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CITY OF NEWPORT BEACH
CALIFORNIA

2019 Water Master Plan

April 29, 2019

WATER MASTER PLAN

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Our Ref.:

05317005.0000

Date:

April 29, 2019

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ACRONYMS AND ABBREVIATIONS

AACE	Association for the Advancement of Cost Estimating
ACP	Asbestos Cement Pipe
ADD	Average Day Demand
AF	Acre-feet
AFY	Acre-feet per year
BCR	Big Canyon Reservoir
BPP	Basin Pumping Percentage
CCC	California Coastal Commission
CDR	Center for Demographic Research
cfs	Cubic Feet per Second
CI	Cast Iron Pipe
CIP	Capital Improvement Program
City	City of Newport Beach
CoF	Consequence of Failure
CRA	Colorado River Aqueduct
CU	Copper Pipe
DEM	Digital Elevation Model
DIP	Ductile Iron Pipe
DU/ac	Dwelling Unit per acre
ENR CCI	Engineering News Record Construction Cost Index
EPS	Extended Period Simulation
EUL	Expected Useful Life
ft	Feet
gpad	Gallons per Acre per Day
gpm	Gallons per Minute
gpm/ac	Gallons per Minute per Acre
GIS	Geographic Information System
GS	Galvanized Steel Pipe
GUN	Gunited Steel Pipe
GWRS	Groundwater Replenishment System

HDPE	High Density Polyethylene
HPR	Hydrant Pressure Recorder
in	Inch
IRWD	Irvine Ranch Water District
LBCWD	Laguna Beach County Water District
LoF	Likelihood of Failure
MDD	Maximum Day Demand
MESA	Mesa Water District
MG	Million Gallons
mg/L	Milligrams per Liter
mgd	Million Gallons per Day
mi	Miles
MLCCSP	Mortar Lined Cement Coated Steel Pipe
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
NRW	Non-Revenue Water
OC Basin	Orange County Groundwater Basin
OCWD	Orange County Water District
PHD	Peak Hour Demand
PRS	Pressure Reducing Station
PRV	Pressure Reducing Valve
PS	Pump Station
psi	Pounds per Square Inch
PVC	Poly Vinyl Chloride
RCSCP	Reinforced Concrete Steel Cylinder Pipe
RRPS	Renewal and Replacement Planning System
SWP	State Water Project
TBL	Triple Bottom Line
TDS	Total Dissolved Solids
USGS	United States Geological Survey
UWMP	Urban Water Management Plan

VFD	Variable Frequency Drive
WMP	Water Master Plan

EXECUTIVE SUMMARY

Introduction

Background

The City of Newport Beach (City) provides water services to a population of approximately 66,000 over 11 square miles of the land located within its boundaries.

The City's last comprehensive Water Master Plan (WMP) was completed in 1999 followed by an update in 2008 to revise the hydraulic model and conduct additional modeling of completed pipeline improvement projects. Because there have been many changes since 1999 and 2008, the WMP needs to be updated again to reflect current water use and future infrastructure needs. The prolonged drought in California from 2010-2016 and Bay-Delta water reliability issues have been major drivers of regulatory changes in California water law. The Water Conservation Act of 2009 (Senate Bill X7-7) mandated urban water suppliers reduce water usage by 20 percent by 2020. The California Governor's State of Emergency ordered urban water suppliers to cut back water use with a collective state goal of 25 percent reduction (based on 2013 usage). Additionally, California passed Senate Bill 555 requiring urban water suppliers to submit a water loss audit annually beginning in 2016. Many changes are occurring, and the regulatory landscape is evolving in response.

Project Purpose and Scope

This 2019 WMP represents the City's water infrastructure planning efforts based on the new reality of the California water climate. The project began in 2017 with the following scope:

- Develop water demand projections and determine the impact of recent water consumption and resultant effect on system demand and peaking factors based on the most recent 10 years of water use trends (2007 – 2016).
- Incorporate the City's 2006 General Plan and subsequent amendments for land use projections and housing density into the water demand analysis.
- Develop a calibrated hydraulic model, using current water demands to analyze the City's water supply and distribution system.
- Conduct a risk analysis to provide the basis for a prioritized pipeline and facilities rehabilitation and replacement program.
- Develop and prioritize recommendations for system improvements over the next 30 years as part of the City's Capital Improvement Program (CIP).

Water Supply Analysis

The City relies on a combination of local groundwater and imported water to meet its potable water demands. Recycled water was added in 1997 to the City's water supply portfolio for irrigation purposes.

The City relies on 70 to 75 percent groundwater, 22 to 27 percent imported water, and approximately 3 percent recycled water. The City, along with the agencies managing the water supplies, ensure that a safe and high-quality water supply will be available during periods of drought or supply shortage.

Groundwater - The City's main water supply source is groundwater from the Orange County Groundwater Basin (OC Basin). Groundwater has been the least expensive and most reliable source of supply for the City. The City has four active wells that pump from the OC Basin. Orange County Water District (OCWD) is the entity that manages the OC Basin. OCWD regulates groundwater levels in the OC Basin by implementing and managing various aquifer recharge projects and by regulating the annual amount of pumping within a safe basin operating range to protect the long-term sustainability of the basin. Pumping is managed through a process that uses financial incentives referred to as Basin Pumping Percentage (BPP) to encourage groundwater producers to pump a sustainable amount of water.

Imported Water - The City supplements its local groundwater with imported water purchased from Metropolitan Water District of Southern California (MWD) through the Municipal Water District of Orange County (MWDOC). MWD's principal sources of water are the Colorado River via the Colorado River Aqueduct and the Lake Oroville watershed in northern California through the State Water Project. The water obtained from these sources is treated at the Robert B. Diemer Filtration Plant located in Yorba Linda for delivery to MWDOC customers.

Recycled Water - The City owns and operates recycled water pump stations for Big Canyon Country Club and the Newport Beach Country Club. In addition to these two sites, there are currently 12 other recycled water connections that supply three different customers. Recycled water is purchased from OCWD and sold to the City's customers. Recycled water is managed in a distribution system separate from the potable distribution system and is, therefore, not further addressed in this WMP and is not included in the City's hydraulic model.

Water Demand Analysis

Water demand analysis for this 2019 WMP includes a review of the City's historic water production and water consumption to determine water usage factors that are used in projecting water demands, and in evaluating existing and future water system performance to identify required system improvements. The developed water usage factors include existing water demands by customer class, non-revenue water (NRW), and peaking factors for maximum month, maximum day, and peak hour water demand variations.

Water Demand Trends

A review of the water production data of the most recent 10 years of water production data (2007 to 2016) indicates the following:

- Although the City service area population increased by approximately 13 percent since 1990, total water demand has continued to decrease. The 10-year average annual demand for 2007-2016 (15,991 AF) is 14 percent less than the 1986-1996 average annual demand (18,626 AF).
- The decrease in demand starting in 2008 is likely due to the national economic downturn.
- The decrease in demand starting in 2014 is due to the mandatory drought restrictions that were set in place by the State.

Non-Revenue Water

The annual water production data was compared to water consumption records (extracted from the City's water billing system) to determine water that is lost in the system before reaching the customer. This lost water is termed non-revenue water (NRW) and is the difference between the distribution system input volume (i.e. production) and billed authorized consumption. During 2007 to 2016, the City's NRW ranged from 2.1 percent to 7.2 percent, and averaged 5.1 percent.

Water Demand Peaking Factors

Water demands vary on a seasonal and daily basis. The adequacy of existing infrastructure and needed system improvements are based on analyses of the system during peak demand periods. The peak demands needed for the analysis include the average demand during maximum demand month (maximum month), the average demand during the maximum demand day (maximum day), and the average demand during the peak demand hour (peak hour).

- **Maximum month peaking factor** represents the maximum monthly production divided by the annual average monthly production. Based on water production data from 2007 to 2016, the maximum month peaking factor ranged from 1.25 to 1.33. To add a degree of conservatism, a factor of 1.35 was used for this WMP.
- **Maximum day peaking factor** represents the maximum day demand (MDD) divided by average day demand (ADD) for the maximum demand month. While daily production data was available for the City wells, corresponding data was not available for the imported water connections to provide a complete depiction of daily demands during the maximum demand month. For this WMP, the peak day demand factor of 1.85 was determined by comparing values used by neighboring communities which ranged from 1.5 to 1.8. This MDD factor is also consistent with the 1999 WMP.
- **Peak hour factor** represents the peak hour demand (PHD) divided by ADD. Peak hour factors were calculated for each of pressure zone based on the City's supervisory control and data acquisition (SCADA) data from July and August 2017. The peak hour factors were 2.6 for Zones 1 and 2; 3.1 for Zone 3, and 4.0 for Zones 4 and 5.

