City of
Santa Monica®

Santa Monica CT No. 9563

December 2014

Sustainable Water Master Plan

for the:

City of Santa Monica, Water Resources Division

KJ Project No. 1283015*00

Kennedy/Jenks Consultants

City of
Santa Monica®

Water Resources Division
1212 5th Street 3rd Floor
Santa Monica, California 90401

Sustainable Water Master Plan Forward

December 2014

Similar to most utility planning documents, the City's Sustainable Water Master Plan is prepared to provide the City with information and recommendations to form the basis of a roadmap for future system improvements and strategies. The information provided herein is designed to document the current information of the City's water system, key planning related assumptions, and forecast future conditions to form a basis of planning.

The challenges of planning and forecasting are magnified in the context of climate change, the severe drought currently in effect in California, and community behavioral changes as they relate to water use and demand patterns, among others. As such, this Sustainable Water Master Plan, as well as other recent water system asset management plans, is intended to be dynamic in nature, as new information, conditions, regulations, and policies may supplement and/or alter some of the conclusions and recommendations established in the plan.

With this in mind, the reader should consider this water plan as an information document that will continue to expand and evolve over time, with updates and amendments from time to time.

This comprehensive effort was an important collaborative undertaking by City staff, local advisory committees, the City's consultants, and guidance from the City Council. The plan was prepared to methodically guide the City towards self-sufficiency in accordance with the ambitious goals established by City Council.

I wish to thank everyone for all their input and hard work in the development and documentation of this strategic water plan for the City of Santa Monica. We look forward to its implementation over the next decade as we continue to improve the resiliency of the City's water system for our customers today and well into the future.

SM water
Santa Monica Saves

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1 December 2014

Mr. Gil Borboa, P.E.
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City of Santa Monica, Water Resources Division
1212 Fifth Street, 3rd Floor
Santa Monica, California 90401

Subject: Final Report – Sustainable Water Master Plan
K/J 1283015*00

Dear Mr. Borboa:

Kennedy/Jenks Consultants is pleased to submit the Final Sustainable Water Master Plan to the City of Santa Monica (City). By way of process, we have submitted this report as a digital ".pdf" file for your distribution as appropriate.

This Master Plan Report is a compilation of the analysis and findings of the City's water utility and incorporates the City's comments obtained from previous draft work products and team discussions. The results of the study are intended to serve as a plan for future capital improvement program requirements and serve as a dynamic roadmap for the development and implementation of additional water system enhancements to assist the City meet its sustainability and self-sufficiency goals over the next 20 years.

It has been a pleasure working with you and City staff on this interesting project. Please contact us if you have any questions or need additional information.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Roger Null, V.P.
Vice President and Project Manager

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City of Santa Monica Sustainable Water Master Plan Final Report

December 2014

Prepared for

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K/J Project No. 1283015*00

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Executive Summary

The City of Santa Monica (City) supplies imported and local water to approximately 91,000 residents covering an area of approximately 8 square miles. Looking to its future, the City hopes to eliminate its reliability on imported water by addressing the challenge of existing groundwater quality, identifying new sources of local water supply, and more effectively reduce and manage its water demands.

With an adopted goal of water self-sufficiency achieved by eliminating reliance on Metropolitan Water District of Southern California (MWD) supply by 2020, the City of Santa Monica retained Kennedy/Jenks Consultants to develop an integrated Sustainable Water Master Plan (SWMP). This SWMP combines relevant components of existing plans with an evaluation of a broad range of water supply and demand management options to assist the City in meeting its goals. This plan has been prepared with the objective of developing a comprehensive document to define supply and demand management options to cost effectively reduce future water demands and enhance local water supply production capabilities.

Goals and Purpose

The purpose of this planning effort is to provide an up-to-date, comprehensive look at the City's water system using recent planning information and the newly-developed distribution system hydraulic model to assess the City's water system infrastructure needs. In a March 2011 study session with the City Council, staff presented concepts and principles that would be involved in achieving water self-sufficiency goal by the year 2020. Since that time, the City has embarked on the development of a sustainable and proactive plan to accomplish this goal.

This SWMP includes an evaluation of expanded demand management measures and a variety of water supply alternatives including recycled water, storm water collection and treatment, rainwater harvesting, gray-water applications, and other water rights, supply and exchange opportunities to align with the above goal. A decision modeling approach was used to package these programs and projects into Supply-Demand Portfolios, where criteria were developed to provide portfolio ranking, economic analysis and ultimately, strategic direction. This plan illustrates projected water supply and demand scenarios, and characterizes the approximate magnitude of supply deficits or unpredictability that needs to be addressed to meet the City's self-sufficiency objectives by 2020. The recommendations resulting from this SWMP are designed to provide a roadmap of phased projects and programs to guide the City's water utility towards self-sufficiency.

Implementation of the SWMP is further supported through the conduct of financial planning services. These services, prepared and documented under a separate cover, included an evaluation of water and wastewater rates, rate structures for conservation support and financial stability, and an update to the City's water and wastewater facility capacity charges.

As discussed above, the development of the SWMP entails a multi-faceted approach to address the City's goal of achieving water self-sufficiency by the year 2020. With the City's current capability to meet approximately 70% of its water demand from local groundwater sources, the objective is to develop strategies to close the "gap" represented by the current purchase of

imported water. Through a combination of demand management approaches and water supply augmentation tactics, various portfolios were developed to represent permutations and combinations of options that best meet the program objectives and continue to support the City's Sustainability Plan. The SWMP documents the mix of strategies that could be undertaken to achieve water self-sufficiency by 2020, and recommends a portfolio of conservation/supply programs and capital projects to meet these self-sufficiency goals.

A summary of the primary goals of this project include:

- Perform a water demand analysis and generate water demand projections, which incorporate the most current information regarding population, land use and the Land Use and Circulation Element (LUCE) information for the City's service area projected to the year 2035. The water demand projections consider the effects of weather and economic conditions on future water demand in order to increase defensibility in a time of increased pressure to reduce potable water demands in response to State legislation,

- Perform an evaluation of the City's current and future Supply Alternatives and Demand Management Options to develop strategic Portfolios of alternative programs,

- Develop a comprehensive potable water system hydraulic model development, including calibration, and perform a hydraulic analysis under various system conditions,

- Perform an evaluation of infrastructure improvements to accommodate existing requirements and meet future needs, including an evaluation of system infrastructure fire flow (FF) requirements, and an updated capital improvement program to support the City's short and long-range capital improvement requirements,

- Perform a comprehensive financial evaluation of the City's water and wastewater utilities and associated rates and rate structures, and

- Prepare and submit separate reports documenting the findings and recommendations of the Sustainable Water Master Plan and the Water and Wastewater Rate and Revenue Studies.

Service Area Description

Santa Monica is a beachfront city in western Los Angeles County. It is situated on the Santa Monica Bay, and is surrounded by the City of Los Angeles on the Northeast, the Pacific Ocean on the west, Mar Vista on the east and Venice on the southeast. The City's service area consists entirely of the City of Santa Monica (City) with limited service in the City of Los Angeles. The City occupies 8.3 square miles (5,312 acres) of land. Figure ES-1 shows the Santa Monica City boundary and the vicinity areas.

Figure ES-1 Santa Monica Boundary and Vicinity Map

The City provides water service to approximately 91,000 residents through a combination of local and imported water supplies. In recent years the City has relied heavily upon MWD water (referred as imported water in this report) due to the presence of contamination in its groundwater supply, necessitating additional local groundwater treatment. Due to recent studies and efforts to mitigate this contamination, the City has started bringing wells back online and pumping more groundwater, which is helping create a more robust, reliable supply of water. The City has also continued to collect and recycle dry-weather urban runoff for use as a treated non-potable water source.

In terms of land use classification, single family and multi-family residential are the City's predominant user type. In addition to the residential land-use, the City also has centralized business, a commercial district, and institutional and industrial areas. Figure ES-2 below shows the current land-use map of the City. It is expected that future changes in growth and land-use type will result from re-development of the existing parcels since almost all of the City's area is at near built-out conditions.

Figure ES-2 Santa Monica Land-Use Map

Growth in Santa Monica

Given the near build-out condition, population growth in the City's service area is projected to be minimal, less than 1 percent per year. As a major commercial center for the region, the City experiences daytime populations of up to 200,000 due, in large part, to the number of businesses and attractions located within the City. This increase in population along with general non-residential growth rate will increase the City's water demands for indoor and outdoor use in future years. Table ES-1 below shows the City's projected population through the 2035 planning period.

Table ES-1 Projected Population

Year	2015	2020	2025	2030	2035
Projected Population	91,243	91,487	91,716	91,926	92,124

Source: 2010 Urban Water Management Plan. Note that the Department of Finance currently suggests higher population values than projected in 2010.

Historical Water Use

Since 2005, annual water use within the City have ranged from 13,000 to 15,000 acre feet (AF). As shown in Table ES-2, the average annual water consumption during this period has been approximately 13,930 AF. The decrease in demands that began in 2008 corresponds with statewide drought conditions promoting the need to conserve water resources and depressed economic conditions. Overall, the City's water use has been steadily declining since the early 1990's as a result of its successful water conservation programs.

Table ES-2 Historical Water Use

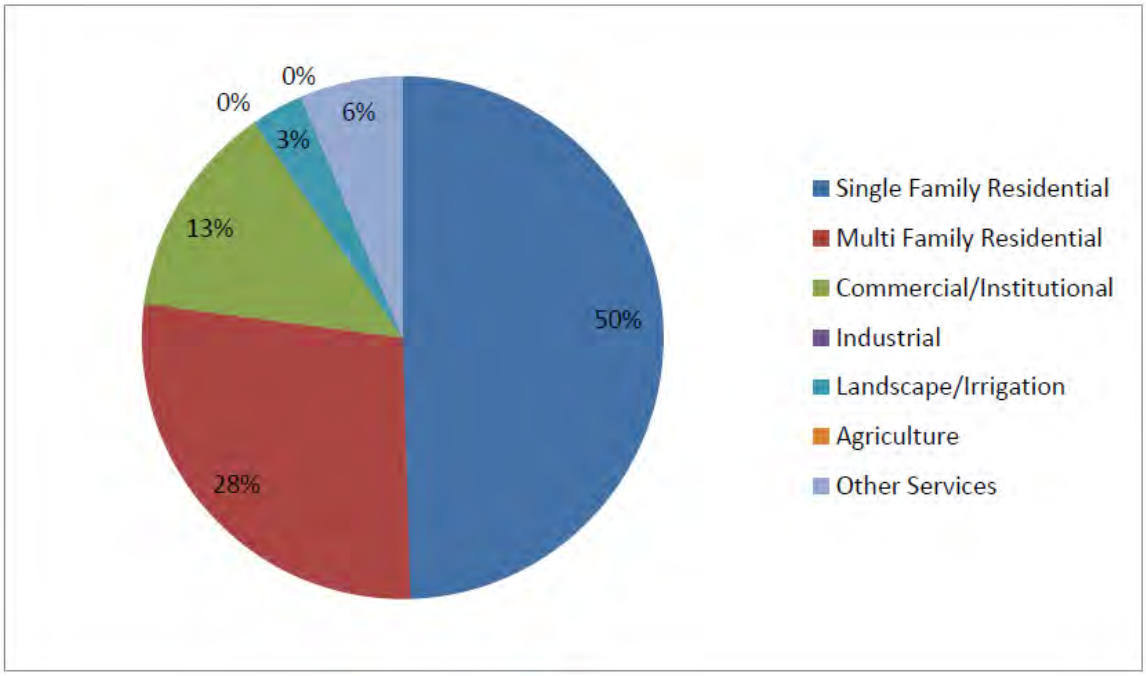
Year	Production (AF)[(a)]
2005	14,917
2006	15,061
2007	15,112
2008	14,491
2009	13,855
2010	13,065
2011	13,142
2012	13,874
2013	14,020
Average	13,934

(a) Source of data for years 2005-2009: City's 2010 UWMP. Source of data for years 2010-2013: City's Department of Water Resources Public Water System Statistics reports.

The City provides water service through over 18,000 metered service connections to a variety of customer types. These include: residential, commercial, institutional, landscape, and fire protection customers. Approximately 80 percent of the City's total service connections are used to serve the City's residential customers. Commercial and institutional accounts account for

approximately 12 percent of the service connections. Landscape irrigation, fire line services and various "other" accounts make up the remaining 8 percent of the City's water customers. Among the "other" accounts is a very small set of customers receiving recycled water from the Santa Monica Urban Runoff Recycling Facility (SMURRF). A graphical summary of the service connections by customer type is shown on Figure ES-3.

Figure ES-3 Service Connections by Customer Type



Source: City utility billing data; calendar year 2013

As expected, the majority of the City's water usage occurs within the residential sector (Table ES-3). As shown, residential usage accounts for approximately 61 percent of the City's total consumption.

Table ES-3 Historical Water Production (AF)

Customer Type	2006	2007	2008	2009	2010	2011	2012	2013
Single Family Residential	3,645	3,752	3,529	3,195	2,862	2,798	3,113	3,143
Multi-Family Residential	5,866	5,784	5,575	5,408	5,100	5,517	5,503	5,431
Commercial/Institutional	3,774	3,745	3,549	3,374	3,003	3,512	3,544	3,718
Landscape Irrigation[(a)]	626	728	698	652	538	606	604	606
Unaccounted for Water[(b)]	1,150	1,103	1,140	1,226	1,562	709	1,110	1,122
Total Water Use[(c)]	15,061	15,112	14,491	13,855	13,065	13,142	13,874	14,020

(a) Includes recycled water produced by the SMURRF.
(b) Unaccounted water for 2012 and 2013 based on average of unaccounted water from 2005 to 2011
(c) Source of data for years 2005-2009: City's 2010 UWMP. Source of data for years 2010-2013: City's Department of Water Resources Public Water System Statistics reports (Total water into the system," including recycled water).

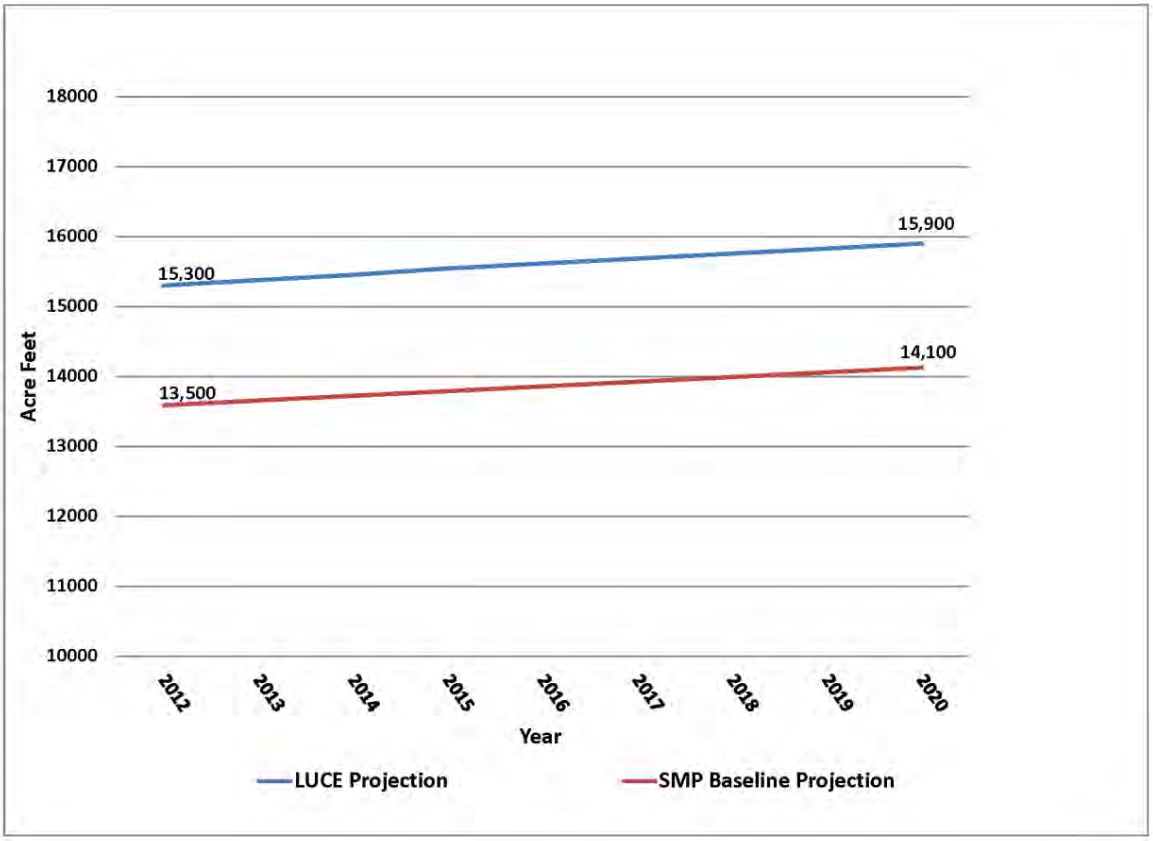
Water Demand Analysis and Projected Future Demands

To achieve water self-sufficiency by the year 2020, the City must have a clear understanding of its future water needs, or demands. The total amount of local water supplies needed to meet the City's sustainability goal includes water supplied to customers as well as an allowance for system water loss, and water lost through the water treatment process referred to as brine or production loss.

The City's initial estimate of the volume of water needed to meet the sustainability goal was approximately 3,700 AF; however, that estimate was based on the assumption that water demand would not increase in the future beyond current levels and did not consider the effects that economic activity and weather may have on historical and future water demands. While the extent of these effects may vary based on local conditions, there is a general increase in demands with increased economic activity and hotter, drier weather conditions. These effects were not incorporated in the demand projections available in current planning documents, including the 2010 Land Use and Circulation Element (LUCE).

To plan for future water supply needs, a comprehensive demand analysis was performed that reconciled prior demand projections with actual water usage in the last several years, and were adjusted for the potential effects of weather and economic activity applicable to Santa Monica. First, a new baseline demand projection was developed. This baseline water use projection begins with current actual demands of approximately 13,500 AF in 2012 and grows at the same rate as the water demand projection found in the LUCE. LUCE annual growth rates were used since it was developed based on the City's best estimates of demographic and development projections used in the City's General Plan and other planning documents. Figure ES-4 compares the water use projection found in the LUCE with the new baseline projection.

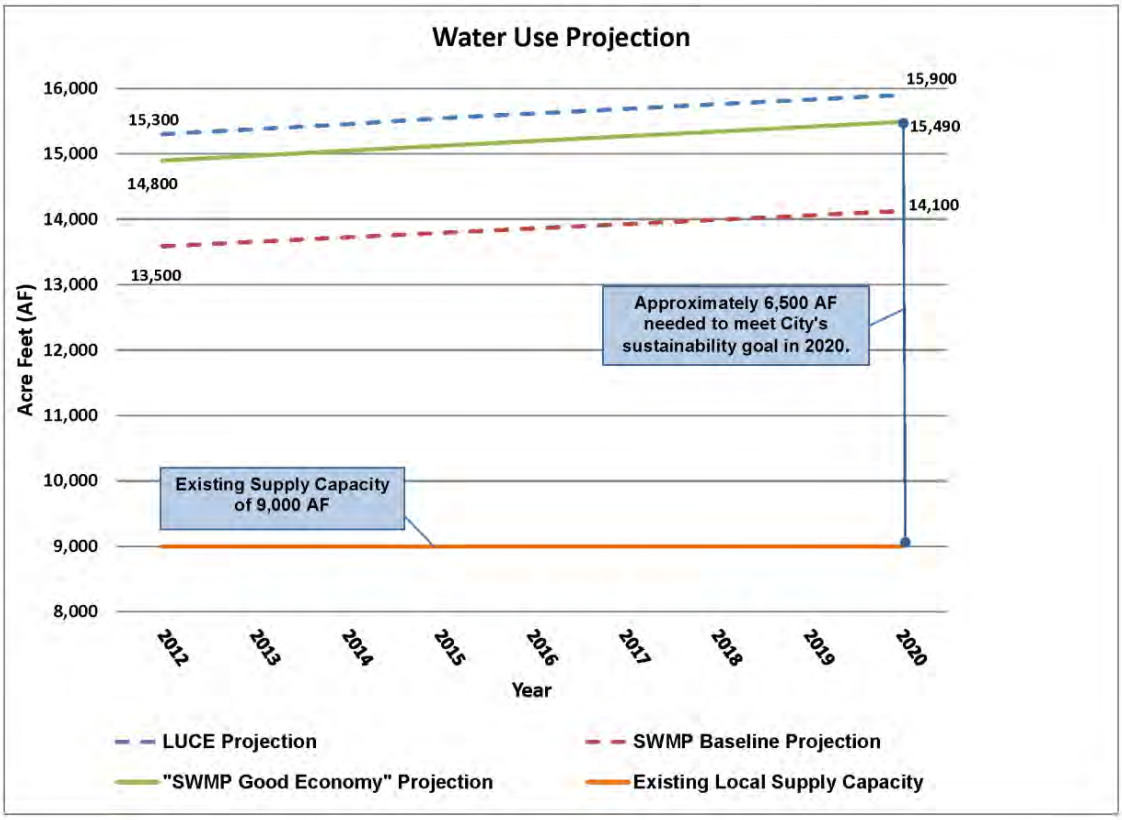
Figure ES-4 Comparison of LUCE Water Projection to Baseline Projection



Next, the effects of weather and economic conditions on the City's water demand were explored. Regression analyses were performed to evaluate the correlation between water use for various customer categories (single family, multi-family, commercial, institutional and landscape irrigation) and weather and economic (unemployment rate) factors. Data from the regression analyses indicated that there was no significant correlation observed with weather related parameters for the City. However, a better correlation was found between the City's unemployment rate and the water use of single family, multi-family and landscape irrigation customer classes. A decrease in the unemployment rate resulted in an increase in water use among these customers. The analysis suggests that an element of the City's reduction in water usage was due to the recent recession and higher unemployment rate.

Accordingly, the baseline water demand was adjusted to project future water demands under good economic conditions, as shown on Figure ES-5. The "good economy" demand projection is approximately 10 percent higher than the baseline water demand projection. Given that the City's existing local water supply capacity is approximately 9,000 AF, the demand analysis suggests that the gap between available local water supply from the Arcadia Water Treatment Plant, and the annual volume of water required to meet the City's sustainability goal in 2020 is closer to 6,500 AFY, rather than 3,700 AFY.

Figure ES-5 LUCE Projection, Baseline Projection and "Good Economy" Projection



Water Conservation Analysis and Effect of Future Demands

Water conservation modeling and analysis were performed to better define the City's opportunities to reduce the projected water demands described above through the implementation of water conservation programs. Following the completion of a detailed billing and historical conservation program and policy analysis, a comprehensive list of water conservation programs was developed and modeled using the Alliance for Water Efficiency's Water Conservation Tracking Tool. This model allows users to analyze the water savings potential and implementation costs of a collection of water conservation programs. The model also uses local demographic and housing characteristics to estimate water savings that could be attributable to enhanced efficiency requirements in State plumbing codes and water fixture usage standards, and predict reductions in demand from other applicable programs.

The suite of programs selected for analysis address each of the City's water customer sectors (single-family, multi-family, commercial, institutional, and landscape) with an emphasis on water users that shows opportunity for additional conservation. Since 1988, the City has invested millions of dollars in resources to retrofit nearly every indoor plumbing fixture in commercial, single-family and multi-family buildings with water saving products. As a result, water usage in

the City has declined even though the City's population and non-residential development have increased.

Results of the billing analysis indicated that the greatest remaining potential for water conservation exists among the City's commercial and institutional customers, as well as in landscape water use. Two specific large water users, St. John's Medical Center, the Santa Monica-Malibu Unified School District, and laundry facilities, were identified by City staff as customers with a high potential for additional water savings and programs were developed to target those potential water saving opportunities.

Implementation levels for each water conservation program modeled were based on analyses of saturation rate of existing water saving plumbing fixtures and landscapes, customer surveys, staff knowledge of the City's customers and their willingness to implement these programs, and products that will have long-term water savings that are not dependent on significant changes in the customer's behavior. The goal was to develop a diverse selection of programs that aggressively pursued demand reduction through retrofitting existing indoor plumbing with plumbing fixtures that save about twenty percent more water in addition to retrofitting landscape customers' with plants and irrigation approaches that can save up to eighty percent more water, compared to existing landscapes.

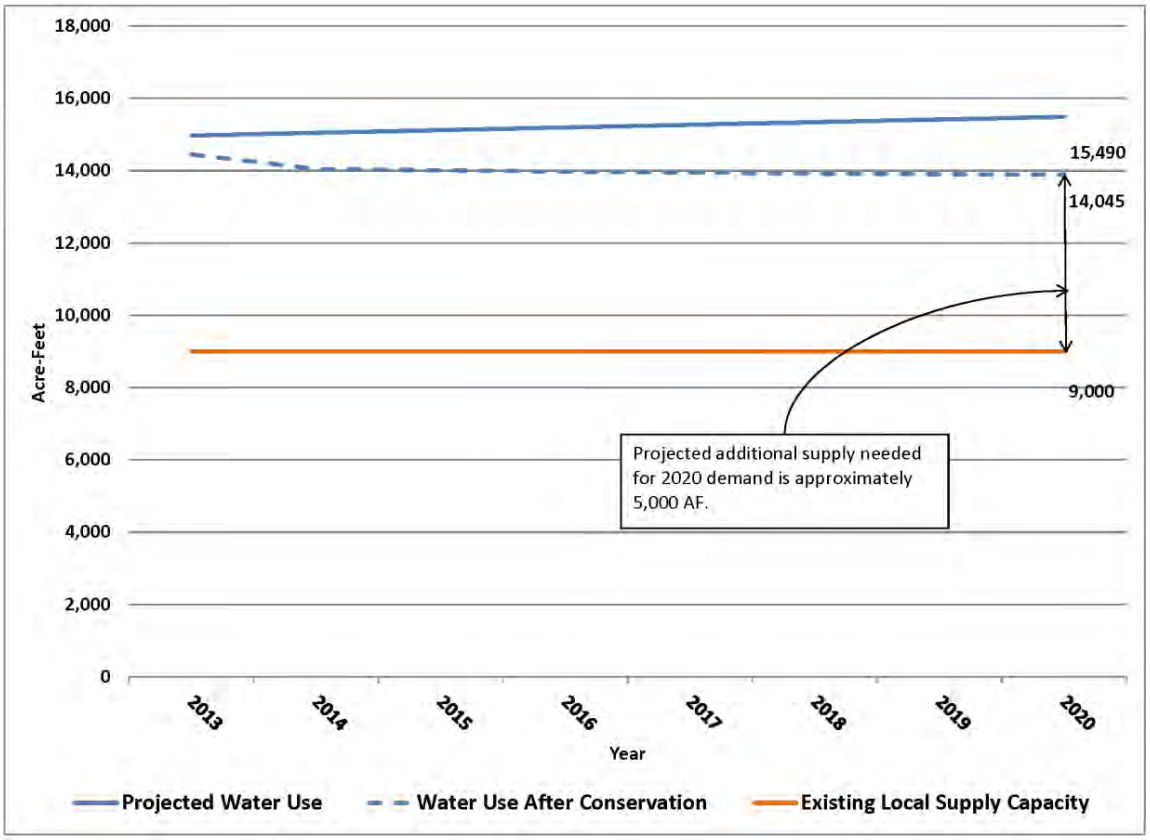
The resulting suite of conservation programs, shown in Table ES-4, is projected to annually save approximately 775 AFY of water by the year 2020. An additional 418 AFY of annual savings is expected by 2020 as a result of State plumbing and building code standards that require higher water saving fixtures. In addition, a reduction in system-wide leaks and non-revenue water through capital investment in the system is projected to annually save another 250 AFY of water for a total annual demand reduction of approximately 1,443 AFY by 2020.

Table ES-4 Water Conservation Programs

Conservation Activity	Class	Total Number of Activities Implemented by 2020	Total Conservation in 2020 (AF)	Estimated Average Annual Cost	Estimated Total Cost Through 2020
Residential HE Clothes Washer Rebate	Single Family	880	30	$24,100	$216,600
Residential HET Rebate	Single Family	3568	77	$14,400	$129,700
Residential WBIC Rebate	Single Family	1920	79	$29,300	$263,800
City's Cash for Grass Rebate Program	Single Family	1,100,000 square feet	51	$209,900	$1,889,100
City's Drip Irrigation Rebate Program	Single Family	1,100,000 square feet	24	$139,900	$1,259,400
City's HE Nozzle Rebate Program	Single Family	550,000 square feet	7	$52,500	$472,300
Water Smart Software - 5% Reduction in Water Use (NEW)	Single Family	3,040 customers	8	$26,600	$239,300
0.8 gpf Toilets (Direct Installation) (NEW)	Multi Family	5,496	73	$174,800	$1,573,100
Residential HE Clothes Washer Rebate	Multi Family	544	19	$9,800	$88,600
Residential HET Rebate	Multi Family	4,000	13	$16,200	$145,400
Laminar Flow Restrictors for St. John's Medical Center (NEW)	Commercial	664	6	$1,500	$13,600
Commercial Dry Vacuum Pump Rebate	Commercial	40	3	$1,400	$12,600
Commercial Connectionless Food Steamer Rebate	Commercial	2	1	$100	$500
Commercial Zero Water Urinal Rebate	Commercial	4	0.1	$25	$200
Commercial Ultra-Low Volume Urinal Rebate	Commercial	544	8	$3,500	$31,100
Commercial Conductivity Controller Rebate	Commercial	2	4	$0	$0
Commercial HET Rebate	Commercial	200	5	$2,500	$22,900
CII Cooling Tower Treatment - Zero Blowdown (NEW)	Commercial	2	1	$200	$1,400
Coin-Operated Laundry Machine Retrofit (NEW)	Commercial	45	360	$3,500	$31,800
HETs for St. John's Medical Center (NEW)	Commercial	10	0.1	$100	$1,100
0.125 gpf Urinals for St. John's Medical Center (NEW)	Commercial	7	0.1	$40	$400
1.5 gpm Faucet Aerators for St. John's Medical Center (NEW)	Commercial	158	0.3	$800	$6,900
SMMUSD Audits & Retrofits - Assumes 5% Reduction in Total H2O Use (NEW)	Institutional	Maintained through 2020	5	$94,400	$849,400
Total Active Water Savings (Programs Listed Above)			**775**	**$805,500**	**$7,249,100**
Total Passive Savings (Codes and Laws)			418		
25% Reduction in System Leaks and Non-Revenue Water			250		
Total Reduction in Demand			1443		

Figure ES-6 shows the potential effect of implementing the recommended water conservation programs on the City's projected water demand assuming the "good economy" water demand projection previously described. Implementation of the recommended water conservation programs reduces the annual volume of additional water the City must produce to meet its self-sufficiency goals from approximately 6,500 AF to approximately 5,000 AF. While water conservation alone will not enable the City to meet its water self-sufficiency goal, it can significantly reduce the volume of additional water supply required.

Figure ES-6 Demand Reduction from Recommended Conservation Programs



While conservation programs are often less expensive than physically constructing and operating new water supply or treatment facilities, the noted reductions in projected water demand are not without a cost. For the City of Santa Monica, these costs include the cost of the actual conservation program, increased staff and public outreach costs associated with new program implementation and management, and the associated loss in water sales revenues (this latter component is partially offset by reduced water supply production costs). Based on the City's current demands and water revenues, it is estimated that the total cost for the recommended water conservation program reflected in Table ES-6 is approximately $7.2 million through 2020.

Water Supply Analysis

Given the City's projected water supply demand conditions, a multi-faceted water supply portfolio is needed to meet the City's water self-sufficiency goal. This portfolio is projected to include both demand reduction measures through the implementation of water conservation programs, as well as new supply and water treatment options. New water supply options may include additional groundwater capacity, rainwater harvesting and stormwater capture, and additional recycled water sources. These current and future supply options are explored in greater detail herein.

Current Water Supply

The City's existing water supply consists of groundwater, purchased imported water, and a small amount of recycled dry weather urban runoff. Historically, groundwater made up the majority of the City's water supply portfolio; however, in 1995 when methyl tertiary butyl ether (MTBE) contamination was discovered in the Charnock Sub-basin, a sub-basin of the Santa Monica Basin, the City was forced to shut down five groundwater wells and purchase the majority of its water supply from MWD. In addition to local groundwater and purchased imported water, the City treats a small volume of dry weather urban runoff, yielding a source of recycled water that can be used for landscape irrigation and other approved uses, such as toilet flushing.

Imported Water

In recent years the main source of potable water supply for the City has been imported water purchased from MWD. MWD receives a negotiated allotment of water from the Colorado River and the San Joaquin River Delta. These allotments are then distributed among its 26 member agencies – a cooperative of municipalities and water agencies located throughout southern California.

The City has a current Tier 1 rate allocation of 11,515 acre feet per year (AFY) of water through MWD. Tier 1 water corresponds to the amount of water the City is entitled to purchase at the Tier 1 rate. MWD Tier 2 water is also normally available to the City; however, the cost per acre-foot is higher and there is less availability and reliability of Tier 2 water in periods of drought. The City has routinely exceeded its Tier 1 entitlement in recent years due to inactivity of many of its wells. Prior to the recent reactivation of its groundwater production, imported water represented approximately 85 percent of the City's total water supply. Table ES-5 shows the City's imported water purchases since 2005.

Table ES-5 Historical Imported Water Supply

Year	Purchases (AF)
2005	12,671
2006	13,216
2007	13,017
2008	12,323
2009	11,685
2010	9,812
2011	6,388
2012	6,550
2013	5,842

Source: City of Santa Monica Water Resources Division.

The City maintains two separate connections with MWD for its supply of imported water. These two connections are shown in Table ES-6.

Table ES-6 City of Santa Monica's MWD Connection Capacities

Description	SM-1	SM-2	Total Capacity
Capacity (AFY)	21,720	18,100	39,820

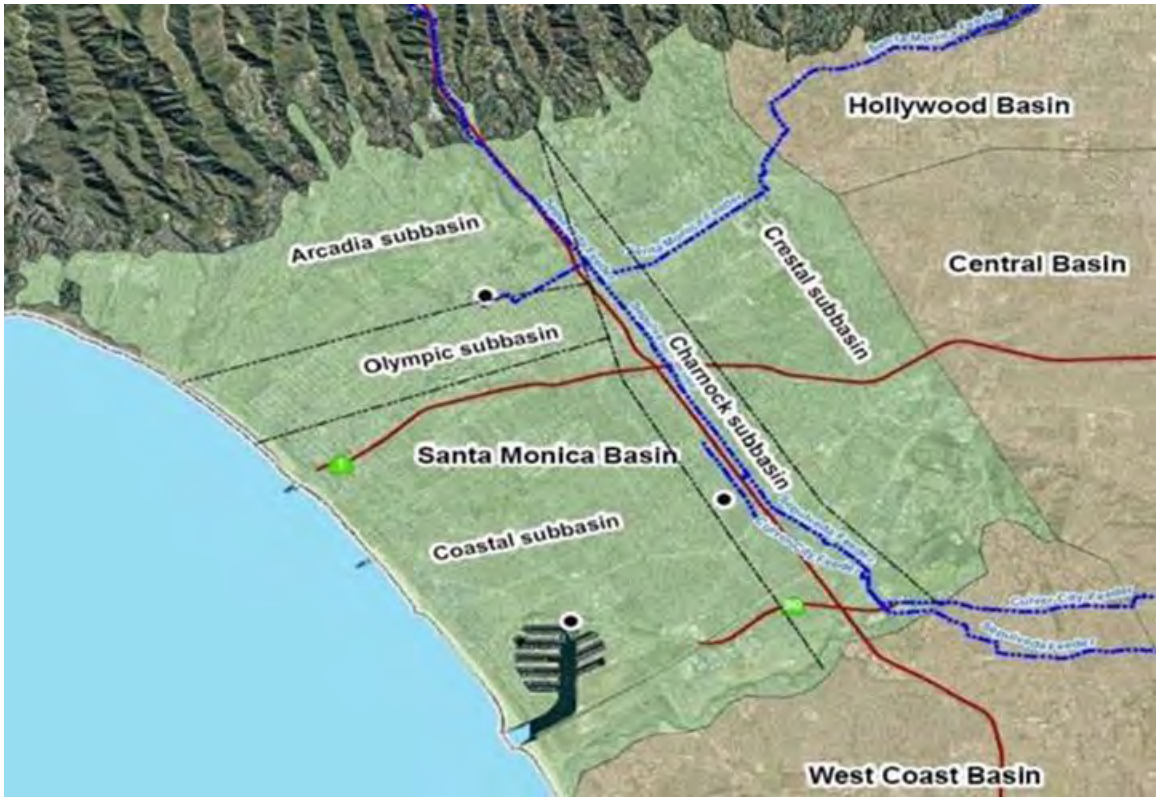
Source: City of Santa Monica Water Resources Division.

Local Groundwater

Local groundwater represents both an existing source of potable water as well as a potential source of future potable water supply. Local groundwater has, until recently, been underutilized due to the shutdown of five Charnock wells that reported MTBE contamination in 1995. Due to the completion of MTBE remediation efforts in February of 2011, the City has been able to bring the five Charnock wells back online.

The City obtains its groundwater supply from the Santa Monica Basin (Basin). The Basin is located in western Los Angeles County and overlies the entire City of Santa Monica, Culver City, Beverly Hills, and portions of western Los Angeles. The Basin has a surface area of 50.2 square miles and consists mostly of flat to mildly hilly terrain. The Basin is bounded by impermeable rocks of the Santa Monica Mountains to the north, the Ballona Escarpment (Bluffs) to the south, the Newport-Inglewood fault to the East, and the Pacific Ocean to the West. Extensive faulting within the Basin separates it into five sub-basins as shown on Figure ES-7.

Figure ES-7 Local Groundwater Basins and Subbasins



Groundwater in the Basin is replenished by percolation from precipitation, receiving an average annual precipitation of about 14 inches, and by surface runoff from the Santa Monica Mountains. Since the basin is mostly urbanized and soil surfaces have been paved to construct roads, buildings, and flood channels, only a small portion of basin soils are capable of transmitting water to the water-bearing formations below.

The City has historically pumped a long-term average volume of groundwater of 4,277 AFY. The historical combined capacity of the City's five wells located in the Charnock Sub-basin has been approximately 9,000 gallons per minute (GPM). An additional five wells, two in the Arcadia Sub-basin and 3 in the Olympic Sub-basin, remained online when the Charnock wells were shut down, and had the ability to produce approximately 3,300 GPM. These five wells have been responsible for approximately 1,950 AFY, or 13 percent of the City's water supply. In total, the City has the ability to pump groundwater at a rate of approximately 10,600 GPM. Table ES-7 shows the capacity of each of the City's groundwater wells.

Table ES-7 Groundwater Well Capacities

Well Name/No.	Sub-basin	Capacity (GPM)
Charnock 13	Charnock	1,800
Charnock 16	Charnock	1,675
Charnock 18	Charnock	1,675
Charnock 19	Charnock	1,840
Charnock 20	Charnock	1,330
Arcadia 4	Arcadia	250
Arcadia 5	Arcadia	180
Santa Monica 1	Arcadia	250
Santa Monica 3	Olympic	820
Santa Monica 4	Olympic	800
	Total Capacity	**10,620**

Source: City of Santa Monica Water Resources. Capacities are average values and vary over time.

Non-Potable Water

To protect the Santa Monica Bay from contamination caused by pollutants found in dry weather urban runoff the City built the Santa Monica Urban Runoff Recycling Facility (SMURRF). The SMURRF project produces a small volume of high-quality recycled water that is used to offset potable water demands for landscape irrigation and indoor plumbing. Designed to routinely treat 0.5 million gallons per day (MGD), with a peak treatment capacity of 0.75 MGD, the SMURRF removes urban contaminants and treats the influent water to Title 22 state standards for tertiary water. The water is then pumped through a separate water distribution system to serve a number of parks, medians, Woodlawn Cemetery and some dual-plumbed buildings.

The SMURRF has allowed the City to slightly reduce its reliance upon MWD water at a time when the City relied heavily upon imported water due to the lack of production from groundwater wells. However, since dry weather urban runoff is an unstable supply, the focus of this facility has been predominantly water quality improvements to Santa Monica Bay. Historically, SMURRF has had an average production of 154 AFY, with a high of approximately 354 AFY and a low of 94 AFY.

Future Opportunities and Portfolio Development

Additional Local Groundwater Opportunities

In addition to implementing the water conservation programs previously described, the City is also desirous of expanding use of its local groundwater resources. Currently, the City obtains local groundwater from the Arcadia and Olympic Sub - basins via five wells. These wells can produce approximately 3,000 AFY. Additionally, there are five wells located outside of the City limits in the Charnock Sub-basin with a combined average production capacity of approximately 6,000 AFY.

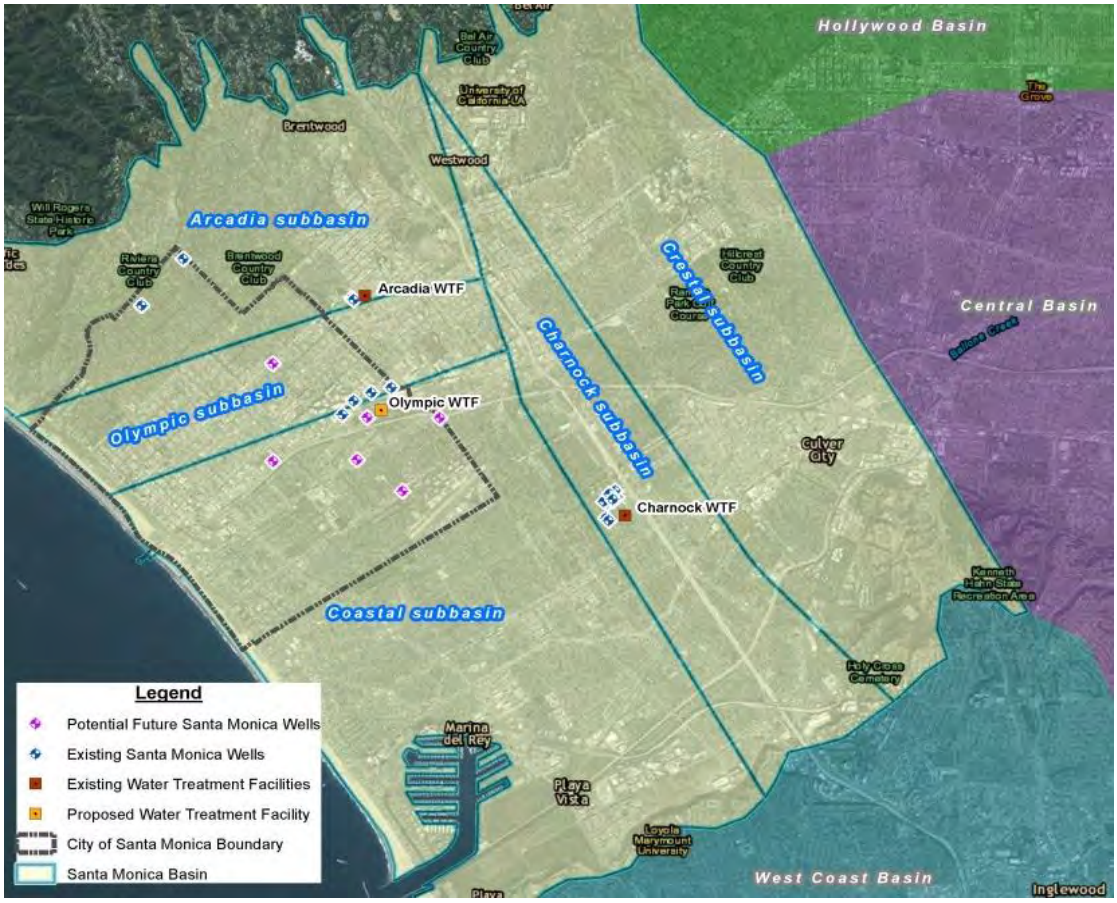
From 1995 to 2010, the City purchased most of its annual water supply needs from MWD as the Charnock well field was shut down due to methyl tertiary butyl ether (MTBE) contamination. The total average annual groundwater production capacity from these sub-basins for local treatment at the Arcadia Water Treatment Plant is approximately 9,000 AFY.

Another study of the groundwater basin was recently performed by Richard C. Slade and Associates, LLC (RCS). The study suggests the City may have additional local groundwater opportunities within the Olympic, Charnock and Coastal Sub-basins. The Coastal Sub-basin has not been utilized as a groundwater source to date due to salt water intrusion; additional treatment would be required to utilize water from this basin. Additional efforts are needed to assess potential sites and derive the potential quality and quantity of additional well production for the City's supply portfolio. Incorporating the RCS study with the SWMP's evaluations and discussions, has led to the following preliminary recommendations for additional local groundwater production and treatment facilities. These preliminary recommendations are:

- Expansion of the existing Arcadia Water Treatment Plant
- Design and construct the new Olympic Water Treatment Plant (Gillette/Boeing Settlement Project)
- Rehabilitate old wells and drill additional new wells in the Olympic, Charnock and Coastal Sub-basins
- Develop and implement improvements in treatment efficiency to reduce the amount of water lost to brine disposal during treatment (reduction of brine water losses from 18% to 9%)

While additional engineering and hydrogeologic studies will be required to determine a realistic production capacity for these wells, it is believed that the City could attain as much as an additional 6,000 AFY of local water if all of these strategies were implemented. Of course, an equivalent increase in local water treatment capacity is required to deliver this water to the City's customers, requiring an increase in the capacity of the Arcadia Water Treatment Plant and/or using settlement funds and other sources to construct a new water treatment plant (currently referred to as the Olympic Water Treatment Plant as it is designed to focus on treating water from the Olympic sub-basin). The current approach for siting some of these future water supplies is reflected graphically on Figure ES-8.

Figure ES-8 Groundwater Basins and Facilities



Beyond the additional local groundwater opportunities described above, potential exists for joint-development of nearby under-utilized groundwater basins, including the Hollywood and Central Basins. These are multi-jurisdictional opportunities that will require coordination between the City and the Los Angeles Department of Water and Power and/or the City of Beverly Hills. Given the nature of institutional-related projects, these opportunities are considered as more long-term water supply options which require additional development and are not included in the list of potential new groundwater opportunities available to the City to meet its self-sufficiency goal by 2020.

Rainwater Harvesting and Stormwater Capture

Given Santa Monica's Mediterranean climate, rainwater harvesting (the capture and onsite use of rainwater for landscape irrigation purposes) offers limited opportunity as a significant additional water supply within the City. However, to quantify the potential benefit of this resource, an analysis was performed to compare the potential for rainwater harvesting based on average monthly precipitation data and monthly landscape water demand for residential and commercial customers.

Results of the above analysis indicate that the potential for rainwater harvesting as a supply option in Santa Monica is limited by the large size of individual property owner cisterns required, and customers' motivation to install them. Historically, residential cistern installation, even with a rebate of $1,000 per cistern, has been minimally accepted by the City's customers. Accordingly, it is estimated that the rainwater harvesting incentive program may provide only 1-2 AFY.

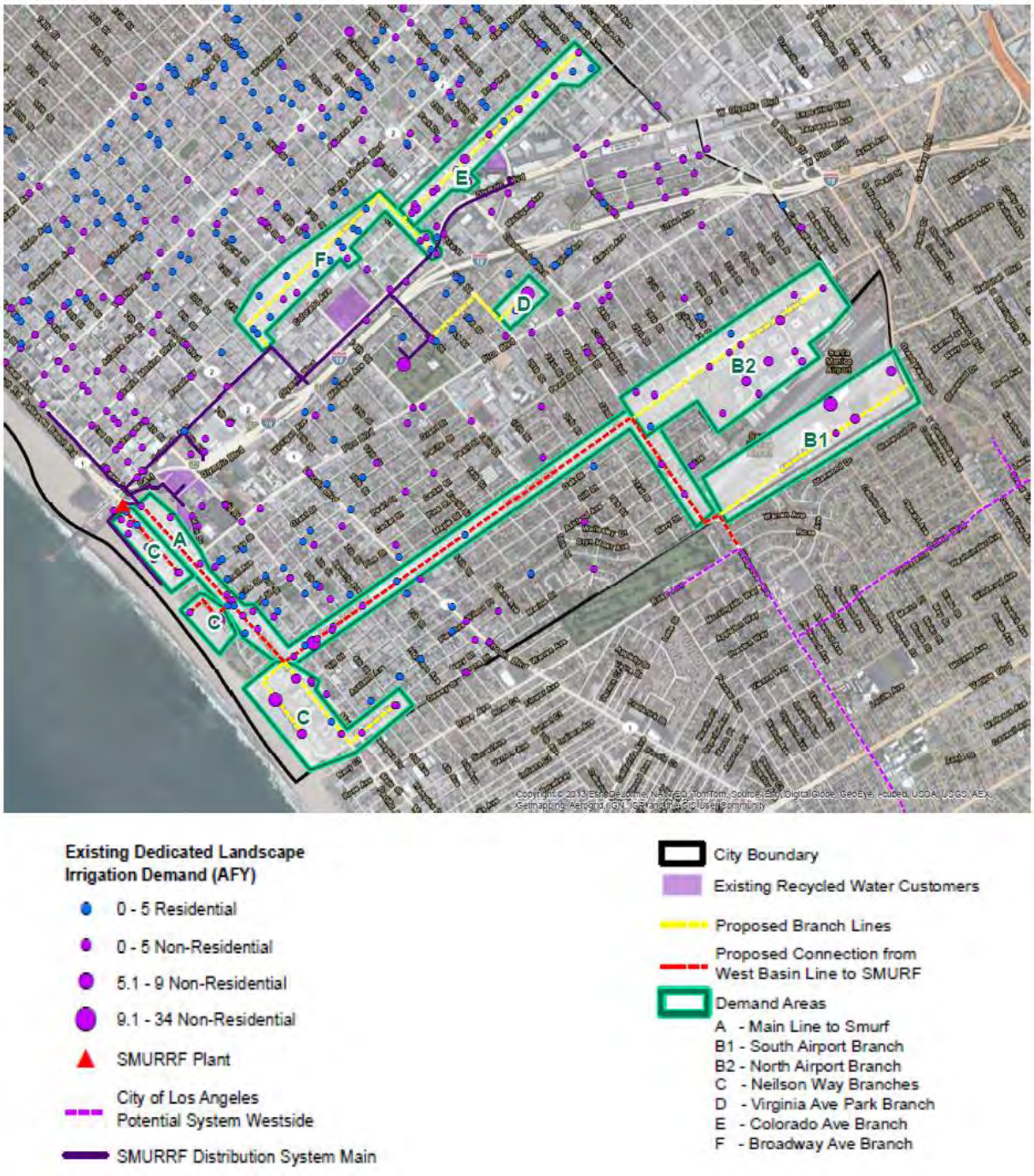
Similarly, a City-wide stormwater capture program offers a seasonal, unreliable additional water supply option for the City. A scenario was developed to rout local stormwater captured by the City's storm drain system to the Santa Monica Urban Runoff Recycling Facility (SMURRF) for distribution to landscape irrigation customers. It is estimated that a City-wide stormwater capture program may be able to generate an additional supply of 160 AFY.

Recycled Water

Currently, the City distributes approximately 85 AFY of recycled urban runoff to customers for landscape irrigation and indoor commercial use through the SMURRF and associated distribution system. The City does not operate a wastewater treatment plant and thus does not have a local source for additional recycled water supplies. However, the City could partner with adjacent agencies that currently produce recycled water in order to bring additional recycled water supplies to its customers. The West Basin Municipal Water District (WBMWD) operates a recycled water system that terminates near Marina Del Rey, which may provide the City with a potentially feasible source for recycled water. The Los Angeles Department of Water and Power (LADWP) also looked into utilizing this source and has prepared a master plan that suggests a potential for connection at this same location.

A recycled water market study was performed to estimate the potential for recycled water use within the City. Results of this study indicate that 350 AF of recycled water could be used by the City's dedicated landscape irrigation customers that reside along some key corridors into the City. Figure ES-9 provides a potential recycled water distribution system that focuses on delivering year-round recycled water to the City and serves a number of customers along the corridor of pipeline facilities.

Figure ES-9 Potential Local Recycled Water Supply System



In this potential system, the City may be able to partner with LADWP to jointly fund a new transmission and pumping system that connects to the WBMWD pipeline and bring recycled water to the southeast side of Santa Monica. The project would require approximately 5 miles of

pipeline from its current point of termination. Establishing the partnerships and agreements necessary to make this type of inter-agency program a reality will require time and funding. Accordingly, this option should be considered a long-range strategy for the City. It is unlikely that the City could deliver additional recycled water to its customers before 2020.

Portfolio Development

As shown in Figure ES-10, implementation of the strategies described herein suggest that the City can meet its self-sufficiency goal through a combination of water conservation programs, additional local groundwater production and additional supplies from rainwater harvesting and City-wide stormwater capture. In the future, the City may also be able to establish additional groundwater or recycled water supplies through inter-agency partnerships with adjacent water agencies and municipalities.

Figure ES-10 Water Supply and Demand Comparison Including New Supply Opportunities

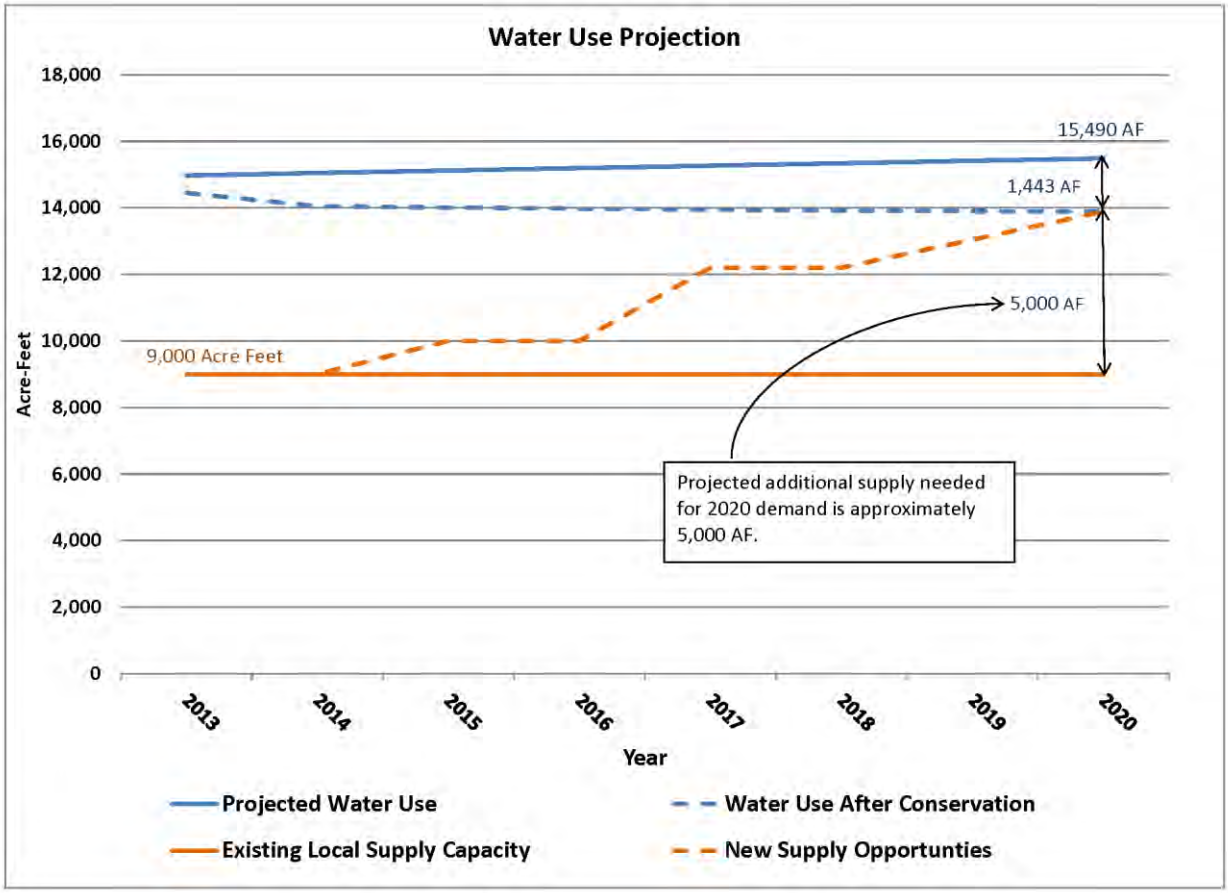
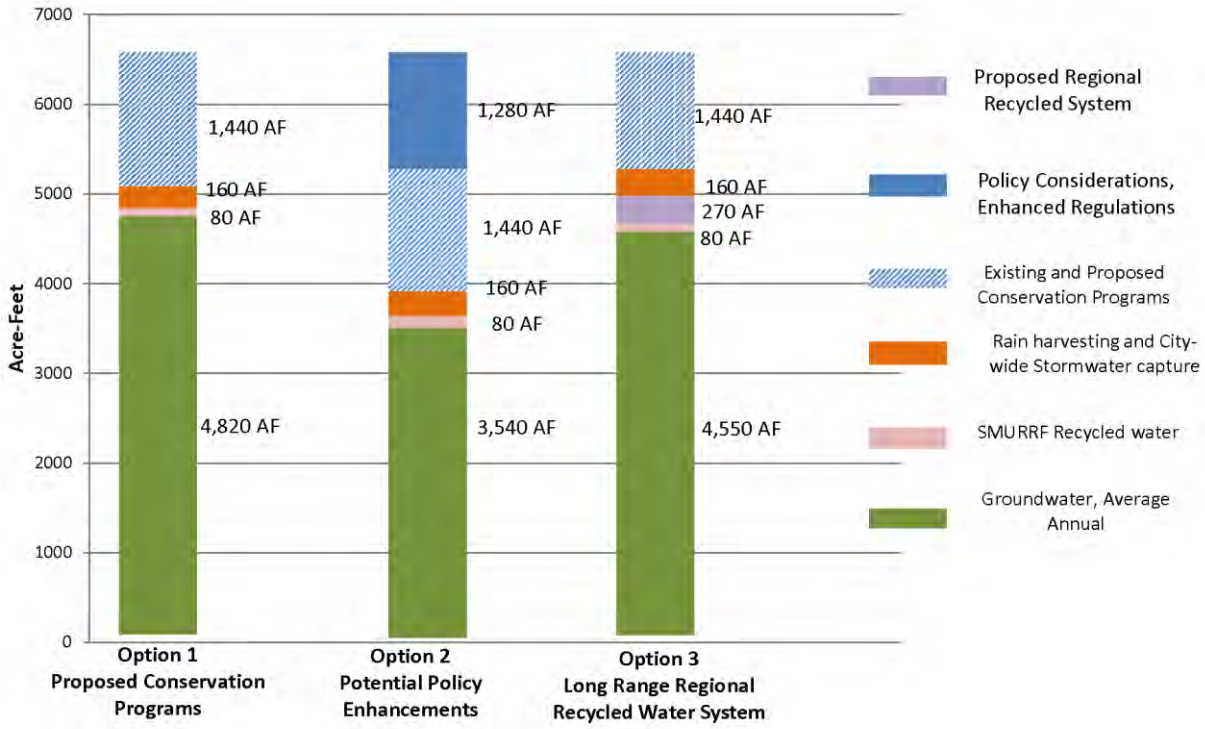


Figure ES-11 presents three different options for obtaining water self-sufficiency. These three portfolios were developed and presented to the City Council on May 14, 2013. At that meeting,

Council directed staff to proceed with the Sustainable Water Master Plan and further develop the demand management approaches and water supply augmentation tactics associated with Option 1 to support the City's sustainable plan goals and objectives. The primary elements of this plan include:

- Implement the identified demand management measures to promote additional water use efficiency,
- Expand groundwater extraction capacity to produce more local groundwater,
- Expand the existing Arcadia Water Treatment Plant capacity and construct the new Olympic Water Treatment Plant to treat the additional supply of local groundwater,
- Augment these core supply demand programs with other non-potable reuse opportunities to reduce potable water usage,
- Develop a roadmap for groundwater management sustainability, and
- Pursue applicable grant funding opportunities to lower the cost of self-sufficiency for the City's ratepayers.

Figure ES-11 Potential Supply/Demand Management Portfolios



Hydraulic System Analysis

To evaluate the potable water system, a computerized hydraulic model was developed using the City's Geographic Information System (GIS) data, facility information, operational controls, system demand curves, and water utility customer billing data. Following completion of the importing of all of the elements of the City's water distribution system into the hydraulic model databases, calibration of the hydraulic model was performed.

The goal of calibration was to develop a hydraulic model which reasonably represents actual conditions in the distribution system. Two phases of calibration were conducted: Steady state and extended period simulations. Steady state simulation calibration involved the process of simulating fire hydrant flow tests with the model so that it provides a reasonable match with the field generated findings. Extended period simulation modeling is associated with modifying the model until it simulates the operations of a specific day or multiple days with relative accuracy.

Upon completion of this task, the City's model was populated with projections of future water demands throughout the system, and used to reliably evaluate the performance of the City's water system under both current and future demand conditions. This modeling tool is now available to be used by the City to perform additional "what if" as-needed water system analysis activities.

System Pressure Zones and Facilities

The following pressure zone and system configuration was used to represent the City's hydraulic model. The City's system is divided into three pressure zones to regulate pressures in the water system. These pressure zones include: the 250, 350 and 500 foot zones. Each zone designation corresponds to ground elevations above the 250 foot, 350 foot, and 500 foot ground elevation contour within the City boundary. Each zone has its own primary sources of supply and facilities and is also hydraulically connected to the zone below it. A description of these zones and facilities follows.

500 Foot Pressure Zone

The 500 foot pressure zone (500 zone) lies at the northern most edge of the City and is the City's smallest zone. The 500 zone serves primarily single family, low density residential land uses. Since the 500 zone is both the smallest and lowest density zone in the system, it also serves the smallest demand of three zones.

The 500 zone is entirely developed, and due to the prohibitively high cost of acquiring land, storage was never built to serve this zone. To compensate for this condition, the 500 zone is served by both a direct connection to MWD which directly feeds the 500 zone and the San Vicente Booster Station which provides additional flow and pressure when conditions warrant.

The supply from MWD that serves the 500 zone typically exceeds the demands in this zone. This excess supply is normally relieved to the 350 foot zone where it serves as supply or goes into storage. The City normally uses the MWD connection to meet the storage needs of the 350 zone that are not satisfied by the output of the Arcadia Booster Pump Station.

350 Foot Pressure Zone

The 350 foot pressure zone (350 zone) is the largest of the three zones in the City and spans from the eastern most point in the City to the western most point. This zone serves low and high density single-family dwellings, commercial, industrial, and educational customers, and the Santa Monica Airport. It encompasses 57% of the City's land area and is supplied its water primarily from the Arcadia Water Treatment Plant (Arcadia WTP). Finished produced water from the Arcadia WTP is delivered to the Arcadia Booster Pump Station for final distribution to the customers in this zone.

The 350 foot zone has four storage reservoirs which provide 40 MG of storage capacity. In order of descending size, the 350 zone is served by the Riviera, San Vicente, Mt. Olivette, and Arcadia reservoirs, which have 25.0, 5.0, 5.0 and 5.0 MG capacities, respectively.

250 Foot Pressure Zone

The 250 foot pressure zone (250 zone) spans the length of the coastline within the City boundary and occupies the majority of the southwest corner of the City. It, like the 350 zone, contains a variety of land uses, most notably the Santa Monica downtown area and pier. Given the characteristics of the customers in this zone, this zone exhibits the largest ratio of water consumption per acre of land in the City.

The 250 zone is served primarily by a direct connection to the Arcadia WTP. The 250 zone is also served by two pressure relief/sustaining valves from the 350 zone, one each at the north and south ends of the zone. These valves supply the 250 zone if pressure in the 350 zone becomes too high and are used to sustain the pressure in the 250 zone should it drop too low.

Similar to the 500 zone, the 250 zone also contains no direct storage. It does however, have indirect access to the storage in the 350 zone by way of the two pressure sustaining valves which connect the two zones.

Summary of Water System Improvements

As discussed herein, the City's water system was evaluated under both current and future conditions with an overall focus of developing those programs and facilities needed to meet the City's water self-sufficiency and water use efficiency goals and objectives. To this end, a comprehensive demand analysis was performed to better understand the implications of the economy and weather on water demands over the last decade and incorporate this finding in a robust demand projection. This projection formed a basis of planning for the City's water use efficiency targets and the water supply and infrastructure needs related to a self-sufficient supply. To achieve both of these goals by 2020, a diverse set of water supply augmentation projects and demand management measures were derived and approved by City Council for further development and potential implementation.

In addition to these programs and projects, the Sustainable Water Master Plan also evaluated and developed programs and projects related to storing and distributing water to the City's customers. These identified improvements are typically prioritized into a capital improvement program (CIP) based on the assessment of a wide variety of factors. These factors include:

capacity considerations under current and future demand conditions, system reliability and performance, and support for the City's sustainability and self-sufficiency goals and objectives. A summary discussion of the City's water system storage and piping recommendations follows.

Water System Storage

As discussed, dedicated water system storage is contained in the 350 zone. This finding suggests a general need to increase the volume of available storage in various areas of the City to meet emergency and outage conditions and improve the resiliency of the City's water system. To this end, the City has performed various studies over the years to assess the potential siting of additional storage to mitigate this condition. At this time, it is believed that additional storage associated with the proposed Olympic Water Treatment Plant may be the most viable location for improving water storage and system resiliency.

Water System Pipelines

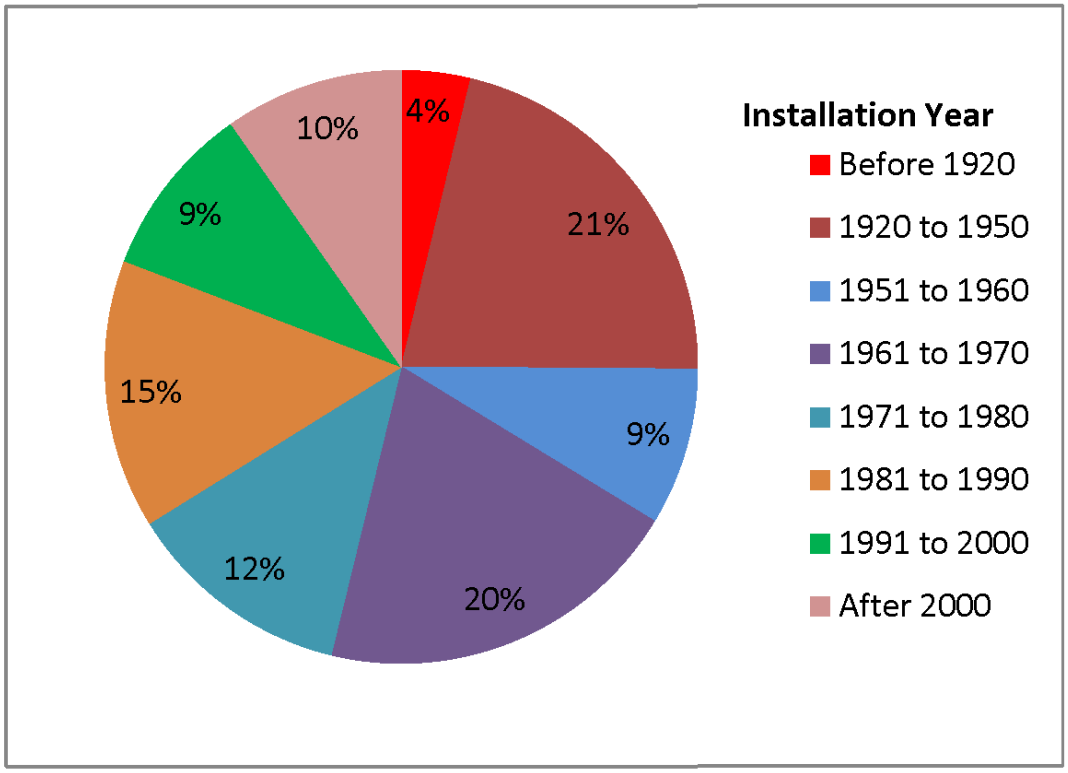
Water system pipeline improvements generally fall into two categories: improvements related to increased capacity or increased reliability.

- Capacity-related improvements were identified through the use of the newly developed water system hydraulic model. With the model, pipelines that did not meet a set of system performance or design criteria under either existing or future demand conditions were identified for replacement with larger diameter facilities.

- Reliability-related improvements were derived in this study based primarily on pipeline age and other asset condition and management related factors. Age information was attained through the City's water system GIS platform, while other condition and reliability information was attained through the City's water asset management system. To simplify the process and discussion in this Executive Summary, pipeline age is used herein to represent the potential reliability and vulnerability to condition-related service outages.

Figure ES-12 is developed to show the age distribution of the pipelines in the City's water distribution network. As shown, approximately twenty-five percent of the system was constructed before 1950 and is therefore in excess of 65 years old, with approximately 4% of the system approximately 100 years old. With a planning-level useful life of 80 to 100 years, the City should plan for the repair/replacement of many of the pipelines in the next 10 to 20 years.

Figure ES-12 Age Distribution of City Water System Pipelines



Source: City water system GIS data for underground pipelines, 2014.

It should be noted that the City has developed an asset management system of its underground water pipelines and has budgeted for the methodical replacement of underground infrastructure for many years. This budget item has historically been underfunded, increasing the risk of significant water main breaks and system losses similar to the ones experienced by other cities in the area.

A projection of the projected capital investment required over the next 30 years for the City's underground pipeline network was established in a 2010 Asset Management Plan. This plan projected the need to invest approximately $13 Million per year in the City's water system pipeline network. The current level of annual funding for this line item is approximately $2 Million, down from the original annual budget level of $3.8 Million to minimize the impacts on water rates at this time.

Working with the City to conduct this Sustainable Water Master Plan (SWMP) has supported the development and use of the City's current water system five-year Capital Improvement Plan. These programs and projects address the full range of capacity, reliability, sustainability, and self-sufficiency improvements. They are phased for implementation to support the methodical implementation of the SWMP to meet the City's needs while minimizing the financial impacts on its customers.

Other Water System Program Recommendations

In addition to the findings of the system hydraulic analysis and age assessment provided herein, there has been substantial discussion and analysis related to staging and operational requirements of the future water supply portfolio. In particular is the need to formalize a water supply plan that aligns with the City's proactive development of the Olympic Well Field Management Plan, the phasing of self-sufficiency improvements and demand management programs, the operational strategies to meet seasonal demands, and the adoption and implementation of appropriate water system funding.

As an implementation element of the SWMP, it is recommended the City consider the development of several additional programs that will support the success of the SWMP. These include:

- Prepare an operational plan that integrates the timing of various supply programs and facilities, documents the sequential priority of each new source of supply, establishes the baseline/peak relationship of the two water treatment plants, and evaluates the seasonal operational plan for each water treatment plant to meet average day, minimum day, and maximum day demands under various hydrologic conditions.

- Develop a Groundwater Management/Sustainability Roadmap to position the City to be the leader of the Santa Monica Groundwater Basin, enhancing its ability to control this local water resource.

- Prepare a Grant Funding Program Plan so that the use of grant funds can be utilized to lessen the impact of these program/facility costs on the City's water customers over the next 10 years.

- Develop an Olympic Water Treatment Plant (OWTP) Technical Oversight Team that will review and evaluate key technical information associated with the new OWTP. This panel of experts will support the City's development of this project and will convene periodically to facilitate the efficient integration of this facility into the City's water self-sufficiency program.

Section 1: Introduction

The City of Santa Monica (City) supplies imported and local water to approximately 91,000 residents within an area of approximately 8 square miles. Looking to its future, the City hopes to eliminate its reliability on imported water by addressing the challenge of existing groundwater quality, identifying new sources of local water supply, and more effectively reduce and manage its water demands.

With an adopted goal of water self-sufficiency achieved by eliminating reliance on Metropolitan Water District of Southern California (MWD) supply by 2020, the City of Santa Monica retained Kennedy/Jenks Consultants to develop an integrated Sustainable Water Master Plan (SWMP). The SWMP combines relevant components of existing plans with an evaluation of a broad range of water supply and demand management options to assist the City in meeting its goals. This plan has been prepared with the objective of developing a comprehensive document to define supply and demand management options to cost effectively reduce future water demands and enhance local water supply production capabilities.

1.1 Goals and Purpose

The purpose of this planning effort is to provide an up-to-date, comprehensive look at the City's water system using recent planning information and the newly-developed distribution system hydraulic model to assess the City's water system infrastructure needs. In a March 2011 study session with the City Council, staff presented concepts and principles that would be involved in achieving water self-sufficiency goal by the year 2020. Since that time, the City has embarked on the development of a sustainable and proactive plan to accomplish this goal.

This SWMP includes an evaluation of expanded demand management measures and a variety of water supply alternatives including recycled water, storm water collection and treatment, rainwater harvesting, greywater applications, and other water rights, supply and exchange opportunities to align with the above goal. A decision modeling approach was used to package these programs and projects into Supply/Demand Portfolios, where criteria were developed to provide portfolio ranking, economic analysis and ultimately, strategic direction. This plan illustrates projected water supply and demand scenarios, and characterizes the approximate magnitude of supply deficits or unpredictability that needs to be addressed to meet the City's self-sufficiency objectives by 2020. The recommendations resulting from this SWMP are designed to provide a roadmap of phased projects and programs to guide the City's water utility towards self-sufficiency.

Implementation of the SWMP is further supported through the conduct of financial planning services. These services, prepared and documented under a separate cover, included an evaluation of water and wastewater rates, rate structures for conservation support and financial stability, and an update to the City's water and wastewater facility capacity charges.

As discussed above, the development of a SWMP entails a multi-faceted approach to address the City's goal of achieving water self-sufficiency by the year 2020. With the City's current capability to meet approximately 70% of its water demand from local groundwater sources, the

objective is to develop strategies to close the "gap" represented by the current purchase of imported water. Through a combination of demand management approaches and water supply augmentation tactics, various portfolios were developed to represent permutations and combinations of options that best meet the program objectives and continue to support the City's Sustainability Plan[1]. The SWMP documents the mix of strategies that could be undertaken to achieve water self-sufficiency by 2020, and recommends a portfolio of conservation/supply programs and capital projects to meet these self-sufficiency goals.

The scope of services required to achieve the primary goals of the City's SWMP include:

- Perform a water demand analysis and generate water demand projections, which incorporate the most current information regarding population, land use and the Land Use and Circulation Element (LUCE) information for the City's service area projected to the year 2035. The water demand projections consider the effects of weather and economic conditions on future water demand in order to increase defensibility in a time of increased pressure to reduce potable water demands in response to State legislation,

- Conduct a rigorous evaluation of the City's current and future supply alternatives and demand management options to be able to build strategic portfolios for the future,

- Develop a comprehensive potable water system hydraulic model development, including calibration, and perform a hydraulic analysis under various system conditions,

- Perform an evaluation of infrastructure improvements to accommodate existing requirements and meet future needs, including an evaluation of system infrastructure fire flow (FF) requirements, and an updated capital improvement program to support the City's short and long-range capital improvement requirements,

- Perform a comprehensive financial evaluation of the City's water and wastewater utilities and associated rates and rate structures, and

- Prepare and submit two separate reports documenting the findings and recommendations of the Sustainable Water Master Plan and the Water and Wastewater Rate and Revenue Study.

1.2 City Background and Previous Studies

The City of Santa Monica provides water service to approximately 91,000 residents through a combination of local and imported water supplies. Historically, groundwater made up the majority of the City's water supply portfolio; however, in 1995 when methyl tertiary butyl ether (MTBE) contamination was discovered in the Charnock Sub-basin, a sub-basin of the Santa Monica Basin (Basin), the City was forced to shut down five groundwater wells and have to rely heavily on purchased water (or imported water) from Metropolitan Water District of Southern

[1] http://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Sustainability/Sustainable-City-Plan.pdf

California (MWD). With a proactive water treatment program now in place, the City is now returning to reliance on groundwater as its primary source of water supply. The City also collects dry-weather urban runoff for use as a treated non-potable water source.

The following background sub-section describes the details of the City's service area, topography, climatic conditions and historical growth patterns.

1.2.1 City's Service Area

Santa Monica is a beachfront city in western Los Angeles County. It is situated on the Santa Monica Bay, and is surrounded by the City of Los Angeles on the Northeast, the Pacific Ocean on the west, Mar Vista on the east and Venice on the southeast. The City's service area consists entirely of the City of Santa Monica with limited service in the City of Los Angeles. The City occupies 8.3 square miles (5,312 acres) of land. Figure 1-1 shows the Santa Monica City boundary and the vicinity areas.

Single family and multi-family residential are the City's predominant land-use type. In addition to the residential land-use, the City also has centralized business, a commercial district, and institutional and industrial areas. Figure 1-2 shows the current land-use map of the City. It is expected that future changes in growth and land-use type will result from re-development of the existing lots since almost all of the City's area is at near built-out conditions.

1.2.2 Topography and Climate

The City rests on mostly flat terrain that slopes down towards Ocean Avenue and towards the south. The north side of the City is separated from the beaches by the high bluffs.

Classified as a moderate Mediterranean climate, Santa Monica enjoys an average of 310 days of sunshine a year. Because of its location, nestled on the vast and open Santa Monica Bay, morning fog is common in May, June and early July (caused by ocean temperature variations and currents). Summers are dry with an average temperature of about 70°F, and winters are cool and wet with an average temperature of about 52°F. The beach temperatures tend to be about 5 to 10 degrees Fahrenheit (3 to 6 degrees Celsius) cooler than it is inland. September tends to be the warmest month of the year.

The City's average rainfall is approximately 14 inches. The rainy season is from late October through late March. Winter storms usually approach from the northwest and pass quickly through the Southland. There is very little rain during the rest of the year.

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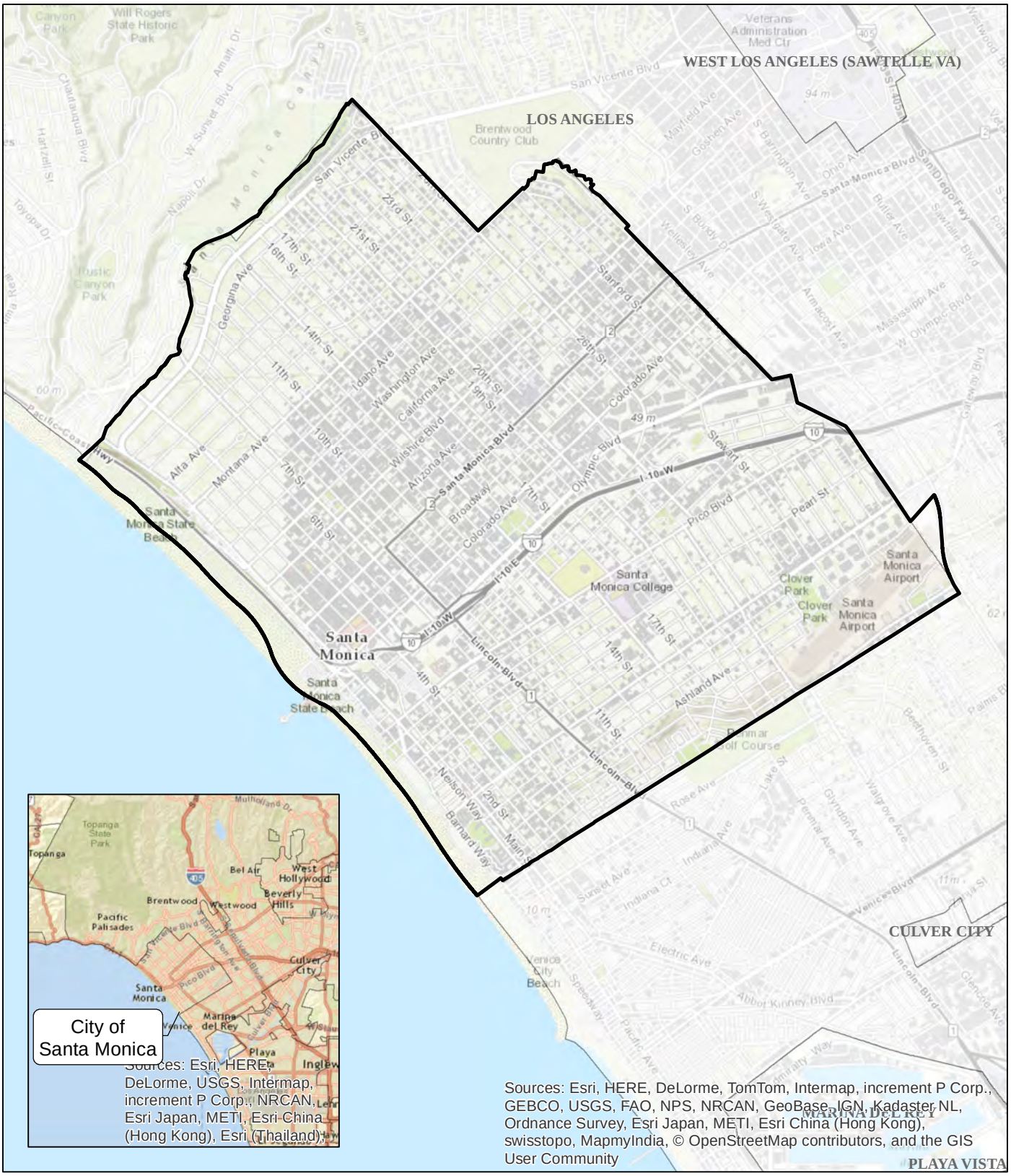

Path:

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

N

0 1,725 3,450

Feet

Kennedy/Jenks Consultants

Santa Monica Sustainable Water Master Plan
Los Angeles County, California

Site Vicinity Map

K/J 1283015*00

Figure 1-1

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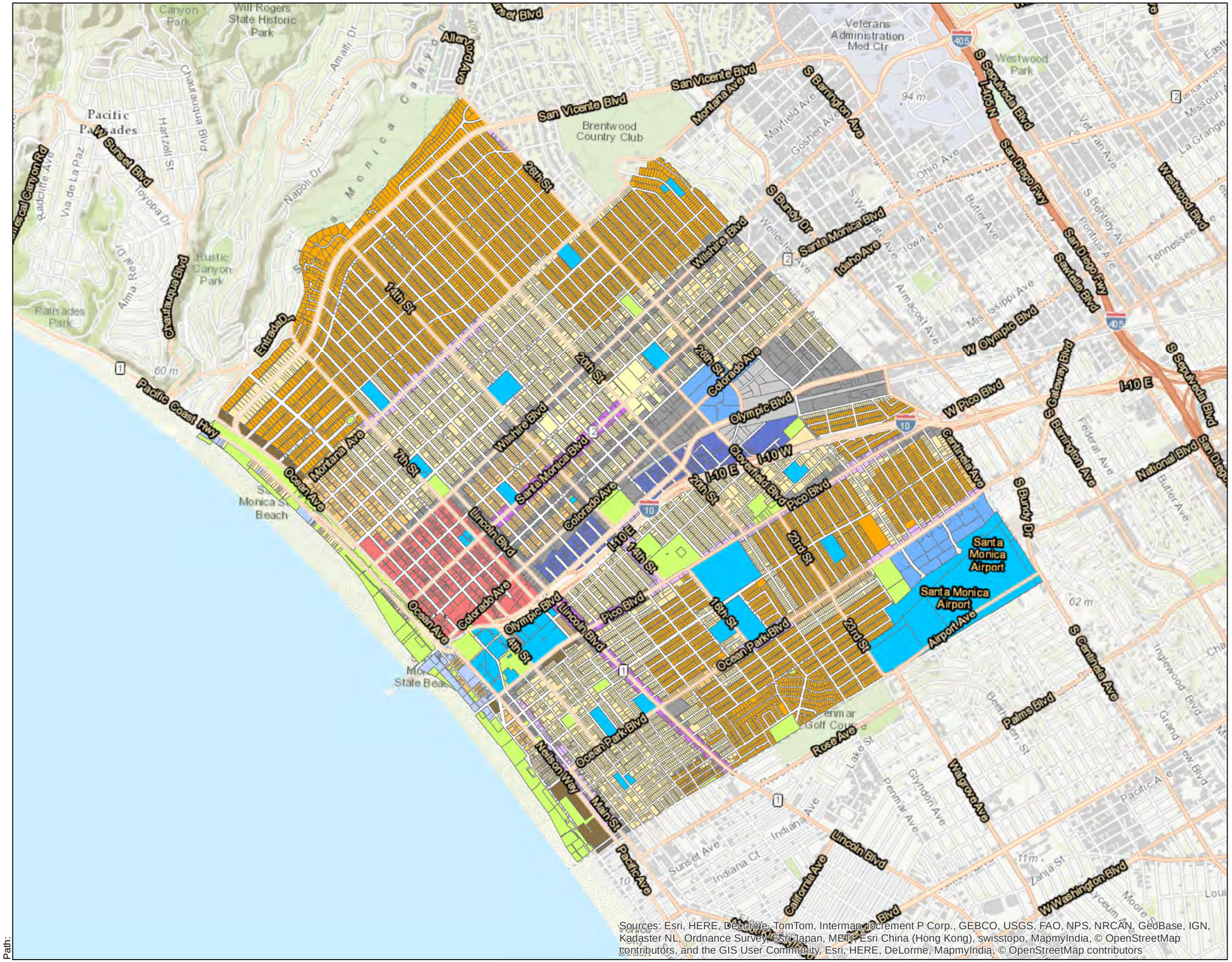


Legend

- City of Santa Monica Boundary

Landuse

- Downtown Core
- General Commercial
- Neighborhood Commercial
- Health Care Mixed Use
- Industrial Conservation
- Institutional/Public Lands
- Low Density Housing
- Medium Density Housing; Meduim Density Housing
- High Density Housing
- Single Family Housing
- Mixed Use Boulevard; Mixed Use Boulevard Low; Mixed Use Creative
- Oceanfront District
- Office Campus
- Parks and Open Space; San Vicente Blvd Median; Civic Main Street Park
- Transit Corridor; Transit Village

N

0 1,250 2,500

Scale: Feet

Kennedy/Jenks Consultants

Santa Monica Sustainable Water Master Plan
Los Angeles County, California

Santa Monica Landuse Map

K/J 1283015*00

Figure 1-2

Path:

1.2.3 Growth in Santa Monica Region

According to the United States Census Bureau, the 2010 residential population of the City is approximately 91,000 persons. Given the near build-out condition, population growth in the City's service area is projected to be minimal, less than 1 percent per year. As a result, population is projected to increase by approximately 1,000 people in the next 25 years. As a major commercial center for the region, the City experiences daytime populations of up to 200,000 due, in large part, to the number of businesses and attractions located within the City. This increase in population along with general non-residential growth rate will increase the City's water demands for indoor and outdoor use in future years. Table 1-1 below shows the City's projected population through the 2035 planning period.

