obtained from a review of historical water production data and previous studies.

a. Maximum Day Demand

The maximum day peaking factor is the ratio of the maximum day production for the WTP to the average day production for the year. Water transmission, treatment, and pumping facilities are typically sized for MDD. The average annual and maximum day production for 2007 to 2010 are shown in Table 5-11. Daily production records for 2011 were not evaluated but the City confirmed that maximum day production in 2011 did not exceed 2.0 MG [21]. Based on analysis of the data presented in Table 5-11, the recommended maximum day peaking factor is 2.2.

TABLE 5-11
CITY OF ANGELS WATER MASTER PLAN
MAXIMUM DAY PRODUCTION PEAKING FACTORS, 2007-2010

	Year			
Item	**2007**	**2008**	**2009**	**2010**
Date of Maximum Day Production[a]	July 6/7	Aug 17/18	July 27/28	Oct 5
Maximum Day Production (MG)	1.80	2.00	1.61	1.66
Average Day Production (MG)[b]	0.91	0.93	0.82	0.75
Maximum Day Peaking Factor	2.0	2.2	2.0	2.2

[a] Per 2011 Water Audit [6].

[b] See Table 5-4.

The recommended maximum day peaking factor of 2.2 is based on actual production data and is intended for master planning purposes (e.g. timing of improvements in the CIP). Even so, the recommended factor of 2.2 is consistent with the City 2010 Improvement Standards which specify a maximum day peaking factor of 2.0 or 3.0 depending on the project size [16]. The recommended factor is also consistent with historical data presented in the City's CDPH permit amendment for 1993 and 1994 with maximum day peaking factors of 2.2 and 2.3, respectively [22]. The City's water supply permit limits the maximum flow rate through the WTP to 1,440 gpm [23]. City growth rates in conjunction with the recommended maximum day peaking factor will influence the timing of improvements needed at the WTP.

b. Peak Hour Demand

The PHD factor is the ratio of the highest hourly demand to the MDD and represents the greatest diurnal demand. PHD is typically met by utilizing water in water storage facilities. Hourly meter records were not available, but the estimated PHD during the summer based on previous studies is 2,400 gpm (3.46 mgd) [6]. The ratio of the estimated PHD of 2,400 gpm (3.46 mgd) to the maximum day production of 2.00 mgd in 2008 (per Table 5-11) is 1.7. Based on this calculation, the recommended PHD factor is 1.7 which is consistent with California Waterworks Standards that specify a minimum PHD factor of 1.5 [10]. The City 2010 Improvement Standards do not specify a PHD factor.

5.5 Development of Water Demand Factor

A water demand factor was developed on the basis of an equivalent water unit (EWU) for consistency with the methodology used in the City Wastewater Master Plan [18]. This section summarizes conversion factors of EWU/ac for the different land uses and an appropriate gpd/EWU water demand factor.

a. Summary of Equivalent Water Unit Conversion Factors

Existing and future EWU conversion factors for residential, commercial, public, and special planning land uses are summarized in Table 5-12. The detailed analysis for development of the existing conversion factors is included as an excerpt from the City Wastewater Master Plan in Appendix A. Future conversion factors are based on projected land use densities presented in the General Plan [1]. Existing EWU conversion factors presented in Table 5-12 were used to develop a water demand factor on the basis of an EWU. The water demand factor was then used in conjunction with the existing and future EWU conversion factors to estimate future water demand projections.

TABLE 5-12
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF EWU CONVERSION FACTORS

	Conversion Factor[a] (EWU/ac)	
Land Use	**Existing**	**Future[b]**
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 (WWTP)[c]	5.0	0.0
P-SCH	10.0	10.0
PR	4.0	4.0
Other		
SP	1.5	1.5

[a] Existing and future conversion factors from the City Wastewater Master Plan [18]. OS and ROW land uses are excluded from the table and the development of a water demand factor because no water demands are assumed for these land uses. The PR-Golf land use is also excluded from the table because irrigation demands associated with GHC Golf Course were evaluated separately.

[b] Future conversion factors based on projected General Plan [1] densities.

[c] Water demands are not anticipated for future WWTP areas. Potential increases in water demands at the existing 18 ac WWTP site associated with future expansions are assumed to be met with Title 22 recycled water.

As shown in Table 5-12, future EWU conversion factors for RE and BAE are lower than existing EWU conversion factors. The existing EWU conversion factor for RE was based on an analysis of existing parcel sizes for areas with the RE land use designation [18]. The existing EWU conversion factor for BAE was based on an analysis of existing developed commercial parcel areas [18]. The future EWU conversion factors, including the factors for RE and BAE, are from the General Plan [1, 18].

There are approximately 18 ac developed and 248 ac vacant at the WWTP site. In Table 5-12, the future conversion factor for P (WWTP) is 0.0 EWU/ac based on the assumption that no water demands will be associated with the future 248 ac at the WWTP site. It is assumed that process water used at the WWTP is accounted for in the water demands associated with the existing 18 ac of WWTP site. Potential increases in water demands at the existing 18 acre WWTP site associated with future expansions are assumed to be met with Title 22 recycled water.

b. Calculation of Water Demand Factor

Using the existing EWU/ac conversion factors and the 2007-2012 average day production of 0.86 mgd, a water demand factor in terms of gpd/EWU was determined. Table 5-13 summarizes the values used to estimate the appropriate water demand factor.

TABLE 5-13
CITY OF ANGELS WATER MASTER PLAN
CALCULATION OF WATER DEMAND FACTOR

Land Use	Total Developed Area[a] (ac)	Existing Density[b] (EWU/ac)	Total Existing EWU
Residential			
HDR	80	5.0	400
MDR	51	3.0	153
RE	14	2.0	28
SFR	372	4.0	1,488
HDR-WMC	21	9.5	200
Commercial			
BAE	26	2.0	52
CC	65	2.0	130
HC	16	2.0	32
SC	32	2.0	64
Industrial			
I	16	2.0	32
Public			
P	28	5.0	140
P (WWTP)	18	5.0	90
P-SCH	50	10.0	500
PR	18	4.0	72
Other			
SP	4	1.5	6
Total	**811**		**3,387**
Total Existing Production[c] (gpd)			860,000
Water Demand Factor (gpd/EWU) (rounded)			**255**

[a] See Table 5-2. Excludes ROW, OS, and PR-Golf.

[b] Existing EWU conversion factor (see Table 5-12).

[c] 2007-2012 average day production (see Table 5-4).

A water demand factor of 255 gpd/EWU results from using the method described in this chapter. It should be noted that the water demand factor is based on an EWU, not per capita or per dwelling unit, and is to be used only with the EWU conversion factors presented in Table 5-12. For context, there are a total of 1,769 existing water meter connections in the City and a total of 3,387 existing EWUs as calculated in Table 5-13. The number of water meters is not comparable to the number of EWUs.

c. Comparison of Estimated Versus Actual Residential Water Demands

A comparison of estimated residential water demands to actual metered residential water usage is presented in Table 5-14. As shown in Table 5-14, a water demand factor of 255 gpd/EWU, along with the existing EWU conversion factors provided in Table 5-12, produces a total estimated residential demand of 579,000 gpd, within 1.2 percent of the "target" residential water demand of 586,000 gpd.

TABLE 5-14
CITY OF ANGELS WATER MASTER PLAN
COMPARISON OF ESTIMATED VERSUS ACTUAL RESIDENTIAL WATER DEMANDS

Residential Use	Total Developed Area[a] (ac)	Conversion Factor[b] (EWU/ac)	Total Existing EWU	Water Demand Factor (gpd/EWU)	Estimated Water Demand (gpd)
HDR	80	5	400	255	102,000
MDR	51	3	153	255	39,000
RE	14	2	28	255	7,100
SFR	372	4	1,488	255	379,400
HDR-WMC	21	10	200	255	50,900
Total Estimated Residential Water Demand (gpd)					**579,000**
Total Actual Residential Water Demand, Adjusted[c] (gpd)					586,000
Percent Difference					**-1.2%**

[a] See Table 5-2.

[b] Existing EWU conversion factor (see Table 5-12).

[c] 2007-2011 average metered water usage for single family and multi-family residential adjusted for non-revenue water (see Table 5-9).

d. Review of Recommended Water Demand Factor

A water demand factor of 255 gpd/EWU is recommended for master planning purposes and projections of future water demands. As mentioned previously, the recommended water demand factor is based on an EWU, not per capita or per dwelling unit, and is to be used only with the EWU conversion factors presented in Table 5-12. The water demand factor of 255 gpd/EWU is designed to mimic water production at the WTP including non-revenue water as described in Section 5.3-d, Non-Revenue Water.

Selection of a water demand factor is a critical step in the hydraulic evaluation of the treatment and distribution system. Use of a greater than appropriate water demand factor will result in overestimation of projected water demands; infrastructure oversizing; or scheduling projects to increase capacity of supply, treatment, and distribution systems earlier than necessary. Conversely the use of a lower than appropriate water demand factor could result in lower water demand projections; infrastructure undersizing; and disconnects in scheduling appropriate supply, treatment, and distribution system projects to address capacity shortfalls.

5.6 Projection of Future Water Demands

Future water demands were projected for 10-year, 20-year, and buildout conditions using an assumed growth rate and water demand factor of 255 gpd/EWU for future development in conjunction with a base-year water demand for existing development. Conversion factors (EWU/ac) for future development, presented previously in Table 5-12, were based on land use densities in the General Plan [1].

Base year water demands, projected growth, and future estimated water demands are discussed below.

a. Base Year

The base year for water demand calculations is 2011. For the 2011 base year, there are a total of 3,387 EWUs representing existing development as shown in Table 5-13. With a water demand factor of 255 gpd/EWU, the base year ADD is 864,000 gpd. A breakdown of the base year water demands by land use type is provided in Appendix B.

b. Projected Growth

Average annual growth rates presented in the Land Use Element of the General Plan [1] vary from 1.80 to 2.52 percent. Observed growth rates from 2008-2010 have been significantly lower, ranging from 0.13 to 1.23 percent, as reported by the California Department of Finance. Based on the growth rates presented in the General Plan [1], a mid-range annual growth rate of 2.16 percent is recommended for future growth projections. The 2.16 percent annual growth rate is consistent with the City Wastewater Master Plan [18].

A base year 2011 population of 3,919 was determined using the published 2010 census population of 3,836 [17, 18] and a mid-range annual growth rate of 2.16 percent.

c. Projection of 10-Year, 20-Year, and Buildout Water Demands

The total EWUs for buildout conditions were calculated based on buildout land use areas provided in Table 5-3 combined with existing and future EWU/ac conversion factors provided in Table 5-12. The 2.16 percent average annual growth rate was applied uniformly to each land use for projections of 10-year and 20-year EWUs and water demands. Estimated City-wide population; development (EWUs); and water demand projections for 10-year, 20-year, and buildout conditions are provided in Table 5-15. Detailed water demand projection calculations are included in Appendix C. As shown in Table 5-15, the available water supply of 1,281 AFY (1,600 AFY less 319 AFY historical maximum demand for GHC Golf Course) will be exceeded in the year 2024.

TABLE 5-15
CITY OF ANGELS WATER MASTER PLAN
PROJECTED POPULATION, DEVELOPMENT, AND WATER DEMANDS

Projection (Year)	Population[a]	Total EWU[a]	Percent of Buildout[b]	Projected ADD (gpd)	Projected Annual Demand[c] (MG)	(AF)
Base Year (2011)	3,919	3,387	41%	864,000	315	967
10-year Projection (2021)	4,853	4,194	51%	1,069,000	390	1,197
20-year Projection (2031)	6,009	5,193	64%	1,324,000	483	1,482
Buildout (2052)	9,453	8,170	100%	2,084,000	761	2,336

[a] Population and EWU projections using a 2.16% growth rate.

[b] Percent of buildout based on existing and/or projected EWU relative to total buildout EWU.

[c] Available supply of 1,281 AFY (1,600 AFY less 319 AFY historical maximum demand for GHC Golf Course) will be exceeded in the year 2024.

d. Projection of Water Demands Including Greenhorn Creek Golf Course

Water demand projections including GHC Golf Course irrigation demands are summarized in Table 5-16. A worst case scenario is assumed for water demand projections in which the WWTP fails to produce reclaimed water meeting Title 22 Standards and GHC Golf Course is entitled to take their entire supply from Angels Creek. For the base year, the annual irrigation demand for GHC Golf Course is 86.0 MG (264 AF) based on the 2009-2011 averages for surface water and recycled water deliveries. For future water demand projections, the annual irrigation demand for GHC Golf Course is assumed at this maximum historical value. Historically, the largest irrigation demand recorded for GHC Golf Course occurred in 2012. The combined surface water diversion and recycled water delivery for irrigation of GHC Golf Course in 2012 was 104 MG (319 AF).

TABLE 5-16
CITY OF ANGELS WATER MASTER PLAN
WATER DEMAND PROJECTIONS INCLUDING
GHC GOLF COURSE SURFACE WATER IRRIGATION DEMANDS

	Projected Annual Demand (MG/year)			Projected Annual Demand (AFY)		
Projection (Year)	**City[a]**	**GHC Golf Course**	**Total**	**City[a]**	**GHC Golf Course**	**Total[d]**
Base Year (2011)	315	86[b]	401	967	264[b]	1,231
10-year Projection (2021)	390	104[c]	494	1,197	319[c]	1,516
20-year Projection (2031)	483	104[c]	587	1,482	319[c]	1,801
Buildout (2052)	761	104[c]	865	2,336	319[c]	2,655

[a] See Table 5-15.

[b] 2009-2011 average GHC Golf Course irrigation demand is 55.0 MG (169 AF) of surface water from Angels Creek and 31.0 MG (95 AF) of recycled water (Section 5.3).

[c] 2012 GHC Golf Course irrigation demand is 53.6 MG (165 AF) of surface water from Angels Creek and 50.1 MG (154 AF) of recycled water (Section 5.3).

[d] Available supply of 1,600 AFY will be exceeded in the year 2024.

5.7 Conclusions

Using historical water production, consumption data, and EWU estimates for the City, this chapter documents a recommended water demand factor of 255 gpd/EWU. The recommended water demand factor and peaking factors are used to project MDD and PHD for evaluation of the supply, treatment, and distribution system capacity requirements.

Critical assumptions which affect the calculated water demand factor and future water demand projections include:

1. EWU densities used for particular land uses (e.g., the number of EWUs per ac).

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

6 Current and Future Water Supplies

This chapter presents the history and agreements governing water supplies in Calaveras County (County) and provides a discussion of alternate water supply strategies for the City.

6.1 Overview

The history of water supply in the County is entwined with the gold mining industry and the influx of people coming to seek their fortune. Water was needed for the mining of gold, the production of power, and the potable water uses of the growing population. The North Fork of the Stanislaus River and multiple tributaries are the key sources of water delivered to and utilized by the City. To understand the current water supply available, the history of water resources in the area (watershed) will be reviewed.

6.2 History of Water Supply Development

In 1848, the town of Murphys (Town) and the surrounding area was inundated with gold seekers. Gold mining was easier in the rainy season because runoff in the watershed was available to wash gold from the gravels. Water was also needed to power the tools used in the mining industry. In addition, to support the growing population, there became a critical need for a reliable and adequate water supply.

Gold miners were employed to build a series of flumes and ditches with picks, shovels, and mules to bring water to where it was needed most. Eventually, several small dams and reservoirs were also constructed. In the beginning, a sawmill was needed to produce lumber for construction of the flumes. The miners took advantage of the natural energy that the water would supply and built a water-powered sawmill just downstream from the head of the flume. The mill straddled the creek; and because it was at the high end of the water conveyance system, the lumber produced at the mill could easily float down the constructed flumes and canals to construction sites downstream. Thus, out of need for the support of the gold mining industry, an intricate water delivery system was created upstream of the Town.

The following paragraphs provide a brief history of the water supply dating from 1852 to the present. A series of water and power companies and utility districts have been formed to convey and distribute water and power throughout the watershed and each of the key entities is described. A schematic of the major facilities along the watershed upstream of the City was prepared by the UPA and is provided in Appendix D.

a. <u>Union Water Company</u>

In 1852, the Union Water Company (UWC) was formed by two companies that were already working to tap the local watershed of Angels Creek and the Mill Creek. Shortly after, in 1854, UWC looked beyond the local watershed to the North Fork of the Stanislaus River.

The long dry summers limited the water flows in creeks, so UWC constructed Union Reservoir in 1858. Also at this time, the UWC acquired the Calaveras County Water Company (CCWC), which had built a roughly parallel ditch from a diversion point on the North Fork of the Stanislaus River. The ditch, known as the Upper Utica Canal, was considered to be superior to the one used by the UWC. Gold miners built the entire Utica flume and canal system to utilize gravity flow from McKays Dam through the Upper Utica Canal to Hunter's Reservoir and on to the mines. The Lower Utica Canal delivers water from Hunter's Reservoir to Murphys.

b. Utica Gold Mining Company

The Utica Gold Mining Company (UGMC) owned some of the richest mines in the County. The mining company acquired UWC in the late 1880s. Over the next several decades, UGMC expanded and improved the water system to provide power for the mining industry.

UGMC put its water to work running the heavy machinery of industrial mining. The first penstocks from what is now the Angels Forebay were run to the mines at Angels Camp in 1890 where the pressure of falling water was harnessed to operate air compressors, hoists, and the stamp mills that processed the ore [24].

Expansion of the water system included providing additional storage on the upper end of the watershed by creating Lake Alpine in 1889-1892.

In 1895, UGMC constructed a small experimental power plant in Angels Camp to supply the first electricity to the Utica mine. The same year, another powerhouse was built above Murphys. This plant provided electricity to mines, mills, and residences of Angels Camp and the County, replacing power from the Angels Camp powerhouse. It is touted to be the first power in the County. It is said that this powerhouse was the fourth to be built in California, and the eighth built west of the Rocky Mountains. In 1899, the Utica Powerhouse was built east of Murphys. The stone powerhouse had a generator powered by water delivered though a penstock.

When the Utica Mine closed in 1918, an air compressor assembly in Angels Camp was converted into a ''temporary'' electric generator. It served until a new Angels Powerhouse was constructed in 1940-1941.

The next significant construction on the North Fork of the Stanislaus was the Utica Reservoir in 1903-1906. The final reservoir constructed by the UGMC was at Spicer Meadow. The reservoir was completed in 1929.

Half of the UGMC was owned by Emma Rose. When she died in 1946, the company was sold to PG&E.

Although built to facilitate the mining industry, the network of ditches fed by the Utica system had become an important source of water for domestic use and irrigation. With UGMC being sold to a power entity, residents of the Murphys area became concerned about retaining their water supply. They organized the Calaveras Water Users Association (CWUA) and secured an agreement for the right to purchase water from the Utica system. The CWUA is the predecessor to the present-day Union Public Utility District (UPUD).

c. Union Public Utility District

The UPUD was formed in 1946. In 1961, UPUD acquired all assets and liabilities from the CWUA.

To this day, UPUD is an active purveyor of water. Two separate systems, a treated water system and a raw water system, are maintained by UPUD. The domestic system treats and supplies water to the communities of Murphys, Douglas Flat, Vallecito and Carson Hill. Untreated or raw water is delivered through ditches to the same areas for irrigation.

d. Pacific Gas & Electric

PG&E purchased the UGMC in 1946 and proceeded to modernize and upgrade the Utica system. This included replacement of the Utica Powerhouse in 1953-1954 and upgrades to the miles of ditches and flumes.

The PG&E system was covered by two licenses issued by the Federal Energy Regulatory Commission (FERC). These facilities are included under each of the licenses listed below.

1. Utica Project – FERC No. 2019: The Utica Project includes the four upper reservoirs (Alpine, Union, Utica, and Spicer Meadow), the diversion dam at McKays Point on the North Fork of the Stanislaus River, and the Upper Utica Canal from McKays to Hunter's Reservoir on Mill Creek. The Lower Utica Canal carries water to the Utica Powerhouse, with diversions into UPUD's ditches, as well as to private users along the canal.

2. The Angels Project – FERC No. 2699: The Angels Project begins at the Angels Diversion Dam about three miles downstream from the Murphys Afterbay. From the diversion, water flows down the Angels Canal through Ross Reservoir to the Angels Forebay and then to the Angels Powerhouse. Additional diversions from the canal are made to the Dogtown Ditch and other small users and to the City WTP.

   In 1997, PG&E transferred by deed and bill of sale all the assets and rights of the Utica and Angels projects to the UPA [24].

e. Calaveras County Water District

CCWD was formed in 1946. By the mid-1980s, CCWD began work on the North Fork Stanislaus River Hydroelectric Development Project, FERC No. 2409. As part of this project, a new diversion from the North Fork of the Stanislaus River was constructed. This large diameter pipeline (Collierville Tunnel) diverts water to generate electricity at Collierville Powerhouse and bypasses much of the Upper Utica Canal. By agreement, a tap on the pipeline is the source of water for CCWD. Water is transferred to the Ebbetts Pass WTP which is owned and operated by the CCWD.

According to the current CCWD website, the "District currently provides water service to approximately 12,500 municipal and residential/commercial customers in four improvement districts throughout the County."

f. <u>Northern California Power Agency</u>

NCPA was established in 1968 to build and operate jointly-owned power plants, to purchase power, and to coordinate and manage wholesale power for member cities and districts. Membership consists primarily of municipalities, a rural electric cooperative, irrigation districts, and other publicly-owned entities interested in the purchase, aggregation, scheduling, and management of electrical energy [25].

NCPA is responsible for operating the two FERC projects that are described briefly below.

1. North Fork Stanislaus River Hydroelectric Development Project – FERC No. 2409: This is a 259 megawatt (MW) project occupying 4,500 ac in Alpine, Calaveras, San Joaquin, Stanislaus, and Tuolumne counties. The project includes a series of dams, tunnels, and smaller powerhouses. This stated power capacity is a maximum project production capacity generated during a wet year with the plants being operated at 'full throttle.' A major component of the project is the Collierville Power Tunnel. The tunnel is 18 ft in diameter and 8 miles long. The tunnel diverts water from McKays Point to the Collierville Powerhouse on the Stanislaus River. Collierville Powerhouse is a 253 MW plant.

   Major project participants in the Collierville Project are the cities of Santa Clara, Palo Alto, Roseville, and Lodi.

   The Collierville Tunnel eliminated an upper portion of the Utica Canal. To maintain service to the Utica system, a pressurized pipe known as the Tunnel Tap connected the Collierville Tunnel to a remaining portion of the Upper Utica Canal at Hunter's Reservoir. UPA's pre-1914 water rights allotment of 60 cubic feet per second (cfs) is delivered through the Tunnel Tap to Hunter's Reservoir according to a monthly schedule.

2. Upper Utica Project – FERC No. 11563: This project is located on Silver Creek and the North Fork of the Stanislaus River, in Tuolumne and Alpine counties. Former PG&E projects were purchased, and NCPA took ownership of the upper reservoirs, Lake Alpine, Union, and Utica, along with the old Spicer Meadow storage rights and North Fork of the Stanislaus River water rights.

The remainder of the PG&E projects, from the Tunnel Tap through the Angels Powerhouse, was transferred to the newly formed UPA.

g. City of Angels

The City is located at the furthest downstream point of the Utica system. The City's history is intimately entwined with all of the gold mining activities, and the water and power supply interactions upstream.