Water Demand Projections

One objective of this WMP was to develop water demand projections to determine the impact of the change in water demand on future distribution system capacities. The water demand projection methodology used in this WMP to project future water demands involved developing water demand factors based on areal use patterns expressed as gallons per acre per day (gpad) for the range of land uses present in the water service area, and applying the water demand factors to existing and anticipated future land use acreages. This methodology provides water demand projections that are spatially distributed throughout the water service area sufficient for hydraulic modeling and determination of required system improvements and expansions.

Land Use Categories and Water Demand Factors

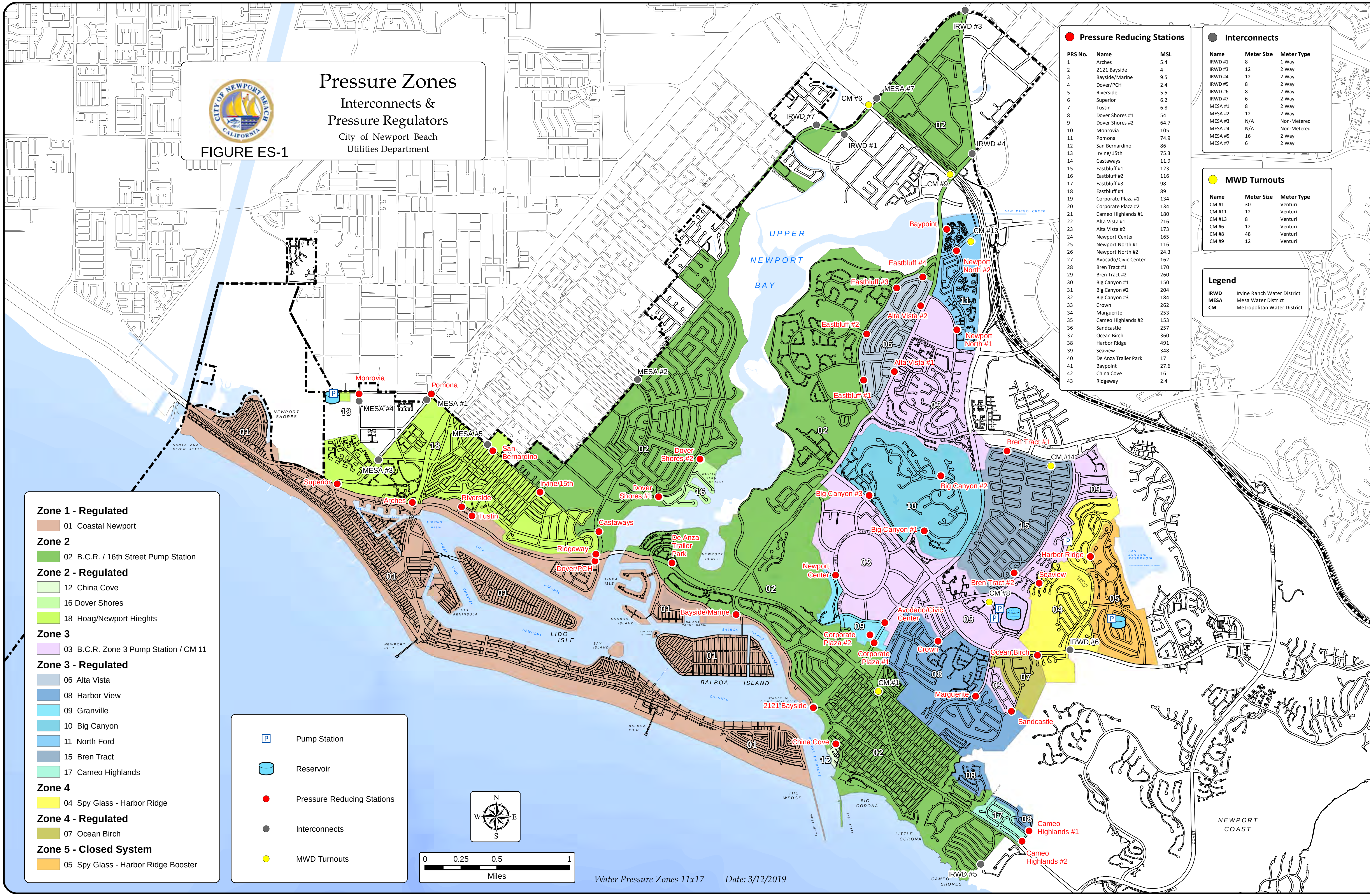
Land use categories from the 1999 WMP and the 2006 General Plan were recategorized for this WMP to establish a manageable 14 land use categories and a land use demand factor for each. The land use categories established for the 2019 WMP are similar to those used in 1999. Examples of new land use categories added in this WMP as identified in the 2006 General Plan include “Residential Very High” to reflect residential densities over 25 dwelling units per acre (DU/ac), and “Office” and “Mixed Use” were separated out from “General Commercial”.

Projected Water Demands

Projected water demands were calculated by multiplying water demand factors to projected total acreage for each land use category. This WMP conservatively assumes that the Banning Ranch tract will be developed. The top ten largest water users were assumed to be point loads. The total projected water demands at build out including Banning Ranch development and adjusted for NRW of 5.1 percent was estimated to be approximately 16,818 acre feet per year (AFY) i.e. a 5.2 percent increase from the 10-year (2007-2016) average of 15,991 AFY.

Existing System Infrastructure

The City’s distribution system consists of approximately 300 miles of distribution pipelines and is divided into five main pressure zones: Zone 1 through Zone 5 with 16 minor zones. Zones 1 and 2 are the largest and cover most of the system demands. Zones 3, 4 and 5 are smaller pumped zones. The system infrastructure consists of four wells, three storage reservoirs, five pump stations and 43 pressure reducing stations (PRS) that manage pressure across the system. Figure ES-1 illustrates the water system schematic.


Pressure Zones
Interconnects &
Pressure Regulators
City of Newport Beach
Utilities Department
CITY OF NEWPORT BEACH CALIFORNIA
FIGURE ES-1
Pressure Reducing Stations
PRS No. Name MSL
1 Arches 5.4
2 2121 Bayside 4
3 Bayside/Marine 9.5
4 Dover/PCH 2.4
5 Riverside 5.5
6 Superior 6.2
7 Tustin 6.8
8 Dover Shores #1 54
9 Dover Shores #2 64.7
10 Monrovia 105
11 Pomona 74.9
12 San Bernardino 86
13 Irvine/15th 75.3
14 Castaways 11.9
15 Eastbluff #1 123
16 Eastbluff #2 116
17 Eastbluff #3 98
18 Eastbluff #4 89
19 Corporate Plaza #1 134
20 Corporate Plaza #2 134
21 Cameo Highlands #1 180
22 Alta Vista #1 216
23 Alta Vista #2 173
24 Newport Center 165
25 Newport North #1 116
26 Newport North #2 24.3
27 Avocado/Civic Center 162
28 Bren Tract #1 170
29 Bren Tract #2 260
30 Big Canyon #1 150
31 Big Canyon #2 204
32 Big Canyon #3 184
33 Crown 262
34 Marguerite 253
35 Cameo Highlands #2 153
36 Sandcastle 257
37 Ocean Birch 360
38 Harbor Ridge 491
39 Seaview 348
40 De Anza Trailer Park 17
41 Baypoint 27.6
42 China Cove 16
43 Ridgeway 2.4
Interconnects
Name Meter Size Meter Type
IRWD #1 8 1 Way
IRWD #3 12 2 Way
IRWD #4 12 2 Way
IRWD #5 8 2 Way
IRWD #6 8 2 Way
IRWD #7 6 2 Way
MESA #1 8 2 Way
MESA #2 12 2 Way
MESA #3 N/A Non-Metered
MESA #4 N/A Non-Metered
MESA #5 16 2 Way
MESA #7 6 2 Way
MWD Turnouts
Name Meter Size Meter Type
CM #1 30 Venturi
CM #11 12 Venturi
CM #13 8 Venturi
CM #6 12 Venturi
CM #8 48 Venturi
CM #9 12 Venturi
Legend
IRWD Irvine Ranch Water District
MESA Mesa Water District
CM Metropolitan Water District
Zone 1 - Regulated
01 Coastal Newport
Zone 2
02 B.C.R. / 16th Street Pump Station
Zone 2 - Regulated
12 China Cove
16 Dover Shores
18 Hoag/Newport Heights
Zone 3
03 B.C.R. Zone 3 Pump Station / CM 11
Zone 3 - Regulated
06 Alta Vista
08 Harbor View
09 Granville
10 Big Canyon
11 North Ford
15 Bren Tract
17 Cameo Highlands
Zone 4
04 Spy Glass - Harbor Ridge
Zone 4 - Regulated
07 Ocean Birch
Zone 5 - Closed System
05 Spy Glass - Harbor Ridge Booster
Pump Station
Reservoir
Pressure Reducing Stations
Interconnects
MWD Turnouts
N
S
E
W
0 0.25 0.5 1
Miles
UPPER
NEWPORT
BAY
LIDO
ISLE
BALBOA
ISLAND
NEWPORT
COAST
Water Pressure Zones 11x17
Date: 3/12/2019

Hydraulic Model Development

As part of this 2019 WMP development, a new geographic information system (GIS) integrated hydraulic model of the City's existing water system, which includes all pipelines, was developed with the Innovyze InfoWater software to effectively model the water system conveyance and distribution improvements. Data from previous modeling and master planning efforts were also used, along with projections of future water use and land use development to also help prioritize future facility needs. The hydraulic model included all components of the City's distribution system including wells, reservoirs, pressure reducing stations (PRS), pump stations, interconnections, and pipes.