Table 1-1 Projected Population

Year	2015	2020	2025	2030	2035
Projected Population	91,243	91,487	91,716	91,926	92,124

Source: 2010 Urban Water Management Plan. Note that the Department of Finance currently suggests higher population values than projected in 2010.

1.2.4 Previous Efforts and Studies

Reports on the water supply and groundwater conditions in and around the Santa Monica region were compiled and reviewed in preparation for this study. Some of the more useful reports that are referenced in this study include those recently completed by, SA Associates, Richard Slade and Associates, and GHD. A summary of the related reports regarding water supply/demand, water quality, and water utility assets include:

- The most recent (2011) update to the Urban Water Management Plan by SA Associates provided key insight into the status of the City's water supply. Items addressed included characterizations of the current water supply, groundwater supply, alternative water supply sources including recycled water, the future of each supply and reliability, conservation and water shortage plans for moving forward.

- In 2012, Richard Slade and Associates prepared a *Conceptual Groundwater Basin Model and Assessment of Available Groundwater Supplies Santa Monica Basin* for the City and a supplemental perennial yield assessment to support this Sustainable Water Master Plan. This material is provided to the City directly under a separate cover.

- In 2010 the City commissioned the development of an Asset Management Plan for the water distribution and wastewater collections systems by GHD. This study assessed the organization and management of the Operations and Maintenance (O&M) functions of the Water Resources Division. A key finding of this study was the development of a long-term capital investment strategy for the water and wastewater assets.

1.3 Report Organization

Section 1- Introduction

This section gives a brief overview of the City's service area, project background, customer demographics, climate, previous efforts and studies relevant to this master plan, and structure of the master plan report.

Section 2 and Section 3 – Historical, Current and Future Water Demands

These sections describes in detail the City's historical water use, demand projections for future, factors influencing the projections, demand management strategies (both current and future), existing and future demand management programs and their impacts etc. Various demand management strategies will be presented which can be used as planning tools to help reach the City's goal of water self-sufficiency and meeting the water use efficiency goals as prescribed in SBx7-7.

Section 4 and Section 5- Current and Future Water Sources, Supplies, and Strategies

These sections describe in detail the current supply sources the City is using to meet its water demands and explores potential new supply options, including but not limited to: groundwater, stormwater collection, greywater, wastewater recycling, non-potable reuse and other potential institutional arrangements that may further improve the reliability of the City's water supply. Portfolios of supply strategies are evaluated in terms of cost, reliability, sustainability, and diversity, and are set forth as potential supply plans for the City. These portfolios are ultimately elevated to the City Council to obtain direction on the strategy to be implemented in the City's sustainable water supply plan.

Section 6 - System Hydraulic Analysis

This section describes the master planning criteria used for hydraulic analysis of the City's water pipeline network and pumping/storage facilities. Design criteria include standard parameters for pipeline sizing, roughness coefficients per pipe type, minimum/maximum velocities, head-loss criteria, fire flow requirements, and storage criteria. This section also discusses the details of the hydraulic model construction using the Innovyze InfoWater software and model calibration using SCADA data, fire hydrant data and the corresponding results. System hydraulic deficiencies in terms of pipeline, pumping, storage, and fire flow are identified as part of this section.

Section 7- Capital Improvement Program

This section describes the results of the water system analysis and develops the Capital Improvement Program (CIP) recommendations. The CIP includes conceptual level costs, and prioritization, and phasing as appropriate.

Appendices

A series of appendices have been assembled to aid the reader in reviewing peripheral information that was useful in the development of the Sustainable Water Master Plan (SWMP). These appendices are located at the conclusion of the basic SWMP report.

Other Deliverables

As an element of the City's Sustainable Water Master Plan, a comprehensive financial evaluation of the City's water and wastewater utilities and associated rates and rate structures was also prepared. The results of these efforts are presented as separate reports and are not contained herein.

1.4 List of Acronyms

The following is the list of acronyms used in this report.

List of Acronyms	
AF	Acre-feet
AFY	Acre-feet per year
AWWA	American Water Works Association
BMP	Best Management Practices
CEQA	California Environmental Quality Act
CFS or cfs	Cubic feet per second
CIP	Capital Improvement Program
City	City of Santa Monica
CUWCC	California Urban Water Conservation Council
DDW	Division of Drinking Water
DO	Dissolved oxygen
ESP	Emergency Storage Project
FBS or fbs	Feet below Surface
FPS or fps	Feet Per Second
FY	Fiscal Year
GPD/FT or gpd/ft.	Gallons per day per foot
GPM or gpm	Gallons per minute
HP or hp	Horsepower
IRP	Integrated Resources Plan
IWRP	Integrated Water Resources Plan
KW or kw	Kilowatts
KWH or kwh	Kilowatt per hour
LF or lf	Linear Foot
MCLs	Maximum contaminant levels
MDD	Maximum Day Demand
MG	Million gallons
MGD or mgd	Million gallons per day
MG/L or mg/L	Milligrams per liter
MWD	Metropolitan Water District of Southern California

List of Acronyms	
M&I	Municipal & Industrial
NEPA	National Environmental Policy Act
PRV	Pressure Reducing Valve
PSI or psi	Pounds per Square Inch
O&M	Operation and maintenance
RWMP	Recycled Water Master Plan
RWQCB	Regional Water Quality Control Board
SWMP	Sustainable Water Master Plan
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total dissolved solids
TOC	Total organic carbon
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VOCs	Volatile Organic Compounds
WRF	Water Research Foundation
WRP	Water Reclamation Plant

Section 2: Historical and Current Water Use

To meet its sustainability goals by the year 2020, the City must have a clear understanding of its current and future water needs, or demands within its service area. Historical water demand data provide information on water use patterns and trends among the City's customers. These patterns and trends can then be analyzed, along with local land use data, to project the City's future water demand and production needs.

This section describes the City's historical water use[2]. A detailed analysis of the City's billing data was conducted to better understand patterns of use among the City's various customer types. Finally, the results of a demand analysis as it relates to the projection of future water needs are provided in Section 3.

2.1 Historical Water Use

Since 2005, annual water use within the City have ranged from 13,000 AF to 15,000 AF with an average annual water consumption of approximately 13,930 AF (Table 2-1). The decrease in demands that began in 2008 corresponds with statewide drought conditions promoting the need to conserve water resources and depressed economic conditions. Overall, the City's water use has been steadily declining since the early 1990's as a result of its successful water conservation programs.

Table 2-1 Historical Water Use

Year	Production (AF)[(a)]
2005	14,917
2006	15,061
2007	15,112
2008	14,491
2009	13,855
2010	13,065
2011	13,142
2012	13,874
2013	14,020
Average	13,934

(a) Source of data for years 2005-2009: City's 2010 UWMP. Source of data for years 2010-2013: City's Department of Water Resources Public Water System Statistics report.

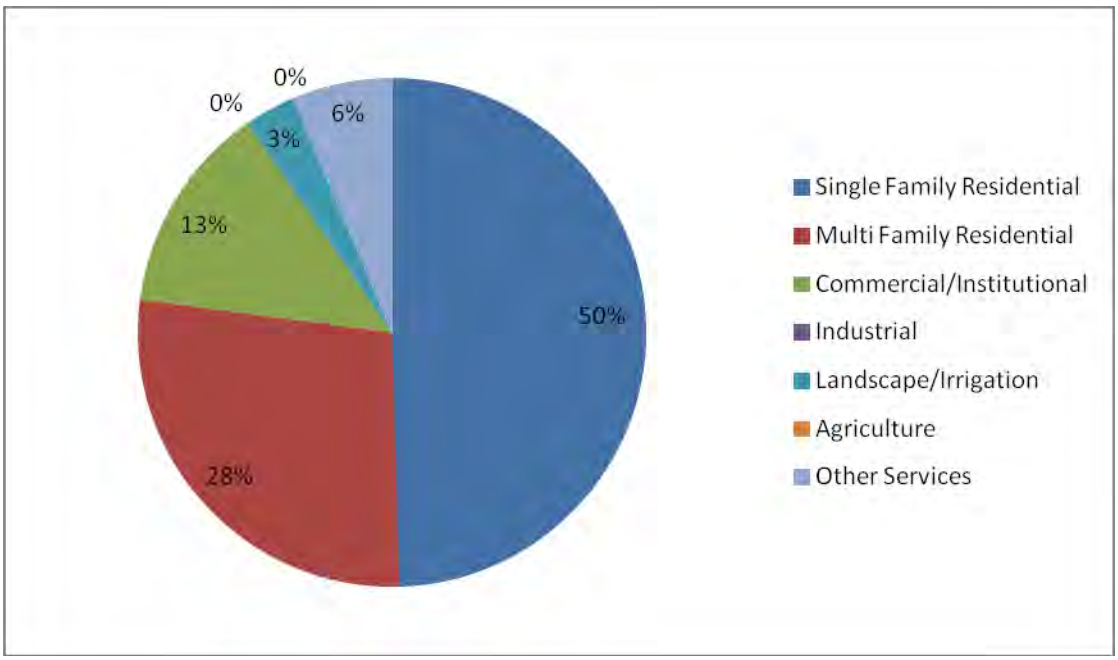
2.1.1 Historical and Current Water Use by Customer Type

The City provides water service to approximately 18,000 metered service connections to a variety of customer types. These include: residential, commercial, institutional, landscape, and

[2] Demand or consumption is used herein to reflect actual billing information. Production is metered water use (demand) plus unaccounted for and other non-revenue water.

fire protection customers. Approximately 80 percent of the City's total service connections are used to serve the City's residential customers. Commercial and institutional accounts account for approximately 12 percent of the service connections. Landscape irrigation, fire line services and various "other" accounts make up the remaining 8 percent of the City's water customers. Among the "other" accounts is a very small set of customers receiving recycled water from the Santa Monica Urban Runoff Recycling Facility (SMURRF). A graphical summary of the service connections by customer type is shown on Figure 2-1

Figure 2-1 Service Connections by Customer Type



Source: City utility billing data; calendar year 2013

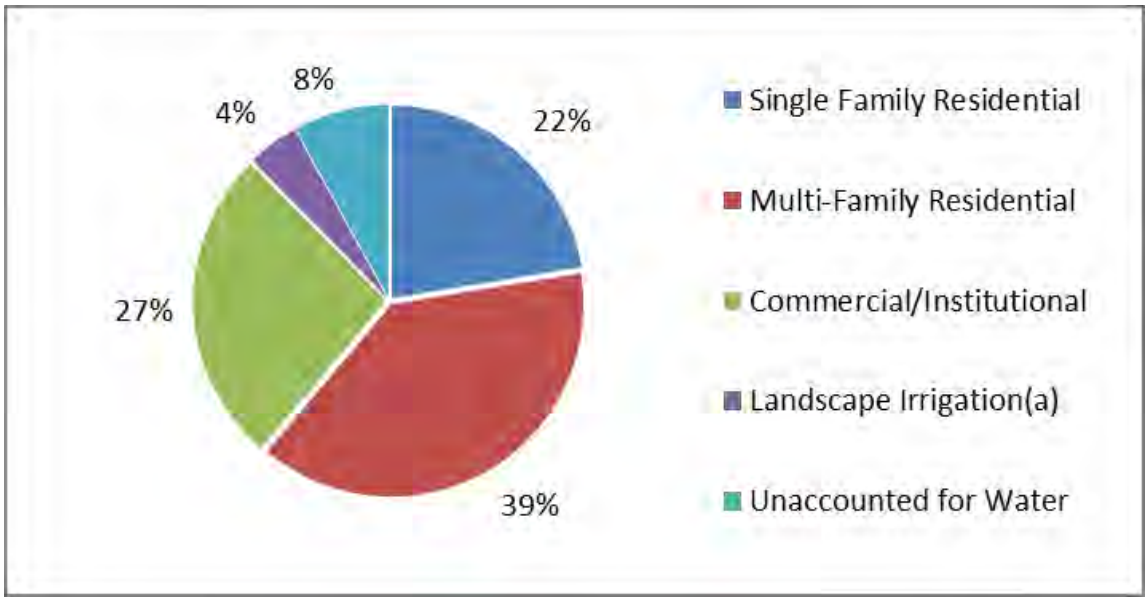
As shown in Table 2-2, the majority of the City's water use occurs within the residential sector, as residential usage accounts for approximately 61 percent of the City's total water consumption; with 23 percent of the usage by the single family customer class, and 38 percent from the multi-family customer class. Since multi-family connections typically serve multiple residences, their water use per service connection is expected to be larger than a typical single family account. Water use from system losses and demand by customer type is graphically depicted on Figure 2-2.

Table 2-2 Historical Water Production (AF)

Customer Type	2006	2007	2008	2009	2010	2011	2012	2013
Single Family Residential	3,645	3,752	3,529	3,195	2,862	2,798	3,113	3,143
Multi-Family Residential	5,866	5,784	5,575	5,408	5,100	5,517	5,503	5,431
Commercial/Institutional	3,774	3,745	3,549	3,374	3,003	3,512	3,544	3,718
Landscape Irrigation[(a)]	626	728	698	652	538	606	604	606
Unaccounted for Water[(b)]	1,150	1,103	1,140	1,226	1,562	709	1,110	1,122
Total Water Use[(c)]	15,061	15,112	14,491	13,855	13,065	13,142	13,874	14,020

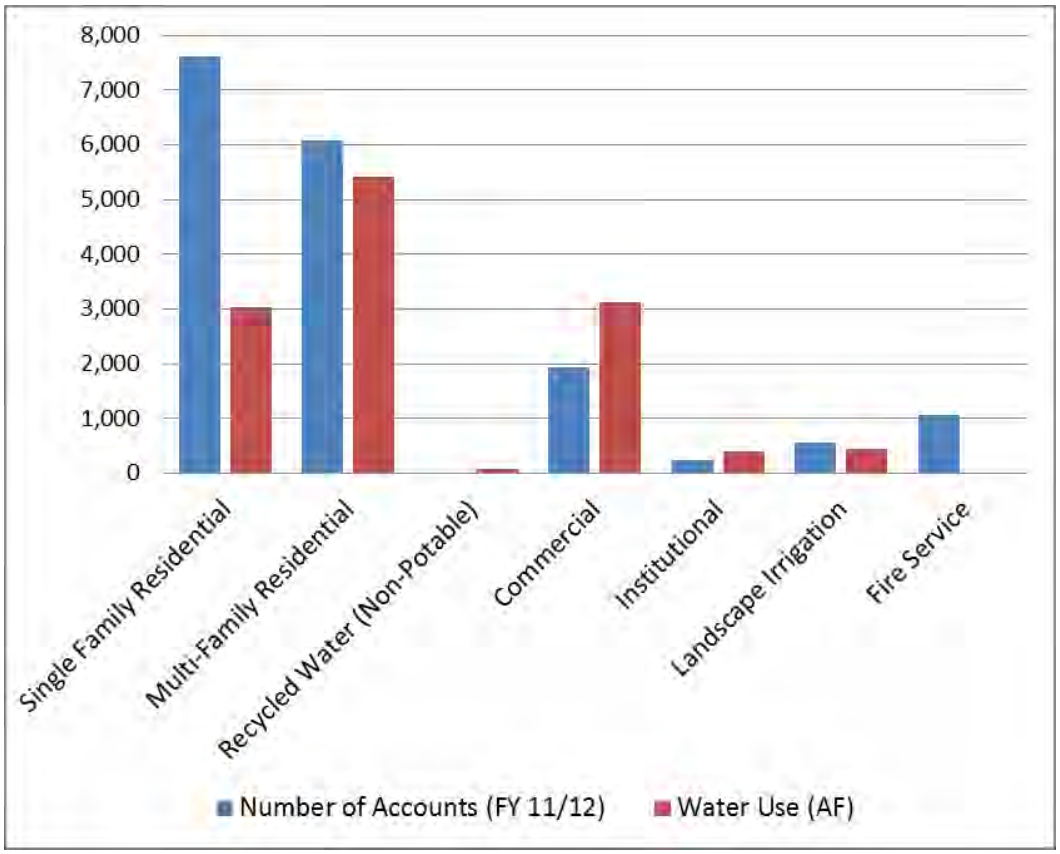
(a) Includes recycled water produced by the SMURRF.
(b) Unaccounted water for 2012 and 2013 based on average of unaccounted water from 2005 to 2011.
(c) Source of data for years 2005-2009: City's 2010 UWMP. Source of data for years 2010 to 2013: City's Department of Water Resources Public Water System Statistics report ("Total water into the system," including recycled water).

Figure 2-2 Water Use from Customer Types (Including System Losses)



While non-residential accounts comprise a little over ten percent of the City's service connections, these commercial and institutional customers account for approximately one-quarter of the City's water consumption. Figure 2-3 is derived to compare the number of active water system service connections with the water use for each of customer type. The City's institutional customers include several large institutions with large populations of water users, including the Santa Monica Civic Auditorium, Santa Monica College and two hospitals.

Figure 2-3 Comparison of Number of Service Connections and Demand



The City's dedicated landscape irrigation customers, customers with separate meters specifically for landscape water use, account for four percent of the City's total water use. Except for these few accounts equipped with dedicated landscape irrigation meters, outdoor water use is not metered separately from indoor use.

Unaccounted for water is the difference between the amount of water that enters the City's distribution system and the amount of water distributed to the City's customers. Unaccounted for water is water lost from the distribution system through a variety of ways, both authorized and unauthorized, including water for firefighting, pipe flushing, leakage from pipelines, meter error, and theft. The City's unaccounted for water is estimated to be 9 percent of total demand.

The City completed the American Water Works Association's M36 Water Loss analysis in order to better understand water loss within their system. Results indicate an Infrastructure Leakage Index (ILI) of 3.34 which, according to general guidelines, is within the "reasonable" range for utilities not exposed to severe limitations. An ILI between 3 and 5 is appropriate when water resources can be developed or purchased at a reasonable expense; existing water supply capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place; and water resources are believed to be sufficient but demand management measures are included in long-term planning. The audit highlights some strengths and weaknesses of the system.

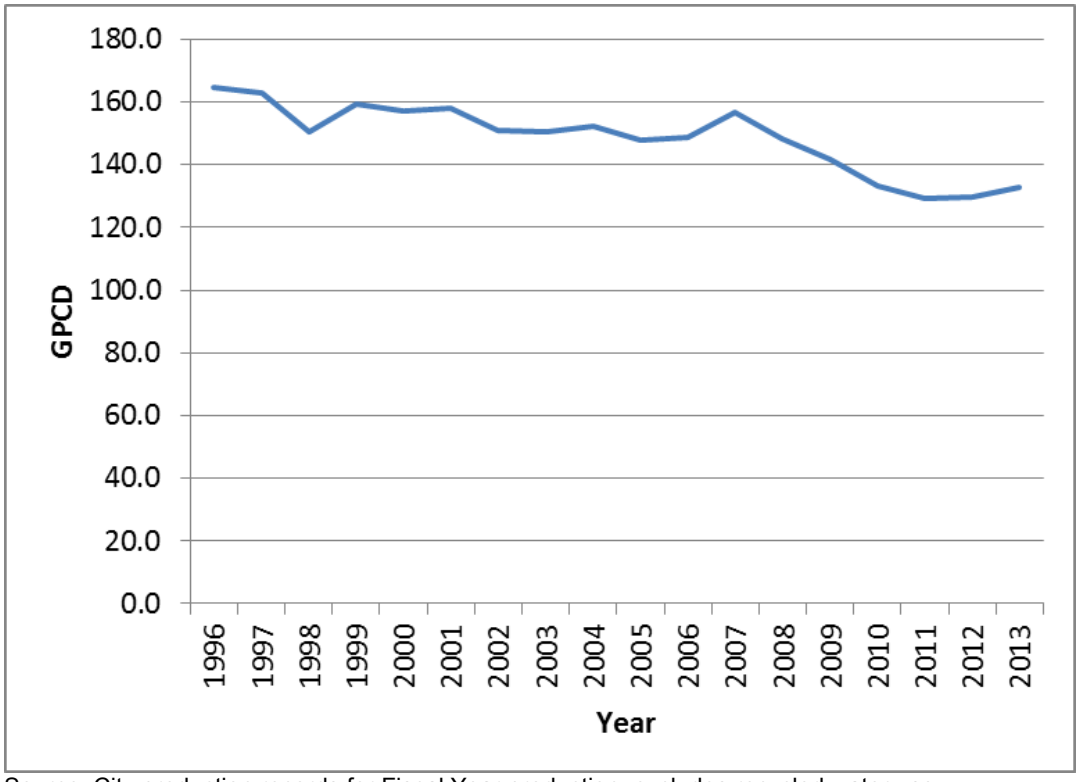
2.1.2 Historical Per Capita Water Use

The City's per capita water consumption has been declining steadily since the early 1990's. Water use in the City hit the lowest level on record in 2011 at 129 gallons per capita per day (gpcd) (Figure 2-4). The decrease in water use is attributed to a combination of factors including the economic downturn, customer awareness of water scarcity, the City's water conservation efforts and tiered water rates.

The California State Legislature drafted the Water Conservation Act of 2009 (SBx7-7) to protect statewide water sources. The new legislation called for a 20 percent reduction in water use in California by the year 2020 and amended the water code to require water agencies to establish 2020 and 2015 per capita water use targets in their 2010 Urban Water Management Plans (UWMPs). These per capita targets included both residential and non-residential accounts.

To satisfy the provisions of SBx7-7, the City set water use targets for 2015 and 2020 at 139 and 123 gpcd, respectively. The City intends to achieve its reduction requirements through the implementation of the California Urban Water Conservation Council's (CUWCC's) Best Management Practices (BMPs) and additional programs designed to reduce landscape water use, including rebates for sustainable landscapes, water-saving irrigation systems, rain barrels and cisterns and free sustainable landscape workshops and classes.

Figure 2-4 Historical Per Capita Water Use (GPCD)



Source: City production records for Fiscal Year production, excludes recycled water use.
Population data is from the Department of Finance, January estimates.

2.2 Factors Affecting Water Use

The City's water use varies vary from year to year depending on a number of factors including population growth, climate conditions, economic activity, and water conservation.

2.2.1 Population

Typically, as population increases, so does the demand for water. Prior to 1990, population growth was a good indicator for total water demands, with water demands increasing in step with population. However in the early 1990's the City began implementing water conservation programs which, combined with new water use standards on plumbing fixtures, were extremely effective in reducing per capita water demands. The City has seen an 18 percent reduction in per capita water use from 1996 to 2010 due in part to the implementation of conservation measures, increased saturation of water-saving plumbing fixtures and general water conservation awareness among its customers. Population, therefore, is no longer a straight-forward indicator of estimated water demand.

2.2.2 Weather

Weather is a significant influence on year to year variation in water demand largely due to landscape requirements. In general, hotter, drier years result in increased water demands while in cooler, wetter years demand decreases. At the same time, during prolonged drought, this effect can be offset by increased public awareness and mandatory water use restrictions.

2.2.3 Economic Activity

Typically, poor economic conditions, characterized by high unemployment rates result in decreased water use; however, the degree of this effect for the City is unknown. It is suspected that recent decrease in water demand experienced in the City can be attributed, at least in part, to poor economic conditions as a result of the recession. In projecting water use for the future, it is important to consider eventual economic recovery and ensuing higher water demand. This is particularly important when considering the City's goal to meet state-mandated SBx7-7 per capita water use targets. If water demand increases as a result of economic recovery, the volume of water that must be conserved in order for the City to meet its targets will increase.

2.2.4 Water Conservation

Water conservation reduces water demand either by improving fixture and/or process efficiency or changing peoples' water using behaviors. Active conservation occurs through efforts such as rebate and incentive programs, system audits and repairs, outreach, education and more. Passive conservation occurs naturally as a result of legislation and plumbing codes when customers are required to replace or upgrade water using products and processes. The City has seen an 18 percent reduction in per capita water use from 1996 to 2010 due, in part, to the implementation of conservation measures, increased saturation of water-saving plumbing fixtures and general water conservation awareness among its customers. Since that time, the City has experienced a slight rise in demands per account, suggesting that the previously noted

impact of an improved economy on water demands is a practical consideration for long-range water supply planning.

2.2.4.1 Summary of Past Water Conservation Efforts

The City has been actively implementing water efficiency programs since 1988, was one of the original signatories to the CUWCC MOU in 1991 and continues in its effort to reach self-sufficiency and meet State requirements. The City has adapted its water use efficiency programs to meet changing customer needs, to take advantage of various opportunities, often funding related, and to capitalize on new processes and technologies.

The City's past water conservation efforts include a combination of incentive programs, regulations, and outreach and education programs. Outreach and education programs lay the foundation for the City's water conservation ethic, supporting the incentive programs that actively encourage water conserving behaviors, while effective regulations are used to support and reinforce conservation efforts when needed. This section briefly summarizes the City's water conservation efforts over the past decade; more detailed information is provided in Appendix A. Information regarding water use efficiency efforts prior to 2001 can be found in the City's 2002 Water Efficiency Strategic Plan.

2.2.4.1.1 Incentive Programs

Incentive programs are typically designed to motivate customers to purchase more efficient fixtures or devices by defraying the costs. Since 2001 the City's incentive programs have included a variety of devices typically delivered as rebates, but also included direct install programs when appropriate. A summary of the City's incentive programs is provided in Table 2-3. The water savings are estimates based on industry standards including those established by MWD.

Table 2-3 City's Water Conservation Incentive Programs 2001 to 2012

Device/Fixture	Incentive Type	Program Dates	Total Quantity Installed	Lifetime Estimated Water Savings (AF)
City Incentive Programs				
ULFT	Rebate	2001 – 2003	790	533.05
ULFT	Direct Installation	2002 – 2004	938	483.07
HET	Direct Installation	2004 – 2004	81	39.85
High Efficiency Showerhead	Direct Installation	2002 – 2004	283	8.49
Faucet Flow Restrictors	Rebate	2002 – 2004	330	0.99
Faucet Aerators	Rebate	2002 – 2004	170	0.51
High Efficiency Clothes Washer	Rebate	2004 – 2009	826	232.34

Device/Fixture	Incentive Type	Program Dates	Total Quantity Installed	Lifetime Estimated Water Savings (AF)
Landscape Retrofits (Irrigation and Plants)	Grant	2004	113 projects	76
Grey Water Conversion Kits	Rebate	2005	5	4.6
HET	Rebate	2006 -2009	316	155.47
Rain Barrel	Rebate	2009	319	1.4
Cisterns (Small)	Rebate	2009	3	0.02
Cisterns (Large)	Rebate	2009	3	0.02
Turf Replacement (Cash for Grass)	Rebate	2010 – 2012	3,170 sq. feet	2.14
Parkway Turf Replacement (Cash for Grass)	Rebate	2011	4,641 sq. feet	6.2
Residential Incentive Programs Operated by MWD				
HETs	Rebate	2008 – 2011	23	20.4
High Efficiency Clothes Washers	Rebate	2008 – 2012	333	145.52
Weather-Based Irrigation Controllers (WBICs)	Rebate	2008 – 2012	14	5.8
Synthetic Turf	Rebate	2008 – 2009	3,171 sq. feet	0.44
Rotary Nozzles	Rebate	2009 – 2012	149	4.18
CII Incentive Programs				
ULFT - Flushometer	Rebate	2000 - 2012	58	43.9
Ultra-Low Flow Urinal	Rebate	2000 – 2012	26	20.9
ULFT	Rebate	2002 – 2012	497	376.7
Flush Valve for Flushometer Toilet	Retrofit	2003 – 2004	9	1.4
HET – Dual Flush	Rebate	2003 – 2008	17	14.5
High Efficiency Clothes Washer	Rebate	2003 – 2010	154	127.5
HET – Tank Type (Multi-Family Customers)	Rebate	2003 – 2012	39	32.5
Pre-Rinse Spray Valves	Rebate	2004 – 2006	150	114.8
Conductivity Controllers	Rebate	2005	14	45.1
Conductivity Controllers – pH	Rebate	2005	3	16.1
Water Broom	Rebate	2005 – 2006	202	154.9
Zero Water Urinals	Rebate	2005 – 2012	386	947.2
HET	Rebate	2006	733	632.1
Dry Vacuum Pump	Rebate	2008	4	2.6

Device/Fixture	Incentive Type	Program Dates	Total Quantity Installed	Lifetime Estimated Water Savings (AF)
Food Steamers	Rebate	2008	3	7.5
High Efficiency Urinal	Rebate	2008	1	1.2
HET – Multi-family Upgrade	Rebate	2008 – 2012	1	0.15
Rotary Nozzles	Rebate	2009	1608	35.4
Synthetic Turf	Rebate	2009	3,000 sq. feet	4.2
Weather-Based Irrigation Controller (WBIC)	Rebate	2009 - 2012	4	3.16
Total Estimated Lifetime Water Savings (AF)				**4,203**

2.2.4.1.2 Audit and Assessment Programs

The City offers water use audits and assessments for both its residential and commercial customers to help identify opportunities to reduce their water use. Currently, three separate programs are available to City water customers:

- Bay Saver Water Assessments
- Green Business Certification Water Assessments
- Landscape Audits of City-Operated Dedicated Landscape Meters

These programs are described in detail in Appendix A.

2.2.4.1.3 Regulatory Programs

The City makes effective use of its rules and regulation to support its conservation efforts. The policies and ordinances listed below comprise one of the most comprehensive water efficiency-related packages in the state. Current regulations and policies programs include:

- Sustainable City Plan
- Parkway Policy
- Greywater Policy
- Retrofit Upon Sale Ordinance (SMMC 7.18)
- Bay Saver Fee Ordinance (SMMC 7.12)
- Water Conservation Ordinance (SMMC 7.16)
- Green Building Ordinance (SMMC 8.106 and SMMC 8.108)

- Water Shortage Response Plan (SMMC 7.16)

Various policies, ordinances, and supporting water conservation materials are provided in Appendix A.

2.2.4.1.4 Outreach and Education Programs

The City recognizes the importance of educating the public, including school-aged children, about the value of local water resources and the importance of water use efficiency. The City's public outreach and education programs are designed to educate about local water resources issues, water shortage advisories and the need to become less dependent upon imported water supplies, as well as inform residents about the various programs available to help reduce their water use.

The City operates a general public outreach program which includes the annual Santa Monica Festival, where staff distributes materials on water production, quality, and conservation, and hosts educational/informational tours of Arcadia and SMURRF treatment plants for schools, universities and other local agencies, and works closely in partnership with MWD in the offering of its water conservation school programs. The City also offers landscape workshop series for both residents and landscape professionals and maintains four different demonstration gardens. The City's outreach and education programs are also described in greater detail in Appendix A.

Section 3: Future Water Use

To meet its goal of achieving water supply self-sufficiency by 2020, the City requires a clear understanding of its future water supply and demand requirements. To sustainably “turn off the valve” to imported water, the City must be able to meet current water production needs, including peak summer water use, as well as those in the future, through local sources and water conservation alone. The total amount of local source water needed to meet the City’s sustainability goal includes water supplied to customers, unaccounted for water, or non-revenue water lost from the distribution system, and any water used in the production process but not provided to the customers, such as brine produced and disposed of as a result of the water treatment process.

The City provided projected water demands in five year increments through 2035 in its 2010 UWMP (Table 3-1). The water demand projections, shown in AF, include the amount of water needed to meet current and future customers’ needs and are based on expected growth within the City, including re-development. Most notable, is the fact that the projections also include the assumption that the City will meet its SBx7-7 water conservation targets described in Section 2.1.2, a stark contrast to the actual historical water usage previously shown in Table 2-2.

Although redevelopment is expected to be an ongoing process, it is not expected to significantly impact water use since the City is already near "built-out". As the City's population continues to grow, and as water conservation measures continue to be implemented, the City expects to experience minimal increases in water consumption due to population increases.

Table 3-1 2010 UWMP Water Demand Projections

	2015	2020	2025	2030	2035
Projected Demand (AF)	12,592	12,625	12,657	12,686	12,713

Source: 2010 Urban Water Management Plan.

The water demand projections included in the 2010 UWMP provide a good starting point for estimating the volume of water needed to meet the City’s sustainability goal; however, additional clarity related to the basis of this planning is needed to appropriately use this water demand projection. Some of the key underlying elements of the 2010 UWMP projection are:

- The water demand projections include an assumption that the City will meet both its interim 2015 and its 2020 SBx7-7 water use reduction goals. In an effort to comply with SBx7-7, the City has committed to reducing its water use to 123 gallons per capita per day by the year 2020. Total customer demand, prior to reductions through the City’s conservation efforts, are necessary to understand the total volume of water the City must produce in order to eliminate dependence on imported water supplies. Once the total volume of water is known, then the best mix of supplies and water conservation programs can be derived to meet the goals of SBx7-7 and cost effectively meet the water supply self-sufficiency goal by 2020.

- The water demand projections shown:
    - Do not include unaccounted for water lost during the distribution process.
    - Do not include the volume of water needed for production processes, including brine created during the treatment process.
    - Are annual average values, and therefore do not include seasonal demand variations, especially the maximum day demands that occur during the summer.
- Finally, the demand projections have not considered the effects of weather and economic conditions on historical demands, which are a core element of the basis of future demand projections. As noted, over the past few years, the City has seen a significant decrease in demand. What is unknown, is how much of this reduction can be attributed to the City's water conservation programs, the downturned economy, and/or the weather, and the public education related influence of California's drought conditions. A better understanding of the effects of these factors on the City's water demand is required to improve the reliability of future water demand projections.

At the inception of this Sustainable Water Master Plan, the City's initial estimate of the average annual volume of water needed to meet the sustainability goal was approximately 3,700 acre-feet per year (AFY). However, similar to the 2010 UWMP demand projection methodology, that estimate was based on the assumption that water demand would not increase in the future beyond current levels and did not consider the effects that economic activity and weather may have on future water demands. While the extent of these effects may vary based on local conditions, there is a general increase in demands with increased economic activity and hotter, drier weather conditions.

These effects were not incorporated in the baseline demand projections available in other planning documents, including the 2010 Land Use and Circulation Element (LUCE). A comparison of current water demands and the LUCE projected demands suggests that the estimates in the 2010 LUCE may actually be too high. The 2010 LUCE projected water demands of approximately 15,300 AF in 2012; a detailed billing data analysis shows actual demand in 2012 was approximately 13,500 AF – a difference of 1,800 AF.

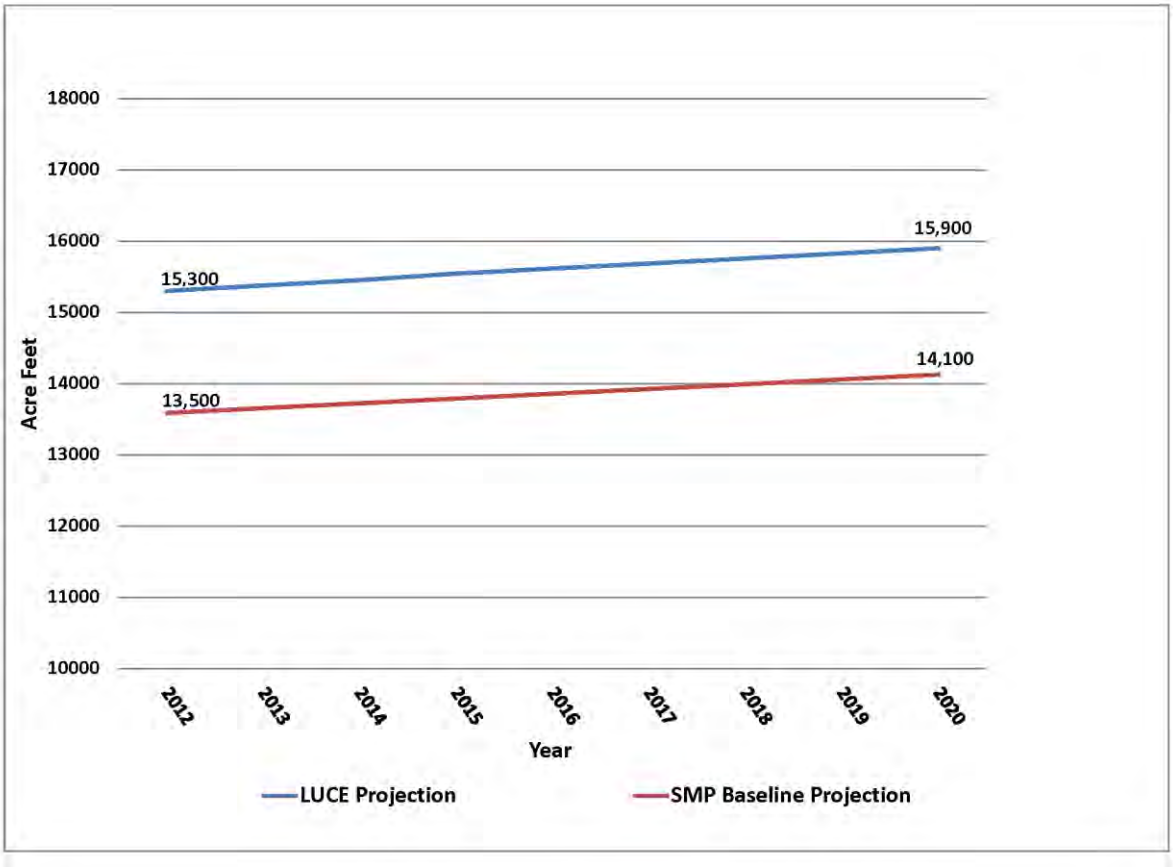
3.1 Water Use Analysis

To plan for future supply needs, a comprehensive demand analysis was performed in order to develop updated demand projections that align more closely with current demands and were adjusted for effects of weather and economic activity applicable to the City. The goal was to capture the total volume of source water the City would need to meet its water needs through local sources alone.

First, a new baseline demand projection was developed. This baseline water use projection begins with actual water production of approximately 13,500 AF (in FY 12-13) and grows at the same rate as the water demand projection found in the LUCE. LUCE annual growth rates were used since it was developed based on the City's best estimates of demographic and development projections used in the City's General Plan and other planning documents.

Figure 3-1 compares the water demand projection found in the LUCE with the new baseline projection developed herein.

Figure 3-1 Comparison of LUCE Water Projection with Baseline Projection

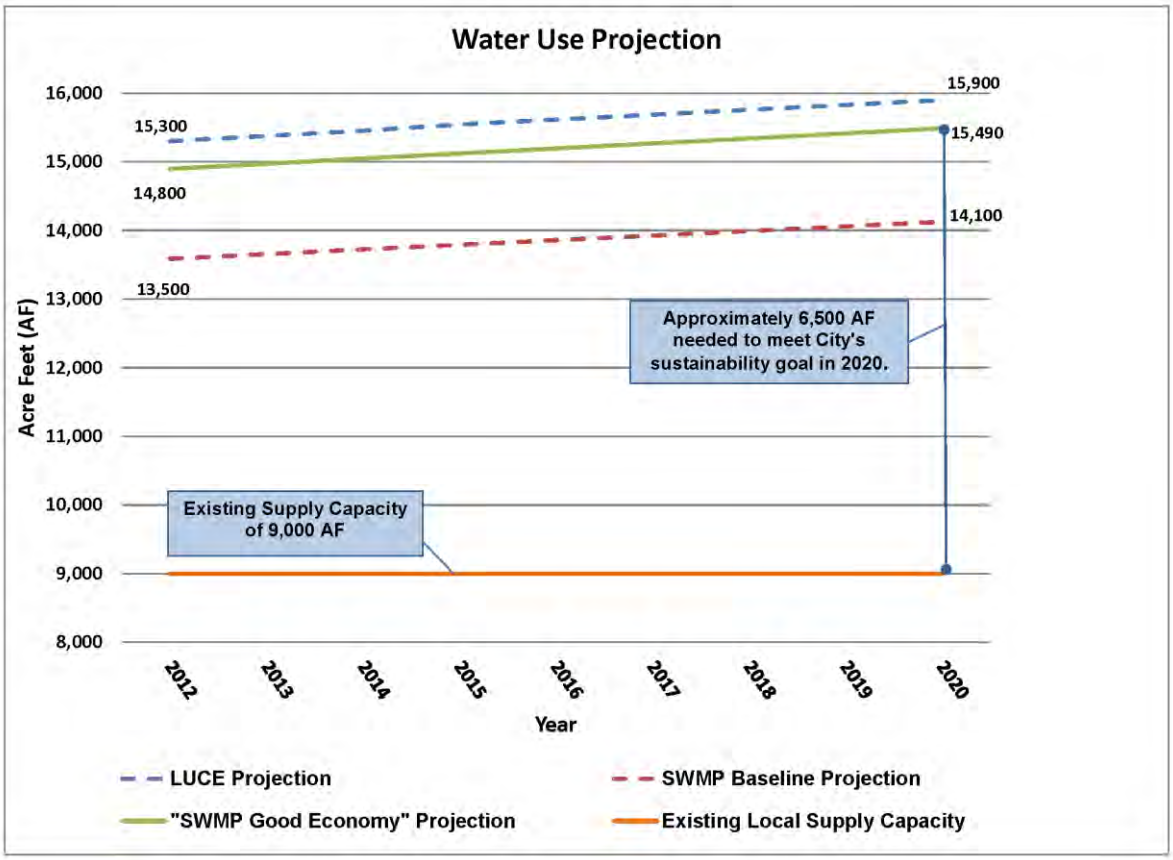


Next, the effects of weather and economic conditions on the City's water demands were explored. Regression analyses were performed to evaluate the correlation between water use for various customer categories (single family, multi-family, commercial, institutional and landscape irrigation) and weather and economic (unemployment rate) factors. Results of the analysis indicated that there was no significant correlation observed between weather related parameters (evapotranspiration (ET) and precipitation) and water use for the City (Appendix B). However, the analyses did find a reasonably high correlation with the City's unemployment rate (R^2 of 0.56 to 0.73) to water use for single family, multi-family and landscape irrigation customer classes. Specifically, water use decreased with an increase in the unemployment rate.

In projecting water use for the future, it is important to consider eventual economic recovery and an accompanying increase in water demand. Hence, compared to the baseline water usage conditions, additional conservation measures or water supplies would be required to meet the City's average annual water needs when economic conditions improve.

In concurrence with the results described above, the baseline water projections shown on Figure 3-1 was adjusted to project future production requirements under good economic conditions, as shown on Figure 3-2. The “good economy” projection is approximately 10 percent higher than the baseline water projection. Given that the City’s existing local water supply capacity is approximately 9,000 AF, the demand analysis suggests that the gap between available water supply and the volume of water required to meet the City’s sustainability goal in 2020 is actually closer to 6,500 AF, rather than 3,700 AF (Figure 3-2).

Figure 3-2 LUCE Projection, Baseline Projection, and "Good Economy" Projection



3.2 Projected Water Use

Table 3-2 presents a reasonable estimate of the City’s projected water usage. This estimate uses the City’s current water use, increases them by the annual growth rate found in the City’s Land Use and Circulation Element (LUCE, and normalizes or adjusts these values for the effects of economic influences. Thus, assuming good economic conditions (unemployment rate less than 4.1 percent) in the future, the City must be able to deliver an approximately15,500 AFY of water in the year 2020. The amount required will then increase to approximately 16,260 AFY in 2035 based on modest increase in demands projected by the 2010 LUCE.

Table 3-2 Projected Average Annual Water Production Requirements

	2015	2020	2025	2030	2035
Normalized Water Demand (AF)[(a)]	13,918	14,255	14,599	14,941	14,967
Unaccounted for Water (AF)[(b)]	1,202	1,233	1,261	1,291	1,294
Total Water Production (AF)	**15,120**	**15,488**	**15,860**	**16,232**	**16,261**

(a) Demand normalized for the 90th percentile unemployment rate (i.e. "good economic conditions," in which the unemployment rate is lower than 4.1 percent 90 percent of the time). Does not include demand reductions that will be achieved by the City's water conservation program as it works to meet SBx7-7.

(b) Assumes 9 percent system wide water loss based on the results of the City's AWWA Water Loss Audit.

It should be noted that Table 3-2 does not represent the total amount of water needed to meet full self-sufficiency through build-out. Additional water supplies are projected to be needed to meet maximum day demands in the summer, provide for water lost as brine during the water treatment system process, and other system losses that may occur over time. While some of these additional water needs are projected to be offset from additional water conservation programs and policies, it is not projected to offset the overall impact of these other water supply requirements. A discussion and analysis of the effect of water conservation programs on future demands follows. Water treatment related water supply requirements are further addressed in Section 5.

3.3 Water Conservation Analysis and Effect on Future Demands

Water conservation modeling and analysis were performed to better define the City's opportunities to reduce the projected water demands described above through the implementation of water conservation programs. Following the completion of a detailed billing and historical conservation program and policy analysis, a comprehensive list of water conservation programs was developed and modeled using the Alliance for Water Efficiency's Water Conservation Tracking Tool. This model allows users to analyze the water savings potential and implementation costs of a collection of water conservation programs. The model also uses local demographic and housing characteristics to estimate water savings that could be attributable to enhanced efficiency requirements in State plumbing codes and water fixture usage standards, and predict reductions in demand from other applicable programs.

The suite of programs selected for analysis address each of the City's water customer sectors (single-family, multi-family, commercial, institutional, and landscape) with an emphasis on water users that shows opportunity for additional conservation. Since 1988, the City has invested millions of dollars in resources to retrofit nearly every indoor plumbing fixture in commercial, single-family and multi-family buildings with water saving products. As a result, water usage in the City has declined even though the City's population and non-residential development have increased.

Results of the billing analysis indicate that the greatest remaining potential for water conservation exists among the City's commercial and institutional customers, as well as in overall landscape water use. Two specific large water users, St. John's Medical Center, the Santa Monica-Malibu Unified School District, and laundry facilities, were identified by City staff as customers with a high potential for additional water savings and programs were developed to target those potential water saving opportunities.

Implementation levels for each water conservation program modeled were based on analyses of saturation rate of existing water saving plumbing fixtures and landscapes, customer surveys, staff knowledge of the City's customers and their willingness to implement these programs, and products that will have long-term water savings that are not dependent on significant changes in the customer's behavior. The goal was to develop a diverse selection of programs that aggressively pursued demand reduction through retrofitting existing indoor plumbing with plumbing fixtures that save about twenty percent more water in addition to retrofitting landscape customers' with plants and irrigation approaches that can save up to eighty percent more water, compared to existing landscapes.

To support the development of development of the SWMP's self-sufficiency strategies, conservation program development, and financial planning requirements, input was obtained from the City's Task Force on the Environment and the SWMP Advisory Committee. Extensive discussions occurred with the Advisory Committee during the project via group meetings, emails and conference calls. This Committee is comprised of: Mark Gold, Chair of the City's Environmental Task Force, Associate Director UCLA Institute of the Environment and Sustainability; Andy Lipkis, Tree People Founder and President; Conner Everts, Southern California Watershed Alliance Executive Director; Ed Osann, Natural Resources Defense Council Senior Policy Analyst, Water Program; Judy Abdo, Santa Monica representative on the MWD Board of Directors, former Santa Monica Mayor and Councilmember; Caryn Mandelbaum, Environment Now Freshwater Program Director, Staff Attorney; and Tracy Quinn, Natural Resources Defense Council Policy Analyst, Water Program.

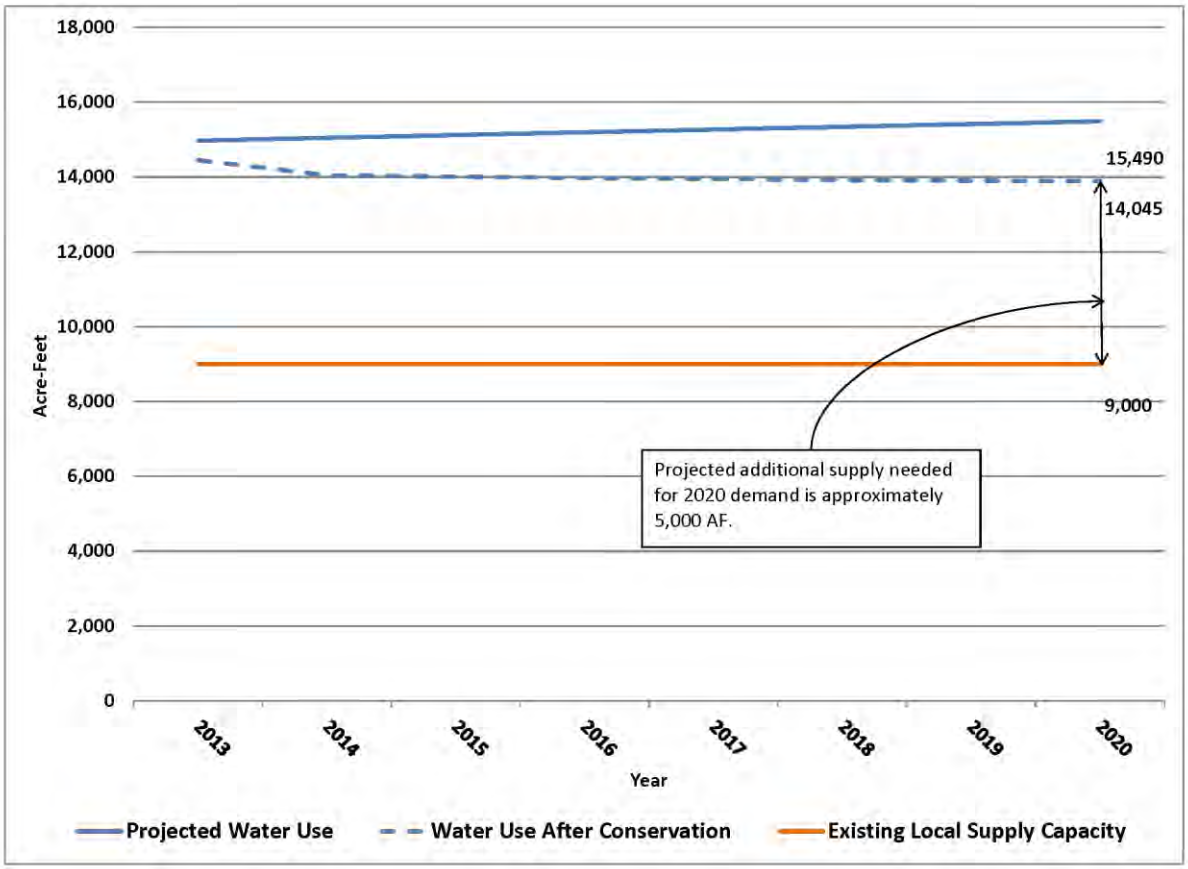
The resulting suite of conservation programs, shown in Table 3-3, is projected to save approximately 775 AFY of water by the year 2020. An additional 418 AFY of savings is expected by 2020 as a result of State plumbing and building code standards that require higher water saving fixtures. In addition, a reduction in system-wide leaks and unaccounted for water through capital investment in the system is projected to save another 250 AFY of water for a total demand reduction of approximately 1,443 AFY by 2020.

Table 3-3 Water Conservation Programs

Conservation Activity	Class	Total Number of Activities Implemented by 2020	Total Conservation in 2020 (AF)	Estimated Average Annual Cost	Estimated Total Cost Through 2020
Residential HE Clothes Washer Rebate	Single Family	880	30	$24,100	$216,600
Residential HET Rebate	Single Family	3568	77	$14,400	$129,700
Residential WBIC Rebate	Single Family	1920	79	$29,300	$263,800
City's Cash for Grass Rebate Program	Single Family	1,100,000 square feet	51	$209,900	$1,889,100
City's Drip Irrigation Rebate Program	Single Family	1,100,000 square feet	24	$139,900	$1,259,400
City's HE Nozzle Rebate Program	Single Family	550,000 square feet	7	$52,500	$472,300
Water Smart Software - 5% Reduction in Water Use (NEW)	Single Family	3,040 customers	8	$26,600	$239,300
0.8 gpf Toilets (Direct Installation) (NEW)	Multi Family	5,496	73	$174,800	$1,573,100
Residential HE Clothes Washer Rebate	Multi Family	544	19	$9,800	$88,600
Residential HET Rebate	Multi Family	4,000	13	$16,200	$145,400
Laminar Flow Restrictors for St. John's Medical Center (NEW)	Commercial	664	6	$1,500	$13,600
Commercial Dry Vacuum Pump Rebate	Commercial	40	3	$1,400	$12,600
Commercial Connectionless Food Steamer Rebate	Commercial	2	1	$100	$500
Commercial Zero Water Urinal Rebate	Commercial	4	0.1	$25	$200
Commercial Ultra-Low Volume Urinal Rebate	Commercial	544	8	$3,500	$31,100
Commercial Conductivity Controller Rebate	Commercial	2	4	$0	$0
Commercial HET Rebate	Commercial	200	5	$2,500	$22,900
CII Cooling Tower Treatment - Zero Blowdown (NEW)	Commercial	2	1	$200	$1,400
Coin-Operated Laundry Machine Retrofit (NEW)	Commercial	45	360	$3,500	$31,800
HETs for St. John's Medical Center (NEW)	Commercial	10	0.1	$100	$1,100
0.125 gpf Urinals for St. John's Medical Center (NEW)	Commercial	7	0.1	$40	$400
1.5 gpm Faucet Aerators for St. John's Medical Center (NEW)	Commercial	158	0.3	$800	$6,900
SMMUSD Audits & Retrofits - Assumes 5% Reduction in Total H2O Use (NEW)	Institutional	Maintained through 2020	5	$94,400	$849,400
Total Active Water Savings (Programs Listed Above)			**775**	**$805,500**	**$7,249,100**
Total Passive Savings (Codes and Laws)			418		
25% Reduction in System Leaks and Non-Revenue Water			250		
Total Reduction in Demand			1443		

Figure 3-3 shows the potential effect of implementing the recommended water conservation programs on the City's projected water demand assuming the "good economy" water demand projection previously described. Implementation of the recommended water conservation programs reduces the volume of additional water the City must produce to meet its self-sufficiency goals from approximately 6,500 AFY down to approximately 5,000 AFY. While water conservation alone will not enable the City to meet its water self-sufficiency goal, it can significantly reduce the volume of additional water supply required.

Figure 3-3 Water Demand Reduction from Recommended Conservation Programs



While conservation programs are often less expensive than physically constructing and operating new water supply or treatment facilities, the noted reductions in projected water demand are not without a cost. For the City, these costs include the cost of the actual conservation program, increased staff and public outreach costs associated with new program implementation and management, and the associated loss in water sales revenues (this latter component is partially offset by reduced water supply production costs). Based on the City's current demands and water revenues, it is estimated that the total cost for the recommended water conservation program reflected in Table 3-3 is approximately $7.2 million through 2020.

Section 4: Current Water Sources and Supplies

The City's current water supply consists of groundwater, purchased imported water, and a small amount of recycled dry weather urban runoff. Historically, groundwater made up the majority of the City's water supply portfolio; however, in 1995 when methyl tertiary butyl ether (MTBE) contamination was discovered in the Charnock Sub-basin, a sub-basin of the Santa Monica Basin, the City was forced to shut down five groundwater wells and purchase the majority of its water supply from MWD. In addition to local groundwater and purchased imported water, the City treats a small volume of dry weather urban runoff, yielding a source of recycled water that can be used for landscape irrigation and other approved uses, such as toilet flushing. With groundwater production from the Charnock Sub-basin renewed, local groundwater supplies makes up approximately two-thirds of the City's water supply, with the balance coming from the purchase of imported water form MWD.

4.1 Imported Water

In recent years, the main source of potable water supply for the City has been imported water purchased from MWD. MWD receives a negotiated allotment of water from the Colorado River and the Sacramento-San Joaquin Delta. These allotments are then distributed among its 26 member agencies which are comprised of municipalities and water agencies located throughout southern California.

The City has a current Tier 1 rate allocation of 11,515 AFY of water through MWD. Tier 1 water corresponds to the amount of water the City is entitled to purchase at the Tier 1 rate. MWD Tier 2 water is also normally available to the City; however, the cost per acre-foot is higher and there is less availability and reliability of Tier 2 water in periods of drought. The City has routinely exceeded its Tier 1 entitlement in recent years due to inactivity of many of its wells. As a result of this inactivity, imported water has made up, on average, 85 percent of the City's total water supply up until recently when local groundwater production was reinstated. Table 4-1 shows the City's imported water purchases since 2005.

Table 4-1 Historical Imported Water Supply

Year	Purchases (AF)
2005	12,671
2006	13,216
2007	13,017
2008	12,323
2009	11,685
2010	9,812
2011	6,388
2012	6,550
2013	5,842

Source: City of Santa Monica Water Resources

MWD provides water to the City through two separate turnouts. Transmission pipelines convey water to two separate reservoirs. The individual and total capacities of these 24-inch connections are shown in Table 4-2.

Table 4-2 Santa Monica's MWD Connection Capacities

	SM-1	SM-2	Total Capacity
Capacity (AFY)	21,720	18,100	39,820

Source: City of Santa Monica Water Resources Division.

4.1.1 Characteristics and Challenges

Fluctuation of available imported supply and drought conditions have and will likely continue to impact southern California's water supply. Imported water is both expensive and variable, and in times of drought, becomes even more scarce and uncertain. To compound the reduced availability of water during times of drought, drought conditions also increase water demand due to increased outdoor water use. The reliability of imported MWD water is a major source of concern and risk for most water agencies, and an important element of the City's self-goal for self-sufficiency.

4.1.2 Reliability

The reliability and availability of MWD water is affected by a large number of factors that are difficult to control and will, in all likelihood, continue to impact California well into the future. With heavy reliance on imported water, the City must examine the various risk elements associated with that supply. This assessment of risk is essential in understanding the importance of developing a water resources plan. Although the City's imported water supplies have been fairly reliable in the past, a number of factors suggest that it will become more difficult to ensure that imported water remains reliable in the future.

Foremost among the risk factors associated with this supply is the magnitude of competing interests for imported water from the State Water Project (SWP) and the Colorado River. This demand, coupled with periods of below-normal rainfall, have resulted in supply shortages over the past 30 years and culminated in a State drought declaration in June 2014. While the requirements of SBx7-7 may support a suppression of future demands, overall growth in southern California will continue to strain the reliability of MWD's water supply for the City.

In spite of the uncertainty present in imported water, the City receives a relatively reliable source of water through MWD. The City has exceeded its Tier 1 entitlement of MWD water frequently in the past ten years and has not had significant reliability problems. It is unclear how the current drought will affect the historical level of reliability in the coming years.

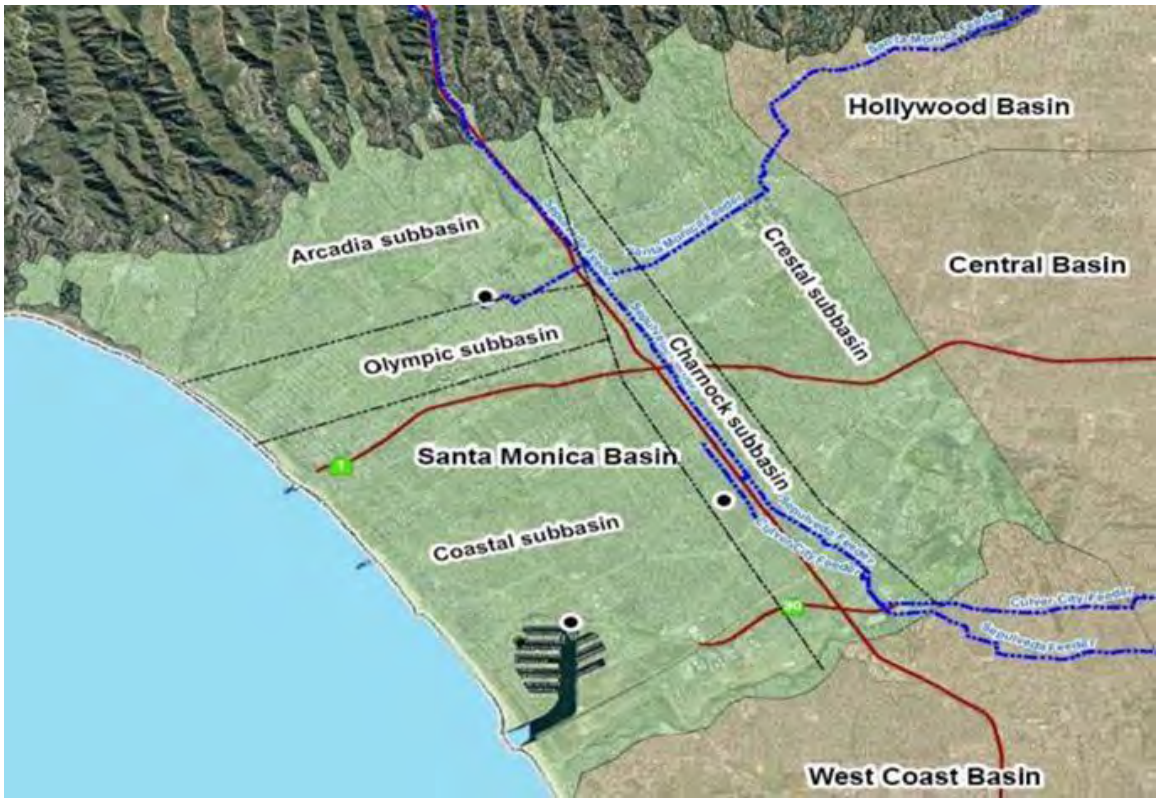
4.2 Local Groundwater

Local groundwater represents both an existing source of potable water as well as a potential source of future potable water supply. Local groundwater has, until recently, been underutilized due to the shutdown of five Charnock wells that reported MTBE contamination in 1995. Due to

the completion of MTBE remediation efforts in February of 2011, the City has been able to bring the five Charnock wells back online.

The City obtains its groundwater supply from the Santa Monica Basin (Basin). The Basin is located in western Los Angeles County and overlies the entire City of Santa Monica, Culver City, Beverly Hills, and portions of western Los Angeles. The Basin has a surface area of 50.2 square miles and consists mostly of flat to mildly hilly terrain. The basin is bounded by impermeable rocks of the Santa Monica Mountains to the north, the Ballona Encarpment (Bluffs) to the south, the Newport-Inglewood fault to the East, and the Pacific Ocean to the West. Extensive faulting within the Basin separates it into five sub-basins as shown on Figure 4-1.

Figure 4-1 Santa Monica Basin with Subbasins



Groundwater in the Basin is replenished primarily from recharge at the basin/mountain interface. Since the Basin is mostly urbanized and soil surfaces have been paved to construct roads, buildings, and flood channels, only a small portion of basin soils are capable of transmitting water to the water-bearing formations below.

The City has historically pumped a long-term average volume of groundwater of 4,277 AFY. The historical combined capacity of the City's five wells located in the Charnock Sub-basin has been approximately 9,000 gallons per minute (GPM). An additional five wells, two in the Arcadia Sub-basin and 3 in the Olympic Sub-basin, remained online when the Charnock wells were shut down, and had the ability to produce approximately 3,300 GPM. These five wells have been

responsible for approximately 1,950 AFY, or 13 percent of the City's water supply. In total, the City has the ability to pump groundwater at a rate of approximately 10,600 GPM. Table 4-3 shows the capacity of each of the City's groundwater wells.

Table 4-3 Groundwater Well Capacities

Well Name/No.	Sub-basin	Capacity (GPM)
Charnock 13	Charnock	1,800
Charnock 16	Charnock	1,675
Charnock 18	Charnock	1,675
Charnock 19	Charnock	1,840
Charnock 20	Charnock	1,330
Arcadia 4	Arcadia	250
Arcadia 5	Arcadia	180
Santa Monica 1	Arcadia	250
Santa Monica 3	Olympic	820
Santa Monica 4	Olympic	800
	Total Capacity	**10,620**

Source: City of Santa Monica Water Resources. Capacities are average values and vary over time.

4.2.1 Characteristics and Challenges

One common problem for coastal groundwater basins is salt water intrusion. Salt water intrusion can occur for a number of reasons, but the most common cause is associated with over pumping of the local groundwater basin. While there is no definitive estimate of the safe yield for the Santa Monica Basin and its five sub-basins, historical pumping/rainfall data and groundwater levels suggests that the Basin has an average perennial yield of approximately 19,000 AFY. The City and other pumpers of this Basin have not approached this level of pumping of the Basin as a whole during its long history of groundwater use.

Although there has been no problem with salt water contamination of the Basin, the City has faced problems with the level of brackish water extracted from much of the Basin. It is for this reason that the City abandoned its well production facilities near the ocean. For long-term management of water quality, the City has implemented and maintains a blending plan to ensure that water quality meets federal and state drinking water standards.

4.2.2 Reliability

The Basin receives inflow from the Santa Monica Mountains as well as percolation from rainfall events. Outflow occurs in the form of withdrawal by the City and outflow to the West Coast Basin. Outflow to the West Coast Basin has historically been minimal and is estimated to be about 1,000 AFY. Additional outflow to the neighboring Central Basin and Hollywood Basin are negligible due to natural restriction by the Newport-Inglewood uplift.

Due to the inflows received from the Santa Monica Mountains and limited outflows to other basins, the Basin is not significantly affected by dry seasons, as is the case with some neighboring basins.

4.2.3 Sustainable Groundwater Management Act of 2014

In response to the effects of the ongoing drought, the Sustainable Groundwater Management Act of 2014 (SGMA) fundamentally alters the management of groundwater basins in California. SGMA requires the designation of groundwater sustainability agencies (GSAs) by one or more local agencies and the adoption of groundwater sustainability plans (GSPs) for basins designated as medium- or high-priority by the Department of Water Resources (DWR). SGMA excludes adjudicated groundwater basins managed by the court and does not affect the water rights of any users. Deadlines are established for the actions required by SGMA. SGMA grants significant new powers to GSAs, including the power to adopt rules, regulations, ordinances, and resolutions; regulate groundwater extractions; and to impose fees and assessments. SGMA also allows the State Water Resources Control Board to intervene if local agencies will not or does not meet the SGMA requirements.

The Basin is expected to be designated as a medium priority basin. Because the City's recommended future water supply portfolio includes expanded use of groundwater in the Santa Monica Basin, SGMA provides the City with an opportunity to manage the Basin or its key sub-basins to sustain the City's expanded use of groundwater. Accordingly, it is recommended that the City develop a roadmap to be designated as the GSA for all or part of the Basin. Through its previous and ongoing hydrogeologic studies, the City has developed much of the information necessary to prepare the required GSP. Additional documentation related to the Sustainable Groundwater Management Act of 2014 is provided in Appendix C.

4.3 Non Potable Water

To protect the Santa Monica Bay from contamination caused by pollutants found in dry weather urban runoff –runoff that occurs when there is no measurable precipitation as a result of human activities such as landscape irrigation and car washing – the City built the Santa Monica Urban Runoff Recycling Facility (SMURRF). The SMURRF project produces a small volume of high-quality recycled water that is used to offset potable water demands for landscape irrigation and indoor plumbing. Designed to routinely treat 0.5 MGD, with a peak treatment capacity of 0.75 MGD, the SMURRF removes urban contaminants and treats the influent water to Title 22 state standards for tertiary water. The water is then pumped through a city wide distribution system that serves parks, medians, Woodlawn Cemetery and some dual-plumbed buildings.

The SMURRF has allowed the City to slightly reduce its reliance upon MWD water at a time when the City relied heavily upon imported water due to the lack of production from groundwater wells. However, dry weather urban runoff is an unstable supply, the focus of this facility has been predominantly water quality improvements to Santa Monica Bay. Historically SMURRF has had an average production of 154 AFY, with a high of 354 AFY and a low of 94 AFY.

4.4 Water Self-Sufficiency Supply Requirements

Prior to City Council's adoption of the goal for water self-sufficiency, all water supply planning documents, including the 2010 UWMP, assumed that imported water from MWD would make up a significant portion of the City's annual water supply.

Table 4-4 compares the total source water required to meet the City's self-sufficiency goal (Section 3.2, Table 3-2) to water supply projections that assume the City will maximize its current groundwater treatment capacity (9,000 AFY) while not relying on imported water from MWD. As shown, in order to become independent from imported water the City will need to significantly enhance current water production sources, develop new water supply sources, and/or significantly reduce water demand through very aggressive and proactive water conservation programs. Not shown herein is the additional supply lost as brine during the water treatment process. A discussion of the various challenges, opportunities, and strategies associated with meeting the City's self-sufficiency goals are provided in Section 5.

Table 4-4 Comparison of Projected Local Production Needs and Availability

	2015	2020	2025	2030	2035
Projected Production Needs(AF)[(a)]	**15,120**	**15,488**	**15,860**	**16,232**	**16,261**
Existing Supply (AF)					
Imported (AF)	0	0	0	0	0
Groundwater (AF)	9,000	9,000	9,000	9,000	9,000
Recycled Water (AF)[(b)]	150	150	150	150	150
Total Existing Supply	**9,150**	**9,150**	**9,150**	**9,150**	**9,150**
Difference Between Existing Supply Capabilities and Needed Production	*(5,970)*	*(6,338)*	*(6,710)*	*(7,082)*	*(7,111)*

(a) Demand normalized for the 90th percentile unemployment rate (i.e. "good economic conditions," in which the unemployment rate is lower than 4.1 percent 90 percent of the time). Does not include demand reductions that will be achieved by the City's water conservation program as it works to meet SBx7-7. Includes water loss; assumes 9 percent system wide water loss based on the results of the City's AWWA Water Loss Audit.

(b) Based on current average annual SMURRF production.

As previously discussed, total long-term water supply needs will vary with the development and implementation of various water conservation programs, the volume of water lost during the local water treatment process and the change in seasonal water demand and production requirements from peak summertime water use. Accordingly, as the City continues to develop its long-term water supply portfolio, these production related factors will need to be integrated with new information associated with the sustainable recharge of the City's local groundwater aquifers.

Section 5: Future Water Supply Options and Strategies

Having projected future water demands and quantified the potential benefits from enhanced water conservation programs, it was determined that the City can't meet its self-sufficiency goal through water conservation alone. Accordingly, additional local water resources are required to avoid purchasing imported water from MWD. This Section evaluates alternative supply sources and develops a set forth a set of options or portfolios for the City to consider for implementation to meet its self-sufficiency objectives. The water resources explored herein included:

- Additional local groundwater production and treatment
- Non-potable reuse opportunities
    - Rainwater harvesting and stormwater capture
    - Greywater
    - Recycled Water
- Multi-jurisdictional agreements

As discussed with City staff, the water resource that has the greatest potential as a viable, cost effective strategy for self-sufficiency is enhanced groundwater production. A discussion of local groundwater opportunities and other water resources options follows.

5.1 Additional Local Groundwater Opportunities

The City obtains its local groundwater from the Santa Monica Basin (Basin). There are multiple sub-basins within the Basin, each of which provides separate groundwater opportunities to the City. The five sub-basins which make up the Santa Monica Basin are the Arcadia, Olympic, Coastal, Charnock and Crestal sub-basins.

Currently, the City obtains local groundwater from the Arcadia and Olympic sub-basins via five wells. These wells can produce approximately 3,000 acre feet per year (AFY). Additionally, there are five wells located outside of the City limits in the Charnock Sub-basin with a combined average production capacity of approximately 6,000 AFY. From 1995 to 2010, the City purchased most of its annual water supply needs from MWD as the Charnock well field was shut down due to methyl tertiary butyl ether (MTBE) contamination. Water produced from these wells is delivered for polishing at the City's Arcadia Water Treatment Plant (Arcadia WTP).

The Arcadia WTP, located at Wilshire and Bundy, is just north of the City's municipal boundary in the City of Los Angeles. This modern plant facility provides pretreatment, filtration via a three-stage reverse osmosis (RO) filtration system, aeration and storage for the City's customers. The design capacity of this facility with three RO units in operation is approximately 9,000 AFY. Under this operational plan, the City is able to rotate the 4th RO unit into production for maintenance of the other three vessels. While not sustainable on a 24 hours/day, 7

days/week, 365 days/year basis, the design capacity of the WTP with four units in operation is approximately 13,000 AFY.

There have been a number of studies performed over the years to provide some clarity for the potential long-term yield from the Basin. In 2011 the City contracted with Richard C. Slade & Associates, LLC (Slade) to conduct additional research in order to better characterize the Basin and its potential for developing additional groundwater supplies, as well as identify possible locations for new well sites. Results of this study indicate that it is hydrogeologically feasible for the City to develop additional groundwater supplies from the aquifer system(s) that lie beneath the City and surrounding areas. This study (Slade Report) was published in June 2012.

A subsequent study was conducted by Slade in March of 2013 in order to determine the level the Basin can safely be pumped based on existing values from past reports for each of the Basin's main sub-basins, known historical groundwater extractions by the City, and hydrographs prepared for the June 2012 report. Slade's reports suggested that there is approximately 300,000 AF of water stored in the Basin, but that additional long-term data are needed to establish reliable perennial yield estimates. Given this need, the City has budgeted for a Groundwater Management Plan update to be performed over the next few years.

In addition to an upcoming assessment of the Basin, the City has taken a proactive commitment to improve local groundwater recharge. Given the City's urbanized condition, the City has incorporated the need for long-term aquifer recharge as a component of the City's water supply self-sufficiency plan. This recharge could come in the form of recharge from a local wastewater treatment plan, ocean desalination, brackish water treatment, additional rain water capture and treatment, and other potential supply programs to support a local seawater barrier intrusion program or sub-basin specific recharge. The merits of these programs will be evaluated over time through the implementation of the SWMP.

As identified in the Slade Report, there are some opportunities for siting new production wells, however, access to groundwater is difficult due to the density of the City. Currently, the City is built out and very little land is available for new wells. For this reason, rehabilitation of existing wells is also a potential method for enhancement of groundwater resources. The following sections describe potential opportunities for enhanced groundwater production in the City.

5.1.1 Charnock Well Field

The City's largest well field is the Charnock well field, which is located approximately 5,000 feet southeast of the southeastern boundary of the City in the Charnock Sub-basin. Though only five wells are currently active, this site has had 19 wells throughout its history. This well field was also recently brought back online after ten years of inactivity caused by VOC contamination. Treatment facilities were put in place at the site to treat the groundwater for VOC contamination prior to pumping it to the Arcadia WTP for further treatment. The Charnock Sub-basin is also the City's most productive well field. Though no formal study has been conducted, listed or original flow values for wells in this well field suggest transmissivity values of between 15,400 gpd/ft to 380,800 gpd/ft (Slade), which is relatively high in comparison to the other sub-basins in the Basin.

Existing wells in the Charnock well field are currently capable of extracting between 1,330 and 1,840 gpm. Casing depth in those wells ranges from 380 to 510 feet below ground surface (fbs). These wells are operated as necessary using variable frequency drives (VFDs) to serve variable plant demand. Under normal operation, four of the five wells are operating at one time. Wells are cycled on and off to keep well locations healthy and prevent over pumping of well locations. Though VOC treatment facilities would need to be expanded, enhancement of groundwater production in the Charnock Sub-basin could come in the form of increased frequency of extraction or additional well sites. While data are insufficient to quantify the safe yield of this basin with certainty, it is believed that the short term safe pumping yield is approximately 6,880 to 8,200 AFY.

5.1.2 Santa Monica Well Field (Olympic Sub-basin)

The Santa Monica well field is located along and around Olympic Boulevard in what is sometimes referred to as the Olympic Corridor. This well field is part of the Olympic sub-basin. As many as seven wells have been constructed in this well field, with only two remaining in operation today. Those two wells are Santa Monica #3 (SM 3) and Santa Monica #4 (SM 4). Though not a part of the Olympic Sub-basin like SM 3 and SM 4, Santa Monica #1 (SM 1) is also considered a part of the Santa Monica well field. Listed or original flow values for wells in this well field suggest that the transmissivity values in the Olympic aquifer are between 13,800 gpd/ft to 90,800 gpd/ft (Slade), which are well below what is estimated for the Charnock well field, but still more productive than the Arcadia Sub-basin.

Existing wells in the Olympic Corridor produce between 750 and 850 gpm under normal operation. SM #1 is continually operated and pumps in the range of 250 gpm. Casing depth for SM 3 and SM 4 are 530 and 550 fbs respectively. SM 3 and SM 4 are both operated using VFDs as necessary to serve plant demand. Additional investigation would be necessary to determine impacts upon the basin and potential water quality issues in order to extract additional flow from each of these wells.

5.1.2.1 Olympic Sub-basin Management Plan

It should be noted that groundwater quality in the Olympic Sub-basin has been adversely impacted from several overlying industrial users over the years. Over the last several years, the City has pursued relief from these responsible parties. Appropriate agreements and administrative orders have been attained and a settlement reached to support the cleanup of the Olympic well field. The process and findings associated with this effort are contained in the *Olympic Well Field Management Plan (ICF international 2012).*

In light of statewide and regional challenges to the supply and availability of imported water, the City's sustainability goals rely significantly upon becoming as self-reliant as possible with respect to its water supply portfolio. Consequently, it is the City's current plan to consider maximizing the production from all of its groundwater basins and supplement with imported water only as needed. As such, the City intends to not only continue to pump groundwater at its current level of 1,500 gpm, but evaluate the feasibility of increasing yield from the Olympic Well Field.

Under this plan, it is likely that groundwater production in the Olympic Well Field will increase over the next several years and be treated at the new Olympic Water Treatment Plant. The City recently commissioned a Preliminary Design Report, Olympic Water Treatment System, to evaluate options for building and operating a new facility to treat groundwater produced from the *Olympic Well Field (Worley Parsons 2012)*. The construction and operation of the facilities needed to mitigate the groundwater contamination in the Olympic Sub-basin are to be funded from settlement funds, and not an obligation of the Water Fund and the City ratepayers.

5.1.3 Arcadia Well Field (Arcadia Sub-basin)

The Arcadia well field is located at the Arcadia WTP just outside of the eastern edge of the City at Bundy Drive and Texas Ave. As many as ten wells have been drilled at this location with only two, Arcadia #4 and #5, remaining in operation today. Though it is not located within the Arcadia well field, Santa Monica #1 is also located in the Arcadia Sub-basin.

Degradation of this well has led to significantly decreased yields. To illustrate the capacity degradation of SM #1, when it was originally drilled it produced a yield of 850 gpm, more than three times the current yield. Due to the lack of production as well as quality issues experienced at SM #1 the City has considered re-drilling this well. Successful re-drilling of this well could provide several hundred additional AFY to the City.

5.1.4 Coastal Sub-basin

The Coastal Sub-basin underlies the southern portion of the City. This sub-basin has not been utilized as a groundwater source to date due to salt water intrusion, and the high cost of additional treatment that would be required to utilize this water source. In the 2012 Slade Report, Slade did consider additional production from this sub-basin and estimated various production parameters and site possibilities. The potential for additional groundwater production facilities has been programmed in the City's self-sufficiency plan.

5.1.5 Crestal Sub-basin

The City does not overlay the Crestal Sub-basin and has not and does not produce any of its water supply from this sub-basin. Given that condition, Slade did not consider this sub-basin in its 2012 study. Given the sub-basin location, probable inferior water quality, and lack of viable production data by other agencies, no groundwater production facilities have been programmed in the City's self-sufficiency plan from this sub-basin.

5.2 Non Potable Reuse

5.2.1 Recycled Water

Recycled water is a growing water resource in California. As local water supplies and the availability of imported water become more stressed, many agencies have explored and invested in recycling as a local and sustainable water resource. The City has used SMURFF in this capacity, albeit limited over the years.

For most applications, water recycling means treating wastewater so that it can be safely used for irrigation and some industrial purposes. In some cases this resource is also used for open reservoir augmentation, groundwater replenishment, and groundwater management as a barrier against seawater intrusion. Since the City's wastewater is conveyed to the City of Los Angeles for treatment, the City does not have immediate access to recycled water in the City, and must deliver this resource from outside the City. A general discussion of the regulatory requirements and other non-potable elements is included in Appendix D. A discussion of the applicability of this resource as a component of the City's water resources portfolio follows.

5.2.1.1 Analytical Approach

A market assessment was performed in order to determine the potential for additional recycled water use within the City. The assessment combined results of a billing data analysis with a GIS analysis to identify potential recycled water customers and estimate total potential recycled water demand within the City. Once customers were identified, a conceptual recycled water distribution system was developed in order to estimate preliminary costs associated with expanded recycled water distribution in the City.

5.2.1.1.1 Results

Billing data from fiscal year 2011/2012 were sorted and analyzed to provide information regarding specific uses and patterns among each of the City's billing classifications with the intent of identifying potential recycled water customers. Results of the billing analysis indicated that the greatest potential for recycled water use exists among the City's non-residential and residential dedicated landscape irrigation customers, with additional potential among some of the City's commercial customers, specifically for use within cooling towers. Use of recycled water by large industrial customers was not considered because the City does not have any large industrial water customers.

The City has 451 dedicated landscape irrigation accounts, or accounts with a separate meter used for landscape irrigation purposes only. Of these, 267 are classified as residential landscape accounts and the remaining 184 accounts are classified as non-residential, including commercial, public school, and City landscape uses. Table 5-1 summarizes this water use for the City's dedicated landscape irrigation accounts.

Table 5-1 Summary of Dedicated Landscape Irrigation Water Use

Account Type	Number of Accounts	Annual Water Use (AF)
Residential	267	94
Non-Residential	288	357
Total	**555**	**451**

Billing data for the City's dedicated landscape irrigation accounts were combined with parcel data from the City's GIS to spatially identify the City's dedicated landscape irrigation customers. Each account was classified by its annual water use into five different water use categories (Residential 0-5 AFY, Non-Residential 0-5 AFY, Non-Residential 5.1-9 AFY, Non-Residential 9.1-34 AFY). This was done in order to locate clusters of large water users within the City where

recycled water could be most cost-effectively delivered. Results of this analysis indicate that the City's largest dedicated landscape irrigation customers are located in the southern half of the City, south of the current SMURRF recycled water distribution system between Ocean Avenue and the Santa Monica Airport.

A conceptual recycled water system was developed that could serve the majority of the City's largest dedicated landscape irrigation customers with recycled water. The system utilizes and expands upon the existing SMURRF distribution system, receiving water from the City of Los Angeles's potential westside recycled water distribution system located to the southeast of the City. In order to estimate the amount of recycled water the conceptual system might be able to deliver, as well as develop a preliminary cost estimate, the conceptual system was divided into seven separate demand areas. Recycled water demand was estimated by selecting the dedicated landscape irrigation customers located within each demand area using GIS and totaling their annual demand. A preliminary cost estimate was developed by estimating the daily flow rate and velocity for each pipe segment in order to estimate an appropriate pipe diameter. Once the pipe diameter was determined, cost estimates were developed based on estimates of the length of pipe needed to construct the system.

The total estimated water demand for the conceptual recycled water distribution system is 390 AFY. The estimated demand consists of 290 AFY of demand from current customers, including existing SMURRF recycled water customers, and an additional 100 AFY of future opportunities. Table 5-2 shows the parameters used to determine the pipe diameter for each pipe section.

Table 5-2 Conceptual Recycled Water System Pipeline Network

Service Area	Demand Area	Demand (AFY)	Demand (Gal/Day)	Hrs/Day	Flow Rate (gpm)	Flow (cfs)	Pipe Diameter (in)	Area (sq. ft)	Velocity (fps)
A	Trunk Line to SMURF[(a)]	113	100,880	8	210	0.5	12	0.8	0.6
B1	South Airport Branch	26	23,211	8	48	0.1	2	0.0	4.9
B2	North Airport Branch	38	33,924	8	71	0.2	4	0.1	1.8
C	Neilson Ave Branches	58	51,779	8	108	0.2	4	0.1	2.8
D	Virginia Avenue Park Branch	16	14,284	8	30	0.1	2	0.0	3.0
E	Broadway Branch	28	24,997	8	52	0.1	2	0.0	5.3
F	Colorado Ave Branch	7	6,249	8	13	0.0	2	0.0	1.3
Subtotal		*290*							
Additional Future Demand		100							

Service Area	Demand Area	Demand (AFY)	Demand (Gal/Day)	Hrs/Day	Flow Rate (gpm)	Flow (cfs)	Pipe Diameter (in)	Area (sq. ft)	Velocity (fps)
Total Recycled Water Demand		**390**							

(a) Based on demand for existing SMURRF customers and new customers along proposed route.

Table 5-3 provides details regarding the cost estimate. In total, it is estimated that the cost to develop a new recycled water source for the City of Santa Monica is $12,699,600, including $1,638,000 in piping, 50 percent of the cost of the transmission main between West Basin's potential westside recycled water distribution system (estimated at $5.5 million), and a booster station with an estimated cost of $2 million. Thus, the total estimated cost to deliver recycled water to the City would be $32,560 per acre-foot – more than 32 times the current MWD Tier 2 cost for treated imported water. However, the receipt of grant funds and participation in MWD's Local Resources Program could mitigate this cost.