Households and businesses in the City purchased their water directly from the Utica system until 1984 when the municipal water system was formed.

h. Utica Power Authority

The UPA was formed as a joint power authority in December 1995. Member agencies included CCWD, UPUD, and the City, thus establishing local ownership of the water supply. UPA is governed by a board comprised of representatives from the member agencies.

In 1995, CCWD negotiated and signed a settlement agreement with NCPA. CCWD purchased the PG&E projects on the Utica system and NCPA would share in the cost. NCPA took ownership of Lake Alpine, Union, and Utica reservoirs, the old Spicer Meadow storage rights, and additional North Fork of the Stanislaus River water rights. A schedule of monthly water allotments for North Fork of the Stanislaus and Mill Creek deliveries was negotiated by CCWD and NCPA. UPA retained all PG&E rights on Angels Creek and French Gulch.

In May of 1997, CCWD granted all water rights, properties, facilities, and contracts to UPA, but remained a member of the entity. New licenses for FERC projects No. 2019 (Utica) and No. 2699 (Angels) were issued to UPA in 2003. On July 1, 2004, the City and UPUD agreed to buy out CCWD, and CCWD withdrew from UPA.

As its name suggests, UPA is also in the business of hydroelectric generation, operating the system developed by the UGMC and PG&E. The Murphys Powerhouse and the Angels Powerhouse generate electricity that is metered by the California Independent System Operator (Cal ISO) and is transmitted out to the grid. The energy produced is certified 100 percent renewable by the California Energy Commission and qualifies for "green energy" purchase through the Western Renewable Energy Generation Information System. As a producer of certified "green power," UPA is eligible for green energy tickets for its electrical output as utilities across California increase their use of environmentally-friendly, renewable energy resources. UPA's green power revenues help pay for much of the cost of operating, maintaining, and improving the UPA water and power system.

i. Water Supply within the North Fork of the Stanislaus River, Mill Creek, Angels Creek System

The gold miners who built the Utica flume and canal system took advantage of the higher elevation gravity flow from McKays Dam through the Upper Utica Canal through Hunter's Reservoir and then through the Lower Utica Canal, thereby avoiding the need for pumping. UPA continues to take advantage of that system to deliver water and to generate green energy.

The North Fork of the Stanislaus River, Mill Creek, and Angels Creek watersheds are shown on the UPA map titled *Utica Power Authority Major Facilities and Related Projects* and provided in Appendix D. The map shows facilities owned and operated by UPA, NCPA, and CCWD. The map also shows UPA's key water and power system, Murphys Powerhouse, and Angels Powerhouse.

6.3 Water Supply Agreements

The UPA was formed in 1995 and included member agencies CCWD, UPUD, and the City. In 1996, CCWD obtained from PG&E the rights to divert and use water from North Fork of the Stanislaus River, Angels Creek, and French Gulch that had historically been used within the Utica and Angels water systems [26]. In 1997, CCWD deeded facilities and water rights to UPA, but remained an entity member until 2004.

The Transfer Deed dated May 1, 1997 transferred the following from CCWD to UPA:

1. Ownership rights in the former PG&E pre-1914 water rights.

2. CCWD's interest in the water delivery allotment defined by Attachment A to the 1995 Restated Agreement (Attachment A can be found in Appendix E).

3. Water conveyance ditches and facilities, and the Angels and Utica (Murphys) hydroelectric powerhouses.

Other key points of the settlement agreement between CCWD and UPA are as listed below.

1. CCWD agreed to only divert water from lower Angels Creek and only after the ''water is no longer needed by UPA, City of Angels, and UPUD to generate power within their service areas and/or at or above Angels Powerhouse or to provide water service to customers within their service areas."

2. Under the 1997 Transfer Deed from CCWD, UPA has exclusive control of Hunter's Reservoir. CCWD owns a pump station near the base of Hunter's Reservoir Dam. CCWD is limited in access to and use of the pump station so as to not interfere with UPA water operations.

3. The settlement agreement clarifies issues relating to the ownership and operation of CCWD-owned/NCPA-operated facilities, UPA owned and operated facilities, and physical access to those respective facilities.

4. Neither party can, without prior written consent, use or occupy any property nor facilities owned by the other party, nor apply for a grant or loan that would require use of the other party's water rights or facilities [26].

Because of CCWD's contracts with NCPA, the water available for use within the Ebbetts Pass-Murphys-Angels area is limited to the following:

1. The water UPA is contractually entitled to under Attachment A. The water is supplied by NCPA but the entitlement is based upon UPA's pre-1914 water rights in the North Fork of the Stanislaus River-Mill Creek-Angels Creek system.

2. The maximum volume of 8,000 AF that CCWD is allowed to divert for consumptive purposes from the North Fork of the Stanislaus River system is subject to the following restrictions:

    a. The water must be diverted "from points upstream of the existing Mill Creek Tap butterfly valve" and CCWD cannot "cause this water to directly or indirectly enter any of the PG&E Project facilities without prior written agreement from NCPA."

    b. Under State Water Resources Control Board (SWRCB) Order No. 97-05 issued in September 1997, CCWD has until December 1, 2015, to put the entire 8,000 AFY to full beneficial use. Failure to do so could result in a partial revocation of CCWD's SWRCB water rights permits; i.e., that portion of the 8,000 AF not put to full beneficial use by December 1, 2015 … "Use It or Lose It" [27].

Because of the above 2015 permit deadline, CCWD and UPA agreed in the November 2009 settlement agreement to use their best efforts to negotiate an agreement by December 31, 2014, for CCWD to transfer water to UPA for consumptive use in the UPA, City, and/or UPUD service areas. The settlement agreement does not identify the amount of water to be transferred but it could be approximately 4,000 to 5,000 AFY. Such water would be in addition to the water delivered to UPA under Attachment A, which is further defined in the following sections [27].

In 1985, CCWD entered into a Revised Power Purchase Contract and the 1995 Restated Agreement with the NCPA wherein CCWD gave control of most of the water in the North Fork of the Stanislaus River system to NCPA for power generation at the Collierville Powerhouse.

Excerpts from the *Asset Sale Agreement By and Between PG&E and Calaveras County Water District,* August 18, 1995 and the Assignment and Assumption Agreement between CCWD and UPA are included as Appendix F.

6.4 Available Surface Water Supplies

Historical water rights for the Utica System included 88 cfs of the combined flow of the North Fork of the Stanislaus River, Beaver Creek, and Mill Creek; the right to store water in the upper reservoirs; and senior rights to the flow of Angels Creek sufficient to fully supply the Angels Canal. As a result of the 1995 Amended and Restated Agreement between NCPA and CCWD, 28 cfs of PG&E's historical 88 cfs water rights were conveyed to NCPA. The remaining 60 cfs were deeded to UPA and is delivered through the Tunnel Tap. Although the water rights are 60 cfs, UPA only receives 46 cfs in the wettest year.

UPA is contractually entitled to receive the volume of water as outlined under Attachment A. Attachment A is a schedule of maximum delivery of water to the Utica/Angels project from the combined flow of the Mill Creek Tap and Mill Creek. The deliveries are based on the DWR May 1 forecast of total unimpaired runoff in the Stanislaus River. The six steps of reduced flow from wet to driest years are defined in the table. DWR makes the determination of the level of allocation each year on May 1. For example, May 1, 2012, was defined to be a Level III water year; therefore, the allocation is 26,830 AF. The Amended Attachment A table is provided in Appendix E.

As mentioned previously, the entitled volume is a maximum of 33,514 AF in normal to wettest years and decreasing in steps to a volume of 16,107 AF in the driest water years. The City has a firm agreement to receive 1,600 AFY, and this amount has not been reduced regardless of the allotment under Attachment A.

It should be noted, however, that during a very dry year there is the possibility of reduced water deliveries to UPA and the member agencies. The existing contracts were written prior to the 1995 Amended and Restated Agreement between NCPA, CCWD, and UPA and therefore do not accurately reflect the reality of the decreasing water deliveries in dry years to the City and UPUD.

UPA has assumed the previous PG&E contracts that were with UPUD and the City. Pursuant to the original assumed agreement with a subsequent amendment, the City can receive 1,600 AFY for domestic and irrigation water supply at no charge until further modified. The combined diversions to UPUD for domestic and irrigation water supply cannot exceed 6.75 cfs at $0.05 per miners-inch. Pursuant to that previous contract with PG&E, UPUD can obtain an additional 1,000 AFY at $15.00 per AF [28].

6.5 Alternate Water Supplies

As discussed previously, the City is completely dependent on the ability of UPA to deliver adequate quantities of water to the Angels Forebay for treatment and distribution.

The UPA is restricted in volumes of water that can be delivered based on multiple agreements and delivery restrictions due to Attachment A. During very dry years, delivery of supplies can be reduced to 52 percent of normal. In addition, problems with the transmission system can severely disrupt the City water supply. As an example, in 2001 the Darby Fire demolished approximately 3,000 ft of the wooden flume.

Because of these possibilities, the City is investigating alternate water supplies, whether for emergency use only or for supplementing demands.

A discussion of alternate water supplies follows below including groundwater, abandoned mines, reduction in surface water divisions to GHC Golf Course, and use of recycled water for non-potable demands.

a. Groundwater

An alternate water supply to the current surface water supply would be the development of one or more wells to pump groundwater into the City's water system.

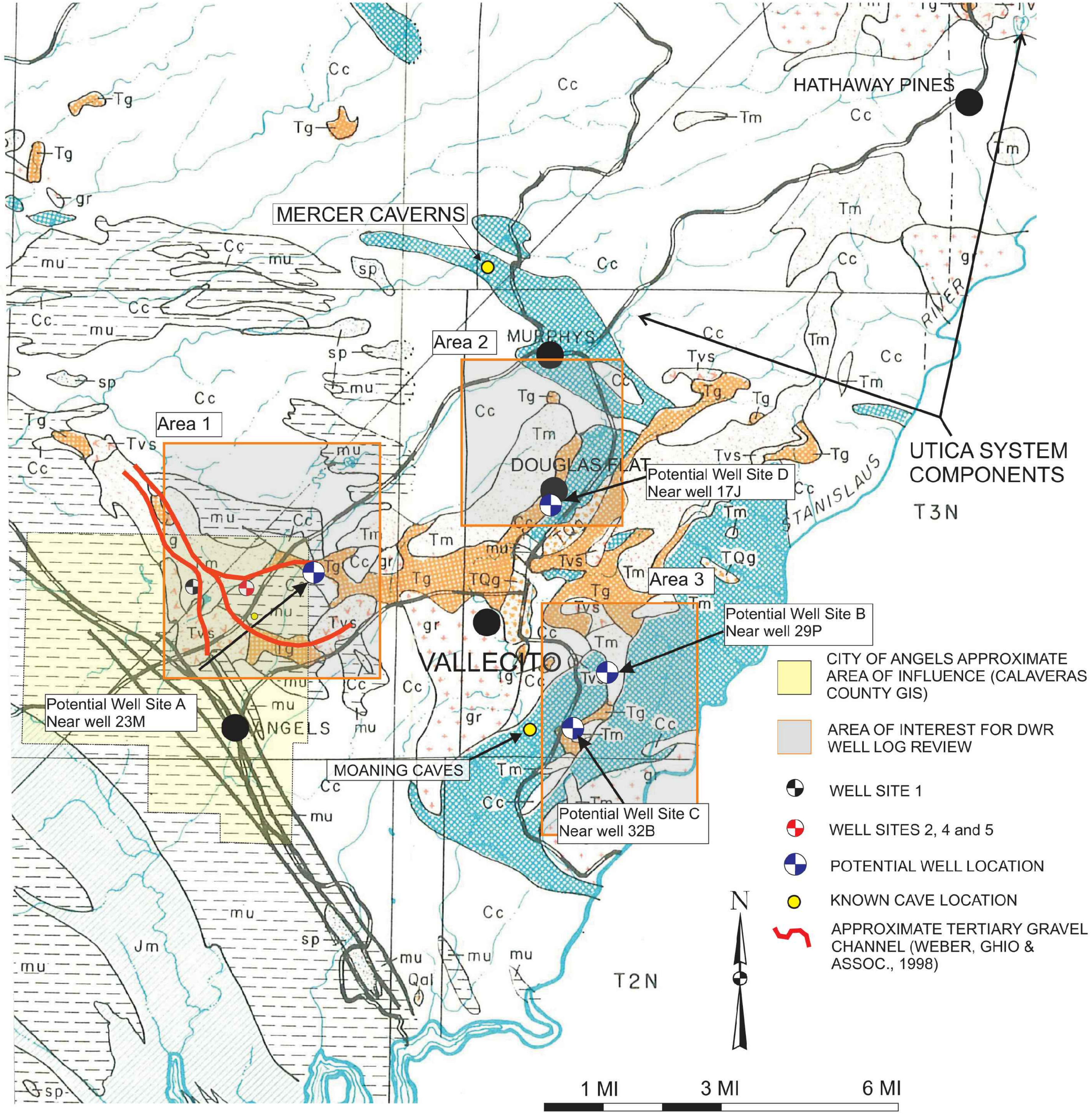
Groundwater flow in the area of the City is primarily related to flow through fractures. Limited flows have been found in some of the alluvial units of the Valley Springs and Mehrten Formations and through natural streams. Regional faults are located in the area and include the Bear Mountain and Melones Fault zones and the Calaveras Shoo-Fly Thrust Fault. Many historic gold mines are present in the area that may significantly influence groundwater occurrence and movement. Review of the area indicates a limited number of monitoring and production wells. To further assess conceptually this alternative, an initial hydrogeological investigation was conducted by Dunn Environmental (DE). The results of the investigation are presented in Appendix G. Based on this "desktop" evaluation, three potential well sites were identified by DE (see Figure 6-1). Each is described below.

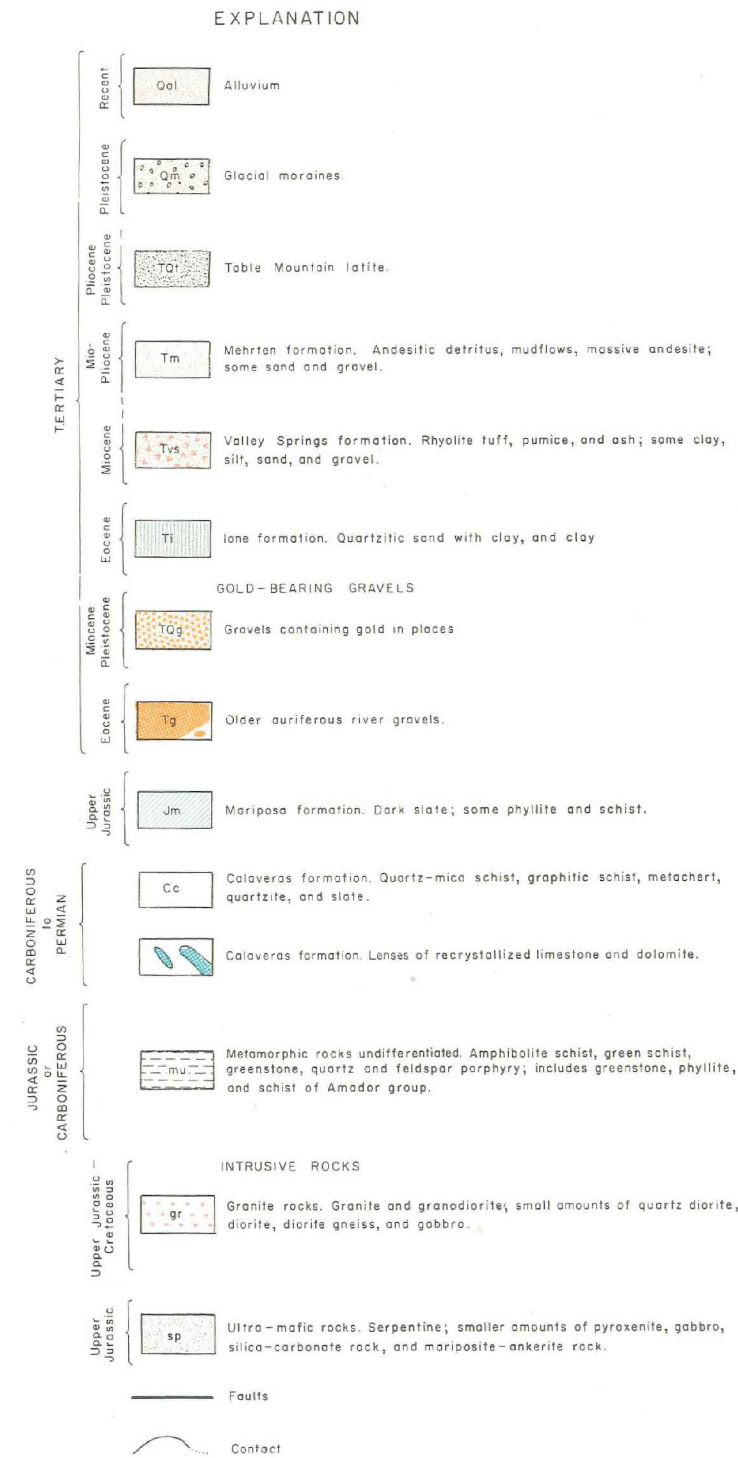
1. Potential Well Site A (Area 1) – This potential well site area has been confirmed by previous test well investigations, including test wells and past surface geophysics, to be a likely high-yielding area. Fractured bedrock conditions, however, may lower the potential. Water quality concerns are not anticipated other than septic tank locations. To meet the water supply shortfall and based upon the reported results of Test Hole No. 2, over three well completions may be necessary. Based on high-yield wells identified in the DWR well log search, the well site should be located to the east of the original testhole investigations, if possible.

2. Potential Well Site B (Area 3) – This potential well site combines the storage potential of the tertiary gravels and limestone package. Yields are anticipated to be high; however, water quality concerns may be identified. Production capacity within limestone is anticipated to be significantly higher and may require fewer wells than Potential Well Site A (Area 1). To meet the water supply short fall, only one well may be necessary. For reference, one well was identified during the DWR well log review with over 100 gpm yield.

3. Potential Well Site C (Area 3) – DE suggests exploring this location for high potential due to the proximity of Mehrten Gravels in conjunction with limestone deposits. Yields are anticipated to be high; however, water quality concerns may be identified. To meet the water supply short fall, only one well may be necessary. Two wells highlighted during the DWR well log search were identified with yields over 100 gpm close to this location.

4. Potential Well Site D (Area 2) – This location was selected as a potential location if the City pursues water well drilling and permitting efforts with the City of Murphys. The site is located in proximity to high-yield wells identified during DWR well log review and in the preferred geology package of tertiary gravels and Mehrten Formation close to limestone.





SOURCE: MINES AND MINERAL RESOURCES OF CALAVERAS COUNTY, CALIFORNIA - CALIFORNIA DIVISION OF MINES AND GEOLOGY, 1962

FIGURE 6-1

CITY OF ANGELS
WATER MASTER PLAN

POTENTIAL WELL SITES

NV5
BEYOND ENGINEERING

b. Abandoned Mines

In 2001, the Darby Fire destroyed 3,000 ft of the Utica Ditch, a wooden flume used to distribute water to the City. At that time, a collaborative review of emergency water supply options was prepared and then summarized by DWR. During this emergency situation, the City utilized an underground water source to meet water demands. Source water from the mines has been utilized successfully in the past, and it is reasonable to consider these sources for the future. Two examples of utilizing the abandoned mines for a water source are described in the following paragraphs with their approximate yield.

1. The Schmauder-Tyron Mine is located northwest of the City at an elevation of 1,765 ft. Mining activity occurred for approximately 5-6 years, ending in 1992. Water was used during the mining processes with no chemicals involved. The mine experiences frequent groundwater flooding due to an ancient river system. The report states that pumping water from the mine could provide approximately 500,000 gpd [29]. Water quality tests were performed at the time to confirm suitability for use.

2. The project titled *Angels Central Calaveras Mine at Rolleri Property* was estimated to cost $80,000 in equipment and $30,000 a month to operate. The project includes installing a pump and pipe into the mine to remove the water. Project concerns include: water quality, water production, and a mine collapse during pumping. Water delivery was anticipated to be approximately 500,000 gpd [29]. In the end, for the emergency situation, the extraction of water from this mine was determined not to be feasible.

c. Reduction in Surface Water Diversions to Greenhorn Creek Golf Course

Of the 1,600 AFY of surface water that the City receives, a full 28 percent (450 AFY) of this supply may be diverted to the GHC Golf Course per agreement. If the golf course reduces the use of this surface water supply, then this would ‘free-up’ water to be used for potable demands within the City. This would not represent an alternate water supply, but an alternative method to increase surface water deliveries to the City’s WTP to meet potable demands.

GHC Golf Course meets its irrigation demands with a combination of surface waters from Angels Creek and recycled water from the City WWTP. The average annual surface water delivery for GHC Golf Course from 2009 through 2011 was 169 AFY or 55 MG/year. The average delivery of recycled water for the years 2009-2011 was 95 AFY. In 2012, 165 AF of creek water and 154 AF of recycled water was delivered to GHC Golf Course for a total irrigation demand of 319 AF. An agreement between the City and Greenhorn Creek Associates L.P. allows up to 450 AFY (147 MG/year) of surface water for irrigation of the GHC Golf Course. If the WWTP could not deliver recycled water meeting Title 22 Standards, GHC Golf Course would be allowed to take their entire supply from Angels Creek.

The second amended agreement dated July 1998 between the City and Greenhorn Creek Associates L.P. ensures that the City maintains a regular supply of water for irrigation of the

GHC Golf Course. The agreement states the following with regard to untreated water from Angels Creek:

> *The City shall make available up to 450 AF of creek water from Angel's Creek for the Project's golf course irrigation at a minimum flow of 700 gpm up to a maximum rate of 1,400 gpm.*

The agreement also states that the golf course irrigation system must use recycled water from the City WWTP as follows:

> *At the time of installation and commencement of operation of the City's substantially new wastewater treatment facility, the golf course irrigation system shall be converted to use of treated waste water as set forth herein. From that time forward, untreated creek water shall become a secondary source of irrigation, available during those times when sufficient treated waste water is not available* [2].

d. Recycled Water for Non-potable Demands

There are opportunities within the City to use recycled water for non-potable uses other than golf course irrigation. Some typical applications include public landscape irrigation, dust control, and fire suppression, which currently utilize treated water.

Effluent from the WWTP is Title 22 tertiary disinfected recycled water as defined by CDPH. The recycled water is used for irrigation of a 136 ac sprayfield (61 ac available for disposal) adjacent to Holman Reservoir and 110 ac at the GHC Golf Course. Recycled water deliveries to the GHC Golf Course from the City WWTP have varied from 77-109 AFY for the years 2009-2011. The average recycled water delivery during this time was 95 AFY. In 2012 the recycled water delivery to GHC Golf Course was 154 AF. The WWTP discharge permit also allows seasonal (winter) discharge to Angels Creek.

Holman Reservoir provides 202 AF, or 66 MG, of storage capacity for recycled water not immediately disposed to the pastureland or GHC Golf Course. In the future, the availability of recycled water from the WWTP will increase as a function of increased wastewater flows. The total annual production of recycled water from the WWTP is estimated to range from 510 AFY in 2021 to 923 AFY at buildout. Assuming a recycled water delivery of up to 319 AFY to the GHC Golf Course, recycled water available for reuse in other areas will range from 191 AFY in 2021 (10-year projection) to 604 AFY in 2051 (buildout).