Demand Allocations

Customer water use throughout the system is converted to model demands at nodes (or junction points) along pipelines. These water demands were developed and allocated based upon land use parcel. Each parcel was given a unit demand factor based on the land use category in gallons per minute per acre (gpm/ac) and are based on a 10-year (2007-2016) average consumption. For each parcel, consumption was calculated by multiplying the unit demand factor by the acreage. Parcel centroids were then defined and used to spatially allocate the water use to the hydraulic model junctions using parcel centroids as GIS meter point data and the InfoWater's demand allocator add-on tool. Demands were allocated to model junctions by pressure zone using the closest pipe methodology in the demand allocator.

Demand Patterns

A diurnal water use pattern represents typical daily fluctuation in customer water use over a 24-hour period. Diurnal curves were developed using the City's SCADA data for storage and incoming and outgoing flows for each pressure zone. A 15-minute increment was used to capture peak water use during the day and establish a more accurate diurnal pattern. Diurnal curves were developed per zone for use during calibration.

Hydraulic Model Calibration

The purpose of the hydraulic model calibration is to compare simulated results to actual measured data and make necessary adjustments to achieve a reasonable match to produce a model that can be used with confidence to predict system performance for the purpose of system planning. The City's water system model was calibrated for steady-state and extended period simulation (EPS) conditions. The model results were compared against 10 fire hydrant flow tests for steady-state and 13 hydrant pressure recorder (HPR) locations for EPS. In addition, available SCADA data were used as additional comparisons for EPS model analysis.

Calibration Procedures and Results

After model construction, system controls and setpoints were added to accurately represent actual system operations based on observed HPR data, SCADA data and/or input from City operations staff. The calibration procedure was an iterative process that required a trial-and-error approach to resolve differences between hydrant test, HPR, and SCADA data and the model. Model simulations were run, and the results were compared graphically to the hydrant test, HPR, and SCADA data. Where obvious differences existed between the model and observed data, these differences were investigated and adjustments to pipe roughness coefficients (C-factors) and distribution facility setpoints and controls were explored. The City's staff provided additional information when available to help reconcile the differences.

Calibration Results

The hydraulic model was validated using calibration criteria and comparing field testing to the model's results. Overall, the model results matched the measured data reasonably well, and the model can confidently be used as a tool to perform system evaluation and predict future hydraulic conditions.

- **Steady-state calibration** was performed using hydrant flow test data collected on July 18 and 19, 2017. For each test, a flow hydrant was used to record flow and an observation hydrant used to record static and residual pressures. Steady-state calibration results show excellent results at all ten hydrant test locations with the difference in pressure drop (between static and residual) of 3 psi or less.
- **EPS calibration** was performed using HPR data at 13 locations and available SCADA data from July 19, 2017. EPS calibration results at the HPR locations showed excellent results at 8 of the 13 locations and very good results at the remaining 5 locations. EPS calibration results at the SCADA locations overall showed very good to excellent results with few exceptions.

Hydraulic System Analysis

The calibrated hydraulic model and design criteria were used to evaluate the existing and future system under current and built-out demands to assess system performance. Deficiencies, if any, were identified during this hydraulic analysis and were incorporated in the CIP development process.

System Performance and Design Criteria

The City has established performance and design criteria for its water system as summarized in Table ES-1.

Table ES-1: System Performance and Design Criteria

Parameters		Criteria
Pipes	Velocity	< 8 ft/s for pipe <= 10 inch
		< 5 ft/s for pipe >= 12 inch
		10 ft/s during Fire Flow
	Headloss	< 5 ft/1000 ft for all pipe sizes
Storage (per Zone)	Regulatory Storage	25% of MDD[1]
	Fire Storage	Depends on area of

Parameters		Criteria
		influence of Zone
	Emergency Storage*	7 average days' demand
System Pressure	Maximum Pressure	140 psi
	Peak Hour Demands	40 psi minimum
	Max Day + Fire Flow Demands	20 psi minimum
	Minimum Day Demand	60-90 psi
Wells	Capacity of direct supply wells	ADD[2]
Booster Pump Station Capacity	Demand Conditions	Assuming the largest pump within the station is out of service, the higher between the PHD[3] or MDD plus fire flow or MDD plus fire flow in case of available floating storage.
Peaking Factors	Maximum Month	1.35
	Maximum Day	1.85
	Peak Hour	Zone 1 & 2 – 2.6 Zone 3 – 3.1 Zone 4 & 5 – 4.0
Fire Flow	Single Family	1,000 gpm for 2 hours
	Community Facilities	1,500 gpm for 2 hours
	Multiple Family & Closely Built Residential (one & two stories)	2,000 gpm for 2 hours
	Multiple Family & Closely Built Residential (three stories or more)	2,500 gpm for 3 hours
	Multiple Family Attached Residential	3,000 gpm for 3 hours
	Commercial (≤ two stories)	3,000 gpm for 3 hours
	Commercial (> two stories)	5,000 gpm for 5 hours

Parameters		Criteria
	High-Rise Residential	5,000 gpm for 5 hours
	Business Park/Industrial Park	5,000 gpm for 6 hours
	Regional Shopping Center	6,000 gpm for 6 hours

Note: [1]MDD = Maximum Day Demand, [2]ADD = Average Day Demand, [3]PHD = Peak Hour Demand

*Emergency Storage is based on MWD Administrative Code Section 4503 b1

Existing System Analysis

The system was analyzed under existing demands against the design criteria. The system storage and pumping were compared against the criteria to identify any deficiencies. The distribution system was analyzed using the hydraulic model under ADD, MDD and fire flow scenarios.

- **Existing Storage and Pumping Analysis -** The storage in the system is used to meet operational daily demand peaks, fire flow, and emergency storage. The sum of these three criteria must be met by the available storage in each pressure zone. Sub-pressure zones that are hydraulically connected and are served by the same facilities are grouped together. Based on the system analysis, the City's available storage (202.5 MG) significantly exceeds the City's storage criteria (108.3 MG). For the pumping analysis, the firm capacity (largest pump out of service) of a pump station in a pressure zone must be greater than the higher of the MDD plus fire flow or the PHD. The analysis shows a small pumping deficiency (0.8 mgd) in Zones 1 and 2. This is not a true deficiency because when demands in Zones 1 and 2 exceeds the capacity of 16th Street Pump Station, the water from Big Canyon Reservoir flows via gravity to make up the difference.
- **Maximum and Minimum Day Demand Analysis -** The distribution system was analyzed under MDD to identify minimum pressures. Three nodes were found to have pressure marginally below 40 psi. These locations were further evaluated with help from the City's staff. All three locations are next to closed pressure zone division valves which the City intends to keep closed, and no low-pressure complaints have been received from these locations. It is recommended that the City monitor pressures at these locations and adjust strategy if pressures decrease over time. No improvements are suggested to improve pressures at these locations. The distribution system was evaluated for high pressures using the minimum day demand scenario (0.66 times ADD) in the hydraulic model (greater than 140 psi). There were a few locations with pressure greater than 140 psi, and most of them were on transmission pipes. These locations do not need any improvements as no customers are directly connected to these high-pressure pipes.
- **Fire Flow Analysis -** The available fire flow across the City was calculated at each node and compared with the requirement using the automated fire flow routine in the hydraulic model. Only four locations were identified where available fire flow at 20 psi residual pressure was less than the City's requirements. Three of the four locations have a 4- or 6-inch pipes. Upsizing these pipes to 8 inches will increase the available fire flow and exceed the City's requirements. The fourth location is next to a pressure zone division valve which is closed. Under emergencies such as a fire, this

valve can be opened to provide the required fire flow. No improvement is recommended for this site.