Table 5-3 Conceptual Recycled Water System Cost Estimate

Demand Area	Description	Cost ($/in Diameter)	Pipe Diameter (in)	Cost/ Linear Foot	LF	Total Cost	Demand (AFY)	Cost/AF
A	Trunk Line to SMURF	14	12	$168	15,000	$2,520,000		
	Misc. Branches	14	2	$28	500	$14,000		
					Area A Subtotal	**$2,534,000**	113	**$22,425**
B1	South Airport Branch	14	2	$28	4,400	$123,200		
	Misc. Branches	14	2	$28	500	$14,000		
					Area B1 Subtotal	**$137,200**	26	**$5,277**
B2	North Airport Branch	14	4	$56	4,500	$252,000		
	Misc. Branches	14	2	$28	500	$14,000		
					Area B2 Subtotal	**$266,000**	38	**$7,000**
C	Neilson Ave Branches	14	4	$56	7,700	$431,200		
	Misc. Branches	14	2	$28	500	$14,000		

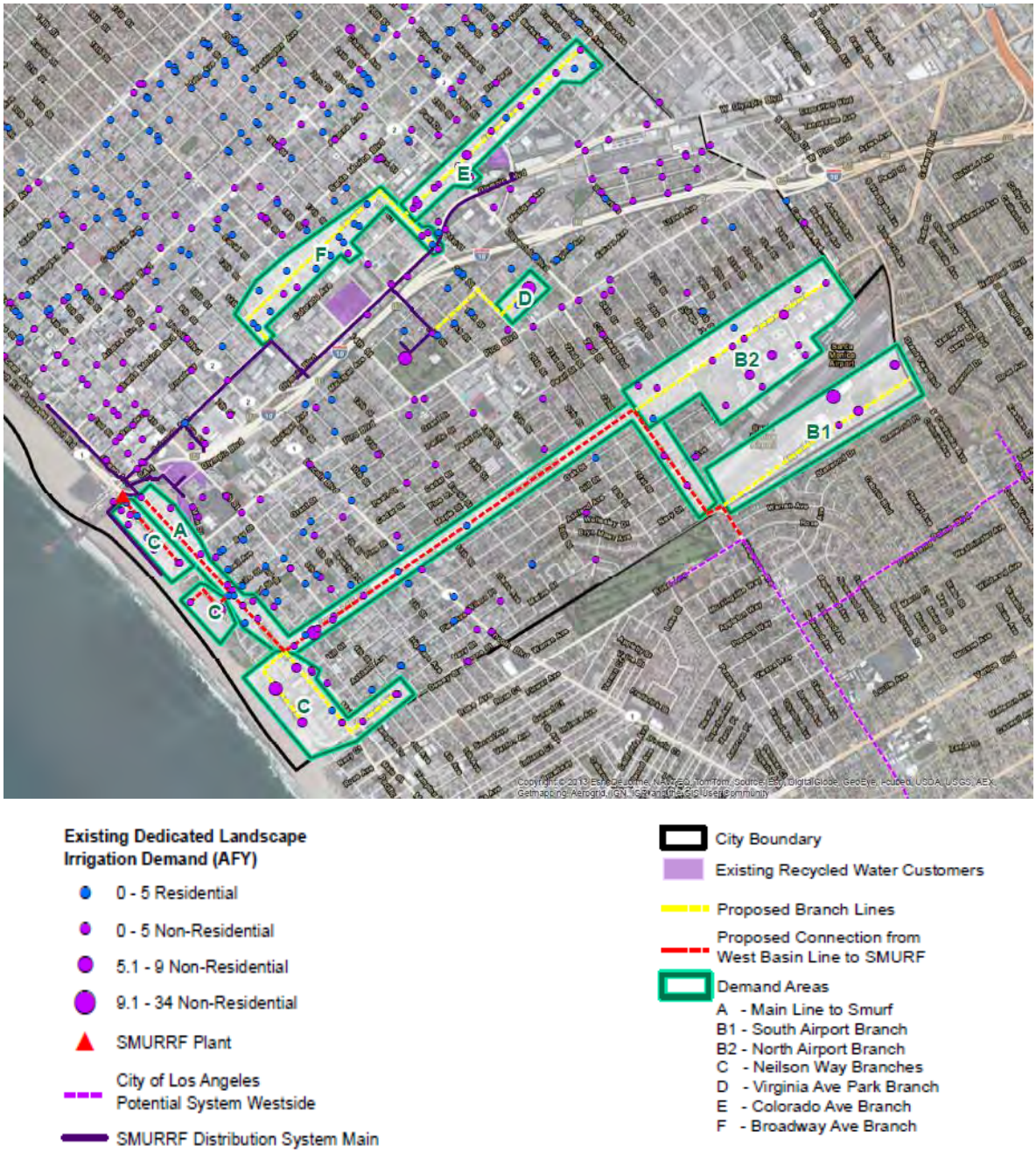
Demand Area	Description	Cost ($/in Diameter)	Pipe Diameter (in)	Cost/ Linear Foot	LF	Total Cost	Demand (AFY)	Cost/AF
					Area C Subtotal	**$445,200**	58	**$7,676**
D	Virginia Ave Park Branch	14	2	$28	700	$19,600		
	Misc. Branches	14	2	$28	500	$14,000		
					Area D Subtotal	**$33,600**	16	**$2,100**
E	Broadway Branch	14	2	$28	4,700	$131,600		
	Misc. Branches	14	2	$28	500	$14,000		
					Area E Subtotal	**$145,600**	28	**$5,200**
F	Colorado Ave Branch	14	2	$28	58,000	$1,624,000		
	Misc. Branches	14	2	$28	500	$14,000		
					Area F Subtotal	**$1,638,000**	7	**$234,000**
Total All Demand Areas						$5,199,600	290	$17,930
Transmission Main (50% of LADWP Estimated Cost)						$5,500,000		
Booster Station Estimate						$2,000,000		
Total Estimated Cost						$12,699,600	390	$32,560

Currently, the City distributes approximately 85 AFY of recycled urban runoff to customers for landscape irrigation and indoor commercial use through the SMURRF and associated distribution system. The City does not operate a wastewater treatment plant and thus does not have a local source for additional recycled water supplies. However, the City could partner with adjacent agencies that currently produce recycled water in order to bring additional recycled water supplies to its customers. The West Basin Municipal Water District (WBMWD) operates a recycled water system that terminates near Marina Del Rey, which may provide the City with a potentially feasible source for recycled water. The Los Angeles Department of Water and Power (LADWP) also looked into utilizing this source and prepared a plan that suggests a potential for connection at this same location.

A recycled water market assessment was performed to estimate the potential for recycled water use within the City. Results of this assessment indicate that approximately 350 AF of recycled water could be used by the City's dedicated landscape irrigation customers that reside along some key corridors into the City. Figure 5-1 shows a potential recycled water distribution

system that focuses on delivering year-round recycled water to the City's existing SMURRF facility and serves a number of customers along the way.

Figure 5-1 Potential Recycled Water System Map



In this potential system, the City may be able to partner with LADWP to jointly fund a new transmission and pumping system that connects to the WBMWD line and bring recycled water to the southeast side of Santa Monica (Figure 5-1). This project would require approximately 5

miles of pipeline to connect to its point of termination. Establishing the partnerships and agreements necessary to make this type of inter-agency program a reality will require time and funding. Accordingly, this option should be considered a long-range strategy for the City. It is unlikely that the City could deliver additional recycled water to its customers before 2020.

5.2.1.2 Stormwater and Rainwater Harvesting

Rainwater harvesting is the accumulating and storing of rainwater for reuse before it reaches the groundwater. Rainwater harvesting can ensure an independent water supply for activities such as irrigation and other non-potable uses. This helps to offset potable water demands by ensuring a renewable source during regular and water restrictive times. In addition, it produces beneficial effects by reducing peak storm water runoff and related processing costs. In municipalities with systems, reducing storm runoff is especially important, because excess runoff during heavy storms leads to the discharge of raw sewage when treatment plant capacity cannot handle the combined flow.

This alternative was evaluated as a water supply option for offsetting potable water demand in addition to reducing the amount of polluted storm water runoff from entering the Santa Monica Bay. The City actively promotes the use of rainwater for landscape irrigation through numerous free workshops for professionals and homeowners in addition to rebates for rain barrels and cisterns. In the recent years, the City initiative has been very successful in promoting rebates on rain harvesting products and the City has been awarded grant funding from the California Department of Water Resources.

Rainwater harvesting (the capture and onsite use of rainwater for landscape irrigation purposes) offers minimal opportunity as an additional water supply within the City. Santa Monica's Mediterranean climate is characterized by seasonal rainfall, with the majority of rain falling in the winter months of November through March. Conversely, landscape water demands are highest in the warmer, drier months of April through September. Analyses were performed to evaluate and compare the potential for rainwater harvesting based on average monthly precipitation data and monthly landscape water demand for residential and commercial customers.

Results of the above analysis indicate that the potential for rainwater harvesting as a supply option in Santa Monica is limited by the large size of cisterns and customers' motivation to install them. For most residential and commercial customers in the City, space is limited; therefore, it was assumed customers would install no more than 500 gallons of rainwater harvesting capacity. A cistern of this size is depleted quickly, even in the wetter winter months. In the drier summer months, rainwater supply is minimal, and when available, landscape irrigation demand far exceeds the capacity of the cistern therefore depleting this supply rapidly. Residential cistern installation, even with a rebate of $1,000 per cistern, has been minimally accepted by the City's customers. Accordingly, it is estimated that the rainwater harvesting incentive program may provide only 1-2 AFY.

Similarly, a City-wide stormwater capture program offers a seasonal, unreliable additional water supply option for the City. A scenario was developed in which stormwater would be captured and routed through the City's storm drain system to the Santa Monica Urban Runoff Recycling Facility (SMURRF) for distribution to landscape irrigation customers. It is estimated that a City-wide stormwater capture program could generate an additional supply of 160 AFY. The costs for this program are not yet developed. Documentation of the stormwater capture and rainwater harvesting analysis is provided in Appendix E.

5.2.1.3 Greywater

Greywater gets its name from its cloudy appearance and from its status as being between fresh, potable water (known as "white water") and sewage ("black water"). Greywater is generated from domestic activities such as laundry, dishwashing, and bathing, which can be recycled on-site for uses such as landscape irrigation and constructed wetlands. Greywater differs from water from toilets which is designated sewage to indicate it contains human waste.

Since its adoption in 1995, greywater in California has been used as an alternative source for irrigation and other non-potable uses. Through biannual workshops for professionals and homeowners the City has actively promoted its use since 2004. The City rebated three residential greywater systems between 2004 and 2007 and realized that the existing laws made it very difficult and costly for homeowners to install simple systems. Furthermore, few off the-shelf greywater systems were available making it harder for people to comply with the rigorous permitting process. Because of the above reasons the City advocated for changes to the law and with the recent passage of SB 1258, it is now easier for homeowners to reuse this water supply for landscape irrigation. The City began offering rebates for simple greywater systems in 2011. To date, a minimal number of greywater systems have been installed in Santa Monica.

5.2.2 SMURRF Enhancements

As previously discussed, the City owns and operates the Santa Monica Urban Runoff Recycling Facility (SMURRF) to treat small volumes of dry weather urban runoff and deliver this water for irrigation purposes. While the focus of this facility has been predominantly water quality improvements to Santa Monica Bay, the City is considering modifying this facility to be able to produce a more consistent level of non-potable water supply, and fully utilizing the current 500 AFY capacity.

To this end, the City is considering utilizing distributed advanced water treatment technologies (e.g. Reverse Osmosis (RO), ultra and nanofiltration and ultraviolet disinfection) to produce potable quality water. Initially the treated water will be utilized for expanded non-potable reuse (irrigation, toilets, and indirect reuse such as aquifer storage and recovery, and/or salt water intrusion barrier maintenance).

The source water for this increased production is planned from multiple non-potable water sources that are currently underutilized or even wasted to the ocean. Specifically, the plan considers using stormwater, urban runoff and brackish/saline groundwater as feed water for the treatment units. The brackish/saline groundwater may be sourced by two extraction wells sited on the beach at existing City maintenance areas, or from existing abandoned wells along the coast. Proceeding under this plan, the City would expand its capture and treatment of stormwater and urban runoff to further enhance its efforts to improve the water quality of Santa Monica Bay and, more specifically, the waters around the Santa Monica Pier.

5.3 Administrative/ Institutional Options

In addition to the additional local groundwater production and other non-potable reuse opportunities, the City may be able to avail itself of other opportunities for water deliveries or exchanges through multi -jurisdictional agreements with nearby agencies. While the mechanics

and opportunities associated with such an arrangement are not defined herein, it is believed that the City could benefit from water resource options of this nature. Similar to the development and implementation of a large scale non-potable system, establishing the partnerships and agreements necessary to make this type of inter-agency program a reality are unlikely to deliver additional water to the City before 2020.

Although these opportunities are difficult to identify at this time, it is recommended that the City pursue these opportunities on a case-by-case basis. These opportunities may take a significant time to develop: however it would allow the City to benefit from the economy-of-scale and share development risks with other agencies. As successful opportunities are developed, the recommendations contained in this SWMP can be adjusted accordingly.

5.4 Water Self-Sufficiency Portfolios

As shown on Figure 5-2, implementation of the strategies described herein suggest that the City can meet its self-sufficiency goal through a combination of water conservation programs, additional local groundwater production, and additional supplies from rainwater harvesting and City-wide stormwater capture. In the future, the City may also be able to establish additional recycled water supplies through inter-agency partnerships with adjacent water agencies and municipalities. Figure 5-3 presents three different options for obtaining water self-sufficiency. Details for each option are presented in this section.

Figure 5-2 Water Supply and Demand Comparison Including New Supply Opportunities

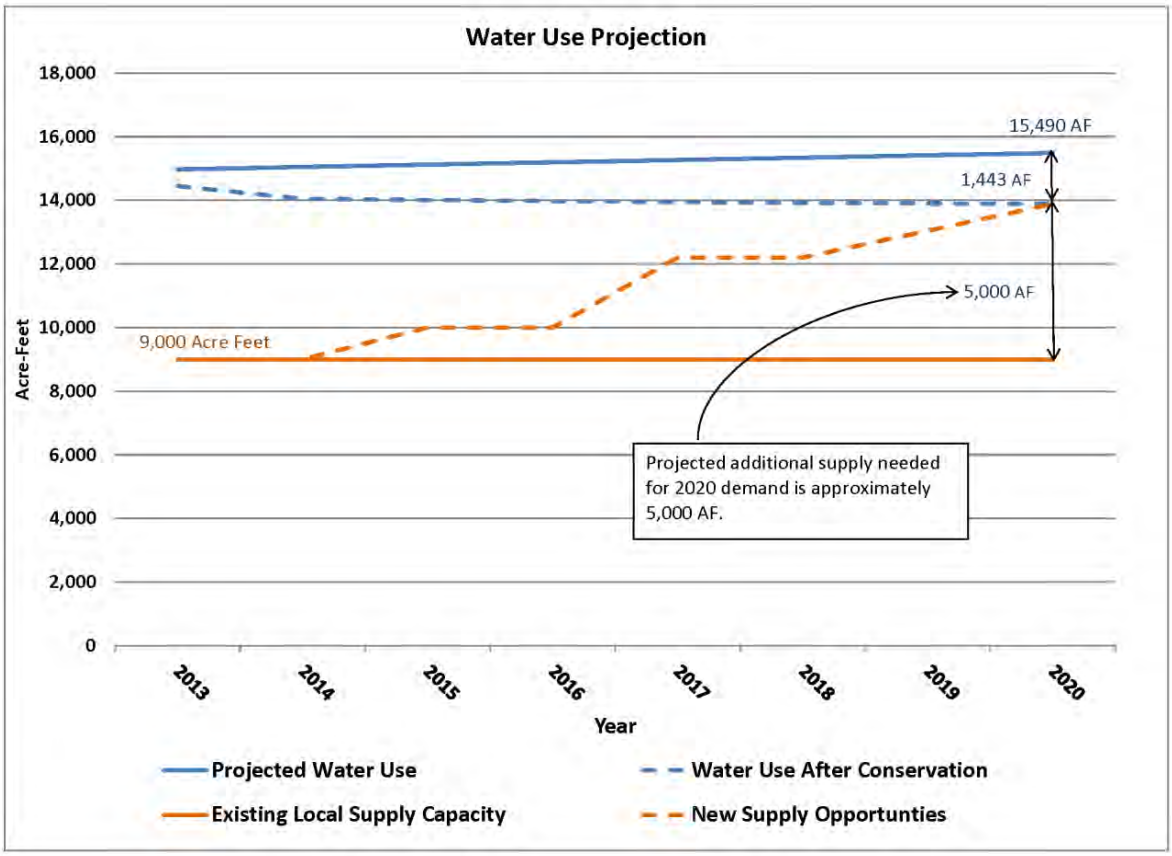
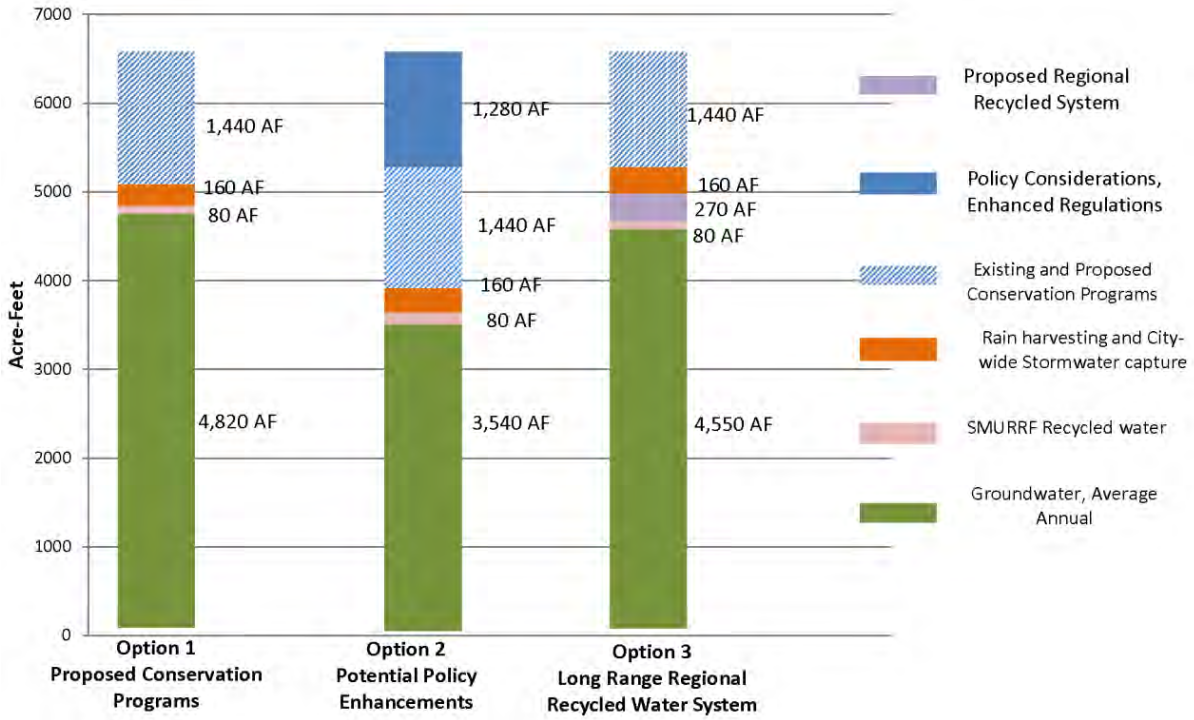


Figure 5-3 Potential Supply/Demand Management Portfolios



5.4.1 Option 1

To implement Option 1, "Staff Recommendation," the City would close the gap of 6,500 AF and achieve water self-sufficiency by 2020 through increased activity in existing water conservation programs, new water conservation programs, establish new groundwater supplies, new rainwater harvesting and stormwater capture programs described above. In this scenario, it is estimated that the City's per capita water use would be 135 gallons per capita per day (GPCD) in 2020. This portfolio should achieve the City's goal of water self-sufficiency by the year 2020, but will fall short of the City's current water use reduction target adopted in the 2010 Urban Water Management Plan (UWMP) in response to Senate Bill x7-7 (SBx7-7). In contrast, the City's adopted target per capita water use in 2020 is 123 GPCD.

The State formula for calculating GPCD is not the standard formula used in the water conservation field. The standard formula divides the water used by the residents by the number of residents. Following this formula, residents are only using 86 GPCD. The State formula divides all the water used by all of the customers (businesses, residents, and landscapes) and divides that by the number of residents. This does not allow the City to include the nearly 250,000 daily visitors to the City in the calculation.

5.4.2 Option 2

To implement Option 2, "Potential Policy Enhancements," the City would close the gap of 6,500 AF, achieve water self-sufficiency and meet the SBx7-7 target of 123 GPCD by 2020 through very aggressive water conservation programs and policies, limited new groundwater supplies, new rainwater harvesting and stormwater capture programs described above. In this scenario, it is estimated that the City's per capita water use would be 123 GPCD in 2020.

In order to reduce demand to levels low enough to permanently achieve a per capita water use of 123 GPCD, 2,880 AF of the City's potable water demand must be reduced or offset by non-potable sources and new regulations requiring residential and commercial property owners to retrofit plumbing fixtures, landscaping with water-saving plants and irrigation, or banning sprinklers and lawns before 2020. Staff is asking for Council's comments on the new policies proposed below by the Advisory Committee for the SWMP. The proposed policies target specific customer categories that have the highest potential for saving water.

- Ban sprinklers and lawns in residential properties - savings 1,280 AFY
- Ban sprinklers in the parkways but allow for hand-watering of street trees
- Require all hotels to retrofit plumbing fixtures to meet the City's current Green Building Ordinance requirements
- Require landscaping to meet the City's current Green Building Ordinance requirements before the sale of the property
- Require City-owned facilities and landscapes to reduce water use

Option 2 could reach the 123 GPCD goal but at a high cost to residents, businesses, and the City to pay for the required retrofits and increased staffing to enforce the requirements.

5.4.3 Option 3

To implement Option 3, "Long Range Regional Recycled Water," the City would develop additional recycled water through regional inter-agency partnerships as a means of reducing potable water use. This option should be considered a long range program and should not be relied upon to meet an adopted per capita water use requirement. As discussed earlier, it is unlikely that these partnerships could be established and the infrastructure completed by 2020.

5.4.4 Recommended Option and City Direction

On May 14, 2013, City staff presented an update on the progress of the Sustainable Water Master Plan and the process and tools developed to allow the Council and the community to evaluate the mix of supply strategies to achieve water self-sufficiency by 2020. Three water supply options were presented, with the following recommendations to Council from City Staff:

1. Direct staff to proceed with the Sustainable Water Master Plan and fully develop Option 1 – "Staff Recommendation." Action: Council directed staff to proceed with Option 1.

2. Review and comment on SBx7-7 water use goal of 123 GPCD and direct staff to change the next Urban Water Management Plan SBx7-7 water use goal from 123 GPCD to 141 GPCD at the UWMP 2015 update. Action: Council chose to continue with the stricter 20 percent reduction of 123 GPCD, and further evaluate this target with the 2015 UWMP.

3. Direct staff to proceed with the water and wastewater rate study. Action: Council directed staff to proceed with the water and wastewater rate studies.

The subsequent sections of this SWMP are based on this direction and are developed to align the City's self-sufficiency and water use efficiency goals. To that end, the two priority elements of the SWMP are:

- The development and construction of additional water supply/treatment through the use of the Olympic Basin settlement funds, and

- Proactively fund and implement the suite of conservation programs identified through the conduct of the SWMP to further reduce water usage prior to 2020.

While these two programs are cornerstone to the success of the City's SWMP, the plan incorporates other peripheral but integral water planning elements to build flexibility into the final water plan. In total, these programs are designed to build additional flexibility in the plan to aid the City in its ability to adapt to the dynamic nature of water system planning and evolving technologies and best management practices that may enhance the City's ability to cost effectively meet its goals for water self-sufficiency and sustainability.

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Section 6: System Hydraulic Analysis

This section discusses the planning criteria used to evaluate the system, the existing system itself, the development of the hydraulic model used to evaluate the system and the findings of the hydraulic model evaluations. The hydraulic model constructed to produce the findings of this section was done using InfoWater, which is a GIS-based modeling and analysis software. The hydraulic system analysis included capacity analysis, storage evaluation and energy analysis.

Kennedy/Jenks used GIS data provided by the City to construct a water distribution model for the City's system to conduct the aforementioned water system analyses, identify hydraulic and operational deficiencies and recommend capital improvement projects for both current and future demand conditions. While the system analysis if summarized herein, Appendix F provides a hydraulic schematic of the existing water system and details of the hydraulic model construction and SCADA calibration process undertaken as part of this master planning effort.

6.1 Planning and Evaluation Performance Criteria

System performance criteria were established and adopted by the City in 1990 and were used to evaluate the existing system, identify deficiencies, and to determine the size of new facilities. Table 6-1 summarizes the criteria for pump stations, storage reservoirs and distribution pipeline facilities. Subsequent sub-sections in this chapter discuss the criteria in more detail.

Table 6-1 Summary of System Performance Criteria

Element	Description
Distribution System	Minimum Pressure:
	− 30 psi during maximum day
	− 20 psi during maximum day plus fire flow
	Maximum Pressure – 150 psi
	Maximum Allowable Velocity:
	− 10 fps for existing pipes under Max Day conditions
	− 5 fps for new pipes under Max Day conditions
	− 15 fps under Max Day and Fire Flow conditions
	Maximum Allowable Head Losses:
	− 5 fps/1000ft under any conditions other than Fire Flow
	Fire Flow Requirements:
	• These requirements are for water system master planning purposes. The Fire Department sets the specific requirements for individual subdivisions.
	• One fire at a time in zone (no simultaneous fires in the same pressure zone).
	Flow Rates and Durations:
	− Single family and low density residential – 1,250 gpm for 2 hours
	− Medium density residential– 2,500 gpm for 2 hours
	− Mixed use and neighborhood commercial – 3,500 gpm for 3 hours

Element	Description
	− High density residential, office, commercial, industrial and schools – 5,000 gpm for 5 hours.
Storage Capacity	Operational Storage:
	− 30 percent of the maximum day demand
	Fire storage:
	− The maximum FF required in a zone times the FF duration for that event
	− Example: 5,000 gpm for 5 hours = 1,500,000 gallons
	Emergency Storage:
	− 50 percent of the maximum day demand
	• The total required storage is the sum of the above three components.
Pumping Capacity	Pumping Capacity:
	− For zones with storage, must be capable of replacing the MDD of a zone over a 16-hour period with the largest pump in the station out of service, also known as the "firm capacity" − For zones with storage, must be capable of replacing the MDD of a higher zone plus the MDD of any lower zone supplied by the upper zone, over a 16-hour period with the largest pump in the station out of service
	− For zones without storage, must be capable of supplying the greater of the peak hour flow using the firm capacity or the fire flow using the total capacity of the pumping station

6.1.1 Distribution System Criteria

The distribution system evaluation criteria specify how the pipes that make up the distribution system should perform. System pressures, velocities and head losses are the major pieces which impact system performance. Acceptable system performance is indicated by each of the elements of the distribution system evaluation meeting the required criteria.

System pressures are generally desired to be above 30 psi under normal and maximum day operation to allow for all users in the system to have adequate working pressures at their connections. Under maximum day and fire flow conditions pressures as low as 20 psi are allowable to avoid oversizing the system. The maximum system pressure allowable is 150 psi. Common pipe and valves are usually rated for 150 psi service and higher regular pressures can damage system components. High system pressures also create dangers for individual users whose plumbing systems are not designed to handle such high pressures.

System velocities and head losses are elements whose criteria are used for sizing new pipes and are designed to identify elements within the system which cause unnecessary energy expenditures and low pressures that are indicative of high velocity and head loss. High velocity and head loss conditions can also cause a number of other problems such as rapidly scouring or deteriorating pipes and high surge pressures, both of which can shorten the lifespan of distribution system elements.

The pressure analysis is applied only at demand junctions where customers are served. At non-demand junctions on system facilities like transmission mains or at pump station inlets lower pressures are acceptable because there are not customers being served; however, care should be taken to keep pressures above 10 psi.

Junctions where pressures are not within the identified parameters are identified and presented as part of the evaluation of the distribution system.

6.1.2 Fire Flow Criteria

The fire flow requirements include the rate of flow in gpm and duration of flow in hours based on the type of land use or facility being protected. The system should be capable of providing the required fire flow under maximum day demand conditions. When storage is available in a zone, it is assumed that fire flows will be met using storage capacity first, rather than from pumping capacity. Where storage is not available, fire flow requirements are met by adequately sizing the pumping stations which serve that zone. When fire flow demands are to be met using a pumping station, that pumping station should be equipped with emergency back-up power generation capabilities.

Fire flow demands impose secondary criteria on each of the other evaluation elements. Pressures should be maintained at a minimum of 20 psi under maximum day plus fire flow demand conditions and velocities under fire flow conditions should not exceed 15 fps.

6.1.3 Storage Criteria

The required storage for a water system is the combination of three parts: operational, fire protection and emergency storage. These components are calculated individually for each zone and are then combined to determine the total required storage for that zone. These components are also analyzed on a system wide basis to determine how well the system meets storage criteria as a whole.

Operational storage is the quantity of water that is required to balance daily fluctuations in demand that occur on an instantaneous basis. Every water system coordinates production rates and the available storage capacity to provide a continuous supply of treated water. Often treatment systems are designed to produce the maximum day demands at a steady rate, with storage available to augment supply during the peak hour demand period, which typically occurs in the early morning and late afternoon. Operational storage is utilized during these daily peak demand periods and is replenished during off-peak periods such as the middle of the day and at night. Historically, operational storage requirements are typically between 20 and 30 percent of MDD and will be set at 30 percent for Santa Monica.

Fire protection storage is calculated from the highest individual fire flow requirement within a pressure zone and the required duration of the fire flow. Pressure zones are analyzed under the premise of a single fire occurring at each location in the zone. The required fire protection storage must be large enough to serve the largest of those individual demands within each pressure zone.

Emergency storage is a calculation of the volume of water desired to serve customers during an emergency. Possible emergencies include earthquakes, water contamination, unplanned electrical outages, pipelines ruptures or other unplanned events. Since the magnitude of emergencies are difficult to predict, the emergency storage criterion is based on the estimated amount of time that is expected to lapse before an emergency can be corrected, which is a function of past experience and judgment. Emergency storage is typically expressed as a percentage of the maximum day demand.

Quantity of emergency storage needed is also a function of the reliability of the sources that serve the system. Since the City has historically received a significant portion of its supply from MWD there is a need for a higher quantity of emergency storage supply. For most agencies relying on MWD, 7 days of average day demand is typically used as an emergency storage criteria. However, since the City is transitioning towards self-sufficiency, the emergency storage volume has been set at 100 percent of MDD for the analysis performed herein.

6.1.4 Pumping Criteria

The capacity of pump stations and the pumping capacities for a zone are evaluated differently where fire protection storage exists versus where fire storage does not exist. For pump stations which serve zones with adequate fire protection storage the pumping capacity should be able to supply the MDD over a period of 16 hours with the largest pump supplying the zone being kept out of service. The term “firm capacity” refers to the capacity of a pump station when the largest pump is out of service.

For pump stations which serve zones that do not have fire protection storage, the pump stations serving that zone are considered hydropneumatic. Hydropneumatic pump stations should be sized to deliver the peak hour flow on the maximum day with the largest pump in the zone out of service. They should also have a fire pump(s) sized to serve the fire flow demand of the zone on the maximum day or the total pumping capacity of the zone should be adequate to serve the fire flow demand on the maximum day. Hydropneumatic stations must also be provided with back-up power generation capabilities to remain operational in the case of an emergency.

6.2 Existing System

This section provides a description of how the City’s water system is supplied and operated within each pressure zone. For each pressure zone, a description is provided for how it is operated, the storage and pumping facilities it contains and how each zone interacts with the others.

6.2.1 Supply Sources

While a complete description of the City’s water supplies can be found in Section 4, this Section provides a brief description of how the City’s distribution system is supplied with treated potable water. The City’s distribution system currently has two major sources of supply, which are the Arcadia WTP, which gets its supply from wells operated by the City, and an MWD potable water connection. A third, smaller supply source is the Santa Monica Well #1, which connects directly to the 350 zone. These supply sources connect to the distribution system in particular locations as described in the following subsections.

6.2.2 Pressure Zones

The City's system is split up into three pressure zones which are the 500, 350 and 250 foot pressure zones. Each zone has its own main primary source of supply and is also hydraulically connected to the zone above or below it. The pressure zones, as well as the major facilities within the distribution system are shown on Figure 6-1.

6.2.2.1 500 Pressure Zone

The 500 pressure zone (500 zone) lies at the northernmost edge of the City and is the smallest zone in the City. The 500 zone serves primarily single family, low density residential land uses. Since the 500 zone is both the smallest and lowest density zone in the system, at 16% of the City's land area, it also serves the smallest demand of three zones.

The City and surrounding areas are beach communities which carry with them relatively high property values. The 500 zone is entirely developed, and due to the prohibitively high cost of acquiring land, storage was never built to serve the 500 zone. To compensate for this the 500 zone is served by both a connection to MWD, which directly feeds the 500 zone and under normal operation sets the HGL, and the San Vicente Booster Station which provides additional flow and pressure when conditions warrant.

The San Vicente Booster Station is used to serve peak demands in excess of the MWD delivery to the 500 zone, compensate for periods of low pressure and provide fire protection when needed. It pumps from the 350 zone into the 500 zone using variable frequency drives set to keep the pressure of the zone above 60 psi at the outlet of the booster station. Since the zone does not have any storage, any flow from MWD that is not required by the 500 zone and whenever pressures at the San Vicente Booster Station significantly exceed 60 psi, water from the 500 zone is relieved to the 350 zone.

While the MWD connection typically sets the HGL of the 500 zone, MWD does not guarantee the pressure of the supply provided to the 500 zone. Therefore, there are times when the San Vicente Booster Station is needed to help maintain the desired HGL in the 500 zone.

The supply from MWD that serves the 500 zone typically exceeds the demands within the 500 zone. This excess is normally planned, and since there is no storage in the 500 zone, this flow is relieved to the 350 zone where it serves as additional supply or goes into storage. The City normally uses the MWD connection to meet the storage needs of the 350 zone that are not satisfied by the output of the Arcadia Booster Station.

6.2.2.2 350 Pressure Zone

The 350 pressure zone (350 zone) spans from the eastern most point in the city to the western most point in the city and is mostly contained between the two other pressure zones. The 350 zone is the largest of the three zones in the City and contains the Santa Monica Airport and land uses that include low density single-family spaces, high density residential, commercial and. This zone encompasses 57% of the City's land area and has higher demands than the other two zones.

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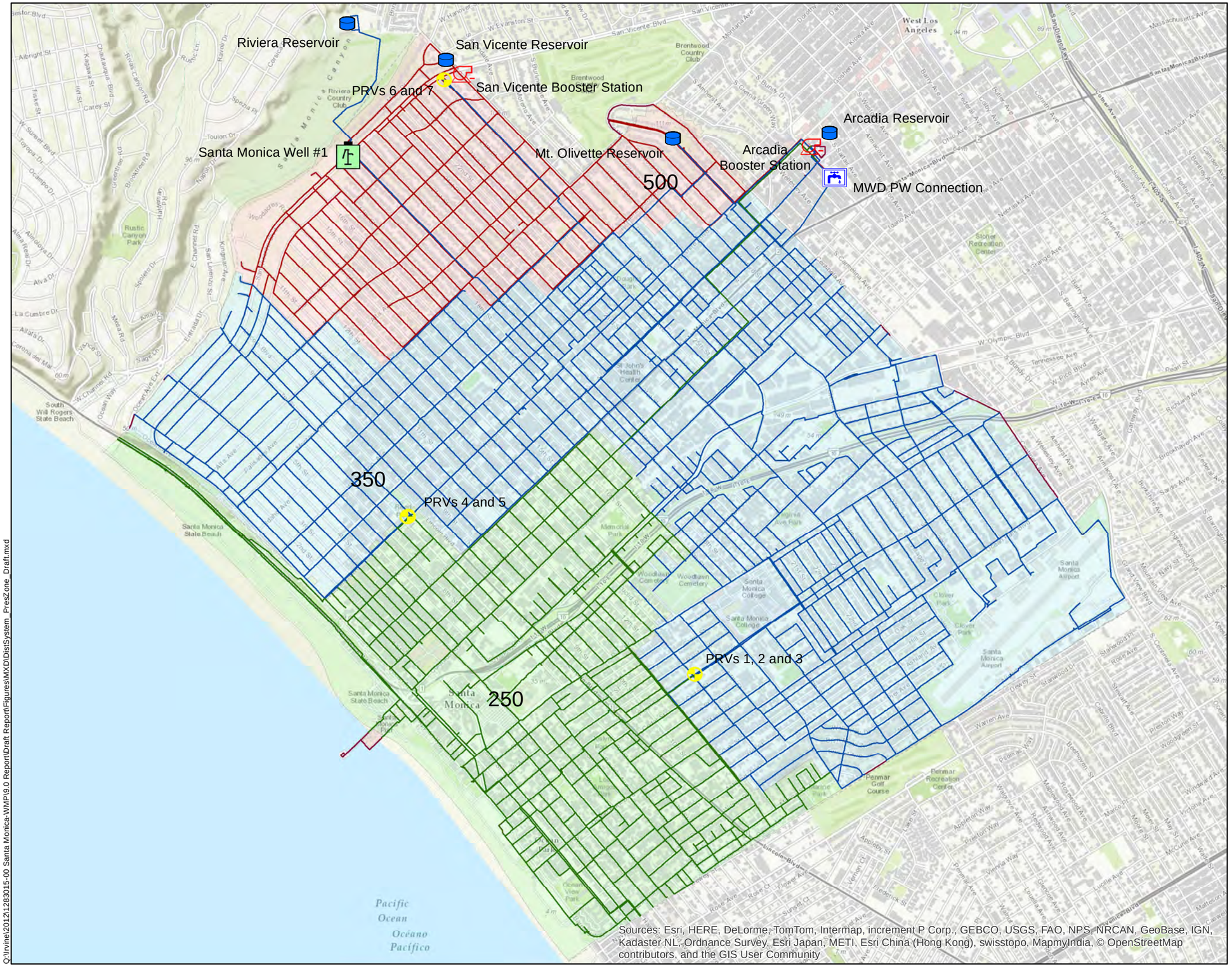

Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Legend

- Distribution Reservoir
- PW Supply Intertie
- Water Booster Station
- Potable Groundwater Well
- Pressure Relief Valve
- 250 Zone Pipes
- 350 Zone Pipes
- 500 Zone Pipes
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 1,600 3,200 Feet

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Existing Distribution System Facilities and Pressure Zones

K/J 1283015*00

Figure 6-1

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The 350 zone has three storage reservoirs that total more than 30 MG of storage capacity. In order of descending size, the 350 zone is served by the Riviera, San Vicente and Mt. Olivette reservoirs, which have 22.4, 5.0 and 3.5 MG capacities respectively. The storage capacity available is well in excess of the required combined storage volume under the 100 percent of MDD criteria, and the zone's fire protection capacities are easily covered by the storage that serves the zone. As will be shown in the capacity analysis the storage capacity in the 350 zone exceeds the demand-based storage requirements. Because of this, the City sometimes has water age and quality issues in these reservoirs.

The 350 zone is served primarily by output from the Arcadia Water Treatment Plant that is pumped from the Arcadia Booster Punp Station at the treatment plant into the 350 zone. The Arcadia Booster Pump Station acts as part of a system which maintains the water level of the 5 MG tank that stores the output from the treatment plant. The booster station is programmed with on and off levels that will provide more flow to the 350 zone as the level inside of the treatment plant storage tank rises.

The 350 zone is also served indirectly by the MWD connection via water that is relieved from the 500 zone. The quantity of water ordered through the MWD supply connection is often deliberately in excess of the requirements of the 500 zone to supply or refill storage within the 350 zone.

6.2.2.3 250 Pressure Zone

The 250 pressure zone (250 zone) spans the length of the coastline within the City boundaries and occupies the majority of the southwest corner of the City. Like the 350 zone, the 250 zone contains a variety of land uses, most notably the Santa Monica downtown area and pier.

The 250 zone is served primarily by a direct connection to the Arcadia WTP. The treatment plant storage tank acts as a clear well at the treatment plant site, and is connected to the 250 zone via a transmission pipeline that bypasses the 500 and 350 zones and directly serves the demands of the 250 zone. The 250 zone is also served by two pressure relief/sustaining valve stations from the 350 zone, one each at the north and south ends of the zone. These valves supply the 250 zone when pressure in the 350 zone becomes too high and sustain the pressure in the 250 zone should it drop too low.

The 250 zone contains no direct storage other than the Arcadia Reservoir, which is its main supply; however it does indirectly have access to the storage in the 350 zone since the two valve stations which connect the two zones are set to sustain the pressure in the 250 zone.

6.2.3 Distribution Pipelines

The City's distribution system has been built and maintained over the course of many years. The variation of pipe materials reflects the different approaches to pipeline construction and repair that were popular in the various years in which the system was built or maintained. The materials for each pipeline segment in the distribution are shown on Figure 6-2.

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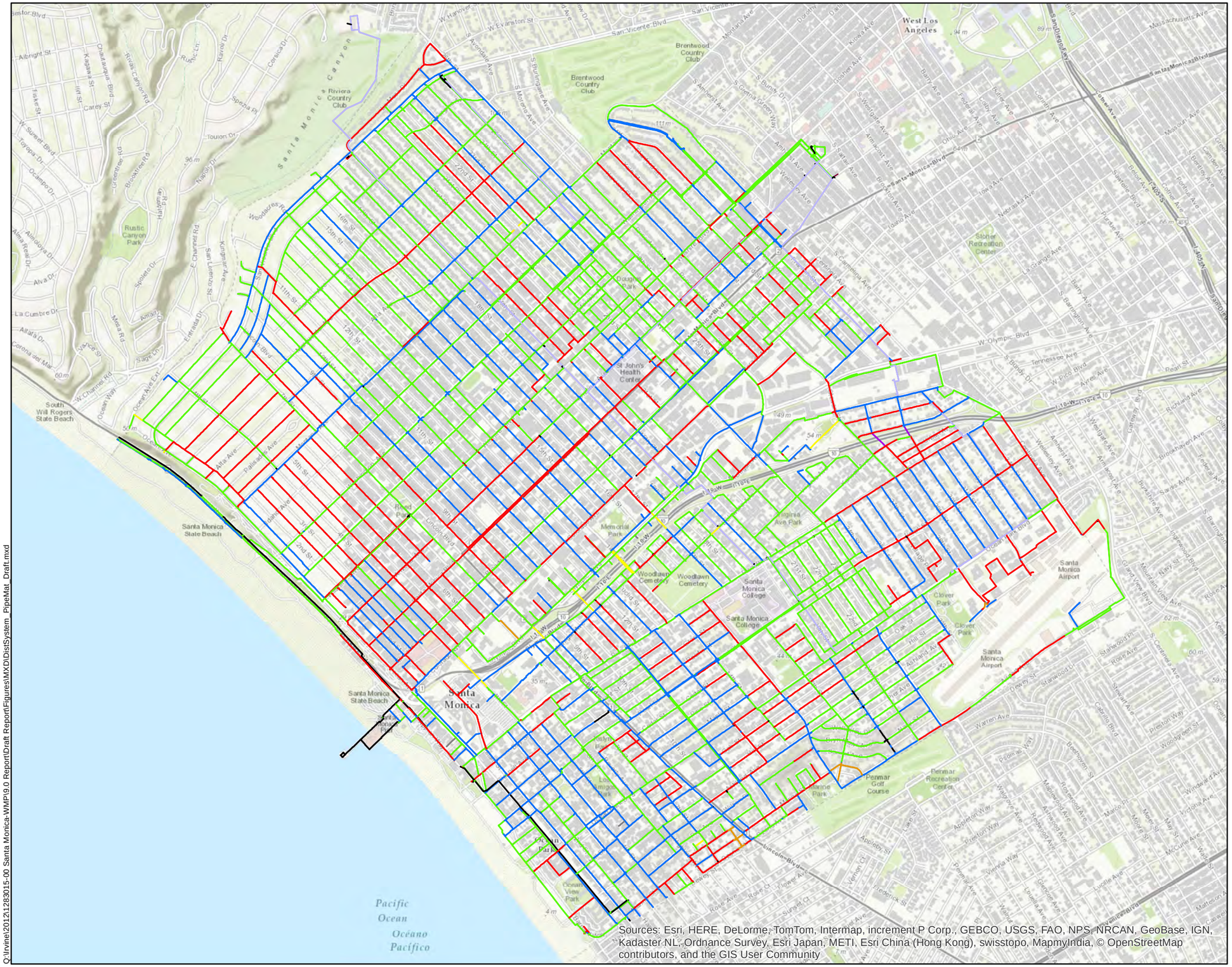

Legend

- Unknown Material
- Asbestos Concrete (ACP)
- Concrete (CP)
- PVC
- Cast Iron (CIP)
- Concrete Steel Cylinder (CSC)
- Ductile Iron (DIP)
- Stainless Steel (SS)
- Steel (STL)
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 1,600 3,200 Feet

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Los Angeles County, California

Existing Distribution System Pipe Material

K/J 1283015*00

Figure 6-2

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The diameters of pipelines in the system varies as well, as pipes were sized based on the flow that they were expected to carry under various demand scenarios. Pipelines that act as supply or transmission lines either from tanks to a pressure zone, or between zones, typically are larger diameter, to help ensure adequate hydraulic capacity. The diameters of each pipeline segment in the distribution system are shown on Figure 6-3.

6.3 Model Development

Kennedy/Jenks developed a hydraulic model of the City's water system infrastructure using InfoWater version 10.1. This software is integrated with GIS and must run in conjunction with the ArcMap software. The City provided Kennedy/Jenks with GIS shapefiles containing special representations and feature data relative to the City's land and water infrastructure, such as pipelines, tanks and valves. The model development process is summarized herein, with additional information contained in Appendix F.

The hydraulic model is a detailed system model that encompasses all facilities and pipelines in the City's distribution system. The GIS and supporting data provided by the City were the basis for construction of the model. The GIS information provided was imported into InfoWater to create a model which contains all of the City's active pipelines, pumps, storage tanks and reservoirs, agency connections and valves.

The City provided the following data for model development:

- GIS shapefiles containing spatial and feature information about the City's land (City Boundary, Assessor Parcel Information, Land Uses, Street Centerlines, Contours, Pressure Zone Boundaries, etc.).
- GIS shapefiles containing special and feature information about the City's water system (Fittings, Hydrants, Valves, Water Mains, Wells, Pumps, Reservoirs, etc.).
- As-builts of various water system facilities.
- Hourly demand data for several days throughout the previous two years.
- Billing data for the previous two years associated with specific parcels.
- Daily production data for the previous sixteen years.
- Operating strategies of existing reservoirs, pump stations and wells.

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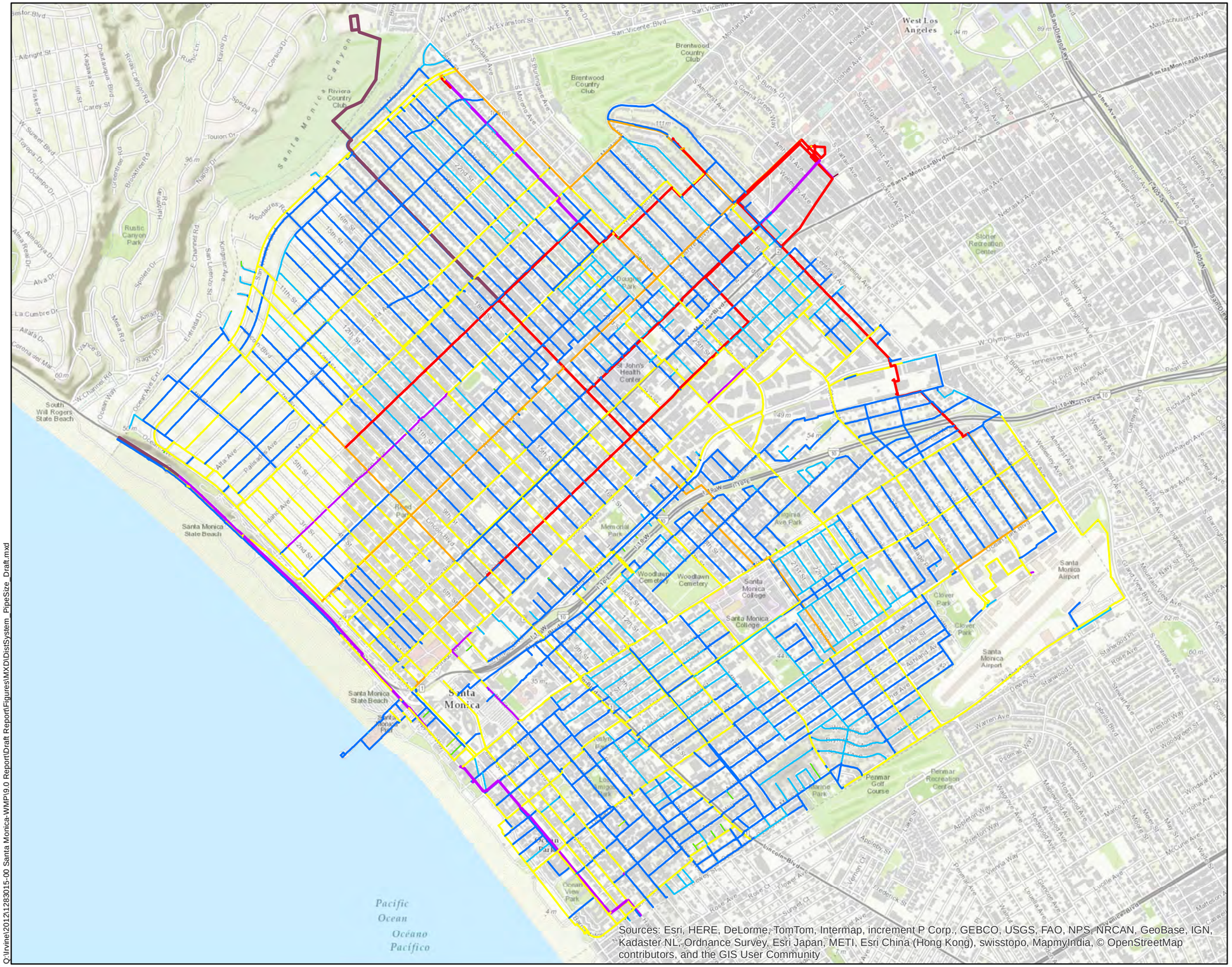

Legend

- 2-inch Pipe
- 3-inch Pipe
- 4-inch Pipe
- 6-inch Pipe
- 8-inch Pipe
- 10-inch Pipe
- 12-inch Pipe
- 14-inch Pipe
- 16-inch Pipe
- 18-inch Pipe
- 20-inch Pipe
- 21-inch Pipe
- 24-inch Pipe
- 27-inch Pipe
- 28-inch Pipe
- 30-inch Pipe
- 36-inch Pipe
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 1,600 3,200 Feet

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Santa Monica Sustainable Water Master Plan
Los Angeles County, California

Existing Distribution System Pipe Sizes

K/J 1283015*00

Figure 6-3

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6.3.1 Pipelines

All pipelines in the model were imported directly from the GIS files supplied by the City. As was necessary to the development of the model, additional fictional pipelines were added, such as at the inlet and outlet of a pump station or reservoir. Pipeline segments are connected using junctions. Most junctions were available from GIS data provided by the City representing valves or fittings, such as reducers, bends and tees. Where the supplied junctions were insufficient, additional model junctions were created to allow the model to function properly. Model inputs for the pipelines imported from the GIS feature information included length, material and diameter. Where lengths were not available, InfoWater automatically calculated the length. Where diameters weren't available they were assigned logically based on surrounding pipes.

Roughness of the pipeline was the final model input feature required to run the model. Prior to calibration an initial roughness value of 130 was assumed for all pipelines. All new pipes added to or replaced in the model will have an assumed roughness of 130. Roughness of the existing pipelines was adjusted as necessary during model calibration to more accurately reflect observed conditions of the pipelines.

Pipelines in the hydraulic model also have several optional controls that were utilized. Most importantly are the closing of a pipeline and the check valve feature. Since most system valves are normally open or normally closed there is no need to represent them as a valve in the model file. Instead, InfoWater allows a pipe to be closed in order to represent a closed valve. This control is utilized mainly in the separation of zones, and was used in the development of the City's model to hydraulically separate the pressure zones. A pipeline can also be fitted with a check valve control that will not allow flow in the reverse direction of the pipe. This feature is useful in areas such as a reservoir effluent line or one way interconnection, such as at the City's connection with MWD.

Modeling outputs provided by the pipeline layer include flow, velocity and head loss through any particular pipe. This information is used to help calibrate the model and analyze the system to determine where deficiencies exist.

6.3.2 Junctions

Junctions in the hydraulic model are a node that represents the end of a pipe. In reality a junction could be a fitting, valve or other facility connected to the system. The City provided several junction shape files, and in order to maintain a relationship between the model and the City's GIS identification system, all appropriate junction files provided by the City were imported directly into the model. Where junction information from the existing shape files did not exist, InfoWater created and connected all necessary additional junctions for a continuously connected system model.

The only modeling inputs required at junctions are demands and elevations. Elevations were assigned to each junction based on of the contour data provided by the City using the Elevation Extraction routine within InfoWater. Procedures for using the Elevation Extractor are described in Section 6.3.8. Demands were assigned to each junction using the Demand Allocator. Procedures for using the Demand Allocator are described in Section 6.3.9.

Modeling outputs provided by the junction layer include head and pressure at any particular junction. This information is used to help calibrate the model and analyze the system to determine where deficiencies exist.

6.3.3 Tanks

Tanks in the hydraulic model are a separately classified junction that represents reservoirs that have a fixed volume or storage and a variable water level. The City provided a shapefile containing spatial and feature information for its tanks. It is common to refer to tanks as reservoirs, and in fact, the City's storage elements are usually referred to as reservoirs. However, but for the purposes of the model, they are input and modeled as tank elements, as the distinction is important.

Tanks contain a variety of modeling inputs. Such inputs include the type of tank, which can be variable area or cylindrical, the elevation of the tank, the minimum and maximum water levels of the tank, the diameter of the tank (if appropriate), the initial level of the tank, the minimum volume of the tank and a tank curve (if desired). For tanks that are neither variable area or cylindrical, the constant area of the tank is converted to a cylindrical equivalent diameter. All of the tank modeling inputs are available through the GIS information provided by the City, from the additional information provided regarding the tanks and their operational strategies, or through conversations with City personnel.

Modeling outputs provided by the tank layer include flow, head, percent full and tank level at each individual tank. This information is used to help calibrate the model and analyze how the system operates.

A summary of the existing tanks within the Santa Monica system is provided in Table 6-2.

Table 6-2 Summary of Existing Storage Tanks

Tank	Zone Served	Capacity (MG)
Riviera	350	22.4
San Vicente	350	5.0
Mt. Olivette	350	3.5
Arcadia	250	5.00

Note: Capacity values are usable capacity, which are less than actual design values.

6.3.4 Reservoirs

Reservoirs in the hydraulic model are a separately classified junction that represents bodies of water or sources of supply which are large enough not to be considered variable in water level. Although the City has no physical or literal reservoirs, interconnections with other agencies and wells can be modeled as reservoirs. The connection with MWD that feeds the 500 zone was modeled as a reservoir, as was the only well, Santa Monica #1, which feeds directly into the distribution system.

The only modeling input required for reservoirs is the water surface level, or head, of the reservoir. For wells the head would be the anticipated groundwater elevation at drawdown during operation. In order for a reservoir to function as a well, a pump must be added to it with the characteristics of the pump that is actually installed.

6.3.5 Pumps

Pumps in the hydraulic model are a junction type which can move flow and increase head. The GIS information provided by the City contained the physical locations of its pump stations but did not contain information regarding the number of pumps, piping layouts or pump specifications. With input from operations, the quantity and specifications of each pump at each pump station were added to the model.

Model inputs required for pumping stations can vary significantly. For pump stations that operate at a typical head or power, those are the only information required. Pumps can also be operated based on a pump curve. Controls for pumps can be added that direct each pump to turn on and off based on the time, pressure/head, and flow in a certain pipe or daily pattern. Pumps can also be operated by VFD controls which allow pumps to operate at reduced speeds.

Modeling outputs provided by the pump layer include flow, head gain, upstream and downstream pressure, available NPSH, speed setting and parallel count for each pump. Some of this information was used to help calibrate the model for pump operations.

A summary of the existing pump facilities in the City's system is provided in Table 6-3.

Table 6-3 Summary of Existing Pump Facilities

Pump	Zone Served	Capacity (MGD)
San Vicente Booster Station		
San Vicente #2	500	1.44
San Vicente #3	500	1.58
San Vicente #4	500	3.60
San Vicente #5	500	3.60
Arcadia Booster Station		
Arcadia #1	350	2.88
Arcadia #2	350	5.04
Arcadia #3	350	5.18
Arcadia #4	350	2.88
Arcadia #5	350	5.04
Santa Monica Well #1	350	0.36

6.3.6 Valves

Valves in the hydraulic model are a junction type that regulates flow at that junction. Several types of valves can be modeled including: pressure reducing, pressure sustaining, pressure breaker, flow control, throttle control, general purpose, float and vacuum breaker valves. In a typical distribution system, there are thousands or tens of thousands of valves. The vast

majority of these valves are butterfly, gate and check valves which are either normally open or normally closed valves and do not serve a more complex function. These valves are not included in the valve layer in InfoWater and are rather modeled as junctions, with their functions of normally open being ignored and function of normally closed or check being modeled in the pipe layer.

Since the modeling software contains eight valve types, there is a large variety of information that could be necessary to operate each individual valve type. The most basic model input required by each valve is the setting of the valve. This is generally a flow or pressure value which activates the valve to perform its function.

Modeling outputs provided by the valve layer include flow, velocity through the valve, head loss through the valve and upstream and downstream pressures. This information is used to help calibrate the model and analyze how the system operates. A summary of the existing control valves in the City's system is provided in Table 6-4.

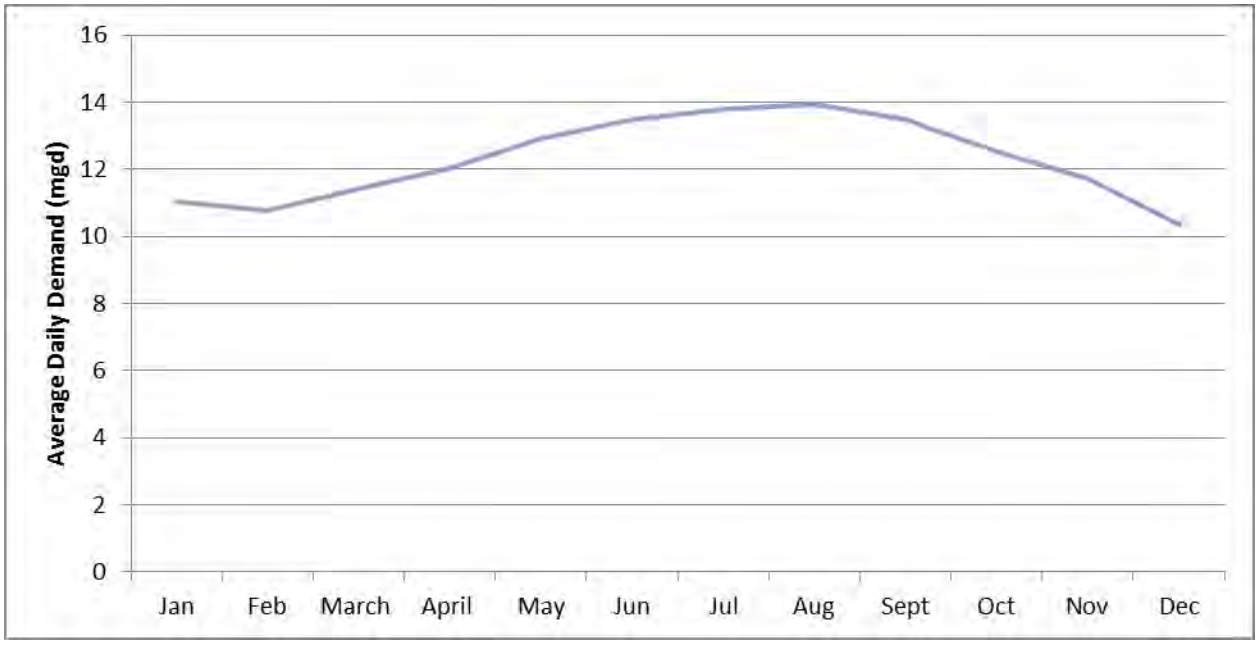
Table 6-4 Summary of Existing Control Valves

Valve	Zone to Zone	Setting
PRV 6	500 to 350	60 psi
PRV 7	500 to 350	65 psi
PRV 1	350 to 250	87 psi
PRV 2	350 to 250	87 psi
PRV 3	350 to 250	87 psi
PRV 4	350 to 250	87 psi
PRV 5	350 to 250	87 psi
RPV 1	350 to 250	65 psi
RPV 10	350 to 250	105 psi

6.3.7 Peaking Factors

In order to establish demands and peaking factors, the City provided daily production data, daily demand data and monthly consumption data. The daily demand data were made available for the last sixteen years. The last two years of data were used to create an average day demand (ADD) for each parcel. The complete sixteen years of data were then used to determine a maximum day demand (MDD) peaking factor, which represents the ratio between average day demands and the demands that occur on the day during the year when the demands are the highest. Analysis of the data provided by Santa Monica revealed that the maximum day peaking factor for Santa Monica is 1.54. The City's seasonal demand patterns are shown on Figure 6-4.

Figure 6-4 Seasonal Demand Variations



Source: City Water Resources Division SCADA data, 2012 values.

6.3.8 Elevation Extraction

Elevations for the model were assigned using the 2-ft. contour data provided by the City. In order for the model to properly calculate the conditions at each junction, elevations for each junction are required. Each individual junction in the GIS information did not have elevation information. Therefore, elevations were added through the InfoWater Elevation Extractor function. Using the 2-ft. contour information the InfoWater software uses the location of each junction to complete an interpolation of the nearest contours to assign each junction an approximate elevation. This elevation is then automatically input into the model. All junction types except for tanks and reservoirs had elevations assigned using the InfoWater Elevation Extractor.

6.3.9 Demand Allocation

The existing water demands in the hydraulic model were allocated using actual water usage information obtained from the City's billing records for the past two years. The future water demands were allocated using the year 2035 demand projections calculated based upon the methods presented in Section 3. The spatial allocation of existing and future demands is described below.

Existing Demand

Consumption data for each water service for fiscal years (FY) 2011 and 2012 were provided by the City. The data included information on Service ID's, Parcel ID's associated with the account, street addresses, billing classifications and bi-monthly meter readings for each account. The water usage for each account from data made available was converted to a daily average day demand.

In order to convert the demands from account level data to junction level data that can be used in the model the InfoWater Demand Allocator was used. The demands from each account were assigned to the nearest junction in the model. The Demand Allocator also separated demands into six different land use categories in the model. Six land use types were used: Single Family (Demand 1), Multi Family (Demand 2), Commercial/Industrial (Demand 3), Public/Government (Demand 4), Irrigation (Demand 5), and Fire Service (Demand 6). For junctions to which demands from multiple accounts were assigned, the demands were aggregated within each land use category. As previously discussed, to account for water losses within the system which do not show up in billing data, the model was updated to include unaccounted for water in the existing water system.

Future Demand

Future demands are allocated based on the parcels selected for development by the Year 2035 through parcel-specific coverages provided by the City. For parcels not selected for development, average demands were increased by a constant factor. For those parcels identified for new or additional development, calculated demands were applied to each individual parcel. The total increase in demand for the future scenario conforms to the basis derived in Section 3.

Diurnal Curve

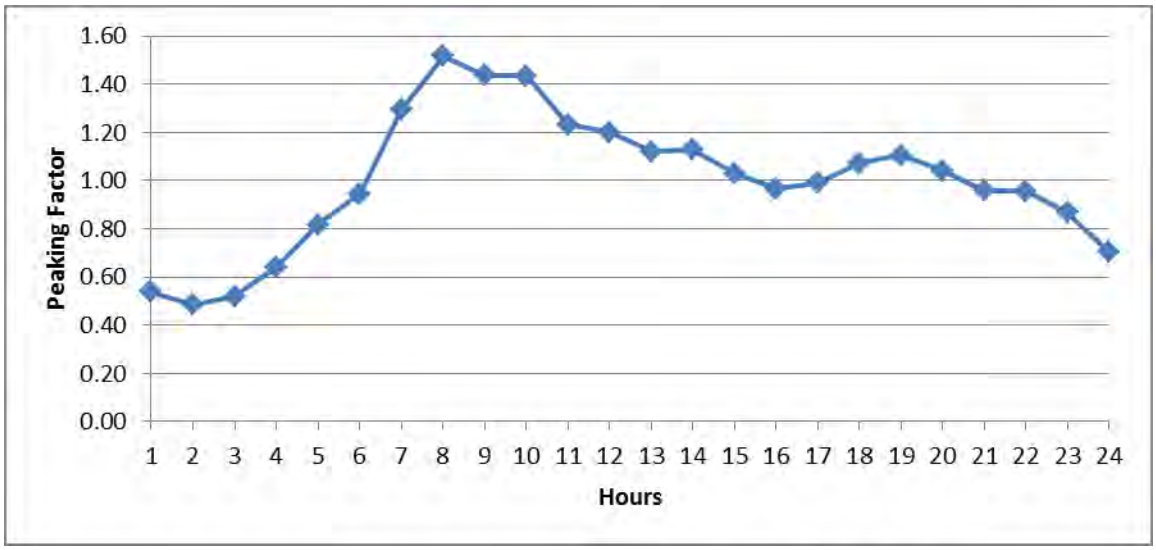
A diurnal curve is a pattern that simulates water demand variations over a 24-hour period. The diurnal curve pattern was assigned to all demand nodes within the City system. Hourly summaries of water supplied to the system and incremental changes in storage volumes are used to determine approximate hourly demand and create diurnal curves (demand = supply production – storage inflows + storage outflows).

Diurnal curve creation was based on system-wide data gathered in November and December of 2012 and August 2013. Individual diurnal curves were created for each day in the period and a combined diurnal curve for application in the model was created from an average of those. Sufficient data to create diurnal curves for specific areas of land use types were not available. Therefore, the same diurnal pattern was assigned to all demands within the system.

The hydraulic model uses the diurnal curve created when it is run for an Extended Period Simulation, which is when the model simulates the system being operated over a period of time. Frequently, this entails simulating a 24-hour time period, with results calculated at one-hour time steps throughout the simulation. At each time step, all demands are multiplied by the appropriate peaking factor throughout the day based on the diurnal curve and the time step being calculated.

The diurnal curve calculated shows a slightly atypical demand pattern with the largest peak occurring in the mornings as expected, with demand tapering off throughout the day until around hour 16 and an evening peak around hour 19. The likely explanation for the atypical pattern of demand in Santa Monica is that the population served by the City during the day, which includes resident businesses and tourism, far exceeds its residential population. The daily diurnal pattern is displayed on Figure 6-5.

Figure 6-5 Daily Diurnal Demand Pattern



Source: City Water Resources Division SCADA data, 2012 values, average of summer and winter data.

6.4 Model Calibration

After importing all of the elements of the City's water distribution system into the hydraulic model databases, calibration of the hydraulic model was performed. Data gathered by City staff on February 5, February 7, February 12, February 14, February 20, February 27, March 4 and March 6 of 2013 were used for calibration of the hydraulic model. The goal of calibration was to complete the development of a hydraulic model which reasonably represents actual conditions in the distribution system.

Two phases of calibration were conducted: Steady State and Extended Period Simulations. Steady State Simulation calibration involved the process of simulating fire hydrant flow tests to match the field results reasonably closely. Extended Period Simulation involved modifying the model until it simulates the operations of a specific day or days with relative accuracy. In both calibration processes, it was necessary to utilize data recorded in the field, such as tank levels and observed static and residual pressures, as well as adjust various settings and factors such as pipeline roughness coefficients and PRV settings.

6.4.1 Steady State Simulation Calibration

Fire hydrant flow tests were conducted at 24 locations throughout the distribution system from February 5 to March 6, 2013. Tests were run by closing a series of valves to isolate a specific pipeline and record the drop in pressure and head experienced along that pipeline. Static pressures were recorded along the pipeline prior to testing, residual pressures during testing. A flowing hydrant and 2 to 4 residual hydrants were specified for each test. Along with the results of the testing, data about the characteristics of the system at the time of each test were also provided. That data included: levels of each reservoir within the system, flow from well Santa Monica #1, flow from the MWD connection, pressure of the 500 zone at the Arcadia WTP, treated water from the Arcadia WTP, treated water flow from the Arcadia Booster Pump Station, effluent pressure at the Arcadia Booster Pump Station and open/close readings for the San Vicente relief valves and Booster Station.

The model results were compared to the field data to test the accuracy of the model. To increase accuracy, settings and parameters were adjusted until an acceptable level of agreement was achieved in the 250 and 350 zones.

When the analysis of model results and the field data revealed discrepancies in the 500 zone that indicated issues with the data received, four more hydrant tests were performed in this zone to obtain more data to analyze. The data from the second set of tests were used to adjust settings and parameters in the model that resulted in better agreement between model results. The results from the calibration of the other two zones were also used to decide the appropriate roughness factors to use in the 500 zone.

6.4.2 Extended Period Simulation Calibration

The model was run in extended period simulation model to produce results for a 24-hour period. Results from this scenario for the tank levels were compared to tank levels in data from the SCADA system to evaluate the accuracy of the simulation. While the complexities of the interplay between the San Vicente Booster and valve Station, the MWD connection and the Arcadia Booster Pump Station make it difficult to adjust the model to completely match field conditions, an acceptable level of calibration was reached for extended period simulation conditions. Additional model calibration support material is provided in Appendix F.

6.5 Existing System Evaluation

Hydraulic evaluation of the City's existing distribution system was performed and is explained in this Section. The existing system evaluation applies current (2013) demands and is based on the current infrastructure and operations strategies in place.

6.5.1 Existing System Evaluation Approach

Evaluations for pumping and storage capacity as well as evaluations of the distribution system under maximum demands and fire flows identify possible recommendations to address existing and future deficiencies. Pumping and storage capacity deficiencies are identified using capacity data provided by the City, whereas capacity deficiencies in the distribution system are identified through analysis with the hydraulic model.

6.5.2 Existing Pump Capacity Evaluation

For the 350 zone, which is served with reservoir storage, it is recommended that adequate pump capacity to supply the MDD by sustaining a firm pumping capacity for 16 hours be available. The 350 zone pumping operation is unique because it is designed to refill storage, but operates at a variable rate based on the level of the Arcadia Reservoir. While there was some consideration for requiring the Arcadia Booster Pump Station to meet the MDD demands of both the 350 and 250 zones, based on discussions with City staff, the firm capacity for the Arcadia Booster Pump Station will be evaluated based on just the max day demands of the 350 zone. The results of the pumping capacity analysis of the 350 foot zone are shown in Table 6-5. A more detailed documentation of the system analysis results is included in Appendix G.

Table 6-5 Pumping Capacity Evaluation for 350 Zone

Item	(mgd)
350 Zone Firm Capacity	16.20
Required Pump Capacity	19.26
Pump Capacity **Deficit**	-3.06

For the 500 zone, which does not have reservoir storage, the design criterion for the evaluation is that pumping capacity should be adequate to provide the maximum day demands and fire flow demand simultaneously, and should also be able to provide the peak hour demands. The results of the pumping capacity analysis of the 500 foot zone are shown in Table 6-6.

Table 6-6 Pumping Capacity Evaluation for 500 Zone

Item	(mgd)
500 Zone Firm Capacity	6.62
Required Pump Capacity	4.36
Pump Capacity Surplus	2.27

The analysis shows that there is a pump capacity deficit of 3.06 mgd for the 350 zone. While the 350 zone does have an alternative supply source through the 500 zone, the criterion used shows a pump capacity deficit. The alternative supply source can be considered when evaluating the priority of the improvement project required to address this pumping capacity deficit. This project may be considered a lower priority than other projects identified because the alternative supply to the 350 zone can be considered as backup to the Arcadia Booster Pump Station.

6.5.3 Existing Storage Evaluation

The storage evaluation determines whether the capacity available in the storage reservoirs to meet operational, emergency and fire storage requirements is sufficient. Storage is evaluated on a pressure zone and system wide basis. If a zone is found to be deficient, the first solution is to determine whether access to storage in a higher and adjacent zone is available that can be

supplied through a PRV. If this is not feasible, another solution is to pump from excess storage to a deficient zone.

The existing distribution system contains 4 storage reservoirs and has a total storage volume of 35.9 MG. A system-wide comparison of available storage and required storage shows a surplus 9.3 MG under existing demand conditions, including operational, emergency and fire storage adequate to serve each zone.

Despite the fact that as a system the required storage is available, deficits within individual zones exist. The 500 zone contains no storage and is served by the City's connection to MWD and is supplemented with pumping capacity, as required. When required the San Vicente Booster Station can access the 350 zone storage in order to supply the 500 zone. The 250 zone has a 3.3 MG storage deficit as its only direct storage is the 5 MG Arcadia Reservoir at the treatment plant. However, the 250 zone has access to the 350 zone storage surplus through 2 PRV stations. The 350 zone contains a large storage surplus of 16.9 MG as it is served by three reservoirs and contains 30.9 of the system-wide 35.9 MG of storage. While a more detailed table compiling the storage analysis results can be found in Appendix G, a summary of the storage evaluation results is shown in Table 6-7.

Table 6-7 Existing Storage Evaluation

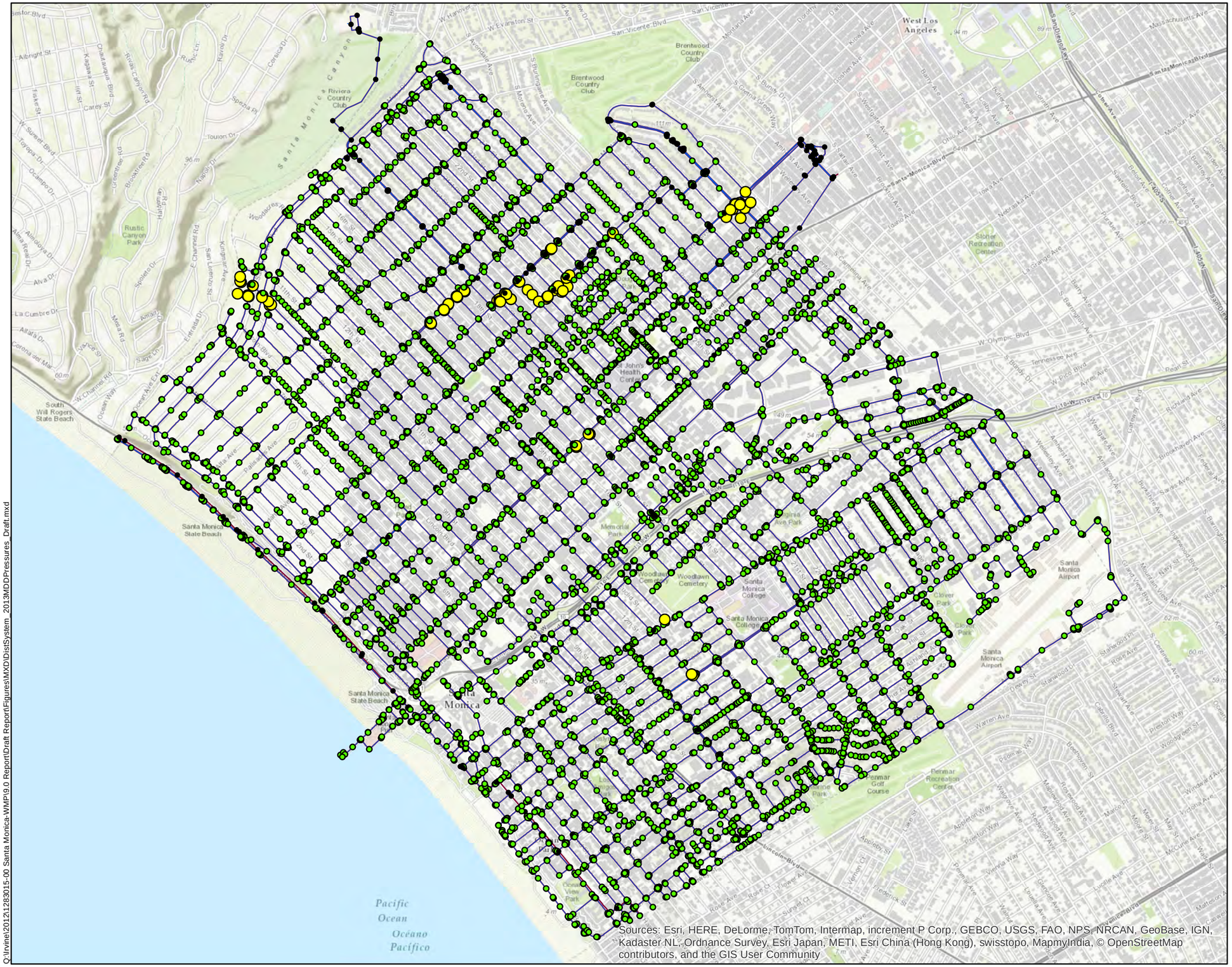
Zone	Storage Required (MG)	Storage Available (MG)	Surplus/Deficit (MG)	Note
500	4.33	0	-4.33	No Storage
350	14.02	30.90	16.88	Large Surplus
250	8.29	5.00	-3.29	Can Access 350 Zone Surplus

6.5.4 Existing Distribution System Evaluation

The hydraulic model constructed for this study was used to evaluate the distribution system performance using the criteria for pressure, velocity and head loss presented in Section 6.1.1.

The pressures at the demand junctions throughout the water distribution system fall within the evaluation criterion of 30 to 150 psi. The majority of non-demand junctions also fell within the requirement of maintaining a minimum pressure of 10 psi, however, near existing storage facilities there was a tendency for some junctions to fall below 10 psi. The pressures in the system as calculated by the hydraulic model are shown on Figure 6-6.

There were no cases of velocity criteria failure under maximum day demand (MDD) conditions. Two pipeline segments in the 350 zone were close to or in violation of the head loss evaluation criteria. Both of those pipes were pinch points, or pipes which were smaller in diameter than their upstream and downstream counterparts. Replacing these pipes, if they were indeed as represented in the City GIS, would alleviate the issues observed at these two locations. However, replacing these pipes is not a recommended improvement project. Unless areas of the system that fail the velocity or head loss criteria also fail the pressure criteria, or the velocity and head loss issues cause problems with system operation, resolving velocity and head loss issues is considered a low priority and is not recommended.



Legend

- Non-Demand Junctions
- Max Day Pressure < 30 psi
- 30 psi < Max Day Pressure < 40 psi
- Max Day Pressure > 40 psi
- System Pipelines
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 1,600 3,200
Feet

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Existing Distribution System Peak Hour Pressures

K/J 1283015*00

Figure 6-6

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6.5.5 Existing Fire Flow Evaluation

The hydraulic model was also used to evaluate the distribution system under fire flow conditions. The specific criterion evaluated included a minimum system pressure of 20 psi when fire flow demands are applied to the system in addition to maximum day demands.

In several locations, the distribution system was not able to satisfy the allowable criterion. These locations are predominantly located at dead end pipelines serving large multi family or commercial land uses and are located in the 350 and 250 pressure zones. Since most of these pipelines are dead ends branched from a larger pipeline, a simple upsizing of the pipe in question generally solves all velocity and pressure problems. For pipelines not at dead ends, replacement of a larger length of pipe is often necessary. The pressures in the system under fire flow conditions, as calculated in the model, are shown on Figure 6-7.

Given its age, the distribution system performed well under the fire flow evaluation. Of the locations found to have issues with pressures, velocity and/or head loss under fire flow conditions, only 4 locations over 1000 LF have issues and half of the projects were under 700 LF.

In several locations, specific hydrants had large fire flow demands of as high as 5,000 gpm. It is not generally possible for a single hydrant to supply 5,000 gpm, even if the distribution system can supply that rate of flow to the hydrant. In some locations, there were multiple nearby hydrants that could assist in meeting the fire flow requirement. If there were more than one hydrant in the vicinity of a hydrant that did not meet the criterion, the total capacity of the failing hydrant and the nearby hydrants was considered. If the total capacity was sufficient to meet the fire flow requirements in the area, then no improvement project was recommended.

6.5.6 Recommendations for System Improvements

As a complete system, the City's distribution system operates well. The only issues revealed through various evaluations and the hydraulic modeling analyses included a minimal number of undersized pipes, the lack of storage available in the 500 foot zone, and an increase in the Arcadia Booster Pump Station pumping capacity.

As shown in Table 6-8 and detailed further in Section 7, approximately 1.5 miles of pipe is being recommended for replacement. Upsizing of these pipes will correct deficiencies which have been identified as existing problems. The pipeline improvement projects are shown on Figures 6-8 and 6-9.