6.6 Overview of City Water Demands and Water Supply

Future water demands are summarized below including potable and non-potable demands. A comparison of demand and supply is then presented for various options.

a. Estimates of Future Demands

Existing and projected water demands for 10-year, 20-year, and buildout conditions developed in Chapter 5 are summarized below in Table 6-1. Diversions from Angels Creek for irrigation of GHC Golf Course are included as part of the City's annual allocation of surface water from UPA and are reflected in Table 6-1. For the base year, the water demand for GHC Golf Course is 169 AFY of creek water plus 95 AFY of recycled water based on the 2009-2011 averages for a total of 264 AFY. Per agreement, the golf course shall use recycled water from the WWTP as their primary irrigation water source, and creek water use becomes a secondary supply. For future water demand projections, the irrigation demand for GHC Golf Course is 319 AFY based on actual demand from 2012 (surface water diversion plus recycled water delivery).

TABLE 6-1
CITY OF ANGELS WATER MASTER PLAN
CURRENT AND PROJECTED WATER DEMANDS

	Projected Demands (AFY)		
Projection (Year)	**City[a]**	**GHC Golf Course**	**Total**
Base Year (2011)	967	264[b]	1,231
10-Year Projection (2021)	1,197	319[c]	1,516
20-Year Projection (2031)	1,482	319[c]	1,801
Buildout (2051)	2,336	319[c]	2,655

[a] Per Table 5-16.

[b] Annual irrigation demand for GHC Golf Course based on 2009-2011 average of surface water diversions (169 AF) plus recycled water (95 AF).

[c] 2012 GHC Golf Course irrigation demand is 165 AF of surface water from Angels Creek and 154 AF of recycled water [21].

Currently, all of the City's demands are met by the use of surface water. There is potential for reduction in overall projected surface water demands by reducing potable demands through City ordinances related to conservation efforts during droughts and/or emergency conditions. Reducing the use of potable water for non-potable uses will also provide additional capacity for meeting potable demands. Non-potable water demands include irrigation of landscaping for GHC Golf Course as well as residential, commercial, institutional, and industrial accounts and irrigation of agricultural lands.

Non-potable water demands can be estimated by identifying months with low irrigation demands (typically during the rainy season). The demand in the rainy season is assumed to the base potable water demand. Any demand above this base rate is assumed to be demand for non-potable uses such as landscape irrigation. Historical flow data collected from the influent meter at the WTP were used to calculate the monthly production of treated water for the City. The 2007-2012 average annual production was estimated to be 314 MG (per Table 5-4). In Table 6-2, monthly treated water production at the plant is displayed as a percentage of total year production.

TABLE 6-2
CITY OF ANGELS WATER MASTER PLAN
2007-2012 HISTORICAL MONTHLY PERCENTAGE OF ANNUAL TREATED WATER PRODUCTION

	2007-2012 Monthly Percentage of Annual Production, %[a]		
Month	**Monthly Production[b]**	**Baseline Demand[c]**	**Non-potable Demand[d]**
January	4.8	4.8	
February	4.3	4.8	
March	5.0	4.8	
April	6.2		1.4
May	9.3		4.5
June	11.2		6.4
July	13.9		9.1
August	14.2		9.4
September	11.8		7.0
October	8.5		3.7
November	5.8		1.0
December	5.0	4.8	
Total	**100.0**		**42.5**

[a] Per Table 5-4.

[b] Monthly production as a percentage of annual production.

[c] 2007-2012 average December-March demand (rounded).

[d] 2007-2012 April-November non-potable demand = monthly production – baseline demand.

Months with the lowest production can be correlated to the rainy season when irrigation demands are low. As shown in Table 6-2, the lowest monthly demands for 2007-2012 occurred from December through March, with an average winter monthly demand of 4.8 percent of yearly production. The 2007-2012 estimated non-potable demand for April through November is the additional percentage above the monthly 4.8 percent identified as the base potable water demand. The additional non-potable or irrigation demand in the summer months adds to approximately 43 percent (42.5 percent) of the annual demand. Using this factor, the estimate of non-potable demands for the City is summarized in Table 6-3.

TABLE 6-3
CITY OF ANGELS WATER MASTER PLAN
ESTIMATE OF NON-POTABLE DEMANDS FOR CITY

Item	Value, %
2007-2012 Average Winter Month Demand (Dec-Mar)[a]	4.8
2007-2012 Total Additional Demand (Apr-Nov)	42.5
Estimated Non-Potable Demand as Percentage of Annual Demand[b]	42.5
Estimated Potable Demand as Percentage of Annual Demand	57.5

[a] Assumed baseline potable demand based on percentage of annual production data presented in Table 6-2.

[b] Estimated percent of demand that is Non-Potable = Additional production percentage above the baseline Winter Demand percentage of total demand.

Existing and projected water demands for 10-year, 20-year, and buildout conditions separated into potable and non-potable demands are presented in Table 6-4.

TABLE 6-4
CITY OF ANGELS WATER MASTER PLAN
POTABLE AND NON-POTABLE PROJECTED WATER DEMANDS

	Projected Annual Demand (AFY)				
		Non-Potable			
Projection (Year)	Potable	City[a]	GHC Golf Course[b]	Total	Total Potable and Non-Potable
Base Year (2011)	556	411	264	675	1,231
10-Year Projection (2021)	688	509	319	828	1,516
20-Year Projection (2031)	852	630	319	949	1,801
Buildout (2051)	1,343	993	319	1,312	2,655

[a] Non-potable demand for City assumed to be 42.5 percent of total demand per Table 6-3.

[b] See Table 6-1.

b. <u>Comparison of Available Supply vs. Projected Demands</u>

Comparing the current supply from UPA with the projected demands illustrates that the need for supplemental water supplies will occur within the next ten years. The estimated deficit in future water supplies at buildout will be 1,055 AFY as shown in Table 6-5.

TABLE 6-5
CITY OF ANGELS WATER MASTER PLAN
COMPARISON OF WATER SUPPLY VERSUS DEMAND PROJECTIONS
GHC GOLF COURSE SURFACE WATER IRRIGATION DEMANDS

Projection (Year)	Annual Supply[a] (AFY)	Projected Annual Demand[b] (AFY)			Supply – Demand (AFY)
		City	GHC Golf Course	Total	
Base Year (2011)	1,600	967	264	1,231	369
10-year Projection (2021)	1,600	1,197	319	1,516	84
20-year Projection (2031)	1,600	1,482	319	1,801	-201
Buildout (2051)	1,600	2,336	319	2,655	-1,055

[a] Assuming no recycled water deliveries to GHC Golf Course.

[b] Per Table 6-1.

If approximately 43 percent of the City's water demands is non-potable, then the opportunity exists to provide recycled water for the majority of these uses. For comparison purposes, Table 6-6 displays the balance of supply vs. demand using only City potable water demands, but keeping the GHC Golf Course surface water diversions in place. In this scenario, an additional supply of 62 AFY is required at buildout.

TABLE 6-6
CITY OF ANGELS WATER MASTER PLAN
COMPARISON OF WATER SUPPLY VERSUS DEMAND PROJECTIONS
ASSUMING ONLY CITY POTABLE WATER DEMANDS AND
GHC GOLF COURSE SURFACE WATER IRRIGATION DEMANDS

Projection (Year)	Annual Supply[a] (AFY)	Projected Annual Demand (AFY)			Supply – Demand (AFY)
		City Potable[b]	GHC Golf Course[c]	Total	
Base Year (2011)	1,600	556	264	820	780
10-year Projection (2021)	1,600	688	319	1,007	593
20-year Projection (2031)	1,600	852	319	1,171	429
Buildout (2051)	1,600	1,343	319	1,662	-62

[a] Assuming no recycled water deliveries to GHC Golf Course.

[b] Assumes potable demand is 57.5 percent of City demand (see Table 6-4).

[c] Per Table 6-1.

Separating the GHC Golf Course demand for surface water supply from the City's water demand (potable and non-potable) provides the City with adequate supply through the 20-year projected growth, but not to buildout. This scenario is presented in Table 6-7. At buildout, an additional supply of 736 AFY is required.

TABLE 6-7
CITY OF ANGELS WATER MASTER PLAN
COMPARISON OF WATER SUPPLY VERSUS DEMAND PROJECTIONS EXCLUDING GHC GOLF COURSE SURFACE WATER IRRIGATION DEMANDS

Projection (Year)	Annual Supply (AFY)	Projected Annual Demand (AFY)			Supply – Demand (AFY)
		City[a]	GHC Golf Course	Total	
Base Year (2011)	1,600	967	0	967	633
10-year Projection (2021)	1,600	1,197	0	1,197	403
20-year Projection (2031)	1,600	1,482	0	1,482	118
Buildout (2051)	1,600	2,336	0	2,336	-736

[a]Potable and non-potable demands (per Table 6-1).

Under the current agreement with UPA for a firm 1,600 AFY of surface water supply, a combination of reducing the City's demand to only potable uses and separating the GHC Golf Course from the demand would be required to stay within the existing allocation through buildout. This scenario is illustrated in Table 6-8.

TABLE 6-8
CITY OF ANGELS WATER MASTER PLAN
COMPARISON OF WATER SUPPLY VERSUS DEMAND PROJECTIONS EXCLUDING NON-POTABLE WATER DEMANDS

Projection	Annual Supply (AFY)	Projected Annual Demand (AFY)				Supply – Demand (AFY)
		City Potable[a]	City Non-potable	GHC Golf Course	Total	
Base Year (2011)	1,600	556	0	0	556	1,044
10-year Projection (2021)	1,600	688	0	0	688	912
20-year Projection (2031)	1,600	852	0	0	852	748
Buildout (2051)	1,600	1,343	0	0	1,343	257

[a] Assumes potable demand is 57.5 percent of City demand (see Table 6-4).

6.7 Options for Meeting Future Demands

In the following sections, three options are outlined. Any one of these options, or combination of options, can be implemented as a future strategy to make up for the water supply deficit and meet the estimated future demands.

a. Option 1 – Obtain Increased Allocations from UPA

Option 1 would be to acquire all needed future supplemental water from UPA. Key considerations are as follows:

1. The current agreement with UPA provides a maximum allocation from UPA of 1,600 AFY. This quantity is and has been provided regardless of the allotment provided through Attachment A.

2. UPUD receives 4,800 AFY with an option for an additional 1,000 AF from UPA. In reality, UPUD cannot receive this total amount due to contractual restrictions in diversions.

3. CCWD is allowed to divert, for consumptive purposes, up to 8,000 AFY. Of this volume, CCWD currently uses approximately 1,800 AFY for the Ebbetts Pass WTP.

4. Considering "2" and "3", opportunities exist for acquiring additional supplies. However, the City must plan for very dry years and the possibility that UPA may need to restrict supplies in alignment with reduced allocations through Attachment A. For reference, UPA receives a reduced percentage of water in each successive dry year in a stepped allocation from Scenario I thought Scenario VI. The scenarios and respective allocations are as follows:

   - Scenario I (a normal wet year) = 100 percent of the allocation
   - Scenario II = 90 percent of normal
   - Scenario III = 80 percent of normal
   - Scenario IV = 68 percent of normal
   - Scenario V = 58 percent of normal
   - Scenario VI = 48 percent of normal

   The Amended Attachment A, a table prepared by UPA to further describe the water allocation, and a table of Amended Attachment A allocations from 1999 through 2012 can be found in Appendix E.

b. Option 2 – Supplement with Groundwater

For Option 2, it is assumed that supplemental water would be provided through groundwater extraction and pumping. As described earlier, three potential areas have been identified for further consideration.

Due to the extremely variable geology and potential significant differences in production well exploration findings, a phased iterative approach is proposed using a conceptual model that has been developed to maximize the placement of future production wells. The model has been developed to depict the preferred hydrogeologic setting which consists of the sand and gravel sequences of the Mehrten Formation near permeable limestones located east of the City. These areas have the most sustainable groundwater resources as they are near recharge areas for groundwater. The well yields in these areas are anticipated to be high to satisfy the water supply demand shortfall. Based on the proposed investigation effort of the well sites, higher well yield areas can be used to reduce the number of wells needed to address the water supply shortfall.

c. Option 3 – Enhanced Use of Non-potable Water

Non-potable water is either the raw supply water that comes through the canal system or the recycled water that is produced at the WWTP facility. The City's WWTP facility can provide water for non-potable uses within the City. Available recycled water supplies align well with projected non-potable water demands. It has been estimated that 43 percent of the City treated water demand is used for non-potable uses as summarized in Table 6-4. Through the use of non-potable water, the City's supply can provide potable water for future growth.

A significant amount of recycled and raw water is directed to the GHC Golf Course. The average amount between 2009 and 2011 is 264 AFY. By agreement, GHC Golf Course is allowed 450 AFY in the future. By separating this demand from the City's allotment from UPA, this will free-up the raw water that is being diverted to the golf course and direct that flow to the WTP for potable water uses. If the golf course converts to use of all recycled water, but then finds another source (for example an irrigation well), this would free-up recycled water for use within the City for other non-potable uses.

6.8 Planning for Drought Years

Because of potential planned or unplanned cutbacks in surface water supplies in the future, provisions for drought conditions are critical. A discussion of management strategies is provided below.

a. Emergency Use of Mines

Based on the emergency situation in 2001, abandoned mines seem to be an appropriate source for temporary supplemental water. In particular the Schmauder-Tyron Mine, has proven to be an adequate source. Reports state that the mine fills constantly, and this suggests that recharge of this groundwater is constant. However, tapping this source has not been implemented for long periods of time. Reliability of this source over the long term cannot be predicted.

As proven in 2001, this supplemental water supply is an excellent resource for emergencies, to be tapped when necessary. It is recommended that the City have a response plan in place to activate in the event of a disaster such as a fire on the flume system, an earthquake, a City-wide power outage, or even a bioterrorism attack on the City's water treatment and distribution system. When activated, the City would coordinate damage surveys, gather information, and conduct responses to damaged processes and systems. The plan would include the following elements:

1. List of water system components (wells, distribution system, storage tanks, etc.).
2. Measures to be taken prior to and following an emergency event.
3. List of City emergency operation personnel.

4. Information regarding coordination with police and fire department personnel.

5. List of water testing laboratories, water system contractors, and pipe repair and installation contractors.

6. Utility service numbers for traffic signal repairs, gas and electrical repairs, and water works suppliers.

An important part of the emergency response plan would be information and the required steps to obtain supplemental water from the mines.

b. <u>Water Conservation (Drought Contingency Plans)</u>

Water conservation can significantly reduce the demand on the City's treated water. The estimated 43 percent of non-potable uses within the City can be reduced by a combination of conservation and supplemental use of recycled water.

Adoption of a summer water restriction ordinance to reduce overall water demand by reducing peak usage on maximum days could be implemented. Encouraging conservation with suggestions of incorporating xerophytic landscaping for residential and commercial properties is a sensible way to plan for additional water savings into the future.

The City is encouraged to develop and adopt an emergency action plan. This would include steps to take in case of a long-term decreased supply (drought conditions leading to UPA reducing supply) or temporary interruption in the raw water supply coming through the flumes (as experienced with the Darby Fire).

As part of an emergency action plan, the City should identify locations and availability of pumps and pipelines that could be used to convey water from other sources. The City should pursue agreements with other member agencies for emergency diversions. In addition, a system should be in place to regulate outdoor irrigation and all non-potable water use during emergency water shortage situations.

To plan for droughts and emergencies, the City can adopt a three stage Water Conservation Ordinance with goals that include voluntary and mandatory stages to be implemented in normal, drought, and emergency stages. An example of water shortage stages are presented in Table 6-9.

TABLE 6-9
CITY OF ANGELS WATER MASTER PLAN
WATER SHORTAGE STAGES AND WATER USE REDUCTION GOALS

Shortage	Stage	Water Use Reduction Goal	Program Type
0 up to 10%	Normal	0 to 10% Reduction	Voluntary
10% to 30%	Drought	10% to 30% Reduction	Mandatory
30% to 50%	Emergency	30% to 50% Reduction	Mandatory

To achieve these goals, City Council would declare the appropriate water conservation stage based on reduced supply. The specific criteria for triggering the City's water conservation stages would be based on the amount that projected supply does not meet projected demand. Under drought and emergency stages, the City's rate structure can be set as flexible to attain water use reduction up to 50 percent, if required. In some cases, it may be necessary for the City to skip stages of the water use reduction plan. For example, stages may be skipped during a natural disaster or when the health and safety of customers in the City's water service area are jeopardized.

6.9 Alternate Future Water Supply Strategies

Currently, the City relies exclusively on surface water delivered through UPA as a source of potable water. Other future options include the development of groundwater and the increased use of recycled water for non-potable demands. By combining elements of the three primary options (surface water, groundwater, and recycled water), a broad array of strategies can be explored and evaluated. From this process, seven alternate water supply strategies are identified as presented in Table 6-10. For comparison purposes, order of magnitude capital costs are also included for buildout facilities for each strategy.

TABLE 6-10
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF FUTURE ALTERNATE WATER SUPPLY STRATEGIES

Strategy	Order of Magnitude Cost, $M	Key Characteristics
1 – Increase Deliveries through UPA	10.1	Depends on transfer of allocations from UPUD/CCWD.
2 – Additional Supply through UPA through New Downstream Diversion	12.5	Diversion would be downstream of hydroelectric plants. Implementation would require construction of second WTP.
3 – Develop Groundwater Supply from Local Wells (Area 1)	2.7	May require six wells to meet buildout demands.
4 – Develop Groundwater Supply from Regional Wells (Area 3)	4.7	May require three wells to meet buildout demands.
5 – Some Increase in Deliveries through UPA, Minimize Diversions from Angels Creek to Supply GHC Golf Course by Replacing with Recycled Water	7.7	Depends on transfer of allocations from UPUD/CCWD. Requires effective communication/coordination between GHC Golf Course and City to minimize surface water diversions.
6 – Some Increase in Deliveries through UPA, Minimize Diversions from Angels Creek to Supply GHC Golf Course by Replacing with Local Groundwater	7.9	Depends on transfer of allocations from UPUD/CCWD. Groundwater well(s) would substitute for surface water diversions for golf course irrigation.
7 – Some Increase in Deliveries through UPA, Construct City-wide Dual Distribution System, Minimize Diversions from Angels Creek to Supply GHC Golf Course by Replacing with Local Groundwater	10.0	Depends on transfer of allocations from UPUD/CCWD and construction of dual distribution system. Groundwater wells would substitute for surface water diversion for golf course irrigation.

a. Evaluation of Water Supply Strategies

To determine a potentially superior alternate, the seven strategies described in Table 6-10 were evaluated considering multiple criteria. These criteria included economic and non-economic factors as presented in Table 6-11. Based on input from City staff, the criteria were prioritized through the use of importance factors. Specifically, the evaluation criteria considered most important were assigned a value of 1.0. Conversely, less important criteria were designated with importance factors of 0.5 and 0.7.

TABLE 6-11
CITY OF ANGELS WATER MASTER PLAN
EVALUATION CRITERIA FOR ALTERNATE WATER SUPPLY STRATEGIES

Evaluation Criteria	Description	Importance Factor
Meet 10-year Projection	Capacity to deliver 10-year projected demands.	1.0
Meet Buildout Projection	Capacity to deliver buildout projected demands.	0.5
WTP Expansion	Need to expand existing WTP.	0.5
Second WTP	Need to construct second WTP.	1.0
Minimize Impact of a Single Point of Failure (Single Pipeline)	Level of redundancy in key transmission pipelines.	1.0
Provisions for Emergency Conditions (Failure of Upstream Conveyance)	Ability to tolerate interruptions in raw water supply.	0.7
Impact from Drought	Potential reduction in supply due to drought.	0.7
Capital Cost	Relative magnitude of capital investment.	1.0
Operational Cost	Relative magnitude of annual operation and maintenance costs.	1.0
Ease of Implementation	Number/complexity of agreements, permits, approvals required for implementation.	1.0
Coordinated with Other City Plans	Consistency with other City master plans or programs.	0.5

In evaluating a strategy, a score of 1-5 was selected for each criterion. Lower scores reflected an inferior alternate while a score of 5 signified a superior strategy when considering a specific evaluation criteria. As an example, for the criterion, WTP Expansion, if the strategy required an expansion of the existing WTP, the strategy would be assigned a low score. In contrast, strategies that do not incorporate improvements to the existing WTP would receive a higher score. By then applying the importance factor to each criterion score, a weighted score could be calculated and aggregated to identify a preferred alternate. This process is summarized in Table 6-12.

TABLE 6-12
CITY OF ANGELS WATER MASTER PLAN
EVALUATION MATRIX FOR ALTERNATE WATER SUPPLY STRATEGIES

		Water Supply Strategy[a]													
		1		2		3		4		5		6		7	
Criteria[b]	**Importance Factor**	**Value[c]**	**Weighted[d]**	**Value**	**Weighted**	**Value**	**Weighted**	**Value**	**Weighted**	**Value**	**Weighted**	**Value**	**Weighted**	**Value**	**Weighted**
Meet 10-year Projection	1	5	5	5	5	3	3	5	5	5	5	3	3	3	3
Meet Buildout Projection	0.5	3	1.5	3	1.5	3	1.5	5	2.5	1	0.5	1	0.5	5	2.5
WTP Expansion	0.5	1	0.5	5	2.5	5	2.5	5	2.5	3	1.5	3	1.5	3	1.5
Second WTP	1	5	5	1	1	5	5	5	5	5	5	5	5	5	5
Minimize Impact of a Single Point of Failure (Single Pipeline)	1	1	1	3	3	3	3	3	3	1	1	1	1	1	1
Provisions for Emergency Conditions (Failure of Upstream Conveyance)	0.7	1	0.7	3	2.1	3	2.1	3	2.1	1	0.7	1	0.7	1	0.7
Impact from Drought	0.7	5	3.5	5	3.5	1	0.7	3	2.1	5	3.5	3	2.1	3	2.1
Capital Cost[e]	1	3	3	1	1	5	5	3	3	3	3	3	3	1	1
Operational Cost	1	5	5	1	1	3	3	3	3	5	5	5	5	1	1
Ease of Implementation	1	5	5	1	1	3	3	3	3	5	5	3	3	3	3
Coordinated with Other City Plans	0.5	3	1.5	3	1.5	3	1.5	3	1.5	5	2.5	1	0.5	1	0.5
Totals			32		23		30		33		33		25		21

[a] See Table 6-10 for description.

[b] See Table 6-11 for description.

[c] Value of 1 represents least favorable, value of 5 represents best or superior alternate.

[d] Weighted = Value x Importance Factor.

[e] Strategies with capital costs greater than $10M were considered least favorable. The strategy with the lowest capital cost was considered superior.

b. Preliminary Recommendation

From a review of the weighted scores in Table 6-12, three strategies appear superior – Strategy 1 (Increased Deliveries through UPA), Strategy 4 (Develop Groundwater Supply from Regional Wells), and Strategy 5 (Some Increase in Delivery through UPA, Minimize Diversions from Angels Creek to Supply GHC Golf Course by Replacing with Recycled Water). A possible mix of the three strategies in meeting buildout water supply requirements of 2,655 AFY (see Table 6-1) is illustrated in Table 6-13.