Future System Analysis

The City's water distribution system was also analyzed for future build-out demands using the City's system performance criteria.

- **Future Storage and Pumping Analysis** – The City has enough available storage in the system under future build out demands as well. Proper and regular maintenance of this available storage should suffice to maintain its reliability to the City. The pumping analysis showed a deficit in available pumping in Zones 1 and 2 under build-out demands similar to the one seen under existing system demands. As with the existing storage and pumping analysis, this is not a true deficiency as water from Big Canyon Reservoir can flow to Zones 1 and 2 via gravity to make up the difference.
- **Maximum and Minimum Day Demand Analysis** – The analysis under future build-out demands showed similar results consistent with the existing system demand analysis. The same three locations show low pressures as seen under existing system analysis as they are at dead end zone boundaries near closed valves. Since pressures at these locations are just slightly (3-5 psi) below 40 psi, therefore no improvements are recommended to address them, but the City should continue to monitor these areas for low pressure. Similar to existing system analysis, the few locations that violate maximum pressure criteria under minimum day future demands are on transmission lines and not directly connected to customers. No improvements are recommended for these.
- **Fire Flow Analysis** - Fire flow analysis was performed using the hydraulic model under maximum day future demands. The same four nodes, as found in the existing system analysis, were found deficient in this analysis. Upsizing these pipes to 8 inches will address the City's fire flow criteria.

System Improvements

Hydraulic modeling of the City's distribution system under existing and future build-out demands revealed the necessity for very few improvements. The only system improvements identified in this WMP involves upsizing three pipes from 4 or 6-inch to 8 inches to meet fire flow criteria.

Risk Analysis Methodology

The City's 30-year CIP was developed using a risk-based approach. Both horizontal assets (i.e. pipelines) and vertical facilities were analyzed using a risk method to determine their priority in the CIP. To identify projects that should be incorporated into the City's CIP, a field assessment was performed to evaluate all facilities and a desktop analysis was performed on all pipes within the distribution system.

Information from both efforts were combined to assess the physical condition, performance, and impact of failure of the City's individual assets. The scoring of an asset's physical and performance condition is represented as Likelihood of Failure (LoF) and impact to the City if a failure were to occur is referred to as Consequence of Failure (CoF). The LoF and CoF were used to calculate the risk score for each individual asset.

Risk Score = Likelihood of Failure (LoF) x Consequence of Failure (CoF)

Pipeline (Horizontal Asset) Assessment Methodology

For this WMP, assessment was performed only on system pipes (distribution and transmission) and not on the appurtenances along the pipes. An asset's risk was determined by quantifying the LoF score (1-5) based on its physical and performance condition and the CoF score (1-5) based on the impact of the asset failure on the City's water operations and ability to serve its customers. Physical condition was defined as the current state of operation and repair of an asset that is influenced by age, breaks, historical maintenance, and operating environment. It was inferred using the pipe characteristics like age (install year), number of breaks, and material documented in the City's GIS. Performance condition was assigned based on how well assets are accomplishing their designed tasks. This was inferred from the hydraulic analysis of the pipes. CoF was assigned through proximity analysis of pipes to environmentally sensitive areas, critical customers, and pipe characteristics. The risk of an asset (1 through 25) was calculated as the product of the LoF multiplied by the CoF.

Facility (Vertical Asset) Assessment Methodology

A vertical asset was defined as a single item that relates to the storage, transmission, or distribution of potable water. The vertical assets in the City includes valves, pumps, buildings, storage reservoirs, and flowmeters. This WMP established a complete inventory of all assets within the City's water distribution system. To catalogue assets within the system, hierarchies were developed for vertical assets. Hierarchies help filter and find asset records within the database and allow information to be summarized at various hierarchical levels. For vertical assets, a seven-tiered system was used to store component information and accommodate the variety of assets seen in the City's system. Asset attributes and physical condition assessment criteria were also defined for each asset classifications. The classifications include structural, electrical, and mechanical.

Facility Assessment

Every asset that is a part of the City's water system was visually inspected to help prioritize their rehabilitation or replacement and inclusion in the CIP. The sites inspected include the City's interconnections and turnouts with other agencies, 5 pump stations, 3 reservoirs, 2 well buildings, and 43 PRS accounting for 734 assets in total.

Likelihood of Failure for Vertical Assets

- **Physical Condition** – Seventy-seven percent of inspected assets scored either very good condition or minor defects only. Nineteen percent received a score of maintenance required leaving only three percent of assets requiring renewal or asset being unserviceable (e.g. CM-9 turnout, IRWD-7 interconnect, and Zone 5 Auxiliary Pump Station).
- **Performance Condition** – Based on hydraulics evaluation and interview of City staff, 91 percent of the inspected assets are in very good condition to minor defects only. Six percent require maintenance and three percent require renewal. The two assets deemed unserviceable were the pump and motor located at the Zone 5 Auxiliary Pump Station due to missing bolts and equipment, high pressures, and proximity to electrical panel.

Consequence of Failure for Vertical Assets

Ninety-eight percent of the City's assets were assigned a low to medium consequence score as most of the assets have redundancies in the system. All sixteen assets with a high consequence are located at the 16th street reservoir and pump station. As the first major pump station and reservoir after the City's wells, the assets within the facility play a crucial role in the operation of the City's water system. No assets were scored as very high consequence.

Risk for Vertical Assets

There are no high or very high-risk assets in the inspected facilities. Only three assets were identified to have moderate risk which were prioritized to be included in the City's CIP. This includes the Zone 5 Auxiliary Pump Station and Zone 4 Pump No. 4 that runs on an old motor and requires renewal.

Vertical Assets for CIP Inclusion

The assessment of vertical assets identified 25 assets that were found to require renewal or be in unserviceable condition. Three assets in Zone 5 Auxiliary Pump Station and Zone 4 Pump Station were identified as moderate risk, the highest risk calculated for all vertical assets assessed. These assets are included in the CIP to address these elevated risk scores.

Water Mains Assessment

The City's water mains were assessed using the risk framework and criteria where a risk score was assigned to every pipe. The desktop analysis included assessment of the City's break data, identification of pipe cohorts, and development of effective useful life (EUL) by pipe material to assign a LoF score for each pipe segment.

Likelihood of Failure for Horizontal Assets

Physical condition score was assigned to each pipe segment using the EUL estimates for each material. The pipe segments were also assigned a performance score based on the hydraulic constraints. The majority of the City's pipes were installed in the second half of the 20th century, and hence most of them are predicted to be in excellent condition (94.4 percent).

Consequence of Failure for Horizontal Assets

The Triple Bottom Line approach was used to assign CoF scores for each pipe segment using GIS tools. To evaluate each individual criterion, GIS calculated the proximity to roads and environmentally sensitive areas, identified pipes that served critical customers, and related the pressure output from the model to pipes. Only 10 percent of the City's pipes are highly critical.

Risk for Horizontal Assets

Overall the system has only 3.3 percent of its pipes at an elevated risk score (high or very high) as shown in Table ES-2. While this shows the City's system is at low risk overall, as pipes continue to age, the risk score will continue to rise. Therefore, the riskiest pipes will be targeted in the CIP followed by older pipes that will eventually raise the risk score.

Table ES-2: Pipe Risk Score Breakdown

Risk	Segments of Pipes	Pipe Length (miles	Percentage of Pipe Length
Very Low	5,954	171.5	57.6
Low	3,092	86.7	29.1
Medium	787	30.1	10.1
High	171	7.4	2.5
Very High	38	2.3	0.8

Capital Improvement Program

The City's 30-year CIP was developed based on risk analysis and inclusion of projects requested by the City to maintain the level of service and operation of the distribution system. Planning level budgets were assigned to the developed CIP projects using unit costs developed from recent projects the City has completed and contacting vendors. The level of accuracy for the cost estimates corresponds to the Class 4 estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International. The accuracy range of a Class 4 estimate is minus 15 percent to plus 20 percent in the best case and minus 30 percent to plus 50 percent in the worst case.

The 30-year CIP covers facilities projects, pressure reducing stations (PRS) projects, and pipeline projects assuming an escalation factor of 2.5 percent per year. Over the 30-year period an average of $7.2M will be needed each year. The majority of projects in the CIP cover the water main replacement projects (64.6 percent), followed by facilities projects (34.9 percent), and PRS projects (0.5 percent) as summarized in Table ES-3.