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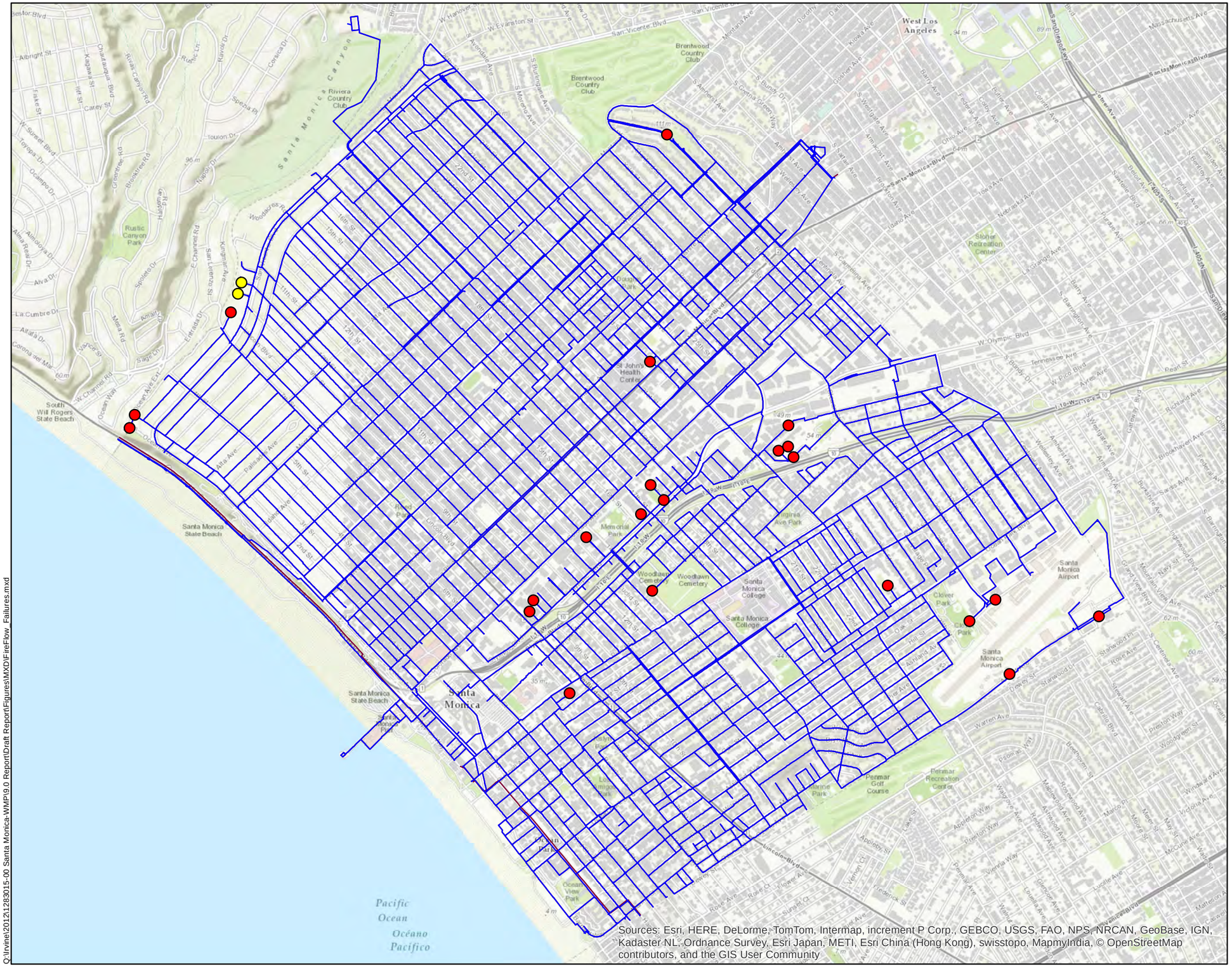

Legend

- Existing System Fire Flow Failures
- Future System Fire Flow Failures
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 1,600 3,200 Feet

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Distribution System Fire Flow Findings

K/J 1283015*00

Figure 6-7

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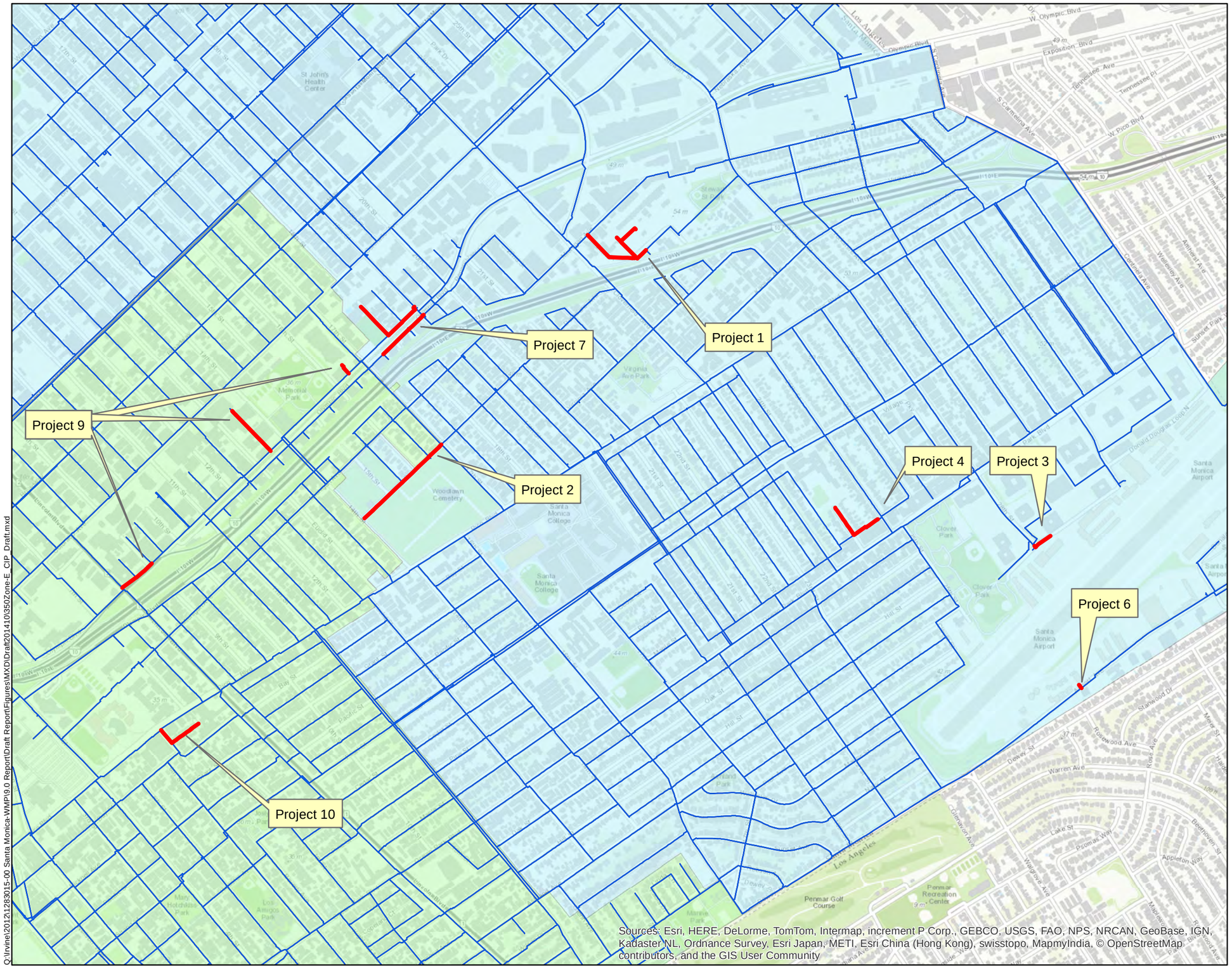

Legend

- 2014 CIP
- Acceptable System Pipe
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 825 1,650 Feet

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Capital Improvement Program East

K/J 1283015*00

Figure 6-8

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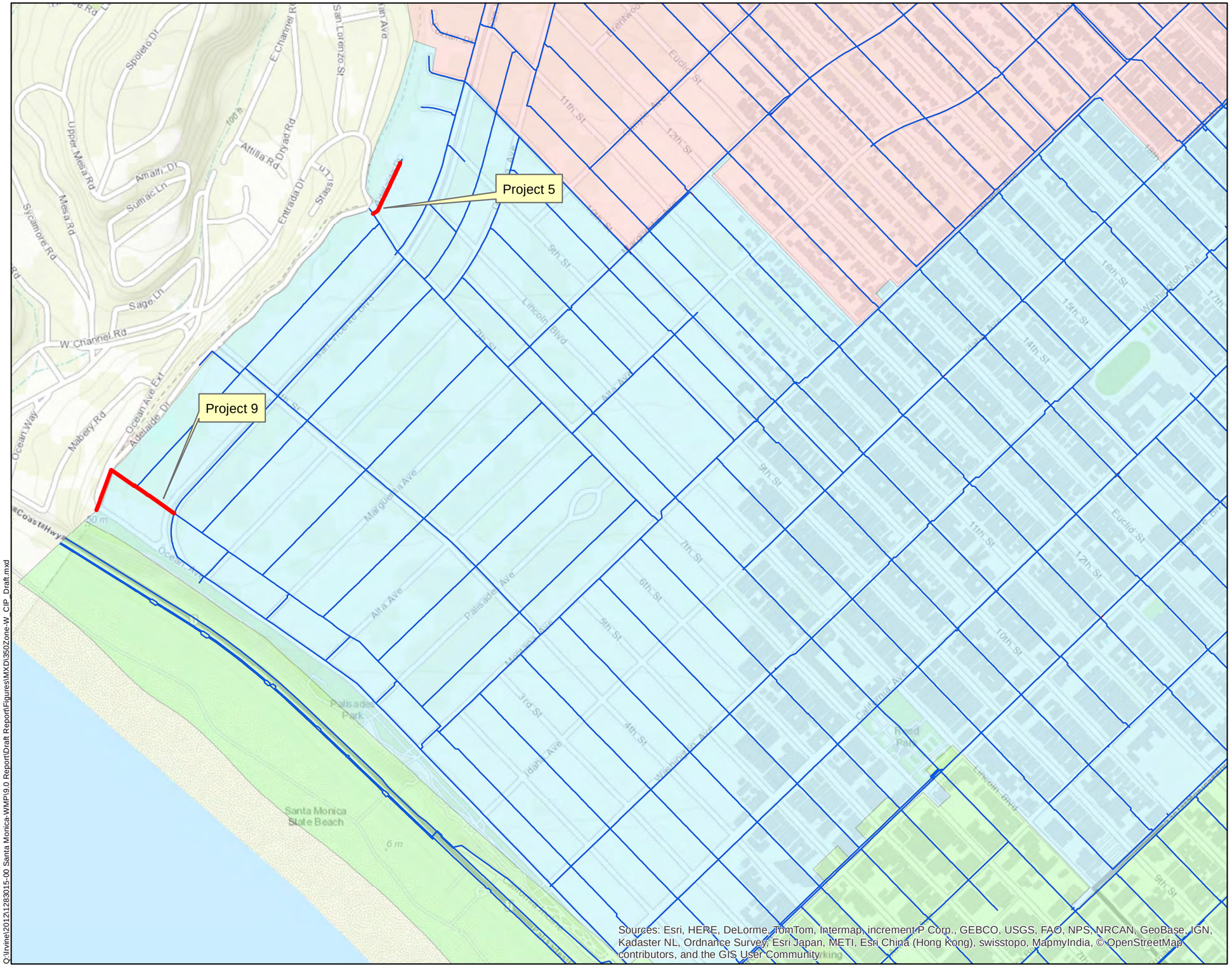

Legend

- 2014 CIP
- Acceptable System Pipe
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 550 1,100 Feet

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Capital Improvement Program West

K/J 1283015*00

Figure 6-9

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Table 6-8 Recommended Pipeline Projects

Project Number	Streets	Pipe Diameter (in)	Pipe Length (ft)	Zone
1	Delaware Avenue and Frank Street	10	1302	350
2	Delaware Avenue S of 17th Street	10	1156	350
3	Donal Douglas Loop North, E of 28th Street	10	223	350
4	24th Street and Ocean Park Place North	8	671	350
5	Adelade Place and 7th Street	8	422	350
6	Airport Ave, W end of the Airport	8	44	350
7	18th Street and Olympic Boulevard (border of 350/250 zone)	8	1489	350
8	Adelade Drive and 1st Court	10	864	350
9	Olympic Boulevard, Lincoln Court, 9th Street, Euclid Court and 16th Court	12	1133	250
10	6th Street and Pico Place	10	539	250

It is recommended to add pumping capacity to the Arcadia Booster Pump Station to address the pumping capacity deficiency identified for the 350 zone.

Installation of storage would assist the operation of the 500 zone, however it is recognized as infeasible due to existing circumstances. The 500 zone and areas surrounding it are built out and have very high property values, which would make acquisition of land difficult and costly. Additionally, since the area surrounding the 500 zone is outside of the City and is primarily single family residential land uses, additional difficulty in securing community support for such a project would be anticipated. Adequate pumping capacity to serve the 500 zone under typical and emergency situations exists to mitigate the unavailability of storage to this zone.

6.6 Future System Evaluation

Hydraulic evaluation of the City's future distribution system was performed and is explained in this Section. The evaluation is based upon the future demand projections described earlier in this report. The infrastructure and operational strategies used in the future analyses are primarily the same as those used in the existing system evaluation. The City's land area is built out and changes in demand are anticipated primarily due to development in the form of revitalization of outdated or underserved areas and redevelopment of specific properties which will increase density.

6.6.1 Future System Evaluation Methodology

Each of the evaluations that follow was performed under the same methodology as the existing system evaluations that preceded them. Since the City is nearly built out, no new distribution system facilities have been planned as part of the future system evaluation. Facility replacements recommended to serve the existing system are tested for compliance with the

evaluation criteria for future demands. Where additional issues are identified they will be discussed.

6.6.2 Future Pump Evaluation

For the 350 zone, the pumping capacity evaluation was preformed again using the same criteria, but with the future demands. As expected, with the increase in demands came an increase in the pump capacity deficit. While a more detailed documentation of the future system analysis results are included in Appendix G, the results of the pumping capacity analysis for the 350 zone for future demands conditions are shown in Table 6-9.

Table 6-9 Pumping Capacity Evaluation for 350 Zone for Future Demands

Item	(mgd)
350 Zone Firm Capacity	16.20
Required Pump Capacity	25.00
Existing Pump Capacity Deficit	-3.06
Future Pump Capacity **Deficit**	-5.74

For the 500 zone, for future demand conditions, the pumping capacity should be adequate to provide the max demands and fire flow demand simultaneously, and should also be able to provide the peak hour demands. The results of the 500 zone analysis are shown in Table 6-10.

Table 6-10 Pumping Capacity Evaluation for 500 Zone for Future Demands

Item	(mgd)
500 Zone Firm Capacity	6.62
Required Pump Capacity	5.39
Pump Capacity Surplus	1.13

As with the analysis for existing demand conditions, the analysis for future demand conditions shows an expected pump capacity deficit. The alternative source of supply through the 500 zone can be considered when evaluating the priority of the improvement project required to address this deficiency.

6.6.3 Future Storage Evaluation

The future storage evaluation findings are similar to the existing storage evaluation findings. No new storage was recommended as part of the existing storage evaluation and the large surplus of storage availability that exists in the 350 zone that helps to serve the storage deficits of the 250 and 500 zones is still adequate to do so. The storage capacity of 35.9 MG remains intact and the system wide surplus of storage is 2.3 MG, as shown in Table 6-11. While this analysis suggests adequate storage capacity exists to meet current future demands, additional storage beyond the available capacity may provide an additional buffer to meet extreme demands under emergency conditions.

Table 6-11 Storage Capacity Evaluation for Future Demands

Zone	Storage Required (MG)	Storage Available (MG)	Surplus/Deficit (MG)	Note
500	5.07	0	-5.07	No Storage
350	17.75	30.90	13.15	Large Surplus
250	10.74	5.00	-5.74	Can Access 350 Zone Surplus

6.6.4 Future Distribution System Evaluation

The hydraulic model was used to evaluate performance of the future distribution system for pressure, velocity and head loss. The future system evaluated included the entire existing system with the pipelines recommended for replacement upsized accordingly. No additional facilities that require modeling are currently anticipated.

Under the future demand conditions and with the future system recognizing replacements of pipelines failing in various criteria under existing demands the system showed no new deficiencies. Pressure at all demand junctions was adequate, with inadequate pressures observed at some junctions near storage facilities and on transmission pipelines. The pressures in the system under future demands as calculated by the hydraulic model are shown on Figure 6-10.

6.6.5 Future Fire Flow Evaluation

Fire flow demands were assumed to be identical in the existing system and future system. Because fire flow demand is much larger than the MDD at any junction it is not surprising that the recommendations made as a result of the fire flow testing of the existing system are satisfactory for the future demand projections. Fire flow demand assignments should continue to be monitored and updated as development occurs. However, no new fire flow deficiencies were identified during the analysis of the system with future demands. Therefore, no distribution system improvement projects are recommended.

6.6.6 Future Recommendations

Based on the findings of the system hydraulic analysis derived herein, the future demand conditions triggered minimal additional hydraulic deficiencies. The only additional system improvement under future demand conditions is the need to further increase the pumping capacity in the 350 foot zone.

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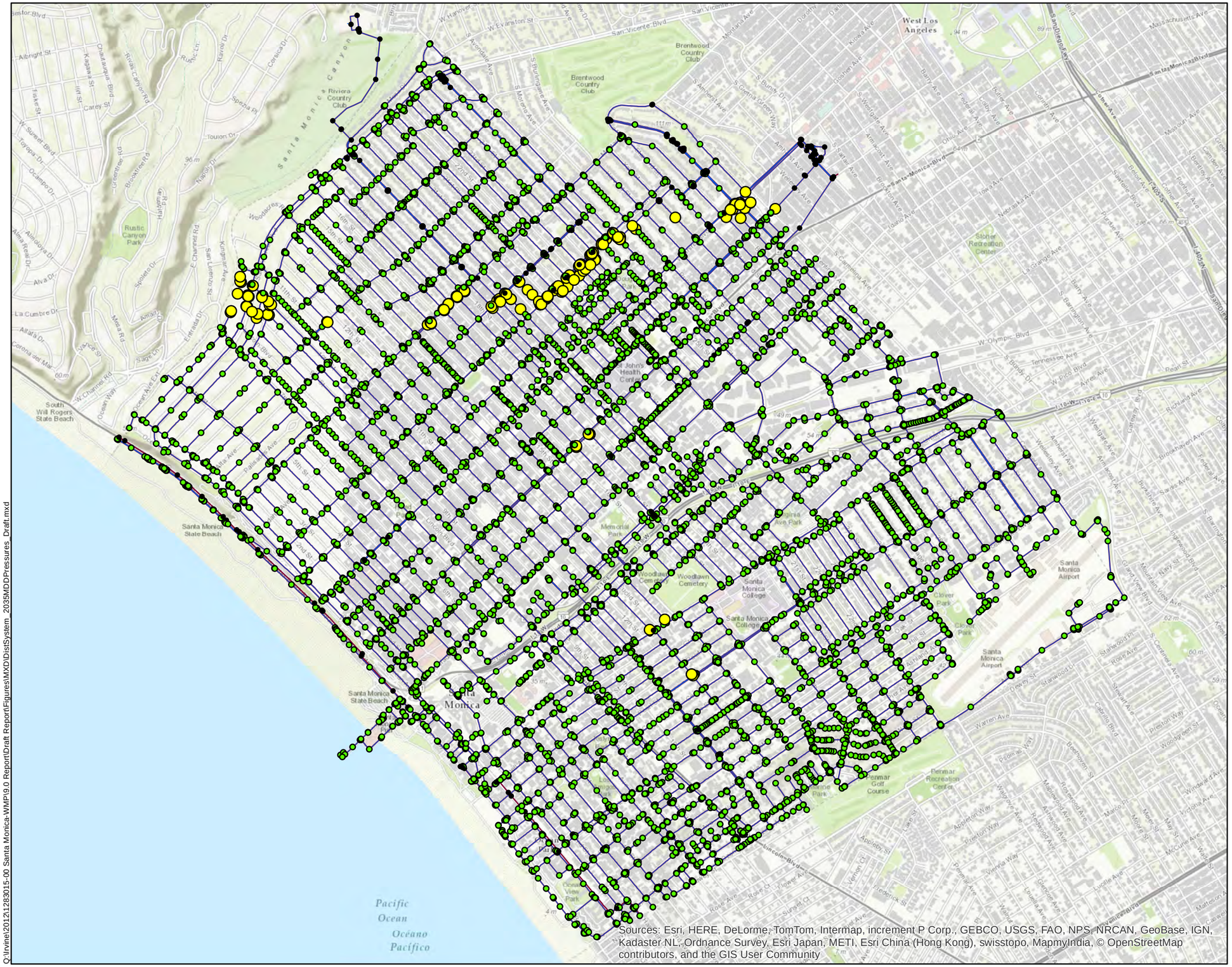

Legend

- Non-Demand Junctions
- Max Day Pressure < 30 psi
- 30 psi < Max Day Pressure < 40 psi
- Max Day Pressure > 40 psi
- System Pipelines
- 250 Pressure Zone
- 350 Pressure Zone
- 500 Pressure Zone

N

0 1,600 3,200
Feet

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Los Angeles County, California

Future Distribution System
Peak Hour Pressures

K/J 1283015*00

Figure 6-10

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6.7 Energy Analysis

In a typical distribution or supply system the largest consumers of energy are typically treatment plants, pumping and booster stations and wells. Other facilities such as reservoirs and regulating stations typically have relatively insignificant energy consumption in comparison. Energy intensive facilities often operate for long periods of time and, when coupled with rate structures which charge a premium during periods of the day, can be extremely inefficient and expensive. The City has a small distribution system with few facilities, containing only ten pumps and one well.

6.7.1 Arcadia Booster Pump Station

The Arcadia Booster Pump Station serves as one of two outlets for the Arcadia Reservoir. The Arcadia Reservoir is the treated water storage for the Arcadia WTP and also sets the HGL for the 250 zone. Since the HGL and demand of the 250 zone is regulated by the Arcadia Reservoir it is important that the level of the tank be kept somewhat constant. To accomplish this, the Arcadia Booster Pump Station has on and off controls set to various tank levels. The goal of these settings is to minimize the variations in tank levels at the Arcadia Reservoir to give the 250 zone consistency.

By operating the Arcadia Reservoir with the primary objective being to maintain a stable level in the reservoir, the operating strategy of the Arcadia Booster Pump Station operation is unpredictable. Any strategy to alter the operation of the booster station to minimize peak energy consumption or to minimize total time of operation would jeopardize control over the Arcadia Reservoir level and subsequently the 250 zone HGL. Therefore, no adjustments to operational controls are recommended.

6.7.2 San Vicente Booster Station

The 500 zone contains no storage and is thus reliant upon booster station capacity to serve its needs on a daily basis. The main source of supply to the 500 zone is the connection to MWD from which the City gets a significant amount of its supply. In times when the supply provided by MWD is deficient or when MWD is unavailable, the 500 zone must be served by the San Vicente Booster Station. The San Vicente Booster Station also serves to maintain the pressure in the 500 zone to a minimum level.

The San Vicente Booster Station operates solely by requirement to maintain a minimum level of service to the 500 zone. The booster station also operates using VFDs in order to avoid raising the pressure in the 500 zone too high and providing excessive flow. Due to these facts the San Vicente Booster Station already operates at or near its peak efficiency. Without adding storage for the 500 zone, there is little that can be done to increase the energy efficiency of the San Vicente Booster Station. Therefore, no adjustments to operational controls are recommended.

6.7.3 Santa Monica Well #1

Santa Monica Well #1 (SM #1) provides direct potable supply to the 350 zone. The well pumps from the groundwater table and joins with the transmission main from Riviera Reservoir that serves the 350 zone. SM #1 operates at a steady flow and head based upon the hydraulic conditions in the distribution system and in the aquifer from which it extracts its flow. This well typically operates around the clock, stopping only for scheduled and unscheduled maintenance.

Energy savings at this location are only available at this location by reducing the number of hours that the well operates. Decreasing the operating time of the well would also decrease the supply available to the City, which is contrary to the City's goals. Therefore, no adjustments to operational controls are recommended at this time.

Section 7: Capital Improvement Program

This Section presents the recommended Capital Improvement Program (CIP) for the City of Santa Monica through year 2035 and the methods used to determine the estimated cost of that program. The recommended projects allow the City to address the deficiencies that have been identified throughout this document that are necessary to adequately serve the current population and future growth.

7.1 Development of CIP

Recommended system improvements are based upon deficiencies recognized throughout the evaluation process of the existing system, anticipated development throughout the City, additional deficiencies recognized after accounting for anticipated development and improvement of the water system reliability. All projects developed in the existing and future system evaluations have been prioritized.

7.2 Planning Level Unit Costs

The opinions of probable construction costs are based on conceptual costs obtained from industry manufacturers, previous master planning project experience, master planning costs presented by similar agencies, and bid histories from comparable projects. All cost assumptions are based on 2014 U.S. Dollars. Cost estimates reflect conceptual-level estimates which range between 50 percent above and 30 percent below actual capital costs. Engineering and administration costs are estimated to be 30 percent of the construction costs, Contractor overhead and profit are estimated to be 15 percent of performed work and 12 percent of subcontracted work, and a 25 percent contingency is added to the subtotal of all costs. Costs for land acquisition, right-of-way easements and environmental documentation preparation are not included as part of the estimated costs.

7.2.1 Pipelines

It is common for pipeline unit costs to vary considerably form one community to another. This variation is primarily attributed to the availability of nearby vacant land for construction staging, the age of the community and the magnitude of underground utilities and corridor limitations. For the City, pipeline unit costs are driven by these factors, with minimal change in cost from the actual pipe diameter. Discussions with City staff indicate a cost of $400/foot, regardless of pipe diameter, is to be used in this planning effort.

7.2.2 Reservoirs

Similar to the development of pipeline unit costs, new reservoirs are based on above ground steel tanks, the preferred structure used by the City. The unit cost for new reservoirs is based on $1.00 per gallon. Similar to the development of the pipeline unit cost, a 35 percent factor for design and management related costs are included, resulting in total unit costs of $1.35 per gallon of storage. This cost does not include an allowance for land acquisition.

7.2.3 Booster Stations

The unit costs for pump station improvements are based on the system analysis estimate of additional pumping capacity and the associated increase in horsepower required. For the City, the unit cost is based on the estimated horsepower for the new pump station. Table 7-1 shows the unit cost data used to estimate the cost for each pump station. To these costs, a 35% allowance for design and management related costs should be included.

Table 7-1 Booster Station Unit Costs

Size (hp)	Construction Cost ($/hp)
10	$22,500
25	$18,500
50	$15,000
75	$12,000
100	$9,000
150	$7,500
200	$7,200
250	$6,750
300	$6,300
400	$6,000
500	$5,550
600	$5,250
750 or larger	$4,800

7.3 Recommended CIP

Like most cities, Santa Monica and its supporting infrastructure has continued to evolve over the years, resulting in a wide range of both asset type and asset age. To support the management of these assets, the City has been tracking its assets in Hansen's asset management software program, and in its GIS database.

7.3.1 Pipeline Replacement Program

To proactively move forward with improving long-term asset reliability, a capital rehabilitation program has been developed for the City's buried pipelines, often referred to as linear assets. With approximately 250 miles of buried pipelines, ranging from 1 to 100 years old, focusing on the asset type enables the City to enhance its asset management and reliability program in a proactive manner.

The broad purpose of this program is to maintain and/or enhance system reliability by replacing deteriorated and/or critical assets. In the absence of actual condition assessment data, age is being used to establish an initial pool of assets that are most apt to need additional attention. Since age in and of itself is not an appropriate predictor of pipeline performance, some additional general criteria is required to prioritize the vast number of pipelines that are greater than 50 years old, and effectively implement the capital replacement program. When practical,

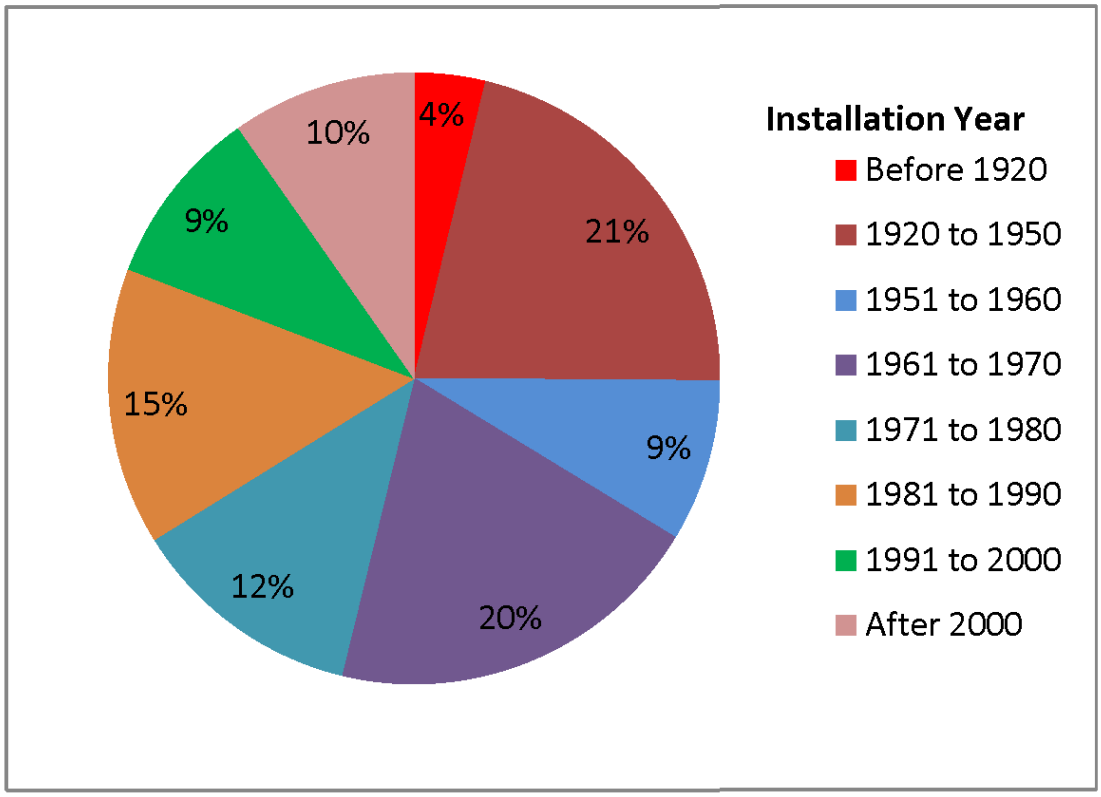
pipeline replacements should be implemented in groups rather than individual pipelines in various streets within the community.

The following criteria (excluding capacity considerations) are ranked in general order of importance and should be considered for the phased replacement of these assets:

1. Leak or main break history
2. Facilities that serve as critical transmission pipelines (if any),
3. Infrastructure or street repavement coordination to minimize community disruption, and
4. Pipelines constructed with Cast Iron.

Since a comprehensive condition assessment has not been performed, pipeline age is used herein been used to establish a programming level priority replacement plan and assess short and long-term funding needs. A summary of the compiled asset age of water system pipelines is shown on Figure 7-1.

Figure 7-1 Age Distribution of Water System Pipelines



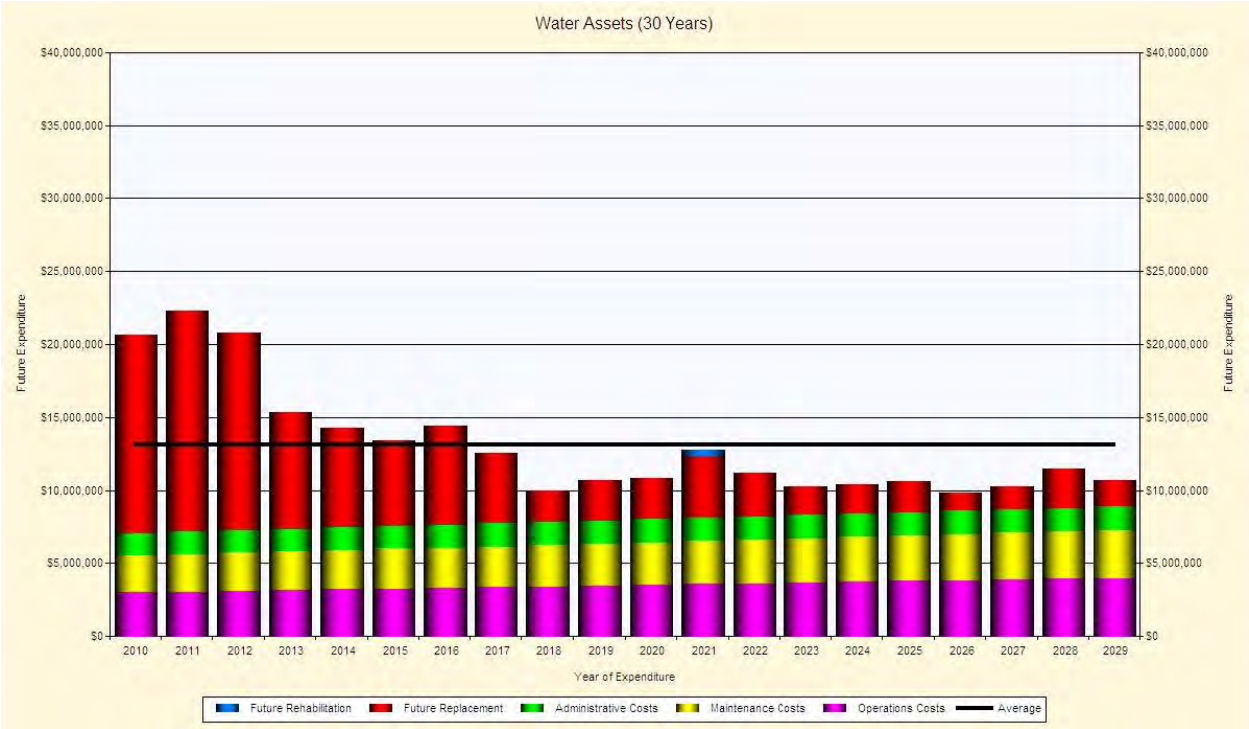
Source: City water system GIS data for underground pipelines, 2014.

As shown, approximately 25% of the water distribution system was constructed before 1950 and is therefore in excess of 65 years old; 4% of the system is approximately 100 years old. With a

planning-level useful life of 80 to 100 years, the City should plan for the repair/replacement of many of the pipelines in the next 10 to 20 years.

It should be noted that the City has developed an asset management system of its underground water pipelines and has budgeted for the methodical replacement of underground infrastructure for many years. The infrastructure replacement line item has historically been underfunded, increasing the risk of water main breaks and system losses similar to the ones experienced by other cities in the area. A projection of the projected capital investment required over the next 30 years for the City's underground water pipeline network was established in the 2010 Asset Management Plan (GHD). The findings of this assessment are shown on Figure 7-2.

Figure 7-2 Water System 30-year Future Investment Projection



Source: Asset Management Implementation Program, December 2010, GHD

As demonstrated in the 2010 Asset Management Plan, the City is projected to need to invest approximately $13 Million per year in the water system pipeline network. The current level of annual funding for this line item is approximately $2 Million in the FY 14-15 budget, down from the originally proposed annual budget level of $3.8 Million to minimize the impacts on water rates at this time.

7.4 Capacity Improvement Program

As previously discussed, a number of capacity related improvements have been identified for the City. These improvements are located throughout the City's service area and consist of

pumping improvements, and increases in pipeline capacity. The costs and prioritization of these improvements are provided herein.

7.4.1 Capacity Related Prioritization Criteria

Similar to the pipeline replacement program, some general criteria are required to prioritize the identified improvements to promote an efficient capital improvement implementation plan. For The criteria for the three primary asset categories (tanks, pumps, and pipes) are as follows:

Storage Tank Capacity Improvements - Storage deficiencies under current conditions are greater priority than future storage deficits. Current storage deficits are prioritized by the severity of the deficiency by pressure zone.

Pumping Capacity Improvements - Pumping deficiencies under current conditions are greater priority than future pumping deficits. Current pumping deficits are prioritized by the severity of the deficiency by pressure zone. Pumping capacity deficits for zones with no alternate supply are greater priority than those for zones with an alternate supply.

Pipeline Capacity Improvements - Similar to the storage and pumping prioritization, pipelines that were identified to have capacity deficiencies under current conditions have a higher priority than those pipelines that exhibited a capacity deficit only under future demand conditions. Additionally, fire flow-related capacity deficiencies have a higher priority than peak hour pressure-related capacity deficiencies, which have a higher priority than deficiencies related to excessive velocity or head loss. The degree of deficiency also provides a tertiary criterion for phasing improvements among both fire flow and capacity improvements.

7.4.2 Capacity Improvement Program Summary

A capacity-based improvement program is derived by applying the unit costs and prioritization criteria to the system hydraulic improvements identified in Section 6. The results are summarized by facility type in Table 7-2.

Table 7-2 Summary of Capacity-Based Capital Improvements

CIP Description	Existing Cost	Future Cost
Pipe CIP	$3,137,000	$0
Storage CIP	$0	$0
Pumping CIP	$2,154,000	$1,677,000
Total CIP	**$5,291,000**	**$1,677,000**

Note that the pumping capacity improvement projects are all for the 350 zone. As noted previously, the 350 zone has an alternate supply from the 500 zone. This fact can be considered when prioritizing CIP projects.

All of the pipeline projects that were identified are recommended to address fire flow-related deficiencies. Because all of these projects were derived based on the same fire-flow related design criteria, there is no effective method of prioritizing these projects based on their capacity

deficiency. However, given that there is already an effort within the City to replace pipes that have reached their useful life, the material of the pipes identified for capacity-based improvements were further examined. From this review, it was determined that the pipes recommended for replacement by CIP projects 1, 2, 6, 7, 8 and 9 were either all or mostly cast iron. Project 10 was a mixture of asbestos cement and cast iron. Projects 4 and 5 were asbestos cement, and project 3 was ductile iron.

To prioritize these capacity-based pipeline improvement projects using material as an indication of age, it is recommended that cast iron pipes be the highest priority, asbestos cement be the second priority and ductile iron be the third priority. Since these particular improvements are primarily facilities scheduled for replacement anyway, the annual capital replacement fund would be an appropriate funding mechanism, suggesting no additional capacity-based CIP line item is required in the City's future budget. Pipeline capacity projects are recommended to be of a higher priority than the pumping capacity deficiency identified for the 350 zone.

7.5 Capital Improvement Program Summary

The City's capital improvement program is formed by merging the capacity, operational, and reliability-related improvements derived herein with other asset management and infrastructure identified by staff in its five year CIP. These programs and projects are developed to address the full range of capacity, reliability, sustainability, and self-sufficiency improvements, and generally phased to incorporate the new facilities associated with the Olympic Sub-basin settlement funds and support the methodical implementation of the SWMP while minimizing the financial impacts on its water system customers. This plan is intended to be a living document and will evolve over time to adapt to new conditions, regulations, operational efficiencies, and local policies.

In addition to the findings of the system hydraulic analysis provided herein, there has been substantial discussion and analysis related to staging and operational requirements of the future water supply portfolio. In particular, there is the need to formalize a water supply plan that aligns with the City's proactive development of the Olympic Well Field Management Plan, the phasing of self-sufficiency improvements and demand management programs, the operational strategies to meet seasonal demands, and the adoption and implementation of appropriate water system funding.

As an implementation element of the SWMP, it is recommended the City consider the development of several additional programs that will support the success of the SWMP. These include:

- Prepare an operational plan that integrates the timing of various supply programs and facilities, documents the sequential priority of each new source of supply, establishes the baseline/peak relationship of the two water treatment plants, and evaluates the seasonal operational plan for each water treatment plant to meet average day, minimum day, and maximum day demands under various hydrologic conditions.

- Develop a Groundwater Management/Sustainability Roadmap to position the City to be the leader of the Santa Monica Groundwater Basin, enhancing its ability to control this local water resource.

- Prepare a Grant Funding Program Plan so that the use of grant funds can be utilized to lessen the impact of these program/facility costs on the City's water customers over the next 10 years.

- Develop an Olympic Water Treatment Plant (OWTP) Technical Oversight Team that will review and evaluate key technical information associated with the new OWTP. This panel of experts will support the City's development of this project and will convene periodically to facilitate the efficient integration of this facility into the City's water self-sufficiency program.

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Appendix A: Miscellaneous Water Conservation Support Material

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History of Water – Efficiency Programs

The City has a strong history of environmental activism and has been implementing water efficiency programs since 1988. In an effort to reach the City's goal to be water self-sufficient by 2020 and meet the State water-efficiency requirements (SBx7-7), the City implements a variety of programs, policies and ordinances.

The Office of Sustainability and the Environment (OSE) manages the City's water efficiency programs and employs five full-time staff and consultants as needed.

Cost to Manage Water-Efficiency Programs

Yearly average budget is approximately $500,000 and include staff, programs, and outreach/marketing. There are 2 full-time staff conservation staff; 1 full-time urban runoff staff member; 2 as needed staff for enforcement/administration (this positions end June 30, 2013).

The City receives on average $22,000 in credits and/or grants from MWD for the installation of water-efficient fixtures within our service area.

The City also received from the California Department of Water Resources $250,000 for sustainable landscape grants and $70,000 for rain harvesting equipment rebates. These grants end December 2013.

Programs

The City provides several programs for residents, businesses, and public agencies to conserve water through retrofits of existing buildings, installation of efficient products in new construction, and changes in behavior.

The City is a member of the California Urban Water Conservation Council and as such is required to implement water-efficiency best management practices (BMPs). The City has opted for the Flex Track approach to meeting the BMPs. The programs listed below and in detail on the following pages describe the City efforts to comply with the BMPs.

The City's Water Efficiency programs, policies and ordinances are listed below.

1. Rebates……page 2
2. Audits and Assessments……..page 6
3. Demonstration Gardens……page7
4. Landscape Workshops……..page 8
5. Outreach……..page 9
6. Policies……page 10
7. Ordinances……..page 11
8. Committees……page 13

1. REBATES

The City participates in MWD's regional rebate programs at www.bewaterwise.com. The City supplements MWD's funding with additional rebate incentives.

MWD Rebates for single-family homes:

High-efficiency Clothes Washers -$300
Smart Irrigation Controllers -$200
(City residents are not eligible for the Rotating Nozzles for Sprayheads rebates because they rebate on nozzles with a precipitation rate that exceeds 0.75 inches/hour which is not legal in SM)

Effectiveness - MWD no longer advertises these rebates nor provides materials directly to the local retail stores in Santa Monica.

Clothes Washer rebates were sluggish at $200 but reached an all-time-high participation rate at $300 (average cost for our residents is $820). Without issuing rebates we won't know how many are installed in the area to meet BMP requirements.

Smart Irrigation Controllers still appear to be a mystery to gardeners, contractors and residents. They require special knowledge for proper installation and programming. Only two models can be purchased at big box stores. The rest must be ordered at irrigation supply stores. Few are kept in stock.

(The MWD Rotating Nozzles for Sprayheads has a minimum of 15 nozzles per home, which is still too high for the average SM home which may only have 10 sprinklers.)

MWD Rebates for businesses:

Smart Irrigation Controllers -$25/station
Central Computer Irrigation Controller - $25/station
Large Rotary Nozzles -$13/set (minimum 8 sets/site)
HETs tank-$150
HETs flushometer -$200
HE Urinals -$250
pH-Cooling Tower Conductivity Controller-$1,750
Dry Vacuum Pump - $400
Connectionless Food Steamers -$685/compartment
Ice-Making Machines $1,200
Laminar Flow Restrictors - $12 (started July 1, 2012)

Effectiveness – MWD doesn't provide marketing at the retail level for this program, just trade organizations or member agency events.

Zero Water Urinals were the number 1 rebated item because one manufacturer had a team of sales people that went door-to-door in many cases and filled out the application for the client. This company is no longer aggressively marketing these urinals.

Dry Vacuum Pumps for dentists' offices could save a lot of water. Two direct mailings to the nearly 60 individual dentists in SM were mailed in 2009 and 2010 but virtually no response.

Ice-Makers are new to the rebate list but few rebates have been issued. Many restaurants buy refurbished equipment for less or they already have air-cooled machines but they are inefficient. The rebate is to replace water-cooled systems only at this time.

Laminar Flow Restrictors was added July 1, 2012. One company installed their laminar flow restrictors in UCLA Hospital in Westwood and they are doing a 2-year research project on bacteria levels. Once this is finished we'll know if they can be in Santa Monica UCLA. This company has provided a quote to do installations at St. John's Hospital in 2013. I'm waiting for the okay. The City will cover the additional $10,000 so there will be no out of pocket expense to St. John's. The projected savings is 1.7 million gallons/year.

pH Cooling Tower Controllers are not moving mainly b/c of the acid required for treatment. There is resistance from the chemical treatment companies and facilities engineers. There could be more potential savings with cooling towers that install a water-softener as a pre-treatment. This water can be cycled many more times than with pH control.

Connectionless Food Steamers could be a potential program at the hospitals. Only a few in opportunities in Santa Monica.

City Rebates:

July 1, 2012 the only City rebate available was the Rain Harvest Rebate so we could evaluate the water efficiency programs as part of the SWMP and marketing survey results.

Rebates July 1 – Aug 2012

- Rain Harvest Rebate – The City provides rebates for rain harvesting equipment.
  - Downspout re-direct -$40
  - Rain Barrels $200
  - Small Cisterns $500
  - Large Cisterns $1,000
- Drip Irrigation - $1,000
- Cash for Grass - $2,000
- Parkway Cash for Grass - $2,000
- Greywater- $75 for clothes washer; $250 for simple and complex systems

Effectiveness for programs implemented in 2011/2012

Rain Harvest Rebates were almost non-existent until Sustainable Works (a local non-profit we fund to implement greening programs for students, residents, and businesses) started selling rain barrels in 2010 made from re-purposed food containers at $100 as part of their fundraiser. In addition, DWR grant increased our rebate from $100 to $200 which covers materials and labor. Since 2010, 351 rain barrels haven installed.

Drip Irrigation was slow to start but was promoted as a special rebate during AltBuild 2012. We hoped to register 50 residents but registered 20. We collaborated with the top 3 irrigation manufacturers that had booths at the event and whose products were listed

on the rebate application. This has a lot of potential as a Do-It-Yourself (DIY) program or promoted by local landscapers/licensed contractors. Converting sprinklers to drip can save up to 80% of landscape water use.

Cash for Grass was slow. It is believed that the daunting application process which requires a pre-inspection and measurement of the existing lawn and sprinklers, in part contributed to the lack of response. Several applicants were denied the rebate, because they had already done the project prior to applying or they had dead grass and no sprinklers. The program was evaluated to for streamlining the process.

Parkway Cash for Grass was challenging. However, there is a lot of potential to eliminate runoff, save water and protect the health of the street trees. Like the Cash For Grass rebate, a pre-inspection was required and sign-off by the City Arborist required prior to starting work. The arborist was busy and not able to do pre-inspections, so the program couldn't move forward as designed.

Greywater has not been a successful program. We had a lot of calls and demand for greywater systems but to date only 6 have been permitted in Santa Monica. We don't know how many clothes washer systems have been installed. We offered 2 free workshops with free kits worth $100 (essentially a complete clothes washer greywater kit) and only three residents registered, so the workshops were cancelled. However, we could have filled the classes up with residents from LA and beyond (we even had one person from Mexico want to sign-up). We marketed this program for months through ads, emails, websites, displays at the Main library, press release. We also offered a rebate for 2 years and did not have a single participant take advantage of the rebate.

Rebates Implemented in 2012/2013

Rain Harvest Rebate – The City provides rebates for rain harvesting equipment.

- Downspout re-direct -$40
- Rain Barrels $200
- Small Cisterns $500
- Large Cisterns $1,000

Landscape Rebate – up to $3,000

- Cash For Grass $1.50/square foot
- Drip Irrigation $1.00/square foot
- Sprinkler System $0.75/square foot

Customers can mix and match these rebates to fit their individual needs. No pre-inspections are required. There is a short on-line application. A final inspection is required to ensure that qualified parts are installed per the Green Building Ordinance requirements. No receipts required unless the project is very small and is questionable if it cost up to $3.25/square foot (if doing all 3) or $3,000.

So far this program has been very well received by the residents and landscapers. Residents like that it's easy to participate. Landscapers like it b/c they don't have to share their itemized receipts with the residents.

Since September 2012, 39 projects have been completed.

Sustainable Landscape Grants

Grants up to $3,500 per project that incorporate a water-efficient irrigation system that meets local ordinances plus $1,500 for climate-appropriate plants.

Effectiveness – the Grant began in 2004 when Council reauthorized a zero interest loan program for large businesses to retrofit their plumbing fixtures into a landscape grant program for all property owners. The loan was used by 14 large customers including hotels and office buildings to retrofit their toilets and urinals.

The reason for doing the grant was to have some beautifully designed and properly installed sustainable gardens throughout the community to serve as showcases for residents and landscape professionals. It was apparent at that time that few landscape designers/architects knew how to design these types of gardens and even fewer understood water efficient irrigation systems. It was also apparent that contractors knew nothing about these plants and irrigation systems nor our own plan checkers/inspectors. It was also apparent that these plants and equipment were not readily available at local stores. We needed an entire market transformation. We had been promoting sustainable landscaping since 1990 when we installed the first demonstration garden at City Hall.

We used the information we learned from this program to write a local landscape and irrigation ordinance that was adopted in 2008, which was used as a basis for AB 1881.

From 2004-2008, we gave away $160,000 in grant funding per year through a competitive process. Applicants ranked the highest received up to $20,000 to install new irrigation, new climate-appropriate plants, permeable paving, greywater/cisterns, and weather-based controllers.

In 2008, we received a DWR grant to fund 50 more gardens. However funding was halted until 2011. Starting in 2008 we changed the grant from $20,000 to $5,000 and made it first-come, first-served in order to get more bang for our buck. This change significantly increased the number of projects.

In 2011 we added criteria that the existing lawn must be 1,000 square feet with operational sprinklers. This has decreased the number of applicable projects.

In 2013 we are focusing only on the top single family water users. A direct mailer from Dean was sent in February to the top 40 users. One has returned the application. Follow-up phone calls will be made in March.

Continuing challenges include knowledgebase of landscape professionals including architects, designers, irrigation designers, contractors, gardeners, plan checkers, inspectors, irrigation supply store staff, and big box store staff as well as a lack of available equipment, and lack of local nurseries carrying climate-appropriate plants.

The number one issue we have is the 100% failure rate for properly installed valves with back flow prevention. Contractors and gardeners use the wrong flow rate valve, install it below the required height and use schedule 40 PVC instead of schedule 80 PVC. This occurs even when the contractor/gardener has an approved and stamped set of plans

that include specific make and model numbers and specs and details. Contractors are not trained properly.

2. AUDITS & ASSESSMENTS

Green Business Certification Water Assessments

The City partners with Sustainable Works to provide free assessments to local businesses that are participating in a voluntary green certification program to ensure the property is utilizing water-efficient fixtures and landscaping.

Effectiveness – is extremely limited because most businesses participating are small and only occupy one suite in a larger building. If the business is not responsible for maintaining the plumbing fixtures, they are still awarded certification for inefficient fixtures. The participants are required to send a letter to the landlord notifying them of the certification and programs the city has to offer to upgrade fixtures.

Bay Saver Water Assessments

The City offers free water assessments for residents and businesses. Assessments include audit of toilets, showers, faucets, laundry, landscaping, cooling systems, and kitchens. These audits are also used for residential properties still paying the Bay Saver Fee.

Effectiveness – These assessments are not taken advantage of nor prominently advertised. The properties still paying the Bay Saver Fee are usually multi-family where only a few units have not been upgraded.

Landscape Audits of dedicated City landscape meters

OSE staff has performed landscape audits for a few City owned and maintained landscapes that have dedicated landscape water meters. In addition, the City has been using a weather-based central irrigation control system since 1994 (the first of its kind in the US). This system uses real-time local weather data to water the plants as needed.

Effectiveness – The audits required that each zone be evaluated separately and combined with zones that overlapped. That required that multiple zones be on during the day-time, which interfered with the public's use of the parks/open spaces. It also meant that weather conditions were very different (windy during the day) from the typical weather conditions experienced at night when the system operates. Just by turning on the zones without a formal evaluation showed deficient and inherent design flaws that couldn't be fixed even with formal audit results. The flaws included poor distribution uniformity from the placement sprinklers, poor pressure regulation, mix-matched precipitation rates. These flaws can't be fixed by simple adjustment or watering schedules.

However, city landscape use has decreased 17% since 2007. OSE is developing water budgets for the oldest and newest parks to compare their budgeted use with actual use and determine if other sites should be given water budgets. This has been extremely time intensive due to GIS problems and intern availability.

3. DEMSONTRATION GARDENS

Demonstration Gardens

The City has 4 very successful demonstration gardens that highlight water-efficient irrigation, climate-appropriate plants, rainwater mitigation, permeable paving, and integrated pest management. The Gardens include: City Hall, garden\garden, and Airport Avenue Demonstration.

garden\garden includes 2 distinct gardens that are side-by-side. One garden is California native plants with drip irrigation, weather-based controller, permeable paving, and a rainwater infiltration pit below a dry creek bed. The other garden is a traditional high-water use garden with lawn, shrubs and sprinklers. Water consumption data, green waste generation and labor hours have been collected and posted since 2004. The native garden uses 80% less water; generates 60% less waste and requires 50% less maintenance.

Airport Avenue Demonstration Garden includes 3 separate designs demonstrating the latest trends in sustainable home gardens: veggie gardens, outdoor rooms, lawn alternative, rainwater harvesting, permeable paving, and native and Mediterranean plants. The designs, complete with a list of materials and local stores that provide these plants and equipment, are available on-line.

City Hall Garden is our oldest demonstration garden and continues to thrive. With the upcoming Town Center and Palisades Walk projects, this garden will be reduced in size to accommodate handicap access ramps. The landscape will fit in with the new climate-appropriate plants in the new park. However, City Public Landscape staff refused to use drip irrigation with SMURRF water so traditional non-efficient sprinklers will be used. The project will be given a water budget but no penalties will be applied for non-compliance.

Beach Maintenance Garden includes urban runoff mitigation using a bioswale that collects waste water from the truck washing station in addition to salt-tolerant low water using plants and drip irrigation.

<u>Effectiveness</u> – these have been invaluable as showcase examples for the public to visit and get ideas that they can incorporate into their own gardens. garden\garden's data has been cited in many articles and used by many other agencies. It is a clear example of actual water savings from switching irrigation and plants.

4. **LANDSCAPE WORKSHOPS**

Sustainable Landscape Workshops for Homeowners

Twelve hands-on workshops are held each year to help residents design and install sustainable gardens. Each month a different topic is discussed such as veggie gardens, composting, picking the right plants, drip irrigation, etc.

Effectiveness – this series started in 2004 with just one class a year. We quickly realized the need and desire from the community to provide more detailed classes for the DIY crowd. The classes are open to the public. Each one has about 30 to 80 attendees. Veggie gardening and composting classes are the best attended. These classes take a lot of staff time and few residents have actually changed their gardens, so in FY12/13 many of these classes will be taught by MWD consultants.

Sustainable Landscape Workshops and Seminars for Landscape Professionals

Three separate series are provided free for Landscape Architects/Designers, contractors, and maintenance professionals. Each class covers a different topic designed to educate professionals regarding the latest water-efficient irrigation equipment, such as drip irrigation, weather-based controllers, water budgets, sustainable landscape principles, such as hyrdozoning, and local landscape related policies and ordinances. The maintenance series is taught in both English and Spanish. Two gardener classes were provided in Spanish but not well attended even though we gave out flyers to every gardener we saw in the field each day over a month and posted at lawn mower repair shops.

Effectiveness- the classes for architects/designers is very well attended with many of the same people attending multiple years in a row. The contractor and maintenance classes are not well attended but we have done virtually no marketing for any of these classes. We especially want to target the gardeners who maintain ~80% of the residential landscapes in Santa Monica. They have virtually no knowledge of proper maintenance for sustainable landscapes. Educating them will have a regional impact since they work all over LA county.

5. OUTREACH

Outreach

Extensive resources are available on-line or upon request. Staff makes presentations at various community meetings and conferences.

- Watch The Water – a water conservation campaign designed to help residents and businesses save 20 gallons of water each day during the current water shortage advisory. Tip sheets are available on-line at www.sustainablesm.org/water. Free showerheads, faucet aerators, hose-nozzles and shower timers are provided to customers upon request.
- Websites: www.sustainablesm.org/water
  - www.sustainablesm.org/landscape
  - www.sustinablesm.org/RUS
  - www.ssutainablesm.org/gardengarden
  - www.lacoastalgardens.com
- Tabling Events: Santa Monica Festival; AltBuild; AltCar
- Recycling/garbage Truck signs
- CityTV ads, packages, slides
- Seascape community newsletter article quarterly
- E-news letter sent monthly
- Social marketing via Facebook and Twitter

Effectiveness

Since 2011 the city has done minimal marketing in addition to the website, Facebook/Twitter, Seascape newsletter, and our email newsletters. A marketing firm has been hired to develop a campaign.

The City lacks an organized school program. MWD does most of this for us now. It is difficult to get into the schools. However SMMUSD is working toward implementing more sustainability-based curriculum, so this may help.

6. POLICIES

Sustainable City Plan (SCP)

The SCP sets goals in the area of resource conservation, including water demand reductions, for city operations and the community. The most recent SCP goal is a 2.6 million gallon per day water savings by 2010. The SCP goal will be updated in 2013.

Effectiveness – This policy provided goals for which programs were implemented and funding made available. The next update to the SCP will need to reflect upon the city's new goal for self-sufficiency by 2020 and SBx7-7 compliance requirements.

The Parkway Policy

This is now referenced in the Urban Forest Master Plan 2012, which includes water-efficient irrigation and landscape guidelines in parkways. Parkways are a liability issue that the City is still grappling with given the uncertainty of who actually owns them.

Effectiveness – This is a policy and is not enforceable. However, many new landscapes are following this policy.

7. ORDINANCES

Effective July 1, 2013 enforcement of these codes will be handled by the City's Code Compliance Division. OSE will no longer be enforcing (warning/citing) them.

Retrofit Upon Sale Ordinance (RUS)

Any property transferred or sold in the City must have low flow toilets (1.6 gpf or less), showers and faucets (2.5 gallons per minute or less) as a condition of escrow. City certified plumbers perform verification inspections to ensure compliance. SMMC 7.18

Effectiveness – for the past 7 years the percentage of properties not in compliance has ranged from 5% to 12%. The majority of the non-compliant fixtures are toilets followed by faucets. On average 60 toilets are replaced annually with 1.28 gpf toilets (local ordinance changed in 2012) which will save on average 1 acre feet per year. This program takes approximately 10 to 15 hours of staff time per week to implement. We will recommend that this ordinance be repealed and let state laws AB 715 and SB 407 define local requirements.

Bay Saver Fee

This fee is charged to all single-family ($2/bill) and multi-family ($1.60/unit/bill) properties until those properties are retrofitted with low flow toilets, showers and faucets. City staff perform compliance inspections.

Effectiveness – works well in conjunction with RUS. When a property is RUS certified the Bay Saver Fee is removed. However, the fee is low and most residents think it's a water quality program and are willing to keep paying it. Because of rent control and the tenuous relationship between tenants and landlords, many renters will not allow the landlords in their unit to upgrade the fixtures. The majority of customers paying this fee are multi-family condos.

Water Conservation Ordinance

Water waste is prohibited. OSE staff actively enforce this ordinance by patrolling the city looking for violations such as irrigation overspray and runoff, hosing of hardscapes, watering during prohibited times of the day, and leaks. SMMC 7.16

Effectiveness – we see a decrease in runoff when staff routinely patrol for this ordinance. However, the overall water use for those customers warned/cited went up 119,000 gallons one year later. With OSE's enforcement of the leaf blower ban, staff has seen a dramatic rise in hosing violations.

Green Building Ordinance

This ordinance requires energy star fixtures such as clothes washers in new or remodeled buildings. Water-efficient irrigation and landscaping standards are required to be met for all new or remodeled landscapes. OSE reviews and approves landscape and irrigation plans and performs inspections. SMMC 8.108

Effectiveness – this ordinance was developed based on staff experience in the field as a result of the sustainable landscape grant. Landscapes were poorly designed, installed, and maintained. There is a lack of training in this area for landscape professionals. Much of staff's time is dedicated to educating residents and landscape professionals about sustainable landscaping, which is very complex. This ordinance has the potential to save millions of gallons per year. However, with limited staff to inspect all landscapes being installed many inefficient landscapes will continue to be installed. Building and Safety and Planning do not feel that this water conservation ordinance fits into their framework for safety and discontinued plan checking and inspecting. OSE took back this role in 2012. There is a need to help other divisions understand the need for water conservation/water self-sustainability.

Water Shortage Response Plan

A plan to achieve immediate water savings during an emergency water shortage was adopted by Council in June 2009. Currently the City is in a Water Shortage Advisory, and water customers are asked to voluntarily reduce water use by 10%. SMMC 7.16

Effectiveness – we are currently in an Advisory Level Water Shortage which was heavily promoted in 2009-2010. But when the Governor declared an end to the drought in 2010, water use began to rise.

Greywater

The City has developed a guideline for the permitting and use of simple and complex greywater systems. This guideline was developed in cooperation with the Los Angeles County Public Health Department and is being modified to help streamline the process. OSE was able to have the permit fees waived for these systems, except for combination permits for large scale remodels or new construction.

Effectiveness – Greywater programs have not been successful, as only 6 systems have been permitted since 2005. There is concern about drain line carry due to inadequate flow in older buildings that install high-efficiency fixtures and a greywater system. In addition, in Australia greywater systems are exempt from drought restrictions and as a result many residents would turn on clothes washers with no clothes just to water their landscapes (this information was provided by a delegation visiting from Melbourne in 2010).

Leaf Blower Ordinance

Staff enforces this ban on all types of leaf blower equipment. Although not related to water efficiency, OSE enforces this ban and has seen an increase in hosing as a result as an alternative cleaning practice.

8. COMMITTEES

MWD Conservation Coordinators Committee and Program Advisory Committee – meets monthly to share ideas, programs, challenges, solutions to water-efficiency issues on local, regional, state levels.

CUWCC Landscape Committee – meets monthly to discuss current BMP requirements and potential ones.

Santa Monica Malibu School District Green Team- just forming a district-wide team with a goal to have the district adopt a sustainable school plan and implement more projects that save water and energy.

For more information, visit www.sustainablsm.org or call Kim O'Cain at (310) 458-8459.

City of
Santa Monica®

CITY OF SANTA MONICA

WATER SHORTAGE RESPONSE PLAN

Note: This Water Shortage Response Plan is subject to modification and amendment from time to time. The reader is advised to contact the City of Santa Monica to review the most up to date version of the document.

Department of Public Works
Water Resources Division
1212 5th St.
Santa Monica, CA 90401
(310) 458-8975
www.smgov.net/water

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Section 1: Introduction

The City of Santa Monica City Council adopts this Water Shortage Response Plan (WSRP) pursuant to Santa Monica Municipal Code ("SMMC") section 7.16.030. The WSRP is intended both as an action plan and as the implementing regulations for water conservation as authorized by Section 7.16.030. It is designed to reduce water demand during water shortages. The WSRP is based in part on the State of California Department of Water Resources *2007 Urban Drought Guidebook*. The Urban Water Management Planning Act (Section 10632 of the California Water Code) requires water shortage contingency planning as a component of the Urban Water Management Plan, which is updated every five years.

The WSRP establishes five stages of water shortage severity based on predicted or actual water supply reductions. Each stage establishes water use reductions through voluntary or mandatory measures. Triggers for implementing the WSRP may include such events as a state or local emergency; natural disaster; a localized event that critically impacts the water supply; drought or the City's wholesale water agency imposing water allocation restrictions.

Section 2: Objectives and Priorities of Water Use

A. The objectives of the WSRP are to:

(1) Prioritize essential uses of available water;
(2) Avoid irretrievable loss of natural resources;
(3) Manage current water supplies to meet ongoing and future needs;
(4) Maximize local municipal water supplies;
(5) Eliminate water waste city-wide;
(6) Create equitable demand reduction targets; and
(7) Minimize adverse financial effects.

B. The following priorities for use of available water are listed in order from highest to lowest priority:

(1) Health and Safety including: consumption and sanitation for all water users; fire suppression; hospitals, emergency care, nursing and other convalescent homes and other similar health care facilities; shelters and water treatment;
(2) Institutions, including government facilities and schools such as public safety facilities, essential government operations, public pools and recreation areas;
(3) All non-essential commercial, institutional, and residential water uses;
(4) New water demand.

Section 3: Triggers for Implementation

The City Council may declare by resolution that an Advisory or Stage 1, 2, 3 or 4 Water Supply Shortage exists and that the actions outlined in this WSRP are necessary. Upon Council adoption by resolution, any Advisory or Stage may be rescinded. The type of event which may prompt the City Council to declare an Advisory or Stage1, 2, 3, 4 Water Supply Shortage may include, among other factors:

- Drought;
- State or local emergency;
- A natural disaster that critically impacts the water treatment or water distribution system;
- A localized event that critically impacts the water supply, water quality, water treatment or water distribution system;
- The City's wholesale water agency requests extraordinary water conservation efforts in order to avoid mandatory water allocations;
- The City's wholesale water agency implements a water allocation.

Section 4: Stages of Water Shortage Supply

The WSRP establishes five stages of severity based on predicted or actual water supply reductions. Each stage establishes water use reductions either through voluntary or mandatory measures. Mandatory water restrictions include water use allowance for each water customer category. Table 1 below outlines the stages and water use reduction goals.

Table 1: Water Shortage Reduction Targets

Water Shortage Stage	Water Use Restrictions	City-wide Use Reduction Goal
Advisory	Voluntary	10%
Stage 1	Mandatory	15%
Stage 2	Mandatory	20%
Stage 3	Mandatory	30%
Stage 4	Mandatory	50%

Section 5: Water Use Restrictions for All Stages

The following water conservation requirements apply to all persons within the City of Santa Monica and are permanently enforced in accordance with SMMC section 7.16.

The following water use restrictions shall apply as a result of implementing in addition to SMMC 7.16 during any stage of the WSRP:

Section 6: City of Santa Monica Staff Responsibilities

(A) City staff will be informed of the water supply shortage. Each staff member will be expected to use water efficiently.

(B) The City's landscaped areas will be efficiently irrigated based on the Irrigation Association's Best Management Practices.

(C) Each staff member will be expected to notify the appropriate City department immediately of any leaks seen on City property or private property.

Section 7: Water Allowances for Stages 1,2,3,4

A Water Use Allowance (WUA) is established for each water customer. Examples of Water Allowances are found in Exhibits 1 and 2.

The WUA shall not apply to:

(A) Any water customer of the City of Santa Monica during an Advisory water supply shortage stage;

(B) Any water customer account designated for municipal non-potable water.

Summary of Allowances

A water use allowance is the maximum allowable amount of water that could be used by a water customer and it is calculated as a percent reduction in the amount of water available for each water customer in the City of Santa Monica for the duration of a declared water shortage.

The water use allowance is calculated as a percentage of the baseline year's water usage. The baseline is calendar year 2013. Each water customer will receive a water use allowance for each billing period. A billing period is approximately 60-days.

Public agency individual landscape only accounts will be combined and receive one water use allowance. Water Use Allowances for new water accounts, new water customers, properties vacant in 2013, and water accounts with zero usage in 2013 will be based on the average usage of water customers in the same water customer class (single-family, multi-family, mixed-use, commercial, industrial, landscape, etc.) with the same meter size.

For example a single-family water customer whose home was vacant due to a remodel in 2013 and as a result of the remodel their meter size increased from ¾ inch to 2 inch because the house size increased significantly, would get a Water Use Allowance that was the average of other single-family homes with a 2 inch meter.

Water Use Allowances

Table 2: Water Use Allowance for all Water Customers

	Stage 1	Stage 2	Stage 3	Stage 4
% Water Available per Customer	85%	80%	70% or	50%

Residential Water Conservation Thresholds – see Exhibit 1 for calculation

Water Shortage Supply Stage 1 & 2

Penalties will not be assessed for single family customers using less than 22 HCF per bi-monthly billing period and each multi-family unit per building using less than 11 HCF per bi-monthly billing period.

Water Shortage Supply Stage 3 & 4
Penalty surcharges will not be assessed for single family customers using less than 16 HCF per bi-monthly billing period and each multi-family unit per building using less than 8 HCF per bi-monthly billing period.

Section 8: Penalty

When a water customer's water usage exceeds the applicable Water Use Allowance during a billing period, a Penalty may be imposed. The notice of the penalty may be issued to the responsible party in the same mailing as the water bill and will be calculated as set forth below.

Customers that exceed their Water Use Allowance for one or more billing periods and are penalized but subsequently stay within their Water Use Allowance for three consecutive billing periods (6 months), would have their violations reset to zero. If the customer then exceeds their Water Use Allowance, that violation would be considered a first violation.

Customers that exceed their Water Use Allowance 3 times may be required to have a water audit performed by a licensed engineering firm with water audit experience to be paid by the water customer. The audit must be performed and a full report submitted to the City of Santa Monica within 30-days of notice. The audit report must include how the audit was administered, list all interior and exterior uses of domestic and non-domestic water uses, results of the audit, recommendations, and return on investment calculations. The City may require all or a portion of the audit recommendations be performed within 60-days of notice. After recommendations are performed, a request for a water use allowance adjustment may be made.

Customers that exceed their Water Use Allowance seven or more times must pay the full amount of the penalty and may have a flow restrictor installed in the meter which restricts the flow of water going into the building, be charged with a civil penalty, and/or be charged with a criminal penalty.

The water customers/responsible party that exceeded their Water Use Allowance for one or more billing periods and were penalized but stay within their Water Use Allowance for three consecutive billing periods, their violations will be reset to zero. If responsible party then exceeds their Water Use Allowance, that violation would be considered a first violation.

Section 9: Water Use Allowance Adjustment

Application for Water Use Allowance Adjustment

- Comply with requirements listed under Required Finding for an Adjustment.

- Fill out a Water Use Allowance Adjustment application available at www.smgov.net/water and 1717 4th St., Suite 150, Santa Monica, CA 90401.
- Submit completed application and required supporting documentation (such as photographs, itemized receipts, maps, drawings, engineering reports, water audit reports, utility bill showing participation in any low income assistance program, or other pertinent information) by mail or in-person at 1717 4th St., Suite 150, Santa Monica, CA 90401.

Determination of a Water Use Allowance Adjustment

An adjustment to increase a water customer's Water Use Allowance may be granted or conditionally granted only upon a written finding of the existence of facts demonstrating:

- an undue hardship that would result in an emergency condition relating to health and safety or
- an undue financial hardship to a single-family water customer; or
- a new water account is requested; or
- properties were vacant during 2013 but are inhabited as of January 1, 2015; or
- increase in household size; or
- change in tenancy

Approval Authority

The Adjustment Administrator will exercise approval authority and act upon any completed Water Use Allowance Adjustment Application after submittal and may approve, conditionally approve, or deny the adjustment request. The applicant requesting the adjustment will be notified in writing of any action taken.

The decision of the Adjustment Administrator shall be issued within sixty days after the conclusion of the hearing or the submission of all written materials if no hearing is conducted. The water customer may appeal any such decision pursuant to Chapter 6.16 of this Code. Unless specified otherwise at the time the adjustment is approved, the adjustment applies to the subject property during the term of the applicable stage of the WSRP.

Required Findings for an Adjustment

An application for an adjustment will be denied unless the approving authority finds, based on the information provided in the application, supporting documentation, and/or such additional information as may be requested, and on water use information for the property as shown by the records of the City of Santa Monica, all the following:

1. The subject property has implemented all practical water saving measures at minimum unless unique circumstances that makes meeting these requirements impossible:
    a. High-efficiency toilets (uses1.28 gallons per flush or less)
    b. High-efficiency urinals (uses 0.5 gallons or less per flush or is waterless)
    c. High-efficiency showerheads (uses 2.0 gallons per minute or less)
    d. High-efficiency faucets (uses 1.5 gallons per minute or less for residential or guest rooms; uses 0.5 gallons per minute or less for commercial)
    e. No leaks anywhere on the property
    f. No irrigation runoff and overspray

2. That the adjustment does not constitute a grant of special privilege inconsistent with the limitations placed upon other City of Santa Monica water customers.
3. That because of special circumstances applicable to the property or its use, the requirements of the Water Shortage Response Plan would have a disproportionate impact on the property or use that exceeds the impacts to customers generally.
4. That the adjustment will not materially affect the ability of the City of Santa Monica to effectuate the purpose of the Water Shortage Response Plan and will not be detrimental to the public interest.

Section 10: Definitions

Billing Period. The billing period is approximately 60 days between water meter readings;

Commercial Water Customer. Any water customer whose property is not designated as single family, multi-family or landscape only. This may include mixed-use properties, schools, businesses;

HCF. The billing measurement for water in hundred cubic feet. One HCF is equal to 748 gallons;

Irrigation. Any system for distribution of pressurized water in the landscape, including but not limited to any system in which any portion is installed below grade or affixed to any structure;

Landscape. Modification of the ground surface with live planting materials such as trees, shrubs, turf, groundcover or other horticultural materials; as well as non-living materials such as mulch, synthetic turf, hardscape, or stone;

Landscape Only Account. Any water meter installed to measure the flow of water for irrigation and landscape purposes only;

Master Meter Account. A meter that serves multiple tenants in a building and may include but is not limited to water used for common areas such as toilets, urinals, laundry, irrigation equipment and pools;

Multi-Family. A residential property with two or more units on the premises. This may include master metered or individually metered units;

Multi-Family Individual Meter Account. A meter that serves only one unit and does not include outdoor or landscape water use;

New Water Account. A new water service connection where one was not previously installed;

Responsible Person. Also referred to as the water customer.

Potable Water. Water suitable or intended for human consumption;

Single-Family. A residential property with one unit;

Shortage. The actual or projected demand for water placed upon the water supply system by water customers which exceeds the actual supply, where the actual supply of water is the amount of water available for delivery from the municipal water supply system for subsequent delivery to water customers;

Water: All potable water supplied from the municipal water supply system to any water customer. Non-potable water that is metered separately is excluded;

Water Customer. The person designated on the water account records maintained by the City as the person responsible for payment of charges incurred for the use of the water supply system.

Water Demand. The amount of water used by water customers;

Water Use Allowance. The amount of water assigned to water customers based on a percentage of the baseline water usage.

Exhibit 1 – Residential Water Conservation Threshold Calculations

The water use allowance is a percentage of 2013 water usage. Each water customer will receive a water use allowance for each billing period. Residential water customers that are at or below the residential water conservation threshold outlined in Section 7 will not need to reduce water use.

The residential water conservation thresholds are calculated based on the following:

Assumptions for Calculating the Water Conservation Thresholds:

1. Number of Single Family Residents per Home = 4 (based on 2010 Census data)
2. Number of Multi-Family Residents per Unit = 2 (based on 2010 Census data)

Table 5: Water Use Gallons Per Capita Day Calculation Stage 1 & 2 based on AWWA Residential End Uses Report and pre-2013 plumbing code standards

Allocated water use is 68 gallons per capita per day (gpcd)		
Toilets	5 flushes x 1.6 gallons per flush	8.0
Shower/bath	5 min x 2.5 gallons per minute	12.5
Clothes Washer	1/3 load	6.0
Kitchen/Dishwasher	4 gpcd	4.0
Bathroom Sinks	4 gpcd	4.0
Inside Total (gpcd)		34.5
Cleaning/outdoor Use		33.5
TOTAL		68.0 gpcd

Table 6: Water Use Gallons Per Capita Day Calculation Stage 3 & 4 based on AWWA Residential End Uses Report and 2013 plumbing code standards

Allocated water use is 50 gallons per capita per day (gpcd)		
Toilets	5 flushes x 1.6 gallons per flush	8.0
Shower/bath	5 min x 2.5 gallons per minute	12.5
Clothes Washer	1/3 load	6.0
Kitchen/Dishwasher	4 gpcd	4.0
Bathroom Sinks	4 gpcd	4.0
Inside Total (gpcd)		34.5
Cleaning/outdoor Use		15.5
TOTAL		50.0 gpcd

Single-family Water Customer Threshold Calculation:
68 gallons gpcd x 4 people x 60 days (bi-monthly billing period) x 748 gallons (HCF) = 22 HCF

Multi-family Water Customer Threshold Calculation:
68 gallons gpcd x 2 people/unit x 60 days (bi-monthly billing period) x 748 gallons (HCF) = 11 HCF/unit

Table 7: Threshold Water Use Billing Unit (HCF) Calculations

	Stage 1 & 2	**Stage 3 & 4**
Single Family Water Account	22 HCF/bi-monthly billing period	16 HCF/ bi-monthly billing period
Multi-Family Master Meter Water Account	11 HCF//unit/ bi-monthly billing period	8HCF/ unit/bi-monthly billing period

Appendix B: Statistical Analysis of Historical Water Demand Support Material

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November 12, 2012

Memorandum

To: Gil Borboa, Water Resources Manager

From: Roger Null; Ganesh Rajagopalan

Subject: Potable Water Demand Analysis: Effects of the Economy and Climate on Historical Water Demands
K/J 1283015*00

Water use by residential, commercial and other water customers can be affected by climate (e.g. evapotranspiration (ET), precipitation) and economic factors. Generally, increased ET is associated with increased water use. Also, time periods characterized by good economic conditions are often associated with higher water use than time periods when economic conditions are poor.

The extent of these effects may vary based on local conditions and can be significant. For example, previous studies by Kennedy/Jenks Consultants found that enhanced economic conditions could result in an increase in water demands by as much as twenty percent (20%). Increased demands may result in the need for additional system capacities, enhanced water conservation efforts in order to comply with state mandates, and/or need for additional water supply sources. Hence, it is essential to evaluate the effect of these factors for the City of Santa Monica (City) as a component of the larger water master planning effort.

Effects of Economy and Climate on Water Demands

Historic water use data (years 2001 to 2012) for various customer types were obtained from the City's Sustainable Water Master Plan, and tabular data extracted from the City's previous Urban Water Management Plans (UWMPs).

Subsequently, regression analyses were performed to evaluate the correlation between water use among various customer types and weather (ET, precipitation) and economic (unemployment rate) factors. The City has several different potable water customer classes, including single family residential (SFR), multi-family residential (MFR), commercial/Industrial, and landscape irrigation. The water use customer categories selected for analyses are shown in Table 1.

Table 1: Water Use Customer Categories

Water Use Type	Average Water Use (AF) (and Number of Accounts)
SFR	3,390 (7,516)
MFR	5,960 (6,059)
Commercial/Industrial	3,660 (2,263)
Landscape Irrigation	540 (470)

Evapotranspiration data for these analyses were obtained from the California Irrigation Management Information System (CIMIS) database. Data from Station #99 (Santa Monica) was used for the ET regression analysis. Precipitation data for the City was also obtained from CIMIS database. Unemployment data for the City was obtained from the State of California Employment Development Department database.

Results of the regression analyses indicated that for the City, the water use for SFR, MFR, and landscape irrigation correlate better with the unemployment rate (R^2 of 0.56 to 0.73) than with weather related variables. While water use decreased with an increase in the unemployment rate, the commercial/industrial class did not have a significant correlation with unemployment. Similarly, no significant correlation was observed with ET or precipitation (R^2 less than 0.2) for any of the customer categories.

Table 2 shows the equations developed for the correlation of the customer categories, labeled as water use types in the table, with unemployment. Graphical results of the economic and weather related water demand analysis are provided in Appendix TM-A of this Technical Memorandum.

Table 2: Regression Equations Used for Each Water Use Type

Water Use Type	Correlation Equation with Unemployment[(a)]
SFR	y= -0.0124X + 0.5296
MFR	y= -0.0183X + 1.0559
Commercial/Industrial	NA
Landscape Irrigation	y= -0.0687X + 1.5848

Notes:
(a) y = Water use (AF/Connection); x = Unemployment rate (%); NA – Not applicable since the R2 value is low

The equations in Table 2 were used to determine the coefficients of determination (R^2) for each water use type. Higher values of R^2 (1 being the maximum), indicate that the regression line fits the data set well. For this data set, it is assumed that R^2 values higher than 0.55 indicate a significant relationship between the data set and the correlating factor (i.e. unemployment rate, ET). The R^2 values for this data set are listed in Table 3. Table 3 also displays additional information, such as the 2012 water use and the percentage of use for each customer category.

The "Adjustment Factor for Good Economic Conditions" column shows approximately how much the water use would increase if the unemployment rate were to decrease to the 10th percentile unemployment rate (i.e. the unemployment rate will be lower than this value 90% of the time) of 4.1 percent from the 9.77 percent in 2012. Depending on the type of water user, 2012 demands could be expected to increase 12 to 43 percent under good economic conditions. The weighted adjustment factor considering all the customer classes used in the analyses is 10.9%, which means the overall 2012 water use is expected to increase by approximately 10.9% under good economic conditions.

The "Adjustment Factor for 50th Percentile Unemployment Rate" column shows approximately how much water use would increase if the unemployment rate were to decrease to the 50th percentile unemployment rate (years 2000 – 2012) of 5.5 percent from the 9.77 percent in 2012. In this scenario, 2012 demands could be expected to increase 9 to 32 percent, depending on the specific customer category. The weighted adjustment factor considering all the customer classes used in the analyses is 8.2%, which means the overall 2012 water use is expected to increase by approximately 8.2% under the 50th percentile unemployment rate. This is important because year 2012 was a recessionary period with a high unemployment rate in the City of Santa Monica service area (approximately 9.77 percent), which resulted in lower water use.

Table 3: Water Use, R^2 Values, and Adjustment Factors by Customer Category (2012)

Water Use Type	2012 Water Use (HCF) (% of Total Demand)	R^2 Value for Unemployment	Adjustment Factor for Good Economic Conditions (Unemployment Rate = 4.1%)[(a)]	Adjustment Factor for 50th Percentile Unemployment Rate of 5.5%[(b)]
SFR	3,034 (24.50%)	0.7265	17%	13%
MFR	5,380 (43.44%)	0.6999	12%	9%
Commercial/Industrial	3,520 (28.42%)	0.2313	NA	NA
Landscape Irrigation	452 (3.65%)	0.5524	43%	32%
Totals	12,386 AF		13,970	13,400

Notes:
(a) Adjustment Factor for Good Economic Conditions = Percent Change in water use relative to 2012 use if the unemployment rate were to decrease to the 10th percentile unemployment rate (i.e. unemployment rate will be lower than this value at 90% of the time) of 7.2% from the 16% in 2012.
(b) Adjustment Factor for 50th Percentile Unemployment Rate = Percent Change in water use relative to 2012 use if the unemployment rate were to decrease to 50th percentile unemployment rate of 5.5% from the 9.77% in 2012.

Summary and Recommendation

Results of the demand analyses indicate that water demand correlates well with economic conditions within the City of Santa Monica service area. When the economy is “good” with a low unemployment rate, water usage increases. Compared to the water demands in 2012, overall water usage is predicted to increase by approximately 8 to 11%, under good economic conditions. The correlation between water demand and economic conditions is strong for each of City’s customer categories except commercial/industrial use, with R^2 values ranging from 0.56 to 0.73. Water use for commercial/industrial use did not show a strong correlation with economic conditions or weather-related parameters.

Due to the level of statistical significance between unemployment rates and water usage, it would appear appropriate to factor in a return to a good economy in the City’s water demand projections. However, given the implications of this decision on future capital improvement requirements, resolution and final direction regarding the use of these factors is a City policy decision. As such, the final projection values will be derived following direction by the City.