TABLE 6-13
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF POSSIBLE "BLEND" OF ALTERNATIVE WATER SUPPLY SOURCES
TO MEET BUILDOUT WATER DEMAND OF 2,655 AFY

	Available Supply (AFY)		
Alternate Water Supply Source	**Current**	**Future**	**Comment**
Surface Water Deliveries through UPA	1,600	2,000	Additional annual delivery of 400 AFY
Groundwater Development	0	505	Develop 2-3 groundwater wells
Recycled Water Use for GHC Golf Course Irrigation	95[a]	150[b]	Maximum historical delivery
Total	**1,695**	**2,655**	

[a] Recycled water deliveries, 2009-2011 average.

[b] Recycled water deliveries, 2012.

Based on this initial evaluation, for future water supplies, the following actions by the City are recommended:

1. Pursue multiple parallel opportunities.
2. Request additional deliveries through UPA.
3. Initiate next steps in groundwater exploration.
4. Maximize use of recycled water at GHC Golf Course in lieu of surface water.

These actions are incorporated into a series of recommended projects described in Chapter 9.

7 Water Treatment Plant Evaluation

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

7.1 Current and Projected Treated Water Demands

Water demands and peaking factors were developed in Chapter 5. The ADD projections were based on historical influent flow meter records for raw water delivered to the WTP. Peaking factors were established based on historical influent flow meter records, input from WTP personnel, and previous studies. The recommended MDD and PHD factors are 2.2 and 1.7, respectively (as discussed in Section 5.4).

Although current and projected water demands presented in Chapter 5 were useful for evaluations of available water supply and distribution system performance, the WTP influent flow meter does not account for water used in various unit processes at the plant. Water is drawn from the storage tank outlet and used to generate sodium hypochlorite solution that is injected prior to flocculation and filtration (see Figure 7-1). Water for internal processes represents a significant demand at the WTP and is included in hydraulic evaluations of the various treatment processes. Based on input from the WTP Supervisor, "process water" demands are estimated at 70 gpm (100,800 gpd). A summary of current and projected water demands is provided in Table 7-1. Detailed water demand projections in one-year increments are included in Appendix H.

The projected MDD (influent demand plus in plant process demand) was used to evaluate facilities for coagulation, flocculation, sedimentation, filtration, and disinfection. For evaluating treated water storage, the projected MDD and PHD (influent demand plus in-plant process demand) were used. The projected MDD and PHD (influent demand, excluding in-plant process demand) were used to evaluate the transmission main from the WTP to the distribution system.

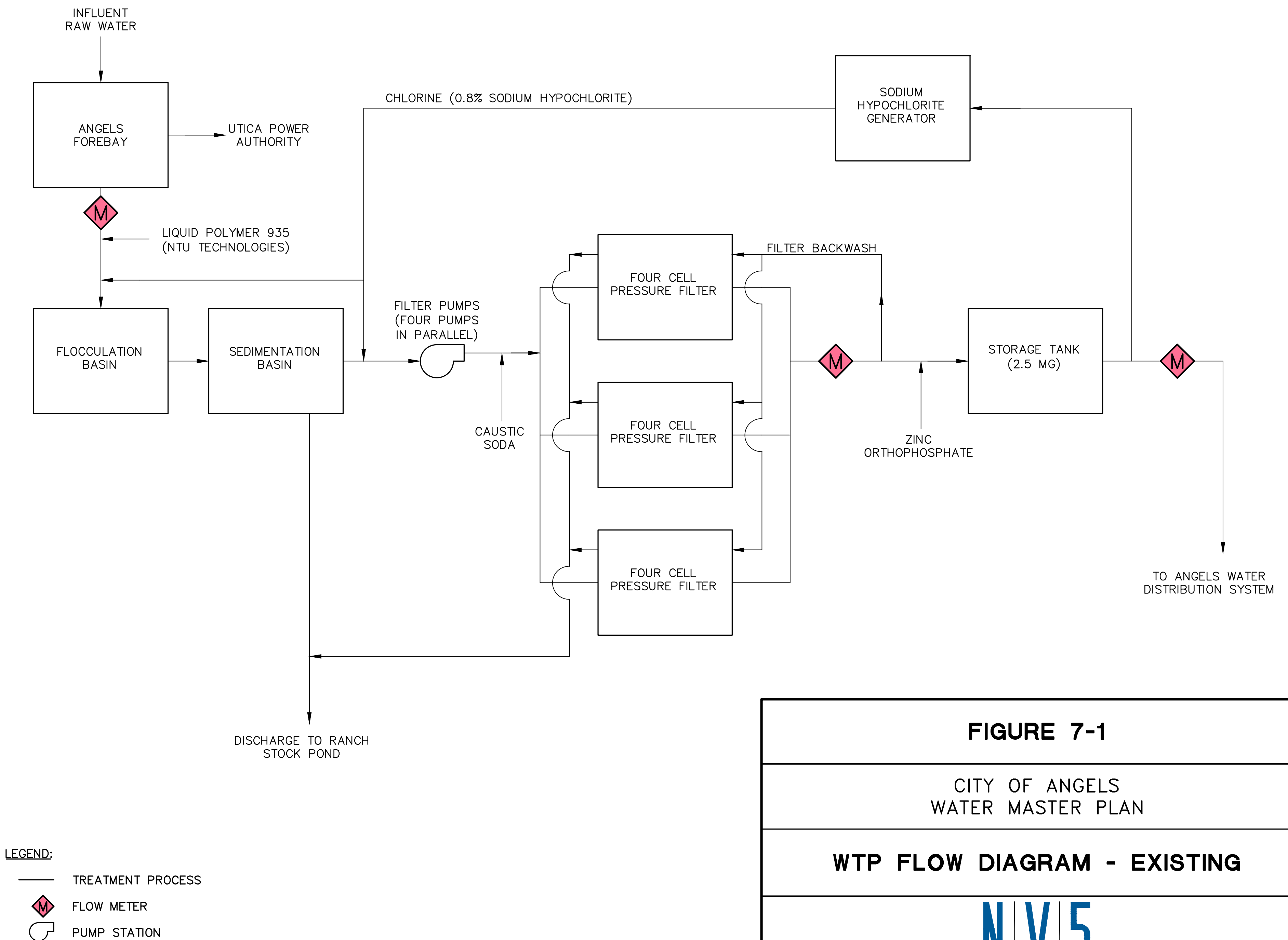


FIGURE 7-1

CITY OF ANGELS
WATER MASTER PLAN

WTP FLOW DIAGRAM - EXISTING

NV5
BEYOND ENGINEERING

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TABLE 7-1
CITY OF ANGELS WATER MASTER PLAN
CURRENT AND PROJECTED WATER DEMANDS FOR WTP EVALUATION

		Projected WTP Influent Demand[a]			WTP Unit Process Demand[b] (Including In-plant Process Demand)		
Year	Population	ADD[c] (gpd)	MDD[d] (gpm)	PHD[e] (gpm)	ADD (gpd)	MDD[d] (gpm)	PHD[e] (gpm)
Base Year (2011)	3,919	864,000	1,320	2,244	964,800	1,390	2,314
10-year Projection (2021)	4,853	1,069,000	1,633	2,776	1,169,800	1,703	2,846
20-year Projection (2031)	6,009	1,324,000	2,023	3,439	1,424,800	2,093	3,509
Buildout (2052)	9,453	2,084,000	3,184	5,413	2,184,800	3,254	5,483

[a] Projections based on WTP influent flow meter (upper plant meter).

[b] Projected WTP Influent Demand + In-plant Process Demand at 70 gpm (100,800 gpd).

[c] See Table 5-15.

[d] MDD = 2.2 x ADD.

[e] PHD = 1.7 x MDD.

7.2 Evaluation of Facilities

The City acquired the WTP from PG&E in 1984. In general, the WTP is equipped for conventional filtration treatment and disinfection with sodium hypochlorite solution. For more than a decade, the WTP has consistently complied with applicable state and federal drinking water regulations, although concerns have been raised regarding capacity and reliability. An evaluation of each unit process is presented below.

a. Coagulation and Flocculation

An aluminum-based coagulant (NTU Technologies 935) is injected into raw water between the Angels Forebay and the flocculation basin. A streaming current controller is used for process monitoring and automatic coagulant dose adjustments. The WTP is equipped with two coagulant feed pumps.

Flocculation occurs in a single, four-stage basin with a rotating paddle assembly. An electric motor and drive gearing are used to achieve a paddle speed of approximately 9 revolutions per minute (rpm). The basin is 48 ft long and 12 ft wide, with three interior baffles and a water depth of approximately 9 ft. California surface water treatment regulations do not include flocculation process criteria or loading limits. Optimal floc formation, however, typically requires gentle mixing for a period of 10-30 minutes [30]. Estimated detention times under current and projected demand conditions are summarized in Table 7-2 and suggest that the capacity of the existing flocculation basin will be adequate through 2031. A second flocculation basin, however, is needed to allow the WTP to continue operating when the existing flocculation basin is removed from service for maintenance or repairs. The standby flocculation basin would provide additional reliability should the need for unscheduled repairs arise during high-demand periods or at times when the water level in the treated water storage tank is low.

TABLE 7-2
CITY OF ANGELS WATER MASTER PLAN
WTP FLOCCULATION BASIN HYDRAULIC LOADING SUMMARY

Demand Condition	Estimated Detention Time, minutes
Base Year MDD (2011)	28
10-year MDD (2021)	23
20-year MDD (2031)	19

b. Sedimentation

Water flows from the flocculation basin into a single, gunite-lined sedimentation basin. The sedimentation basin is 100 ft long and 38 ft wide (at top), with sloped walls and a capacity of approximately 310,000 gallons. Estimated surface loading rates for the existing sedimentation basin under current and projected demand conditions are summarized in Table 7-3 and suggest that the capacity of the existing sedimentation basin will be adequate through 2031. California surface water treatment regulations do not include sedimentation process criteria or loading limits, but typical design surface loading rates for sedimentation basins are in the range of 800-1,200 gallons per day per square foot (gpd/ft^2) [30].

TABLE 7-3
CITY OF ANGELS WATER MASTER PLAN
WTP SEDIMENTATION BASIN HYDRAULIC LOADING SUMMARY

Demand Condition	Estimated Surface Loading Rate, gpd/ft^2
Base Year MDD (2011)	530
10-year MDD (2021)	650
20-year MDD (2031)	800

The sedimentation basin was constructed when the WTP was under PG&E ownership and lacks modern design features. Major issues and concerns are listed below.

1. Lack of automatic sludge removal system. Periodically, the sedimentation basin must be removed from service, drained, and manually cleaned. Sludge and wash water flow into a stock pond on a neighboring ranch. The cleaning procedure is time-consuming and labor-

intensive, and the WTP cannot produce water while sedimentation basin cleaning is in progress.

2. Structural deterioration. With age, large cracks have developed in the walls and floor of the basin. In 2011, in response to CDPH inspection findings [15], a sealant was used to repair two cracks.

3. Single point of failure. Because the WTP lacks multiple parallel sedimentation units, the entire facility must be shut down when sedimentation maintenance and repairs are in progress. Certain maintenance events can be scheduled during lower-demand periods. Unscheduled repairs, which could be needed during high-demand periods or at times in which the water level within the treated water storage tank is low, could result in City water service interruptions.

4. Short-circuiting. Performance of the sedimentation basin is adversely affected by hydraulic short-circuiting. As a result, settling time is reduced, and the solids loading on downstream treatment units increases. The basin has been retrofitted with baffle curtains, but the short-circuiting problem persists.

c. <u>Filtration</u>

Filtration is achieved at the WTP with three pressure filters, each with four 60 square foot (ft^2) cells. The maximum filtration capacity of each filter is limited to 720 gpm. According to Condition No. 10 of the City's water supply permit, the maximum flow rate through the WTP shall not exceed 1,440 gpm [23] which is the capacity of two pressure filters operating in parallel (with one filter out of service).

As mentioned previously, sodium hypochlorite added to the headworks and prior to filtration represents a significant amount of flow processed by the pressure filters. Depending on the pace of future increases in water demands, under current operations the filtration capacity of 1,440 gpm could be exceeded at MDD in 1-2 years. Installation of a fourth filter is under consideration by the City. The fourth filter would bring the total filtration capacity to 2,160 gpm with one filter out of service, which would not be exceeded until 2033 (beyond the 20-year planning horizon). A summary of the MDD projections and filtration capacities is provided in Table 7-4.

TABLE 7-4
CITY OF ANGELS WATER MASTER PLAN
WTP FILTRATION SYSTEM CAPACITY

Item	Value
Base Year MDD (2011), gpm[a]	1,390
10-year MDD (2021), gpm[a]	1,703
20-year MDD (2031), gpm[a]	2,093
Current Operation (3 filters): Maximum Capacity, gpm[b]	1,440
Current Operation: Year that Capacity will be Exceeded	2013
Future Operation (4 filters): Maximum Capacity, gpm[b]	2,160
Future Operation: Year that Capacity will be Exceeded	2033

[a] See Table 7-1. Includes 70 gpm of in-plant process water.

[b] Capacity with one filter out of service.

Following installation of the fourth filter, the filtration system will have sufficient capacity for the 10-year and 20-year MDD projections.

d. Disinfection

Sodium hypochlorite solution is generated at the WTP and, under normal operating conditions, injected upstream of the filters for disinfection. Disinfectant contact is provided within the filters and the storage tank. Short-circuiting (T_{10}/T) factors of 0.7 and 0.3 are applied to the filters and storage tank, respectively, when calculating pathogen inactivation rates.

The on-site sodium hypochlorite solution generator is capable of producing 62.5 gallons of 0.8 percent sodium hypochlorite solution per hour, and the 0.8 percent solution is stored in a 1,000 gallon tank [8]. The WTP is equipped with two sodium hypochlorite solution feed pumps. According to City staff, the generator functions at capacity during higher-demand summer months, often generating sodium hypochlorite solution without stopping for periods in excess of two days.

The disinfection equipment is operated to simultaneously achieve four objectives: 1) $\geq$0.5-$\log_{10}$ Giardia inactivation; 2) $\geq$2-$\log_{10}$ virus inactivation; 3) maintain a detectable residual chlorine concentration throughout the distribution system; and 4) comply with disinfection byproducts regulations. Operational records suggest that disinfection process control is, in general, governed by the third objective. Throughout 2011, calculated inactivation rates for Giardia and viruses were greater than 10 times the required rates. Over the same period, the WTP complied with limits for disinfection byproducts (trihalomethanes and haloacetic acids) and disinfection byproduct precursors.

e. Treated Water Storage

Following the pressure filters, water is routed into a single 2.5 MG storage tank that feeds the City's distribution system by gravity. With only one treated water storage tank for the entire water system, the City water system lacks redundancy and reliability. To avoid service interruptions, CDPH staff suggested that the City construct an additional storage tank for operation in parallel with the existing storage tank [11]. The addition of a second storage tank would allow City staff to remove a tank from service for maintenance or repairs.

The capacity of the future storage tank should satisfy the greater of the requirements of the California Waterworks Standards [10] and the City 2010 Improvement Standards [16]. The California Waterworks Standards require that the system be able to meet four hours of PHD with source capacity, storage capacity, and/or emergency source connections [10]. In addition, a minimum volume of 937,500 gallons is required in the tank for chlorine contact volume according to Condition No. 9 of the City's 2003 water supply permit amendment [6]. A summary of storage requirements meeting the California Waterworks Standards for current and projected demand conditions is provided in Table 7-5. As shown in Table 7-5, the minimum storage required by California Waterworks Standards at the 20-year demand condition is 1.8 MG.

TABLE 7-5
CITY OF ANGELS WATER MASTER PLAN
SYSTEM STORAGE REQUIREMENTS FOR CALIFORNIA WATERWORKS STANDARDS

Demand Condition	Storage Required for California Waterworks Standards[a] (gal)	Minimum Chlorine Contact Volume[b] (gal)	Total Required Storage (MG)
Base Year (2011)	555,360	937,500	1.5
10-year (2021)	683,143	937,500	1.7
20-year (2031)	842,093	937,500	1.8

[a] California Waterworks Standards = 4 hours of PHD (including in-plant process demands) [10].

[b] Condition No. 9 of the City's 2003 permit amendment states that a minimum volume of 937,500 gallons must be maintained for disinfectant contact time [6].

The City 2010 Improvement Standards require storage capacity be greater than or equal to the sum of the required fire storage, operational storage, and emergency storage [16]. A summary of storage requirements meeting the City 2010 Improvement Standards for current and projected demand conditions is provided in Table 7-6.

TABLE 7-6
CITY OF ANGELS WATER MASTER PLAN
SYSTEM STORAGE REQUIREMENTS FOR CITY IMPROVEMENT STANDARDS

Demand Condition	Fire Storage[a] (gal)	Operational Storage[b] (gal)	Emergency Storage[c] (gal)	Minimum Chlorine Contact Volume[d] (gal)	Total Required Storage (MG)
Base Year (2011)	240,000	400,320	333,600	937,500	2.0
10-year (2021)	240,000	490,520	408,767	937,500	2.1
20-year (2031)	240,000	602,720	502,267	937,500	2.3

[a] Fire storage = maximum fire flow condition of 2,000 gpm (multiple residential, three stories, heavy commercial, or heavy industrial) for a 2 hour duration.

[b] Operational storage = 20% of MDD (including in-plant process demands).

[c] Emergency storage = 4 hours of MDD (including in-plant process demands).

[d] Condition No. 9 of the City's 2003 permit amendment states that a minimum volume of 937,500 gallons must be maintained for disinfectant contact time [6].

As shown in Table 7-6, the minimum storage required by the City 2010 Improvement Standards at the 20-year demand condition is 2.3 MG. A second treated water storage tank with a volume of 2.3 MG is recommended for redundancy to avoid service interruptions during maintenance and repairs if the second tank is constructed at or near the WTP.

If an alternative location (i.e., not at the WTP site) is selected for the second storage tank, the minimum chlorine contact volume requirement and in-plant process demands do not apply. Based on the 20-year demand condition, the minimum storage volume without a chlorine contact requirement or in plant process demands is approximately 1.4 MG. Tank site alternatives are further discussed in Chapter 9.

f. Transmission

Finished water from the treated water storage tank is fed to the City's distribution system via a single welded steel transmission main that is approximately 3,508 ft in length. The diameter of the existing transmission main is unknown but is believed to be 10-inches or 14-inches. The transmission main is 50-60 years old and in poor condition [5]. If the transmission main were to fail, the City would be unable to supply water to its customers. CDPH staff has commented that the City needs an additional transmission main in parallel with the existing transmission main [11].

The parallel transmission main should be sized to meet velocity and head loss criteria for the greater of PHD or fire flow plus MDD. The 20-year projection for PHD is 3,439 gpm. Using a fire flow of 2,000 gpm, the 20-year projection for fire flow plus MDD is 4,023 gpm. A summary of requirements for sizing of the parallel transmission main based on fire flow plus MDD is provided in Table 7-7.

TABLE 7-7
CITY OF ANGELS WATER MASTER PLAN
SIZING OF PARALLEL WATER TRANSMISSION MAIN

Item	Value
20-year Projection of Fire Flow + MDD (2031), gpm[a]	4,023
Maximum Velocity for Short Durations[b], fps	12
Minimum Pipe Diameter to Meet Velocity Criteria, in	12
Maximum Head Loss[c], ft	35
Minimum Pipe Diameter to Meet Head Loss Criteria, in	16

[a] Fire flow of 2,000 gpm + MDD of 2,023 gpm (per Table 7-1) for 20-year projection.

[b] Velocity criteria per Table 4-2.

[c] Maximum head loss criteria of 10 ft per 1,000 ft (per Table 4-2) and a total pipe length of 3,508 ft.

As shown in Table 7-7, the minimum pipe diameter is controlled by the head loss evaluation criteria. Because a 16-inch diameter pipeline is a less common size, the recommended diameter for the parallel water transmission main is 18-inches, consistent with the suggestion in the 2011 Water Audit [6]. The addition of a parallel water transmission main addresses a critical need for reliability, security, and system redundancy.

g. Backwash Water and Sludge Handling

Currently, filter backwash water and water from sedimentation basin cleaning is discharged into a stock pond on a neighboring ranch. The stock pond in turn can discharge to Cherokee Creek. The following two alternative strategies have been identified and discussed in previous documents [3, 6]: 1) construction of sludge lagoons and a pump station to recycle sludge lagoon supernatant to the head of the WTP; and 2) construction of a sludge pipeline and appurtenances from the WTP to a point within the City wastewater collection system. Due to a lack of available capacity in the City wastewater collection system and potential adverse effects on the City wastewater treatment facility, Alternative 1 is recommended. Implementation of Alternative 1 would also significantly increase the efficiency of the WTP.

Under Alternative 1, two lined sludge lagoons would be constructed adjacent to the existing WTP facilities. The capacity of each lagoon would be approximately 500,000 gallons. Filter backwash water and water from sedimentation basin cleaning would flow to the sludge lagoons. Sedimentation would occur in the sludge lagoons, and baffles would be provided to prevent short-circuiting. Supernatant would flow from the sludge lagoons to the wet well of a duplex recycle pump station. The pump station would be equipped with a flow meter to monitor the flow from the sludge lagoons to the head of the WTP. The recycled water flow should not exceed 10 percent of the total plant influent flow. (The flow of process water to the head of the WTP is minor and will not be a factor in determining the recycled water flow.) Proper design, operation, and maintenance of the lagoons and recycle pump station should prevent discharges and eliminate the need for National Pollutant Discharge Elimination System (NPDES) permitting.

Periodically, on a rotating basis, sludge lagoons would be removed from service, drained, and allowed to dry. Dried sludge would be removed and hauled to a landfill or other approved destination.

7.3 Conclusions and Recommendations

In general, the WTP lacks redundancy. The following WTP elements were constructed without parallel backup units to use while maintenance and repair operations are in progress:

1. Flocculation basin
2. Sedimentation basin
3. Storage tank
4. Transmission main from WTP to distribution system

Treated water demand projections indicate that a fourth filter could be required in the near future. The City should complete design of the fourth filter project and proceed with construction. Additional on-site sodium hypochlorite generation capacity will also be required.

The following needs have been identified considering current operational practices and difficulties:

1. Replacement of the existing sedimentation with a modern unit that is equipped with a sludge removal system.
2. Construction of sludge lagoons, a recycle pump station, and appurtenances to eliminate discharges offsite and potential regulatory issues with the Regional Water Quality Control Board triggered by releases to Cherokee Creek. Non-permitted releases to Cherokee Creek could be subject to administrative civil liabilities.