Table ES-3: 30-Year CIP Cost by Project Category

Project Category	2018 Cost
Pipeline Replacement and Relining	$103,540,000
Facilities	$60,451,000
Pressure Reducing Stations	$1,207,000
Total	**$165,198,000**

Pipeline Projects

A total of 30 pipe renewal or replacement projects are included in the CIP. For larger pipes on major streets, the City preferred relining of pipes as these projects are estimated to cost 70 percent of a full replacement. Near-term projects include the Balboa Island Water Main Replacement (Phase 2) project and the design of the Bay Crossing Water Main project. Figure ES-2 shows all of the pipeline CIP projects.

Facilities Projects

Seventeen facilities projects were identified in the City's 30-year CIP including facility improvements, system wide rehabilitation programs, and distribution system upgrades that fall outside of pipeline replacements or specific PRS projects. The inclusion of these projects are based on the risk assessment and insight from the City. Facilities projects range from near-term projects such as installation of advanced metering infrastructure (AMI), installation of a mixing system for Spyglass Reservoir, or water well rehabilitation to long-term projects such as installation of new wells and associated pipelines.

Pressure Reducing Stations Projects

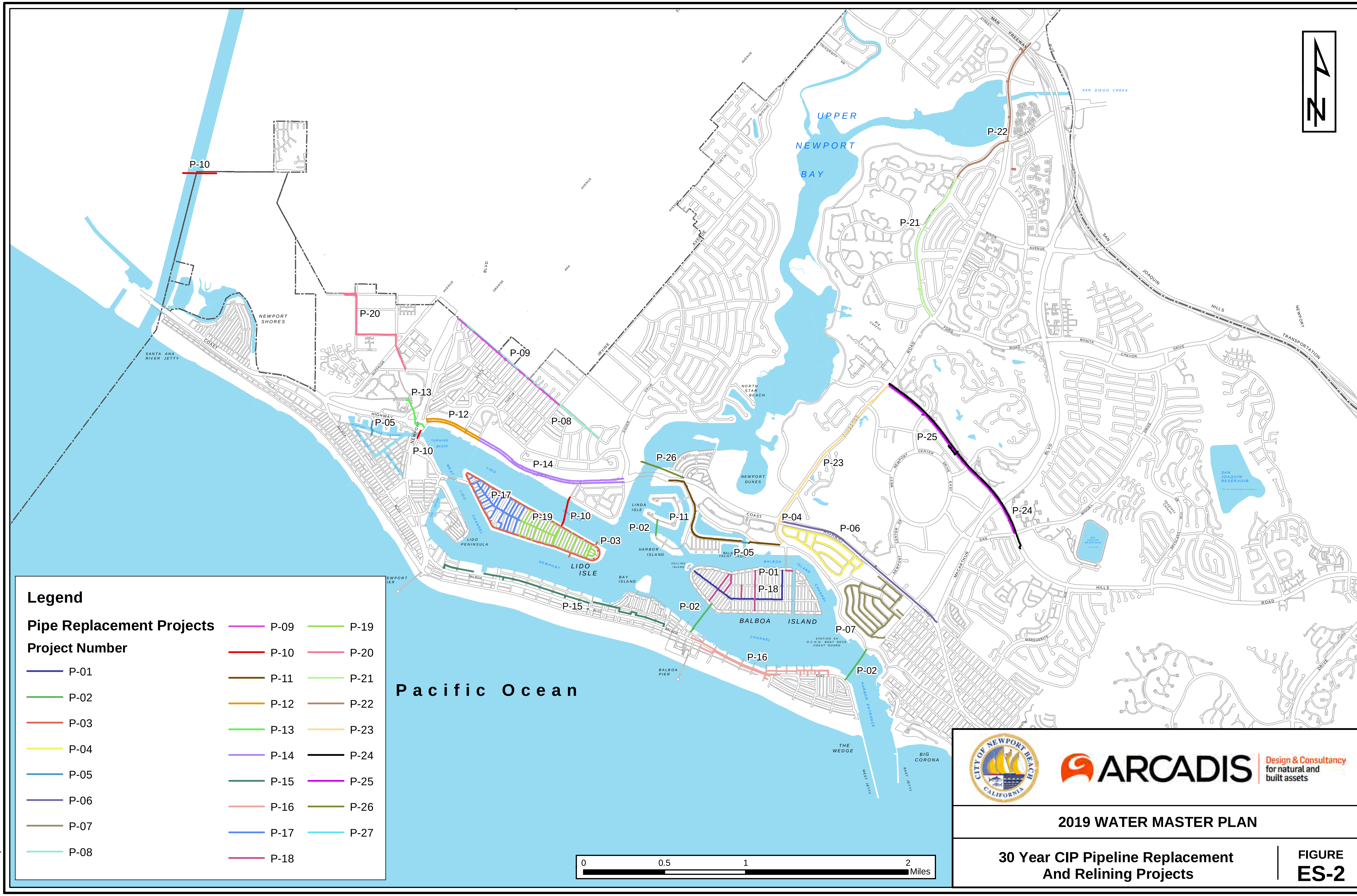
With 43 PRSs in the City's distribution network, the City needs to be proactive in their maintenance. Five PRS projects that have been included to improve system operations.

General Recommendations

Through developing the WMP, implementing the projects outlined in the CIP can be supported with continued effort by the City. This includes the following actions that can be implemented at minimal cost to support items in the CIP.

- The City should take the updated water system model from this WMP and continue to keep it current through coordination with field staff and the City's GIS department.
- The 30-year CIP identified in this WMP should be updated to reflect completed, postponed, or new projects.
- The risk calculation for the City's assets can be updated with visual inspection to better understand the appropriate replacement of aging assets in the City's system.

By beginning to perform analysis of water main breaks in this WMP, the City can now collect more information on breaks and conduct studies on pipe wall thickness to better establish a water main's estimated useful life. This information can feed into the planned replacement projects and help the City prioritize future work.



City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure ES-2 CIP Pipe Replacement Projects.mxd 4/5/2019 2:52:44 PM
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1 INTRODUCTION

The City of Newport Beach (City) Utilities Department is responsible for the operation and maintenance of the City's water, wastewater, and storm drain systems, as well as and other municipal utilities within the City. The City's Public Works Department is responsible for engineering services including, capital project delivery, water quality and environmental services, and transportation and development services. The two departments work collaboratively to plan for the City's water supply and distribution system improvements through master planning and capital improvement program (CIP) efforts.

1.1 Background

The City's last comprehensive Water Master Plan (WMP) was completed in 1999 followed by a minor update in 2008. The main purpose of the 2008 Water Master Plan Update was to update the hydraulic model and conduct additional hydraulic modeling of pipeline improvement projects. Because there have been many changes since 1999 and 2008, the WMP needs to be updated again to reflect current water use trends and future infrastructure needs. Recent events affecting water use include an increase in population, the economic downturn in 2007-08 and the six-year drought in California. The City's service area population grew by approximately 13 percent between 1990 and 2016 from approximately 58,000 to 66,000. Adding to population growth are changes in the City's land use planning to accommodate future development and redevelopment as outlined in the City's General Plan adopted in 2006 and subsequent amendments.

The prolonged drought in California from 2010-2016, Bay-Delta water reliability issues, and the 16-year long drought within the Colorado River Basin system were major drivers of regulatory changes in California water law and both had a significant impact on future water system planning. The Water Conservation Act of 2009 (Senate Bill X7-7) mandated urban water suppliers to reduce water usage by 20 percent by 2020. In response to the recently ended six-year drought, the Governor proclaimed a State of Emergency and ordered urban suppliers to cut back water use with a collective state goal of 25 percent reduction (based on 2013 usage). Additionally, California passed Senate Bill 555 requiring urban water suppliers to submit a water loss audit annually beginning in 2016. This 2019 WMP represents the City's water infrastructure planning efforts based on these recent changes.

1.2 Project Purpose and Scope

This 2019 WMP evaluates the City's water system to identify any deficiencies, and needed system improvements and to provide an up-to-date CIP to prioritize the City's water infrastructure rehabilitation and replacement projects.