Appendix TM-A: Economic Analysis

Supporting Tables and Figures

Table A1. Data Summary

Factor	***Land Use***	***R^2***
% Unemployment	Single Family	**0.7265**
	Multi Family	**0.6999**
	Commercial/Industrial	0.2313
	Landscape Irrigation	**0.5524**
ET	Single Family	0.0815
	Multi Family	0.0023
	Commercial/Industrial	0.0022
	Landscape Irrigation	0.1034
Total Precipitation	Single Family	0.199
	Multi Family	0.0443
	Commercial/Industrial	0.014
	Landscape Irrigation	0.0937
Days Over 0.10 in Precipitation	Single Family	0.1856
	Multi Family	0.0165
	Commercial/Industrial	0.00001
	Landscape Irrigation	0.0949

Table A2. Comparison of Historic and Project Period Precipitation

	Average Rainfall (in/day)	***Max Annual Rainfall (in/Yr)***	***Min Annual Rainfall (in/Yr)***
Historic Data (1938 – 2011)	0.0311	28.8	0.5
Project Period (2001 – 2011)	0.0361	21.82	4.15

A1.Effect of Unemployment on Water Use

Figure A1. Effect of unemployment on SFR water use

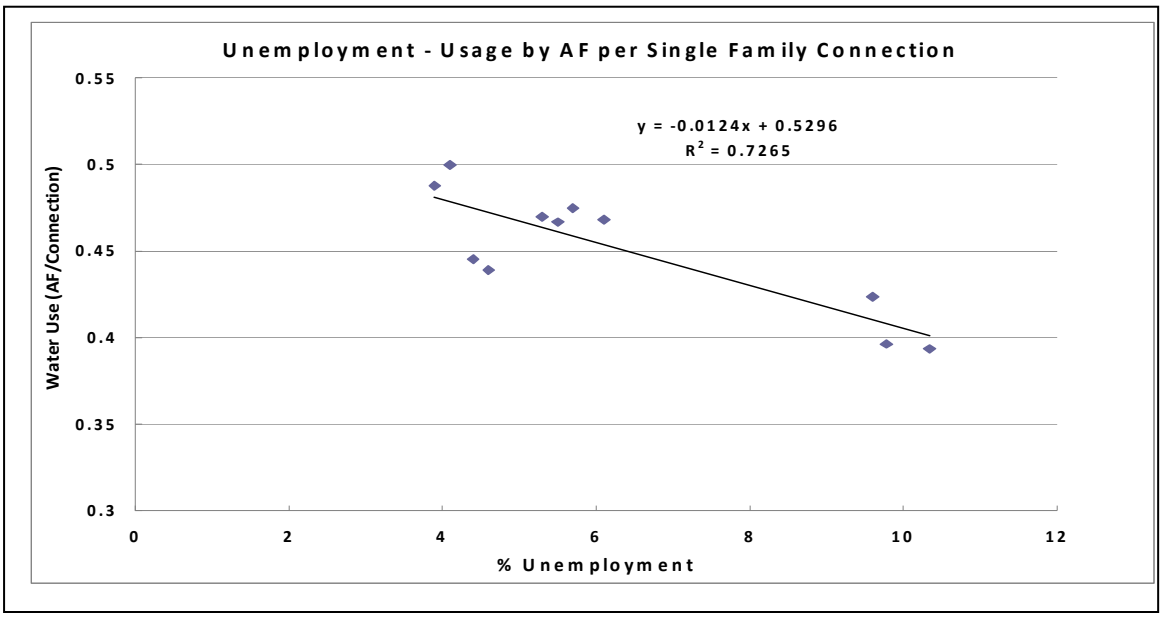


Figure 2. Effect of unemployment on MFR water use

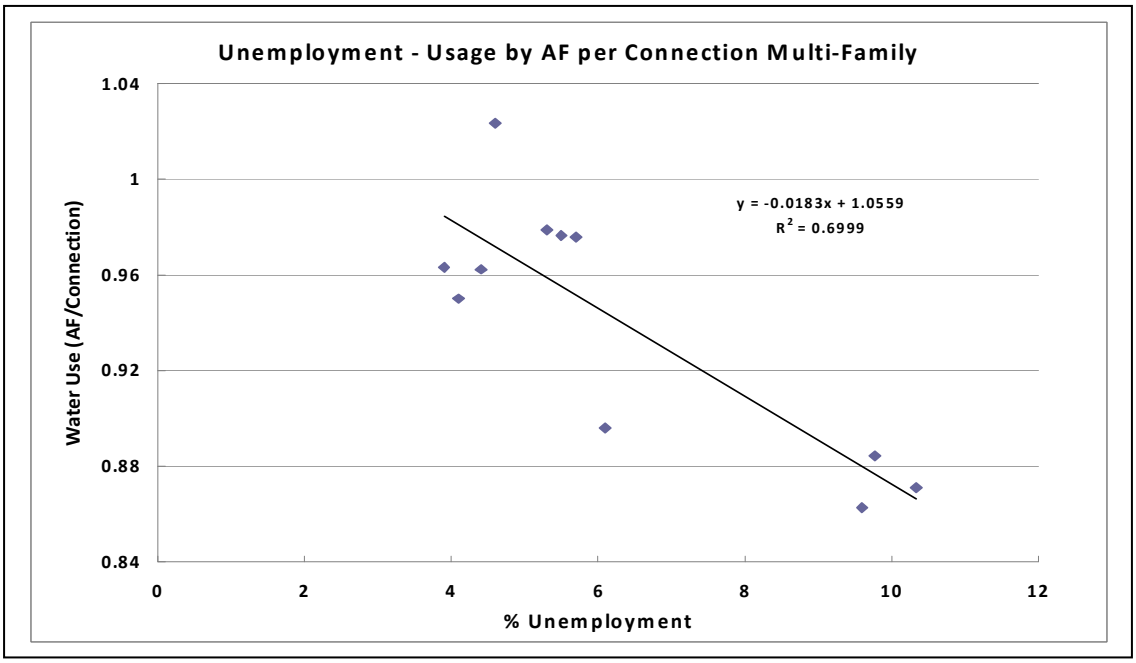


Figure A3. Effect of unemployment on commercial/industrial water use

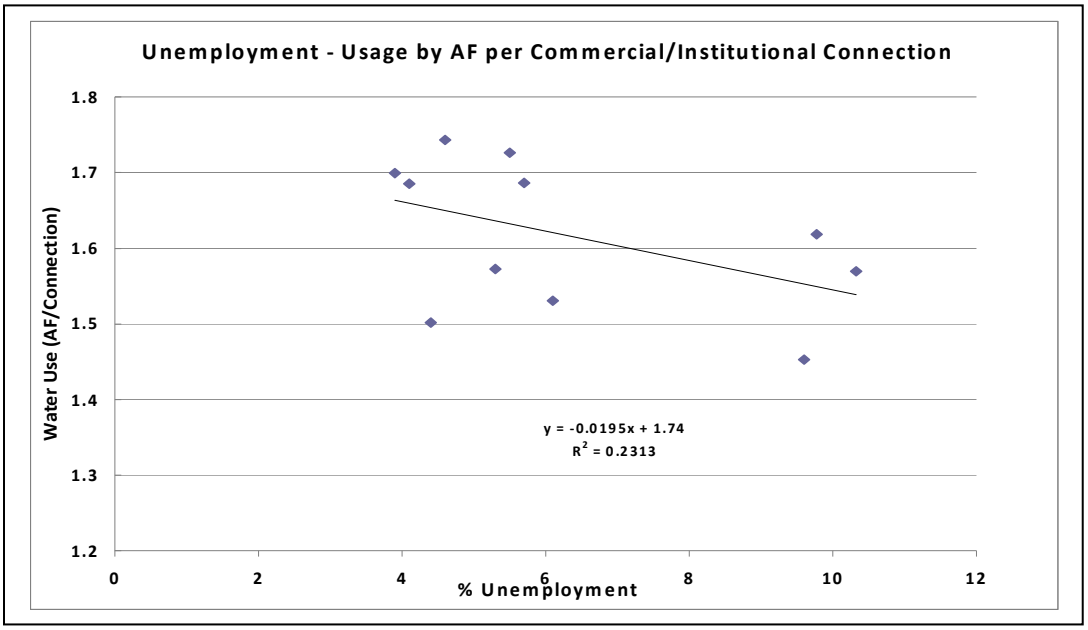
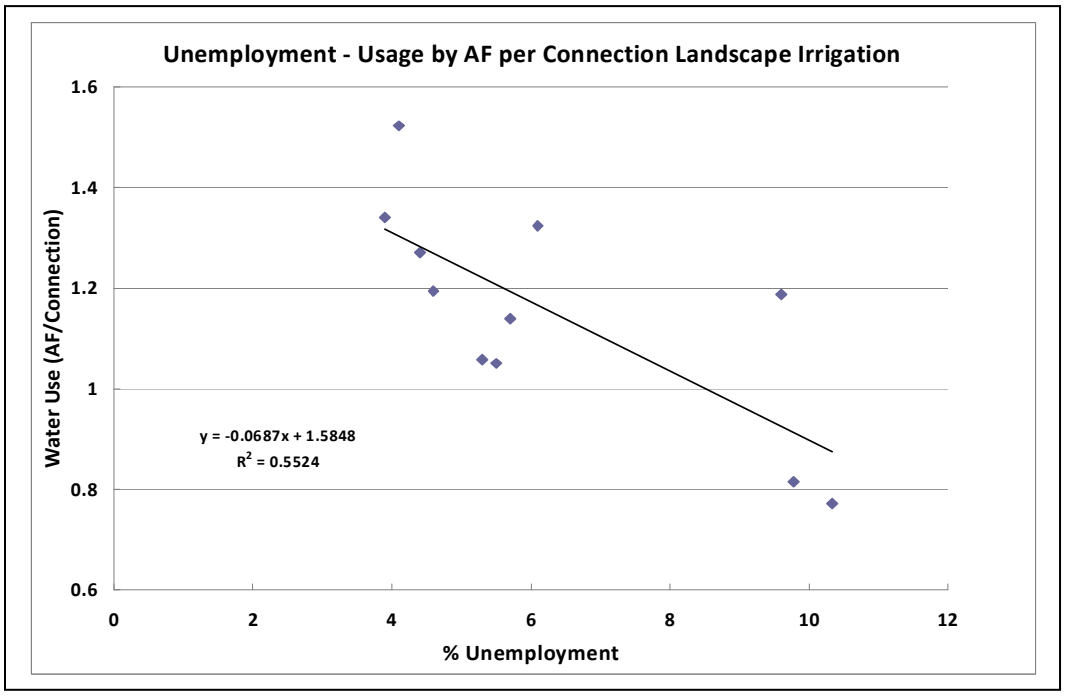


Figure A4. Effect of unemployment on commercial/industrial water use



A2. Effect of ET on Water Use

Figure A5. Effect of ET on SFR water use

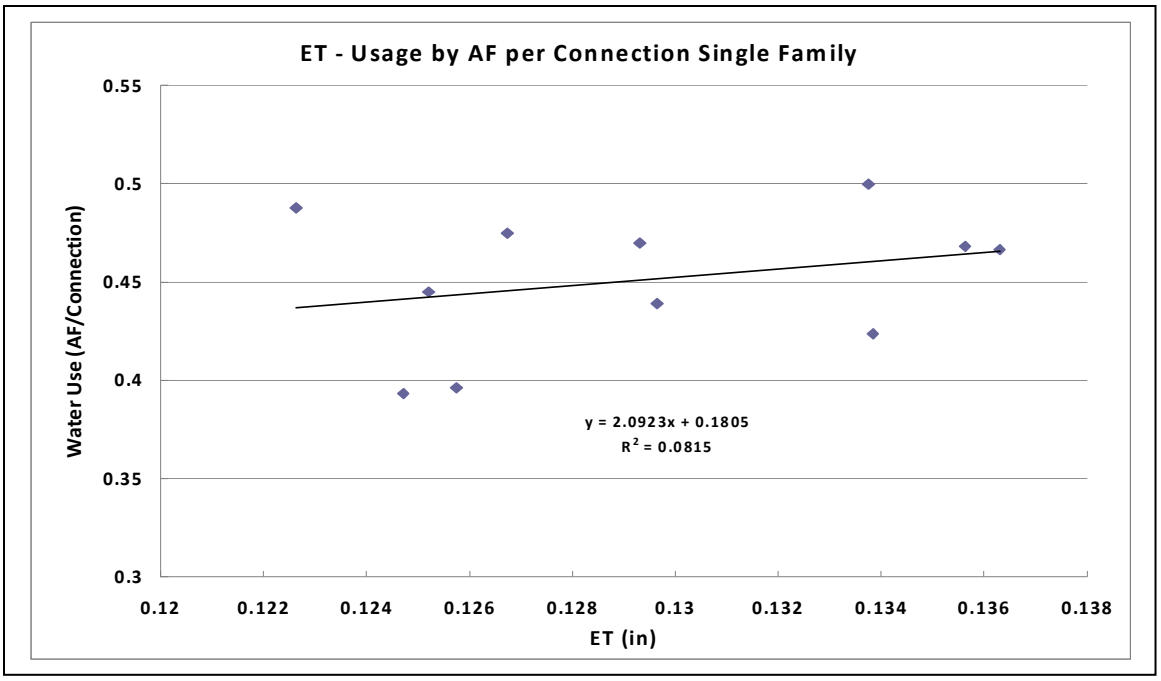


Figure A6. Effect of ET on MFR water use

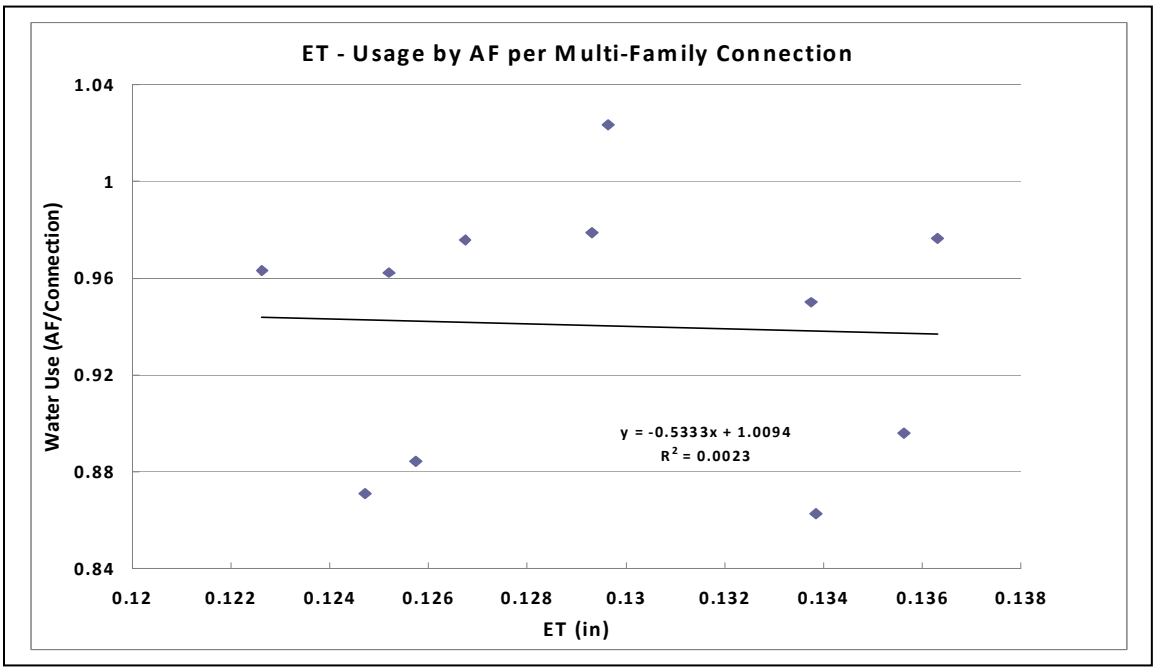


Figure A7. Effect of ET on commercial/industrial water use

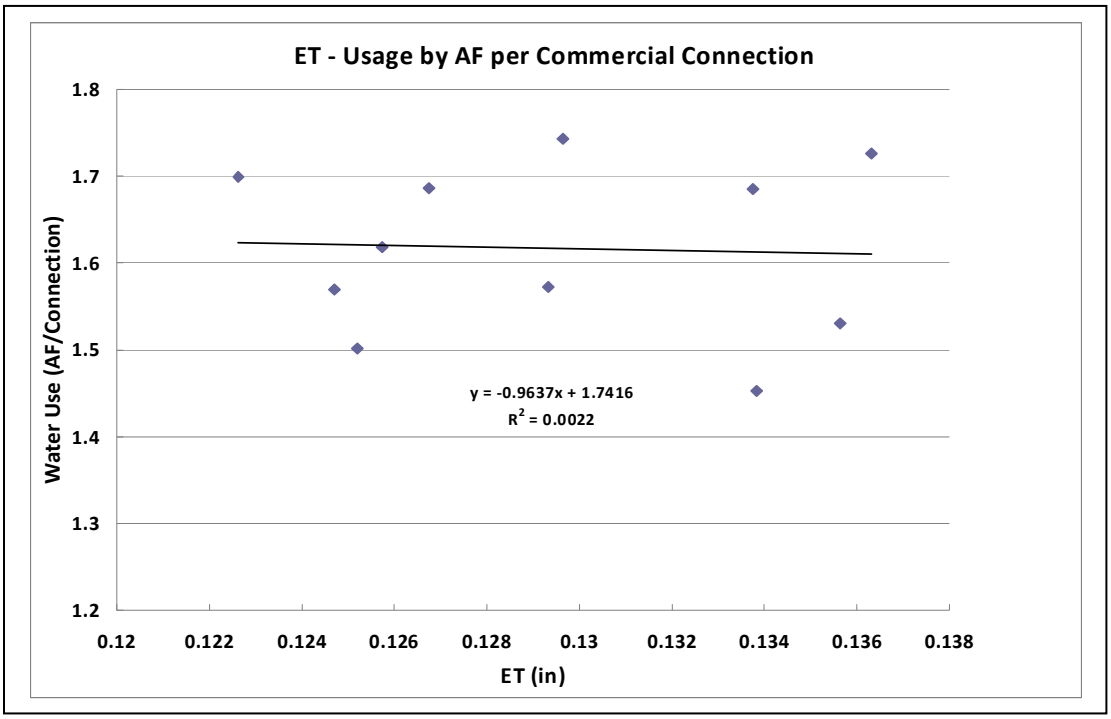
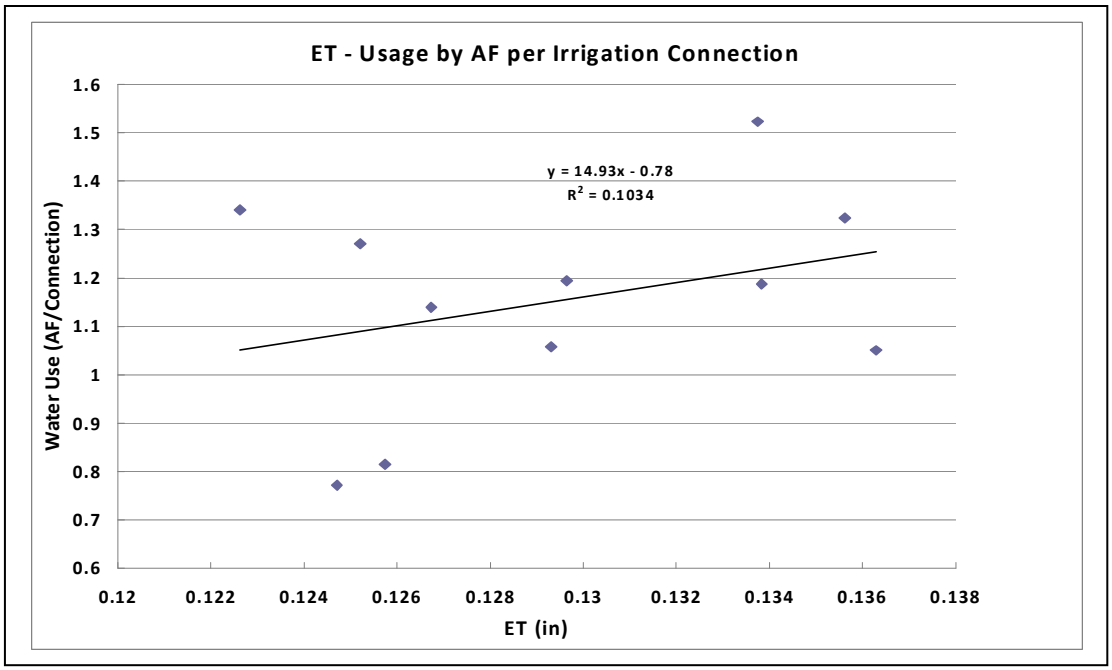


Figure A8. Effect of ET on irrigation water use



A3. Effect of Total Rainfall on Water Use

Figure A9. Effect of Precipitation on SFR water use

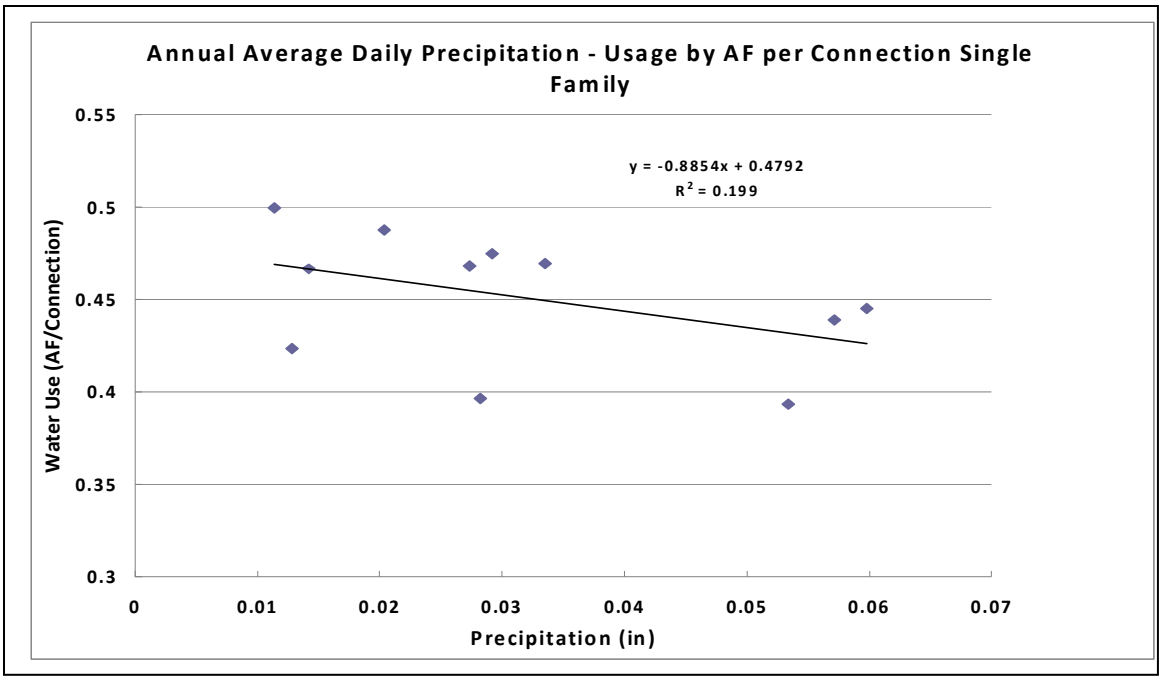


Figure A10. Effect of Precipitation on MFR water use

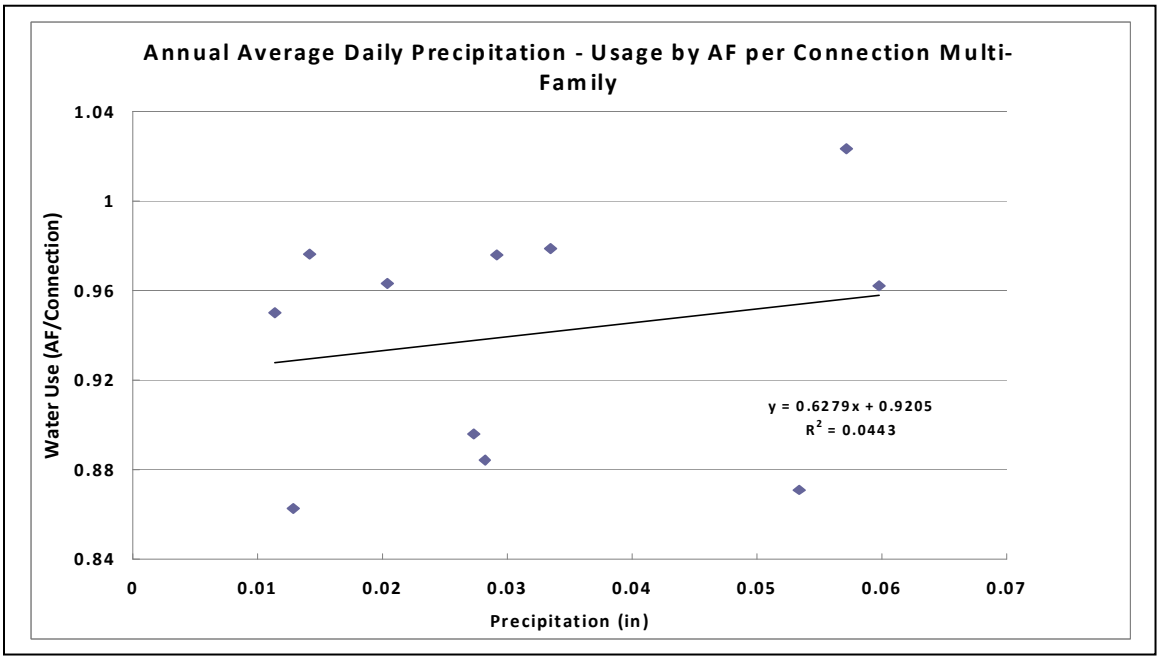


Figure A11. Effect of Precipitation on commercial/industrial water use

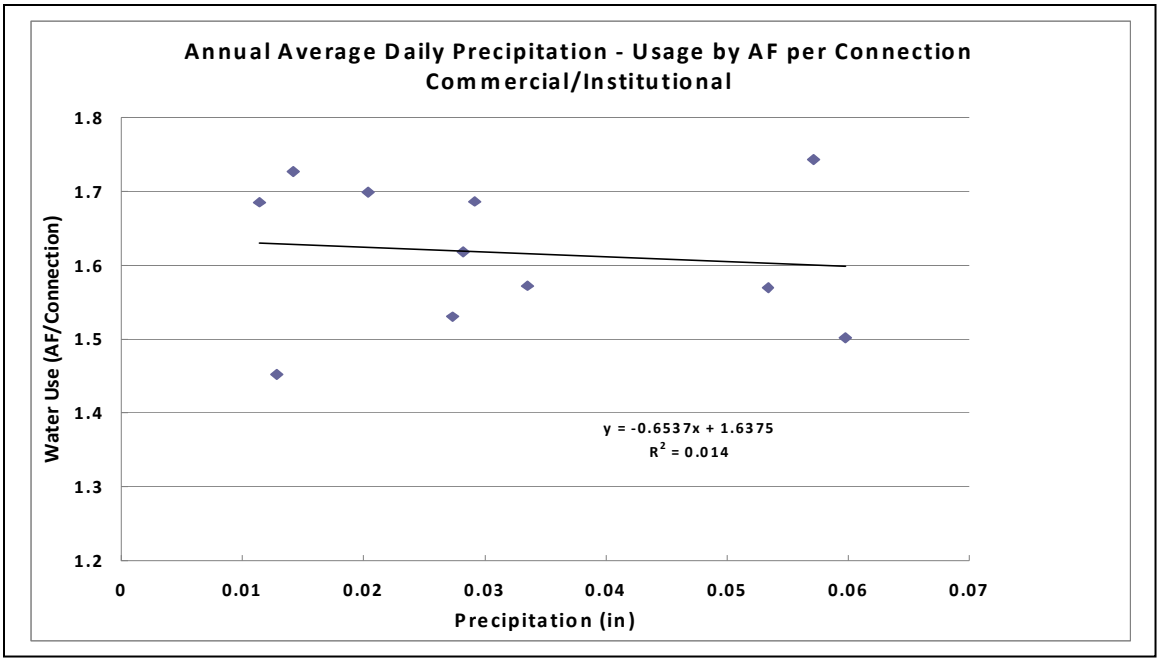
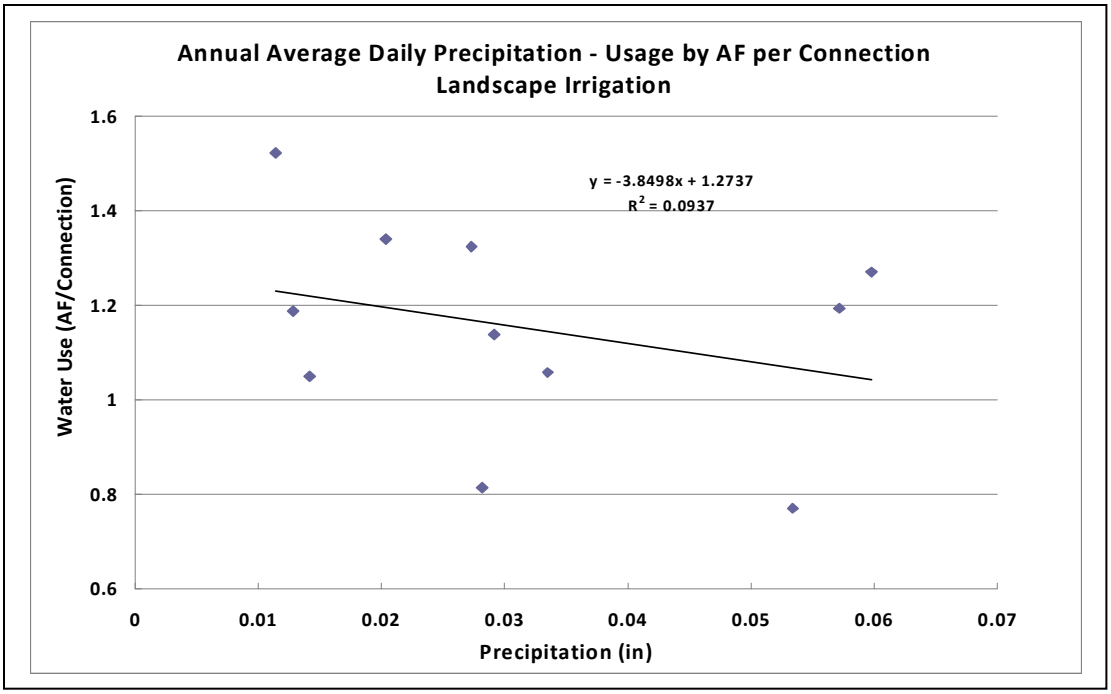


Figure A12. Effect of Precipitation on irrigation water use



A4. Effect of Higher Rainfall (>0.1 in) Days on Water Use

Figure A13. Effect of high precipitation (>0.1 in) Days in an year on SFR water use

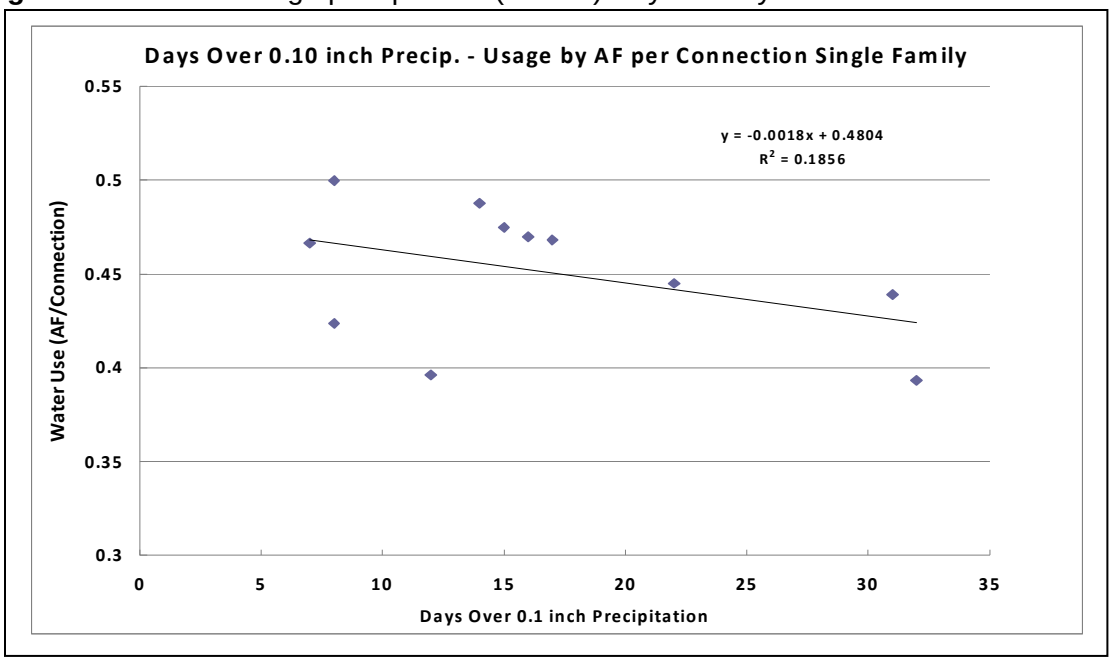


Figure A14. Effect of high precipitation (>0.1 in) Days in an year on MFR water use

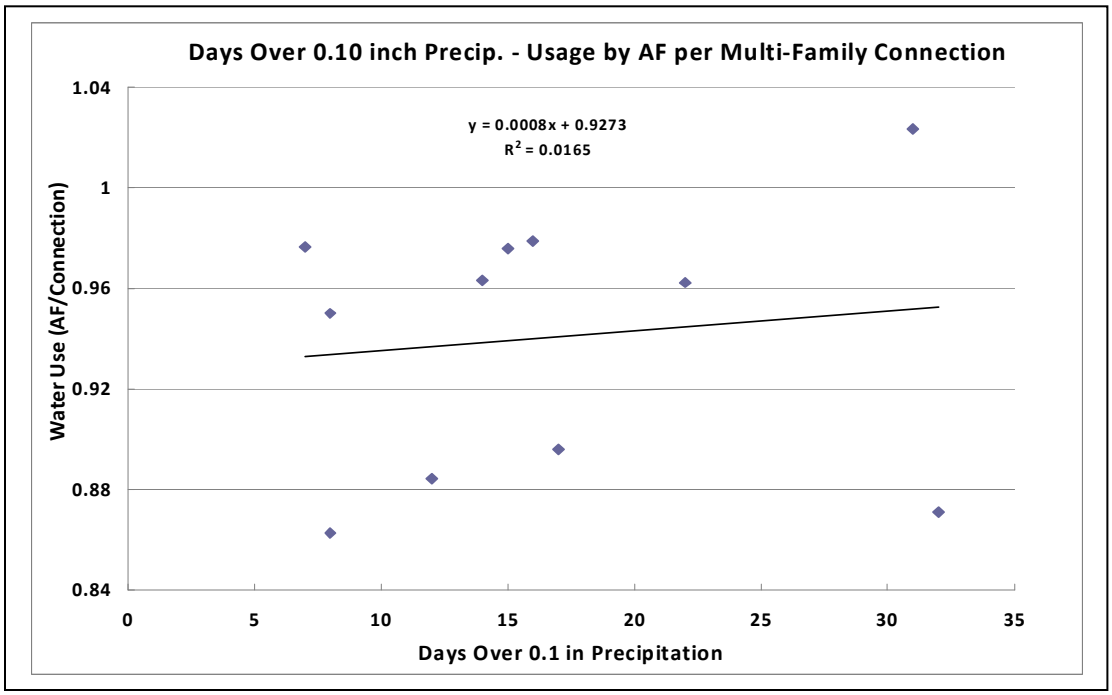


Figure A15. Effect of high precipitation (>0.1 in) Days in an year on Commercial water use

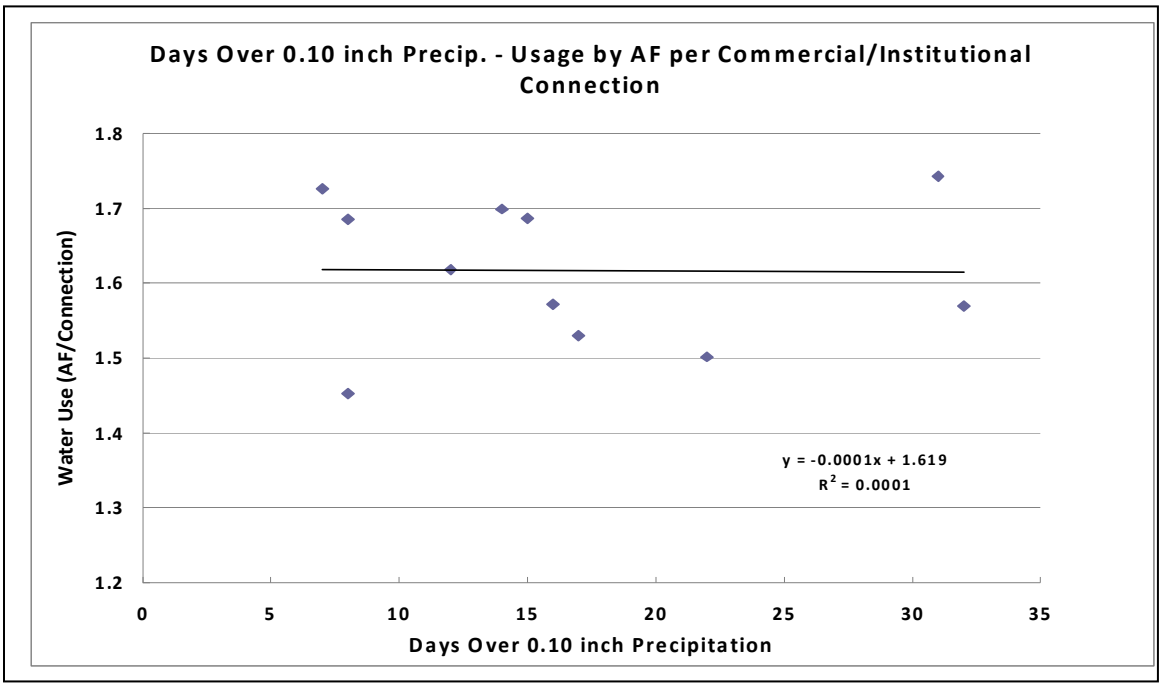


Figure A16. Effect of high precipitation (>0.1 in) Days in an year on landscape water use

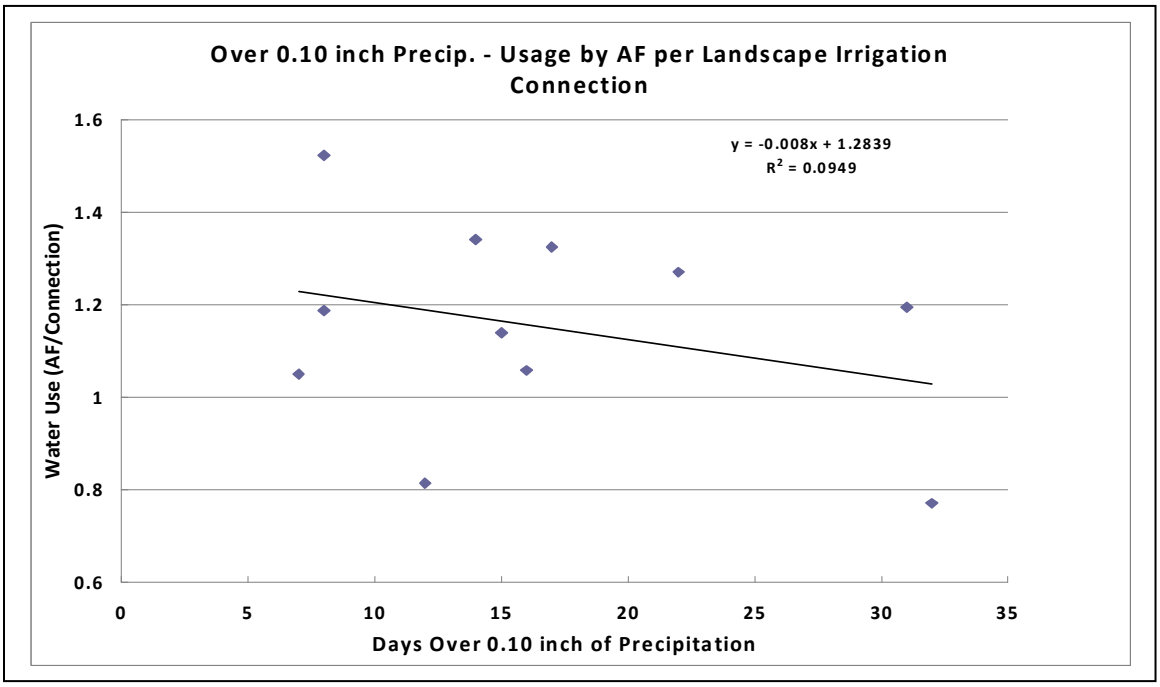


Table A3. Data used for evaluation

Year	*% Unemployment*	*ET (in)*	*Total Precipitation (in)*	*No. of Days Pptn >0.1 inch*	*SFR (AF)*	*MFR(AF)*	*Commercial /Industrial (AF)*	*Irrigation Use (AF)*
2000	4.4							
2001	4.6	0.130	0.057	31	0.439	1.024	1.743	1.194
2002	5.5	0.136	0.014	7	0.467	0.976	1.727	1.051
2003	5.7	0.127	0.029	15	0.475	0.976	1.687	1.139
2004	5.3	0.129	0.033	16	0.470	0.979	1.572	1.058
2005	4.4	0.125	0.060	22	0.445	0.962	1.502	1.271
2006	3.9	0.123	0.020	14	0.488	0.963	1.699	1.340
2007	4.1	0.134	0.011	8	0.500	0.950	1.685	1.523
2008	6.1	0.136	0.027	17	0.468	0.896	1.530	1.324
2009	9.6	0.134	0.013	8	0.423	0.863	1.452	1.188
FY 11 (2010)	10.4	0.125	0.053	32	0.393	0.871	1.570	0.771
FY 12 (2011)	10.2	0.126	0.028	12	0.396	0.884	1.618	0.814

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Appendix C: Sustainable Groundwater Management Act of 2014 Support Material

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SUSTAINABLE GROUNDWATER MANAGEMENT ACT OF 2014

Summary

AB 1739 (Dickinson), SB 1168 (Pavley) and SB 1319 (Pavley)

The Sustainable Groundwater Management Act empowers local agencies to manage groundwater basins in a sustainable manner over a long-term horizon. The Act provides five to seven years for locals to form a Groundwater Sustainability Agency (GSA) and to create a Groundwater Sustainability Plan (GSP). The plan would have a 20-year implementation horizon with the opportunity for two five-year extensions, if the agency is making progress towards sustainability.

(All references to code sections are to the Water Code, unless otherwise noted.)

State Policy and Local Government Coordination

- Establishes that it is the policy of the state that groundwater resources be managed sustainably for long-term water supply reliability and multiple economic, social, or environmental benefits for current and future beneficial uses. Section 1. (a) of SB 1168
- Requires a city or county planning agency, before adopting or substantially amending a general plan, to review and consider groundwater sustainability plans. Government Code Section 65352.5

I. Core Provisions

Groundwater Sustainability Agency Formation

- Local Agencies have until June 30, 2017, to form a GSA. Section 10735.2 (1)
- Any local agency or combination of local agencies overlying a groundwater basin may elect to be a Groundwater Sustainability Agency. Section 10723
- Agencies that have been created by statute to manage groundwater are deemed the exclusive agencies to comply with the Act within their boundaries, unless the agency elects to opt out. Section 10723 (c)(1) and (c)(2)
- A GSA may adopt rules, regulations, ordinances, and resolutions for the purposes of the Act.

Tools for GSAs

- The Act gives local agencies new tools to manage groundwater sustainably.
- A GSA may conduct investigations to carry out the requirements of the Act. Section 10725.4
- A GSA may require the registration of wells. Section 10725.6

- A GSA may require the installation of water-measuring devices on all groundwater wells within the basin boundaries at the expense of the operator or owner. Section 10725.8
- A GSA may require annual extraction statements or other reasonable method to determine groundwater extractions. Section 10725.8 (c) and (d)
- A GSA may impose well spacing requirements and control extractions by regulating, limiting or suspending extractions from individual groundwater wells. Section 10726.4 (a)(1) and (2)
- A GSA may assess fees to establish and implement local groundwater management plans. Section 10725.4 (a)(3)
- Local agencies may request that the Department of Water Resources (DWR) revise the boundaries of a basin, including establishing new subbasins. The request shall include information, to be specified by DWR in regulations by January 1, 2016, to support the request. Section 10722.2 (a)

Creation of Groundwater Sustainability Plans

- GSAs much create and implement a GSP in each high- and medium-priority basin to meet the sustainability goal of the Act. Section 10727 (a) [See the attached map indicating the location high- and medium-priority basins as currently identified.]
- GSAs in basins that are in "critical conditions of overdraft" must adopt a compliant plan by January 31, 2020. Section 10720.7 (a)(1)
- GSAs in all other high- and medium-priority basins must adopt a compliant plan by January 31, 2022. Section 10720.7 (a)(2)
- A plan may be a single plan covering the entire basin, a single plan covering the entire basin created by multiple agencies, or multiple plans created by multiple agencies. Section 10727 (b)(1), (2), and (3)
- A GSP must include:
    - A description of the physical setting and characteristics of the aquifer system. Section 10727.2 (a)
    - Historical date, groundwater levels, ground water quality, subsidence, groundwater-surface water interaction, a discussion of historical and projected water demands and supplies. Section 10727.2 (1), (2) and (3)
    - A map that details the area of the basin and boundaries. Section 10727.2 (4)
    - A map identifying existing and potential recharge areas that substantially contribute to the recharge of the basin. Section 10727.2 (5)
    - Measurable objectives, as well as interim milestones in increments of five years, to achieve the sustainability goal in the basin within 20 years. Section 10727.2 (b) (1)
    - A planning and implementing horizon. Section 10727.2 (c)
    - The monitoring and management of groundwater levels, water quality, groundwater quality degradation, and inelastic land surface subsidence. Section 10727.2 (d)(1), (2), (3), (4), and (5)
    - A summary of the type of monitoring. Section 10727.2 (e)
    - The monitoring protocols. Section 10727.2 (f)

  - A description of the consideration of other applicable local government plans and how the GSP may affect those plans. Section 10727.2 (g)
- DWR may grant two five-year extensions upon a showing of good cause beyond the 20-year sustainability timeframe. Section 10727.2 (3) (A)
- DWR may grant an extension beyond the two five-year extensions, if the local agency demonstrates a need for an extension, has made progress toward meeting its sustainability goal and adopts a feasibility work plan for meeting the sustainability goal during the extension period. Section 10727.2 (3) (B) (i), (ii) and (iii)

DWR Evaluation and Assessment

- DWR shall periodically review GSPs to evaluate whether they conform with the Act and are likely to achieve the sustainability goal. Section 10733 (a)
- If multiple plans are created for a basin, DWR shall evaluate whether the plans conform with the Act and together are likely to achieve the sustainability goal. Section 10733 (b)
- DWR shall evaluate whether a GSP adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of the sustainability goals in an adjacent basin. Section 10733 (c)

Probationary Status

In general, the State Water Resources Control Board (State Board) may designate a basin as "probationary" if, after consulting with DWR, it is found that a GSA has not been formed, a GSP has not been created, the GSP is inadequate or the GSP is not being implemented in a way that will lead to sustainability. "Sustainable groundwater management" means the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." "Undesirable results" are defined as follows, based on a "significant and unreasonable" standard:

- Chronic lowering groundwater level
- Seawater intrusion
- Degraded water quality
- Land subsidence
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses

Probationary status requires a GSA to respond to the State Board and describe how it intends to rectify these shortcomings.

Specifically, the State Board may designate a basin as a probationary, if:

  - After June 30, 2017, the State Board finds that there is no local agency or a collection of agencies that has elected to become the GSA or an agency has not provided an alternative plan. Section 10735.2 (1)

  - After January 31, 2020, a GSA in any high- or medium-priority basin in critical condition of overdraft has not adopted a GSP for the entire basin. Section 10735.2 (2)
  - After, January 31, 2020, DWR in consultation with the State Board determines that the GSP is inadequate or the GSP is not being implemented in a manner that will likely achieve the sustainability goal. Section 10735.2 (3)
  - After January 31, 2022, a GSA in any high- or medium-priority basin that is not subject to the critical conditions of overdraft has not adopted a plan for the entire basin. Section 10735.2 (4)
  - After January 31, 2022, DWR in consultation with the State Board determines that the GSP is inadequate or that the GSP is not being implemented in a manner that will achieve the sustainability goal and the State Board determines that the basin is in a condition of long-term overdraft. Section 10735.2 (5)(A)
  - After January 31, 2025, DWR in consultation with the State Board determines that the GSP is inadequate or that the GSP is not being implemented in a manner that will achieve the sustainability goal and the State Board determines that the basin is in a condition where groundwater extractions result in significant depletions of interconnected surface waters. Section 10735.2 (5)(B)

- A GSA has 180 days to remedy any deficiency with additional time provided if the agency is making substantial progress toward remedying the problem. Section 10735.4 (a) and (b)

State Board Intervention/Interim Plans

A GSA has 180 days to respond appropriately to the designation of “probationary status” before the State Board can move forward with the next step. Failure to respond to the deficiencies in the GSP could lead to limited state intervention and the development of a State Board- created interim plan.

- The State Board may develop an “interim plan” for a probationary basin if at the end of the time provided for rectifying the deficiency the State Board, in consultation with DWR, determines that the local agency has not remedied the deficiency. Section 10735.4 (c)
- The State Board must exclude from probationary status any portion of a basin for which a GSA demonstrates compliance with the sustainability goal. Section 10735.2 (e)
- Before January 1, 2025, the State Board is prohibited from establishing an interim plan to remedy a condition where the groundwater extractions result in significant depletions of interconnected surface waters. Section 10735.8 (h)
- The State Board may adopt regulations to establish the allocation, administration or collection of fees in carrying out its duties. Section 10736 (d)(3)

Protections for Areas under Sustainable Management

- The State Board must exclude from probationary status any portion of a basin for which a GSA demonstrates compliance with the sustainability goal. Section 10735.2 (e)

- State fees may be assessed by the State Board to carry out its duties only in areas not in compliance with the Act after 2017, or 2020, or later, as described in the requirements for "probationary status" designation.

II. Other Important Provisions

California Environmental Quality Act (CEQA)

- The formation of a GSA is not expressly exempt from CEQA. Any deadlines missed due to litigation challenging the formation of the agency would be extended until the litigation is resolved. Section 10735.2 (d)
- The preparation of a GSP is exempt from CEQA. Section 10728.6
- The Act does not exempt the implementation of projects under a GSP from CEQA. Section 10728.6

Water Rights

- The Act states that the intent of the Legislature is to "respect overlying and other proprietary rights to groundwater, consistent with section 1200 of the Water Code." Section 1(b)(4) of AB 1739
- The Act further states that it is in the intent of the Legislature to "preserve the security of water rights in the state to the greatest extent possible consistent with the sustainable management of groundwater." Section 10720.1(b)
- Additionally, the Act states that "nothing in this part or in any groundwater management plan adopted pursuant to this part, determines or alters surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights." Section 10720.5(b). Similar language is at Section 10726.8(b)

Application to Adjudicated Basins

- The Act does not contain any provisions affecting the adjudicatory process.
- Adjudicated basins are required to submit to DWR a copy of a governing final judgment, or other judicial order or decree and any amendments entered before April 1, 2016. Section 10720.8 (f)(1) [See the attached map indicating the location of adjudicated basins.]
- After April 1, 2016, adjudicated basins are required to submit:
    - Any amendment made to the decree or final judgment.
    - Groundwater elevation data unless submitted under Section 10932.
    - Annual aggregate data identifying extraction for the preceding year.
    - Surface water supply used for or available for groundwater recharge or in-lieu use.
    - Total water use.
    - Change in groundwater storage.
    - The annual report submitted to the court.

Tribal Lands

- The Act applies to tribes to the extent authorized under federal law. Section 10720.3(b)
- The Act provides that tribes may voluntarily agree to participate in a GSA and GSP. Section 10720.3(c)
- The Act provides that federally reserved rights to groundwater shall be respected in full. Section 10720.3(d)

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
1	3-4.02	SALINAS VALLEY	EAST SIDE AQUIFER	Central Coast	SCRO	**27.0**	High
2	4-4.02	SANTA CLARA RIVER VALLEY	OXNARD	South Coast	SRO	**26.8**	High
3	5-22.11	SAN JOAQUIN VALLEY	KAWEAH	Tulare Lake	SCRO	**26.5**	High
4	3-3.01	GILROY-HOLLISTER VALLEY	LLAGAS AREA	Central Coast	SCRO	**25.8**	High
5	5-22.01	SAN JOAQUIN VALLEY	EASTERN SAN JOAQUIN	San Joaquin River	NCRO	**25.5**	High
6	5-22.06	SAN JOAQUIN VALLEY	MADERA	San Joaquin River	SCRO	**25.0**	High
7	4-11.04	COASTAL PLAIN OF LOS ANGELES	CENTRAL	South Coast	SRO	**24.8**	High
8	3-2	PAJARO VALLEY		Central Coast	SCRO	**24.8**	High
9	8-2.03	UPPER SANTA ANA VALLEY	RIVERSIDE-ARLINGTON	South Coast	SRO	**24.5**	High
10	8-5	SAN JACINTO		South Coast	SRO	**24.3**	High
11	3-12	SANTA MARIA		Central Coast	SRO	**24.0**	High
12	3-4.01	SALINAS VALLEY	180/400 FOOT AQUIFER	Central Coast	SCRO	**24.0**	High
13	5-22.02	SAN JOAQUIN VALLEY	MODESTO	San Joaquin River	SCRO	**23.5**	High
14	3-4.06	SALINAS VALLEY	PASO ROBLES AREA	Central Coast	SCRO	**23.3**	High
15	8-2.01	UPPER SANTA ANA VALLEY	CHINO	South Coast	SRO	**23.3**	High
16	9-5	TEMECULA VALLEY		South Coast	SRO	**23.0**	High
17	5-22.08	SAN JOAQUIN VALLEY	KINGS	Tulare Lake	SCRO	**22.8**	High
18	5-21.57	SACRAMENTO VALLEY	VINA	Sacramento River	NRO	**22.8**	High
19	4-4.07	SANTA CLARA RIVER VALLEY	SANTA CLARA RIVER VALLEY EAST	South Coast	SRO	**22.8**	High
20	3-7	CARMEL VALLEY		Central Coast	SCRO	**22.8**	High
21	5-22.14	SAN JOAQUIN VALLEY	KERN COUNTY	Tulare Lake	SCRO	**22.5**	High
22	5-22.09	SAN JOAQUIN VALLEY	WESTSIDE	Tulare Lake	SCRO	**22.5**	High
23	5-22.04	SAN JOAQUIN VALLEY	MERCED	San Joaquin River	SCRO	**22.5**	High
24	5-21.64	SACRAMENTO VALLEY	NORTH AMERICAN	Sacramento River	NCRO	**22.5**	High
25	4-6	PLEASANT VALLEY		South Coast	SRO	**22.5**	High
26	5-22.07	SAN JOAQUIN VALLEY	DELTA-MENDOTA	San Joaquin River	SCRO	**22.3**	High
27	5-22.12	SAN JOAQUIN VALLEY	TULARE LAKE	Tulare Lake	SCRO	**22.3**	High
28	5-22.13	SAN JOAQUIN VALLEY	TULE	Tulare Lake	SCRO	**22.3**	High
29	5-21.65	SACRAMENTO VALLEY	SOUTH AMERICAN	Sacramento River	NCRO	**22.3**	High
30	5-21.67	SACRAMENTO VALLEY	YOLO	Sacramento River	NCRO	**22.3**	High
31	4-8	LAS POSAS VALLEY		South Coast	SRO	**22.3**	High
32	3-1	SOQUEL VALLEY		Central Coast	SCRO	**22.3**	High
33	5-27	CUMMINGS VALLEY		Tulare Lake	SCRO	**22.0**	High
34	3-8	LOS OSOS VALLEY		Central Coast	SCRO	**22.0**	High
35	6-42	UPPER MOJAVE RIVER VALLEY		South Lahontan	SRO	**21.8**	High
36	4-4.06	SANTA CLARA RIVER VALLEY	PIRU	South Coast	SRO	**21.8**	High

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
37	6-44	ANTELOPE VALLEY		South Lahontan	SRO	**21.5**	High
38	5-22.03	SAN JOAQUIN VALLEY	TURLOCK	San Joaquin River	SCRO	**21.5**	High
39	5-21.58	SACRAMENTO VALLEY	WEST BUTTE	Sacramento River	NRO	**21.5**	High
40	5-22.05	SAN JOAQUIN VALLEY	CHOWCHILLA	San Joaquin River	SCRO	**21.3**	High
41	4-13	SAN GABRIEL VALLEY		South Coast	SRO	**21.3**	High
42	8-2.06	UPPER SANTA ANA VALLEY	BUNKER HILL	South Coast	SRO	**21.3**	High
43	8-4	ELSINORE		South Coast	SRO	**21.3**	High
44	8-1	COASTAL PLAIN OF ORANGE COUNTY		South Coast	SRO	**20.8**	Medium
45	4-11.03	COASTAL PLAIN OF LOS ANGELES	WEST COAST	South Coast	SRO	**20.8**	Medium
46	2-2.01	NAPA-SONOMA VALLEY	NAPA VALLEY	San Francisco Bay	NCRO	**20.8**	Medium
47	4-23	RAYMOND		South Coast	SRO	**20.8**	Medium
48	3-4.08	SALINAS VALLEY	SEASIDE AREA	Central Coast	SCRO	**20.8**	Medium
49	8-2.07	UPPER SANTA ANA VALLEY	YUCAIPA	South Coast	SRO	**20.8**	Medium
50	4-4.05	SANTA CLARA RIVER VALLEY	FILLMORE	South Coast	SRO	**20.8**	Medium
51	3-26	WEST SANTA CRUZ TERRACE		Central Coast	SCRO	**20.8**	Medium
52	4-4.04	SANTA CLARA RIVER VALLEY	SANTA PAULA	South Coast	SRO	**20.5**	Medium
53	2-9.02	SANTA CLARA VALLEY	SANTA CLARA	San Francisco Bay	NCRO	**20.3**	Medium
54	1-4	SHASTA VALLEY	SHASTA VALLEY	North Coast	NRO	**20.3**	Medium
55	5-21.54	SACRAMENTO VALLEY	ANTELOPE	Sacramento River	NRO	**20.3**	Medium
56	5-28	TEHACHAPI VALLEY WEST		Tulare Lake	SCRO	**20.3**	Medium
57	5-21.52	SACRAMENTO VALLEY	COLUSA	Sacramento River	NRO	**19.8**	Medium
58	4-12	SAN FERNANDO VALLEY		South Coast	SRO	**19.8**	Medium
59	2-9.01	SANTA CLARA VALLEY	NILES CONE	San Francisco Bay	NCRO	**19.8**	Medium
60	4-7	ARROYO SANTA ROSA VALLEY		South Coast	SRO	**19.8**	Medium
61	5-21.51	SACRAMENTO VALLEY	CORNING	Sacramento River	NRO	**19.5**	Medium
62	5-12.01	SIERRA VALLEY	SIERRA VALLEY	Sacramento River	NRO	**19.5**	Medium
63	8-2.09	UPPER SANTA ANA VALLEY	TEMESCAL	South Coast	SRO	**19.5**	Medium
64	3-9	SAN LUIS OBISPO VALLEY		Central Coast	SCRO	**19.5**	Medium
65	7-21.01	COACHELLA VALLEY	INDIO	Colorado River	SRO	**19.3**	Medium
66	4-11.01	COASTAL PLAIN OF LOS ANGELES	SANTA MONICA	South Coast	SRO	**19.3**	Medium
67	5-22.15	SAN JOAQUIN VALLEY	TRACY	San Joaquin River	NCRO	**19.0**	Medium
68	8-2.08	UPPER SANTA ANA VALLEY	SAN TIMOTEO	South Coast	SRO	**19.0**	Medium
69	9-7	SAN LUIS REY VALLEY		South Coast	SRO	**19.0**	Medium
70	9-10	SAN PASQUAL VALLEY		South Coast	SRO	**19.0**	Medium

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
71	1-55.01	SANTA ROSA VALLEY	SANTA ROSA PLAIN	North Coast	NCRO	**18.8**	Medium
72	7-21.04	COACHELLA VALLEY	SAN GORGONIO PASS	Colorado River	SRO	**18.8**	Medium
73	3-4.09	SALINAS VALLEY	LANGLEY AREA	Central Coast	SCRO	**18.8**	Medium
74	3-16	GOLETA		Central Coast	SRO	**18.8**	Medium
75	4-2	OJAI VALLEY		South Coast	SRO	**18.5**	Medium
76	2-1	PETALUMA VALLEY		San Francisco Bay	NCRO	**18.3**	Medium
77	1-1	SMITH RIVER PLAIN		North Coast	NRO	**18.3**	Medium
78	8-2.04	UPPER SANTA ANA VALLEY	RIALTO-COLTON	South Coast	SRO	**18.3**	Medium
79	6-5.01	TAHOE VALLEY	TAHOE SOUTH	North Lahontan	NCRO	**18.3**	Medium
80	8-2.02	UPPER SANTA ANA VALLEY	CUCAMONGA	South Coast	SRO	**18.3**	Medium
81	4-3.01	VENTURA RIVER VALLEY	UPPER VENTURA RIVER	South Coast	SRO	**18.3**	Medium
82	9-4	SANTA MARGARITA VALLEY		South Coast	SRO	**17.8**	Medium
83	5-14	SCOTTS VALLEY		Sacramento River	NRO	**17.8**	Medium
84	5-21.59	SACRAMENTO VALLEY	EAST BUTTE	Sacramento River	NRO	**17.5**	Medium
85	5-21.62	SACRAMENTO VALLEY	SUTTER	Sacramento River	NCRO	**17.5**	Medium
86	3-3.03	GILROY-HOLLISTER VALLEY	HOLLISTER AREA	Central Coast	SCRO	**17.5**	Medium
87	9-6	CAHUILLA VALLEY		South Coast	SRO	**17.5**	Medium
88	3-15	SANTA YNEZ RIVER VALLEY		Central Coast	SRO	**17.3**	Medium
89	5-6.03	REDDING AREA	ANDERSON	Sacramento River	NRO	**17.3**	Medium
90	3-4.04	SALINAS VALLEY	FOREBAY AQUIFER	Central Coast	SCRO	**17.3**	Medium
91	1-2.01	KLAMATH RIVER VALLEY	TULELAKE	North Coast	NRO	**17.3**	Medium
92	2-10	LIVERMORE VALLEY		San Francisco Bay	NCRO	**17.3**	Medium
93	5-6.04	REDDING AREA	ENTERPRISE	Sacramento River	NRO	**17.3**	Medium
94	4-4.03	SANTA CLARA RIVER VALLEY	MOUND	South Coast	SRO	**17.3**	Medium
95	6-67	MARTIS VALLEY		North Lahontan	NCRO	**17.0**	Medium
96	3-3.04	GILROY-HOLLISTER VALLEY	SAN JUAN BAUTISTA AREA	Central Coast	SCRO	**16.8**	Medium
97	1-10	EEL RIVER VALLEY		North Coast	NRO	**16.3**	Medium
98	2-2.02	NAPA-SONOMA VALLEY	SONOMA VALLEY	San Francisco Bay	NCRO	**16.3**	Medium
99	3-3.02	GILROY-HOLLISTER VALLEY	BOLSA AREA	Central Coast	SCRO	**16.3**	Medium
100	5-21.50	SACRAMENTO VALLEY	RED BLUFF	Sacramento River	NRO	**16.0**	Medium
101	5-6.01	REDDING AREA	BOWMAN	Sacramento River	NRO	**16.0**	Medium
102	6-43	EL MIRAGE VALLEY		South Lahontan	SRO	**15.8**	Medium
103	7-21.02	COACHELLA VALLEY	MISSION CREEK	Colorado River	SRO	**15.8**	Medium

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
104	1-52	UKIAH VALLEY		North Coast	NCRO	**15.8**	Medium
105	5-15	BIG VALLEY		Sacramento River	NRO	**15.8**	Medium
106	9-15	SAN DIEGO RIVER VALLEY		South Coast	SRO	**15.8**	Medium
107	5-21.66	SACRAMENTO VALLEY	SOLANO	Sacramento River	NCRO	**15.5**	Medium
108	3-4.05	SALINAS VALLEY	UPPER VALLEY AQUIFER	Central Coast	SCRO	**15.5**	Medium
109	1-3	BUTTE VALLEY		North Coast	NRO	**15.5**	Medium
110	6-40	LOWER MOJAVE RIVER VALLEY		South Lahontan	SRO	**15.3**	Medium
111	7-24	BORREGO VALLEY		Colorado River	SRO	**15.3**	Medium
112	1-5	SCOTT RIVER VALLEY		North Coast	NRO	**15.3**	Medium
113	7-12	WARREN VALLEY		Colorado River	SRO	**15.3**	Medium
114	5-22.16	SAN JOAQUIN VALLEY	COSUMNES	San Joaquin River	NCRO	**15.0**	Medium
115	3-14	SAN ANTONIO CREEK VALLEY		Central Coast	SRO	**15.0**	Medium
116	3-4.10	SALINAS VALLEY	CORRAL DE TIERRA AREA	Central Coast	SCRO	**15.0**	Medium
117	6-54	INDIAN WELLS VALLEY		South Lahontan	SRO	**14.8**	Medium
118	2-9.04	SANTA CLARA VALLEY	EAST BAY PLAIN	San Francisco Bay	NCRO	**14.8**	Medium
119	5-21.61	SACRAMENTO VALLEY	SOUTH YUBA	Sacramento River	NCRO	**14.5**	Medium
120	8-9	BEAR VALLEY		South Coast	SRO	**14.5**	Medium
121	5-21.60	SACRAMENTO VALLEY	NORTH YUBA	Sacramento River	NCRO	**14.3**	Medium
122	3-21	SANTA CRUZ PURISIMA FORMATION		Central Coast	SCRO	**14.3**	Medium
123	5-21.56	SACRAMENTO VALLEY	LOS MOLINOS	Sacramento River	NRO	**14.3**	Medium
124	6-12	OWENS VALLEY		South Lahontan	SRO	**13.8**	Medium
125	3-13	CUYAMA VALLEY		Central Coast	SRO	**13.8**	Medium
126	5-21.55	SACRAMENTO VALLEY	DYE CREEK	Sacramento River	NRO	**13.8**	Medium
127	5-4	BIG VALLEY		Sacramento River	NRO	**13.5**	Medium
128	9-1	SAN JUAN VALLEY		South Coast	SRO	**13.3**	Low
129	4-9	SIMI VALLEY		South Coast	SRO	**13.3**	Low
130	4-10	CONEJO		South Coast	SRO	**13.0**	Low
131	7-38	PALO VERDE VALLEY		Colorado River	SRO	**12.8**	Low
132	5-5	FALL RIVER VALLEY		Sacramento River	NRO	**12.8**	Low
133	6-4	HONEY LAKE VALLEY		North Lahontan	NRO	**12.3**	Low

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
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134	7-21.03	COACHELLA VALLEY	DESERT HOT SPRINGS	Colorado River	SRO	**12.3**	Low
135	5-22.10	SAN JOAQUIN VALLEY	PLEASANT VALLEY	Tulare Lake	SCRO	**11.8**	Low
136	5-21.68	SACRAMENTO VALLEY	CAPAY VALLEY	Sacramento River	NCRO	**11.5**	Low
137	1-18	RED ROCK VALLEY		North Coast	NRO	**11.5**	Low
138	6-41	MIDDLE MOJAVE RIVER VALLEY		South Lahontan	SRO	**11.3**	Low
139	4-17	LOCKWOOD VALLEY		South Coast	SRO	**11.3**	Low
140	7-5	CHUCKWALLA VALLEY		Colorado River	SRO	**10.8**	Low
141	6-46	FREMONT VALLEY		South Lahontan	SRO	**10.8**	Low
142	5-2.01	ALTURAS AREA	SOUTH FORK PITT RIVER	Sacramento River	NRO	**10.5**	Low
143	6-47	HARPER VALLEY		South Lahontan	SRO	**9.8**	Low
144	7-19	LUCERNE VALLEY		Colorado River	SRO	**9.8**	Low
145	5-2.02	ALTURAS AREA	WARM SPRINGS VALLEY	Sacramento River	NRO	**9.5**	Low
146	7-39	PALO VERDE MESA		Colorado River	SRO	**9.3**	Low
147	6-1	SURPRISE VALLEY		North Lahontan	NRO	**8.8**	Low
148	7-10	TWENTYNINE PALMS VALLEY		Colorado River	SRO	**8.8**	Low
149	7-8	BRISTOL VALLEY		Colorado River	SRO	**8.3**	Low
150	7-44	NEEDLES VALLEY		Colorado River	SRO	**8.3**	Low
151	6-2	MADELINE PLAINS		North Lahontan	NRO	**7.8**	Low
152	1-2.02	KLAMATH RIVER VALLEY	LOWER KLAMATH	North Coast	NRO	**7.8**	Low
153	7-25	OCOTILLO-CLARK VALLEY		Colorado River	SRO	**7.3**	Low
154	6-14	FISH LAKE VALLEY		South Lahontan	SRO	**6.8**	Low
155	7-30	IMPERIAL VALLEY		Colorado River	SRO	**0.0**	Very Low
156	6-18	DEATH VALLEY		South Lahontan	SRO	**0.0**	Very Low
157	7-3	WARD VALLEY		Colorado River	SRO	**0.0**	Very Low
158	7-2	FENNER VALLEY		Colorado River	SRO	**0.0**	Very Low
159	6-20	MIDDLE AMARGOSA VALLEY		South Lahontan	SRO	**0.0**	Very Low
160	6-33	SODA LAKE VALLEY		South Lahontan	SRO	**0.0**	Very Low

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Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
161	7-43	CHEMEHUEVI VALLEY		Colorado River	SRO	**0.0**	Very Low
162	7-7	CADIZ VALLEY		Colorado River	SRO	**0.0**	Very Low
163	6-58	PANAMINT VALLEY		South Lahontan	SRO	**0.0**	Very Low
164	7-37	ARROYO SECO VALLEY		Colorado River	SRO	**0.0**	Very Low
165	6-31	KELSO VALLEY		South Lahontan	SRO	**0.0**	Very Low
166	6-21	LOWER KINGSTON VALLEY		South Lahontan	SRO	**0.0**	Very Low
167	7-9	DALE VALLEY		Colorado River	SRO	**0.0**	Very Low
168	3-19	CARRIZO PLAIN		Central Coast	SRO	**0.0**	Very Low
169	6-30	IVANPAH VALLEY		South Lahontan	SRO	**0.0**	Very Low
170	6-52	SEARLES VALLEY		South Lahontan	SRO	**0.0**	Very Low
171	7-33	EAST SALTON SEA		Colorado River	SRO	**0.0**	Very Low
172	7-4	RICE VALLEY		Colorado River	SRO	**0.0**	Very Low
173	7-6	PINTO VALLEY		Colorado River	SRO	**0.0**	Very Low
174	6-22	UPPER KINGSTON VALLEY		South Lahontan	SRO	**0.0**	Very Low
175	7-45	PIUTE VALLEY		Colorado River	SRO	**0.0**	Very Low
176	6-9	MONO VALLEY		South Lahontan	SRO	**0.0**	Very Low
177	7-1	LANFAIR VALLEY		Colorado River	SRO	**0.0**	Very Low
178	7-29	COYOTE WELLS VALLEY		Colorado River	SRO	**0.0**	Very Low
179	6-17	SALINE VALLEY		South Lahontan	SRO	**0.0**	Very Low
180	7-42	VIDAL VALLEY		Colorado River	SRO	**0.0**	Very Low
181	6-51	PILOT KNOB VALLEY		South Lahontan	SRO	**0.0**	Very Low
182	7-35	OGILBY VALLEY		Colorado River	SRO	**0.0**	Very Low
183	2-3	SUISUN-FAIRFIELD VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
184	7-34	AMOS VALLEY		Colorado River	SRO	**0.0**	Very Low
185	7-32	CHOCOLATE VALLEY		Colorado River	SRO	**0.0**	Very Low

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186	6-16	EUREKA VALLEY		South Lahontan	SRO	**0.0**	Very Low
187	6-35	CRONISE VALLEY		South Lahontan	SRO	**0.0**	Very Low
188	7-36	YUMA VALLEY		Colorado River	SRO	**0.0**	Very Low
189	7-28	VALLECITO-CARRIZO VALLEY		Colorado River	SRO	**0.0**	Very Low
190	6-49	SUPERIOR VALLEY		South Lahontan	SRO	**0.0**	Very Low
191	7-16	AMES VALLEY		Colorado River	SRO	**0.0**	Very Low
192	7-22	WEST SALTON SEA		Colorado River	SRO	**0.0**	Very Low
193	7-14	LAVIC VALLEY		Colorado River	SRO	**0.0**	Very Low
194	7-31	OROCOPIA VALLEY		Colorado River	SRO	**0.0**	Very Low
195	6-24	RED PASS VALLEY		South Lahontan	SRO	**0.0**	Very Low
196	6-50	CUDDEBACK VALLEY		South Lahontan	SRO	**0.0**	Very Low
197	6-28	PAHRUMP VALLEY		South Lahontan	SRO	**0.0**	Very Low
198	6-32	BROADWELL VALLEY		South Lahontan	SRO	**0.0**	Very Low
199	6-25	BICYCLE VALLEY		South Lahontan	SRO	**0.0**	Very Low
200	7-13.01	DEADMAN VALLEY	DEADMAN LAKE	Colorado River	SRO	**0.0**	Very Low
201	6-29	MESQUITE VALLEY		South Lahontan	SRO	**0.0**	Very Low
202	6-37	COYOTE LAKE VALLEY		South Lahontan	SRO	**0.0**	Very Low
203	6-23	RIGGS VALLEY		South Lahontan	SRO	**0.0**	Very Low
204	1-59	WILSON GROVE FORMATION HIGHLANDS		North Coast	NCRO	**0.0**	Very Low
205	7-41	CALZONA VALLEY		Colorado River	SRO	**0.0**	Very Low
206	5-25	KERN RIVER VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
207	7-18.01	JOHNSON VALLEY	SOGGY LAKE	Colorado River	SRO	**0.0**	Very Low
208	6-38	CAVES CANYON VALLEY		South Lahontan	SRO	**0.0**	Very Low
209	6-11	LONG VALLEY		South Lahontan	SRO	**0.0**	Very Low
210	6-19	WINGATE VALLEY		South Lahontan	SRO	**0.0**	Very Low

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211	5-6.05	REDDING AREA	MILLVILLE	Sacramento River	NRO	**0.0**	Very Low
212	6-27	LEACH VALLEY		South Lahontan	SRO	**0.0**	Very Low
213	6-84	GREENWATER VALLEY		South Lahontan	SRO	**0.0**	Very Low
214	3-6	LOCKWOOD VALLEY		Central Coast	SCRO	**0.0**	Very Low
215	6-79	CALIFORNIA VALLEY		South Lahontan	SRO	**0.0**	Very Low
216	6-104	LONG VALLEY		North Lahontan	NRO	**0.0**	Very Low
217	5-6.02	REDDING AREA	ROSEWOOD	Sacramento River	NRO	**0.0**	Very Low
218	6-57	DARWIN VALLEY		South Lahontan	SRO	**0.0**	Very Low
219	6-56	ROSE VALLEY		South Lahontan	SRO	**0.0**	Very Low
220	2-2.03	NAPA-SONOMA VALLEY	NAPA-SONOMA LOWLANDS	San Francisco Bay	NCRO	**0.0**	Very Low
221	6-10	ADOBE LAKE VALLEY		South Lahontan	SRO	**0.0**	Very Low
222	3-5	CHOLAME VALLEY		Central Coast	SCRO	**0.0**	Very Low
223	7-15	BESSEMER VALLEY		Colorado River	SRO	**0.0**	Very Low
224	2-9.03	SANTA CLARA VALLEY	SAN MATEO PLAIN	San Francisco Bay	NCRO	**0.0**	Very Low
225	1-9	EUREKA PLAIN		North Coast	NRO	**0.0**	Very Low
226	5-1.01	GOOSE LAKE	GOOSE VALLEY	Sacramento River	NRO	**0.0**	Very Low
227	6-34	SILVER LAKE VALLEY		South Lahontan	SRO	**0.0**	Very Low
228	7-18.02	JOHNSON VALLEY	UPPER JOHNSON VALLEY	Colorado River	SRO	**0.0**	Very Low
229	5-6.06	REDDING AREA	SOUTH BATTLE CREEK	Sacramento River	NRO	**0.0**	Very Low
230	6-100	SECRET VALLEY		North Lahontan	NRO	**0.0**	Very Low
231	5-23	PANOCHE VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
232	6-8	BRIDGEPORT VALLEY		North Lahontan	NCRO	**0.0**	Very Low
233	3-30	BITTER WATER VALLEY		Central Coast	SCRO	**0.0**	Very Low
234	6-13	BLACK SPRINGS VALLEY		South Lahontan	SRO	**0.0**	Very Low
235	7-11	COPPER MOUNTAIN VALLEY		Colorado River	SRO	**0.0**	Very Low
236	6-15	DEEP SPRINGS VALLEY		South Lahontan	SRO	**0.0**	Very Low
237	5-66	CLEAR LAKE CACHE FORMATION		Sacramento River	NRO	**0.0**	Very Low

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238	6-53	SALT WELLS VALLEY		South Lahontan	SRO	**0.0**	Very Low
239	7-13.02	DEADMAN VALLEY	SURPRISE SPRING	Colorado River	SRO	**0.0**	Very Low
240	5-9	INDIAN VALLEY		Sacramento River	NRO	**0.0**	Very Low
241	6-48	GOLDSTONE VALLEY		South Lahontan	SRO	**0.0**	Very Low
242	6-26	AVAWATZ VALLEY		South Lahontan	SRO	**0.0**	Very Low
243	7-62	JOSHUA TREE		Colorado River	SRO	**0.0**	Very Low
244	6-55	COSO VALLEY		South Lahontan	SRO	**0.0**	Very Low
245	1-8.02	MAD RIVER VALLEY	DOWS PRAIRIE SCHOOL AREA	North Coast	NRO	**0.0**	Very Low
246	7-40	QUIEN SABE POINT VALLEY		Colorado River	SRO	**0.0**	Very Low
247	2-35	WESTSIDE		San Francisco Bay	NCRO	**0.0**	Very Low
248	6-74	HARRISBURG FLATS		South Lahontan	SRO	**0.0**	Very Low
249	1-54.01	ALEXANDER VALLEY	ALEXANDER AREA	North Coast	NCRO	**0.0**	Very Low
250	3-28	SAN BENITO RIVER VALLEY		Central Coast	SCRO	**0.0**	Very Low
251	9-8	WARNER VALLEY		South Coast	SRO	**0.0**	Very Low
252	1-21	FORT BRAGG TERRACE AREA		North Coast	NCRO	**0.0**	Very Low
253	6-45	TEHACHAPI VALLEY EAST		South Lahontan	SRO	**0.0**	Very Low
254	7-27	SAN FELIPE VALLEY		Colorado River	SRO	**0.0**	Very Low
255	6-71	LOST LAKE VALLEY		South Lahontan	SRO	**0.0**	Very Low
256	8-2.05	UPPER SANTA ANA VALLEY	CAJON	South Coast	SRO	**0.0**	Very Low
257	6-88	OWL LAKE VALLEY		South Lahontan	SRO	**0.0**	Very Low
258	6-76	BROWN MOUNTAIN VALLEY		South Lahontan	SRO	**0.0**	Very Low
259	5-21.53	SACRAMENTO VALLEY	BEND	Sacramento River	NRO	**0.0**	Very Low
260	5-35	MCCLOUD AREA		Sacramento River	NRO	**0.0**	Very Low
261	2-30	NOVATO VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
262	6-66	LEE FLAT		South Lahontan	SRO	**0.0**	Very Low
263	6-7	ANTELOPE VALLEY		North Lahontan	NCRO	**0.0**	Very Low
264	1-25	PRAIRIE CREEK AREA		North Coast	NRO	**0.0**	Very Low
265	6-36.01	LANGFORD VALLEY	LANGFORD WELL LAKE	South Lahontan	SRO	**0.0**	Very Low

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266	5-11	MOHAWK VALLEY		Sacramento River	NRO	**0.0**	Very Low
267	5-1.02	GOOSE LAKE	FANDANGO VALLEY	Sacramento River	NRO	**0.0**	Very Low
268	6-101	BULL FLAT		North Lahontan	NRO	**0.0**	Very Low
269	6-63	HIDDEN VALLEY		South Lahontan	SRO	**0.0**	Very Low
270	2-5	CLAYTON VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
271	6-94	GRASSHOPPER VALLEY		North Lahontan	NRO	**0.0**	Very Low
272	7-51	LOST HORSE VALLEY		Colorado River	SRO	**0.0**	Very Low
273	6-68	SANTA ROSA FLAT		South Lahontan	SRO	**0.0**	Very Low
274	8-6	HEMET LAKE VALLEY		South Coast	SRO	**0.0**	Very Low
275	5-58	CLOVER VALLEY		Sacramento River	NRO	**0.0**	Very Low
276	2-11	SUNOL VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
277	1-11	COVELO ROUND VALLEY		North Coast	NRO	**0.0**	Very Low
278	6-86	RHODES HILL AREA		South Lahontan	SRO	**0.0**	Very Low
279	2-6	YGNACIO VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
280	1-55.02	SANTA ROSA VALLEY	HEALDSBURG AREA	North Coast	NCRO	**0.0**	Very Low
281	5-71	VALLECITOS CREEK VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
282	7-56	YAQUI WELL AREA		Colorado River	SRO	**0.0**	Very Low
283	7-17	MEANS VALLEY		Colorado River	SRO	**0.0**	Very Low
284	8-7	BIG MEADOWS VALLEY		South Coast	SRO	**0.0**	Very Low
285	6-62	RACE TRACK VALLEY		South Lahontan	SRO	**0.0**	Very Low
286	5-46	LAKE BRITTON AREA		Sacramento River	NRO	**0.0**	Very Low
287	1-8.01	MAD RIVER VALLEY	MAD RIVER LOWLAND	North Coast	NRO	**0.0**	Very Low
288	5-59	GRIZZLY VALLEY		Sacramento River	NRO	**0.0**	Very Low
289	1-27	BIG LAGOON AREA		North Coast	NRO	**0.0**	Very Low
290	5-50	NORTH FORK BATTLE CREEK		Sacramento River	NRO	**0.0**	Very Low
291	6-96	EAGLE LAKE AREA		North Lahontan	NRO	**0.0**	Very Low
292	9-11	SANTA MARIA VALLEY		South Coast	SRO	**0.0**	Very Low
293	6-3	WILLOW CREEK VALLEY		North Lahontan	NRO	**0.0**	Very Low

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294	2-4	PITTSBURG PLAIN		San Francisco Bay	NCRO	**0.0**	Very Low
295	7-53	HEXIE MOUNTAIN AREA		Colorado River	SRO	**0.0**	Very Low
296	6-69	KELSO LANDER VALLEY		South Lahontan	SRO	**0.0**	Very Low
297	6-6	CARSON VALLEY		North Lahontan	NCRO	**0.0**	Very Low
298	6-36.02	LANGFORD VALLEY	IRWIN	South Lahontan	SRO	**0.0**	Very Low
299	6-64	MARBLE CANYON AREA		South Lahontan	SRO	**0.0**	Very Low
300	4-11.02	COASTAL PLAIN OF LOS ANGELES	HOLLYWOOD	South Coast	SRO	**0.0**	Very Low
301	6-77	GRASS VALLEY		South Lahontan	SRO	**0.0**	Very Low
302	1-13	LITTLE LAKE VALLEY		North Coast	NRO	**0.0**	Very Low
303	5-60	HUMBUG VALLEY		Sacramento River	NRO	**0.0**	Very Low
304	3-32	PEACH TREE VALLEY		Central Coast	SCRO	**0.0**	Very Low
305	7-52	PLEASANT VALLEY		Colorado River	SRO	**0.0**	Very Low
306	6-92	PINE CREEK VALLEY		North Lahontan	NRO	**0.0**	Very Low
307	6-61	CAMEO AREA		South Lahontan	SRO	**0.0**	Very Low
308	2-22	HALF MOON BAY TERRACE		San Francisco Bay	NCRO	**0.0**	Very Low
309	5-64	BEAR VALLEY		Sacramento River	NRO	**0.0**	Very Low
310	6-81	BUTTE VALLEY		South Lahontan	SRO	**0.0**	Very Low
311	1-49	ANNAPOLIS OHLSON RANCH FM HIGHLANDS		North Coast	NCRO	**0.0**	Very Low
312	1-61	FORT ROSS TERRACE DEPOSITS		North Coast	NCRO	**0.0**	Very Low
313	4-5	ACTON VALLEY		South Coast	SRO	**0.0**	Very Low
314	1-51	POTTER VALLEY		North Coast	NCRO	**0.0**	Very Low
315	5-8	MOUNTAIN MEADOWS VALLEY		Sacramento River	NRO	**0.0**	Very Low
316	3-18	CARPINTERIA		Central Coast	SRO	**0.0**	Very Low
317	7-26	TERWILLIGER VALLEY		Colorado River	SRO	**0.0**	Very Low
318	1-17	BRAY TOWN AREA		North Coast	NRO	**0.0**	Very Low
319	6-90	CADY FAULT AREA		South Lahontan	SRO	**0.0**	Very Low
320	5-26	WALKER BASIN CREEK VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
321	2-40	DOWNTOWN		San Francisco Bay	NCRO	**0.0**	Very Low

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322	5-12.02	SIERRA VALLEY	CHILCOOT	Sacramento River	NRO	**0.0**	Very Low
323	5-69	YOSEMITE VALLEY		San Joaquin River	SCRO	**0.0**	Very Low
324	9-19	TIA JUANA		South Coast	SRO	**0.0**	Very Low
325	9-14	MISSION VALLEY		South Coast	SRO	**0.0**	Very Low
326	3-47	BIG SPRING AREA		Central Coast	SRO	**0.0**	Very Low
327	6-78	DENNING SPRING VALLEY		South Lahontan	SRO	**0.0**	Very Low
328	7-20	MORONGO VALLEY		Colorado River	SRO	**0.0**	Very Low
329	5-36	ROUND VALLEY		Sacramento River	NRO	**0.0**	Very Low
330	5-13	UPPER LAKE VALLEY		Sacramento River	NRO	**0.0**	Very Low
331	9-16	EL CAJON VALLEY		South Coast	SRO	**0.0**	Very Low
332	5-68	POPE VALLEY		Sacramento River	NCRO	**0.0**	Very Low
333	5-7	LAKE ALMANOR VALLEY		Sacramento River	NRO	**0.0**	Very Low
334	7-55	COLLINS VALLEY		Colorado River	SRO	**0.0**	Very Low
335	6-70	CACTUS FLAT		South Lahontan	SRO	**0.0**	Very Low
336	2-7	SAN RAMON VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
337	1-14	LOWER KLAMATH RIVER VALLEY		North Coast	NRO	**0.0**	Very Low
338	7-54	BUCK RIDGE FAULT VALLEY		Colorado River	SRO	**0.0**	Very Low
339	9-18	OTAY VALLEY		South Coast	SRO	**0.0**	Very Low
340	3-44	POZO VALLEY		Central Coast	SRO	**0.0**	Very Low
341	5-10	AMERICAN VALLEY		Sacramento River	NRO	**0.0**	Very Low
342	7-63	VANDEVENTER FLAT		Colorado River	SRO	**0.0**	Very Low
343	5-3	JESS VALLEY		Sacramento River	NRO	**0.0**	Very Low
344	1-60	LOWER RUSSIAN RIVER VALLEY		North Coast	NCRO	**0.0**	Very Low
345	5-18	COYOTE VALLEY		Sacramento River	NRO	**0.0**	Very Low
346	1-54.02	ALEXANDER VALLEY	CLOVERDALE AREA	North Coast	NCRO	**0.0**	Very Low
347	6-95	DRY VALLEY		North Lahontan	NRO	**0.0**	Very Low
348	5-19	COLLAYOMI VALLEY		Sacramento River	NRO	**0.0**	Very Low
349	5-63	STONYFORD TOWN AREA		Sacramento River	NRO	**0.0**	Very Low

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
350	6-99	PAINTERS FLAT		North Lahontan	NRO	**0.0**	Very Low
351	1-30	PEPPERWOOD TOWN AREA		North Coast	NRO	**0.0**	Very Low
352	3-49	MONTECITO		Central Coast	SRO	**0.0**	Very Low
353	3-17	SANTA BARBARA		Central Coast	SRO	**0.0**	Very Low
354	6-5.02	TAHOE VALLEY	TAHOE WEST	North Lahontan	NCRO	**0.0**	Very Low
355	5-54	ASH VALLEY		Sacramento River	NRO	**0.0**	Very Low
356	6-89	KANE WASH AREA		South Lahontan	SRO	**0.0**	Very Low
357	9-17	SWEETWATER VALLEY		South Coast	SRO	**0.0**	Very Low
358	2-33	ISLAIS VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
359	2-32	VISITACION VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
360	5-43	ROCK PRAIRIE VALLEY		Sacramento River	NRO	**0.0**	Very Low
361	5-95	MEADOW VALLEY		Sacramento River	NRO	**0.0**	Very Low
362	6-91	COW HEAD LAKE VALLEY		North Lahontan	NRO	**0.0**	Very Low
363	1-53	SANEL VALLEY		North Coast	NCRO	**0.0**	Very Low
364	7-59	MASON VALLEY		Colorado River	SRO	**0.0**	Very Low
365	1-55.03	SANTA ROSA VALLEY	RINCON VALLEY	North Coast	NCRO	**0.0**	Very Low
366	7-46	CANEBRAKE VALLEY		Colorado River	SRO	**0.0**	Very Low
367	5-52	GRAYS VALLEY		Sacramento River	NRO	**0.0**	Very Low
368	4-18	HUNGRY VALLEY		South Coast	SRO	**0.0**	Very Low
369	4-3.02	VENTURA RIVER VALLEY	LOWER VENTURA RIVER	South Coast	SRO	**0.0**	Very Low
370	7-50	IRON RIDGE AREA		Colorado River	SRO	**0.0**	Very Low
371	6-75	WILDROSE CANYON		South Lahontan	SRO	**0.0**	Very Low
372	6-98	TULEDAD CANYON VALLEY		North Lahontan	NRO	**0.0**	Very Low
373	2-19	KENWOOD VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
374	1-12	LAYTONVILLE VALLEY		North Coast	NRO	**0.0**	Very Low
375	1-19	ANDERSON VALLEY		North Coast	NCRO	**0.0**	Very Low
376	5-53	DIXIE VALLEY		Sacramento River	NRO	**0.0**	Very Low
377	5-70	LOS BANOS CREEK VALLEY		San Joaquin River	SCRO	**0.0**	Very Low
378	6-82	SPRING CANYON VALLEY		South Lahontan	SRO	**0.0**	Very Low