A WTP process flow diagram showing necessary improvements is presented in Figure 7-2. Of the necessary improvement projects, the following address possible regulatory compliance issues:

1. Fourth filter
2. Sludge lagoons, recycle pump station, and appurtenances

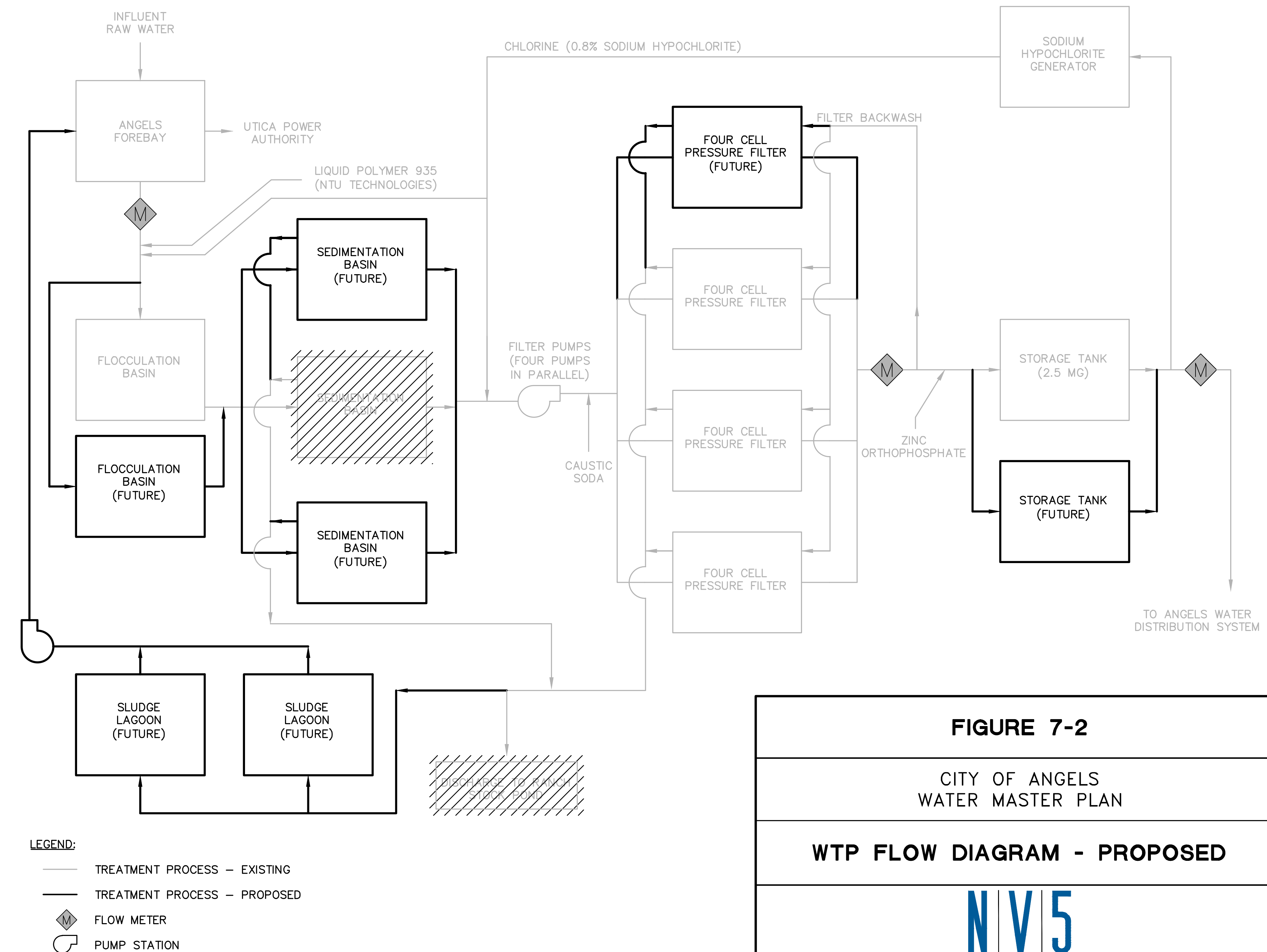

FIGURE 7-2

CITY OF ANGELS
WATER MASTER PLAN

WTP FLOW DIAGRAM - PROPOSED

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8 Hydraulic Evaluation of Existing Distribution System

The purpose of this chapter is to execute a water distribution system hydraulic model for various demand scenarios under existing development conditions. The results of the model scenarios will be used to develop recommended capacity improvement projects for the distribution system. The development and calibration of the hydraulic model using calculated water demands and assumed pipeline friction factors are also discussed.

8.1 Study Area and Existing Land Use

Land use data for the City provided in GIS format were utilized for the calibration of the hydraulic model. The furnished data encompassed a total area of approximately 2,280 ac within the City limits. Water distribution system pressure zones, identified in the 2011 Water Audit [6], are presented in Figure 8-1.

A summary of existing developed land uses (including partially developed areas), previously presented in Table 5-2 and Figure 5-1, is also presented in Table 8-1 for reference. Parcels designated as ROW and OS were assumed to have no water demands and were not included in the analysis of existing demands.

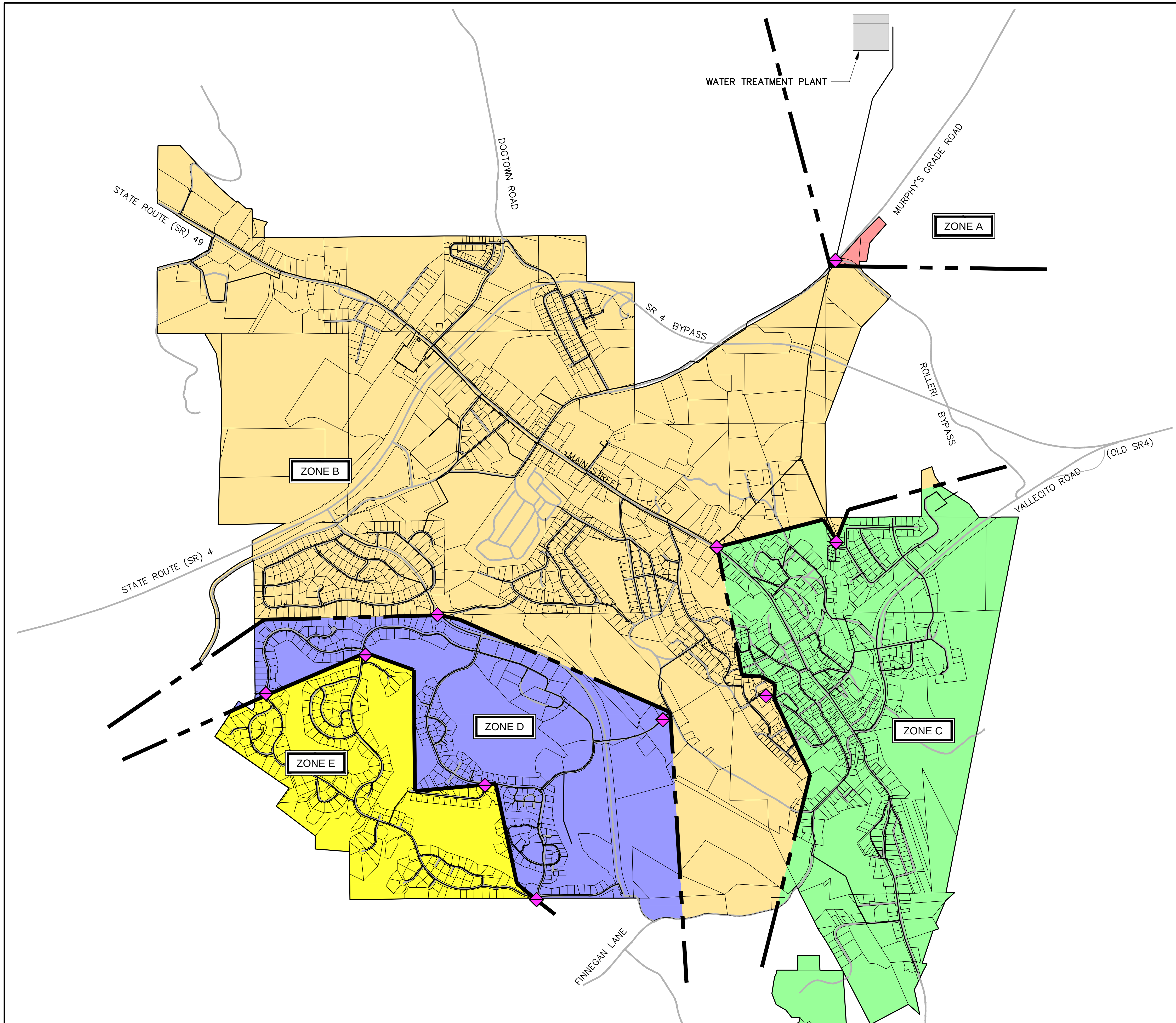

FIGURE 8-1

CITY OF ANGELS
WATER MASTER PLAN

DISTRIBUTION SYSTEM PRESSURE ZONES

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TABLE 8-1
CITY OF ANGELS WATER MASTER PLAN
DEVELOPED LAND USE SUMMARY

Land Use	Description	Number of Parcels[a]	Total Developed Area[a] (ac)
Residential			
HDR	High-Density Residential	128	80
MDR	Medium-Density Residential	68	51
RE	Residential Estates	10	14
SFR	Single-Family Residential	1,190	372
HDR-WMC	Worldmark Club	19	21
Commercial			
BAE	Business Attraction/Expansion	21	26
CC	Community Commercial	101	65
HC	Historic Commercial	79	16
SC	Shopping Commercial	39	32
Industrial			
I	Industrial	5	16
Public			
P	Public	22	28
P (WWTP)	Public (Wastewater Treatment Plant)	2	18
P-SCH	Public School	8	50
PR	Parks and Recreation	9	18
PR-Golf	Golf Course	5	144
Other			
SP	Special Planning	1	4
OS	Open Space	5	12
ROW	Right-of-Way	154	216
Total		**1,866**	**1,183**

[a] Includes partially-developed land uses.

8.2 Summary of Water Demands by Land Use Type

As discussed in Chapter 5, existing and future demands for the system were developed from 2007-2011 average water use. Water demands by land use are presented in Table 8-2. Demands for individual parcels were applied to the nearest point (node) on the distribution system.

TABLE 8-2
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF WATER DEMANDS BY LAND USE

	Conversion Factor[a,b] (EWU/ac)		Demand Factor[a,b] (gpd/EWU)	Demand (gpd/ac)	
Land Use	**Existing**	**Future**		**Existing**	**Future**
Residential					
HDR	5.0	15.0	255	1,275	3,825
MDR	3.0	10.0	255	765	2,550
RE	2.0	0.5	255	510	128
SFR	4.0	6.0	255	1,020	1,530
HDR-WMC	9.5	9.5	255	2,423	2,423
Commercial					
BAE	2.0	1.0	255	510	255
CC	2.0	15.0	255	510	3,825
HC	2.0	15.0	255	510	3,825
SC	2.0	15.0	255	510	3,825
Industrial					
I	2.0	2.0	255	510	510
Public					
P	5.0	5.0	255	1,275	1,275
P (WWTP)	5.0	0.0	255	1,275	0
P-SCH	10.0	10.0	255	2,550	2,550
PR	4.0	4.0	255	1,020	1,020
Other					
SP	1.5	1.5	255	383	383

[a] Conversion factors per Table 5-12.
[b] Demand factor per Table 5-13.

8.3 Existing Distribution System

The existing water distribution system consists of approximately 167,000 lineal feet (LF) of pipelines with diameters ranging from 2-inches to 14-inches. The system includes approximately 300 hydrants, 30 ARVs, 14 blowoff valves, ten PRVs, and one surge valve.

For modeling purposes, only the water distribution trunk network, consisting of 154,900 LF of 4-inch to 14-inch pipelines, 262 hydrants, and ten PRVs was analyzed. This trunk network is presented in Figure 8-2.

8.4 Hydraulic Model

This section will describe the software used to develop the distribution network model.

a. Modeling Software

A model of the existing distribution network was created using Bentley Haestad WaterCAD (version 8i). The software can analyze hydraulic performance and water quality behavior of a distribution network under steady-state and extended period (non-steady) conditions. For calibration of the hydraulic model, analysis of a steady state model under ADD, MDD, and PHD conditions was conducted.

b. Physical Data

GIS data provided by the City included the location and size (diameter) of pipelines, PRVs, ARVs, and hydrants. Ground elevations were determined from United States Geological Survey (USGS) maps and aerial imagery. Pipe cover was assumed to be an average depth of 3 ft to obtain pipe invert elevations. The extents of the modeled distribution network include greater than 90 percent, by length, of the entire City water system.

c. Demand Inputs

GIS parcel maps were reviewed to establish local water service areas along the distribution network. Parcels within each local service area were used to establish water demand loading for the hydraulic model, based on demands presented in Table 8-2.

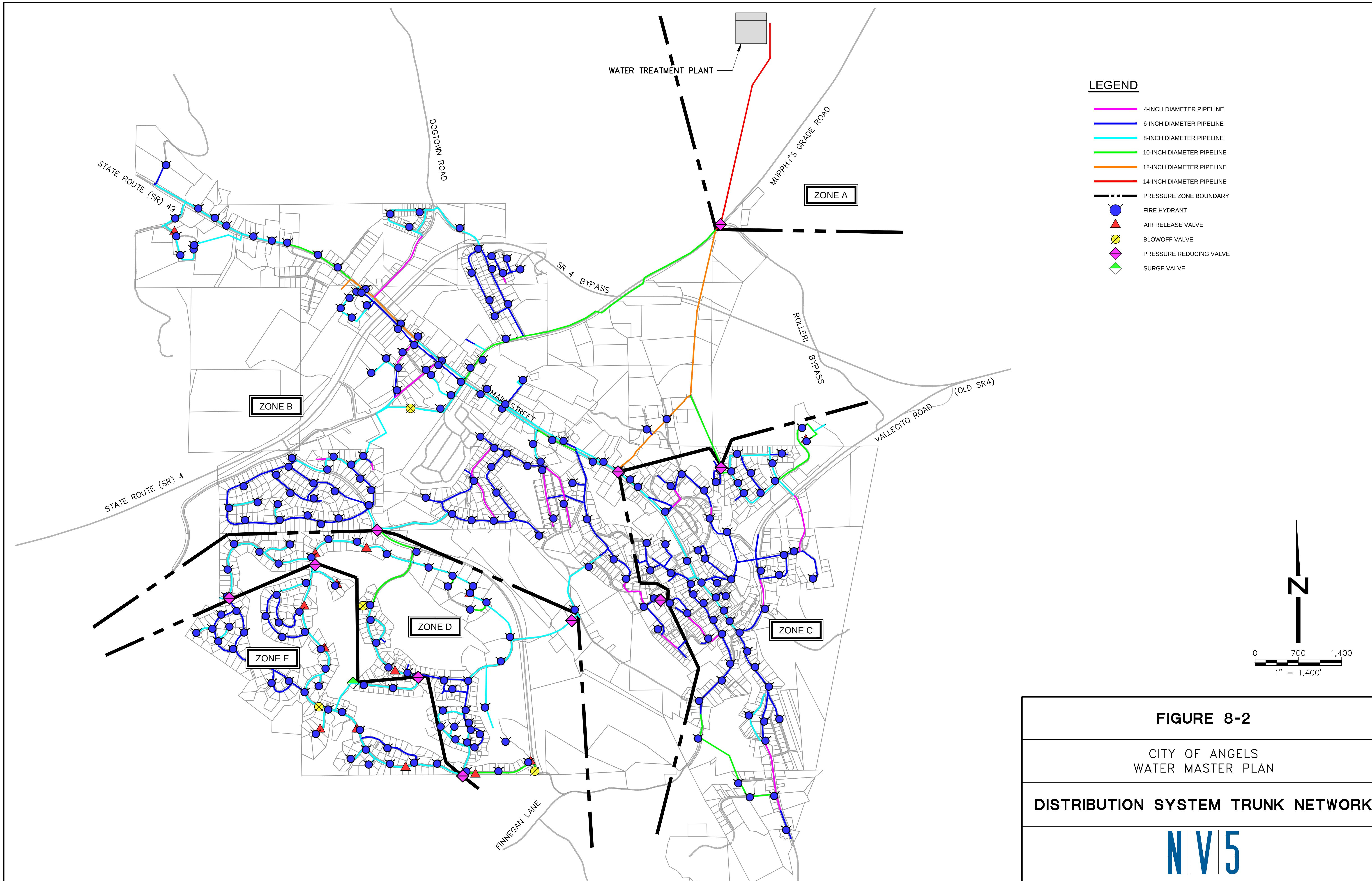

FIGURE 8-2

CITY OF ANGELS
WATER MASTER PLAN

DISTRIBUTION SYSTEM TRUNK NETWORK

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BEYOND ENGINEERING

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8.5 Calibration of the Hydraulic Model

This section will describe the methodology for water model calibration.

a. Typical Friction Coefficients

As pipelines age, deterioration through normal use may result in changes to hydraulic performance. The hydraulic condition of a pipeline is best expressed by the coefficient C within the Hazen-Williams equation which is primarily a function of pipe material and age. Higher C values correspond to lower pipe friction, lower head loss, and improved hydraulic performance.

The 2011 Water Audit [6] provided general pipeline age and material characteristics for the distribution system pressure zones. Existing pipe materials and typical C values are presented in Table 8-3. A conservative C value of 110 is assumed where pipeline information is not available.

TABLE 8-3
CITY OF ANGELS WATER MASTER PLAN
PIPELINE MATERIALS AND FRICTION COEFFICIENTS

Pressure Zone	Pipe Material	Typical Friction Coefficient Range (Hazen-Williams C value)
A	Not Specified	110 (Assumed)
B	50 year old asbestos cement, spiral weld steel, ductile iron, or galvanized steel	110-120
C	50 year old asbestos cement, spiral weld steel, ductile iron, or galvanized steel	110-120
D	10-20 year old C900 PVC	120-130
E	10-20 year old C900 PVC	120-130

b. Applied Friction Coefficients for Model Calibration

The City provided data from three fire hydrant flow tests performed between October 2010 and January 2012. Updated static pressure test results for two of the fire hydrants, performed in August and September 2012, were provided by City staff. To calibrate the model, static pressures (before hydrant flow) observed at each location were compared to model results using an average C value, by zone, obtained from Table 8-3 which would indicate normal degradation. Because it is not known which flow conditions (ADD, MDD, of PHD) were present when the hydrant tests were performed, model results for all flow scenarios were reviewed to confirm calibration within an acceptable margin of error (±10 percent).
Hydrant test locations are presented in Figure 8-3. Static pressure data, flow data, and calibrated model results are presented in Table 8-4. Flow test reports are provided in Appendix I.

TABLE 8-4
CITY OF ANGELS WATER MASTER PLAN
FIRE HYDRANT FLOW TEST AND MODEL CALIBRATION DATA

Hydrant ID	Test Month	Pressure Zone	Test Value	Model		% Diff.	
				ADD[a]	MDD[b]	ADD[a]	MDD[b]
Static Pressure (psi)							
A1-FH-113	Oct. 2010	B	120 psi	108 psi	102 psi	-9.9%	-14.8%
C2-FH-100	Aug. 2012	B	108 psi	98 psi	92 psi	-9.4%	-14.8%
C2-FH-117	Sep. 2012	B	87 psi	90 psi	79 psi	3.9%	-9.8%
Hydrant Flow (gpm) [c]							
A1-FH-113	Oct. 2010	B	2,165 gpm	2,132 gpm	1,796 gpm	-1.5%	-17.0%

[a] ADD conditions.

[b] MDD conditions.

[c] Hydrant flow only available for Oct. 2010 test of Hydrant A1-FH-113.

Based on the results presented in Table 8-4, it is likely that ADD flow conditions were present for the October 2010 and August 2012 hydrant flow tests. ADD or MDD flow conditions were likely present for the September 2012 hydrant flow test.

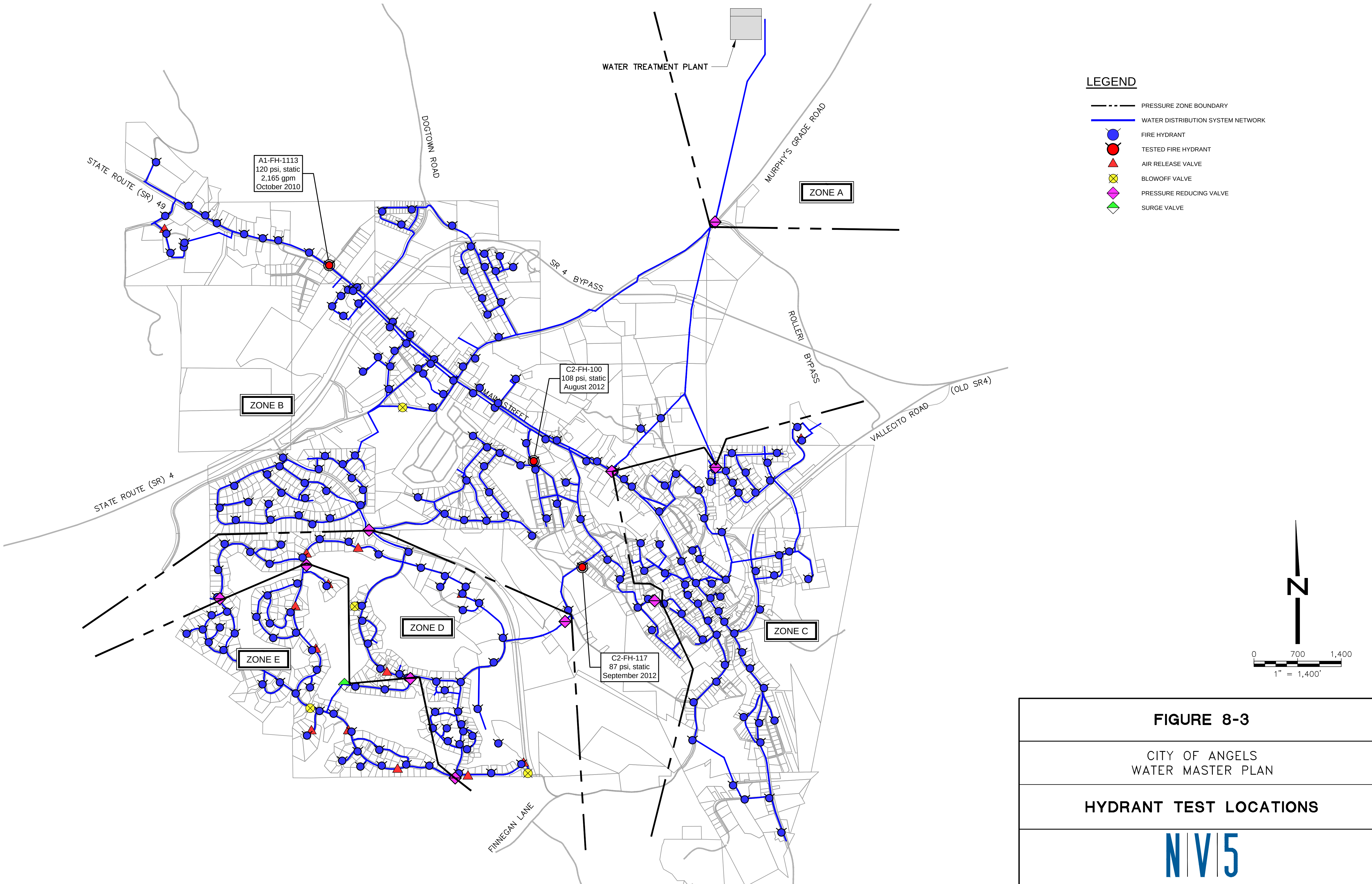

FIGURE 8-3

CITY OF ANGELS
WATER MASTER PLAN

HYDRANT TEST LOCATIONS

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The calibrated C value of 115 for Zone B is within the range of expected friction coefficients and indicates typical pipe degradation from normal use. Because fire hydrant flow data from other pressure zones is not available for analysis, it is assumed that all pipes within the distribution system perform similarly within the respective typical ranges for pipeline age and material. Applied friction coefficients for all pressure zones are presented in Table 8-5.