The scope of this WMP generally includes the following:

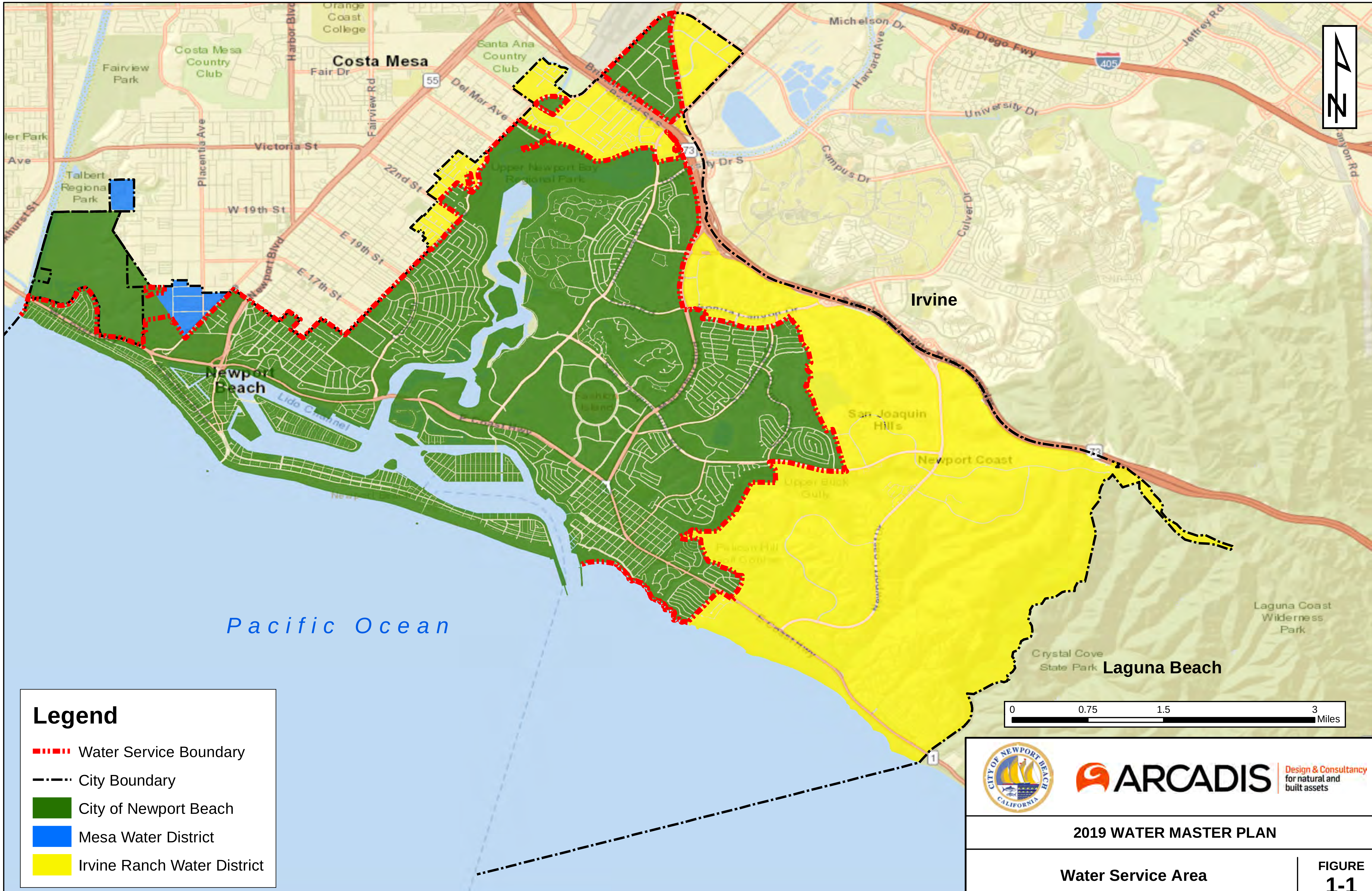
- Develop water demand projections and determine the impact of recent water consumption and the resultant effect on system demand and peaking factors based on the most recent 10 years of water use trends (2007 – 2016).
- Incorporate the City's 2006 General Plan and subsequent amendments for land use projections

and housing density into the demand analysis.

- Develop a calibrated hydraulic model using current water demands to analyze the City's water supply and distribution system.
- Conduct a risk analysis to provide the basis for a prioritized pipe and facilities rehabilitation and replacement program.
- Develop and prioritize recommendations for system improvements over the next 30 years.

1.3 Service Area

The City provides water to approximately 11 square miles of land area located along the Orange County coast of Southern California. The City is bounded to the West by the Pacific Ocean, to the North by the cities of Huntington Beach and Costa Mesa, to the South by Laguna Beach, and to the East by Irvine. The water service area covers most of the City's boundaries with the remaining areas served by Irvine Ranch Water District (IRWD) and Mesa Water District (MESA) as shown on Figure 1-1.



2019 WATER MASTER PLAN

Water Service Area

FIGURE 1-1

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 1-1 Water Service Area.mxd 4/3/2019 10:50:21 AM
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2 WATER SUPPLY ANALYSIS

The City relies on a combination of local groundwater and imported water to meet its potable water demands. Recycled water was added in 1997 to the City's water supply portfolio for irrigation purposes. The City's 2015 Urban Water Management Plan (UWMP) provides an in-depth evaluation of the existing and projected supplies from these three sources, and its findings are briefly summarized here. In 2015, the City relied on approximately 70 to 75 percent groundwater, 22 to 27 percent imported water, and 3 percent recycled water. This supply portfolio is projected to change slightly to 73 percent groundwater, 23.5 percent imported water, and 3.5 percent recycled water through the year 2040. The City, along with the agencies managing the water supplies, ensures that a safe and high-quality water supply will be available during periods of drought or supply shortage.

2.1 Groundwater

The City's main water supply source is groundwater from the Orange County Groundwater Basin (OC Basin). Historically, this groundwater has been the least expensive and most reliable source of supply. The City has four active wells that draw water from the OC Basin. Groundwater in the OC Basin is managed by the Orange County Water District (OCWD). Groundwater levels are managed within a safe basin operating range to protect the long-term sustainability of the OC Basin and to protect against land subsidence. OCWD regulates groundwater levels in the OC Basin by implementing and managing various aquifer recharge projects and by regulating the annual amount of pumping.

The OC Basin is not adjudicated and, as such, pumping is managed through a process that uses financial incentives to encourage groundwater producers to pump a sustainable amount of water. The framework for the financial incentives is based on establishing a Basin Pumping Percentage (BPP), which is the percentage of each producer's total water supply that comes from groundwater. Groundwater production at or below the BPP is assessed a Replenishment Assessment to pay for OC Basin recharge water.

While there is no regulatory limit as to how much a producer may pump from the OC Basin, there is a financial disincentive to pump above the BPP. Agencies that pump above the BPP are charged the Replenishment Assessment plus a Basin Equity Assessment (BEA), which is calculated so that the cost of groundwater production is greater than the service rate for treated imported water. The BPP is set uniformly for all producers by OCWD on an annual basis. In 2013, OCWD adopted a policy to establish a stable BPP with the intention of working toward achieving and maintaining a 75 percent BPP by FY 2015-16. Due to the recent California drought, the BPP remained at 75 percent in FY 2015-16. Additionally, an increase in the BPP from a historical average of 70 percent to 75 percent was approved by the OCWD Board for FY 2016-17 and FY 2017-18.

Pumping limitations driven by the financial disincentives of the BEA and well pumping capacity are the only constraints affecting groundwater production in the City. Based on OCWD's goals and the comparatively lower cost of groundwater, the City meets 75 percent of its annual demand through groundwater pumping and uses imported water to supply the remaining potable water demand gap, particularly during summer months.

The City's wellfield is located in Fountain Valley, approximately five miles north of the City. Figure 2-1 shows the locations of all water supply sources for the City. Groundwater is conveyed from the wellfield to the City via a 30 to 36-inch pipeline that discharges into the 16th Street Reservoir. From the reservoir, the water is pumped into the City's distribution system.

In 2016, the City entered into an agreement with Laguna Beach County Water District (LBCWD) to pump and transport groundwater through the City's system to LBCWD's system. LBCWD's agreement with OCWD entitles them to 2,025 acre-feet (AF) of groundwater per year. In 2016, the first partial year of operation, 671.34 AF was delivered over four months (September to December). The LBCWD groundwater is delivered through the CM-1 interconnection shown on Figure 2-1.

2.2 Imported Water

The City supplements its local groundwater with imported water purchased from Metropolitan Water District of Southern California (MWD) through the Municipal Water District of Orange County (MWDOC). MWD's principal sources of water are the Colorado River, via the Colorado River Aqueduct (CRA), and the Lake Oroville watershed in northern California, through the State Water Project (SWP). The water obtained from these sources is treated at the Robert B. Diemer Filtration Plant, located in Yorba Linda, for delivery to MWDOC customers. Typically, the Diemer Filtration Plant receives a blend of CRA water, from Lake Mathews through the MWD Lower Feeder, and SWP water, through the Yorba Linda Feeder.