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
379	6-107	SWEETWATER FLAT		North Lahontan	NCRO	**0.0**	Very Low
380	3-24	QUIEN SABE VALLEY		Central Coast	SCRO	**0.0**	Very Low
381	3-45	HUASNA VALLEY		Central Coast	SRO	**0.0**	Very Low
382	5-57	LAST CHANCE CREEK VALLEY		Sacramento River	NRO	**0.0**	Very Low
383	4-15	TIERRA REJADA		South Coast	SRO	**0.0**	Very Low
384	6-105	SLINKARD VALLEY		North Lahontan	NCRO	**0.0**	Very Low
385	6-93	HARVEY VALLEY		North Lahontan	NRO	**0.0**	Very Low
386	5-86	JOSEPH CREEK		Sacramento River	NRO	**0.0**	Very Low
387	5-87	MIDDLE FORK FEATHER RIVER		Sacramento River	NRO	**0.0**	Very Low
388	5-83	CUDDY RANCH AREA		Tulare Lake	SCRO	**0.0**	Very Low
389	5-47	GOOSE VALLEY		Sacramento River	NRO	**0.0**	Very Low
390	8-8	SEVEN OAKS VALLEY		South Coast	SRO	**0.0**	Very Low
391	5-41	EGG LAKE VALLEY		Sacramento River	NRO	**0.0**	Very Low
392	1-50	KNIGHTS VALLEY		North Coast	NCRO	**0.0**	Very Low
393	6-65	COTTONWOOD SPRING AREA		South Lahontan	SRO	**0.0**	Very Low
394	1-7	HOOPA VALLEY		North Coast	NRO	**0.0**	Very Low
395	9-27	COTTONWOOD VALLEY		South Coast	SRO	**0.0**	Very Low
396	6-97	HORSE LAKE VALLEY		North Lahontan	NRO	**0.0**	Very Low
397	4-1	UPPER OJAI VALLEY		South Coast	SRO	**0.0**	Very Low
398	1-31	WEOTT TOWN AREA		North Coast	NRO	**0.0**	Very Low
399	7-61	DAVIES VALLEY		Colorado River	SRO	**0.0**	Very Low
400	9-12	SAN DIEGUITO CREEK		South Coast	SRO	**0.0**	Very Low
401	5-29	CASTAC LAKE VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
402	9-28	CAMPO VALLEY		South Coast	SRO	**0.0**	Very Low
403	3-36	SANTA ROSA VALLEY		Central Coast	SRO	**0.0**	Very Low
404	5-93	NORTH FORK CACHE CREEK		Sacramento River	NRO	**0.0**	Very Low
405	5-84	CUDDY VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
406	7-49	PIPES CANYON FAULT VALLEY		Colorado River	SRO	**0.0**	Very Low
407	3-25	TRES PINOS VALLEY		Central Coast	SCRO	**0.0**	Very Low
408	5-37	TOAD WELL AREA		Sacramento River	NRO	**0.0**	Very Low
409	6-73	WILD HORSE MESA AREA		South Lahontan	SRO	**0.0**	Very Low
410	5-82	CUDDY CANYON VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
411	1-6	HAYFORK VALLEY		North Coast	NRO	**0.0**	Very Low
412	1-22	FAIRCHILD SWAMP VALLEY		North Coast	NRO	**0.0**	Very Low

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
413	6-85	GOLD VALLEY		South Lahontan	SRO	**0.0**	Very Low
414	5-51	BUTTE CREEK VALLEY		Sacramento River	NRO	**0.0**	Very Low
415	5-80	BRITE VALLEY		Tulare Lake	SCRO	**0.0**	Very Low
416	1-28	MATTOLE RIVER VALLEY		North Coast	NRO	**0.0**	Very Low
417	9-25	RANCHITA TOWN AREA		South Coast	SRO	**0.0**	Very Low
418	3-53	FOOTHILL		Central Coast	SRO	**0.0**	Very Low
419	4-19	THOUSAND OAKS AREA		South Coast	SRO	**0.0**	Very Low
420	4-20	RUSSELL VALLEY		South Coast	SRO	**0.0**	Very Low
421	5-49	DRY BURNEY CREEK VALLEY		Sacramento River	NRO	**0.0**	Very Low
422	5-90	FUNKS CREEK		Sacramento River	NRO	**0.0**	Very Low
423	9-2	SAN MATEO VALLEY		South Coast	SRO	**0.0**	Very Low
424	3-46	RAFAEL VALLEY		Central Coast	SRO	**0.0**	Very Low
425	1-48	GRAVELLY VALLEY		North Coast	NRO	**0.0**	Very Low
426	6-72	COLES FLAT		South Lahontan	SRO	**0.0**	Very Low
427	9-9	ESCONDIDO VALLEY		South Coast	SRO	**0.0**	Very Low
428	2-26	PESCADERO VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
429	5-17	BURNS VALLEY		Sacramento River	NRO	**0.0**	Very Low
430	3-31	HERNANDEZ VALLEY		Central Coast	SCRO	**0.0**	Very Low
431	5-31	LONG VALLEY		Sacramento River	NRO	**0.0**	Very Low
432	1-15	HAPPY CAMP TOWN AREA		North Coast	NRO	**0.0**	Very Low
433	3-22	SANTA ANA VALLEY		Central Coast	SCRO	**0.0**	Very Low
434	1-57	BODEGA BAY AREA		North Coast	NCRO	**0.0**	Very Low
435	7-48	HELENDALE FAULT VALLEY		Colorado River	SRO	**0.0**	Very Low
436	3-43	RINCONADA VALLEY		Central Coast	SRO	**0.0**	Very Low
437	6-106	LITTLE ANTELOPE VALLEY		North Lahontan	NCRO	**0.0**	Very Low
438	9-13	POWAY VALLEY		South Coast	SRO	**0.0**	Very Low
439	7-47	JACUMBA VALLEY		Colorado River	SRO	**0.0**	Very Low
440	5-40	HOT SPRINGS VALLEY		Sacramento River	NRO	**0.0**	Very Low
441	5-30	LOWER LAKE VALLEY		Sacramento River	NRO	**0.0**	Very Low
442	1-29	HONEYDEW TOWN AREA		North Coast	NRO	**0.0**	Very Low
443	2-38	LOBOS		San Francisco Bay	NCRO	**0.0**	Very Low
444	5-16	HIGH VALLEY		Sacramento River	NRO	**0.0**	Very Low
445	5-48	BURNEY CREEK VALLEY		Sacramento River	NRO	**0.0**	Very Low
446	5-85	MIL POTRERO AREA		Tulare Lake	SCRO	**0.0**	Very Low

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
447	5-56	YELLOW CREEK VALLEY		Sacramento River	NRO	**0.0**	Very Low
448	1-34	DINSMORES TOWN AREA		North Coast	NRO	**0.0**	Very Low
449	1-16	SEIAD VALLEY		North Coast	NRO	**0.0**	Very Low
450	1-20	GARCIA RIVER VALLEY		North Coast	NCRO	**0.0**	Very Low
451	5-92	BLANCHARD VALLEY		Sacramento River	NRO	**0.0**	Very Low
452	4-16	HIDDEN VALLEY		South Coast	SRO	**0.0**	Very Low
453	2-39	MARINA		San Francisco Bay	NCRO	**0.0**	Very Low
454	2-37	SOUTH SAN FRANCISCO		San Francisco Bay	NCRO	**0.0**	Very Low
455	1-38	LOWER LAYTONVILLE VALLEY		North Coast	NCRO	**0.0**	Very Low
456	9-32	SAN MARCOS AREA		South Coast	SRO	**0.0**	Very Low
457	1-32	GARBERVILLE TOWN AREA		North Coast	NRO	**0.0**	Very Low
458	5-38	PONDOSA TOWN AREA		Sacramento River	NRO	**0.0**	Very Low
459	5-91	ANTELOPE CREEK		Sacramento River	NRO	**0.0**	Very Low
460	9-29	POTRERO VALLEY		South Coast	SRO	**0.0**	Very Low
461	3-20	ANO NUEVO AREA		Central Coast	SCRO	**0.0**	Very Low
462	1-26	REDWOOD CREEK AREA		North Coast	NRO	**0.0**	Very Low
463	6-5.03	TAHOE VALLEY	TAHOE NORTH	North Lahontan	NCRO	**0.0**	Very Low
464	2-8	CASTRO VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
465	2-28	ROSS VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
466	6-80	MIDDLE PARK CANYON		South Lahontan	SRO	**0.0**	Very Low
467	1-45	BIG RIVER VALLEY		North Coast	NCRO	**0.0**	Very Low
468	1-43	WILLIAMS VALLEY		North Coast	NCRO	**0.0**	Very Low
469	3-42	CHORRO VALLEY		Central Coast	SRO	**0.0**	Very Low
470	9-24	PAMO VALLEY		South Coast	SRO	**0.0**	Very Low
471	1-40	TEN MILE RIVER VALLEY		North Coast	NCRO	**0.0**	Very Low
472	1-56	McDOWELL VALLEY		North Coast	NCRO	**0.0**	Very Low
473	5-62	ELK CREEK AREA		Sacramento River	NRO	**0.0**	Very Low
474	3-23	UPPER SANTA ANA VALLEY		Central Coast	SCRO	**0.0**	Very Low
475	3-29	DRY LAKE VALLEY		Central Coast	SCRO	**0.0**	Very Low
476	5-61	CHROME TOWN AREA		Sacramento River	NRO	**0.0**	Very Low
477	2-27	SAND POINT AREA		San Francisco Bay	NCRO	**0.0**	Very Low
478	1-39	BRANSCOMB TOWN AREA		North Coast	NCRO	**0.0**	Very Low
479	1-44	EDEN VALLEY		North Coast	NCRO	**0.0**	Very Low
480	5-20	BERRYESSA VALLEY		Sacramento River	NCRO	**0.0**	Very Low
481	3-37	VILLA VALLEY		Central Coast	SRO	**0.0**	Very Low
482	1-35	HYAMPOM VALLEY		North Coast	NRO	**0.0**	Very Low

CASGEM Groundwater Basin Prioritization Results - Abridged Sorted by Overall Basin Score						Overall Ranking	
Basin count	Basin Number	Basin Name	Sub-Basin Name	Hydrologic Region	DWR Region Office	Overall Basin Ranking Score ***	Overall Basin Priority
483	5-45	CAYTON VALLEY		Sacramento River	NRO	**0.0**	Very Low
484	5-89	SQUAW FLAT		Sacramento River	NRO	**0.0**	Very Low
485	5-65	LITTLE INDIAN VALLEY		Sacramento River	NRO	**0.0**	Very Low
486	9-3	SAN ONOFRE VALLEY		South Coast	SRO	**0.0**	Very Low
487	3-39	OLD VALLEY		Central Coast	SRO	**0.0**	Very Low
488	3-50	FELTON AREA		Central Coast	SCRO	**0.0**	Very Low
489	1-42	SHERWOOD VALLEY		North Coast	NCRO	**0.0**	Very Low
490	5-44	LONG VALLEY		Sacramento River	NRO	**0.0**	Very Low
491	2-24	SAN GREGORIO VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
492	5-88	STONY GORGE RESERVOIR		Sacramento River	NRO	**0.0**	Very Low
493	3-33	SAN CARPOFORO VALLEY		Central Coast	SRO	**0.0**	Very Low
494	3-34	ARROYO DE LA CRUZ VALLEY		Central Coast	SRO	**0.0**	Very Low
495	1-33	LARABEE VALLEY		North Coast	NRO	**0.0**	Very Low
496	9-23	SAN ELIJO VALLEY		South Coast	SRO	**0.0**	Very Low
497	2-29	SAN RAFAEL VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
498	1-36	HETTENSHAW VALLEY		North Coast	NRO	**0.0**	Very Low
499	1-41	LITTLE VALLEY		North Coast	NCRO	**0.0**	Very Low
500	2-31	ARROYO DEL HAMBRE VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
501	3-27	SCOTTS VALLEY		Central Coast	SCRO	**0.0**	Very Low
502	1-46	NAVARRO RIVER VALLEY		North Coast	NCRO	**0.0**	Very Low
503	1-37	COTTONEVA CREEK VALLEY		North Coast	NCRO	**0.0**	Very Low
504	9-22	BATIQUITOS LAGOON VALLEY		South Coast	SRO	**0.0**	Very Low
505	3-40	TORO VALLEY		Central Coast	SRO	**0.0**	Very Low
506	1-62	WILSON POINT AREA		North Coast	NRO	**0.0**	Very Low
507	5-94	MIDDLE CREEK		Sacramento River	NRO	**0.0**	Very Low
508	6-108	OLYMPIC VALLEY		North Lahontan	NCRO	**0.0**	Very Low
509	2-36	SAN PEDRO VALLEY		San Francisco Bay	NCRO	**0.0**	Very Low
510	3-41	MORRO VALLEY		Central Coast	SRO	**0.0**	Very Low
511	4-22	MALIBU VALLEY		South Coast	SRO	**0.0**	Very Low
512	3-35	SAN SIMEON VALLEY		Central Coast	SRO	**0.0**	Very Low
513	3-52	NEEDLE ROCK POINT		Central Coast	SCRO	**0.0**	Very Low
514	3-51	MAJORS CREEK		Central Coast	SCRO	**0.0**	Very Low
515	3-38	CAYUCOS VALLEY		Central Coast	SRO	**0.0**	Very Low

* Overall Basin Ranking Score = Population + Population Growth + PSW + (Total Wells x .75) + Irr Acreage + (GW Use + GW %)/2 + Impacts + Other

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Groundwater Legislation Timeline

Jan 1, 2015
Local Agencies may no longer adopt or update GMPs for high and medium priority basins.

Jan 31, 2015 *
DWR updates basin prioritization. **

2015 - 2016 *
DWR identifies basins subject to critical conditions of overdraft.

Jan 1, 2016
DWR adopts regulations to revise basin boundaries.

Apr 1, 2016
Adjudicated basins submit final judgment to DWR and begin submitting annual reports to DWR.

Jun 1, 2016
DWR adopts regulations for evaluating and implementing GSPs and coordination agreements and DWR adopts regulations for evaluating alternatives to GSPs.

Dec 31, 2016 *
DWR publishes report on water available for groundwater replenishment.

2017
DWR publishes Bulletin 118- Interim Update with updated Basin Boundaries, updated Basin Prioritization, and reissues (as needed) basins subject to critical conditions of overdraft.

Jan 1, 2017 *
DWR publishes BMPs for sustainable management of groundwater.

Jan 1, 2017
Alternative to a GSP due to DWR.

Jun 30, 2017
Establish GSAs (or equivalent) for all high and medium priority basins.

Jul 1, 2017
County must affirm or disaffirm responsibility as GSA if no GSA has been established.

2020
DWR publishes Bulletin 118- Comprehensive Update.

Jan 31, 2020
High and medium priority basins identified subject to critical conditions of overdraft must be managed under a GSP.

On April 1 following GSP adoption and annually thereafter, GSAs provide report on progress towards sustainability to DWR.

Jan 31, 2022
All other high and medium priority basins must be managed under a GSP.

On April 1 following GSP adoption and annually thereafter, GSAs provide report on progress towards sustainability to DWR.

2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2025

Jun 30, 2017
Board may hold a hearing to designate a basin as "probationary" if a GSA or approved alternative is not established.

Jul 1, 2017
Board adopts a fee schedule for "state back-stop" related costs.

Dec 15, 2017
Board begins collection of annual reports from persons extracting more than two acre feet per year from areas not managed by a GSA.

Jan 1, 2018
Board may begin to develop interim plans if a local agency has not remedied the deficiency that resulted in the "probationary basin" status. The Board consults with DWR.

Probationary basins may petition for un-designation. The Board consults with DWR to determine if the petition is complete. The Board acts on the petition within 90 days of submittal.

Jan 31, 2020
Board may hold a hearing to designate a critically-overdrafted basin as "probationary" if DWR, in consultation with the Board, determines that the GSP is inadequate or will not achieve sustainability.

Jan 2021
Board may begin developing interim plans for critically overdrafted "probationary basins" one year after the probationary designation, if the Board, in consultation with the DWR, determines that a local agency has not remedied the deficiency that resulted in the probationary status.

Jan 31, 2022
Board may hold a hearing to designate a high and medium priority basin as "probationary" if DWR, in consultation with the Board, determines that the GSP is inadequate or will not achieve sustainability.

Jan 1, 2025
Board may designate a basin as "probationary" if DWR, in consultation with the Board, determines that the GSP is inadequate or not being implemented correctly, and the Board determines that the basin is in a condition where groundwater extractions result in significant depletion of interconnected surface waters.

- Water Board Action
- DWR Action
- Joint Water Board and DWR Action
- Local Action

GMP Groundwater Management Plan
GSA Groundwater Sustainability Agency
GSP Groundwater Sustainability Plan
BMPs Best Management Practices
* Elements to be documented in Bulletin 118 Updates
** Basin prioritization will be updated prior to each Bulletin 118 Update (estimated to be every 5 years)

October 2014

Appendix D: Non-Potable Regulatory Support Material

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Appendix D: Recycled Water Regulations

The production, discharge, distribution, and use of recycled water are subject to federal, state, and local regulations; the primary objectives of which are to protect public health. Regulatory requirements apply for non-potable and potable uses of recycled water.

- **Non-potable reuse** refers to the use of treated municipal wastewater for specific purposes other than drinking; such as landscape irrigation, industrial uses, and agriculture or for environmental benefits. Non-potable reuse usually requires an independent "purple pipe" distribution system for conveying recycled water to customers separate from the potable supply. In California, non-potable reuse has been occurring for the last century and regulations for non-potable reuse have been in place since the 1970s.
- **Potable reuse** refers to the intended use of highly treated or purified municipal wastewater to augment a water supply that is used for drinking and all other purposes. Unplanned potable reuse, where one community draws raw water supplies downstream from discharges from wastewater treatment plants, is regulated by federal discharge requirements. Planned potable reuse involves a more formal public process and regulatory consultation program to implement and the regulations in California for the indirect and direct use of recycled water are at varying stages of development.
    - **Indirect potable reuse (IPR)** is the purposeful introduction of highly purified recycled water into an untreated drinking water supply source, such as groundwater in an aquifer or surface water in a large reservoir. The recycled water is mixed with the untreated water source, and there is a specified blending ratio, travel time and distance between the point of addition and eventual extraction for treatment at a drinking water treatment plant. Regulations for groundwater replenishment using recycled water became effective on June 18, 2014 and the adoption of water recycling criteria for surface water reservoir augmentation are anticipated by December 31, 2016.
    - **Direct potable reuse** (DPR) is the purposeful introduction of highly purified recycled water into a drinking water supply; immediately upstream of a drinking water treatment plant or directly into the potable water supply distribution system downstream of a water treatment plant. DPR is not yet included as an allowable use in California, though a report on the feasibility of developing uniform water recycling criteria for direct potable reuse is anticipated by December 31, 2016.

Meeting regulatory requirements is an integral part of implementing any non-potable or potable recycled water project. This appendix summarizes the regulatory requirements and their administration, with an emphasis on regulations relating to the distribution and use of recycled water in California.

A.1. Federal Requirements

Federal requirements relevant to the discharge of recycled water, or wastewater, and any other liquid wastes to "navigable waters" are contained in the 1972 amendments to the Federal Water Pollution Control Act of 1956, commonly known as the federal Clean Water Act (CWA) (Public Law 92-500). The CWA created the U.S. Environmental Protection Agency (USEPA) and established the National Pollutant Discharge Elimination System (NPDES), a permit system for discharge of contaminants to navigable waters. NPDES requires that all municipal and industrial dischargers of liquid wastes apply for and obtain a permit prior to initiating discharge.

There are no federal regulations governing water reuse in the United States, thus regulations (or guidelines) for recycled water are developed and implemented at the state government level. The lack of federal regulations has resulted in differing standards among states that have developed recycled water regulations (WateReuse 2009). This appendix focuses on recycled water regulations in the State of California.

Recognizing the need to provide national guidance on water reuse regulations and program planning, the U.S. Environmental Protection Agency (USEPA) has developed comprehensive, up-to-date water reuse guidelines in support of regulations and guidelines developed by states, tribes, and other authorities (USEPA 2012). The 2012 USEPA Guidelines for Water Reuse provides support for both project planners and state regulatory officials by providing a national overview of the status of reuse regulations and clarifying some of the variations in the regulatory frameworks that support reuse in different states and regions of the United States

A.2. State Requirements

In the State of California, recycled water requirements are administered by the State Water Resource Control Board (SWRCB) - Division of Drinking Water (DDW), formerly under California Department of Public Health (CDPH), and individual Regional Water Quality Control Boards (RWQCBs). The regulatory requirements for recycled water projects in California are contained in the following sources[1,2] :

- California Code of Regulations (CCR) -Title 22 and Title 17
- California Health and Safety Code
- California Water Code.

[1] State requirements for production, discharge, distribution, and use of recycled water are contained in the California Water Code, Division 7-Water Quality, Sections 1300 through 13999.16 (Water Code); the California Administrative Code, Title 22-Social Security, Division 4 Environmental Health, Chapter 3-Reclamation Criteria, Sections 60301 through 60475 (Title 22); and the California Administrative Code, Title 17-Public Health, Chapter 5, Subchapter 1, Group 4-Drinking Water Supplies, Sections 7583 through 7630 (Title 17).

[2] Applicable excerpts from Title 22, Title 17, and the Health and Safety Code are documented in "The Purple Book", which provides a single source of guidelines and requirements for recycled water use in California (CDPH 2001).

Title 22 State Clean Water Act (CWA)

In 1975, Title 22 was prepared by the California Department of Public Health (now DDW[3]) in accordance with the requirements of Division 7, Chapter 7 of the Water Code. In 1978, Title 22 was revised to conform with the 1977 amendment to the federal CWA. The requirements of Title 22, as revised in 1978, 1990, and 2001, regulate production and use of recycled water in California.

The DDW regulates the treatment, quality, and use of recycled water, as well as the proper separation of recycled water and drinking water systems. Title 22 stipulates the levels of treatment for different uses of recycled water, permissible types of reuse, and minimum recycled water quality requirements. Water meeting these standards is considered safe for non-drinking purposes. Routine monitoring is required to ensure that the intended quality is consistently being produced.

Figure A.1 illustrates the allowable uses of recycled water for each level of treatment. Most recycled water used in California meets the Title 22 standards for "disinfected tertiary recycled water", which has the most stringent requirements for non-potable reuse. "Disinfected tertiary recycled water" means a filtered and subsequently disinfected wastewater that meets certain total coliform concentration, turbidity, and disinfection requirements. A lower degree of treatment, "disinfected secondary recycled water", is allowed for specified irrigation, non-irrigation and environmental uses, and is less frequently used. In some cases, a higher degree of treatment beyond Title 22 requirements is performed to meet more stringent requirements for salt and nutrient-sensitive uses.

[3] The Drinking Water Program for CDPH moved to the SWRCB and was renamed the Division of Drinking Water (DDW) as of July 1, 2014.

Figure A-1 Non-Potable Recycled Water Uses Allowed[1] in California

This summary is prepared by WateRuse Association of California, from the December 2, 2000, Title 22 adopted Water Recycling Criteria, and supersedes all earlier versions.

Recycled Water Use	Treatment Level: Disinfected Tertiary Recycled Water	Disinfected Secondary 2.2 Recycled Water	Disinfected Secondary 23 Recycled Water	Undisinfected Secondary Recycled Water
Irrigation for:				
Food crops where recycled water contacts the edible portion of the crop, including all root crops	ALLOWED	NOT ALLOWED	NOT ALLOWED	NOT ALLOWED
Parks and playgrounds				
School grounds				
Residential landscaping				
Unrestricted-access golf courses				
Any other irrigation uses not specifically prohibited by other provisions of the *California Code of Regulations*				
Food crops, surface-irrigated, above-ground edible portion, not contacted by recycled water		ALLOWED		
Cemetaries			ALLOWED	
Freeway landscaping				
Restricted-access golf courses				
Ornamental nursery stock and sod farms with unrestricted public access				
Pasture for milk animals for human consumption				
Nonedible vegetation with access control to prevent use as a park, playground or school grounds				
Orchards with no contact between edible portion and recycled water				ALLOWED
Vineyards with no contact between edible portion and recycled water				
Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest				
Fodder and fiber crops and pasture for animals not producing milk for human consumption				
Seed crops not eaten by humans				
Food crops undergoing commercial pathogen-destroying processing before consumption by humans				
Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest				
Supply for impoundment:				
Nonrestricted recreational impoundments, with supplemental monitoring for pathogenic organisms	ALLOWED[2]	NOT ALLOWED	NOT ALLOWED	NOT ALLOWED
Restricted recreational impoundments and publicly accessible fish hatcheries	ALLOWED	ALLOWED		
Landscape impoundments without decorative fountains			ALLOWED	
Supply for cooling or air conditioning:				
Industrial or commercial cooling or air conditioning involving cooling tower, evaporative condenser, or spraying that creates a mist	ALLOWED[3]	NOT ALLOWED	NOT ALLOWED	NOT ALLOWED
Industrial or commercial cooling or air conditioning not involving cooling tower, evaporative condenser, or spraying that creates a mist	ALLOWED	ALLOWED	ALLOWED	

Recycled Water Use	Treatment Level			
	Disinfected Tertiary Recycled Water	Disinfected Secondary 2.2 Recycled Water	Disinfected Secondary 23 Recycled Water	Undisinfected Secondary Recycled Water
Other Uses:				
Groundwater Recharge	ALLOWED under special case-by-case permits by RWQCB[4]			
Flushing toilets and urinals	ALLOWED	NOT ALLOWED	NOT ALLOWED	NOT ALLOWED
Priming drain traps				
Industrial process water that may contact workers				
Structural fire fighting				
Decorative fountains				
Commercial laundries				
Consolidation of backfill material around potable water pipelines				
Artificial snow making for commercial outdoor use				
Commercial car washes, not heating the water, excluding the general public from the washing process				
Industrial process water that will not come into contact with workers		ALLOWED	ALLOWED	
Industrial boiler feed				
Nonstructural fire fighting				
Backfill consolidation around nonpotable piping				
Soil compaction				
Mixing concrete				
Dust control on roads and streets				
Cleaning roads, sidewalks and outdoor work areas				
Flushing sanitary sewers				ALLOWED

1 Refer to the full text of the version of California Department of Public Health's "Regulations Related to Recycled Water", published on January 1, 2009. This chart is only an informal summary of uses allowed in that publication. The most current Title 17 and Title 22 regulations can be downloaded from: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/RWregulations_20150625.pdf

2 With "conventional tertiary treatment." Additional monitoring for two years or more is necessary with direct filtration.

3 Drift eliminators and/or biocides are required if public or employees can be exposed to mist.

4 Refer to the June 18, 2014 final Groundwater Recharge Guidelines, available from the DDW website at: http://www.cdph.ca.gov/services/DPOPP/regs/Pages/DPH14-003EGroundwaterReplenishmentUsingRecycledWater.aspx

In addition to recycled water uses and treatment requirements, Title 22 addresses sampling and analysis requirements at the treatment plant, preparation of an engineering report prior to production or use of recycled water, general treatment design requirements, reliability requirements, and alternative methods of treatment.

Title 17 State Drinking Water Code

The focus of Title 17 is protection of drinking (potable) water supplies through control of cross-connections[4] with potential contaminants, including non-potable water supplies such as recycled water. Title 17, Group 4, Article 2 - Protection of Water System, Table 1, specifies the minimum backflow protection required on the potable water system for situations in which there is potential for contamination to the potable water supply. Recycled water is addressed in Title 17 as follows:

- An **air-gap separation** is required on "Premises where the public water system is used to supplement the recycled water supply."
- A **reduced pressure principle backflow prevention device** is required on "Premises where recycled water is used…and there is no interconnection with the potable water system."
- A **double-check valve assembly** may be used for "Residences using recycled water for landscape irrigation as part of an approved dual plumbed use area established pursuant to Sections 60313 through 60316 unless the recycled water supplier obtains approval for the local public water supplier, or (DDW) if the water supplier is also the supplier of the recycled water, to utilize an alternative backflow prevention plan that includes an annual inspection and annual shutdown test of the recycled water and potable water systems pursuant to subsection 60316(a)."

Title 17 specifies the minimum backflow protection on the potable water system for situations in which there is potential for contamination to the potable water supply. In conjunction with local health agencies, DDW reviews and approves final onsite (customer) system plans for cross-connection control in accordance with Title 17, and inspects each system prior to operation. Backflow prevention and cross-connection testing would be performed for each site in accordance with DDW requirements before the recycled water supply is connected to that site.

A.3. State Guidelines

To assist in compliance with Title 22, DDW has prepared a number of guidelines for production, distribution, and use of recycled water. Additionally, DDW recommends use of guidelines prepared by the California-Nevada Section of the American Water Works Association (AWWA). These guidelines are summarized below.

Guideline for the Preparation of an Engineering Report on the Production, Distribution, and Use of Recycled Water. According to Title 22, prior to implementation of a water reclamation project (production, distribution, or use) an engineering report must be prepared and submitted to DDW. This guideline, prepared by DDW and dated March 2001, specifies the contents of an engineering report. The report should describe the production process, including the treated

[4] A cross-connection is an unprotected actual or potential connection between a potable water system used to supply water for drinking purposes and any source or system containing unapproved water or a substance that is not or cannot be approved as safe, wholesome, and potable, which in this case will be recycled water. By-pass arrangements, jumper connections, removable sections, swivel or changeover devices, or other devices through which backflow could occur, shall be considered to be cross-connections

(effluent) water quality, the raw water quality, the treatment process; the plant reliability features the supplemental water supply, the monitoring program, and a contingency plan to prevent distribution of inadequately treated water. The report should include maps of the distribution system and describe how the system will comply with DDW and AWWA guidelines and Title 17. The report should include maps of proposed use areas and should describe the use areas, the types of uses proposed, the people responsible for supervising the uses, the design of the user systems, and the proposed user inspection and monitoring programs.

Manual of Cross Connection Control/Procedures and Practices. This manual, dated July 1981, focuses on establishing a cross-connection control program to protect the public against backflow and back-siphonage of contamination. Main elements of the manual include areas where protection is required; causes of backflow; approved backflow preventers; procedures, installation, and certification of backflow preventers; and water shutoff procedures (for conditions which pose a hazard to the potable water supply).

Guidelines for the Distribution of Nonpotable Water. These guidelines were prepared by the California-Nevada Section of AWWA in 1992. The purpose of these guidelines is to provide guidance for planning, designing, constructing, and operating non-potable water systems, including recycled water systems. Distribution lines, storage and supply, pumping, on-site (user) applications, and system management are discussed. DDW guidelines reference these guidelines.

Guidelines for the On-Site Retrofit of Facilities Using Disinfected Tertiary Recycled Water. The California-Nevada Section of AWWA prepared these guidelines in 1997 to provide guidance on modifying existing on-site facilities for conversion to use of recycled water, including recommendations for signage, backflow prevention, and separation standards, for landscape irrigation, agricultural irrigation, industrial uses, and impoundments.

A.4. State Recycled Water Policy

The SWRCB adopted a Recycled Water Policy (RW Policy) in 2009 to establish more uniform requirements for water recycling throughout the State and to streamline the permit application process in most instances. The RW Policy includes a mandate that the State increase the use of recycled water over 2002 levels by at least 200,000 AFY by 2030. Also included are goals for stormwater reuse, conservation, and potable water offsets by recycled water. The onus for achieving these mandates and goals is placed both on recycled water purveyors and potential users. Absent unusual circumstances, the RW Policy puts forth that recycled water irrigation projects that meet DDW requirements and other State or Local regulations be adopted by Regional Boards within 120 days. These streamlined projects will not be required to include a monitoring component.

The RW Policy requires that salt/nutrient management plans be developed for every basin in California and adopted as Basin Plan Amendments by 2015. These Management Plans are to be developed by local stakeholders and funded by the regulated community.

The RW Policy also required the formation of a Blue-Ribbon Advisory Panel (Panel) to guide future actions with respect to contaminants of emerging concern (CECs). CECs include chemicals and other substances that have no regulatory standard, have recently been "discovered" in natural streams, and potentially cause deleterious effects in aquatic life at environmentally relevant concentrations. The Panel was convened in May 2009 and completed in May 2010. A final report was issued in June 2010. The recommendations of the Panel resulted in the finalization of the Groundwater Recharge and Reuse Regulations in June 2014, which incorporated the Panel's recommendations.

A.5. Indirect Potable Reuse Regulations

The California Water Code addresses the use of recycled water for IPR via groundwater recharge and reservoir augmentation.

Groundwater Recharge Reuse Regulations

Regulations for groundwater replenishment using recycled water became effective on June 18, 2014. These regulations define full advanced treatment (FAT) as the treatment of an oxidized wastewater (wastewater in which the organic matter has been stabilized) using a RO and oxidation treatment process meeting certain minimum criteria. FAT (also referred as Advanced Water Purification (AWP)) is required in the case of groundwater replenishment via injection (subsurface application), but not necessarily for surface spreading. Key aspects of these regulations are summarized in Table A.1 (Trussell et al. 2013; DDW 2014). There are additional regulatory requirements not shown in Table A.1, such as reporting and monitoring requirements. Additional information, such as specific definitions for required treatment, is presented in the regulations (DDW 2014).

Table A.2 - Summary of SWRCB DDW Regulations for Indirect Potable Reuse (via Groundwater Recharge)

Water Quality Limits for Recycled Water	Treatment Required
≥ 12-log virus reduction ≥ 10-log *Giardia* cyst reduction ≥ 10-log *Cryptosporidium* oocyst reduction Drinking water MCLs (except for nitrogen) ≤ 10 mg/L total nitrogen Action levels for lead and copper TOC ≤ 0.5/RWC	Spreading (i.e., surface application) Oxidation Filtration Disinfection Soil aquifer treatment Injection with FAT (i.e., subsurface application) Oxidation Reverse Osmosis (RO) Advanced Oxidation Process (AOP)
Other Selected Requirements	
• Treatment train shall consist of at least 3 separate treatment processes to achieve the pathogenic (microorganism) control • For each pathogen (i.e., virus, *Giardia*, or *Cryptosporidium*), a separate treatment process may be credited with no more than 6-log reduction, with at least 3 processes each being credited with no less than 1.0-log reduction • ≥ 2-month retention (response) time underground • Initial maximum RWC ≤ 20% for spreading tertiary treated water or up to 100% for Injection with FAT. Over time the RWC can be increased if certain requirements are met. • For spreading, or Injection with FAT, 1-log virus reduction credit automatically given per month of subsurface retention • For spreading, 10-log *Giardia* reduction and 10-log *Cryptosporidium* reduction credit given to disinfected tertiary effluents with at least 6 months retention time underground	

Notes: MCL = maximum contaminant level
RWC = recycled water contribution (the quantity of recycled water applied at the recharge site divided by the sum of the quantity of recycled water applied at the site and diluent water)

Reservoir Augmentation Regulations

A recycled water reservoir augmentation project is defined as a project that plans to use recycled municipal wastewater for the purpose of augmenting a reservoir that is designated as a source of domestic water supply. A significant degree of regulatory uncertainty exists with respect to the overall implementation of a reservoir augmentation project. Chief among these uncertainties is the fact that (1) DDW regulations for such a project have not yet been developed, and (2) DDW has not yet convened the required expert panel to assess reservoir augmentation public safety needs. Table A.3 summarizes some probable DDW reservoir augmentation requirements.

Table A.3 - Summary of Probable DDW Reservoir Augmentation Requirements

Parameter	Probable Requirement
Source Control	• Develop and implement a source control program to identify, monitor, and control pollutant discharges from industrial discharge sources
Recycled Water Treatment	• Tertiary filtration treatment that conforms with DDW Title 22 regulations • Reverse osmosis treatment of 100 percent of the flow • AWP that provides additional 4-log removal of virus and pathogens over and above tertiary treatment • Fail-safe provisions for disposing of recycled water in the event of treatment failure • AWP that achieves compliance with drinking water standards
Reservoir Detention	• Reservoir discharge/withdrawal designed to maximize detention time • Reservoir modeling to evaluate detention times and short-circuiting • Tracer studies to confirm detention projections • Plan for responding to adverse reservoir short-circuiting or treatability conditions • Reservoir discharge/withdrawal designed to minimize the potential for short-circuiting
Potable Water Treatment	• Treatment and disinfection that conforms to surface water treatment regulations • Alternative water sources available for use in the event of reservoir augmentation interruption
Monitoring	• Real-time monitoring to assess treatment failure • Monitoring to confirm pathogen reduction in treatment and storage • Advisory panel to assess project technology and health risks

Note: Opinion of probable requirements based on DDW guidance provided to City of San Diego as part of the San Diego Water Purification Demonstration Project. Actual reservoir augmentation requirements anticipated to be issued by DDW in 2016 may include additional provisions over those listed above.

A.6. Direct Potable Reuse Regulations

The California Water Code was modified by legislative statute to require DDW, in consultation with the SWRCB, to investigate and report on the feasibility of developing uniform water recycling criteria for DPR by December 31, 2016. Preliminary DPR regulations may not be available in California until 2020. In addition to FAT or AWP of the recycled water, an "engineered buffer" (storage tank) would need to be provided for a DPR project to ensure that water quality leaving the facility always met regulatory standards. Future DPR regulations, compared to IPR, are anticipated to include additional monitoring and/or treatment requirements to ensure the overall reliability of the treatment scheme, with a focus on acute risks (i.e., pathogens), critical control points, and continuous verification of treatment performance (NWRI 2014). The two major alternatives for the safe design of DPR are 1) focus on the engineered storage buffer that provides time for sample analysis, such as real-time pathogen log reduction monitoring, to ensure water meets quality requirements before distribution, or 2) emphasis on increased advanced treatment to meet the

same goals (i.e., treatment redundancy). The required treatment technologies may be similar to the IPR regulations, i.e., RO and AOP.

References

DDW. 2001. California Health Laws Related to Recycled Water "The Purple Book" Excerpts from the Health and Safety Code, Water Code, and Titles 22 and 17 of the California Code of Regulations. California Department of Public Health [Available at: http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Recharge/Purplebookupdate6-01.PDF, accessed June 30, 2014].

DDW. 2014. California Department of Public Health Regulations Related to Recycled Water – June 18, 2014 (Revisions effective on 6/18/14) [Available at: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/lawbook/RWregulations_20140618.pdf, accessed October 9, 2014].

Trussell RR, Salveson A, Snyder SA, Trussell RS, Gerrity D, Pecson BM. 2013. Potable Reuse: State of the Science Report and Equivalency Criteria for Treatment Trains. WateReuse Research Foundation, Alexandria, VA.

USEPA. 2012. Guidelines for Water Reuse. EPA/600/R-12/618. United States Environmental Protection Agency and National Risk Management Research Laboratory. http://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf

WateReuse Association. 2009. Manual of Practice – How to Develop a Water Reuse Program. Principal authors: Thomas Holliman, Richard Atwater, Dr. James Crook and Lois Humphreys.

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Appendix E: Technical Memorandum – Rainwater Harvesting and Greywater

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RBF Consulting
M E M O R A N D U M

To: City of Santa Monica
From: RBF Consulting and Kennedy/Jenks Consultants
Subject: Water Harvest and Use Feasibility Study
Date: 06/10/2014

Introduction

RBF Consulting, a company of Michael Baker Corporation (RBF), worked in partnership with Kennedy/Jenks Consultants on a feasibility assessment for water harvest and use in the City of Santa Monica. The study focused on a site-by-site feasibility assessment, local and regional regulatory requirements and synergies, and existing programs and projects with similar types of features. The scope of work involved the assessment of multiple water sources for harvest and use, including but not limited to stormwater, rainwater, graywater, cooling tower waste water, and industrial waste water. Water captured from each of these sources was quantified and assessed for use in irrigation, toilet flushing, and air conditioning demand. This technical memorandum summarizes the findings from the study and identifies potential stormwater regulatory or policy synergies for implementation.

Background

Santa Monica has been on the forefront of sustainability and low impact development (LID) for many years. In 1994, the City adopted the Sustainable City Plan, which focuses on the long-term, comprehensive nature of Santa Monica's vision to become a sustainable city. Reduction of runoff and potable water demand in Santa Monica is a critical component of this vision, specifically related to the enhancement of land use and open space conservation, resource conservation, and environmental and public health through water quality. Reduction of runoff provides immediate economic, health, and environmental benefits for the community through the reduction of contaminated runoff. Reduction of potable water demand provides immediate economic and environmental benefits as well, and assists the City in becoming more sustainable. Water harvest and use is a method of reducing both runoff and potable water demand in a sustainable way.

Among the many potential supply sources and potential end uses for harvest and use systems, drip and subsurface irrigation are the only applications permitted by Los Angeles County Department of Public Health (DPH) guidelines, unless treatment requirements are met, i.e., disinfection or Title 22 treatment. According to DPH, the supply sources available for these applications are limited to rainwater, stormwater, dry weather runoff, and graywater. Graywater consists of waste water produced from sinks (excluding kitchen sinks), showers, and laundry machines. Due to the limited scope of the study and DPH guidelines, treatment requirements

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were necessarily minimized and supply sources and discharge applications limited to rainwater and graywater for the City wide and average building scenarios. Stormwater was incorporated in the regional park analysis as the only supply source although graywater could also be considered as a potential supply source albeit minimal.

Potable water service for the City of Santa Monica is provided by the City, sourced from ten groundwater wells from the Santa Monica Basin. The proposed harvest and use systems have the potential to reduce the demand on the groundwater sub-basin.

Rainwater Supply

For the study, potential water supply was collected from rainwater running off building rooftops and graywater within the City. Supply data were generated from multiple sources, including City Geographical Information System (GIS) data, local rain gauge records, City potable water bills, and other available reference information, such as the Leadership in Environmental and Energy Design (LEED) Reference Guide.

Rainwater from building rooftops was quantified using a simplified volume calculation as follows:

$$V = C\ x\ d\ x\ A\ x\ 1/12\ inches/foot$$

Where

$$V = Rainwater\ Volume\ (cubic\ feet)$$
$$C = Runoff\ Coefficient\ (unitless)$$
$$d = Precipitation\ Depth\ (inches)$$
$$A = Area\ (square\ feet)$$

The runoff coefficient is dependent upon the amount of impervious area within a drainage area. Because the runoff is coming from rooftop areas only, a runoff coefficient of 0.9 was used. Precipitation depth is referenced from the Western Regional Climate Center (WRCC) Santa Monica Pier rain station. The WRCC is a partner with the National Climatic Data Center (NCDC), the Regional Climate Centers (RCCs), the National Oceanic and Atmospheric Administration (NOAA), and the State Climate Offices.

The following tables provide statistics of rainfall data recorded from 1937 through 2013, including one of the driest years on record and average annual rainfall. Table 1 and Table 2 show monthly average precipitation normals for the listed years.

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Table 1: Average Precipitation Normals for 1989 (Record Dry Year)

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rate (inches/month)	0.39	1.6	0.93	0	0	0	0	0	0.14	0.41	0.26	0	3.73

Table 2: Historic Average Annual Precipitation Normals from 1937 to 2013

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rate (inches/month)	2.69	3.01	2.03	0.73	0.17	0.03	0.02	0.08	0.15	0.33	1.36	2.04	12.64

The City of Santa Monica maintains a GIS database of building types and footprints for the entire city. Building types are organized by land use type and categorized as follows: Low/Medium/High Density Housing, Single Family Housing, Neighborhood and General Commercial, Oceanfront District, Office Campus, Transit Village, Transit Corridor, Downtown Core, Mixed Use Boulevard/Boulevard Low/Creative, Health Care Mixed Use, Parks and Open Space, Institutional/Public Lands, and Industrial Conservation. These land use building types were grouped into five general categories to reduce the amount of different land use types. These five categories contain building types of similar land use. The five categories include: Commercial, Industrial, Residential, Institutional/Public, and Mixed Use. The following list summarizes which city designated building type was grouped into the revised five categories.

1. **Commercial** – Neighborhood and General Commercial, Oceanfront District, Office Campus, Transit Village, and Transit Corridor

2. **Industrial** – Industrial Conservation

3. **Residential** – Low/Medium/High Density Housing, and Single Family Housing

4. **Institutional/Public** – Parks and Open Space and Institutional/Public Lands

5. **Mixed Use** – Downtown Core, Mixed Use Boulevard/Boulevard Low/Creative, and Health Care Mixed Use

The GIS database provided by the City contains roof surface areas for each of the categories listed above. These areas were used to determine the amount of harvesting tributary from all of the buildings in the City. Table 3 below summarizes the available rooftop area throughout Santa Monica, the total number of buildings, and the average rooftop area per building type. The total C/I/I (commercial, industrial, institutional/public) land use includes commercial, industrial, and institutional/public. Similarly, the total residential land use includes both single family (SF) residential and multi-family (MF) residential land uses. Mixed use was identified as a standalone land use as it encompasses a wide variety of building types. The average roof top area for each land use is computed as the total roof top area divided by the number of buildings.

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Table 3: Roof Area Summary per Land Use within the City of Santa Monica

Land Use	Commercial / Industrial	Institutional / Public	Total C/I/I	Mixed Use	SF Residential	MF Residential	Total Residential
Total Roof Top Area (acre)	363	14	377	36	428	636	1,064
Number of Buildings	2,008	91	2,099	199	11,797	9,373	21,170
Average Roof Top Area (sf)	7,866	6,985	7,828	7,825	1,580	2,954	2,189

Commercial, industrial, and institutional/public (C/I/I) land types were organized into the C/I/I category because the City's water billing data only identifies commercial and institutional/public, and a similar land use type is needed for comparison purposes. Residential was broken into two main categories, single-family (SF) and multi-family (MF). Single-family residential includes detached single family residences and two family residences (duplex). Multi-family residential includes all residences and apartments of four units or more. C/I/I, single-family, and multi-family categories are the three land use types focused on for this feasibility study. Using the drought and average monthly precipitation normals from Tables 1 and 2, and applying them to the roof surface areas in Table 3, rainwater volumes were determined on a monthly basis for an average building and the entire city for each land use type. The results are shown in Tables 4 and 5, respectively.

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Table 4: Average Monthly Rainfall and Volumes per Average Building

Month		Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre- feet / year)
Rainfall (inches/month)		2.69	3.01	2.03	0.73	0.17	0.03	0.02	0.08	0.15	0.33	1.36	2.04	NA
Rainwater (acre-feet)	C/I/I	0.036	0.041	0.027	0.010	0.002	0.000	0.000	0.001	0.002	0.004	0.018	0.027	0.170
	SF Residential	0.007	0.008	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	0.034
	MF Residential	0.014	0.015	0.010	0.004	0.001	0.000	0.000	0.000	0.001	0.002	0.007	0.010	0.064

Table 5: Average Monthly Rainfall and Volumes City Wide

Month		Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre-feet / year)
Rainfall (inches/month)		2.69	3.01	2.03	0.73	0.17	0.03	0.02	0.08	0.15	0.33	1.36	2.04	NA
Rainwater (acre-feet)	C/I/I	76.1	85.2	57.4	20.7	4.8	0.8	0.6	2.3	4.2	9.3	38.5	57.7	357.6
	SF Residential	86.3	96.6	65.2	23.4	5.5	1.0	0.6	2.6	4.8	10.6	43.7	65.5	405.7
	MF Residential	128.3	143.5	96.8	34.8	8.1	1.4	1.0	3.8	7.2	15.7	64.8	97.3	602.6
	Total	290.7	325.3	219.4	78.9	18.4	3.2	2.2	8.6	16.2	35.7	147.0	220.5	1365.9

Graywater Supply

As shown in Tables 1 and 2, rainfall in the Santa Monica area is typically not consistent throughout the year. This creates a lack of supply in the summer months for harvest and use systems which rely solely on rainfall as the supply source. In order to compensate for the lack of supply, graywater was considered as a potential supply source for this study. Graywater is waste water generated from sinks (excluding kitchen sinks), showers, and laundry machines. RBF developed the following methodology to determine existing graywater characteristics:

1. Billing data containing bi-monthly potable water demand per building unit from July 2011 through June 2012.
2. Estimated ratio for graywater production versus black water production.

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Using the total bi-monthly billing data water demand, provided in Table 6, and dividing it by the number of buildings per the billing data, we quantified the bi-monthly water demand for an average building for each land use type. The estimates of potable water demand are exclusive of the billing accounts used solely for landscape irrigation. Commercial, industrial, and institutional/public (C/I/I) land types were organized into the C/I/I category because the City's water billing data only identifies commercial and institutional/public, and a similar land use type is needed for comparison purposes. Table 7 provides the total bi-monthly demand per average building.

Table 6: Total Monthly Potable Water Demand City Wide

Land Use	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Commercial (AF)	239	239	250	250	257	257	265	265	288	288	258	258	3115
Institutional/Public (AF)	24	24	28	28	34	34	39	39	45	45	33	33	405
Total - C/I/I (AF)	263	263	278	278	291	291	305	305	333	333	291	291	3520
Single Family (AF)	217	217	214	214	246	246	304	304	313	313	227	227	3039
Multi Family (AF)	451	451	429	429	459	459	459	459	455	455	450	450	5406
Total Residential (AF)	668	668	644	644	705	705	762	762	767	767	677	677	8445

Table 7: Total Monthly Potable Water Demand per Average Building

Land Use	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Commercial (AF)	0.12	0.13	0.13	0.14	0.15	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.80
Institutional/Public (AF)	0.10	0.12	0.14	0.17	0.19	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.86
Geometric Average - C/I/I (AF)	0.12	0.13	0.13	0.14	0.15	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.81
Single Family (AF)	0.03	0.03	0.03	0.04	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Multi Family (AF)	0.07	0.07	0.08	0.08	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.44
Geometric Average - Residential (AF)	0.05	0.05	0.05	0.06	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.31

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In order to translate the potable demand into graywater supply, potable water demand was reduced to account for outdoor irrigation use. Per direction from the City and information from the Santa Monica 2008 Waste Water Rate Study, of the total potable water billed, 95%, 51%, and 94% of the water was used indoors for the C/I/I, single family residential, and multi-family residential building types respectively. Tables 8 and 9 show a monthly summary of the indoor and outdoor water demand for an average building and the entire city, respectively.

Table 8: Total Monthly Potable Water Demand City Wide

Month		Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre-feet / year)
Indoor Demand (acre-feet)	C/I/I (95%)	249.6	249.6	264.0	264.0	276.6	276.6	289.4	289.4	316.0	316.0	276.5	276.5	3344.0
	SF Residential (51%)	110.4	110.4	109.3	109.3	125.3	125.3	154.9	154.9	159.6	159.6	115.6	115.6	1550.1
	MF Residential (94%)	424.1	424.1	403.5	403.5	431.8	431.8	431.1	431.1	427.3	427.3	422.9	422.9	5081.3
Outdoor Demand* (acre-feet)	C/I/I (5%)	13.1	13.1	13.9	13.9	14.6	14.6	15.2	15.2	16.6	16.6	14.6	14.6	176.0
	SF Residential (49%)	106.1	106.1	105.0	105.0	120.4	120.4	148.8	148.8	153.3	153.3	111.1	111.1	1489.3
	MF Residential (6%)	27.1	27.1	25.8	25.8	27.6	27.6	27.5	27.5	27.3	27.3	27.0	27.0	324.3

* The estimates of potable water demand are exclusive of the billing accounts used solely for landscape irrigation.

Table 9: Total Monthly Potable Water Demand per Average Building

Month		Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre-feet / year)
Indoor Demand (acre-feet)	C/I/I (95%)	0.116	0.116	0.122	0.122	0.126	0.126	0.131	0.131	0.143	0.143	0.127	0.127	1.531
	SF Residential (51%)	0.015	0.015	0.014	0.014	0.016	0.016	0.020	0.020	0.021	0.021	0.015	0.015	0.204
	MF Residential (94%)	0.070	0.070	0.066	0.066	0.071	0.071	0.071	0.071	0.070	0.070	0.069	0.069	0.835
Outdoor Demand* (acre-feet)	C/I/I (5%)	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.007	0.007	0.081
	SF Residential (49%)	0.014	0.014	0.014	0.014	0.016	0.016	0.020	0.020	0.020	0.020	0.015	0.015	0.196
	MF Residential (6%)	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.053

* The estimates of potable water demand are exclusive of the billing accounts used solely for landscape irrigation.

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In order to calculate what the percentage of graywater is in relation to the total indoor potable water used, several references were used:

- The typical building fixture for a residential facility, as derived from the LEED Design Manual v2.2 (2006).
- Typical residential fixture potable water demand from the California Single-Family Water Use Efficiency Study, prepared by Aquacraft Water Engineering and Management June 1, 2011.
- The City's GIS data coupled with the billing information of potable water for the July 2011-June 2012 period indicates that the number of units for a multi-family residential building averages 4.61.

Based on coordination with the City's Planning Department the number of persons per single-family residence and multi-family building averages 2.24 and 1.66, respectively. Typical potable water demands and the associated availabilities of graywater were quantified for three typical buildings that each correspond to a land use. Table 10 summarizes the assumptions and quantifications of available graywater. In Table 10, fixture types that are identified by an asterisk are available for graywater use.

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Table 10: Typical Building Fixture Potable Water Demand (Derived from LEED V2.2, 2006)

Land Use	Sex	Fixture Type*	Uses Per Day	Gallons Per Use	Gallons Per Min	Gallons Used
C/I/I	Female	Water Closet	3	1.6	N/A	4.8
	Male	Water Closet	1	1.6	N/A	1.6
	Female	Urinal	0	1	N/A	0
	Male	Urinal	2	1	N/A	2
	Both	Kitchen Sink – duration 15 sec	4	N/A	2.5	2.5
	Female	Faucet (gpm)* - – duration 15 sec	3	N/A	2.5	1.9
	Male	Faucet (gpm)* - – duration 15 sec	3	N/A	2.5	1.9
	Total Graywater Available					**3.8 gal**
						26%
SF Residential	Female	Water Closet	5	1.6	N/A	8
	Male	Water Closet	5	1.6	N/A	8
	Female	Faucet (gpm)* - – duration 15 sec	5	N/A	2.5	3.1
	Male	Faucet (gpm)* - – duration 15 sec	5	N/A	2.5	3.1
	Both	Showerheads (gpm)* - duration 300 sec	2	N/A	2.5	25
	Both	Laundry* -	0.5	30	N/A	14.8
	Both	Kitchen Sink – duration 60 sec	8	N/A	2.5	20
	Total Graywater Available					**46 gal**
						56%
MF Residential	Female	Water Closet	22	1.6	N/A	35.2
	Male	Water Closet	22	1.6	N/A	35.2
	Female	Faucet (gpm)* - duration 15 sec	22	N/A	2.5	13.8
	Male	Faucet (gpm)* - duration 15 sec	22	N/A	2.5	13.8
	Both	Showerheads (gpm)* - duration 300 sec	9	N/A	2.5	112.5
	Both	Laundry*	2.2	30	N/A	66.0
	Both	Kitchen Sink – duration 60 sec	35	N/A	2.5	87.5
	Total Graywater Available					**206.1 gal**
						57%

* Available for Graywater Use

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Table 11 summarizes the percentage of available graywater in an average building based on the California Single-Family Water Use Efficiency Study.

Table 11: Typical Residential Fixture Potable Water Demand

Land Use	Fixture Type	Gallons Per Household Per Day Used
Single-Family Residential	Toilet	37.3
	Leaks	30.7
	Other	3.6
	Bath	3.7
	Dish Washer	1.5
	Faucet*	32.6
	Shower*	34.3
	Laundry*	30.6
	Total	**174.3 gallons**
	Graywater Available	**97.5 gallons**
		56%

* Available for Graywater Use

Information provided in Table 10 is principally based on findings from the LEED Design Guide v2.2 (2006) and is based on theoretical averages. Table 10 also does not take into account leaks which would reduce the amount of graywater available. Comparing this information to the data shown in Table 11 is helpful because the California Single-Family Water Use Efficiency Study data is based on actual case studies and is much more accurate. The total amount of gallons used per household per day is very similar to that of the typical household in Santa Monica, which is 182 gallons per day based on local data from the City of Santa Monica.. One issue with using the information in Table 11 is the fact that the volume used per faucet does not disseminate between water used in the kitchen and throughout the rest of the house. If this were separated then the amount of graywater available would be reduced from 56%. Based on the findings of table 10 and table 11, the total graywater available for single-family residential and multi-family residential land uses is of 56%. Similarly, the total graywater available for C/I/I land use is of 26%.Tables 12 and 13 show the average monthly graywater supply quantities for an average building and the entire city, respectively.

Table 12: Total Monthly Graywater Supply per Average Building Type

Month		Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre-feet / year)
Graywater Supply (acre feet)	C/I/I	0.022	0.022	0.023	0.023	0.023	0.023	0.024	0.024	0.026	0.026	0.023	0.023	0.283
	SF Residential	0.007	0.007	0.007	0.007	0.008	0.008	0.010	0.010	0.010	0.010	0.007	0.007	0.098
	MF Residential	0.034	0.034	0.032	0.032	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.404

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Table 13: Total Monthly Graywater Supply City Wide

Month		Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (AF/yr)
Gray Water Supply (AF)	C/I/I	46	46	49	49	51	51	54	54	59	59	51	51	619
	SF Residential	60	60	59	59	68	68	84	84	86	86	62	62	836
	MF Residential	229	229	218	218	233	233	233	233	230	230	228	228	2741
Total		335	335	325	325	352	352	370	370	375	375	342	342	4196

Table 14 identifies the total available annual rainwater and graywater potential supply in the City for each land use. Based on the irrigation demand for each land use the table also identifies the surplus or deficit for each land use based on the supply and demand. The total supply of annual rainwater and graywater of 5949 acre feet represents a potential significant reduction of imported supply for the City.

Table 14: Total Annual Rainwater and Graywater Supply City-Wide

Factor	Building Type	Total
Rainfall Supply (AF)	C/I/I	357.6
	SF Residential	405.7
	MF Residential	602.6
Graywater Supply (AF)	C/I/I	869.5
	SF Residential	868.1
	MF Residential	2845.5
Total Supply (AF)	C/I/I	1227.10
	SF Residential	1273.8
	MF Residential	3448.1
	Total	5949
Irrigation Demand (AF)	C/I/I	176.0
	SF Residential	1489.3
	MF Residential	324.3
Total Surplus or Deficit (AF)	C/I/I	1051.0
	SF Residential	-215.5
	MF Residential	3123.8

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Demand

As previously discussed the main source of demand analyzed in this study is landscape irrigation. The primary method identified by the City for estimating outdoor demand is based on sewer discharge factors that were determined in the 2008 Santa Monica Waste Water Rate Study. The Study found that 95%, 51%, and 94% of the supplied potable water was used indoors for the C/I/I, single family residential and multi-family residential building types respectively. The primary method assumes that the potable water that is not re-collected in the City sewer system is solely used for outdoor irrigation. Using the City water usage data per building unit from July 2011 through June 2012, outdoor water demands were computed for an average building and for the entire City, respectively. Table 15 and Table 16 summarize the outdoor water demand for an average building and the entire City, respectively. The outdoor water demand for the entire City is computed based on the number of buildings as identified in Table 3.

Table 15: Building Footprint to Parcel Ratio

Land Use	Total Parcel Area (acre)	Total Building Footprint (acre)	Building/Parcel (%)
Commercial/Industrial	752.88	362.60	48%
Institutional	119.42	11.40	10%
Public Parks	81.60	3.19	4%
Total C/I/I	**953.90**	**377.19**	**40%**
SF Residential	1,093.02	427.98	39%
MF Residential	1,238.00	635.70	51%
Total Residential	**2,331.02**	**1,063.67**	**46%**
Mixed Use	**95.48**	**35.75**	**37%**

Table 16: Outdoor Water Demand per Average Building

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre-feet / year)
C/I/I (acre-feet)	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.007	0.007	0.081
SF Residential (acre-feet)	0.014	0.014	0.014	0.014	0.016	0.016	0.020	0.020	0.020	0.020	0.015	0.015	0.196
MF Residential (acre-feet)	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.053

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Table 17: Outdoor Water Demand City Wide

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total (acre-feet / year)
C/I/I (acre-feet)	13.1	13.1	13.9	13.9	14.6	14.6	15.2	15.2	16.6	16.6	14.6	14.6	176.0
SF Residential (acre-feet)	106.1	106.1	105.0	105.0	120.4	120.4	148.8	148.8	153.3	153.3	111.1	111.1	1489.3
MF Residential (acre-feet)	27.1	27.1	25.8	25.8	27.6	27.6	27.5	27.5	27.3	27.3	27.0	27.0	324.3

* The estimates of potable water demand are exclusive of the billing accounts used solely for landscape irrigation.

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Water Balance & Met Demand

This section compares, on a monthly basis, the irrigation demand to two sources for supply, including captured stormwater and captured graywater, to determine if there is sufficient supply to meet the irrigation demand. The results are expressed in terms of surplus (supplies are higher than demands in a given month) or deficit (demands are higher than supplies in a given month). The objective of the water balance is to quantify the performance of implementing stormwater and/or graywater systems, and identifying throughout the year the periods of surplus and deficit for water planning purposes. Three scenarios were investigated:

1. Scenario 1 – Supplies are made of captured stormwater only for a typical building
2. Scenario 2 – Supplies are made of both captured stormwater and captured graywater for a typical building
3. Scenario 3 - Supplies are made of both captured stormwater and captured graywater and the analysis is performed for the entire City.

The three scenarios were only evaluated without storage. If feasible, the implementation of a storage tank or cistern next to each building will facilitate the capture and storage of stormwater onsite. The benefits of including a storage tank or cistern are also evaluated in this section.

Water balance without storage

For Scenario 1, the analysis shows a surplus in supply from November through March for the C/I/I and multi-family residential land uses. Conversely, the water balance shows a deficit in supply from stormwater throughout the entire year. Table 17 summarizes the components of the water balance and Figure 1 depicts the variation in supply and demand and the net surplus or deficit each month based on the results in Table 17.

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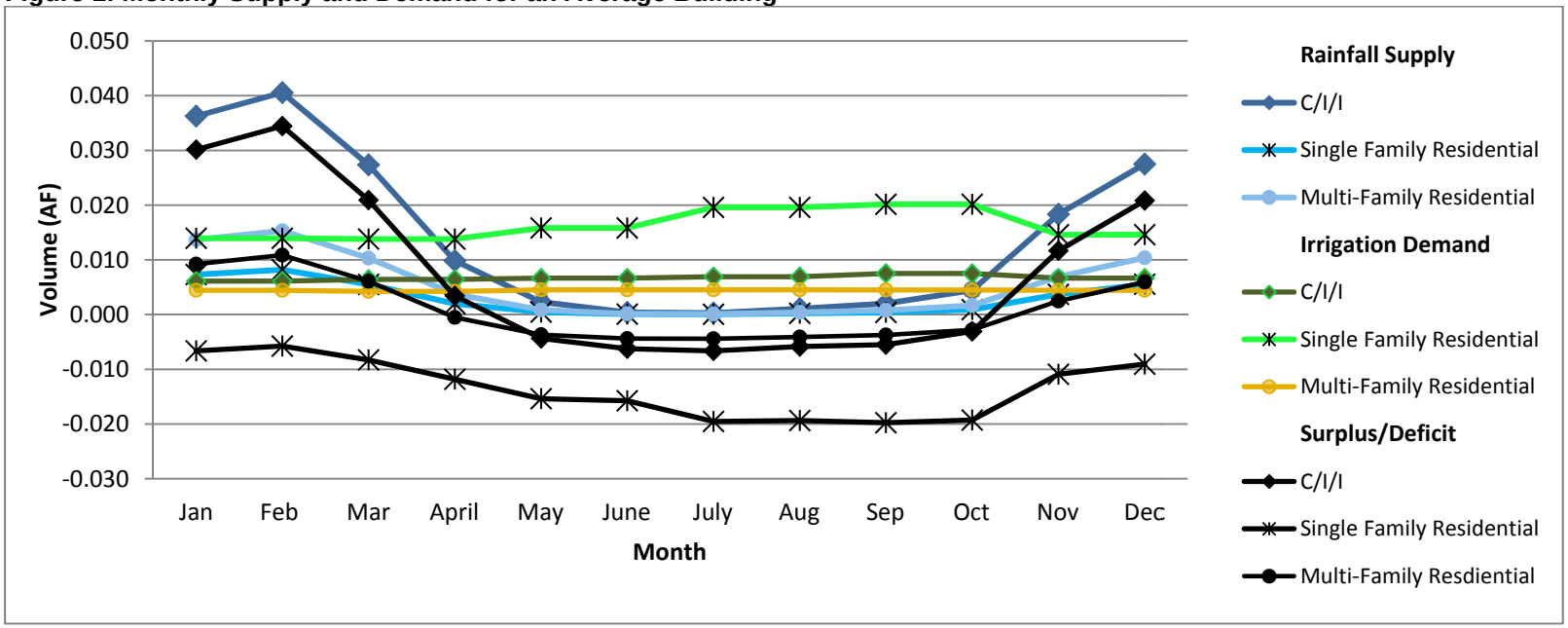
Table 18: Monthly Supply and Demand Comparison for an Average Building (Rainwater Only)

Parameter	Building Type	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rainfall Supply (AF)	C/I/I	0.036	0.041	0.027	0.010	0.002	0.000	0.000	0.001	0.002	0.004	0.018	0.027	**0.170**
	SF Residential	0.007	0.008	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	**0.034**
	MF Residential	0.014	0.015	0.010	0.004	0.001	0.000	0.000	0.000	0.001	0.002	0.007	0.010	**0.064**
Irrigation Demand (AF)	C/I/I	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.007	0.007	**0.081**
	SF Residential	0.014	0.014	0.014	0.014	0.016	0.016	0.020	0.020	0.020	0.020	0.015	0.015	**0.196**
	MF Residential	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	**0.053**
Total Surplus or Deficit (AF)	C/I/I	0.030	0.034	0.021	0.003	-0.004	-0.006	-0.007	-0.006	-0.005	-0.003	0.012	0.021	**0.090**
	SF Residential	-0.007	-0.006	-0.008	-0.012	-0.015	-0.016	-0.020	-0.019	-0.020	-0.019	-0.011	-0.009	**-0.161**
	MF Residential	0.009	0.011	0.006	-0.001	-0.004	-0.004	-0.004	-0.004	-0.004	-0.003	0.002	0.006	**0.011**

Figure 1: Monthly Supply and Demand for an Average Building



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For Scenario 2, the analysis demonstrates the benefits of capturing graywater. A surplus in supply is observed throughout the year for the C/I/I and multi-family residential land uses. Alternatively, the water balance exhibits a surplus in supply from stormwater for the months of January and February, and a deficit smaller than 0.01 acre-feet per month for the other months. Table 18 summarizes the components of the water balance and Figure 2 depicts the variation in supply and demand and the net surplus or deficit each month based on the results in Table 18, when both rainwater and graywater are used as the supply source.

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Table 19: Monthly Supply and Demand Comparison for an Average Building (Rain and Graywater Included)

Parameter	Building Type	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rainfall Supply (AF)	C/I/I	0.036	0.041	0.027	0.010	0.002	0.000	0.000	0.001	0.002	0.004	0.018	0.027	**0.170**
	SF Residential	0.007	0.008	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	**0.034**
	MF Residential	0.014	0.015	0.010	0.004	0.001	0.000	0.000	0.000	0.001	0.002	0.007	0.010	**0.064**
Graywater Supply (AF)	C/I/I	0.022	0.022	0.023	0.023	0.023	0.023	0.024	0.024	0.026	0.026	0.023	0.023	**0.283**
	SF Residential	0.007	0.007	0.007	0.007	0.008	0.008	0.010	0.010	0.010	0.010	0.007	0.007	**0.098**
	MF Residential	0.034	0.034	0.032	0.032	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	**0.404**
Irrigation Demand (AF)	C/I/I	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.007	0.007	**0.081**
	SF Residential	0.014	0.014	0.014	0.014	0.016	0.016	0.020	0.020	0.020	0.020	0.015	0.015	**0.196**
	MF Residential	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	**0.053**
Total Surplus or Deficit (AF)	C/I/I	0.052	0.056	0.044	0.026	0.019	0.017	0.018	0.018	0.021	0.023	0.035	0.044	**0.090**
	SF Residential	0.000	0.001	-0.001	-0.005	-0.007	-0.008	-0.010	-0.010	-0.010	-0.009	-0.004	-0.002	**-0.161**
	MF Residential	0.043	0.045	0.038	0.032	0.031	0.030	0.030	0.030	0.030	0.031	0.036	0.040	**0.011**

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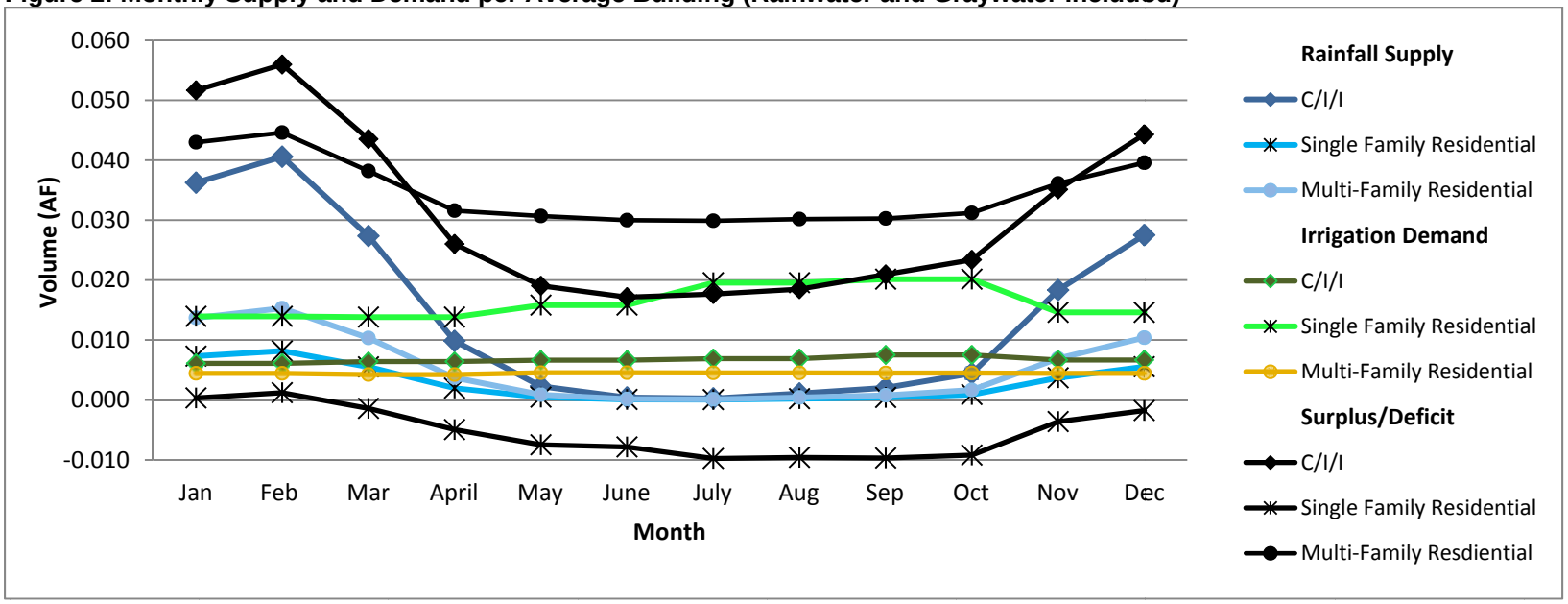
Figure 2: Monthly Supply and Demand per Average Building (Rainwater and Graywater Included)



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For Scenario 3, Table 19 summarizes the irrigation demand with the rainwater and graywater supply sources and the overall supply and demand potential. The results are consistent with the findings of Scenario 1 and Scenario 2. The combined supply of rainwater and graywater fully satisfies the irrigation demand for the average on a citywide basis for the C/I/I and multi-family residential land uses. Alternatively, only 77% of the irrigation demand can ultimately be met for single-family residential land uses, if all rainwater and graywater was captured and reused throughout the year.

For the C/I/I and multi-family residential land uses, rainwater could solely meet the irrigation demand. It would need to be stored throughout the year, which would increase the capital costs due to larger storage requirements. In addition, rainwater is also not a reliable supply source, as its availability decreases dramatically during dry years. Incorporating graywater contributes significantly to the annual supply availability.

Table 20: Annual Supply and Demand Balance

Type	Customer Class	Irrigation Demand (acre-feet)	Rainwater Supply (acre-feet)	Graywater Supply (acre-feet)	Total (acre-feet)	Satisfied Demand
City Wide	C/I/I	176.0	357.6	619.3	800.8	555%
	Single-Family	1489.3	405.7	743.1	-340.5	77%
	Multi-Family	324.3	602.6	2436.0	2714.3	937%
Average Building	C/I/I	0.081	0.170	0.283	0.373	563%
	Single-Family	0.196	0.034	0.098	-0.064	67%
	Multi-Family	0.053	0.064	0.404	0.415	879%

It is important to note that Tables 18, 19, and 20 are theoretical supply and demand comparisons assuming storage capacity is not a constraint. The second configuration evaluates the performance of rainwater and/or graywater capture to meet irrigation demand, if onsite storage tanks or cisterns are implemented.

Water balance including storage

The City of Santa Monica has adopted a local urban runoff mitigation ordinance to facilitate the implementation of storage tanks and cisterns for rainwater harvest and use. The ordinance states that rain barrels or cisterns should be sized according to the roof footprint of the building it is intended to capture rainfall from. The City of Santa Monica refers to the Development Best Management Practices Handbook, published by the City of Los Angeles (www.lastormwater.rog), for sizing guidelines of cisterns. The Handbook states that:

"At a minimum, capture and use BMPs must be designed and maintained to ensure adequate capacity is available to capture the stormwater quality design volume within 3 days of a likely storm event."

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The Handbook also characterizes the feasibility of capture and use through the evaluation of several landscaping, geotechnical, and vector control factors, including a comparison by comparing the Estimated Total Water Usage (ETWU) from October 1 through April 30 with the captured volume. Based on the rooftop area of an average building, the feasibility of capture and use of stormwater was established, as such:

- For the C/I/I land use, the volume produced by the 85th percentile storm averages 3,294 gallons and the ETWU averages 2,000 gallons, which renders capture and use as potentially feasible. To meet the drawdown time requirement of 72 hours following a storm event, the maximum capacity of a storage cistern averages 146 gallons. Capture and use of the 85th percentile storm volume is only partial; the implementation of infiltration BMPs and biotreatment BMPs is needed to achieve mitigation per the LID ordinance. Alternatively, if other water demands are identified onsite, the capacity of the storage cistern may increase.
- For the single-family residential land use, the volume produced by the 85th percentile storm averages 663 gallons and the ETWU averages 4,569 gallons, which renders capture and use as feasible. For residential projects with less than 4 units, Appendix E of the LID Handbook considers that the average-size project meets the LID requirements if 10 rain barrels of 55 gallons capacity each, or equivalent storage capacity, are implemented onsite. An appropriate area for overflow should also be incorporated into the design.
- For the multi-family residential land use, the volume produced by the 85th percentile storm averages 1,240 gallons and the ETWU averages 1,337 gallons, which renders capture and use as feasible. To meet the drawdown time requirement of 72 hours following a storm event, the maximum capacity of a storage cistern averages 97 gallons. Capture and use of the 85th percentile storm volume is only partial; the implementation of infiltration BMPs and biotreatment BMPs is needed to achieve mitigation per the LID ordinance. Alternatively, if other water demands are identified onsite, the capacity of the storage cistern may increase.

Table 20 summarizes the monthly supply and demand quantities incorporating storage systems that meet the local urban runoff mitigation ordinance through capture and use. For the average project in C/I/I or multi-family residential land uses, the storage systems that meet the local urban runoff mitigation ordinance will typically not capture the entire volume produced by the 85th percentile storm. Sizing of complementary biotreatment BMPs is not investigated in this report. .

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Table 21: 85th Percentile Storm Capture Approach

Parameter	Building Type	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rainfall Supply (AF)	C/I/I	0.036	0.041	0.027	0.010	0.002	0.000	0.000	0.001	0.002	0.004	0.018	0.027	**0.170**
	SF Residential	0.007	0.008	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	**0.034**
	MF Residential	0.014	0.015	0.010	0.004	0.001	0.000	0.000	0.000	0.001	0.002	0.007	0.010	**0.064**
Irrigation Demand (AF)	C/I/I	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.007	0.007	**0.081**
	SF Residential	0.014	0.014	0.014	0.014	0.016	0.016	0.020	0.020	0.020	0.020	0.015	0.015	**0.196**
	MF Residential	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	**0.053**
Total Surplus or Deficit (AF)	C/I/I	0.030	0.034	0.021	0.003	-0.004	-0.006	-0.007	-0.006	-0.005	-0.003	0.012	0.021	**0.090**
	SF Residential	-0.007	-0.006	-0.008	-0.012	-0.015	-0.016	-0.020	-0.019	-0.020	-0.019	-0.011	-0.009	**-0.161**
	MF Residential	0.009	0.011	0.006	-0.001	-0.004	-0.004	-0.004	-0.004	-0.004	-0.003	0.002	0.006	**0.011**
Storage (AF)	C/I/I	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.003**
	SF Residential	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
	MF Residential	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.001**
Demand Met with Storage (AF)	C/I/I	0.006	0.006	0.006	0.006	0.003	0.000	0.000	0.001	0.002	0.004	0.007	0.007	**0.049**
	SF Residential	0.000	0.008	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	**0.027**
	MF Residential	0.004	0.004	0.004	0.004	0.001	0.000	0.000	0.000	0.001	0.002	0.004	0.004	**0.030**
Rainfall Captured (AF)	C/I/I	0.007	0.006	0.006	0.006	0.002	0.000	0.000	0.001	0.002	0.004	0.007	0.007	**0.050**
	SF Residential	0.007	0.008	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.006	**0.034**
	MF Residential	0.005	0.004	0.004	0.004	0.001	0.000	0.000	0.000	0.001	0.002	0.005	0.004	**0.030**
Total Surplus or Deficit (AF) with Storage	C/I/I	0.030	0.035	0.021	0.004	-0.004	-0.006	-0.007	-0.006	-0.005	-0.003	0.012	0.021	**0.000**
	SF Residential	-0.007	-0.006	-0.008	-0.012	-0.015	-0.016	-0.020	-0.019	-0.020	-0.019	-0.011	-0.009	**-0.007**
	MF Residential	0.009	0.011	0.006	0.000	-0.004	-0.004	-0.004	-0.004	-0.004	-0.003	0.002	0.006	**0.000**

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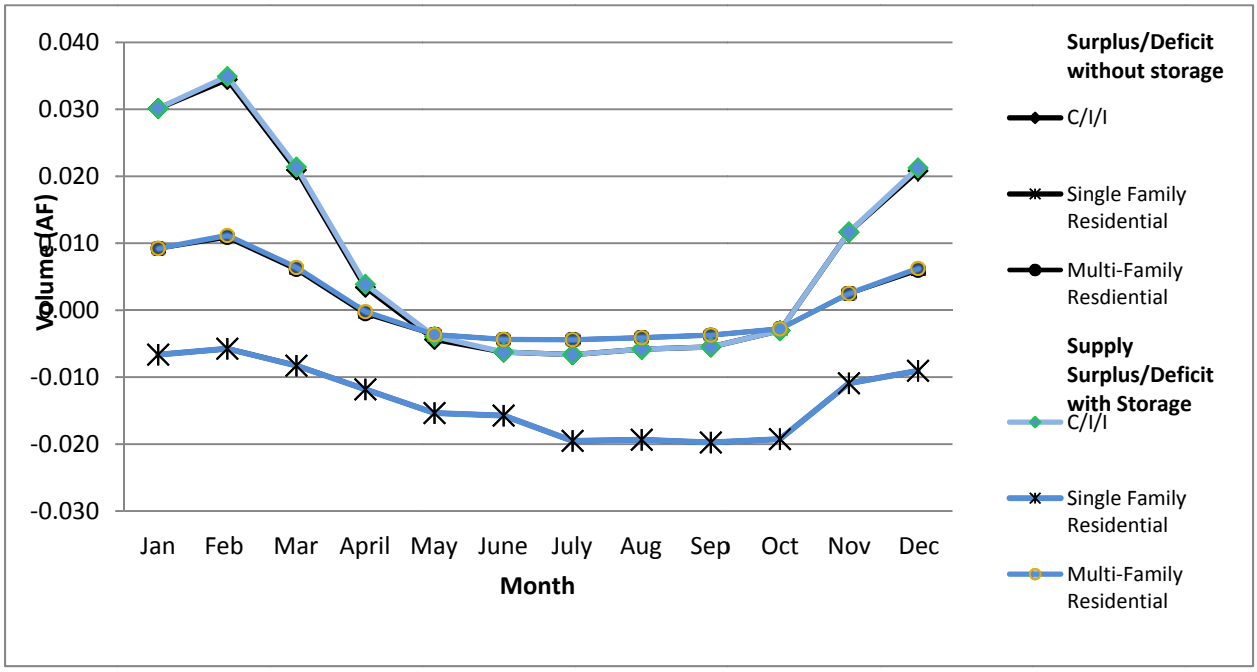
Because the storage volumes are relatively small, a deficit exists throughout the majority of the year. Figure 3 depicts the data from Table 20.

Figure 3: Total Monthly Potable Water Demand per Average Building (Rainwater Only)



Using the LID methodology the C/I/I, single family residential, and multi-family residential meet 61%, 14%, and 56% of the annual demand, respectively. In addition, the storage facilities capture 29%, 79%, and 47% of the annual runoff from the respective rooftops. The implementation of a storage tank will:

- Create a surplus of supply from November through April for the C/I/I land use. Alternative sources of water supply for irrigation are needed from May through October.
- Create a surplus of supply from November through April for the multi-family residential land use. Alternative sources of water supply for irrigation are needed from May through October.
- Not compensate for the deficits observed from one month to the next for the single-family residential land use throughout the year. The implementation of a storage tank is still needed to temporarily store rainwater before it can be used for irrigation during irrigation times.

This exercise was intended to provide a practical example of how implementing storm water harvesting systems can be used to meet regulatory requirements. Although this proves to be a challenging solution, rainwater harvesting does provide many additional benefits beyond this example and these benefits are discussed in further detail in the following sections of this Memorandum.

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Regional Park Supply and Demand

The City of Santa Monica is predominately made up of urban development although there are several public parks which provide open space recreational use throughout the City. These parks are typically large open space areas consisting of predominately turf vegetation which create potential opportunities for both surface water storage and potable water reduction. Three parks within the City are located adjacent to existing storm drains which convey a significant amount of the available runoff produced within the City. These three parks are known as Memorial Park, Marine Park, and Ozone Park. Because these parks are located adjacent to existing storm drain infrastructure they were considered to have the lowest need for additional infrastructure improvements providing the best cost to benefit opportunity. Watershed information used in the development of this section was referenced from the City of Santa Monica Watershed Management Plan prepared by Brown and Caldwell in 2006 as well as GIS data provided by the City.

Memorial Park is located in the center of the City within the Kenter Canyon Basin which is the largest watershed in Santa Monica with a total area of 3,968 acres, 35% of which is located within the City limits. Ozone Park is located in the Lincoln Basin which is located on the southern edge of the City and has an area of approximately 402 acres. Marine Park is located in the 16th Street Basin also located on the southern edge of the City and is approximately 230 acres. Table 21 provides a summary for each of the basins drainage area and the percentage it comprises of the overall area of Santa Monica.

Table 22: Regional Park Watershed Summary

Basin	Park	Basin Drainage Area (acres)	% of Basin Tributary to Park	Area Tributary to Park (acre)	Park Area % Tributary of City
City	**NA**	5373	NA	NA	NA
Kentor Basin	**Memorial**	1,423	20%	284.6	5%
Lincoln Basin	**Ozone**	402	15%	60.3	1%
16th Street Basin	**Marine**	230	100%	230.0	4%

Because these parks are located adjacent to existing storm drain infrastructure they provide a relatively inexpensive opportunity to capture urban runoff from the City storm drains. Tables 22 through 24 provide a summary of the monthly supply and demand if captured runoff was used to irrigate each of the parks.