TABLE 8-5
CITY OF ANGELS WATER MASTER PLAN
APPLIED FRICTION COEFFICIENTS

Pressure Zone	Applied C-value
A	110
B	115
C	115
D	125
E	125

Approximately 6,180 LF of 8-inch to 12-inch pipeline within Pressure Zone B, identified as recent construction by the City, is assumed to have a C value of 130, typical of newly constructed C900 PVC.

8.6 Scenarios Analyzed with Hydraulic Model

Using friction coefficients and demand factors discussed in Section 8.4 and 8.5, the hydraulic model was analyzed to evaluate the condition and capacity of the distribution system for existing and future (buildout) demand scenarios. Detailed results are included in Appendix J. Executed hydraulic model scenarios are presented in Table 8-6.

TABLE 8-6
CITY OF ANGELS WATER MASTER PLAN
EXECUTED HYDRAULIC MODEL SCENARIOS

Demand Scenario	Scenario Description
Existing Conditions	
Existing ADD	ADD for existing parcels; based on demand factors presented in Table 8-2
Existing MDD	Existing ADD scenario with an applied MDD peaking factor of 2.2 (per Section 5.4)
Existing PHD	Existing MDD scenario with an applied PHD peaking factor of 1.7 (per Section 5.4)
Existing MDD Plus Fire Flow[a]	Existing MDD scenario with fire flow demands applied and analyzed independently at each hydrant location
Buildout Conditions[b]	
Buildout ADD	ADD for buildout parcels; based on demand factors presented in Table 8-2
Buildout MDD	Buildout ADD scenario with an applied MDD peaking factor of 2.2 (per Section 5.4)
Buildout PHD	Buildout MDD scenario with an applied PHD peaking factor of 1.7 (per Section 5.4)
Buildout MDD Plus Fire Flow[a]	Buildout MDD scenario with fire flow demands applied and analyzed independently at each hydrant

[a] Fire flow requirements presented in Table 8-7.

[b] Buildout Conditions based on ultimate General Plan [1] land uses.

The results of scenarios presented in Table 8-6 were analyzed to evaluate the distribution system for areas with excessively low or high pressures and the effectiveness of future infrastructure improvements. Fire flow requirements, previously presented in Table 4-1, are also presented in Table 8-7 for reference.

TABLE 8-7
CITY OF ANGELS WATER MASTER PLAN
FIRE FLOW REQUIREMENTS

Land Use Category	Fire Flow[a] (gpm)	Duration (hours)
Rural residential (<2 lots/acre)	500	2
Single family residential (<2 lots/acre)	500	2
Single family residential (≥3 lots/acre)	750	2
Multiple residential up to a fourplex; neighborhood businesses of one story	750	2
Multiple residential units of >4 units, one and two story; light commercial and light industrial	1,500	2
Multiple residential, three stories, heavy commercial, or heavy industrial	2,000	2

[a] Fire flows and durations established in City Resolution 21-78.

8.7 Distribution System Performance under Existing Conditions

The distribution system was analyzed under existing conditions for ADD, MDD, and PHD. Additionally, a fire flow analysis was performed using MDD and City fire flow requirements, identified in Table 8-7.

Desired hydraulic performance criteria for the distribution system, previously presented in Table 4-2, are presented in Table 8-8 for reference.

TABLE 8-8
CITY OF ANGELS WATER MASTER PLAN
DISTRIBUTION SYSTEM HYDRAULIC PERFORMANCE CRITERIA

Criteria	Value	Source
Minimum pressure – ADD	40 psi	2010 Improvement Standards [16]
Minimum pressure – MDD	35 psi	Typical design standard
Minimum pressure – PHD	20 psi	California Waterworks Standards [10]
Minimum pressure – fire flow plus MDD	20 psi	2010 Improvement Standards [16], California Waterworks Standards [10]
Maximum pressure at service connection	150 psi (PRV required at 80 psi)	2010 Improvement Standards [16]
Maximum velocity	8 fps (typical) 12 fps (short durations)	Typical design standards
Maximum head loss gradient	10 ft per 1,000 ft	Typical design standard

a. Average Day, Maximum Day, and Peak Hour Demands (Existing)

Several pipe segments and one junction were identified as failing to meet hydraulic performance criteria for maximum pressure and maximum head loss gradient under existing conditions. Hydraulically deficient junctions and pipe segments are summarized in Table 8-9 and presented in Figure 8-4. Hydraulic performance criteria for minimum pressure and maximum velocity were achieved in all demand scenarios for existing conditions.

TABLE 8-9
CITY OF ANGELS WATER MASTER PLAN
HYDRAULICALLY DEFICIENT JUNCTIONS AND PIPE SEGMENTS, EXISTING CONDITIONS

		Maximum Pressures		Maximum Head Loss Gradient		
Scenario	Location	No. of Junctions	Pressure Range (psi)	Pipe Length (ft)	Pipe Diameter (in)	Head Loss Gradient (ft per 1,000 ft)[a]
ADD	Greenhorn Creek Road	1	151	-	-	-
	Moose Trail	-	-	958	4	13
MDD	Golden Chain Highway	-	-	47	6	35
	Mark Twain Road	-	-	825	6	13
	Moose Trail	-	-	958	4	31
PHD	Golden Chain Highway	-	-	802	6 - 8	25
	Hillcrest Street	-	-	175	6	22
	Mark Twain Road	-	-	1,740	6	25
	Moose Trail	-	-	958	4	32
	Murphy's Grade Road	-	-	3,329	6 - 8	12
	Oneida Street	-	-	548	4	13
	Stanislaus Avenue	-	-	542	4	13

[a] Length-weighted average.

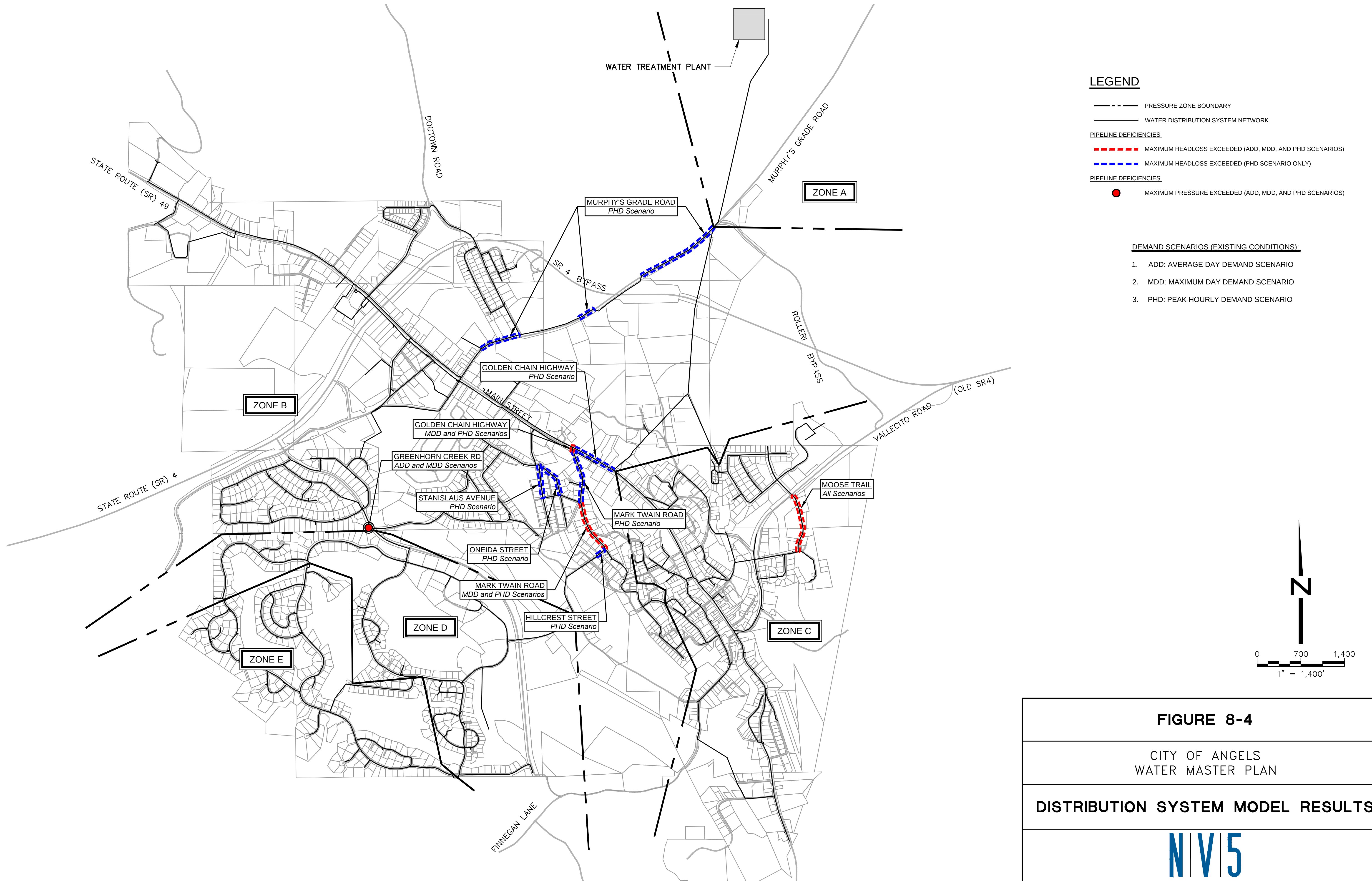

FIGURE 8-4

CITY OF ANGELS
WATER MASTER PLAN

DISTRIBUTION SYSTEM MODEL RESULTS

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b. Fire Flow Analysis (Existing)

The distribution system contains approximately 300 fire hydrants. All hydrants connected to mains 4-inches in diameter or smaller are "wharf" style hydrants. Additionally, City staff have identified approximately 30 wharf hydrants on mains 6-inches in diameter or larger. The hydraulic model is generally comprised of pipe segments 6-inches in diameter or larger and contains 262 fire hydrants, 28 of which are wharf-type hydrants. GIS data for the City were reviewed to determine fire flow requirements for each hydrant based on adjacent land uses.

Several fire hydrants were identified as failing to produce the required fire flow under existing MDD conditions. Hydraulically deficient fire hydrants are summarized in Table 8-10 and presented in Figure 8-5.

TABLE 8-10
CITY OF ANGELS WATER MASTER PLAN
HYDRAULICALLY DEFICIENT FIRE HYDRANTS, EXISTING CONDITIONS

Model Hydrant ID	City Hydrant ID	Location	Assumed Land Use Category	Fire Flow (gpm)		Residual Pressure (psi)[b,c]
				Required	Available[a]	
D3-FH-105	53	Mark Twain Road	Single family residential (<2 lots/acre)	500	436	8
D3-FH-106	54[d]	Fairview Street		500	422	1
D3-FH-107	52	Mark Twain Road		500	454	13
A1-FH-101	A59	Copello Road	Multiple residential units of >4 units, one and two story; light commercial and light industrial	1,500	1,452	14
A1-FH-102	A69	Golden Chain Hwy		1,500	1,416	11
A1-FH-103	A68	Golden Chain Hwy		1,500	1,459	15
A1-FH-104	A67	Golden Chain Hwy		1,500	1,495	19
A1-FH-114	A962	Brunner Hill Road		1,500	1,010	(N/A)
B2-FH-119	A332	Monte Verde Street		1,500	1,488	18
B2-FH-121	A311	Monte Verde Street		1,500	1,194	(N/A)
B2-FH-130	A20	Lee Lane		1,500	1,364	3
B2-FH-131	A36	Golden Chain Hwy		1,500	855	(N/A)
D2-FH-116	391	Gold Cliff Road		1,500	934	(N/A)
D2-FH-112	806	Jumping Frog Way	Multiple residential, three stories, heavy commercial, or heavy industrial	2,000	1,989	16
D2-FH-113	807	Miner's Circle		2,000	1,966	1

[a] Available fire flow with 20 psi residual pressure.

[b] Residual pressure with achievement of required fire flow.

[c] N/A indicates that required fire flow was not achieved with any residual pressure.

[d] Wharf-type hydrant.

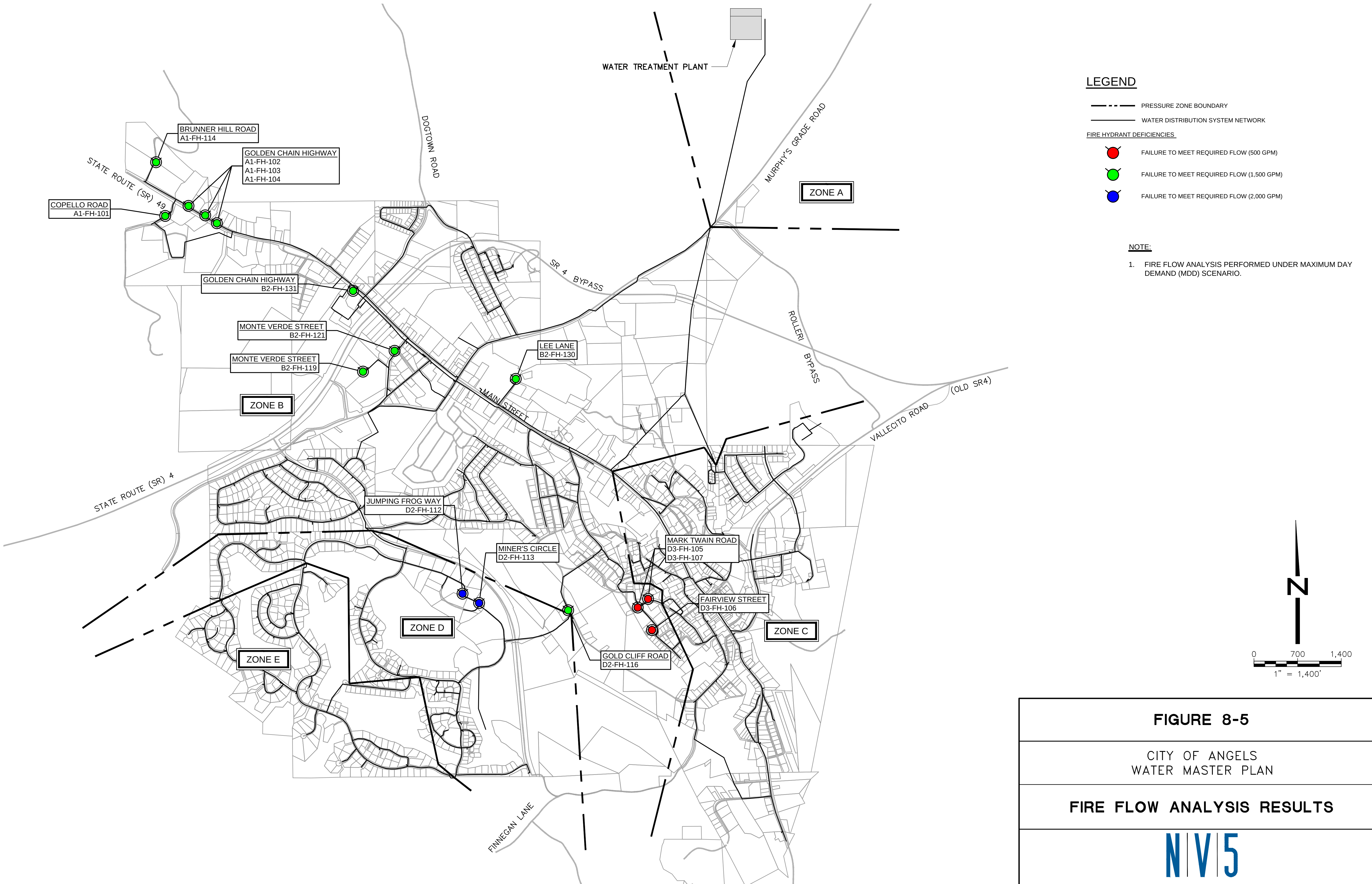

FIGURE 8-5

CITY OF ANGELS
WATER MASTER PLAN

FIRE FLOW ANALYSIS RESULTS

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9 Recommended Improvements

Improvements for City water supply, treatment, distribution, and storage systems described in Chapters 6, 7, and 8 are assembled into a series of recommended projects in this chapter. Additional projects previously planned by the City are also described. Probable costs are presented in Chapter 10.

9.1 Recommended Water Supply Improvements

Currently, the City relies exclusively on surface water delivered through UPA as a source of potable water. The development of groundwater supplies from regional wells was identified in Chapter 6 as a recommended strategy to augment the City's water supply. A subsequent hydrogeologic technical memorandum (Appendix G) identified four potential well sites for further investigation. The potential well sites and associated pipeline routes are provided in Figure 9-1.

A preliminary hydraulic analysis was performed for each pipeline route to determine booster pumping requirements. A hydraulic summary for each well site and pipeline supply route is provided in Table 9-1.

TABLE 9-1
CITY OF ANGELS WATER MASTER PLAN
HYDRAULIC SUMMARY OF SUPPLY ROUTE ALTERNATIVES

Well Site Alternative	Well Elevation	Maximum Pipeline Elevation along Route	Connection Elevation[a]	Pipeline Length (ft)	TDH Required (ft)[b]
A	1,598	1,642	1,570	8,300	170
B	1,893	1,895	1,415	30,600	135
C	1,740	1,895	1,415	33,100	290
D	2,127	2,127	1,415	27,100	N/A[c]

[a] Elevation where the supply pipeline connects to the distribution system.

[b] Total Dynamic Head (TDH) required at booster pump station to supply water to distribution system.

[c] Well Site Alternative D does not require a booster pump station.

As shown by Table 9-1, all groundwater supply alternatives, with the exception of Well Site Alternative D, require a booster pump station to facilitate delivery. Each alternative also requires installation of a pressure-reducing station prior to connection to the existing distribution system. The existing PRV downstream of the WTP may be suitable for use with Well Site Alternative A.

Well Sites B, C, and D have the advantage of being located to the east of the City which facilitates connection to a proposed storage tank site in Pressure Zone C (see Section 9.4).

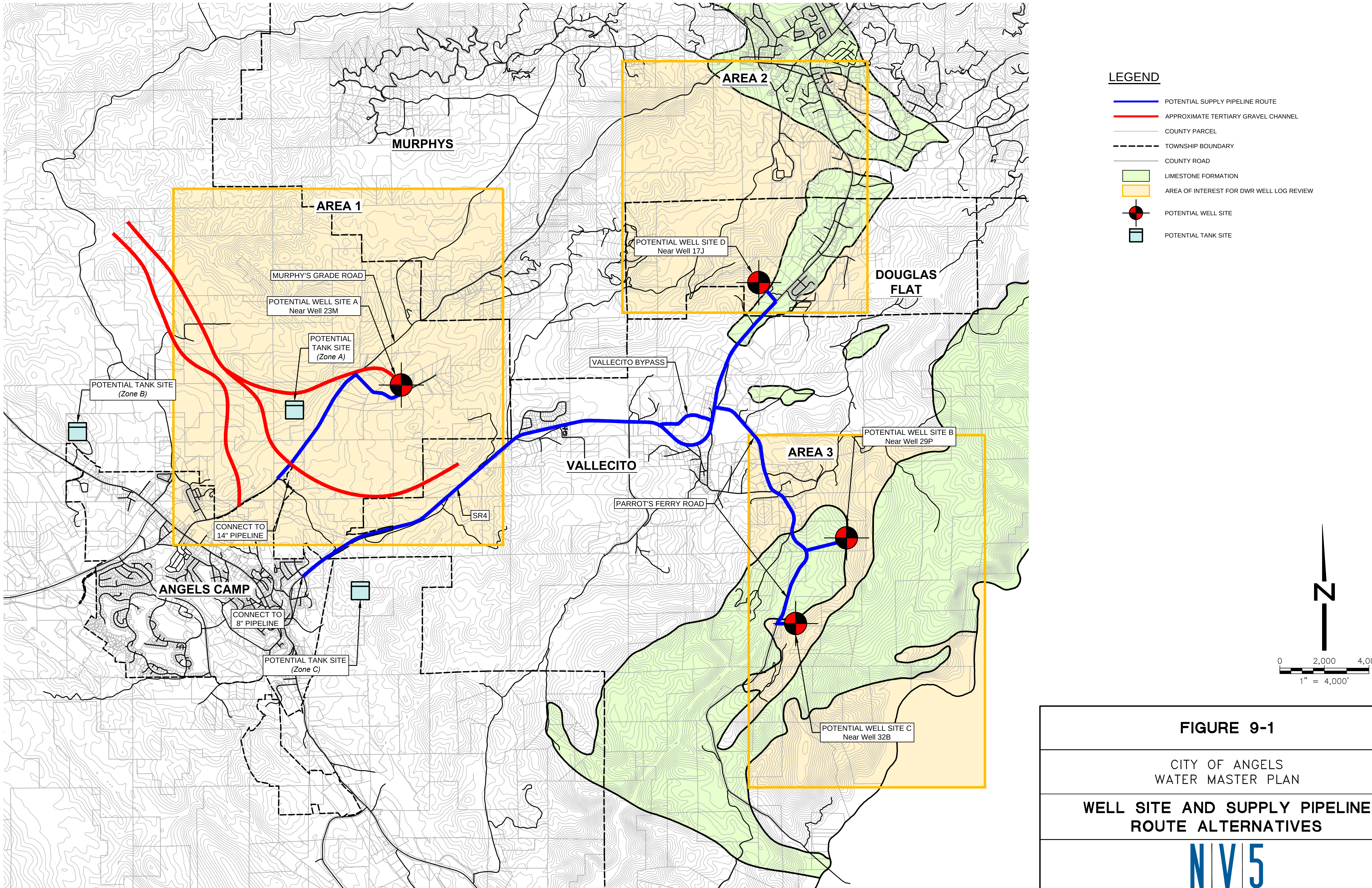

FIGURE 9-1

CITY OF ANGELS
WATER MASTER PLAN

WELL SITE AND SUPPLY PIPELINE ROUTE ALTERNATIVES

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An assessment of Well Site/Supply Pipeline Alternatives, considering hydraulic and operational advantages/disadvantages, is provided in Table 9-2.

TABLE 9-2
CITY OF ANGELS WATER MASTER PLAN
ASSESSMENT OF WELL SITE/SUPPLY PIPELINE ALTERNATIVES

Well Site Alternative	Advantages	Disadvantages
A	- Shortest pipeline length - Reduced installation costs	- Requires booster pumping - No connection to Zone C Tank - Lacks operational redundancy
B	- Allows connection to Zone C Tank - Operational redundancy - Relatively low TDH requirement	- Requires booster pumping - Increased operational costs - Relatively long pipeline length - Increased installation costs
C	- Allows connection to Zone C Tank - Operational redundancy	- Requires booster pumping - Increased operational costs - Relatively long pipeline length - Increased installation costs
D	- Does not require booster pumping - Reduced operational costs - Allows connection to Zone C Tank - Operational redundancy	- Relatively long pipeline length - Increased installation costs

Final well site selection will be dependent upon the results of test well drilling and hydrogeologic assessment.

For planning purposes and because of superior hydrogeological characteristics, Area 3 (Well Site B) is targeted for the next phase of groundwater development (geophysical profiling, test hole drilling). Two wells are desired to meet future water demands in conjunction with continued use of surface water delivered through UPA.