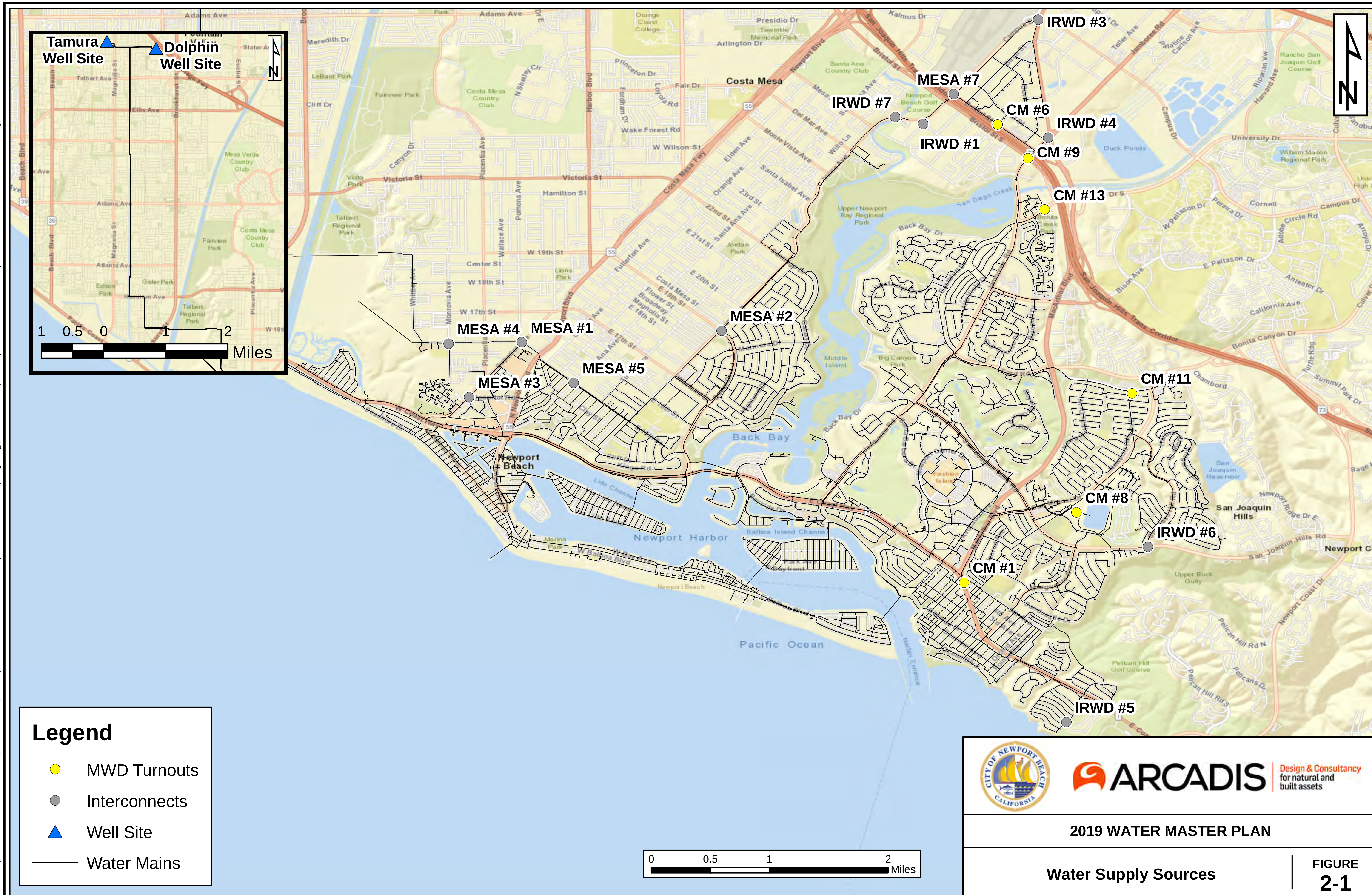
The City currently maintains six turnouts from the MWD system along the Orange County Feeder and the East Orange County Feeder No. 2. Maximum turnout capacity equals 67 million gallons per day (mgd). The imported water turnouts are also shown on Figure 2-1 and additional turnout details are presented in Section 5.

2.3 Recycled Water

The City owns and operates recycled water pump stations for Big Canyon Country Club and the Newport Beach Country Club. Including these two sites, there are currently 15 recycled water connections that supply five different customers. Recycled water is purchased from OCWD and sold to the City's customers. Recycled water is managed in a distribution system separate from the potable water distribution system and, therefore, is not addressed in this WMP or included in the hydraulic model of the City. Refer to Figure 2-2 for all recycled water users.

2.4 Emergency Interconnections

The City has emergency interconnections with IRWD and MESA as shown on Figure 2-1. The connections, which are a mix of one and two-way flow, are used only during emergency water shortage or outage conditions. There is a total of six connections with IRWD and seven with MESA.



2019 WATER MASTER PLAN

Water Supply Sources

FIGURE 2-1

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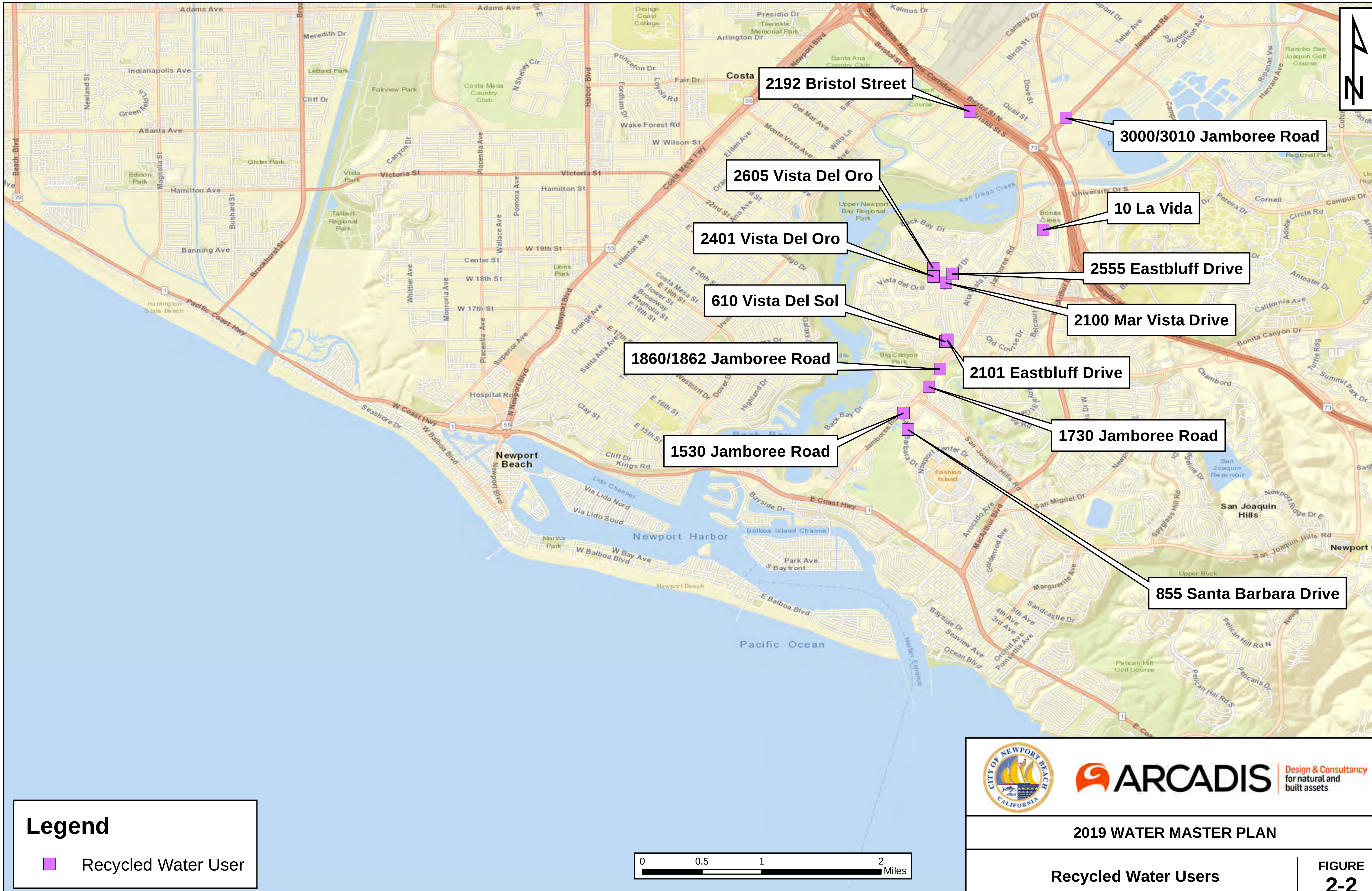

2019 WATER MASTER PLAN

Recycled Water Users

FIGURE 2-2

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 2-2 Recycled Water Users.mxd 4/3/2019 4:31:49 PM
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2.5 Water Quality

2.5.1 Groundwater

OCWD conducts an extensive monitoring program to manage groundwater production, to control groundwater contamination, and to comply with all required state and federal drinking water regulations. A network of nearly 700 wells provides OCWD a source for water sample collection, which totals 600 to 1,700 samples each month to monitor basin water quality. These samples are collected and tested according to approved state and federal procedures as well as industry-recognized quality assurance and control protocols.