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Table 23: Memorial Park Summary

Average Annual Condition	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Memorial Park Runoff (acre-feet)	44.66	49.97	33.70	12.12	2.82	0.50	0.33	1.33	2.49	5.48	22.58	33.87	209.85
Memorial Park Turf Demand (acre-feet)	0.48	0.65	1.19	1.50	1.79	1.96	1.91	1.79	1.50	1.07	0.69	0.48	15.01
Total deficit or surplus (acre-feet)	44.18	49.32	32.51	10.62	1.03	-1.46	-1.58	-0.46	0.99	4.41	21.89	33.39	194.84
Storage (acre-feet)	1.05	1.05	1.05	1.05	1.05	0.00	0.00	0.00	0.99	1.05	1.05	1.05	9.39
Demand Met with Storage (acre-feet)	0.48	1.05	1.05	1.05	1.05	1.55	0.33	1.33	0.99	1.05	1.05	1.05	12.02

- Monthly deficits are identified by the minus sign (-)

Table 24: Marine Park Summary

Average Annual Condition	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Marine Park Runoff (acre-feet)	33.00	36.92	24.90	8.95	2.09	0.37	0.25	0.98	1.84	4.05	16.68	25.02	155.05
Marine Park Turf Demand (acre-feet)	0.43	0.58	1.07	1.34	1.60	1.76	1.71	1.60	1.34	0.96	0.62	0.43	13.44
Total deficit or surplus (acre-feet)	32.57	36.34	23.83	7.61	0.48	-1.39	-1.46	-0.62	0.50	3.09	16.06	24.60	141.61
Storage (acre-feet)	1.03	1.03	1.03	1.03	1.03	0.00	0.00	0.00	0.50	1.03	1.03	1.03	8.74
Demand Met with Storage (acre-feet)	0.43	1.03	1.03	1.03	1.03	1.40	0.25	0.98	0.50	1.03	1.03	1.03	10.76

- Monthly deficits are identified by the minus sign (-)

Table 25: Ozone Park Summary

Average Annual Condition	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Ozone Park Runoff (acre-feet)	8.25	9.23	6.22	2.24	0.52	0.09	0.06	0.25	0.46	1.01	4.17	6.25	38.74
Ozone Park Turf Demand (acre-feet)	0.05	0.07	0.12	0.15	0.18	0.20	0.19	0.18	0.15	0.11	0.07	0.05	1.53
Total deficit or surplus (acre-feet)	8.20	9.16	6.10	2.09	0.34	-0.11	-0.13	0.06	0.31	0.90	4.10	6.20	37.22
Storage (acre-feet)	0.13	0.13	0.13	0.13	0.13	0.02	0.00	0.06	0.13	0.13	0.13	0.13	1.26
Demand Met with Storage (acre-feet)	0.05	0.13	0.13	0.13	0.13	0.02	0.08	0.06	0.13	0.13	0.13	0.13	1.26

- Monthly deficits are identified by the minus sign (-)

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The investigation identified the storage capacity of a capture system that would meet 80% of the annual irrigation demand. The criteria will be met for storage units are of 1.05 acre-feet, 1.03 acre-feet, and 0.13 acre-feet for the Memorial, Marine, and Ozone Parks, respectively. This water can be used for on-site irrigation within each of the parks or allowed to infiltrate and recharge the ground water table. Another potential option would be to convey this stored water to the SMURRF system located near the Santa Monica Pier. All of these methods would not only reduce potable water demand but reduce pollutant loading by capturing dry weather runoff and a percentage of storm water runoff. The reduction in potable water demand and pollutant loading has synergistic benefits discussed in further detail later in the Memorandum.

Potential Policy/Regulatory and Environmental Synergies

As previously discussed the City is at the forefront of providing a sustainable environment for the local community. Santa Monica has implemented various programs including the Sustainable City Plan and the Watershed Management Plan. The City' sustainability goals incorporate programs which include some of the following:

- Complying with the California Regional Water Quality Control Board, Los Angeles Region, Order No. R4-2012-0175 NPDES Permit No. CAS004001. This Permit requires the reduction of urban runoff pollution by infiltrating or treating for onsite use the first ¾-inch of rainfall in a 24-hour period (consistent with the City's Urban Runoff Mitigation Ordinance, which is approximately equivalent to the runoff from the 85th percentile 24-hour storm event).
- Development of the Enhanced Watershed Management Program (EWMP) for Santa Monica Bay Jurisdictions 2 & 3. The City of Santa Monica is collaborating with the cities of El Segundo and Los Angeles, the County of Los Angeles, and the LA County Flood Control District to develop an EWMP to meet the requirements of Order No. R4-2012-0175.
- Achieve 100 percent diversion, infiltration, and reuse of dry weather runoff for all Santa Monica storm drains from April through November, and the maximum amount possible from December through March.
- Increase water conservation by maximizing the installation of graywater systems and harvested urban runoff, during dry and wet weather, maximizing permeable surfaces, minimizing impermeable surfaces, and maximizing storage and use of stormwater.
- Increase recreational opportunities and open space and achieve compliance with the Recreation and Parks Commission standard of 2.5 acres of open space per 1000 residents.
- Maximize the use of multipurpose solutions.
- Increase efforts to maximize wildlife corridors.

Implementing graywater systems as well as runoff and stormwater harvest and use provides many environmental benefits and works hand in hand with the City's current and future programs discussed above. Implementing strategic programs and projects are critical in creating a sustainable environment for the local community in an effective and efficient manner.

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Appendix F: Hydraulic Schematic and Model Development/Calibration Support Material

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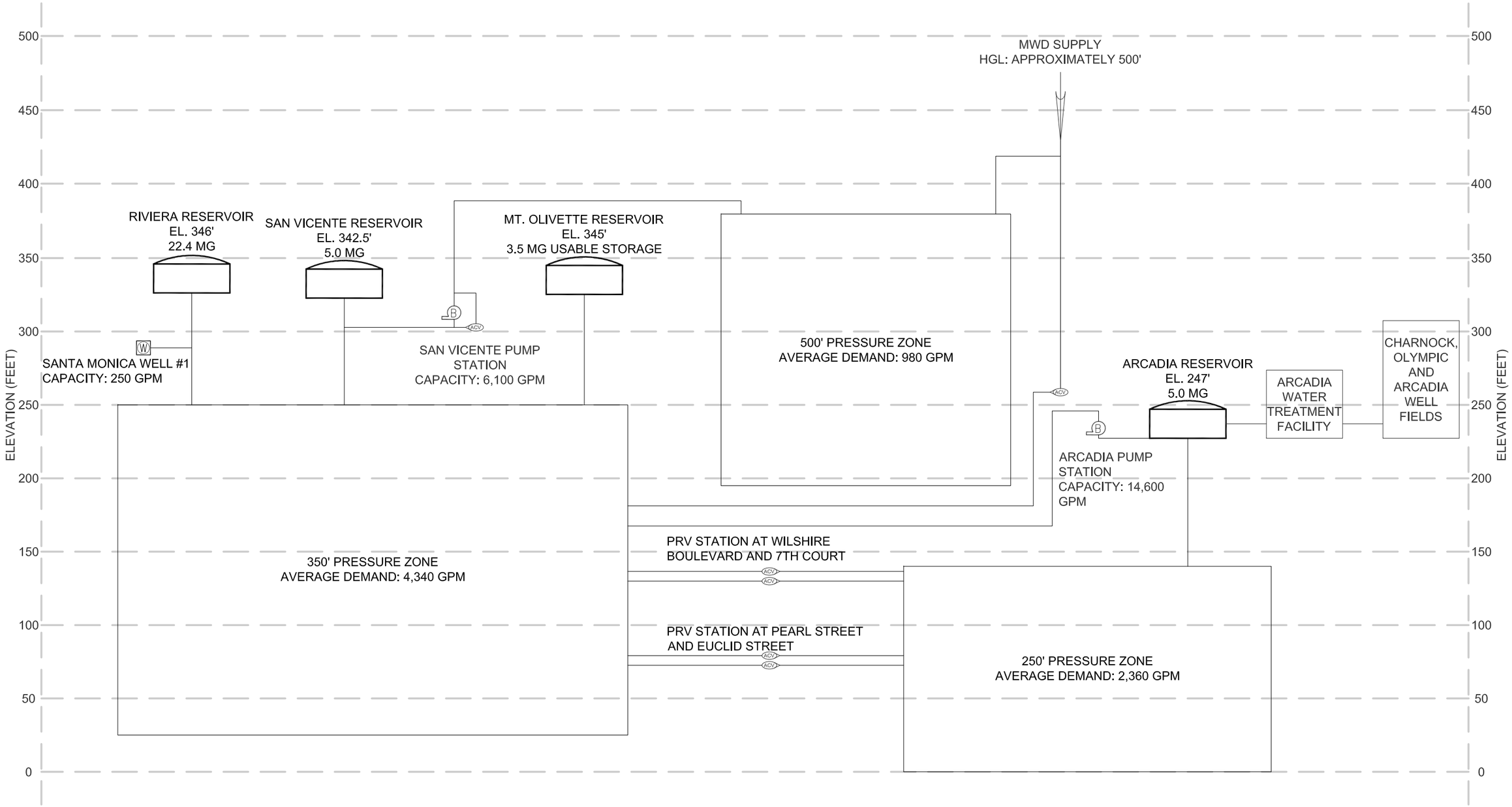


LEGEND

- PRESSURE REDUCING VALVE
- BOOSTER PUMP
- WELL
- RESERVOIR

Kennedy/Jenks Consultants

CITY OF SANTA MONICA, CALIFORNIA

HYDRAULIC SCHEMATIC OF POTABLE WATER DISTRIBUTION SYSTEM

1283015*00

APPENDIX FIGURE

4 March 2014

Memorandum

To: City of Santa Monica

From: Patrick Johnston

Subject: Hydraulic Model Construction and Calibration
K/J 1283015*00

Hydraulic distribution models are frequently used for the planning, design and operational management of water distribution systems. In order to evaluate distribution system hydraulics, computerized modeling software is used to develop hydraulic models that represent actual distribution system infrastructure and its operation using complex mathematical equations. These models serve as tools to identify potential deficiencies in the system, size future facilities and develop long range planning studies. This technical memorandum describes development of the hydraulic model of the City of Santa Monica's (City) distribution system and the calibration methodology and results. As described above, the hydraulic model is the primary analytical tool used to determine facility sizing, capacity needs and fire flow requirements and a comprehensive calibration process is integral to increasing its ability to accurately mimic actual field conditions. The calibration process of water distribution system models allows for accurate and reliable hydraulic analysis results and thus, is of utmost importance.

The methods used to develop the City's water system hydraulic model are described in the section that follows, including model creation and model calibration. The model will subsequently be used to identify deficiencies within the existing and the future system in meeting water demand conditions. This evaluation will guide the development of a Capital Improvement Program (CIP) for the distribution system under existing and future conditions.

Hydraulic Model Development and Approach

In agreement with the City over the needs and goals for the modeling task and how it fits in the Master Planning project, K/J's modeling team selected Innovyze's *InfoWater* (version 10.5) software to use for this project. The software is capable of transferring data to and from the City's water system GIS, which is integrated using *ArcMap GIS* as part of this Water Master Plan. The model includes all water facilities in the distribution system including water pipelines 2-inch in diameter and greater, groundwater wells, storage tanks, booster stations, inter-tie connections, pressure regulating valves, and other infrastructure within the system.

Water pipelines and their associated parameters (e.g. diameter, year of installation, material, lengths, etc.) are imported from the City's GIS into *InfoWater* to form the initial pipe network. Spatial data such as location of valves, hydrants, billing meters, ground elevations, was provided by the City as part of this Master Plan project. Water demands and other necessary modeling data like operating conditions, control sets, system curves, etc. are also incorporated into the model using both *ArcMap GIS* and *InfoWater*. *InfoWater* uses Innovyze's proprietary

hydraulic engine, which provides a fully dynamic solution for modeling distribution systems. The program has a GIS-based model interface and features many useful add-on tools for model development, calibration, and simulation results analysis.

Data Sources and Integration of GIS Data

InfoWater uses a GIS based interface integrated with ESRI's ArcGIS platform. In order to accurately construct the model, the City provided several pieces of vital GIS information that were used as the basis of the model. This detailed information with comprehensive attribute data that was required for the development of the hydraulic model for this master planning effort. The following data sources were used in the development of the hydraulic model:

- GIS shape files containing spatial and feature information about the City's land (City Boundary, Assessor Parcel Information, Land Uses, Street Centerlines, Contours, Pressure Zone Boundaries, etc.).
- GIS shape files containing special and feature information about the City's water system (Fittings, Hydrants, Valves, Water Mains, Wells, Pumps, Reservoirs, etc.).
- As-builts of various water system facilities.
- Hourly demand data for several days to support model calibration.
- Billing data for the previous two years associated with specific parcels.
- Daily production data for the previous sixteen years.
- Operating strategies of existing reservoirs, pump stations and wells.

Additional data have been gathered over the course of the project as needed for the model development and calibration. These data include drawings and reports for projects currently under planning, design, or construction.

Necessary updates to the City's existing GIS were performed to allow for easy transfer and compatibility to the InfoWater hydraulic modeling program. Items addressed within the City's GIS database included:

Pipelines

All pipelines in the model were imported directly from the GIS files supplied by the City. As was necessary to the development of the model, additional fictional pipelines were added, such as at the inlet and outlet of a pump station or reservoir. Pipeline segments are connected using junctions. Most junctions were available from GIS data provided by the City representing valves or fittings, such as reducers, bends and tees. Where the supplied junctions were insufficient, additional model junctions were created to allow the model to function properly. Model inputs for the pipelines imported from the GIS feature information included length, material and diameter. Where lengths were not available, InfoWater automatically calculated the length. Where diameters weren't available they were assigned logically based on surrounding pipes.

Roughness of the pipeline was the final model input feature required to run the model. Prior to calibration an initial roughness value of 130 was assumed for all pipelines. All new pipes added to or replaced in the model will have an assumed roughness of 130. Roughness of the existing pipelines was adjusted as necessary during model calibration to more accurately reflect observed conditions of the pipelines.

Pipelines in the hydraulic model also have several optional controls that were utilized. Most importantly are the closing of a pipeline and the check valve feature. Since most system valves are normally open or normally closed there is no need to represent them as a valve in the model file. Instead, InfoWater allows a pipe to be closed in order to represent a closed valve. This control is utilized mainly in the separation of zones, and was used in the development of the City's model to hydraulically separate the pressure zones. A pipeline can also be fitted with a check valve control that will not allow flow in the reverse direction of the pipe. This feature is useful in areas such as a reservoir effluent line or one way interconnection, such as at the City's connection with MWD.

Modeling outputs provided by the pipeline layer include flow, velocity and head loss through any particular pipe. This information is used to help calibrate the model and analyze the system to determine where deficiencies exist.

Junctions

Junctions in the hydraulic model are a node that represents the end of a pipe. In reality a junction could be a fitting, valve or other facility connected to the system. The City provided several junction shape files, and in order to maintain a relationship between the model and the City's GIS identification system, all appropriate junction files provided by the City were imported directly into the model. Where junction information from the existing shape files did not exist, InfoWater created and connected all necessary additional junctions for a continuously connected system model.

The only modeling inputs required at junctions are demands and elevations. Elevations were assigned to each junction based on of the contour data provided by the City using the Elevation Extraction routine within InfoWater. Procedures for using the Elevation Extractor are described in Section 6.3.8. Demands were assigned to each junction using the Demand Allocator. Procedures for using the Demand Allocator are described in Section 6.3.9.

Modeling outputs provided by the junction layer include head and pressure at any particular junction. This information is used to help calibrate the model and analyze the system to determine where deficiencies exist.

Tanks

Tanks in the hydraulic model are a separately classified junction that represents reservoirs that have a fixed volume or storage and a variable water level. The City provided a shape file containing spatial and feature information for its tanks. It is common to refer to tanks as reservoirs, and in fact, the City's storage elements are usually referred to as reservoirs. However, but for the purposes of the model, they are input and modeled as tank elements, as the distinction is important.

Tanks contain a variety of modeling inputs. Such inputs include the type of tank, which can be variable area or cylindrical, the elevation of the tank, the minimum and maximum water levels of the tank, the diameter of the tank (if appropriate), the initial level of the tank, the minimum volume of the tank and a tank curve (if desired). For tanks that are neither variable area or cylindrical, the constant area of the tank is converted to a cylindrical equivalent diameter. All of the tank modeling inputs are available through the GIS information provided by the City, from the additional information provided regarding the tanks and their operational strategies, or through conversations with City personnel.

Modeling outputs provided by the tank layer include flow, head, percent full and tank level at each individual tank. This information is used to help calibrate the model and analyze how the system operates.

A summary of the existing tanks within the Santa Monica system is provided in Table 1.

Table 1: Summary of Existing Storage Tanks

Tank	Zone Served	Capacity (MG)
Riviera	350	22.4
San Vicente	350	5.0
Mt. Olivette	350	3.5
Arcadia	250	5.00

Note: Capacity values are usable capacity, which are less than actual design values.

Reservoirs

Reservoirs in the hydraulic model are a separately classified junction that represents bodies of water or sources of supply which are large enough not to be considered variable in water level. Although the City has no physical or literal reservoirs, interconnections with other agencies and wells can be modeled as reservoirs. The connection with MWD that feeds the 500 zone was modeled as a reservoir, as was the only well, Santa Monica #1, which feeds directly into the distribution system.

The only modeling input required for reservoirs is the water surface level, or head, of the reservoir. For wells the head would be the anticipated groundwater elevation at drawdown during operation. In order for a reservoir to function as a well, a pump must be added to it with the characteristics of the pump that is actually installed.

Pumps

Pumps in the hydraulic model are a junction type which can move flow and increase head. The GIS information provided by the City contained the physical locations of its pump stations but did not contain information regarding the number of pumps, piping layouts or pump specifications. With input from operations, the quantity and specifications of each pump at each pump station were added to the model.

Model inputs required for pumping stations can vary significantly. For pump stations that operate at a typical head or power, those are the only information required. Pumps can also be operated based on a pump curve. Controls for pumps can be added that direct each pump to turn on and off based on the time, pressure/head, and flow in a certain pipe or daily pattern. Pumps can also be operated by VFD controls which allow pumps to operate at reduced speeds.

Modeling outputs provided by the pump layer include flow, head gain, upstream and downstream pressure, available NPSH, speed setting and parallel count for each pump. Some of this information was used to help calibrate the model for pump operations.

A summary of the existing pump facilities in the City's system is provided in Table 2.

Table 2: Summary of Existing Pump Facilities

Pump	Zone Served	Capacity (MGD)
San Vicente Booster Station		
San Vicente #2	500	1.44
San Vicente #3	500	1.58
San Vicente #4	500	3.60

Pump	Zone Served	Capacity (MGD)
San Vicente #5	500	3.60
Arcadia Booster Station		
Arcadia #1	350	2.88
Arcadia #2	350	5.04
Arcadia #3	350	5.18
Arcadia #4	350	2.88
Arcadia #5	350	5.04
Santa Monica Well #1	350	0.36

Valves

Valves in the hydraulic model are a junction type that regulates flow at that junction. Several types of valves can be modeled including: pressure reducing, pressure sustaining, pressure breaker, flow control, throttle control, general purpose, float and vacuum breaker valves. In a typical distribution system, there are thousands or tens of thousands of valves. The vast majority of these valves are butterfly, gate and check valves which are either normally open or normally closed valves and do not serve a more complex function. These valves are not included in the valve layer in InfoWater and are rather modeled as junctions, with their functions of normally open being ignored and function of normally closed or check being modeled in the pipe layer.

Since the modeling software contains eight valve types, there is a large variety of information that could be necessary to operate each individual valve type. The most basic model input required by each valve is the setting of the valve. This is generally a flow or pressure value which activates the valve to perform its function.

Modeling outputs provided by the valve layer include flow, velocity through the valve, head loss through the valve and upstream and downstream pressures. This information is used to help calibrate the model and analyze how the system operates. A summary of the existing control valves in the City's system is provided in Table 3.

Table 3: Summary of Existing Control Valves

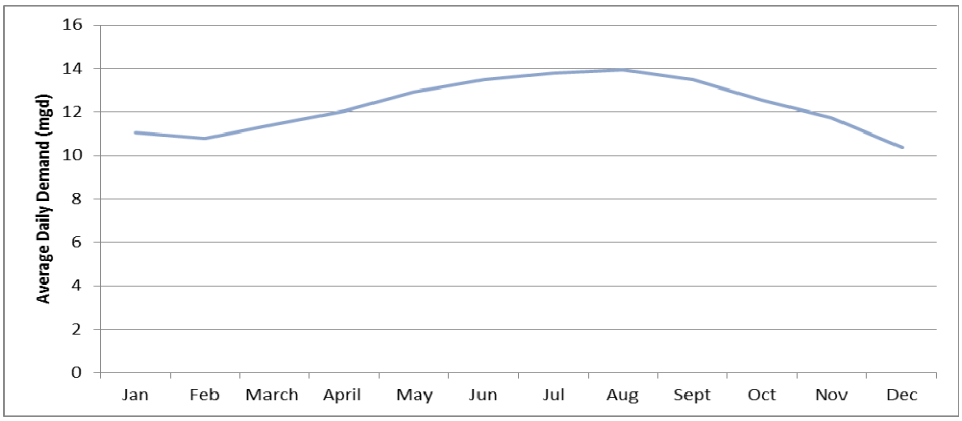
Valve	Zone to Zone	Setting
PRV 6	500 to 350	60 psi
PRV 7	500 to 350	65 psi
PRV 1	350 to 250	87 psi
PRV 2	350 to 250	87 psi
PRV 3	350 to 250	87 psi

Valve	Zone to Zone	Setting
PRV 4	350 to 250	87 psi
PRV 5	350 to 250	87 psi
RPV 1	350 to 250	65 psi
RPV 10	350 to 250	105 psi

Peaking Factors

In order to establish demands and peaking factors, the City provided daily production data, daily demand data and monthly consumption data. The daily demand data were made available for the last sixteen years. The last two years of data were used to create an average day demand (ADD) for each parcel. The complete sixteen years of data were then used to determine a maximum day demand (MDD) peaking factor, which represents the ratio between average day demands and the demands that occur on the day during the year when the demands are the highest. Analysis of the data provided by Santa Monica revealed that the maximum day peaking factor for Santa Monica is 1.54. The City's seasonal demand patterns are shown on Figure 1.

Figure 1: Seasonal Demand Variations



Source: City Water Resources Division SCADA data, 2012 values.

Elevation Extraction

Elevations for the model were assigned using the 2-ft. contour data provided by the City. In order for the model to properly calculate the conditions at each junction, elevations for each junction are required. Each individual junction in the GIS information did not have elevation information. Therefore, elevations were added through the InfoWater Elevation Extractor function. Using the 2-ft. contour information the InfoWater software uses the location of each junction to complete an interpolation of the nearest contours to assign each junction an approximate elevation. This elevation is then automatically input into the model. All junction types except for tanks and reservoirs had elevations assigned using the InfoWater Elevation Extractor.

Demand Allocation

The existing water demands in the hydraulic model were allocated using actual water usage information obtained from the City's billing records for the past two years. The future water demands were allocated using the year 2035 demand projections calculated based upon the methods presented in Section 3 of the Sustainable Water Master Plan. The spatial allocation of existing and future demands is described below.

Existing Demand

Consumption data for each water service for fiscal years (FY) 2011 and 2012 were provided by the City. The data included information on Service ID's, Parcel ID's associated with the account, street addresses, billing classifications and bi-monthly meter readings for each account. The water usage for each account from data made available was converted to a daily average day demand.

In order to convert the demands from account level data to junction level data that can be used in the model the InfoWater Demand Allocator was used. The demands from each account were assigned to the nearest junction in the model. The Demand Allocator also separated demands into six different land use categories in the model. Six land use types were used: Single Family (Demand 1), Multi Family (Demand 2), Commercial/Industrial (Demand 3), Public/Government (Demand 4), Irrigation (Demand 5), and Fire Service (Demand 6). For junctions to which demands from multiple accounts were assigned, the demands were aggregated within each land use category. As previously discussed, to account for water losses within the system which do not show up in billing data, the model was updated to include unaccounted for water in the existing water system.

Future Demand

Future demands are allocated based on the parcels selected for development by the Year 2035 through parcel-specific coverages provided by the City. For parcels not selected for development, average demands were increased by a constant factor. For those parcels identified for new or additional development, calculated demands were applied to each individual parcel.

Diurnal Curve

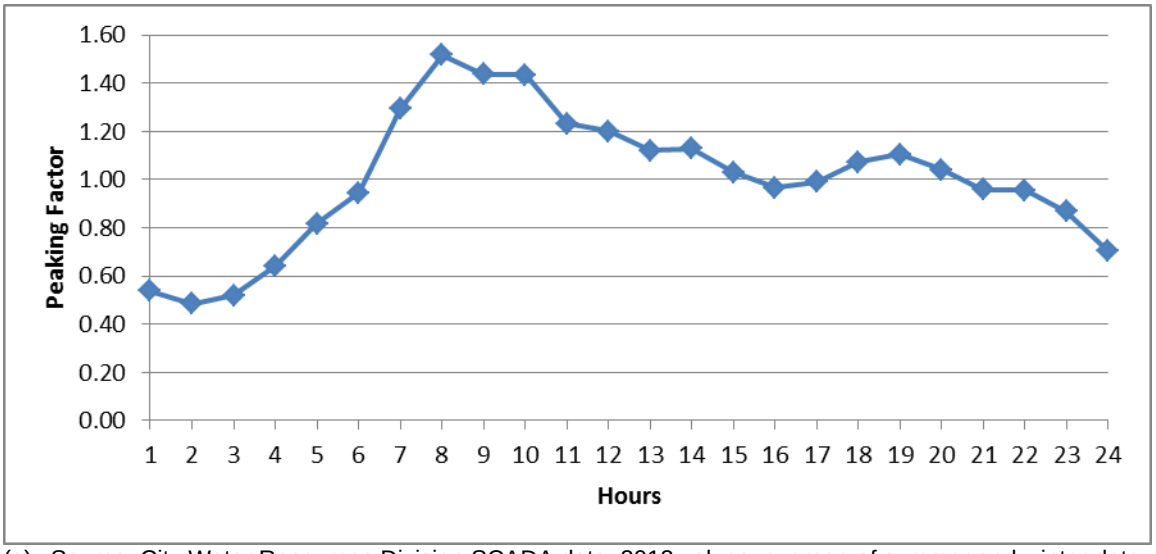
A diurnal curve is a pattern that simulates water demand variations over a 24-hour period. The diurnal curve pattern was assigned to all demand nodes within the City system. Hourly summaries of water supplied to the system and incremental changes in storage volumes are used to determine approximate hourly demand and create diurnal curves (demand = supply production – storage inflows + storage outflows).

Diurnal curve creation was based on system-wide data gathered in November and December of 2012 and August 2013. Individual diurnal curves were created for each day in the period and a combined diurnal curve for application in the model was created from an average of those. Sufficient data to create diurnal curves for specific areas of land use types were not available. Therefore, the same diurnal pattern was assigned to all demands within the system.

The hydraulic model uses the diurnal curve created when it is run for an Extended Period Simulation, which is when the model simulates the system being operated over a period of time. Frequently, this entails simulating a 24-hour time period, with results calculated at one-hour time steps throughout the simulation. At each time step, all demands are multiplied by the appropriate peaking factor throughout the day based on the diurnal curve and the time step being calculated.

The diurnal curve calculated shows a slightly atypical demand pattern with the largest peak occurring in the mornings as expected, with demand tapering off throughout the day until around hour 16 and an evening peak around hour 19. The likely explanation for the atypical pattern of demand in Santa Monica is that the population served by the City during the day, which includes resident businesses and tourism, far exceeds its residential population. The daily diurnal pattern is displayed on Figure 2.

Figure 2: Daily Diurnal Demand Pattern



(a) Source: City Water Resources Division SCADA data, 2012 values, average of summer and winter data.

Identify Data Gaps and Correct Connectivity Issues

A variety of desktop analysis tools were used to perform this analysis. These tools include: spatial analysis, database queries, topographical relationship, and logical population of attributes by use of existing data, relational queries, creation of spatial overlays to identify gaps, and populated feature attributes. Minor connectivity issues were corrected as part of the hydraulic modeling task.

The initial pipe network was created by importing the updated network data from the City's GIS to InfoWater. The network was reviewed and updated for completeness and correctness prior to adding facilities and controls in the model. The review tasks included checking of pipeline information (e.g. location, year of installation, material and diameter) and fixing of pipeline connectivity errors. Developed from the City's GIS data, the model is projected to the same coordinate system as the GIS database. This makes it possible to overlay the GIS layers from the City and those created in the model either in InfoWater or ArcMap GIS.

Model Calibration

After importing all of the elements of the City's water distribution system into the hydraulic model databases, calibration of the hydraulic model was performed. Data gathered by City staff during an initial round of hydrant testing performed on February 5, February 7, February 12, February 14, February 20, February 27, March 4 and March 6 of 2013 were used for calibration of the hydraulic model. A second round of hydrant testing was performed on December 31 of 2013, the data from which was also used for calibration. The goal of calibration was to complete the development of a hydraulic model which reasonably represents actual conditions in the distribution system.

Two phases of calibration were conducted: Steady State and Extended Period Simulations. Steady State Simulation calibration involved the process of simulating fire hydrant flow tests to match the field results reasonably closely. Extended Period Simulation involved modifying the model until it simulates the operations of a specific day or days with relative accuracy. In both calibration processes, it was necessary to utilize data recorded in the field, such as tank levels and observed static and residual pressures, as well as adjust various settings and factors such as pipeline roughness coefficients and PRV settings. Additional model calibration documentation and support material is provided as an attachment to this Memorandum.

Steady State Simulation Calibration

Fire hydrant flow tests were conducted at 24 locations throughout the distribution system from February 5 to March 6, 2013. Tests were run by closing a series of valves to isolate a specific pipeline and record the drop in pressure and head experienced along that pipeline. Static pressures were recorded along the pipeline prior to testing, residual pressures during testing. A flowing hydrant and 2 to 4 residual hydrants were specified for each test. Along with the results of the testing, data about the characteristics of the system at the time of each test were also provided. That data included: levels of each reservoir within the system, flow from well Santa Monica #1, flow from the MWD connection, pressure of the 500 zone at the Arcadia WTP, treated water from the Arcadia WTP, treated water flow from the Arcadia Booster Pump Station, effluent pressure at the Arcadia Booster Pump Station and open/close readings for the San Vicente relief valves and Booster Station.

Separate scenarios were developed in the hydraulic model for each of the 24 initial hydrant tests. For each scenario, the demands in the model were scaled up or down to match the estimate of the overall demands in the system at the time of the hydrant test. Other information about the system was incorporated into each of the scenarios, such as tank levels, valve settings and pump flow rates. Additionally, the flow rate that was recorded at the flowing hydrant for each test was incorporated into the model as an additional demand. Each of the 24 hydrant

tests were represented by a separate scenario in the model, each with its own demands and settings.

The model results were compared to the field data to test the accuracy of the model. To increase accuracy, settings and parameters were adjusted until an acceptable level of agreement was achieved in the 250 and 350 zones. A table showing the comparison between the field test results and the model results is included at the end of this memo. As can be seen in the table, there are some hydrant tests where the agreement between the model and field results is not as close as desired. Some possible reasons for this include:

- Fire flow tests in the model are based on flow at the nearest model node. The hydrant piping branch run and losses through the hydrant are not included in the model.
- Pressure meters and flow meters used for the fire flow testing have some level of inaccuracy, both in the actual measuring and reading of such meters.
- Demand varies temporally between various days. The diurnal curve created for calibration is used to determine demand at each hour for the fire flow tests. However, the actual demand pattern varies from day to day.
- Demand varies spatially between different times. The demand allocation spatially distributes the demand using annual average billing data. All demand nodes are assigned the same diurnal curve.
- The elevation data contains possible inaccuracies, both in the source contours and the interpolation process.
- Not all facility settings are captured by SCADA data. One example is a closed isolation valve that is normally open.

The data received from the City regarding the system parameters during the hydrant tests revealed inconsistencies with the results from the 500 zone. During these tests, the San Vicente pump station was turned off, according to City crews. Therefore, the only supply into the 500 zone is from the MWD connection. Readings from the flow meter at this connection were taken at one-minute intervals during each hydrant tests. During each of the tests, it was expected that an increase in flow through the MWD connection would be measured that roughly equaled the flow measured at the flowing hydrant. However, this was not the case. No significant variation of the flow at the MWD connection was measured during each of the hydrant tests in the 500 zone. Because no explanation for this could be found during discussions with City staff, 4 more hydrant tests were proposed for the 500 zone. During these tests, the San Vicente pump station was turned off. However, as before, the readings taken at the MWD flow meter at one-minute intervals showed no significant variation.

The data from the second set of tests were used to adjust settings and parameters in the model that resulted in better agreement between model results. However, because the boundary conditions for the 500 zone could not be explained, the results from the calibration of the other two zones were also used to decide the appropriate roughness factors to use in the 500 zone. Roughness factors from the 250 and 350 zones were assigned to pipes in the 500 zone that are of the same material. The final roughness factors determined for each material found in the GIS database are shown in the table below.

Table 4: Calibrated Roughness Factors

Material	C Factor
ACP	125
C	130
C900	130
C909	130
CIP	115
CIP-CL	125
CSC	130
DIP	140
DIP-CL	130
FG	130
PVC	130
SS-CL	130
SS-CL	130
STL	130
Unknown	130

The reason for the lack of variation at the MWD flow meter during the flow tests was not determined. However, it appears likely that the flow meter at the MWD connection cannot be relied upon to provide accurate detailed readings of the flow entering the 500 zone. The flow meter itself may not be accurate, although City staff expressed assurance that it had been calibrated recently. Another possibility is that there is more than one pipe that provides flow into the 500 zone, and the flow meter measures flow in only one of them. A resolution of the issue was not found during this project.

Extended Period Simulation Calibration

The model was run in extended period simulation model to produce results for a 24-hour period. Results from this scenario for the tank levels were compared to tank levels in data from the SCADA system to evaluate the accuracy of the simulation. While the complexities of the interplay between the San Vicente Booster and valve Station, the MWD connection and the Arcadia Booster Pump Station make it difficult to adjust the model to completely match field conditions, an acceptable level of calibration was reached for extended period simulation conditions. The model shows that the tank levels tend to stay at a fairly constant level over the course of a 24-hour period. While this does not always occur in reality, significant changes in tank levels are usually induced by Santa Monica staff when they are trying to turn over the water in the tanks. However, there are periods of time in the SCADA data provided where the tanks to show consistent tank levels, similar to the model results.

Conclusion

As discussed in this memorandum, calibration results within the 250 and 350 pressure zones were considered acceptable. The results for the 500 pressure zone showed discrepancies due to the data from the flow meter measuring the supply to the zone through the MWD connection. Because of this, results from the 250 and 350 zones were extrapolated to the 500 to assign roughness factors to the pipelines in the 500 zone. After this effort was completed, the model was considered acceptably calibrated to proceed with the hydraulic analysis of the system.

Kennedy/Jenks Consultants

Engineers & Scientists

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15 January 2013

Jean Higbee
City of Santa Monica
1212 5th Street, 3rd Floor
Santa Monica, CA 90401

Subject: Hydrant Testing Plan
Sustainable Water Master Plan
K/J 1283015*00

Dear Ms. Higbee:

Kennedy/Jenks Consultants (Kennedy/Jenks) is currently working on the development and calibration of a hydraulic model for the City of Santa Monica (City). To calibrate the model to improve its accuracy, Kennedy/Jenks is requesting the City perform Hydrant Testing. The goal of calibrating the model is to check its results against hydrant flow test results, and update as necessary so that the model more closely represents actual conditions (e.g., increased friction due to corrosion and sediment). The data collected will be used to adjust modeling parameters.

This memo describes the recommended locations for flow testing as well as the procedures that should be followed while performing the testing. It is Kennedy/Jenks's understanding that City staff will conduct the flow tests. The attached maps show the twenty-four (24) locations where Kennedy/Jenks recommends conducting flow tests. Since it is expected that each flow test will take approximately 1.0 to 1.5 hours, the twenty-four flow tests should take a total of approximately three to five days. Kennedy/Jenks determined the locations of hydrants and valves to be used in the flow tests based on the current water system GIS mapping provided by the City.

Record Keeping

Before starting each flow test, the locations of all hydrants used during the testing and any changes to the original flow testing plan should be recorded on the Hydrant Testing Data Recording forms so that Kennedy/Jenks can incorporate the correct data into the model. Additionally, information about the water distribution system for each day of the flow testing should be recorded, such as tank levels and pump station operation. If there are any valves in the system, which are known to be closed that day, the locations of these valves need to be noted on the maps. Any other available information about the existing conditions of the water system on that day should also be recorded.

Normally, each individual flow test uses four or five hydrants as the water system configuration permits; some tests have the option to use six hydrants. The first hydrant of each test will be

used as the flowing hydrant, where flow and pressure are measured. hese hydrants are identified on the Figures as the Flow Hydrant (FH). Only pressure will be recorded at the remaining hydrants. The remaining hydrants are identified as Residual Hydrants (RH) on the Figures.

After the flow tests are complete, Kennedy/Jenks will compare pressures recorded during the testing with static pressure readings in order to determine pressure differentials through the system during fire flow conditions. If a flow or pressure hydrant is unavailable or inoperable, use the nearest hydrant to the specified location and note the new hydrant location on the appropriate Flow Test Figure.

Procedures

The recommended field-testing procedures for fire hydrant flow testing required for the calibration of the Santa Monica Water Distribution System Model are as follows:

1. At isolation valves:
    a. Close the isolation valves as indicated on the Flow Test Figures.
2. At all hydrants (flow and residual):
    a. Flush the hydrant to remove sediment by opening the hydrant pumper outlet. Sediment could damage the pressure gage if not flushed.
    b. Shut the flow off and install a pressure gage with the appropriate adaptor on the hydrant pumper outlet.
    c. Slowly open the valve fully and read and record the static pressure at the hydrant.
    d. Use the hydrant spanner wrench to operate the hydrant nuts.
3. At the Flow Hydrant:
    a. Insert the pitot gage in the slot provided on the hydrant diffuser.
    b. Remove the hose outlet cap and install a discharge diffuser on the hydrant. The diffuser should be installed on a different hydrant pumper outlet than the pressure gage so that the pressure gage remains installed to take pressure readings during flow conditions.
    c. Locate nearby storm drains or drainage ditches. Make accommodations to direct discharge water to the most appropriate acceptance point. Follow standard dechlorination procedures for the discharge water, as required.

d. Slowly open the flow hydrant until it is fully open. Always open hydrants slowly to avoid a negative pressure surge in the distribution system.

e. Ensure water is safely flowing without creating any problems. If required, install a hose and energy dissipater to reduce the energy from the flowing water. This should be done only if the energy dissipater does not restrict the flow or pressure at the hydrant.

f. Allow time (5 to 10 minutes) to eliminate any remaining sediment from the hydrant flow.

4. Measuring flow (at the flow hydrant):

   a. Read and record the pressure reading from the pitot gage.

   b. Notify the personnel at the other hydrants to record the residual pressure.

5. Completing work at the flowing hydrant:

   a. Slowly shut the hydrant off until fully closed. Close hydrant slowly to prevent water hammer or positive surge.

   b. Shut off all valves, remove gages and hydrant diffuser, and close all nozzle caps.

6. Completing work at the Residual Hydrants:

   a. Shut off all valves, remove gages and hydrant diffuser, and close all nozzle caps.

7. At the isolation valves

   a. Open all isolation valves that were closed as part of the flow test.

Upon completion of all fire hydrant testing, provide the recording forms and marked-up maps to Kennedy/Jenks.

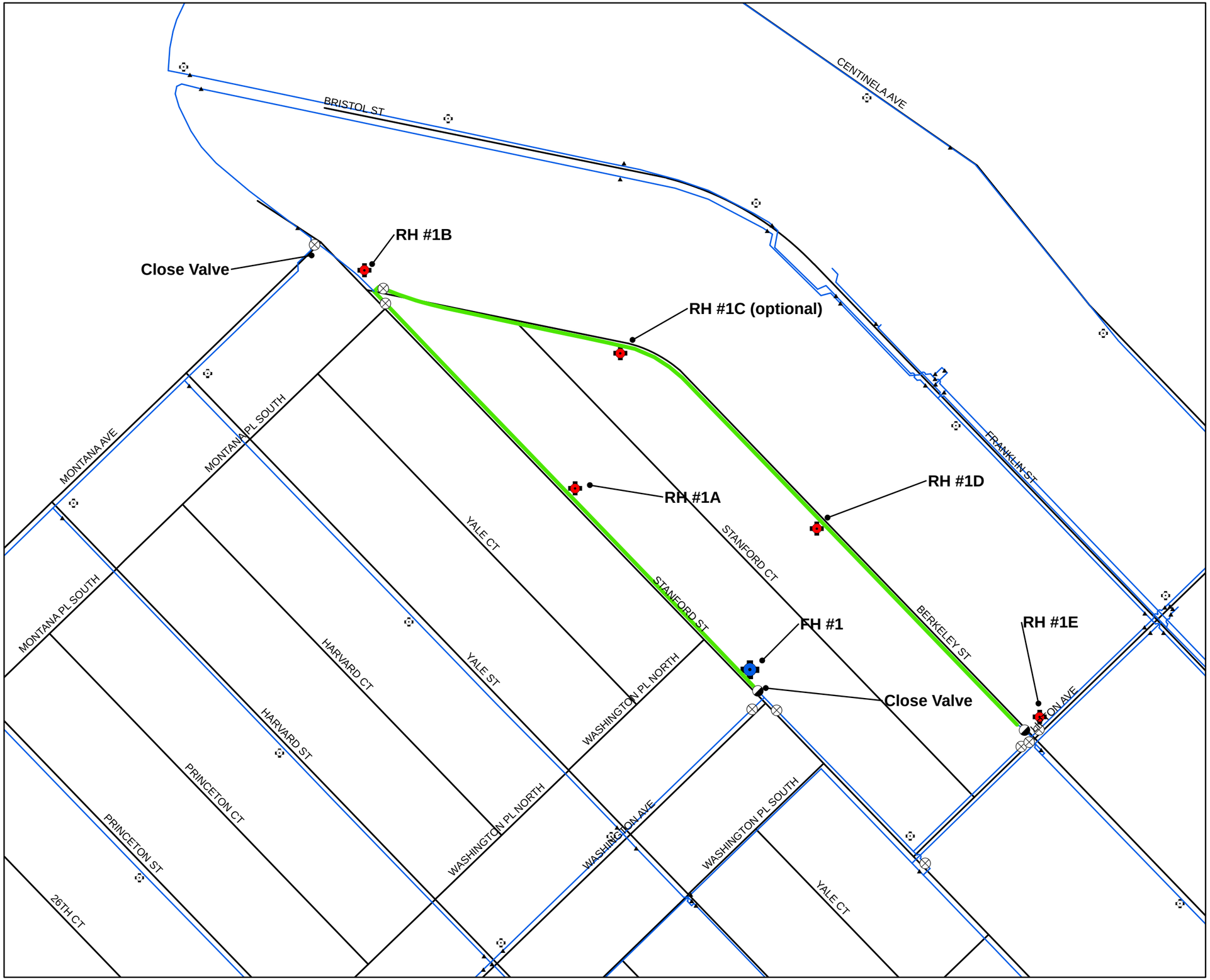
Very truly yours,

KENNEDY/JENKS CONSULTANTS

Patrick A Johnston

Patrick Johnston
Senior Associate Civil Engineer

Enclosure: Hydrant Test Plan Figures and Hydrant Testing Data Recording Form



Legend

- Test Pipe: ACP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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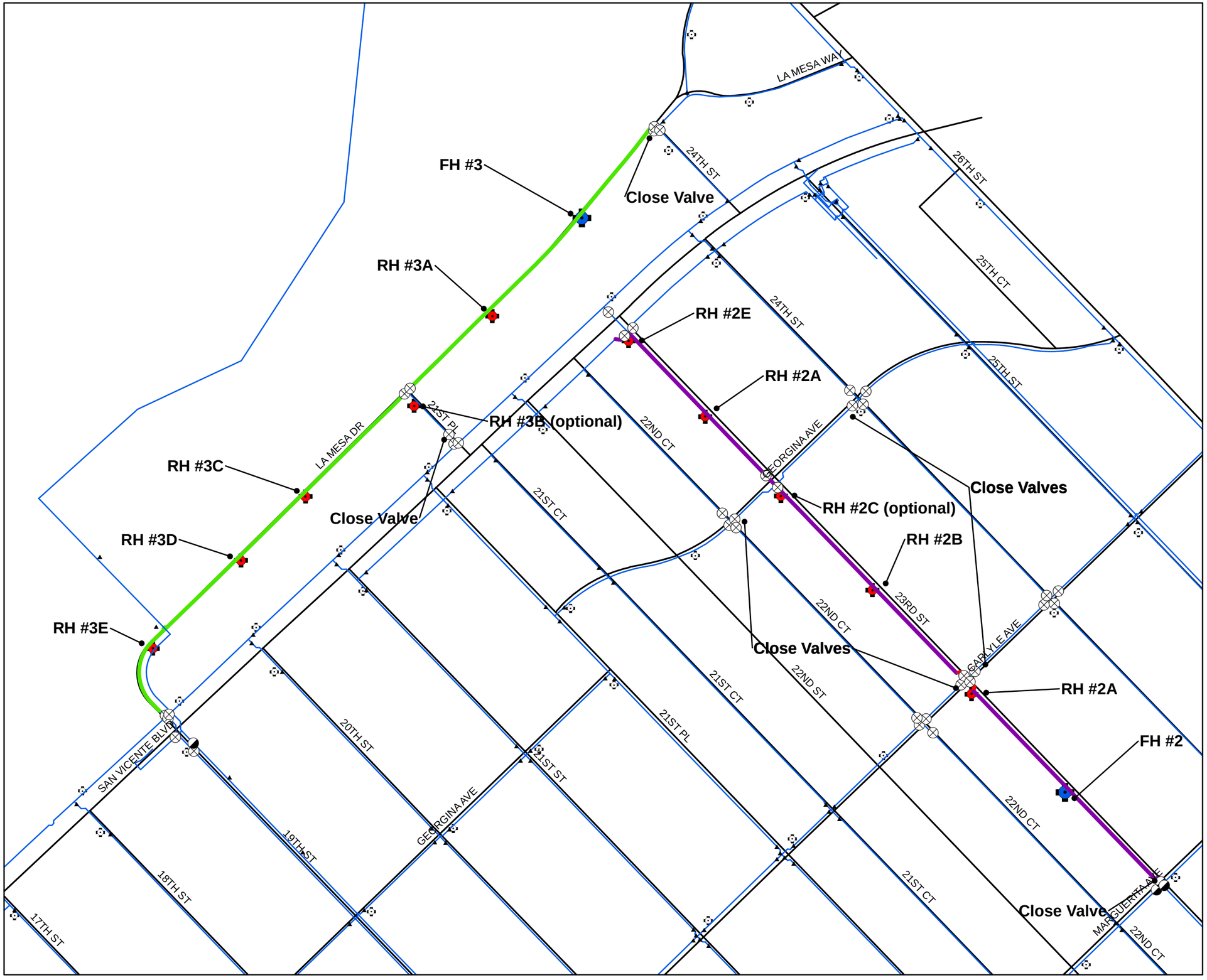
Santa Monica
Los Angeles County, California

Hydrant Testing

K/J 1283015*00
January 2013

Figure 1 - Test 1



Legend

- Test Pipe: DIP
- Test Pipe: ACP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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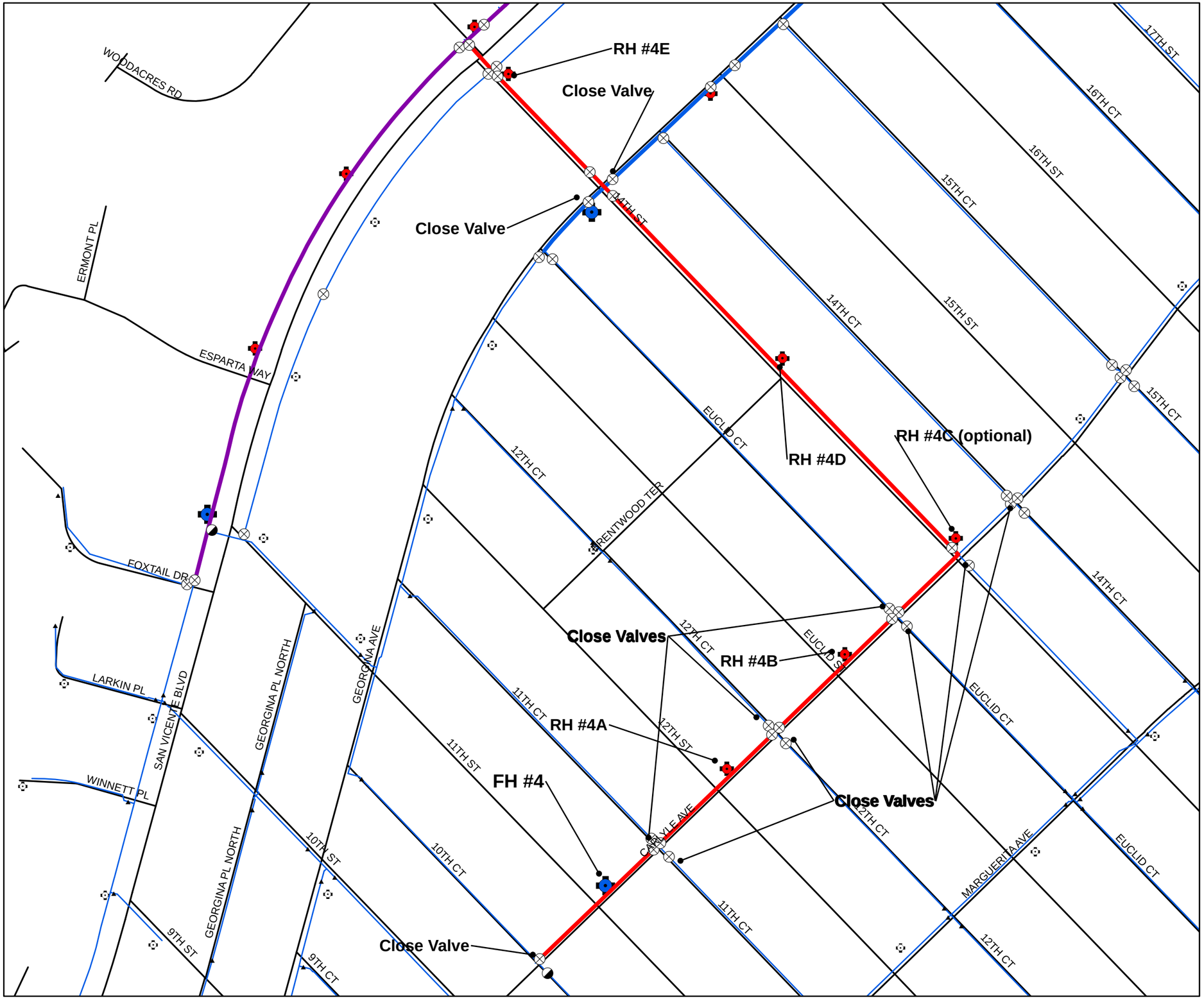
Figure 2 - Test 2-3



Legend

- Test Pipe: CIP
- Test Pipe: DIP
- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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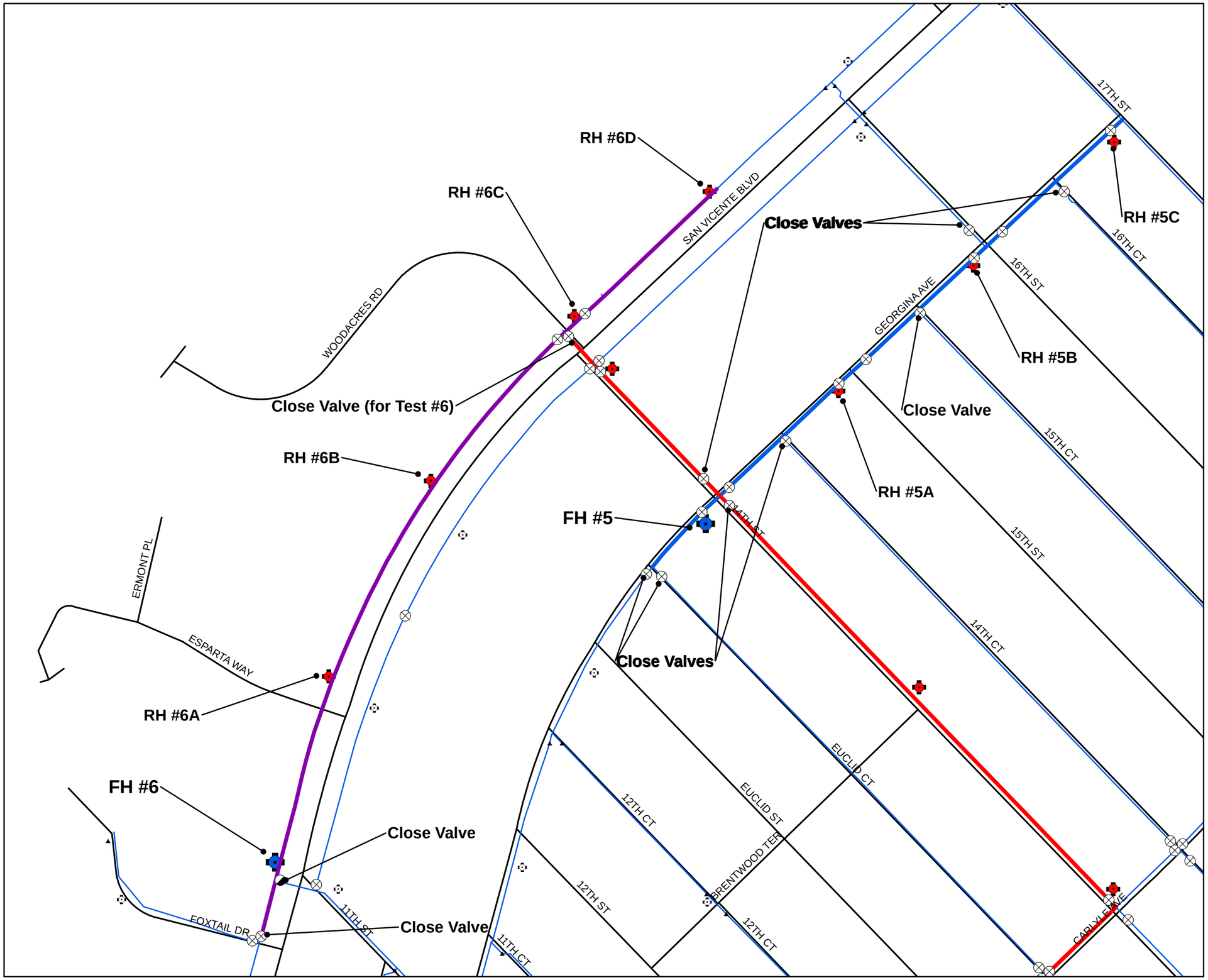
Figure 3a - Test 4



Legend

- Test Pipe: CIP
- Test Pipe: DIP
- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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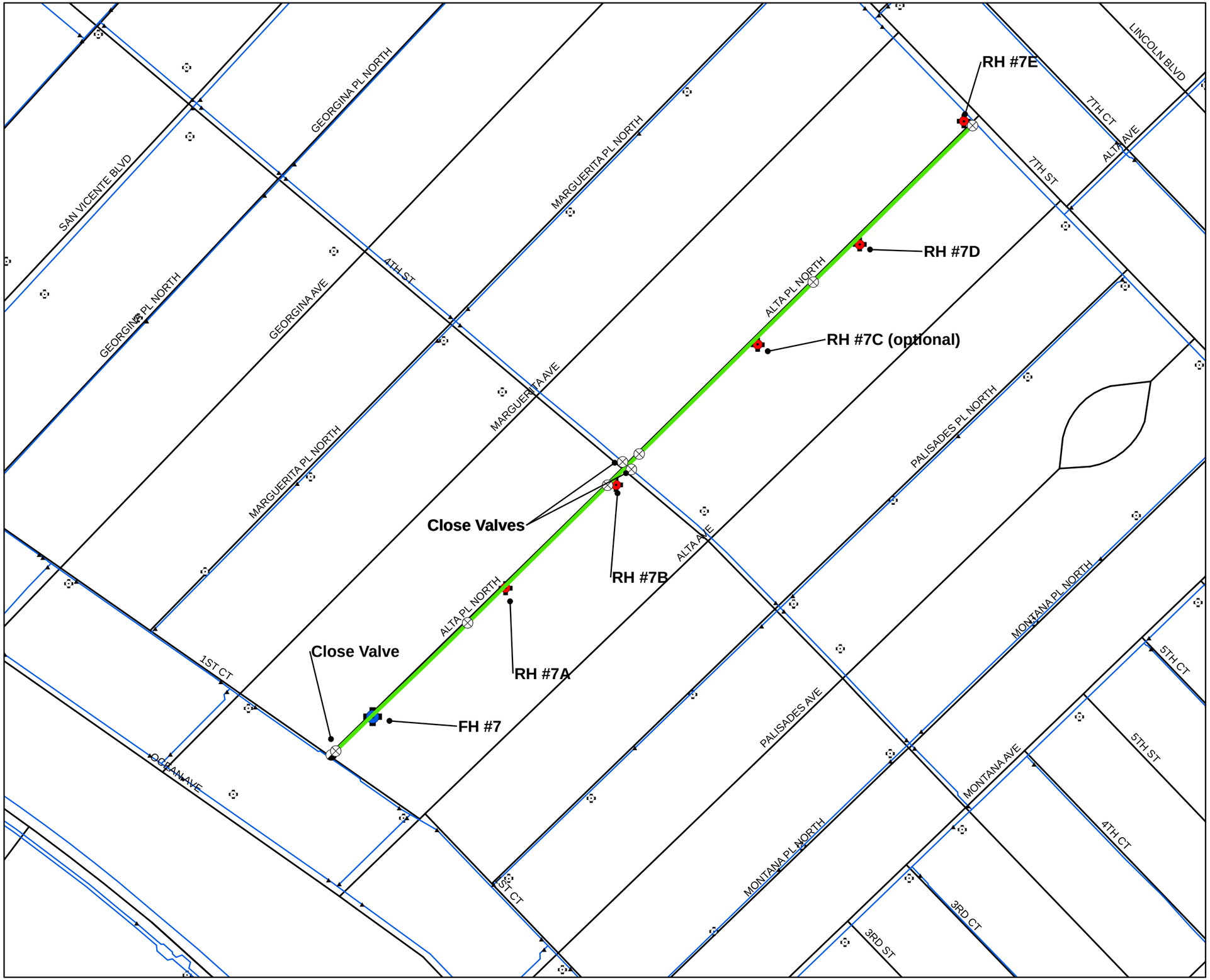
Figure 3b - Test 5-6



Legend

- Test Pipe: ACP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

N

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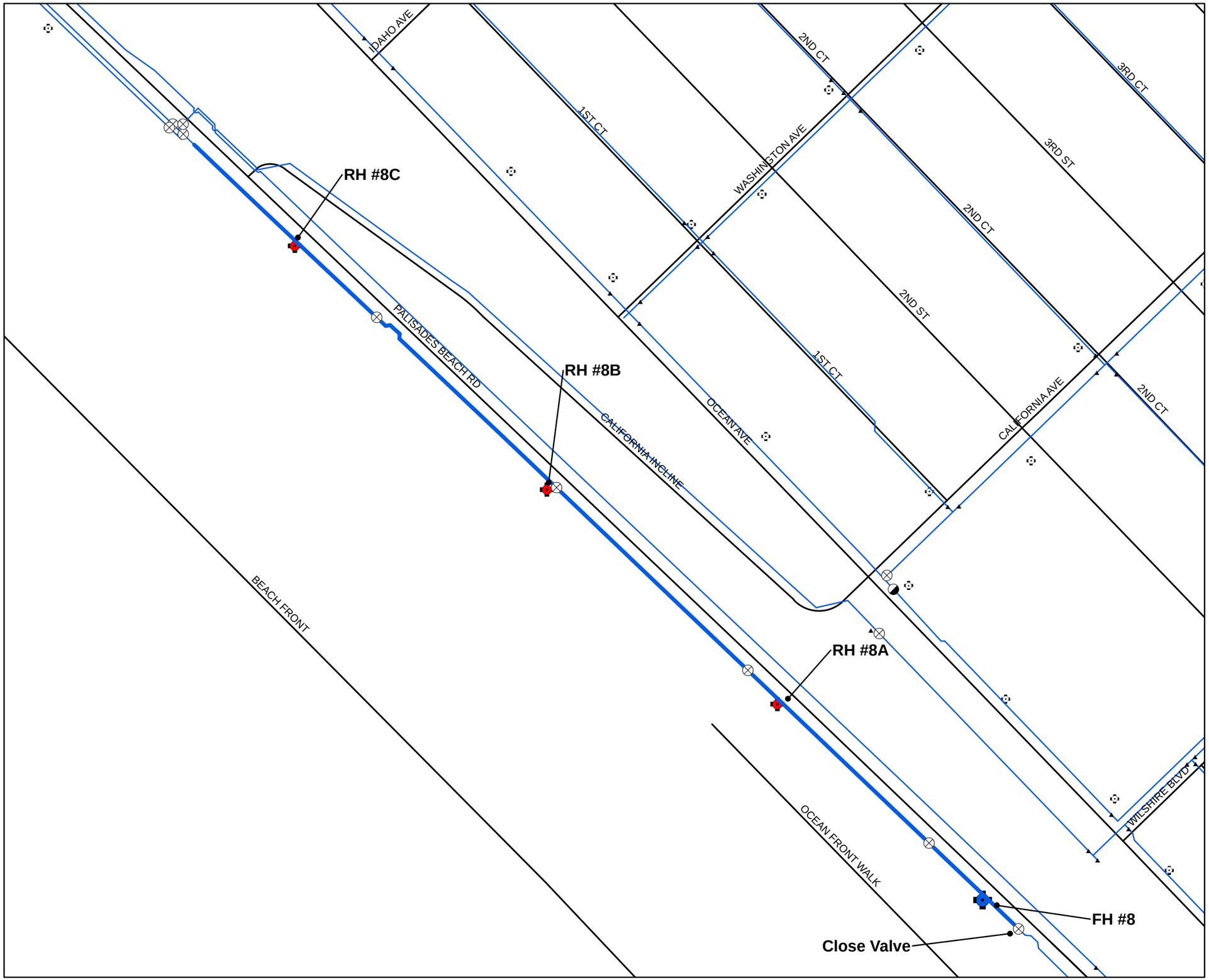
January 2013

Figure 4 - Test 7



Legend

- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

N

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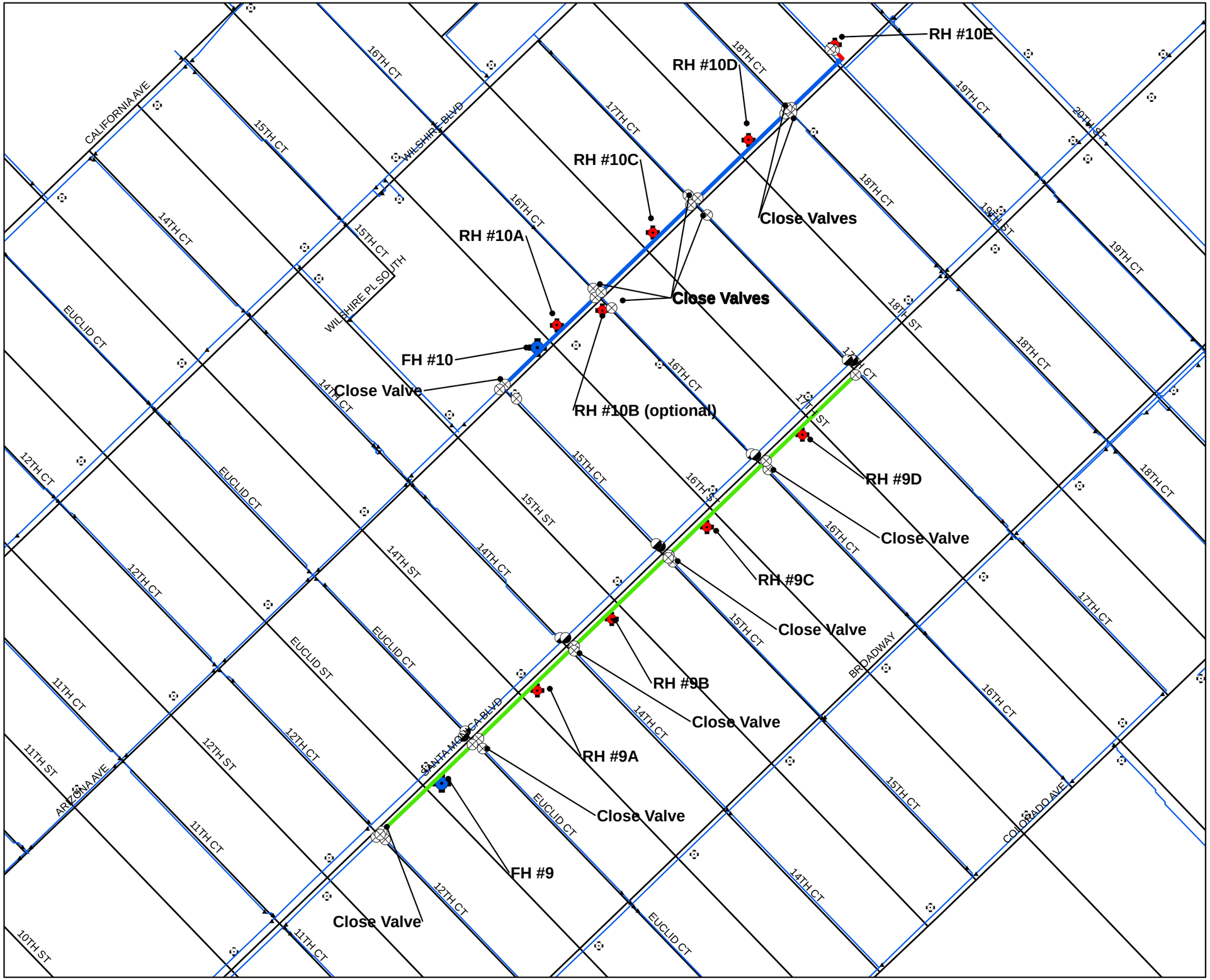
Los Angeles County, California

Hydrant Testing

K/J 1283015*00
January 2013

Figure 5 - Test 8



Legend

- Test Pipe: ACP
- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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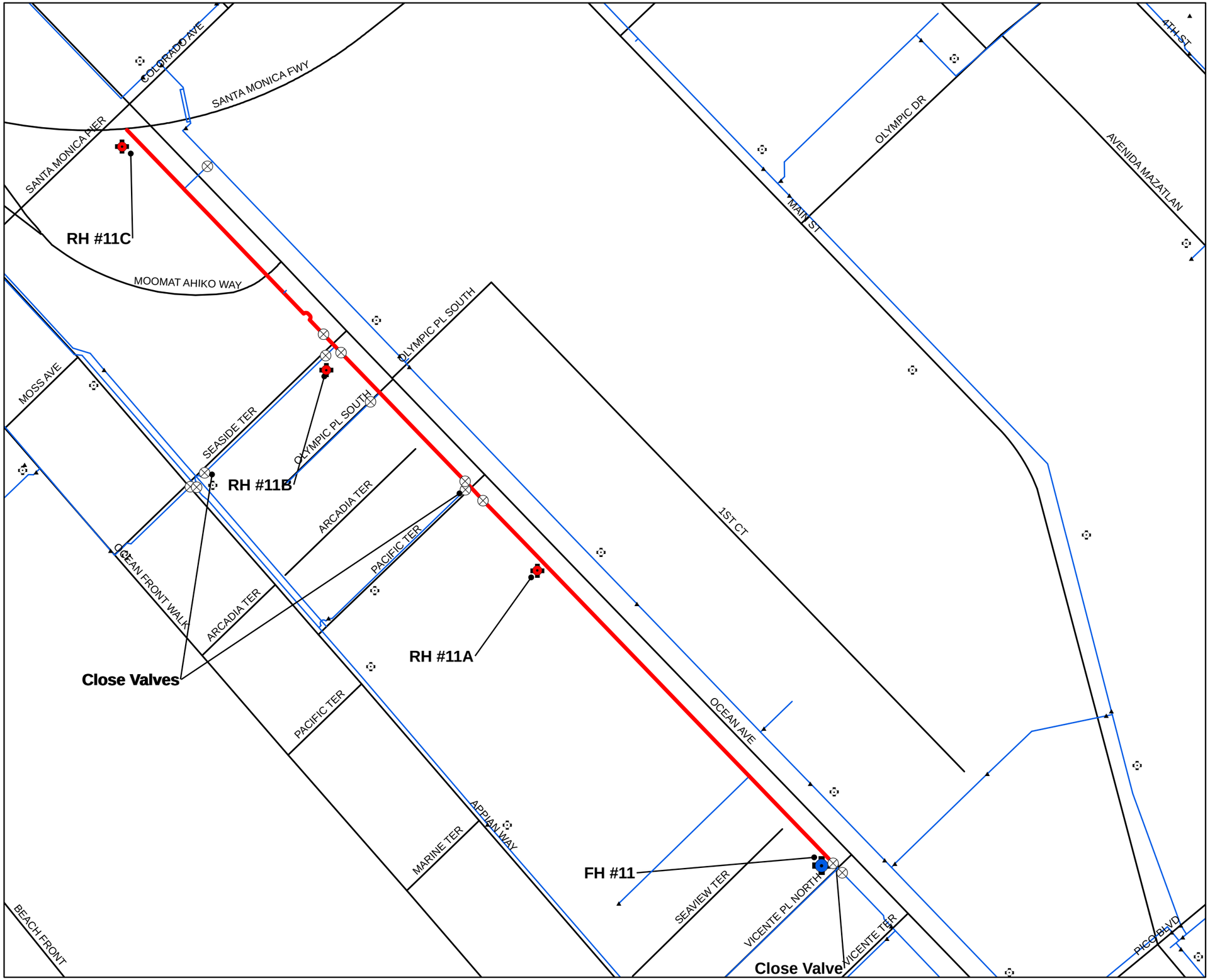
January 2013

Figure 6 - Test 9-10



Legend

- Test Pipe: CIP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

N

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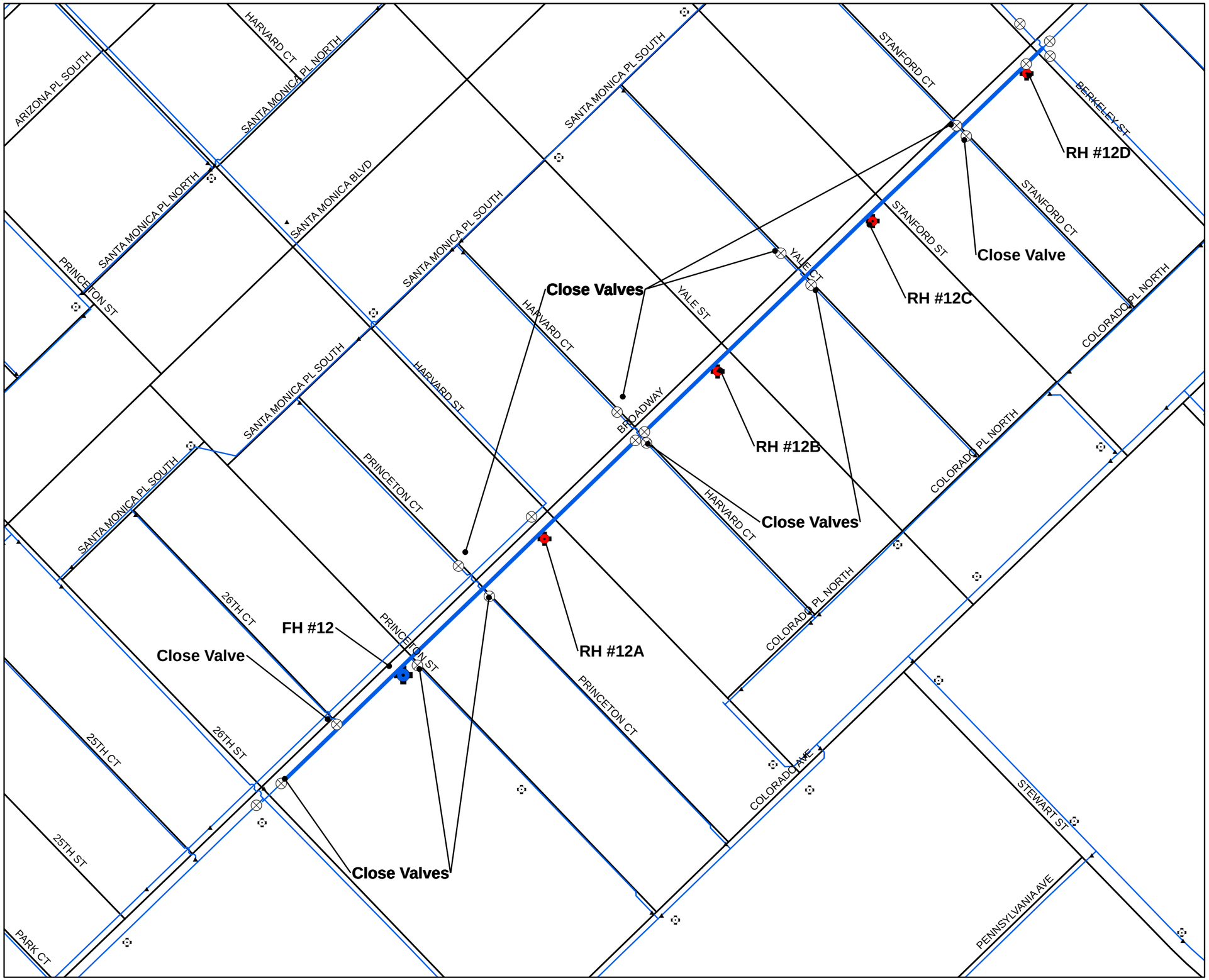
January 2013

Figure 7 - Test 11



Legend

- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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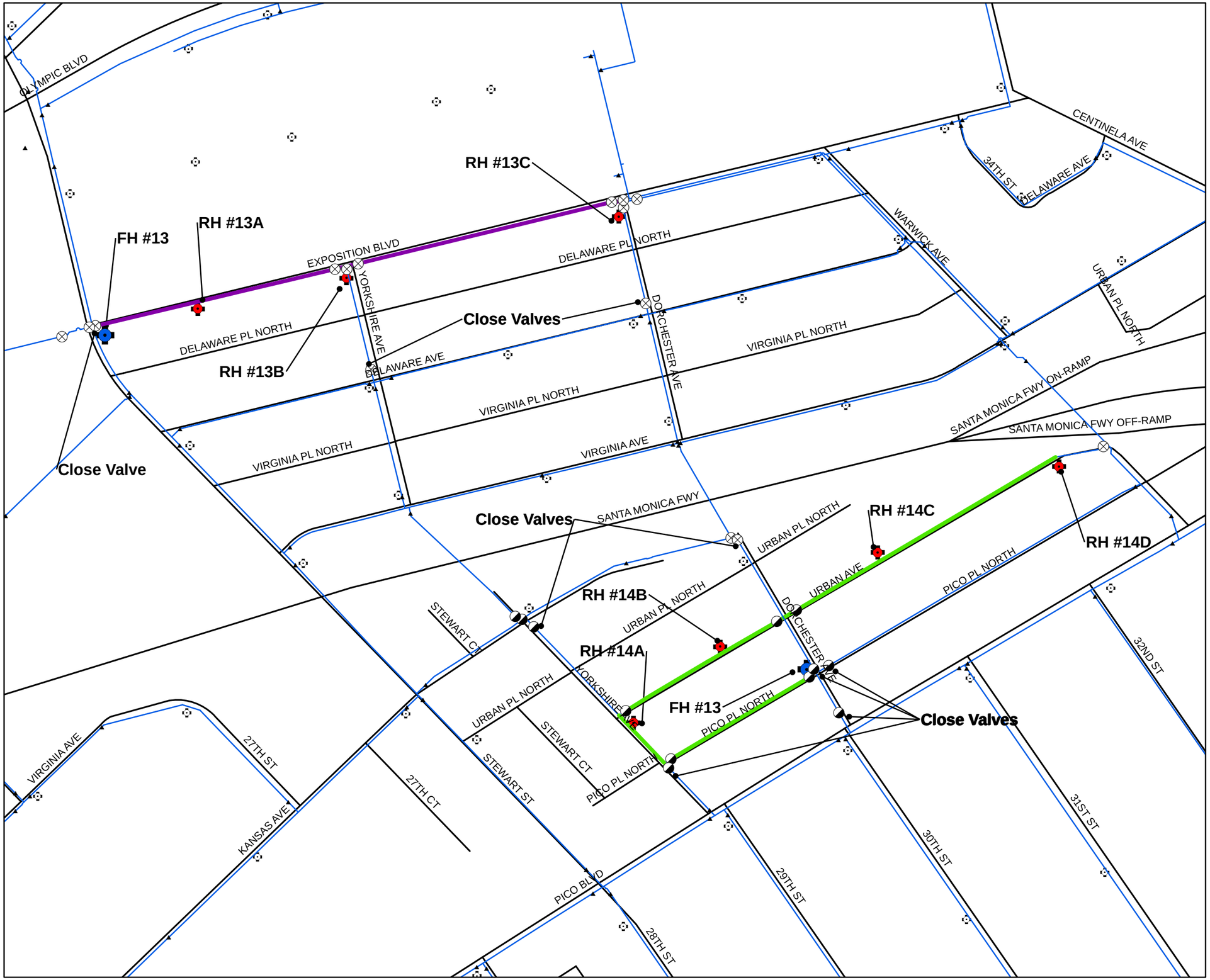
Figure 8 - Test 12



Legend

- Test Pipe: DIP
- Test Pipe: ACP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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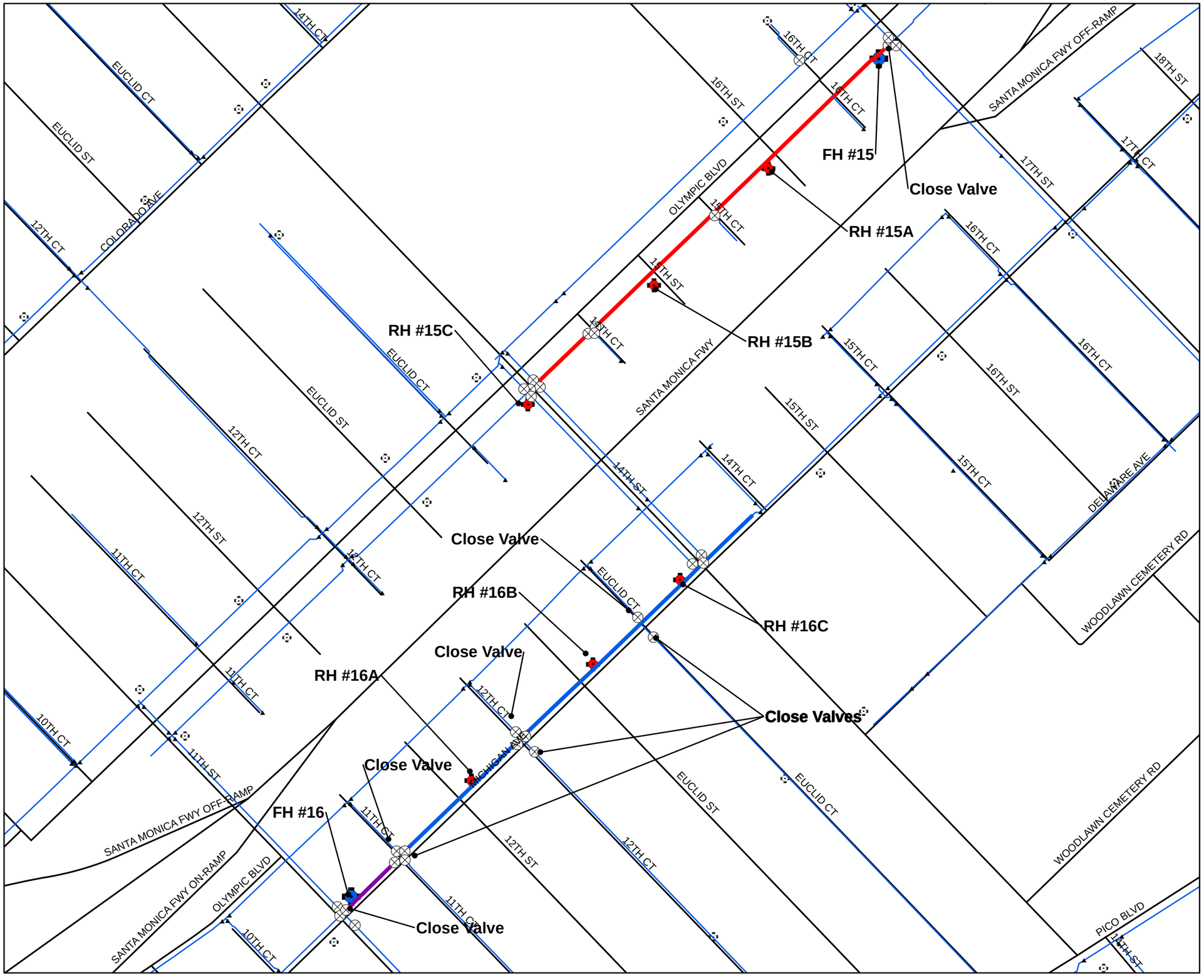
Figure 9 - Test 13-14



Legend

- Test Pipe: CIP
- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

N

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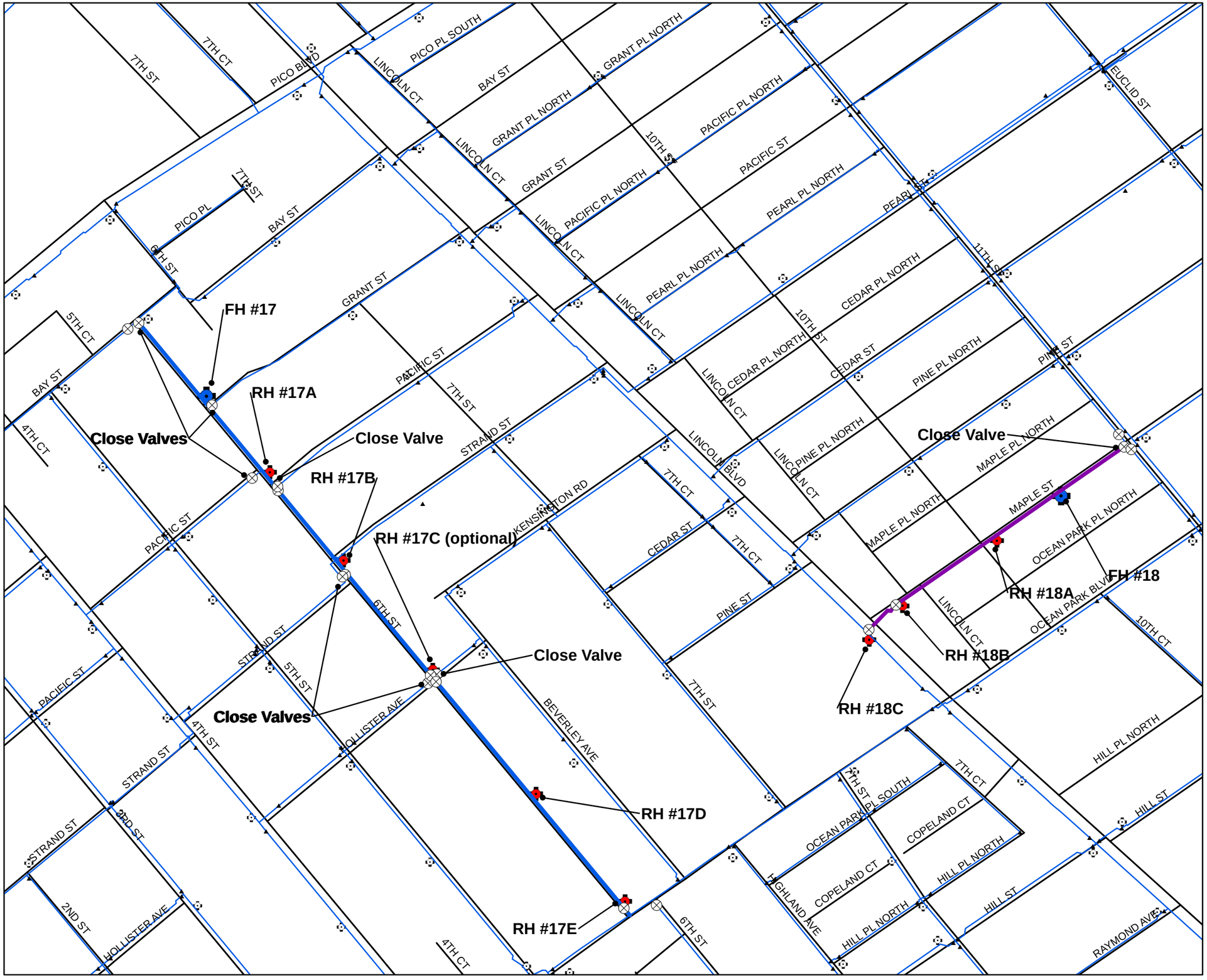
Figure 10
Test 15-16



Legend

- Test Pipe: DIP
- Test Pipe: CIP-CL
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