Selection of Area 3 is based on recommendations presented in the Initial Hydrogeologic Investigation (Appendix G) which indicate Area 3 is the likeliest to yield a sufficient quantity of high-quality groundwater requiring the fewest number of wells. If geophysical profiling and test hole drilling confirm the initial findings, Well Site and Waterline Route B will be the preferred water supply system improvements.

9.2 Water Treatment Plant Recommended Improvements

As discussed in Chapter 7, several improvements are recommended at the WTP to address treatment capacity, redundancy, operational difficulties, and regulatory concerns. These improvement projects are summarized in Table 9-3.

TABLE 9-3
CITY OF ANGELS WATER MASTER PLAN
RECOMMENDED WATER TREATMENT PLANT IMPROVEMENTS

Project	Description	Benefits				
		Capacity	Redundancy	Operational Difficulties	Aging Infrastructure	Regulatory Concerns
Second Flocculation Basin	Construction of a four-stage flocculation basin (approximately 48 ft long, 12 ft long, and 9 ft water depth to match existing) with a rotating paddle assembly and associated piping		X			
Second Sedimentation Basin	Construction of a sedimentation basin with an automatic sludge removal system and associated piping		X			
Replace Existing Sedimentation Basin	Construction of a sedimentation basin with an automatic sludge removal system and associated piping			X	X	
Sludge Lagoons and Recycle Pump Station	Construction of two lined 500,000 gallon sludge lagoons, associated piping, and duplex recycled pump station			X		X
Fourth Filter	Construction of a 720 gpm four-cell pressure filter, associated piping, and additional sodium hypochlorite generation	X				X
Parallel Transmission Main	Installation of an upsized 18-inch diameter transmission main (3,508 ft) from WTP to distribution system (parallel to existing transmission main) to meet future water demands in conjunction with supplemental transmission pipelines and storage facilities		X		X	X

The recommended WTP improvements in Table 9-3 would accommodate future demands through 2031 (20-year projection). Beyond 2031, to meet buildout demands, additional improvements at the WTP would be required, most notably a fifth pressure filter. However, these buildout improvements could be deferred, downsized, or eliminated altogether depending on the success of the groundwater exploration and development program.

9.3 Distribution System Recommended Improvements

The distribution system was evaluated for existing and future (buildout) demand conditions to identify specific pipeline segments which require upsizing. Desired hydraulic performance criteria for the distribution system, previously presented in Table 4-2, are presented in Table 9-4 for reference.

TABLE 9-4
CITY OF ANGELS WATER MASTER PLAN
DISTRIBUTION SYSTEM HYDRAULIC PERFORMANCE CRITERIA

Criteria	Value	Source
Minimum pressure – ADD	40 psi	2010 Improvement Standards [16]
Minimum pressure – MDD	35 psi	Typical design standard
Minimum pressure – PHD	20 psi	California Waterworks Standards [10]
Minimum pressure – fire flow plus MDD	20 psi	2010 Improvement Standards [16], California Waterworks Standards [10]
Maximum pressure at service connection	150 psi (PRV required at 80 psi)	2010 Improvement Standards [16]
Maximum velocity	8 fps (typical) 12 fps (short durations)	Typical design standards
Maximum head loss gradient	10 ft per 1,000 ft	Typical design standard

Generally, the existing distribution network has sufficient capacity for buildout ADD and MDD demand conditions. However, under buildout PHD demand conditions, there are a number of areas that fail to meet the minimum pressure specified in Table 9-4 and the fire flow requirements identified previously in Table 8-7. Based on the hydraulic analyses, approximately 27,400 LF of existing distribution mains were identified for upsizing to facilitate buildout demands. Recommended distribution main improvements are summarized in Table 9-5 and presented in Figure 9-2.

The remaining segments of the SR-49 Pipeline Replacement (from Stanislaus Street to Altaville Post Office), identified in Section 2.2, are included in the Golden Chain Highway 8-inch to 10-inch improvement (upsize) project.

Phasing of distribution system improvements are suggested considering the following priorities:

a. Provide required fire flow for existing demands (Phase 1A)
b. Meet hydraulic performance criteria for existing demands (Phase 1B)
c. Provide required fire flow for future demands (Phase 2A)
d. Meet hydraulic performance criteria for future demands (Phase 2B)

TABLE 9-5
CITY OF ANGELS WATER MASTER PLAN
RECOMMENDED DISTRIBUTION MAIN IMPROVEMENTS

Location	Project Description	Length (ft)
Phase 1A - Meet Fire Flow Requirements (Existing Demand)		
Gold Cliff Road	Upsize 8-inch to 10-inch	1,144
Golden Chain Highway	New 6-inch main	49
	Upsize 6-inch to 10-inch	47
	Upsize 8-inch to 10-inch	3,316
Hillcrest Street	Upsize 6-inch to 10-inch	175
	Upsize 8-inch to 10-inch	108
Mark Twain Road	Upsize 6-inch to 10-inch	1,740
McCauley Ranch Road	Upsize 8-inch to 10-inch	294
Monte Verde Street	Upsize 4-inch to 6-inch	281
Phase 1B - Meet Hydraulic Performance Criteria (Existing Demand)		
Depot Road	Upsize 6-inch to 10-inch	225
Moose Trail	Upsize 4-inch to 10-inch	958
Murphy's Grade Road	Upsize 10-inch to 16-inch	995
	Upsize 6-inch to 16-inch	1,289
	Upsize 8-inch to 16-inch	2,673
Valecito Road	Upsize 4-inch to 6-inch	476
Phase 2A - Meet Fire Flow Requirements (Buildout Demand)		
Replace Principal Transmission Main	Upsize 14-inch to 18-inch	3,508
Golden Chain Highway	Upsize 4-inch to 6-inch	857
Mark Twain Road	Upsize 4-inch to 6-inch	681
Phase 2B - Meet Hydraulic Performance Criteria (Buildout Demand)		
12-inch Transmission Main	Upsize 12-inch to 16-inch	2,718
Bret Harte Drive	Upsize 4-inch to 6-inch	186
Depot Road	Upsize 6-inch to 8-inch	797
Dogtown Road	Upsize 4-inch to 6-inch	1,278
Fairview Drive	Upsize 4-inch to 6-inch	237
Gardner Lane	Upsize 6-inch to 8-inch	529
Kurt Drive	Upsize 8-inch to 10-inch	355
Mark Twain Road	Upsize 4-inch to 6-inch	583
McCauley Ranch	Upsize 8-inch to 10-inch	914
S. Baker Road	Upsize 4-inch to 6-inch	353
Suzanne Drive	Upsize 6-inch to 8-inch	648
Total		**27,414**

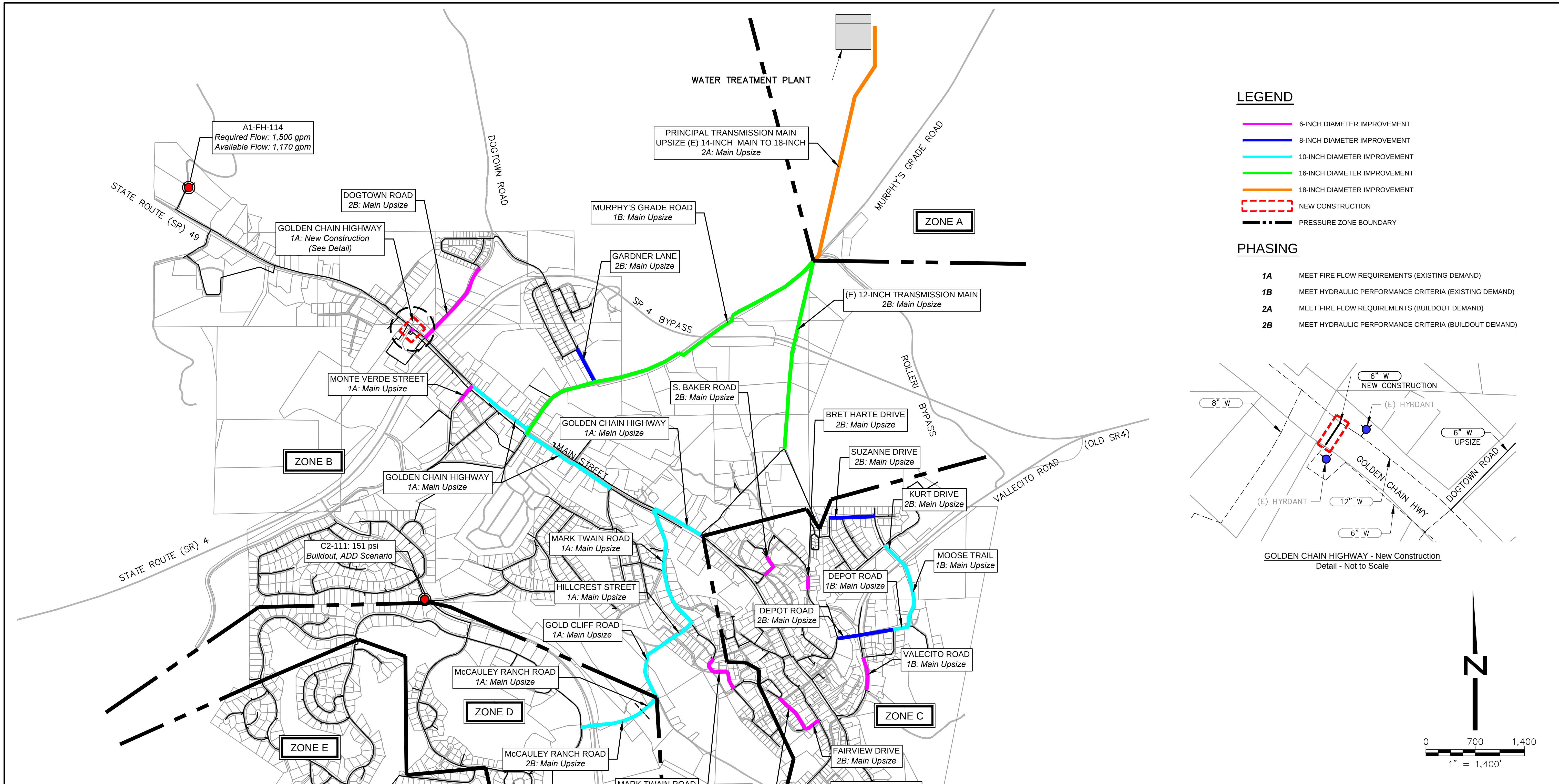

FIGURE 9-2

CITY OF ANGELS
WATER MASTER PLAN

RECOMMENDED DISTRIBUTION MAIN IMPROVEMENTS

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Implementation of the improvements identified in Table 9-5 will alleviate distribution system and fire flow deficiencies for buildout demands with the exception of Hydrant A1-FH-114, located near Brunner Hill Road. The fire flow available at Hydrant A1-FH-114 under buildout MDD conditions is approximately 1,100 gpm, or 75 percent of the 1,500 gpm dictated by surrounding land uses. Due to the relatively high elevation of this hydrant, upsizing the adjacent distribution line is insufficient to correct the fire flow deficiency.

Additionally, under buildout ADD conditions, three junctions (C2-11, E3-100, and E3-112) have maximum pressures ranging from 151-152 psi, approximately 1% greater than the design criteria maximum pressure. These junctions are identified in Figure 9-2. The 1% pressure differential is within the allowable error for the hydraulic model and further improvements to reduce pressure in these junctions were not considered.

One new main is recommended for installation on Golden Chain Highway near 23 North Main Street which will close an existing 6-inch diameter pipeline loop and increase the available fire flow at hydrant B2-FH-131 to the desired 1,500 gpm.

9.4 Recommended Water Storage Improvements

Currently, storage for the distribution system is provided by a single 2.5 MG tank located near the WTP. As discussed in Chapter 4 and Chapter 7, CDPH has commented on the reliability of the City water system. To avoid service interruptions, a new storage tank is recommended. As discussed in Section 7.2, the minimum volume of a storage tank constructed at or near the WTP (Zone A) is 2.3 MG (see Section 7.2). The minimum volume of a storage tank constructed in Zone B or Zone C is 1.4 MG.

City staff have identified three potential sites for construction of a new storage tank. Storage tank site alternatives are summarized in Table 9-6 and presented in Figure 9-3.

TABLE 9-6
CITY OF ANGELS WATER MASTER PLAN
STORAGE TANK SITE ALTERNATIVES

Pressure Zone	Tank Location	Ground Elevation	Required Volume (MG)	Adjacent Pipeline Diameter (in)
A	WTP; North of City	1,810	2.3	14
B	Brunner Hill Road; Northwest of City	1,840	1.4	6
C	Southeast of SR-4; East of City	1,800	1.4	8

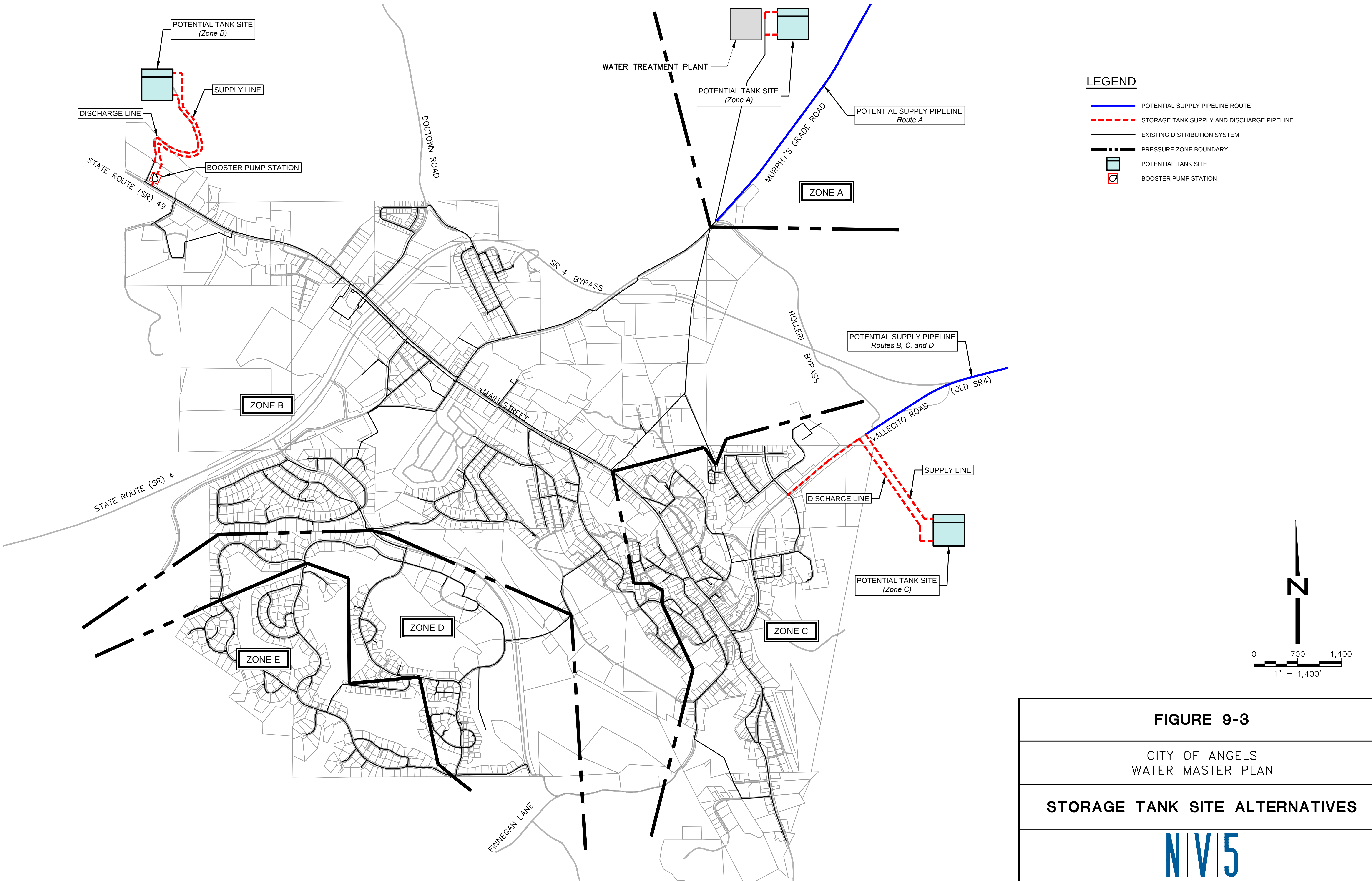

FIGURE 9-3

CITY OF ANGELS
WATER MASTER PLAN

STORAGE TANK SITE ALTERNATIVES

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An assessment of Storage Tank Site Alternatives, considering hydraulic and operational advantages and disadvantages, is provided in Table 9-7. A discussion follows below.

TABLE 9-7
CITY OF ANGELS WATER MASTER PLAN
ASSESSMENT OF STORAGE TANK SITE ALTERNATIVES

Tank Site Alternative (Zone)	Advantages	Disadvantages
A	- Located near WTP and existing tank - Hydraulically ideal location	- Greatest required volume (2.3 MG) - 14-inch transmission main represents single point of failure - Lacks redundancy of other options
B	- Highest elevation of all sites - Lesser required volume (1.4 MG)	- Requires booster pumping to fill - Increased operational costs
C	- Located near proposed supply routes - Lesser required volume (1.4 MG)	- Lowest elevation of all sites

The Zone A tank would provide the same hydraulic service as the existing storage tank. However, this site is not recommended as it places the new tank in proximity to the existing tank with a subsequent connection to a common 14-inch transmission main. The existing 14-inch transmission main would then represent a single point of failure for both storage tanks. As such, the new tank would fail to improve the system reliability of the City.

Based on site elevation, the Zone B tank site is a potentially ideal location for a new storage tank. However, there is no nearby supply source and a pump station would be required to fill the tank, increasing long-term operational costs. Construction of the Zone B tank would, however, alleviate the fire flow deficiency at Hydrant A1-FH-114.

The Zone C tank site is recommended as it is located in proximity to the proposed pipeline supply route for Well Site Alternatives B, C, and D. This would facilitate filling the tank and simplify operational requirements while providing a suitable parallel storage source.

9.5 Meter System Upgrade and Leak Detection Survey

As discussed in Section 2.6, past recommendations for the City include conducting a leak detection survey, replacing old water meters, and upgrading to an automatic meter reading (AMR) system. The leak detection survey and replacement of water meters would help close the gap on lost water due to aging pipes and meters. An upgrade to an AMR system significantly reduces hours spent reading meters and increases customer awareness in water usage and conservation efforts.

9.6 Additional Recommended Projects

In addition to the improvement projects recommended to address water supply, treatment, distribution, and storage systems, there are several useful activities related to periodically assessing water facilities. These include:

1. Water Master Plan (or Asset Management Plan)
2. Water Rate and Connection Fee Study

Water master plans and rate and connection fee studies are updated periodically to re-assess the water system 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 significant undertaking, asset management plans offer the advantage of better estimating costs for maintaining systems 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.

10 Probable Project Costs

Probable project costs were developed for the recommended improvements described in Chapter 9. The basis for the costs, including allowances for engineering, construction management, and administration, is described below.

10.1 Construction Cost Accuracy

The opinions of construction costs presented in this Master Plan are based on documentation 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 Associated for the Advancement of Cost Engineering (AACE). The costs are based on an Engineering News Record (ENR) San Francisco Construction Cost Index (SF-CCI) of 10369 (February 2013).

10.2 Project Costs for Water Supply Improvements

Project costs for water supply improvements are composed of construction costs plus contingencies for engineering, construction management, and administration. Construction costs are based on a review of recent bid results, indexed to the current ENR SF-CCI, and include a 20 percent contingency. To obtain total project costs, a 25 percent contingency for engineering, construction management, and administration was added.

Project costs for water supply improvements include cost components for municipal wells, transmission piping, ARVs, booster pump stations, and pressure-reducing stations. Unit costs for these project elements are provided in Table 10-1.

TABLE 10-1
CITY OF ANGELS WATER MASTER PLAN
UNIT COSTS FOR WATER SUPPLY IMPROVEMENTS

Item	Unit[a]	Unit Cost ($)
Municipal Well, Drilling/Equipping	EA	400,000
12-inch Transmission Main Piping (Rural Routes)[b]	LF	100
Air Release Valves	EA	2,000
Booster Pump Station, 135 ft TDH	LS	525,000
Booster Pump Station, 170 ft TDH	LS	660,000
Booster Pump Station, 290 ft TDH	LS	1,125,000
Pressure Reducing Station	LS	40,000

[a] EA = each, LS = lump sum.

[b] Includes cost for pavement removal and replacement.

A preliminary hydraulic analysis was performed for each supply alternative to determine booster pumping and pressure reducing requirements and the projected quantity of ARVs. Total project costs for the drilling and equipping of two wells in Area 3, Site B, and associated conveyance facilities, are provided in Table 10-2.

TABLE 10-2
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR WATER SUPPLY IMPROVEMENTS

Component	Quantity	Unit	Unit Cost ($)	Base Cost ($)	Construction Cost[a] ($)	Project Cost[b] ($)
Area 3, Well Site B						
Municipal Well, Drilling/Equipping	2	EA	400,000	800,000	960,000	1,200,000
12-inch Transmission Main (Rural Route)	30,600	LF	100	3,060,000	3,672,000	4,590,000
Air Release Valves	17	EA	2,000	34,000	41,000	52,000
Booster Pump Station, 135 ft TDH	1	LS	525,000	525,000	630,000	790,000
Pressure Reducing Station	1	LS	40,000	40,000	48,000	60,000
Total Cost						**6,692,000**

[a] Includes 20 percent contingency for construction.

[b] Includes 25 percent contingency for engineering, construction management, and administration.

10.3 Project Costs for Water Treatment Plant Improvements

WTP project costs are composed of construction costs plus contingencies for engineering, construction management, and administration. Construction costs are based on a review of recent bid results, and EPA guidelines (*Modeling the Cost of Infrastructure*, [31]) indexed to the current ENR SF-CCI, and include a 20 percent contingency. To obtain total project costs, a 25 percent contingency for engineering, construction management, and administration was added. Total project costs for each WTP improvement project, identified in Table 9-3, are provided in Table 10-3.

For budgeting purposes, the Parallel Transmission Main identified in Table 9-3 is included as part of the distribution system improvements (see Table 9-5, Phase 2A). Recommended construction of the 1.4 MG Zone C Storage Tank and Well Site and Water Supply Route B pipeline eliminates the need for a redundant transmission main from the WTP. While the existing 14-inch transmission main will not be removed from service, the new 18-inch pipeline will serve as the principal transmission main from the WTP.

TABLE 10-3
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR WATER TREATMENT PLANT IMPROVEMENTS

Project	Base Cost ($)	Construction Cost[a] ($)	Project Cost[b] ($)
Second Flocculation Basin	500,000	600,000	750,000
Second Sedimentation Basin	990,000	1,190,000	1,490,000
Replace Existing Sedimentation Basin	990,000	1,190,000	1,490,000
Sludge Lagoons and Recycle Pump Station	520,000	625,000	785,000
Fourth Filter[c]	885,000	1,065,000	1,335,000
Total Cost			**5,850,000**

[a] Includes 20 percent contingency for construction.

[b] Includes 25 percent contingency for engineering, construction management, and administration.

[c] Cost for fourth filter is based on estimate from 2011 Water Audit [6].

10.4 Project Costs for Distribution System Improvements

Distribution system improvement project costs are composed of construction costs plus contingencies for engineering, construction management, and administration. Construction costs are based on a review of recent bid results, indexed to the current ENR SF-CCI, and include a 20 percent contingency. To obtain total project costs, a 25 percent contingency for engineering, construction management, and administration was added.

Project costs for distribution system improvements include cost components for replacement (upsizing) of existing mains, installation of new mains to create loops in the existing system, and pavement removal and replacement. Unit costs for distribution system improvements are provided in Table 10-4.

TABLE 10-4
CITY OF ANGELS WATER MASTER PLAN
UNIT COSTS FOR DISTRIBUTION SYSTEM IMPROVEMENTS

Diameter (in)	Unit Cost ($/unit)[a]
6	67
8	100
10	134
12	150
16	236
18	258

[a] Includes cost for pavement removal and replacement.

Total project costs for each distribution system improvement project, identified in Table 9-5, are provided in Table 10-5.

TABLE 10-5
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR DISTRIBUTION SYSTEM IMPROVEMENTS

Location	Project Description	Length (ft)	Unit Cost ($/LF)	Base Cost ($)	Construction Cost[a] ($)	Project Cost[b] ($)
Phase 1A - Meet Fire Flow Requirements (Existing Demand)						
Gold Cliff Road	Upsize 8-inch to 10-inch	1,144	134	154,000	185,000	232,000
Golden Chain Highway	New 6-inch main	49	67	4,000	5,000	7,000
	Upsize 6-inch to 10-inch	47	134	7,000	9,000	12,000
	Upsize 8-inch to 10-inch	3,316	134	445,000	534,000	668,000
Hillcrest Street	Upsize 6-inch to 10-inch	175	134	24,000	29,000	37,000
	Upsize 8-inch to 10-inch	108	134	15,000	18,000	23,000
Mark Twain Road	Upsize 6-inch to 10-inch	1,740	134	234,000	281,000	352,000
McCauley Ranch Road	Upsize 8-inch to 10-inch	294	134	40,000	48,000	60,000
Monte Verde Street	Upsize 4-inch to 6-inch	281	67	19,000	23,000	29,000
Phase 1A, Subtotal						**1,420,000**
Phase 1B - Meet Hydraulic Performance Criteria (Existing Demand)						
Depot Road	Upsize 6-inch to 10-inch	225	134	31,000	38,000	48,000
Moose Trail	Upsize 4-inch to 10-inch	958	134	129,000	155,000	194,000
Murphy's Grade Road	Upsize 10-inch to 16-inch	995	236	235,000	282,000	353,000
	Upsize 6-inch to 16-inch	1,289	236	305,000	366,000	458,000
	Upsize 8-inch to 16-inch	2,673	236	631,000	758,000	948,000
Valecito Road	Upsize 4-inch to 6-inch	476	67	32,000	39,000	49,000
Phase 1B, Subtotal						**2,050,000**
Phase 2A - Meet Fire Flow Requirements (Buildout Demand)						
Replace Principal Transmission Main	Upsize 14-inch to 18-inch	3,508	258	906,000	1,088,000	1,360,000
Golden Chain Highway	Upsize 4-inch to 6-inch	857	67	58,000	70,000	88,000
Mark Twain Road	Upsize 4-inch to 6-inch	681	67	46,000	56,000	70,000
Phase 2A, Subtotal						**1,518,000**

TABLE 10-5 (Cont.)
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR DISTRIBUTION SYSTEM IMPROVEMENTS

Location	Project Description	Length (ft)	Unit Cost ($/LF)	Base Cost ($)	Construction Cost[a] ($)	Project Cost[b] ($)
Phase 2B - Meet Hydraulic Performance Criteria (Buildout Demand)						
12-inch Transmission Main	Upsize 12-inch to 16-inch	2,718	236	642,000	771,000	964,000
Bret Harte Drive	Upsize 4-inch to 6-inch	186	67	13,000	16,000	20,000
Depot Road	Upsize 6-inch to 8-inch	797	100	80,000	96,000	120,000
Dogtown Road	Upsize 4-inch to 6-inch	1,278	67	86,000	104,000	130,000
Fairview Drive	Upsize 4-inch to 6-inch	237	67	16,000	20,000	25,000
Gardner Lane	Upsize 6-inch to 8-inch	529	100	53,000	64,000	80,000
Kurt Drive	Upsize 8-inch to 10-inch	355	134	48,000	58,000	73,000
Mark Twain Road	Upsize 4-inch to 6-inch	583	67	40,000	48,000	60,000
McCauley Ranch	Upsize 8-inch to 10-inch	914	134	123,000	148,000	185,000
S. Baker Road	Upsize 4-inch to 6-inch	353	67	24,000	29,000	37,000
Suzanne Drive	Upsize 6-inch to 8-inch	648	100	65,000	78,000	98,000
Phase 2B, Subtotal						**1,792,000**
Total, Distribution System Improvements						**6,780,000**

[a] Includes 20 percent contingency for construction.

[b] Includes 25 percent contingency for engineering, construction management, and administration.

10.5 Project Costs for Storage Improvements

Storage improvement project costs are composed of construction costs plus contingencies for engineering, construction management, and administration. Construction costs are based on a review of recent bid results, indexed to the current ENR SF-CCI, and include a 20 percent contingency. To obtain total project costs, a 25 percent contingency for engineering, construction management, and administration was added.

Project costs for storage improvements include cost components for welded steel storage tanks, supply and discharge piping, and booster pumping where required. Unit costs for storage improvements are provided in Table 10-6.

TABLE 10-6
CITY OF ANGELS WATER MASTER PLAN
UNIT COSTS FOR STORAGE IMPROVEMENTS

Item	Unit	Unit Cost ($)
12-inch Supply and Discharge Pipeline[a]	LF	150
1.4 MG Storage Tank	LS	1,400,000
2.3 MG Storage Tank	LS	2,300,000
Booster Pump Station, 300 ft TDH	LS	1,160,000

[a] Includes cost for pavement removal and replacement.

Total project costs for the recommended storage tank site alternative are provided in Table 10-7.

TABLE 10-7
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR RECOMMENDED STORAGE TANK SITE ALTERNATIVE

Tank Location	Quantity	Unit	Unit Cost ($)	Base Cost ($)	Construction Cost[a] ($)	Project Cost[b] ($)
Zone C						
1.4 MG Storage Tank	1	LS	1,400,000	1,400,000	1,680,000	2,100,000
12-inch Supply Line	1,800	LF	150	270,000	324,000	405,000
12-inch Discharge Line	3,640	LF	150	546,000	656,000	820,000
				Total Cost		**3,325,000**

[a] Includes 20 percent contingency for construction.

[b] Includes 25 percent contingency for engineering, construction management, and administration.

10.6 Project Costs for Meter System Upgrade and Leak Detection Survey

Meter system upgrade project costs are composed of construction costs plus contingencies for engineering, construction management, and administration. Construction costs are based on a review of recent bid results, indexed to the current ENR SF-CCI, and include a 20 percent contingency. To obtain total project costs, a 25 percent contingency for engineering, construction management, and administration was added.

Project costs for the meter upgrades and conversion to an AMR system include cost components for meters, boxes, radio transmitters, and AMR system equipment and software. Total project costs are provided in Table 10-8.

TABLE 10-8
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR METER SYSTEM UPGRADE

Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Meter Boxes[a]	1,790	EA	90	161,100
Meters with Encoder Registers and Radio Transmitters[b]				
5/8-inch	1,644	EA	320	525,300
3/4-inch	34	EA	379	12,900
1-inch	50	EA	440	22,000
1-1/2-inch	27	EA	752	20,300
2-inch	35	EA	944	33,000
3-inch	8	EA	2,832	22,700
4-inch	2	EA	3,795	7,600
6-inch	1	EA	7,082	7,100
AMR System Hardware[c]	1	LS	20,750	20,800
AMR System Software	1	LS	6,820	6,800
AMR Fixed Network Transceiver	1	LS	6,880	6,900
Cellular Backhaul[d]	1	LS	910	900
On-Site Training	1	LS	2,200	2,200
Total Base Cost				850,000
Total Construction Cost[e]				1,020,000
Total Project Cost[f]				**1,275,000**

[a] Assume new boxes for 2-inch and smaller meters and existing vaults to remain for 3-inch and larger meters.

[b] Meter quantities by size provided by City Account Clerk on 01/31/13.

[c] Includes one handheld data collector and one laptop for AMR system in mobile (drive-by) mode.

[d] Annual cellular charge for fixed network to backhaul hourly meter reads to main computer.

[e] Includes 20 percent contingency for construction.

[f] Includes 25 percent contingency for engineering, construction management, and administration.

Project costs for a leak detection survey of the distribution system were based on input from a local leak detection contractor and include labor costs plus a 20 percent contingency. Project costs for the leak detection survey are provided in Table 10-9.

TABLE 10-9
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR LEAK DETECTION SURVEY

Project	Project Cost ($)
Leak Detection Survey	12,000

10.7 Project Costs for Master Plan and Rate Study

Project costs for preparing a water master plan and water 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 comparable size. Project costs are summarized in Table 10-10.

TABLE 10-10
CITY OF ANGELS WATER MASTER PLAN
PROJECT COSTS FOR MASTER PLAN AND RATE STUDY

Document	Project Cost ($)
Water Master Plan	100,000
Water Rate and Connection Fee Study	40,000

11 Capital Improvement Plan

This chapter summarizes recommended CIP projects developed based on a review of applicable regulations, treatment plant performance, distribution system hydraulic capacity, and projected water demands. The treatment, supply, and storage CIP was prioritized based on the following, in descending order of importance:

1. Addressing regulatory concerns (Phase 1A)
2. Improving reliability by providing operational redundancy (Phase 1B)
3. Replacing aging infrastructure (Phase 1C)
4. Providing capacity for future development (Phase 2A)

The distribution system CIP was prioritized based on the following, in descending order of importance:

1. Providing required fire flow for existing demands (Phase 1A)
2. Meeting hydraulic performance criteria for existing demands (Phase 1B)
3. Providing required fire flow for future (buildout) demands (Phase 2A)
4. Meeting hydraulic performance criteria for future (buildout) demands (Phase 2B)

11.1 Project Costs

Chapter 9 summarized recommended improvements to the City water treatment, supply, storage, and distribution systems. The CIP for treatment, supply, and storage system improvements considering priorities is presented in Table 11-1 and includes additional reports, studies, and miscellaneous projects. The CIP for distribution system improvements, also considering priorities, is presented in Table 11-2. The combined CIP is included as Table 11-3. As was described in Chapter 10, project costs include a 20 percent construction contingency and 25 percent contingency for engineering, construction management, and administration. Recommended timing of projects is as follows:

1. Phase 1A: Year 1 – Year 2
2. Phase 1B: Year 3 – Year 5
3. Phase 1C: Year 5 – Year 10
4. Phase 2A: Year 5 – Year 10
5. Phase 2B: Year 11 – Year 20

TABLE 11-1
CITY OF ANGELS WATER MASTER PLAN
CAPITAL IMPROVEMENT PROJECTS FOR TREATMENT, STORAGE, AND SUPPLY SYSTEMS

Description	Phase	Quantity	Unit of Measure	Unit Cost ($/unit)	Base Cost ($)	Construction Cost ($)	Project Cost ($)
Water Treatment Plant Improvements							
Install Fourth Pressure Filter	1A	1	LS	885,000	885,000	1,065,000	1,335,000
Construct Sludge Lagoons and Recycle Pump Station	1A	1	LS	520,000	520,000	625,000	785,000
Replace Existing Sedimentation Basin	1C	1	LS	990,000	990,000	1,190,000	1,490,000
Construct Second Flocculation Basin	1C	1	LS	500,000	500,000	600,000	750,000
Construct Second Sedimentation Basin	1C	1	LS	990,000	990,000	1,190,000	1,490,000
					3,885,000	**4,670,000**	**5,850,000**
Water Supply Improvements - Well Site and Water Supply Route B							
Construct and Equip Municipal Well(s)		2	EA	400,000	800,000	960,000	1,200,000
Construct 12-inch Transmission Main		30,600	LF	100	3,060,000	3,672,000	4,590,000
Install Air Release Valves	1B	17	EA	2,000	34,000	41,000	52,000
Construct 135-ft TDH Booster Pump Station		1	LS	525,000	525,000	630,000	790,000
Construct Pressure Reducing Station		1	LS	40,000	40,000	48,000	60,000
					4,459,000	**5,351,000**	**6,692,000**
Water Storage Improvements - Zone C Storage Tank							
Construct 1.4 MG Storage Tank		1	LS	1,400,000	1,400,000	1,680,000	2,100,000
Construct Storage Tank Supply Line	1B	1,800	LF	150	270,000	324,000	405,000
Construct Storage Tank Discharge Line		3,640	LF	150	546,000	656,000	820,000
					2,216,000	**2,660,000**	**3,325,000**
Reports, Studies, and Miscellaneous Projects							
Leak Detection Survey		1	LS	12,000	-	-	12,000
Meter System Upgrade		1	LS	850,000	850,000	1,020,000	1,275,000
Water Rate and Connection Fee Study, FY2013-2014		1	LS	40,000	-	-	40,000
Water Master Plan, FY2020-2021		1	LS	100,000	-	-	100,000
Water Rate and Connection Fee Study, FY2021-2022		1	LS	40,000	-	-	40,000
Water Master Plan, FY2028-2029		1	LS	100,000	-	-	100,000
Water Rate and Connection Fee Study, FY2029-2030		1	LS	40,000	-	-	40,000
					850,000	**1,020,000**	**1,607,000**
Total, Treatment, Supply, and Storage CIP					**11,410,000**	**13,701,000**	**17,474,000**

TABLE 11-2
CITY OF ANGELS WATER MASTER PLAN
CAPITAL IMPROVEMENT PROJECTS FOR DISTRIBUTION SYSTEM

Location	Project Description	Unit Cost ($/LF)	Length (LF)	Base Cost ($)	Construction Cost ($)	Project Cost ($)
<u>Phase 1A - Existing Fire Flow Deficiencies</u>						
Gold Cliff Road						
	Upsize 8-inch to 10-inch	134	1,144	154,000	185,000	232,000
Golden Chain Highway						
	Upsize 6-inch to 10-inch	134	47	7,000	9,000	12,000
	Upsize 8-inch to 10-inch	134	3,316	445,000	534,000	668,000
	New 6-inch main	67	49	4,000	5,000	7,000
Hillcrest Street						
	Upsize 6-inch to 10-inch	134	175	24,000	29,000	37,000
	Upsize 8-inch to 10-inch	134	108	15,000	18,000	23,000
Mark Twain Road						
	Upsize 6-inch to 10-inch	134	1,740	234,000	281,000	352,000
McCauley Ranch Road						
	Upsize 8-inch to 10-inch	134	294	40,000	48,000	60,000
Monte Verde Street						
	Upsize 4-inch to 6-inch	67	281	19,000	23,000	29,000
	Subtotal, Phase 1A		**7,154**	**942,000**	**1,132,000**	**1,420,000**
<u>Phase 1B - Existing Hydraulic Deficiencies</u>						
Depot Road						
	Upsize 6-inch to 10-inch	134	225	31,000	38,000	48,000
Moose Trail						
	Upsize 4-inch to 10-inch	134	958	129,000	155,000	194,000
Murphy's Grade Road						
	Upsize 10-inch to 16-inch	236	995	235,000	282,000	353,000
	Upsize 6-inch to 16-inch	236	1,289	305,000	366,000	458,000
	Upsize 8-inch to 16-inch	236	2,673	631,000	758,000	948,000
Valecito Road						
	Upsize 4-inch to 6-inch	67	476	32,000	39,000	49,000
	Subtotal, Phase 1B		**6,616**	**1,363,000**	**1,638,000**	**2,050,000**

TABLE 11-2 (CONT.)
CITY OF ANGELS WATER MASTER PLAN
CAPITAL IMPROVEMENT PROJECTS FOR DISTRIBUTION SYSTEM

Location	Project Description	Unit Cost ($/LF)	Length (LF)	Base Cost ($)	Construction Cost ($)	Project Cost ($)
Phase 2A - Buildout Fire Flow Deficiencies						
Replace Principal Transmission Main						
	Upsize 14-inch to 18-inch	258	3,508	906,000	1,088,000	1,360,000
Golden Chain Highway						
	Upsize 4-inch to 6-inch	67	857	58,000	70,000	88,000
Mark Twain Road						
	Upsize 4-inch to 6-inch	67	681	46,000	56,000	70,000
	Subtotal, Phase 2A		**5,046**	**1,010,000**	**1,214,000**	**1,518,000**
Phase 2B - Buildout Fire Flow Deficiencies						
12-inch Transmission Main						
	Upsize 12-inch to 16-inch	236	2,718	642,000	771,000	964,000
Bret Harte Drive						
	Upsize 4-inch to 6-inch	67	186	13,000	16,000	20,000
Depot Road						
	Upsize 6-inch to 8-inch	100	797	80,000	96,000	120,000
Dogtown Road						
	Upsize 4-inch to 6-inch	67	1,278	86,000	104,000	130,000
Fairview Drive						
	Upsize 4-inch to 6-inch	67	237	16,000	20,000	25,000
Gardner Lane						
	Upsize 6-inch to 8-inch	100	529	53,000	64,000	80,000
Kurt Drive						
	Upsize 8-inch to 10-inch	134	355	48,000	58,000	73,000
Mark Twain Road						
	Upsize 4-inch to 6-inch	67	583	40,000	48,000	60,000
McCauley Ranch						
	Upsize 8-inch to 10-inch	134	914	123,000	148,000	185,000
S. Baker Road						
	Upsize 4-inch to 6-inch	67	353	24,000	29,000	37,000
Suzanne Drive						
	Upsize 6-inch to 8-inch	100	648	65,000	78,000	98,000
	Subtotal, Phase 2B		**8,598**	**1,190,000**	**1,432,000**	**1,792,000**
Total, Distribution System CIP			**27,414**	**4,505,000**	**5,416,000**	**6,780,000**

TABLE 11-3
CITY OF ANGELS WATER MASTER PLAN
20-YEAR CAPITAL IMPROVEMENT PLAN

Description	Project Cost Allocation ($)				Project Total ($)
	FY2013-2015 (Phase 1A)	FY2015-2018 (Phase 1B)	FY2018-2023 (Phases 1C, 2A)	FY2023-2033 (Phase 2B)	
Water Treatment Plant Improvements					
Install Fourth Pressure Filter	1,335,000	-	-	-	1,335,000
Construct Sludge Lagoons and Recycle Pump Station	785,000	-	-	-	785,000
Replace Existing Sedimentation Basin	-	-	1,490,000	-	1,490,000
Construct Second Flocculation Basin	-	-	750,000	-	750,000
Construct Second Sedimentation Basin	-	-	1,490,000	-	1,490,000
Water Supply Improvements - Well Site and Water Supply Route B					
Construct and Equip Municipal Well(s)	-	1,200,000	-	-	1,200,000
Construct 12-inch Transmission Main	-	4,590,000	-	-	4,590,000
Install Air Release Valves	-	52,000	-	-	52,000
Construct 135-ft TDH Booster Pump Station	-	790,000	-	-	790,000
Construct Pressure Reducing Station	-	60,000	-	-	60,000
Water Storage Improvements - Zone C Storage Tank					
Construct 1.4 MG Storage Tank	-	2,100,000	-	-	2,100,000
Construct Storage Tank Supply Line	-	405,000	-	-	405,000
Construct Storage Tank Discharge Line	-	820,000	-	-	820,000
Reports, Studies, and Miscellaneous Projects					
Leak Detection Survey	12,000	-	-	-	12,000
Meter System Upgrade	1,275,000	-	-	-	1,275,000
Water Rate and Connection Fee Study, FY2013-2014	40,000	-	-	-	40,000
Water Master Plan, FY2020-2021	-	-	100,000	-	100,000
Water Rate and Connection Fee Study, FY2021-2022	-	-	40,000	-	40,000
Water Master Plan, FY2028-2029	-	-	-	100,000	100,000
Water Rate and Connection Fee Study, FY2029-2030	-	-	-	40,000	40,000

TABLE 11-3 (CONT.)
CITY OF ANGELS WATER MASTER PLAN
20-YEAR CAPITAL IMPROVEMENT PLAN

Description	Project Cost Allocation ($)				Project Total ($)
	FY2013-2015 (Phase 1A)	FY2015-2018 (Phase 1B)	FY2018-2023 (Phases 1C, 2A)	FY2023-2033 (Phase 2B)	
Distribution System Projects					
Replace Principal Transmission Main	-	-	1,360,000	-	1,360,000
12-inch Transmission Main	-	-	-	964,000	964,000
Bret Harte Drive	-	-	-	20,000	20,000
Depot Road	-	48,000	-	120,000	168,000
Dogtown Road	-	-	-	130,000	130,000
Fairview Drive	-	-	-	25,000	25,000
Gardner Lane	-	-	-	80,000	80,000
Gold Cliff Road	232,000	-	-	-	232,000
Golden Chain Highway	687,000	-	88,000	-	775,000
Hillcrest Street	60,000	-	-	-	60,000
Kurt Drive	-	-	-	73,000	73,000
Mark Twain Road	352,000	-	70,000	60,000	482,000
McCauley Ranch Road	60,000	-	-	185,000	245,000
Monte Verde Street	29,000	-	-	-	29,000
Moose Trail	-	194,000	-	-	194,000
Murphy's Grade Road	-	1,759,000	-	-	1,759,000
S. Baker Road	-	-	-	37,000	37,000
Suzanne Drive	-	-	-	98,000	98,000
Valecito Road	-	49,000	-	-	49,000
Fiscal Year Total	**4,867,000**	**12,067,000**	**5,388,000**	**1,932,000**	**24,254,000**

Total CIP costs for treatment, supply, storage, and distribution systems are summarized in Table 11-4.

TABLE 11-4
CITY OF ANGELS WATER MASTER PLAN
SUMMARY OF CAPITAL IMPROVEMENT PLAN COSTS

Component	Total Cost ($)
Treatment System Improvements	5,850,000
Supply System Improvements	6,692,000
Storage System Improvements	3,325,000
Distribution System Improvements	6,780,000
Reports, Studies, and Miscellaneous Projects	1,607,000
Total Cost	**24,254,000**

12 References

[1] Angels Camp 2020 General Plan, adopted 3 February 2009.

[2] Second Amended Agreement for Golf Course Irrigation Water for Greenhorn Creek Golf Course, City of Angels and Greenhorn Creek Associates L.P., July 1998.

[3] *City of Angels Water Master Plan 2001-2015*, Prepared by Weber, Ghio & Associates, Inc., May 2002.

[4] *City of Angels Municipal Service Review*, Prepared by LAFCO of Calaveras County, adopted December 2009.

[5] Internal City of Angels correspondence from Garett Walker to City Administrator, Subject: Continuance of the 2002 City of Angels Master Plan, January 20, 2011.

[6] *Angels Camp Water Audit*, Prepared by Stetson Engineers, Inc., October 12, 2011.

[7] Flow Meter Report, Internal City of Angels Correspondence from Water/Wastewater Treatment Department Staff to City Administrator, Subject: Growing Concerns over Lost Water in our System and Potential Solutions, April 20, 2012.

[8] *City of Angels Water Treatment Facilities Operations Plan*, Prepared by Weber, Ghio & Associates, Inc., May 2012.

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