N

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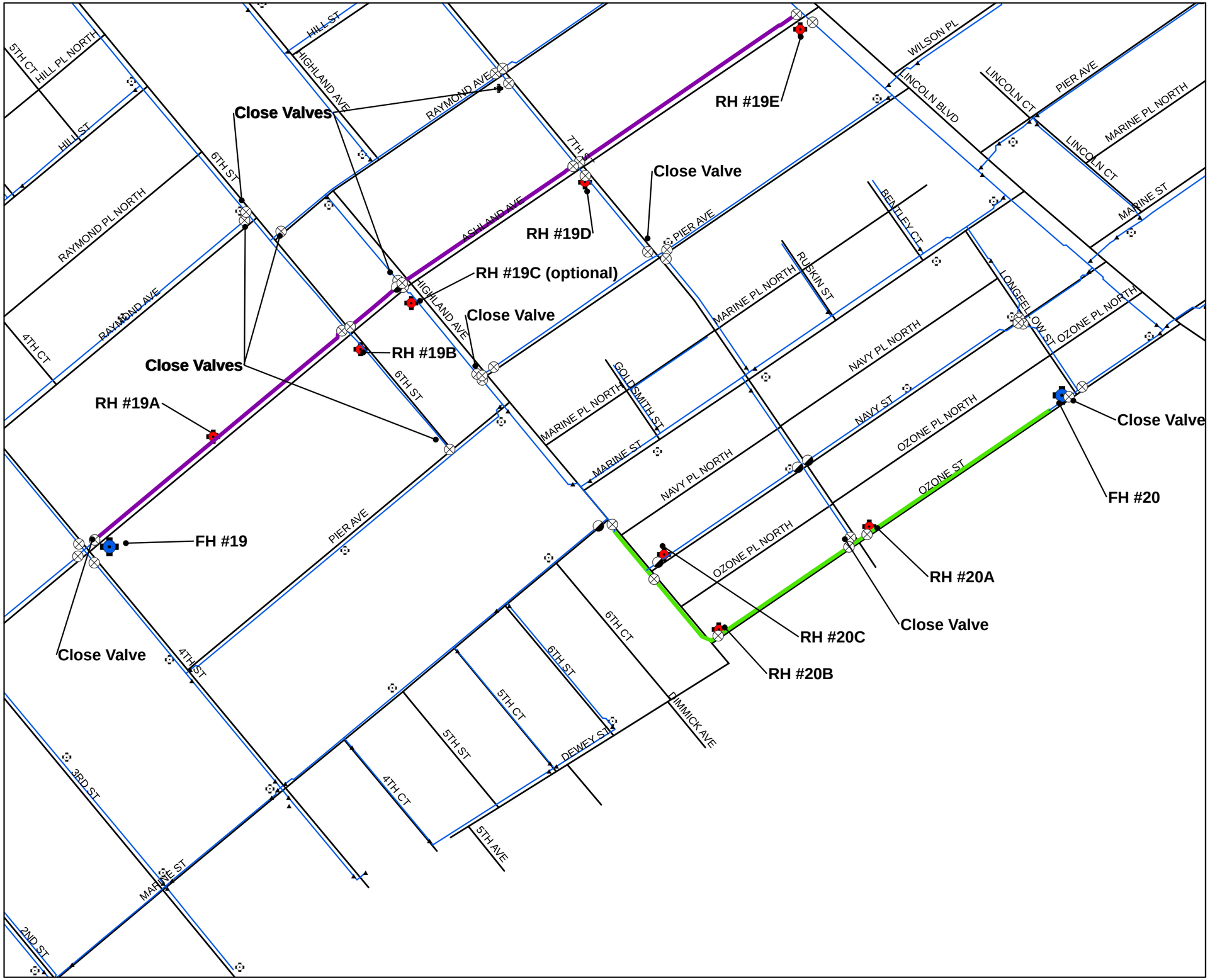
Figure 11
Test 17-18



Legend

- Test Pipe: DIP
- Test Pipe: ACP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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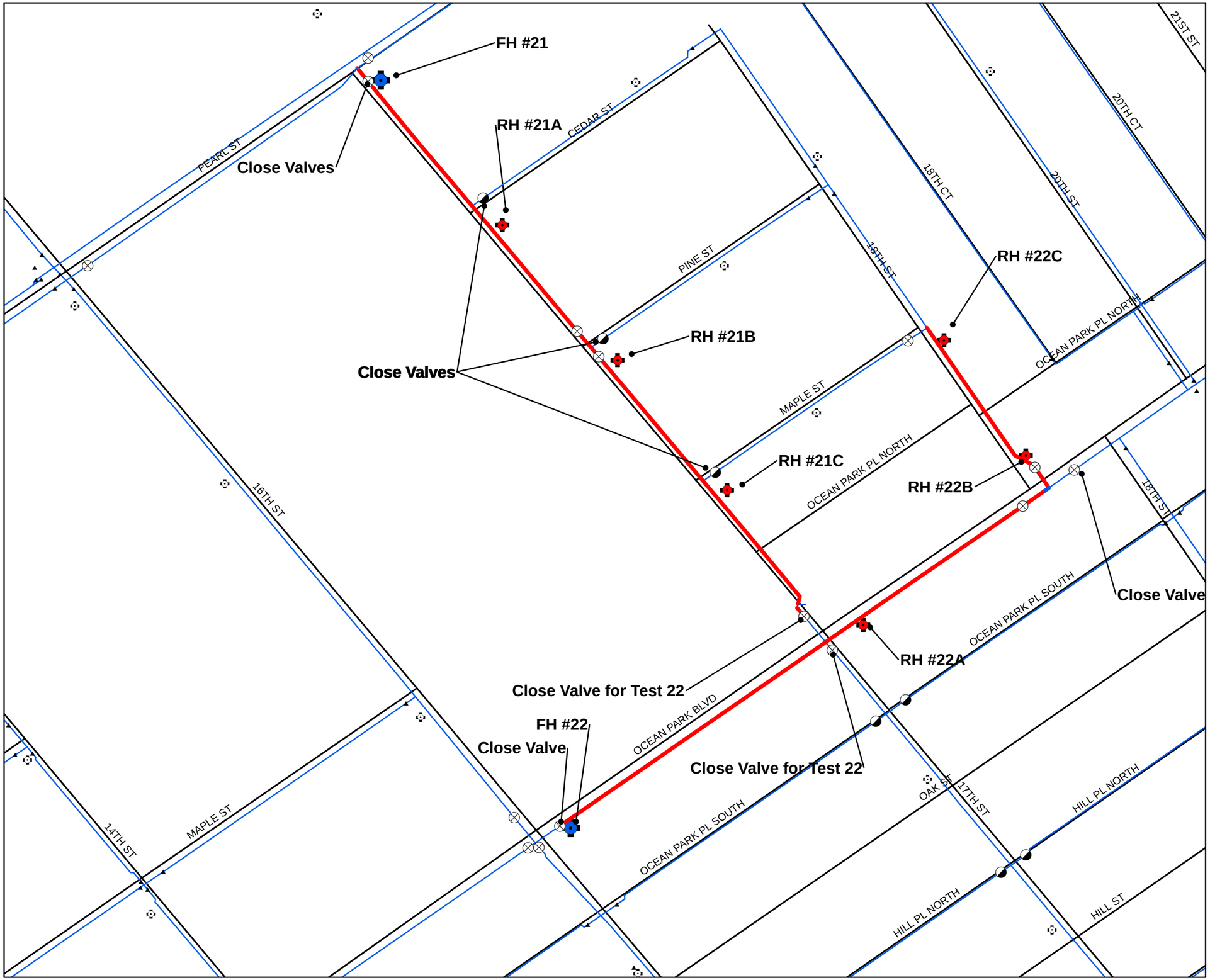
Figure 12
Test 19-20



Legend

- Test Pipe: CIP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

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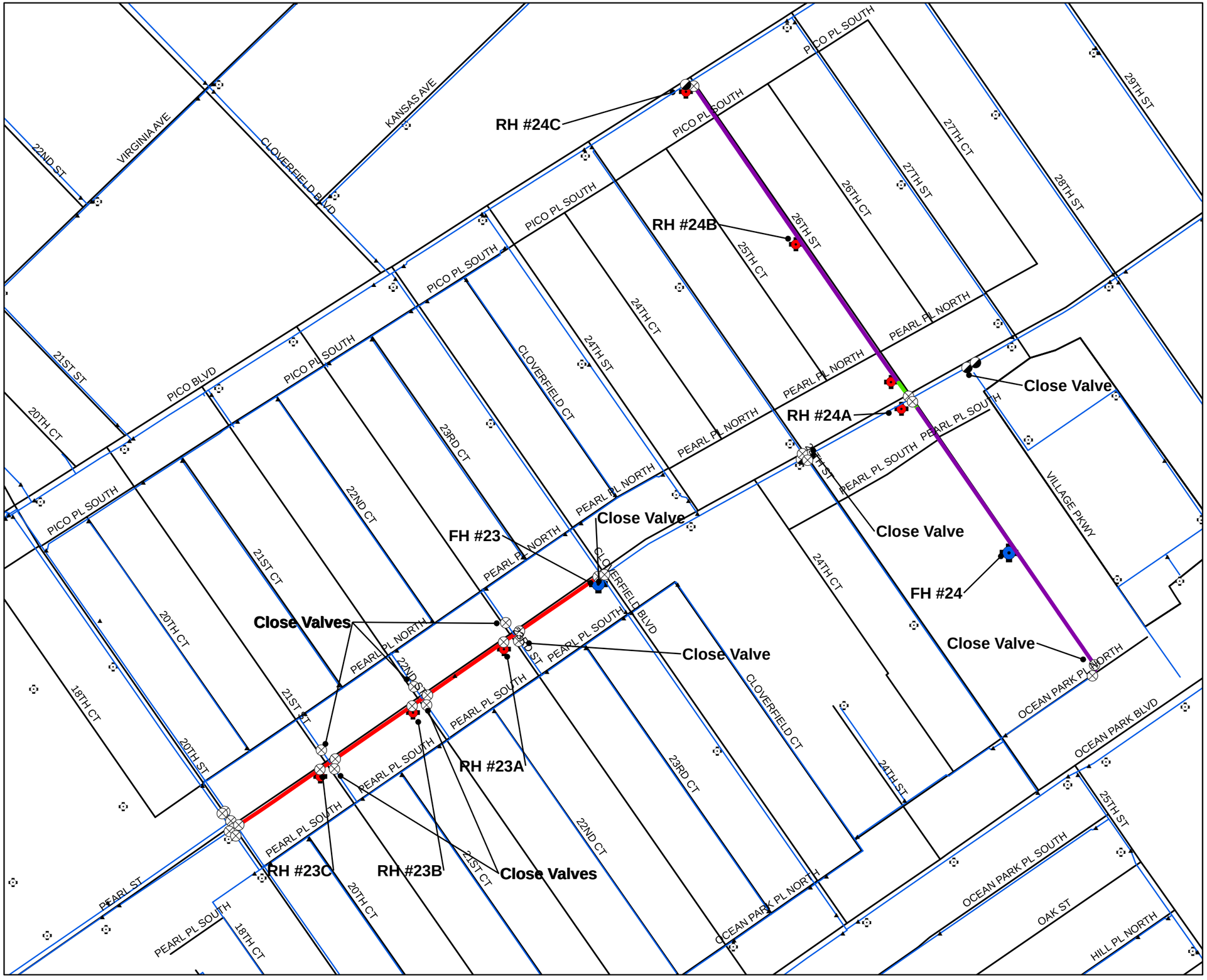
Figure 13
Test 21-22



Legend

- Test Pipe: CIP
- Test Pipe: DIP
- Non-Test Pipe
- Residual Hydrant
- Flow Hydrant
- Street
- Butterfly Valve
- Gate Valve

N

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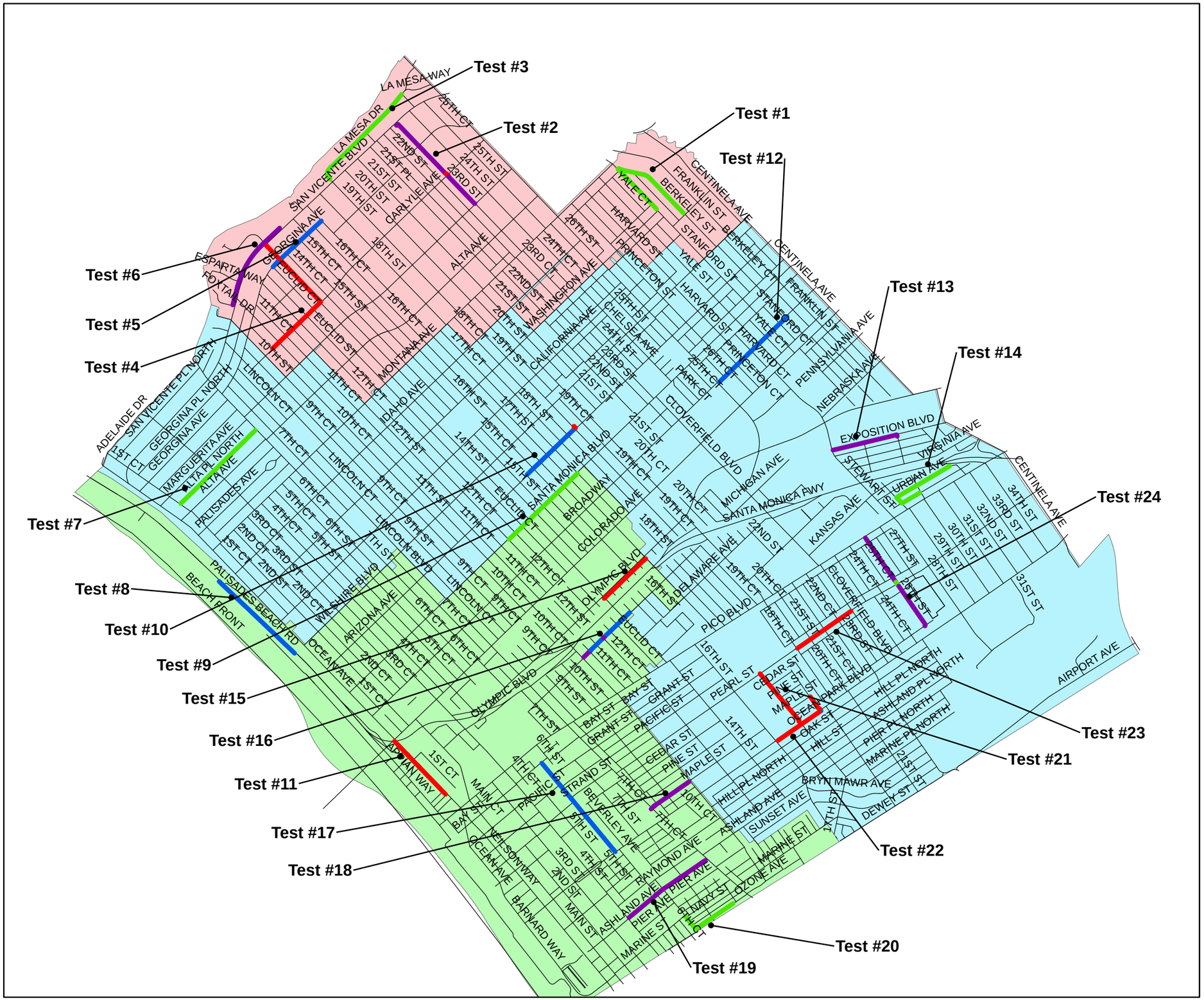
Figure 14
Test 23-24



Legend

- Test Pipe: CIP
- Test Pipe: DIP
- Test Pipe: ACP
- Test Pipe: CIP-CL
- Street
- 250
- 350
- 500

N

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Hydrant Testing

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January 2013

Figure 15 - All Tests

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME ☐ A.M. ☐ P.M.	CITY/AREA	PRESSURE ZONE	MAIN SIZE

TESTER NAME(S)

TEST CONDITIONS/REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-							

HYDRANT BODY TYPE

☐RICH ☐CLOW ☐GREENBERG ☐LONG BEACH ☐WHARF ☐OTHER _____

COEFFICIENT OF DISCHARGE

NUMBER OF OUTLETS

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED)

☐1ST _____ ☐2ND _____ ☐3RD _____

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☐YES ☐NO THREADS ☐YES ☐NO CHAINS ☐YES ☐NO OPERATING NUT ☐YES ☐NO PAINT ☐YES ☐NO

ACCESSIBILITY

HYDRANT ☐YES ☐NO GATE VALVE ☐YES ☐NO

WATER CLARITY

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-					
RH-					
RH-					
RH-					
RH-					

DATE:

TIME:

PRESSURE ZONE WATER DEMAND:

RESERVOIR	WATER SURFACE ELEVATION (ft)
REMARKS	

PUMP STATION/WELL PUMP	PUMP STATUS
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
	☐ ON ☐ OFF FLOWRATE: PRESSURE:
REMARKS	

TURNOUTS/VALVES	STATUS
	☐ INTO ZONE ☐ OUT OF ZONE FLOWRATE: PRESSURE:
	☐ INTO ZONE ☐ OUT OF ZONE FLOWRATE: PRESSURE:
	☐ INTO ZONE ☐ OUT OF ZONE FLOWRATE: PRESSURE:
	☐ INTO ZONE ☐ OUT OF ZONE FLOWRATE: PRESSURE:
REMARKS	

NOTES:

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
1	2/05/13	11:30 ☑ A.M. ☐ P.M.	SANTA MONICA	500	6

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, D. WEBB, E. BELL

TEST CONDITIONS/REMARKS: AC - PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 1	953 STANFORD ST	106	20	10	VT-1	4	1360

EL 259.98 Junc REDCR-107

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD N/A

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-1a	867 STANFORD	94	26	VT-2	EL 276.39 Junc TEE-539
RH-1b	801 STANFORD	86	30	PW-1	EL 299.27 Junc BEND-355
RH-1c	868 BERKELEY	78	34	PW-2	EL 326.85 Junc TEE-540
~~RH-1d~~	~~944 BERKELEY ST~~	~~88~~	~~60~~	~~PW-3~~	EL 293.81 (calculated, no nearby junction)
~~RH-1e~~	~~1041 BERKELEY ST~~	~~104~~	~~92~~	~~PW-4~~	EL 260.77 Junc 21-42

Don't use this point, not directly in line with other points

Don't use this point, no accurate elevation available

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
2	2/05/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	500	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, D. WEBB, E. BELL

TEST CONDITIONS/REMARKS

Ductile Iron Pipe

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-2	440 23rd Street	76	15	7	VT-1	4	1665

EL 317 (estimated)

Junc Cross-25 (closest)

HYDRANT BODY TYPE

☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☐ OTHER ____ 700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED)

☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD ____

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY

HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-2a	402 23rd St	66	48	VT-2	EL 327.1 Junc REDCR-107
RH-2b	340 23rd St	60	50	PW-4	EL 333 (est) Junc CROSS-388
RH-2c	302 23rd St	70	62	PW-2	EL 315.3 Junc 20-71
RH-2d	232 23rd St	66	58	PW-3	
RH-2e	200 23rd St.	54	50	PW-1	EL 343.5 Junc 20-43

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
3	2/05/13	10:15 ☑ A.M. ☐ P.M.	SANTA MONICA	500	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, D. WEBB, E. BELL

TEST CONDITIONS/REMARKS: AC PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 3	2304 LA MESA DR	57	20	12	VT-1	4	1490

BEND-476

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-3a	2202 LA MESA DR	57	28	VT-2	
RH-3b	2134 LA MESA DR	60	36	PW-4	
RH-3c	2034 LA MESA DR	62	58	PW-2	
RH-3d	2012 LA MESA DR	66	54	PW-3	
RH-3e	1920 LA MESA DR	66	58	PW-1	

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
4	2/05/13	9:00 ☑ A.M. ☐ P.M.	SANTA MONICA	500	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, D. WEBB, E. BELL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 4	1107 Carlyle Ave	106	12	4	VT-1	4	870

Tee-1065

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4 ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-4a	1201 Carlyle Ave	102	6	VT-2	
RH-4b	1301 Carlyle Ave	94	6	P-W4	
RH-4c	353 14th St	92	16	PW-2	
RH-4d	251 14th St	88	8	PW-3	
RH-4e	100 14th St	86	80	PW-1	

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
5	2/07/13	1:00 ☐ A.M. ☑ P.M.	SANTA MONICA	500	8

TESTER NAME(S): I. GARCIA, J RAMIREZ, J EVANS, A. ESPARZA, D. ROSA, E. BELL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 5	1330 GEORGINA	84	12	6	VT-1	4	1050

11-85

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-5a	1430 GEORGINA	79	48	PW-1	DR
RH-5b	1536 GEORGINA	77	46	PW-2	AE
RH-5c	1628 GEORGINA	70	44	PW-4	EB
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
6	2/07/13	10:30 ☑ A.M. ☐ P.M.	SANTA MONICA	500	12

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J. EVANS, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: DUCTILE IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-6	1107 SAN VICENTE	96	38	27	VT-1	4	2240

tee-1259

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☐ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-6a	1141 SAN VICENTE	90	40	VT-2	
RH-6b	1233 SAN VICENTE	89	40	PW-1	
RH-6c	1401 SAN VICENTE	86	38	PW-2	
RH-6d	1433 SAN VICENTE	80	38	PW-4	
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
7	2/07/13	2:45 ☐ A.M. ☑ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J RAMIRES, J EVANS, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: AC PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-7	139 ALTA PL	80	27	17	VT-1	4	1770

tee-1511

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-7a	233 ALTA PL	77	38	VT-2	
RH-7b	327 ALTA PL	77	40	PW-2	
RH-7c	503 ALTA PL	70	46	PW-3	
RH-7d	537 ALTA PL	67	47	PW-1	
RH-7e	629 ALTA PL	65	40	PW-4	

Hydrant Test Form
Page 1 of 2

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
8	2/07/13	9:30 ☑ A.M. ☐ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, S. RAMIREZ, J. EVANS, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 8	1060 PALISADES B.	96	26	16	VT-1	4	1720

2-15

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-8a	1050 PALISADES B.	94	46	VT-2	
RH-8b	978 PALISADES B.	95	62	PW-1	
RH-8c	908 PALISADES B.	92	78	PW-4	
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
9	2/12/13	9:00 ☑ A.M. ☐ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J. EVANS, D. ROSA, E BELL, A. ESPARZA

TEST CONDITIONS/REMARKS: AC- PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 9	1230 SANTA MONICA	55	15	6	VT-1	4	1050

8-51

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☑ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-9a	1402 SANTA MONICA	50	12	VT-2	JE
RH-9b	1434 SANTA MONICA	50	16	PW-1	DR
RH-9c	1530 SANTA MONICA	40	18	PW-2	AE
RH-9d	1630 SANTA MONICA	40	21	PW-4	EB
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
10	2/12/13	6:00 ☑ A.M. ☐ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J. EVANS, D. ROSA, A. ESPARZA

TEST CONDITIONS/REMARKS: CAST IRON - PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-10	1531 ARIZONA	87	54	35	VT-1	4	2550

13-31

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☑ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-10a	1601 ARIZONA	84	68	VT-2	JE
RH-10b	1620 ARIZONA	84	68	PW-4	JE
RH-10c	1707 ARIZONA	85	72	PW-1	DR
RH-10d	1813 ARIZONA	80	73	PW-3	DR
RH-10e	1257 19th St	80	78	PW-2	AE

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
11	2/12/13	11:00 ☑ A.M. ☐ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J. EVANS, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS

CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 11	1760 OCEAN AV	80	28	17p	VT-1	4	1770

tee-1429

HYDRANT BODY TYPE

☐ RICH ☐ CLOW ☐ GREENBERG ☑ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED)

☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY

HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-11A	1700 OCEAN AV	78	52	PW-1	DR
RH-11b	1646 OCEAN AV	78	60	PW-2	AE
RH-11c	1602 OCEAN AV	74	71	PW-4	EB
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
12	2/12/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	350	6

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J. EVANS, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 12	2628 BROADWAY	78	8	7	VT-1	4	1140

tee-483

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☑ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-12a	2726 BROADWAY	77	33	VT-2	IG
RH-12b	2828 BROADWAY	72	44	PW-1	JE
RH-12c	2930 BROADWAY	71	55	PW-2	AE
RH-12d	3030 BROADWAY	70	67	PW-4	EB
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
13	2/14/13	10:15 ☑ A.M. ☐ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: DUCTILE IRON PIPE - (MODIFIED TEST LOCATIONS)

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 13	2832 EXPOSITION	80	12	12	VT-1	4	1490

17-69

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY

HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-13a	2866 EXPOSITION	80	20	PW-2	AE
RH-13b	2960 EXPOSITION	79	25	PW-3	DR
RH-13c	3050 EXPOSITION	80	32	PW-4	EB
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
14	2/14/13	9:00 ☑ A.M. ☐ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: AC - PIPE (MODIFIED TEST LOCATIONS)

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 14	3214 URBAN AVE	80	18	12	VT-1	4	1490

23-141

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-14a	3027 URBAN AVE	82	22	PW-2	AE
RH-14b	2933 URBAN AVE	74	31	PW-3	DR
RH-14c	2902 URBAN AVE	70	38	PW-4	EB
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
15	2/14/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 15	1600 OLYMPIC	49	4	4	VT-1	4	870

bend-526

HYDRANT BODY TYPE: ☐ RICH ☑ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY

HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-15a	1500 OLYMPIC	53	29	PW-1	
RH-15b	1400 OLYMPIC	51	39	PW-3	
RH-15c	1300 OLYMPIC	54	53	PW-4	
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
16	3/04/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	250	6/8

TESTER NAME(S): I. GARCIA, J. RAMIREZ

TEST CONDITIONS/REMARKS: 6" CAST IRON PIPE / 8" DUCTILE IRON PIPE.

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-16	1757 11th St	56	18	10	VT-1	4	1360

7-111b

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☑ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☑ 1ST 2.5" ☑ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS: 2ND Test - FIRST TEST FAILED DUE TO CLOSED VALVES ON 14th St

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-16a	1761 12th St	55	39	PW-1	
RH-16b	1301 Michigan	52	39	VT-2	
RH-16c	1762 14th St	50	46	PW-2	
RH-					
RH-					

Hydrant Test Form **City of Santa Monica**

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
17	2/27/13	9:00 ☑ A.M. ☐ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J. EVANS, D. ROSA, D. MCGILL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 17	2029 6th St	58	10	8	VT-1	4	1220

tee-1339

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH- 17a	2119 6th St	58	39	VT-2	
RH- 17b	2317 6th St	62	46	PW-2	
RH- 17c	2329 6th St	64	50	PW-1	
RH- 17d	2501 6th St	70	63	PW-3	
RH- 17e	2541 6th St	66	62	PW-4	

Hydrant Test Form
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City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
18	2/20/13	9:00 ☑ A.M. ☐ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: DUCTILE IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 18	1028 Maple St	60	36	25	VT-1	4	2150

6-74

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-18a	1002 Maple St	60	50	PW-4	
RH-18b	2537 Lincoln	70	68	PW-1	
RH-18c	2538 Lincoln	72	67	PW-2	
RH-					
RH-					

Hydrant Test Form **City of Santa Monica**

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
19	2/27/13	10:45 ☑ A.M. ☐ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, J EVANS, D ROSA, D. MCGILL

TEST CONDITIONS/REMARKS: DUCTILE IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-19	400 ASHLAND AV	60	26	20	VT-1	4	1890

5-128

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-19a	437 ASHLAND AV	67	47	VT-2	
RH-19b	536 ASHLAND AV	82	74	PW-2	
RH-19c	602 ASHLAND AV	68	62	PW-1	
RH-19d	658 ASHLAND AV	69	62	PW-3	
RH-19e	750 ASHLAND AV	76	72	PW-4	

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
20	2/20/13	10:00 ☑ A.M. ☐ P.M.	SANTA MONICA	250	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: AC - PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 20	753 OZONE ST	82	26	26	VT-1	4	2190

6-24

HYDRANT BODY TYPE: ☐ RICH ☑ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-20a	701 OZONE St	82	42	PW-1	
RH-20b	631 OZONE St	82	52	PW-4	
RH-20c	631 NAVY St	82	61	PW-2	
RH-					
RH-					

Hydrant Test Form
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City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
21	2/20/13	11:00 ☑ A.M. ☐ P.M.	SANTA MONICA	350	6

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 21	1702 PEARL ST	82	2	2	VT-1	4	615

tee-802

HYDRANT BODY TYPE: ☐ RICH ☑ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☐ OTHER _____

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD _____

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS: PIPE RUN TESTED @ 17th st (PEARL - OCEAN PARK)

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-21a	1702 CEDAR ST	82	72	PW-1	
RH-21b	1702 PINE ST	81	72	PW-2	
RH-21c	1702 MAPLE ST	82	80	PW-4	
RH-					
RH-					

Hydrant Test Form
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City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
22	3/06/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-22	1602 OCEAN PARK	87	0	1	VT-1	4	400

tee-947

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☑ 1ST 2.5" ☑ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS: 2ND TEST - RETESTED DUE TO LOW RESIDUAL + PITOT PRESSURES - ALL VALVES ARE OPEN - SUSPECT PROBLEM IS 6" CIP IN POOR CONDITION ON 17th ST FROM PEARL to ~~17th ST~~ OCEAN PARK BLVD

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-22a	1700 OCEAN PARK	86	20	VT-2	
RH-22b	1801 OCEAN PARK	87	22	PW-1	
RH-22c	2501 18th St.	85	26	PW-2	
RH-					
RH-					

Hydrant Test Form
Page 1 of 2

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
23	2/27/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J RAMIREZ, D. ROSA, J. EVANS, D. MCGILL

TEST CONDITIONS/REMARKS: CAST IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-23	2332 PEARL St	74	30	18	VT-1	4	1820

16-123

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5 ☐ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: OK

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-23a	2228 PEARL St	74	46	PW-1	
RH-23b	2128 PEARL St	74	58	PW-3	
RH-23c	2028 PEARL St	79	68	PW-4	
RH-					
RH-					

Hydrant Test Form
Page 1 of 2

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
24	2/20/13	1:30 ☐ A.M. ☑ P.M.	SANTA MONICA	350	8

TESTER NAME(S): I. GARCIA, J. RAMIREZ, D. ROSA, A. ESPARZA, E. BELL

TEST CONDITIONS/REMARKS: DUCTILE IRON PIPE

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-24	2510 26th St	76	32	18	VT-1	4	1830

cross-648

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☑ OTHER JONES 3700

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES -CHECK OUTLET FLOW TESTED): ☐ 1ST 2.5" ☐ 2ND 4" ☐ 3RD

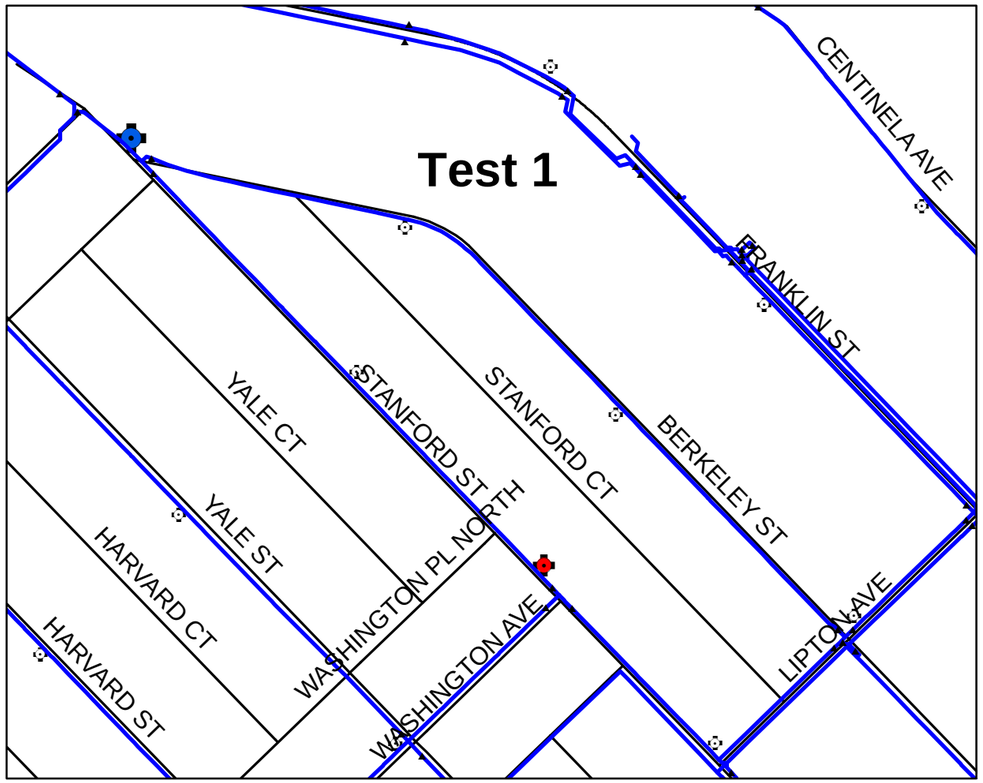
BODY APPEARANCE (CHECK YES IF OK): CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

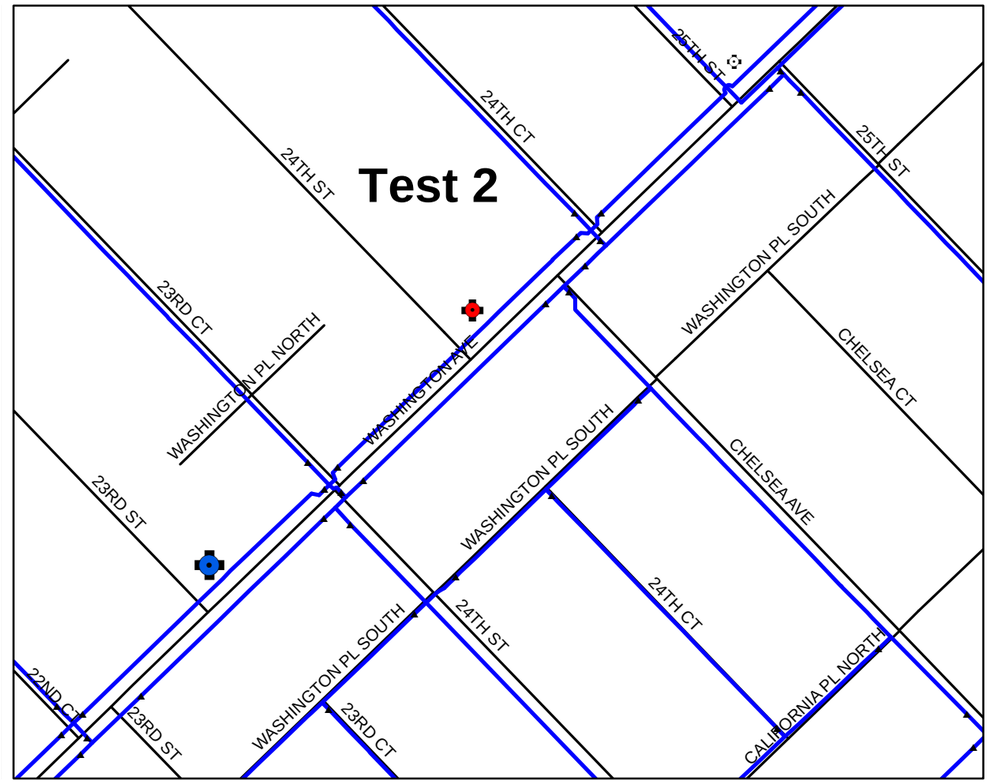
ACCESSIBILITY: HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY:

REMARKS: PIPE RUN TESTED @ 26th St (OCEAN PARK - PICO BLVD)

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-24a	2530 PEARL St	74	50	PW-3	
RH-24b	2266 26th St	72	54	PW-2	
RH-24c	2530 PICO BLVD	72	60	PW-1	
RH-					
RH-					

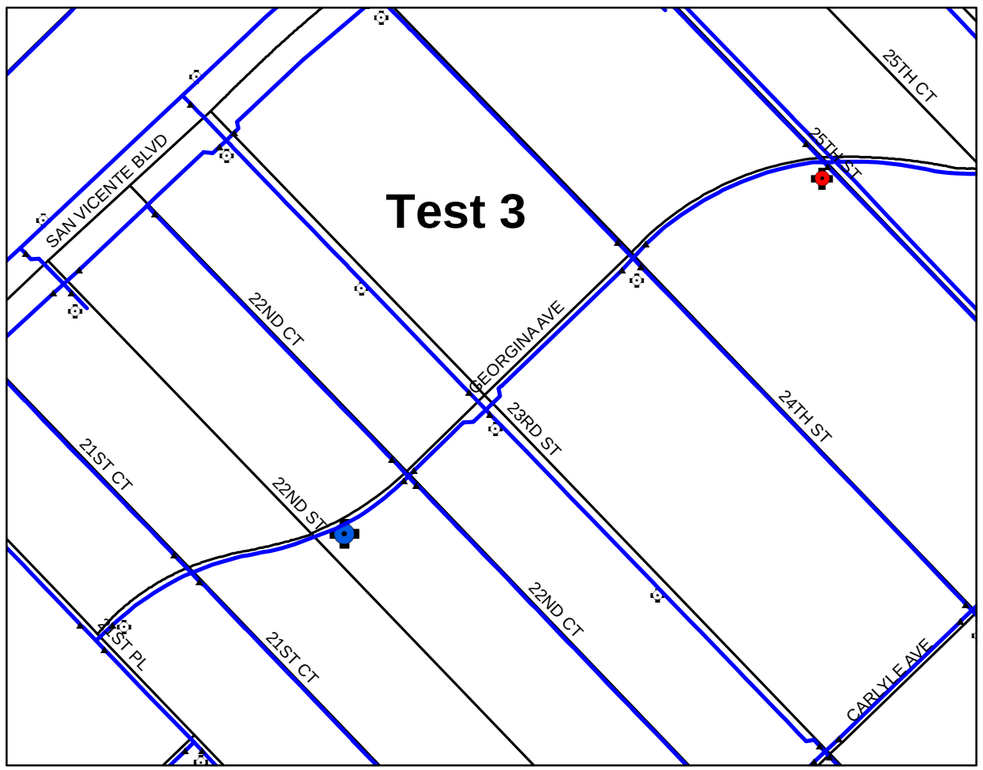


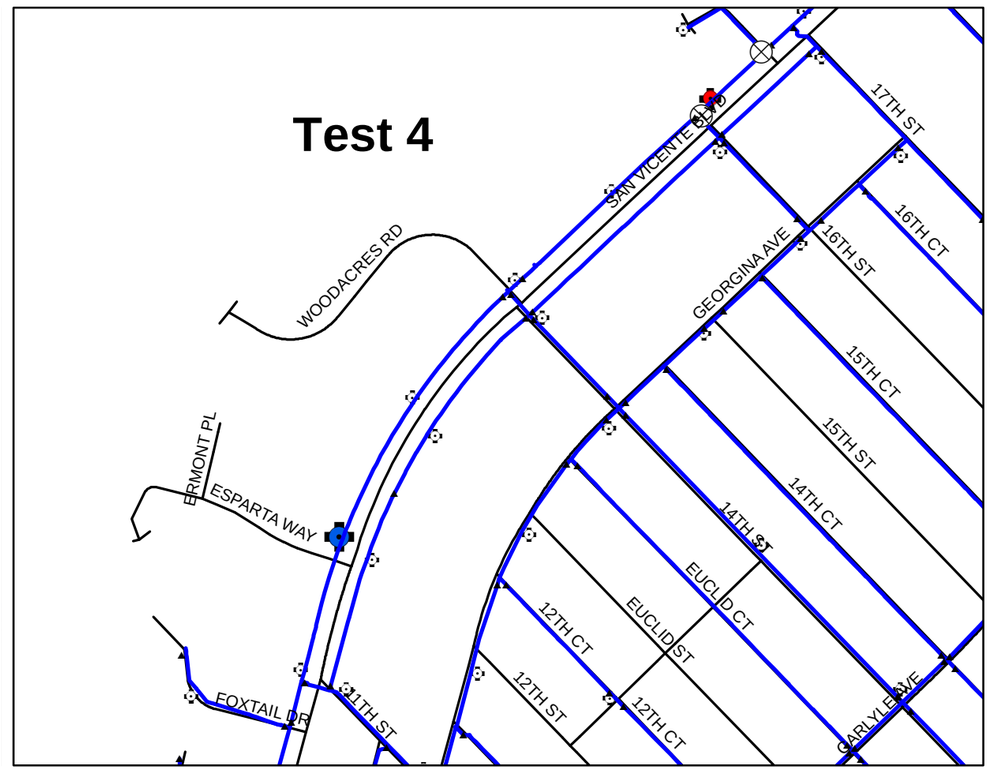


Legend

- Flow Hydrant
- Residual Hydrant
- Pipe
- Street

N





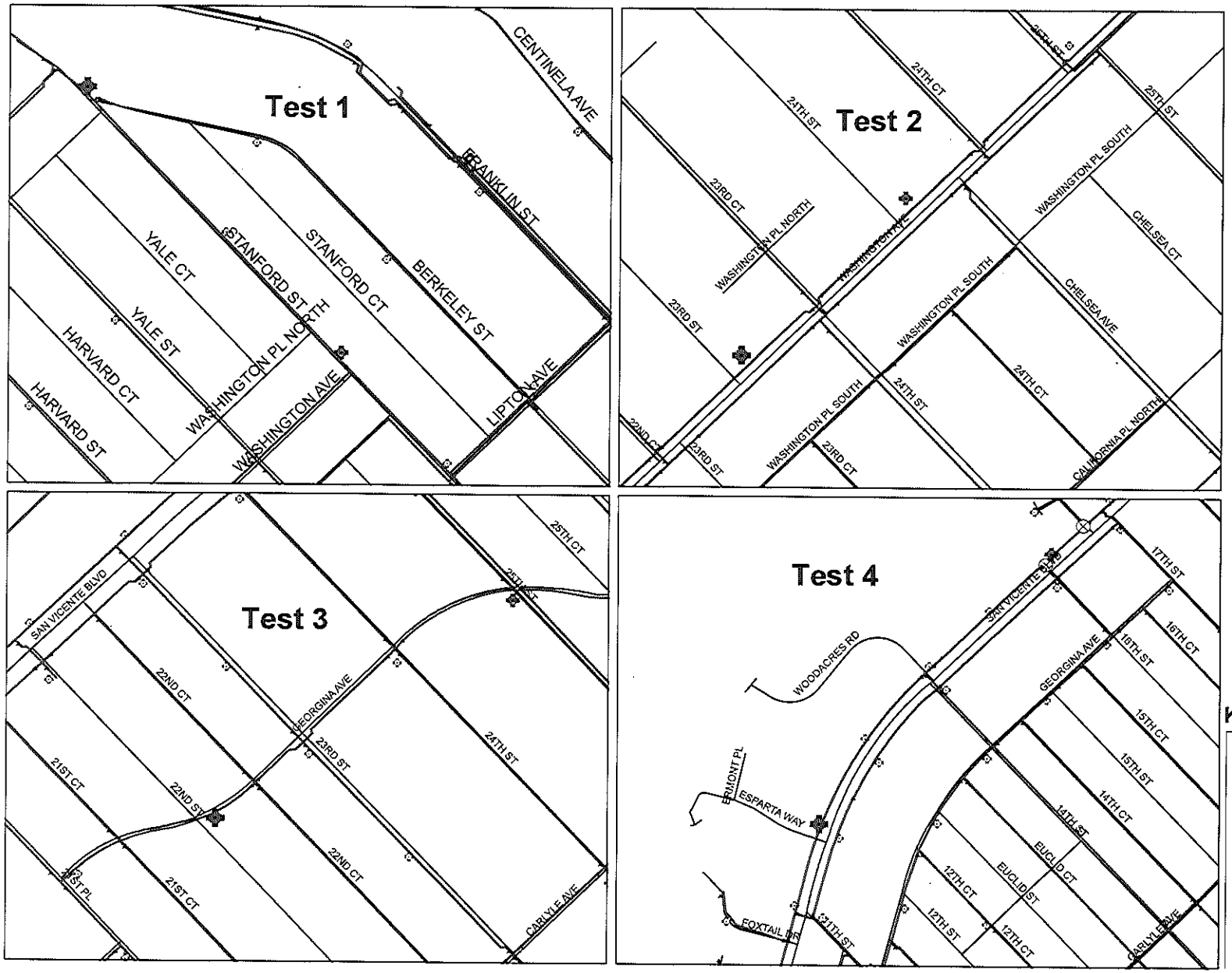
Kennedy/Jenks Consultants

Santa Monica
Los Angeles County, California

Hydrant Testing

K/J 1283015*00
November 2013

500 Zone Hydrant Tests



Legend

- Flow Hydrant
- Residual Hydrant
- Pipe
- Street

N

Kennedy/Jenks Consultants

Santa Monica
Los Angeles County, California

Hydrant Testing

K/J 1283015*00
November 2013

500 Zone Hydrant Tests

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
1	12/31/13	7:40 ☑ A.M. ☐ P.M.		700	6"

TESTER NAME(S): A. ESPARZA, T. Dodson

TEST CONDITIONS/REMARKS: NORMAL

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-890	801 STANFORD	82	16	13		4"	1720

Residual Pressure

1550 - Pitot PSI

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☐ OTHER Jones

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☑ 1ST 2.5" ☑ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☑ YES ☐ NO THREADS ☑ YES ☐ NO CHAINS ☑ YES ☐ NO OPERATING NUT ☑ YES ☐ NO PAINT ☑ YES ☐ NO

ACCESSIBILITY

HYDRANT ☑ YES ☐ NO GATE VALVE ☑ YES ☐ NO

WATER CLARITY: CLEAR

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-897	953 STANFORD	95	46		~~NO PITOT READING~~
RH-					
RH-					
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
2	12/31/13	8:10 ☒ A.M. ☐ P.M.		500	8"

TESTER NAME(S): A. Esparza, T. Dodson

TEST CONDITIONS/REMARKS: NORMAL

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-789	2301 WASHINGTON	106	30	26			2350

Residual Pressure

2190 - Pitot PSI

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☒ OTHER Jones

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☒ 1ST 2.5" ☒ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☒ YES ☐ NO THREADS ☒ YES ☐ NO CHAINS ☒ YES ☐ NO OPERATING NUT ☒ YES ☐ NO PAINT ☒ YES ☐ NO

ACCESSIBILITY

HYDRANT ☒ YES ☐ NO GATE VALVE ☒ YES ☐ NO

WATER CLARITY: CLEAR

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-791	2401 WASHINGTON	106	45		
RH-					
RH-					
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
3	12/31/13	8:50 ☒ A.M. ☐ P.M.		500	8"

TESTER NAME(S): A. ESPARZA, T. Dodson

TEST CONDITIONS/REMARKS: NORMAL

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH-753	2202 GEORGINA	74	20	11			1920

Residual Pressure

1420 – Pitot PSI

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☒ OTHER Jones

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☒ 1ST 2.5" ☒ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK)

CAPS ☒ YES ☐ NO THREADS ☒ YES ☐ NO CHAINS ☒ YES ☐ NO OPERATING NUT ☒ YES ☐ NO PAINT ☒ YES ☐ NO

ACCESSIBILITY

HYDRANT ☒ YES ☐ NO GATE VALVE ☒ YES ☐ NO

WATER CLARITY: CLEAR

REMARKS

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH-1547	302 25th ST	72	37		
RH-					
RH-					
RH-					
RH-					

Hydrant Test Form

City of Santa Monica

TEST #	DATE	TIME	CITY/AREA	PRESSURE ZONE	MAIN SIZE
4	12/31/13	9:35 ☒ A.M. ☐ P.M.		500	12"

TESTER NAME(S): A. ESPARZA, T. Dodson

TEST CONDITIONS/REMARKS: NORMAL

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	PITOT PRESSURE (PSI)	GAGE NUMBER	NOMINAL ORIFICE SIZE (in)	OBSERVED DISCHARGE (GPM)
FH- 364	151 ESPARTA	92	34	28			2580 - Residual Pressure

2280 - Pitot PSI

HYDRANT BODY TYPE: ☐ RICH ☐ CLOW ☐ GREENBERG ☐ LONG BEACH ☐ WHARF ☒ OTHER Jones

COEFFICIENT OF DISCHARGE: .90

NUMBER OF OUTLETS: 2

OUTLET SIZE (INSIDE DIAMETER IN INCHES - CHECK OUTLET FLOW TESTED): ☒ 1ST 2.5" ☒ 2ND 4" ☐ 3RD

BODY APPEARANCE (CHECK YES IF OK): CAPS ☒ YES ☐ NO THREADS ☒ YES ☐ NO CHAINS ☒ YES ☐ NO OPERATING NUT ☒ YES ☐ NO PAINT ☒ YES ☐ NO

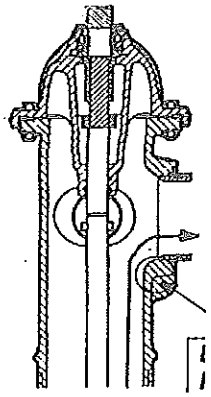
ACCESSIBILITY: HYDRANT ☒ YES ☐ NO GATE VALVE ☒ YES ☐ NO

WATER CLARITY: CLEAR

REMARKS:

HYDRANT NUMBER	LOCATION	STATIC PRESSURE (PSI)	RESIDUAL PRESSURE (PSI)	GAGE NUMBER	REMARKS
RH- 1149	1609 SAN VICENTE	82	26		
RH-					
RH-					
RH-					
RH-					

COMPUTATION TABLE



Flowing Capacities of Water-Free Flows Indicated in Gallons per Minute

Coefficient 1.0 - Inlet Edge Smooth/Round

Coefficient .88 - Inlet Edge Square/Sharp
Coefficient .77 - Inlet Edge Square/Raised
Coefficient 1.1 - for Open End Pipe

** All Results Rounded to Nearest 5 GPM*

PITOT GAUGE PSI	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	6"
1	60	110	170	245	330	435	550	680	980
2	85	150	240	345	470	615	775	960	1380
3	105	185	290	420	570	740	940	1160	1670
4	125	220	340	490	665	870	1100	1360	1960
5	135	240	380	545	745	960	1220	1520	2190
6	150	260	410	590	805	1050	1340	1640	2360
7	160	280	440	635	860	1140	1440	1760	2535
8	175	310	480	690	940	1220	1540	1920	2765
9	180	320	500	720	980	1290	1640	2000	2880
10	190	340	530	765	1040	1360	1730	2120	3050
11	200	355	555	800	1090	1420	1800	2220	3195
12	210	370	580	835	1135	1490	1890	2320	3340
13	220	390	605	870	1185	1550	1960	2420	3485
14	230	405	630	910	1235	1610	2040	2520	3625
15	235	415	650	935	1275	1665	2105	2600	3745
16	240	430	670	965	1315	1720	2180	2680	3860
17	250	440	690	995	1350	1770	2235	2760	3975
18	255	455	710	1020	1390	1830	2310	2840	4090
19	265	465	730	1050	1430	1870	2365	2920	4205
20	270	480	750	1080	1470	1920	2430	3000	4320
22	285	505	790	1140	1550	2020	2550	3160	4550
24	295	525	820	1180	1605	2110	2660	3280	4720
26	310	550	860	1240	1685	2190	2770	3440	4950
28	320	570	890	1280	1745	2280	2880	3560	5125
30	330	590	920	1325	1805	2350	2980	3680	5295
32	340	610	950	1370	1860	2430	3080	3800	5470
34	355	625	980	1410	1920	2510	3170	3920	5640
36	365	645	1010	1455	1980	2580	3260	4040	5815
38	375	665	1040	1500	2040	2650	3350	4160	5990
40	380	680	1060	1525	2075	2720	3440	4240	6105
42	395	700	1090	1570	2135	2780	3520	4360	6275
44	400	710	1110	1600	2175	2850	3610	4440	6390
46	410	730	1140	1640	2235	2920	3690	4560	6565
48	420	740	1160	1670	2275	2980	3770	4640	6680
50	430	760	1190	1715	2330	3040	3860	4760	6850
52	435	775	1210	1740	2370	3100	3940	4840	6965
54	445	785	1230	1770	2410	3160	4010	4920	7080
56	450	800	1250	1800	2500	3220	4080	5000	7200
58	460	820	1280	1845	2510	3280	4160	5120	7370

JOSEPH G. POLLARD CO., INC.

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COMPUTATION TABLE
(CONTINUED)

PITOT GAUGE

PSI	1-1/2"	2"	2-112"	3"	3-1/2"	4"	4-1/2"	5"	6"6
60	470	830	1300	1870	2550	3330	4230	5200	7484
62	480	850	1320	1905	2595	3380	4290	5295	7625
64	485	860	1340	1940	2635	3435	4360	5380	7750
66	490	875	1360	1970	2680	3490	4425	5460	7870
68	500	890	1385	1995	2720	3540	4490	5545	7985
70	505	900	1405	2025	2755	3595	4560	5630	8100
72	515	910	1425	2055	2795	3645	4620	5705	8220
74	520	925	1445	2080	2835	3695	4685	5785	8330
76	530	940	1465	2110	2875	3745	4750	5860	8440
78	535	950	1480	2140	2910	3795	4810	5940	8555
80	540	960	1500	2165	2950	3840	4870	6015	8660
82	550	975	1520	2190	2985	3890	4930	6090	8770
84	555	985	1540	2220	3020	3935	4990	6165	8875
86	560	1000	1555	2245	3055	3985	5050	6240	8980
88	570	1010	1575	2270	3090	4030	5110	6310	9085
90	575	1020	1590	2300	3125	4075	5170	6380	9190
92	580	1030	1610	2320	3160	4120	5225	6450	9290
94	590	1045	1625	2345	3195	4165	5280	6520	9390
96	595	1055	1645	2370	3230	4210	5340	6590	9490
98	600	1065	1660	2400	3260	4250	5390	6660	9590
100	605	1075	1680	2420	3295	4295	5450	6725	9685
102	610	1090	1695	2445	3330	4340	5500	6790	9780
104	620	1100	1710	2470	3360	4380	5555	6860	9875
106	625	1110	1730	2495	3395	4425	5610	6925	9970
108	630	1120	1745	2515	3425	4465	5660	6990	10065
110	635	1130	1760	2540	3455	4505	5715	7055	10160
112	640	1140	1775	2560	3490	4545	5765	7120	10250
114	645	1150	1790	2585	3520	4585	5815	7180	10340
116	650	1160	1810	2610	3550	4625	5870	7240	10430
118	660	1170	1825	2630	3580	4665	5920	7305	10520
120	665	1180	1840	2650	3610	4705	5970	7370	10610
122	670	1190	1855	2675	3640	4745	6020	7430	10695
124	675	1200	1870	2695	3670	4785	6055	7490	10785
126	680	1210	1885	2720	3700	4820	6115	7550	10870
128	685	1220	1900	2740	3730	4860	6160	7610	10955
130	690	1230	1915	2760	3760	4900	6210	7670	11040
132	695	1235	1930	2780	3785	4935	6260	7725	11125
134	700	1245	1945	2805	3815	4970	6305	7785	11210
136	705	1255	1955	2825	3845	5010	6350	7840	11295
138	710	1265	1970	2845	3870	5045	6400	7900	11375
140	715	1270	1985	2865	3900	5085	6445	7960	11460
142	720	1280	2000	2885	3930	5120	6490	8015	11540
144	725	1290	2015	2905	3955	5155	6540	8070	11620
146	730	1300	2030	2925	3980	5190	6580	8125	11700
148	735	1310	2040	2945	4010	5225	6630	8180	11780
150	740	1320	2055	2965	4035	5260	6670	8235	11860
152	745	1330	2070	2985	4065	5295	6715	8290	11940
154	750	1335	2080	3005	4090	5330	6760	8350	12020
156	755	1345	2095	3025	4115	5365	6805	8400	12095
158	760	1350	2110	3045	4140	5400	6850	8450	12170
160	765	1360	2120	3060	4170	5435	6890	8510	12250

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Santa Monica Sustainable Water Master Plan
Hydrant Testing Results
1283015*00

Test ID	Date	Time	Test Location	Pipe Type	Pipe Age	Pipe Dia (in)	PZ	Flowing Hydrant	Residual Hydrants	Model Elevation (ft)	Static OBSERVED (psi)	Static OBSERVED HGL (ft) (calculated)	Static SIMULATED (psi)	Static SIMULATED HGL (ft)	Difference (psi)	% Difference	OBSERVED Discharge (gpm)	Residual OBSERVED (psi)	Residual OBSERVED HGL (ft) (calculated)	Residual SIMULATED (psi) without Resolution	Residual SIMULATED HGL (ft)	Difference (psi)	Difference (head)	% Difference (psi)	% Difference (head)	Notes from 10/13/12	Test Rating	Notes
Test 1	2/5/2013	11:30 AM	**Justin Joseph:** MWD 2700 Arc PS 3470 PRV6 1520 gpm 250Flow 2000 Res HGL 510	ACP	1972	6	500	FH-1		259.98	106	505	103.63	499.37	2.37	2.2%	1,360	20	306	25.92	319.86	5.92	13.68	30%			4.0	5 - Great 4 - Pretty Good 3 - Ok 2 - Poor 1 - Nothing
									RH-1A	276.39	94	494	96.52	499.35	2.52	2.7%		26	336	53.49	399.95	27.49	63.50	106%		**Pipes set to original diameter**		
									RH-1B	299.27	86	498	87.29	500.91	1.29	1.5%		30	369	81.27	487.00	51.27	118.43	171%		**FCV set to 158 gpm**		
									RH-1C	326.85	78	507	74.67	499.34	3.33	4.3%		34	405	70.18	488.97	36.18	83.58	106%		**Negative pressures indicate that not all valves were closed. Results are with one valve open at NW end of test.**		
Test 2	2/5/2013	1:30 PM	**Justin Joseph:** MWD 2700 Arc PS 3350 250Flow 2000 PRV6 1590 gpm Res HGL 510	DIP	1999	8	500	FH-2		306.00	76	482	81.22	493.62	5.22	6.9%	1,665	15	341	31.53	378.83	16.53	38.18	110%	11%		3.0	
									RH-2A	327.10	65	477	72.09	493.63	**7.09**	**10.9%**		48	438	36.56	411.55	11.44	26.43	**24%**	**6%**			
									RH-2B	333.70	60	472	69.23	493.62	**9.23**	**15.4%**		50	449	51.13	451.81	1.13	2.61	2%	1%			
									RH-2C	315.30	70	477	77.20	493.63	**7.20**	**10.3%**		62	459	63.68	462.40	1.68	3.88	3%	1%			
									RH-2E	343.50	54	468	64.98	493.60	**10.98**	**20.3%**		**50**	459	63.26	489.63	13.26	30.63	27%	7%			
																										FCV set to zero.		
Test 3	2/5/2013	10:15 AM	**Justin Joseph:** MWD 2850 Arc PS 3470 250Flow 2000 PRV6 1800 gpm Res HGL 503	ACP	1979	8	500	FH-3		361.07	57	493	52.92	483.32	4.08	7.2%	1,490	20	407	8.87	381.56	11.13	25.71	56%	6%		1.0	
									RH-3A	340.51	57	472	61.83	483.34	4.83	8.5%		28	405	66.70	494.59	38.70	89.40	138%	22%			
									~~RH-3B~~									~~36~~	~~83~~									
									~~RH-3C~~									~~58~~	~~134~~									
									~~RH-3D~~									~~54~~	~~125~~									
									RH-3E	314.17	66	467	73.25	483.38	**7.25**	**11.0%**		58	448	78.12	494.63	20.12	46.48	35%	10%			
																										FCV set to 580 gpm.		
Test 4	2/5/2013	9:00 AM	**Justin Joseph:** MWD 3000 Arc PS 3470 250Flow 1920 PRV6 1600 gpm Res HGL 502.5	CIP	1956	8	500	FH-4		233.23	106	478	108.14	483.03	2.14	2.0%	870	12	261	80.48	419.14	68.48	158.19	571%	61%		2.0	
									RH-4A	247.59	102	483	101.91	483.00	0.09	0.1%		6	261	78.42	428.74	72.42	167.29	1207%	64%			
									RH-4B	256.68	94	474	97.98	483.01	3.98	4.2%		6	271	77.58	435.89	71.58	165.35	1193%	61%			
									RH-4C	260.02	92	473	96.53	483.00	4.53	4.9%		**16**	297	77.96	440.11	61.96	143.13	387%	48%			
									RH-4D	283.25	88	487	86.46	482.97	1.54	1.8%		8	302	76.95	461.00	68.95	159.27	862%	53%			
									RH-4E	272.43	86	471		272.43	86.00	100.0%		80	457	84.72	468.13	4.72	10.90	6%	2%			
																										FCV set to 1400 gpm.		
Test 5	2/7/2013	1:00 PM	**Justin Joseph:** MWD 1700 Arc PS 3450 250Flow 1950 PRV6 590 gpm Res HGL 487	CIP-CL	1954	8	500	FH-5		282.63	84	477	85.63	480.44	1.63	1.9%	1,050	12	310	78.39	463.71	66.39	153.36	553%	49%		1.5	
									RH-5A	290.00	79	472	82.44	480.44	3.44	4.4%		48	401	76.54	466.81	28.54	65.93	59%	16%			
									RH-5B	298.08	77	476	78.94	480.43	1.94	2.5%		46	404	74.33	469.78	28.33	65.44	62%	16%			
									RH-5C	303.15	70	465	76.74	480.42	**6.74**	**9.6%**		44	405	73.53	473.00	29.53	68.21	67%	17%			
																										FCV set to zero.		
Test 6	2/7/2013	10:30 AM	**Justin Joseph:** MWD 1700 Arc PS 3460 250Flow 2020 PRV6 500 gpm Res HGL 488	DIP	1986	12	500	FH-6		253.38	96	475	98.75	481.49	2.75	2.9%	2,240	38	341	77.24	431.80	39.24	90.64	103%	27%		1.5	
									RH-6A	263.59	90	471	94.33	481.49	4.33	4.8%		40	356	74.73	436.22	34.73	80.23	87%	23%			
									~~RH-6B~~		~~89~~	-						~~40~~	-		-	40.00		100%				
									RH-6C	273.68	86	472	89.96	481.49	3.96	4.6%		38	361	74.46	445.68	36.46	84.22	96%	23%			
									RH-6D	279.81	80	465	87.30	481.47	**7.30**	**9.1%**		38	368	73.48	449.55	35.48	81.96	93%	22%			
																										FCV set to zero.		
Test 7	2/7/2013	2:45 PM	**Justin Joseph:** MWD 1715 Arc PS 3720 250Flow 1800 PRV6 130 gpm Res HGL 487	ACP	1985	8	350	FH-7		149.99	80	335	79.91	334.58	0.09	0.1%	1,770	27	212	24.55	206.70	2.45	5.66	9%	3%		3.0	
									RH-7A	155.46	77	333	77.54	334.58	0.54	0.7%		38	243	32.20	229.84	5.80	13.40	15%	6%			
									RH-7B	161.18	77	339	75.06	334.57	1.94	2.5%		40	254	41.56	257.18	1.56	3.60	4%	1%			
									RH-7C	174.31	70	336	69.37	334.55	0.63	0.9%		46	281	53.40	297.66	7.40	17.09	16%	6%			
									RH-7D	177.89	67	333	67.82	334.55	0.82	1.2%		47	286	55.73	306.63	8.73	20.17	19%	7%			
									RH-7E	183.37	65	334	65.45	334.56	0.45	0.7%		**40**	276	63.12	329.18	23.12	53.41	58%	19%			
Test 8	2/7/2013	9:30 AM	**Justin Joseph:** MWD 1715 Arc PS 3470 250Flow 2100 PRV6 0 gpm Res HGL 489	CIP-CL	1955	8	250	FH-8		16.50	96	238	93.58	232.67	2.42	2.5%	1,720	26	77	**26.31**	77.28	0.31	0.72	1%	1%		4.0	
									RH-8A	21.30	94	238	91.50	232.67	2.50	2.7%		46	128	46.72	129.22	0.72	1.66	2%	1%			
									RH-8B	22.37	95	242	91.04	232.67	3.96	4.2%		62	166	57.79	155.86	4.21	9.73	7%	6%			
									RH-8C	20.27	92	233	91.95	232.67	0.05	0.1%		78	200	70.13	182.27	7.87	18.18	10%	9%			
Test 9	2/12/2013	9:00 AM	**Justin Joseph:** MWD 1720 Arc PS 0 250Flow 2020 PRV6 0 gpm Res HGL 488	ACP	1976	8	250	FH-9		129.08	**55**	256	45.98	235.29	**9.02**	**16.4%**	1,050	15	164	**29.13**	196.37	**14.13**	**32.64**	**94%**	**20%**		3.0	
									RH-9A	131.88	**50**	247	44.76	235.28	**5.24**	**10.5%**		12	160	**31.80**	205.34	**19.80**	**45.74**	**165%**	**29%**			
									RH-9B	136.07	**50**	252	42.95	235.28	**7.05**	**14.1%**		16	173	**33.70**	213.92	**17.70**	**40.89**	**111%**	**24%**			
									RH-9C	139.95	**40**	232	41.27	235.28	1.27	3.2%		18	182	**35.76**	222.56	**17.76**	**41.03**	**99%**	**23%**			
									RH-9D	142.65	**40**	235	40.10	235.28	0.10	0.3%		21	191	**38.20**	230.89	**17.20**	**39.73**	**82%**	**21%**			
Test 10	2/12/2013	6:00 AM	**Justin Joseph:** MWD 1780 Arc PS 4360 250Flow 1630 PRV6 200 gpm Res HGL 487.5	CIP-CL	1963	8	350	FH-10		149.31	87	350	80.50	335.27	6.50	7.5%	2,550	54	274	**13.44**	180.36	**40.56**	**93.69**	**75%**	**34%**		2.0	
									~~RH-10A~~		~~84~~	-		–				~~68~~	–		–							
									RH-10B	150.54	84	345	79.97	335.27	4.03	4.8%		68	308	**29.78**	219.33	**38.22**	**88.29**	**56%**	**29%**			
									RH-10C	151.85	85	348	79.40	335.26	5.60	6.6%		72	318	**47.12**	260.70	**24.88**	**57.47**	**35%**	**18%**			
									RH-10D	155.32	80	340	77.89	335.25	2.11	2.6%		73	324	63.36	301.68	9.64	22.27	13%	7%			
									RH-10E	159.36	80	344	76.14	335.24	3.86	4.8%		78	340	74.67	331.85	3.33	7.69	4%	2%			
Test 11	2/12/2013	11:00 AM	**Justin Joseph:** MWD 1700 Arc PS 4550 250Flow 1910 PRV6 0 gpm Res HGL 488.5	CIP		8	250	FH-11		50.78	80	236	78.86	232.95	1.14	1.4%	1,770	28	115	35.61	133.04	7.61	17.58	27%	15%		5.0	
									RH-11A	56.39	78	237	76.43	232.94	1.57	2.0%		52	177	54.82	183.02	2.82	6.51	5%	4%			
									RH-11B	56.71	78	237	76.30	232.96	1.70	2.2%		60	195	64.55	205.82	4.55	10.51	8%	5%			
									RH-11C	58.84	74	230	75.39	232.99	1.39	1.9%		71	223	73.90	229.55	2.90	6.70	4%	3%			
Test 12	2/12/2013	1:30 PM	**Justin Joseph:** MWD 1720 Arc PS 4540 250Flow 1890 PRV6 0 gpm Res HGL 493	CIP-CL	1966	6	350	FH-12		160.00	78	340	76.86	337.55	1.14	1.5%	1,140	8	178	3.56	168.22	4.44	10.26	56%	6%		3.0	
									RH-12A	168.24	77	346	73.29	337.54	3.71	4.8%		33	244	25.68	227.56	7.32	16.91	22%	7%			
									RH-12B	175.62	72	342	70.10	337.55	1.90	2.6%		44	277	41.79	272.15	2.21	5.11	5%	2%			
									RH-12C	183.15	71	347	66.83	337.53	4.17	5.9%		55	310	56.24	313.06	1.24	2.86	2%	1%			
									RH-12D	186.14	70	348	65.54	337.54	4.46	6.4%		67	341	62.60	330.75	4.40	10.16	7%	3%			
									RH-12E																			
Test 13	2/14/2013	10:15 AM	**Justin Joseph:** MWD 1760 Arc PS 4680 250Flow 2090 PRV6 0 gpm Res HGL 487	DIP	201	8	350	FH-13		155.27	80	340	77.36	333.97	2.64	3.3%	1,490	12	183	**53.40**	278.62	**41.40**	**95.63**	**345%**	**52%**		1.0	
									~~RH-13A~~		~~80~~	-						~~20~~	–		-							
									RH-13B	153.46	79	336	78.15	333.99	0.85	1.1%		25	211	**65.03**	303.68	**40.03**	**92.47**	**160%**	**44%**			
									RH-13C	151.93	80	337	78.81	333.98	1.19	1.5%		32	226	**77.77**	331.58	**45.77**	**105.73**	**143%**	**47%**			

Santa Monica Sustainable Water Master Plan
Hydrant Testing Results
1283015*00

Test ID	Date	Time	Test Location	Pipe Type	Pipe Age	Pipe Dia (in)	PZ	Flowing Hydrant	Residual Hydrants	Model Elevation (ft)	Static OBSERVED (psi)	Static OBSERVED HGL (ft) (calculated)	Static SIMULATED (psi)	Static SIMULATED HGL (ft)	Difference (psi)	% Difference	OBSERVED Discharge (gpm)	Residual OBSERVED (psi)	Residual OBSERVED HGL (ft) (calculated)	Residual SIMULATED (psi) without Resolution	Residual SIMULATED HGL (ft)	Difference (psi)	Difference (head)	% Difference (psi)	% Difference (head)	Notes from 10/13/12	Test Rating	Notes
Test 14	2/14/2013	9:00 AM	**Justin Joseph:** MWD 1710 Arc PS 0 250Flow 2080 PRV6 510 gpm Res HGL 489	ACP	1984	8	350	FH-14		164.87	80	350	71.89	330.94	8.11	10.1%	1,490	18	206	32.93	240.94	14.93	34.49	83%	17%		2.0	
									RH-14A	166.15	82	356	71.34	330.95	10.66	13.0%		22	217	43.81	267.35	21.81	50.38	99%	23%			
									RH-14B	157.71	74	329	74.99	330.94	0.99	1.3%		31	229	52.57	279.15	21.57	49.83	70%	22%			
									RH-14C	154.75	70	316	76.27	330.93	6.27	9.0%		38	243	58.82	290.62	20.82	48.09	55%	20%			
									RH-14D	150.20																		
Test 15	2/14/2013	1:30 PM	**Justin Joseph:** MWD 1720 Arc PS 6240 250Flow 1560 PRV6 0 gpm Res HGL 489	CIP		8	250	FH-15		121.05	49	234	48.60	233.32	0.40	0.8%	870	4	130	39.30	211.83	35.30	81.54	883%	63%		2.0	
									RH-15A	115.36	53	238	51.07	233.33	1.93	3.6%		29	182	43.27	215.31	14.27	32.96	49%	18%			
									RH-15B	111.66	51	229	52.67	233.33	1.67	3.3%		39	202	49.66	226.37	10.66	24.62	27%	12%			
									RH-15C	109.60	54	234	53.57	233.35	0.43	0.8%		53	232	53.00	232.03	0.00	0.00	0%	0%			
Test 16	3/4/2013	1:30 PM	**Justin Joseph:** MWD 2410 Arc PS 3630 250Flow 1800 PRV6 500 gpm Res HGL 505	CIP-CL	1964	6 AND 8	250	FH-16		100.90	56	230	58.16	235.25	2.16	3.9%	1,360	18	142	0.27	101.52	17.73	40.96	99%	29%		2.0	
									RH-16A	115.84	55	243	51.68	235.22	3.32	6.0%		39	206	16.23	153.33	22.77	52.60	58%	26%			
									RH-16B	118.38	52	239	50.58	235.22	1.42	2.7%		39	208	37.87	205.86	1.13	2.61	3%	1%			
									RH-16C	120.00	50	236	49.88	235.22	0.12	0.2%		46	226	47.84	230.51	1.84	4.25	4%	2%			
Test 17	2/27/2013	9:00 AM	**Justin Joseph:** MWD 2840 Arc PS 0 250Flow 1880 PRV6 610 gpm Res HGL 513	CIP-CL	1924	8	250	FH-17		97.56	58	232	58.37	232.39	0.37	0.6%	1,220	10	121	35.16	178.78	25.16	58.12	252%	48%		4.0	
									RH-17A	96.83	58	231	58.69	232.40	0.69	1.2%		39	187	35.04	177.77	3.96	9.15	10%	5%			
									RH-17B	91.43	62	235	61.03	232.41	0.97	1.6%		46	198	42.21	188.94	3.79	8.75	8%	4%			
									RH-17C	86.67	64	235	63.09	232.41	0.91	1.4%		50	202	49.85	201.82	0.15	0.35	0%	0%			
									~~RH-17D~~		~~70~~	~~162~~						~~63~~										
									RH-17E	76.79	66	229	67.37	232.41	1.37	2.1%		62	220	65.84	228.88	3.84	8.87	6%	4%			
Test 18	2/20/2013	9:00 AM	**Justin Joseph:** MWD 1690 Arc PS 0 250Flow 2150 PRV6 0 gpm Res HGL 488.5	DIP	1984	8	350	FH-18		94.21	60	233	59.88	232.53	0.12	0.2%	2,150	36	177	29.54	162.45	6.46	14.92	18%	8%		5.0	
									RH-18A	81.58	60	220	65.16	232.10	5.16	8.6%		50	197	52.48	202.81	2.48	5.73	5%	3%			
									RH-18B	65.88	70	228	71.96	232.11	1.96	2.8%		68	223	66.57	219.66	1.43	3.30	2%	1%			
									RH-18C	65.51	72	232	72.12	232.11	0.12	0.2%		67	220	70.46	228.27	3.46	7.99	5%	4%			
Test 19	2/27/2013	10:45 AM	**Justin Joseph:** MWD 2810 Arc PS 3630 250Flow 1870 PRV6 700 gpm Res HGL 516	DIP	1989	8	250	FH-19		89.86	60	228	61.86	232.76	1.86	3.1%	1,890	26	150	7.07	106.19	18.93	43.73	73%	29%		1.0	
									~~RH-19A~~		~~67~~	~~-~~						~~47~~	~~-~~		~~-~~							
									RH-19B	77.97	82	267	67.01	232.76	14.99	18.3%		74	249	31.63	151.04	42.37	97.87	57%	39%			
									RH-19C	88.03	68	245	62.66	232.77	5.34	7.9%		62	231	31.50	160.80	30.50	70.46	49%	30%			
									RH-19D	81.88	69	241	65.32	232.77	3.68	5.3%		62	225	46.82	190.03	15.18	35.07	24%	16%			
									RH-19E	58.60	76	234	75.41	232.80	0.59	0.8%		72	225	71.67	224.16	0.33	0.76	0%	0%			
Test 20	2/20/2013	10:00 AM	**Justin Joseph:** MWD 1700 Arc PS 4480 250Flow 1910 PRV6 0 gpm Res HGL 488.5	ACP	1960	8	250	FH-20		43.97	82	233	81.61	232.49	0.39	0.5%	2,190	26	104	33.14	120.52	7.14	16.49	27%	16%		3.0	
									RH-20A	41.91	82	231	82.51	232.51	0.51	0.6%		42	139	54.16	167.02	12.16	28.09	29%	20%			
									RH-20B	39.12	82	229	83.72	232.51	1.72	2.1%		52	159	70.34	201.61	18.34	42.37	35%	27%			
									RH-20C	39.94	82	229	83.36	232.50	1.36	1.7%		61	181	78.84	222.06	17.84	41.21	29%	23%			
Test 21	2/20/2013	11:00 AM	**Justin Joseph:** MWD 1670 Arc PS 4480 250Flow 1740 PRV6 0 gpm Res HGL 490	CIP		6	350	FH-21		142.76	82	332	81.25	330.45	0.75	0.9%	615	2	147	58.16	277.11	56.16	129.73	2808%	88%		3.0	
									RH-21A	142.21	82	332	81.49	330.45	0.51	0.6%		72	309	63.10	287.97	8.90	20.56	12%	7%			
									RH-21B	142.00	81	329	81.58	330.45	0.58	0.7%		72	308	69.18	301.81	2.82	6.51	4%	2%			
									RH-21C	139.92	82	329	82.49	330.47	0.49	0.6%		80	325	75.01	313.19	4.99	11.53	6%	4%			
Test 22	3/6/2013	1:30 PM	**Justin Joseph:** MWD 2380 Arc PS 0 250Flow 1590 PRV6 250 gpm Res HGL 508	CIP	1924	~~8~~ 6	350	FH-22		135.80	87	337	85.46	333.21	1.54	1.8%	400	0	136	74.09	306.95	73.99	170.92	73990%	126%		2.0	
									RH-22A	133.95	86	333	86.26	333.21	0.26	0.3%		20	180	77.57	313.14	57.57	132.99	288%	74%			
									RH-22B	137.97	87	339	84.52	333.21	2.48	2.9%		22	189	78.50	319.31	56.50	130.52	257%	69%			
									RH-22C	139.86	85	336	83.70	333.21	1.30	1.5%		26	200	79.02	322.40	53.02	122.48	100%	61%			
Test 23	2/27/2013	1:30 PM	**Justin Joseph:** MWD 2820 Arc PS 0 250Flow 2170 PRV6 1270 gpm Res HGL 513.5	CIP	1961	8	350	FH-23		155.95	74	327	75.25	329.78	1.25	1.7%	1,820	30	225	32.31	230.59	2.31	5.34	8%	2%		5.0	
									RH-23A	151.68	74	323	77.10	329.78	3.10	4.2%		46	258	44.93	255.47	1.07	2.47	2%	1%			
									RH-23B	152.63	74	324	76.69	329.78	2.69	3.6%		58	287	55.30	280.37	2.70	6.24	5%	2%			
									RH-23C	147.90	74	319	78.74	329.79	4.74	6.4%		68	305	67.57	303.99	0.43	0.99	1%	0%			
Test 24	2/20/2013	1:30 PM	**Justin Joseph:** MWD 1690 Arc PS 4460 250Flow 1850 PRV6 0 gpm Res HGL 503	DIP	1995	8	350	FH-24		161.44	76	337	73.89	332.13	2.11	2.8%	1,830	32	235	33.48	238.78	1.48	3.42	5%	1%		4.0	
									RH-24A	166.52	74	337	71.69	332.12	2.31	3.1%		50	282	43.60	267.24	6.40	14.78	13%	5%			
									RH-24B	169.88	72	336	70.23	332.11	1.77	2.5%		54	295	55.27	297.55	1.27	2.93	2%	1%			
									RH-24C	171.93	72	338	69.35	332.13	2.65	3.7%		60	311	67.04	326.79	7.04	16.26	12%	5%			

Santa Monica Sustainable Water Master Plan
Hydrant Testing Results
1283015*00

Test ID	Date	Time	Test Location	Pipe Type	Pipe Age	Pipe Dia (in)	PZ	Flowing Hydrant	Residual Hydrants	Model Elevation (ft)	Static OBSERVED (psi)	Static OBSERVED HGL (ft) (calculated)	Static SIMULATED (psi)	Static SIMULATED HGL (ft)	Difference (psi)	% Difference	OBSERVED Discharge (gpm)	Residual OBSERVED (psi)	Residual OBSERVED HGL (ft) (calculated)	Residual SIMULATED (psi) without Resolution	Residual SIMULATED HGL (ft)	Difference (psi)	Difference (head)	% Difference (psi)	% Difference (head)	Notes
Test 1	12/31/2013	7:40 AM				6	500	FH-1		297.70	82	487	80.13	482.80	1.87	2.3%	1,720	16	335	73.95	468.52	57.95	133.86	362%	40%	
									RH-1A	259.98	95	479	96.38	482.62	1.38	1.5%		46	366	95.32	480.17	49.32	113.93	107%	31%	
Test 2	12/31/2013	8:10 AM				8	500	FH-2		230.79	106	476	111.16	487.57	5.16	4.9%	2,350	30	300	104.11	471.28	74.11	171.19	247%	57%	
									RH-2A	230.71	106	476	111.21	487.61	5.21	4.9%		45	335	108.27	480.81	63.27	146.15	141%	44%	
Test 3	12/31/2013	8:50 AM				8	500	FH-3		313.62	74	485	70.12	475.60	3.88	5.2%	1,920	20	360	53.00	436.05	33.00	76.23	165%	21%	
									RH-3A	331.10	72	497	62.56	475.61	9.44	13.1%		37	417	48.00	441.98	11.00	25.41	30%	6%	
Test 4	12/31/2013	9:35 AM				12	500	FH-4		263.59	92	476	91.67	475.35	0.33	0.4%	2,580	36	347	64.00	411.43	28.00	64.68	78%	19%	
									RH-4A	287.88	82	477	81.14	475.31	0.86	1.0%		26	348	56.00	417.24	30.00	69.30	115%	20%	

Test Rating	Notes
	5 - Great
	4 - Pretty Good
	1 - Nothing

Appendix G: Miscellaneous Technical Analysis Support Material

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Santa Monica Sustainable Water Master Plan

Existing Conditions

Cost per gallon =	1.35

Model Storage Analysis - Existing Demand Conditions

Location Zone	Tank	Tank Label	Existing Storage Capacity (MG)	MDD (gpm) (ADD * X.XX) 1.54	MDD (MGD)	Max FF Requirement (gpm)	Required Storage Volume (MG): Operational Storage (XX% MDD) 30%	Emergency Storage (XX% MDD) 100%	Fire Storage (Xhr * FF) 5	Total Storage Needed	Shortage/Surplus	
500	None		0.00	1513	2.18	5000	0.65	2.18	1.50	4.33	(4.33)	$ -
	San Vicente Reservoir		5.00									
	Mt. Olivette Reservoir		3.50									
	Riviera Reservoir		22.40									
350	Total		30.90	6688	9.63	5000	2.89	9.63	1.50	14.02	16.88	$ -
	Arcadia Reservoir		5.00									
250	Total		5.00	3629	5.23	5000	1.57	5.23	1.50	8.29	13.59	$ -
Totals			35.90	11829	17.03		5.11	17.03	4.50	26.64	9.26	
											Total	$ -

* Cost per gallon includes 35% for design, environmental, survey, permits and construction management.

* Surplus storage for the 350 zone is assumed to be available for the 250 zone, and is included in the shortage/surplus calculation for the 250 zone.

Santa Monica Sustainable Water Master Plan

Future Conditions

Cost per gallon =	1.35

Model Storage Analysis - Future Demand Conditions

Location Zone	Tank	Tank Label	Existing Storage Capacity (MG)	MDD (gpm) (ADD * X.XX) 1.54	MDD (MGD)	Max FF Requirement (gpm)	Required Storage Volume (MG): Operational Storage (XX% MDD) 30%	Emergency Storage (XX% MDD) 100%	Fire Storage (Xhr * FF) 5	Total Storage Needed	Shortage/Surplus	
500	None		0.00	1906	2.74	5000	0.82	2.74	1.50	5.07	(5.07)	$ -
	San Vicente Reservoir		5.00									
	Mt. Olivette Reservoir		3.50									
	Riviera Reservoir		22.40									
350	Total		30.90	8680	12.50	5000	3.75	12.50	1.50	17.75	13.15	$ -
	Arcadia Reservoir		5.00									
250	Total		5.00	4937	7.11	5000	2.13	7.11	1.50	10.74	7.41	$ -
Totals			35.90	15523	22.35		6.71	22.35	4.50	33.56	2.34	
											Total	$ -

* Cost per gallon includes 35% for design, environmental, survey, permits and construction management.

* Surplus storage for the 350 zone is assumed to be available for the 250 zone, and is included in the shortage/surplus calculation for the 250 zone.

Santa Monica Sustainable Water Master Plan

Existing Conditions

Model Pumping Analysis - Existing Demand Conditions															
				Existing Pumping Capacity											
Discharge Zone	**Pump**	**HP**	**GPM**	**Total (mgd)**	**Firm (mgd)**	**MDD Pump Cap (mgd) 16hr Repl.**	**Peak Hour Pump Cap (gpm)**	**Fire Flow Capacity Required (gpm)**	**Firm Capacity Needed (mgd)**	**Firm Capacity Needed (gpm)**	**Approximate TDH (ft)**	**Calculated HP**	**Esimtated Cost**	**CIP Priority**	**Note**
500	San Vicente Pump #2	50	1000	1.44	1.44						144				
500	San Vicente Pump #3	40	1100	1.58	1.58						155				
500	San Vicente Pump #4	150	2500	3.60	3.60						150				
500	San Vicente Pump #5	150	2500	3.60	0.00						150				
Zone 500 Total				**10.22**	**6.62**	4.36	2570	3500	**0.00**	**0.00**	**150**	**0**	**$ -**	3	
350	Arcadia #1	75	2000	2.88	2.88						125				
350	Arcadia #2	150	3500	5.04	5.04						180				
350	Arcadia #3	50	3600	5.18	0.00						42				
350	Arcadia #4	100	2000	2.88	2.88						125				
350	Arcadia #5	150	3500	5.04	5.04						125				
350	Santa Monica Well #1	50	250	0.36	0.36						200				
Zone 350 Total				**21.38**	**16.20**	19.26	11370	5000	**3.06**	**2126**	**125**	**67**	**$ 1,315,000**	3	350 Zone Only
350 / 250	Total Available Pumping Capacity			21.38											
Zone 350 + 250 Total				**21.38**		29.71	17540	5000	**8.33**	**5783**	**125**	**183**	**$ 2,154,000**		250 & 350 Zones
250	None														
Zone 250 Total				**0.00**	**0.00**	10.45	6170	5000		**0**	**0**	**0**	**$ -**		
												Total	**$ 2,154,000**		

*Cost is per HP as shown in New Pump Station Table

New Pump Station Cost

Size (hp)	Construction Cost ($/hp)	30% Engineering, Legal & Admin ($/hp)	20% Contingency ($/hp)	Total Cost ($/hp)
10	$22,500	$6,750	$4,500	$33,750
25	$18,000	$5,400	$3,600	$27,000
50	$15,000	$4,500	$3,000	$22,500
75	$12,000	$3,600	$2,400	$18,000
100	$9,000	$2,700	$1,800	$13,500
150	$7,500	$2,250	$1,500	$11,250
200	$7,200	$2,160	$1,440	$10,800
250	$6,750	$2,025	$1,350	$10,125
300	$6,300	$1,890	$1,260	$9,450
400	$6,000	$1,800	$1,200	$9,000
500	$5,550	$1,665	$1,110	$8,325
600	$5,250	$1,575	$1,050	$7,875
750 and larger	$4,800	$1,440	$960	$7,200

Note: Contingency is applied to construction cost only.

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