Salinity is a significant water quality concern in many parts of southern California, including Orange County. Salinity is a measure of the dissolved minerals in water including both total dissolved solids (TDS). OCWD continuously monitors the levels of TDS in wells throughout the OC Basin. Portions of the OC Basin with the highest levels of TDS are generally located in the northern part of the county. There is also a broad area in the central portion of the OC Basin where TDS ranges from 500 to 700 milligrams per liter (mg/L). Sources of TDS include imported water supplies used to recharge the OC Basin. The TDS concentration in the Basin is expected to decrease over time due to low TDS water (50 mg/L) from OCWD's Groundwater Replenishment System (GWRS) which is used to recharge the OC Basin.

Nitrates have historically originated from fertilizer use, animal feedlots, wastewater disposal systems, and other sources. OCWD regularly monitors nitrate levels in groundwater and works with producers to treat wells that have exceeded safe levels of nitrate concentrations. OCWD manages the nitrate concentration of recharge via the Prado Wetlands, which was designed to remove nitrogen and other pollutants from the Santa Ana River before the water is diverted for percolation into OCWD's surface water spreading basins.

2.5.2 Imported Water

MWD is responsible for providing high quality potable water throughout its service area. Over 300,000 water quality tests are performed per year on MWD's water to test for regulated contaminants and additional contaminants of concern to ensure the safety of its waters.

MWD's primary water sources face individual water quality issues. CRA water contains higher TDS than SWP water; and SWP water contains higher concentrations of organic matter than the CRA water, lending to the formation of disinfection by-products. To mitigate the high levels of salinity and organic matter, MWD blends the two supplies throughout its distribution system to reduce TDS and has upgraded all its treatment facilities to include ozone to reduce disinfection by-products. In addition, MWD has been engaged in efforts to protect its CRA supplies from threats of uranium, perchlorate, and chromium VI, while also investigating the potential water quality impact of emerging contaminants in both sources. MWD's current strategies ensure the delivery of high-quality water.

The presence of Quagga Mussels in imported water sources is also a concern due to adverse impacts on hydraulics and operations. Quagga Mussels are an invasive species first discovered in 2007 at Lake Mead, located on the Colorado River. This species of mussel forms massive colonies in short periods of time, disrupting ecosystems and blocking water intakes. They can cause significant disruption and damage to water distribution systems. Controlling the spread and impacts of this invasive species within the CRA system requires extensive maintenance and results in reduced operational flexibility. It has also resulted in MWD eliminating deliveries of CRA water into Diamond Valley Lake to keep the reservoir free from Quagga Mussels.

2.6 Water Supply Reliability

Every urban water supplier in California is required to assess the reliability of their water service to customers under normal, dry, and multiple-dry water years. The City's 2015 UWMP considered various factors that may impact the reliability of groundwater and imported water supplies such as legal, environmental, water quality and climate change. Full service demands were estimated based on a water demand forecasting model previously developed by MWDOC that considered the impacts that weather and future climate change can have on water demand.

The UWMP analysis concluded that the City's groundwater and imported water supplies are 100 percent reliable for normal year demands through the planning period from 2020 through 2040. A single-dry year is the year that represents the lowest water supply available to the City. The UWMP analysis also found that the City's groundwater and imported water supplies are 100 percent reliable for single-dry year demands. The multiple-dry year period is the period that represents the lowest average water supply availability to the agency for three or more years. The UWMP analysis found that the City can meet all customers' demands for the multiple-dry year condition with conservation and significant reserves held by groundwater and imported water suppliers from 2020 through 2040.

2.7 Potential Future Supplies

Developing local supplies within its service area is part of MWD's Integrated Water Resources Plan goal of improving water supply reliability in the region. MWD participates by providing partial funding for local projects such as recycled water use, groundwater storage/conjunctive use, conservation device distribution, and groundwater treatment.

In 2015, the State Water Resources Control Board approved an amendment to the State's Water Quality Control Plan for the Ocean Waters of California to address effects associated with the construction and operation of seawater desalination facilities. The amendment supports the use of ocean water as a reliable supplement to traditional water supplies while protecting marine life and water quality. The California Ocean Plan now formally acknowledges seawater desalination as a beneficial use of the Pacific Ocean and the Desalination Amendment provides a uniform, consistent process for permitting seawater desalination facilities statewide.

One project being considered locally to reduce imported water deliveries is the Huntington Beach Seawater Desalination Project. This project would be located in the City of Huntington Beach along the Pacific Coast Highway and produce up to 50 mgd (56,000 AFY) of drinking water to provide approximately 10 percent of Orange County's water supply needs.

OCWD's current Long-Term Facilities Plan identifies the Huntington Beach Seawater Desalination project as a priority project and determined the plant as the single largest source of new, local drinking water available to the region. In addition to offsetting imported demand, water from this project could provide OCWD with management flexibility in the OC Basin by augmenting supplies into the Talbert Seawater Barrier to prevent seawater intrusion.

In May 2015, OCWD and the project developer entered a Term Sheet that provided the overall partner structure in order to advance the project. Currently, the project is in the late-stages of the regulatory permit approval process and the project developer hopes to obtain the last discretionary permit necessary to construct the plant from the California Coastal Commission (CCC).

3 WATER DEMAND ANALYSIS

This section provides a review of historic water production and consumption, which are used to determine water usage factors. These water usage factors are used to project water demands and to evaluate the existing and future water system performance to identify required system improvements. The water usage factors developed include existing water demands by customer class, non-revenue water (NRW), and peaking factors for maximum month, maximum day and peak hour water demand variations.

3.1 Historical Water Production

Information on historical potable water production is available from the 1999 WMP and from more recent production data provided by the City. The 1999 WMP evaluated 12 years of water production data (1986/87 through 1997/98). More recent production data provided by the City covered a 10-year period (2007 through 2016). Water production data between these two periods was not provided. Water production includes groundwater from wells managed by OCWD and imported water purchased from MWDOC.

Table 3-1 presents the available annual water production data from the City and available population data from the Center for Demographic Research (CDR) at California State University Fullerton (2016).

Table 3-1: Historical Annual Water Production and Service Area Population

Year	Annual Water Production (AF)	City Service Area Population
1986	19,814	--
1987	20,272	--
1988	20,605	--
1989	20,363	--
1990	19,013	
1991	16,902	58,437
1992	17,245	59,033
1993	17,522	59,581
1994	17,255	59,964
1995	17,959	60,288
1996	19,140	60,709
1997	17,427	61,277

Year	Annual Water Production (AF)	City Service Area Population
1998	17,630	61,896
1999	17,914	62,514
2000	13,023	64,923
2001	17,633	65,774
2002	18,504	66,053
2003	17,588	66,119
2004	18,421	64,785
2005	17,732	65,079
2006	17,604	64,862
2007	18,658	64,930
2008	17,405	65,263
2009	16,969	65,366
2010	15,206	65,668
2011	15,829	64,581
2012	15,830	65,054
2013	16,392	65,460
2014	16,730	65,551
2015	13,798	65,777
2016*	13,094	65,869**

*Note: In 2016, the City delivered 671 AFY to LBCWD. This portion of water is excluded from the analysis.

**Note: 2016 population is an extrapolation of 2006 – 2015 data.

Figure 3-1 illustrates the water production data along with historic City service area population. The 1999 WMP made the following conclusions based on review of production data:

- The significant reduction in water demand beginning in 1991/92 is a testament to water conservation measures during drought and the economic recession that occurred at that time. A post-drought "rebound" was not apparent through 1997/98.
- Any increase in demand due to increased population (9.5 percent increase) and new development was not apparent for the 12-year period.

A review of the most recent 10 years of water production data indicates the following:

- Although the City service area population increased by approximately 13 percent since 1990, total water demand has continued to decrease. The most recent 10-year average annual demand (15,991 AF) is approximately 14 percent less than the 1986 – 1996 average annual demand (18,626 AF).
- The decrease in demand starting in 2008 is likely due to the national economic downturn.
- The decrease in demand starting in 2014 is due to the mandatory drought restrictions that were set in place by the state.

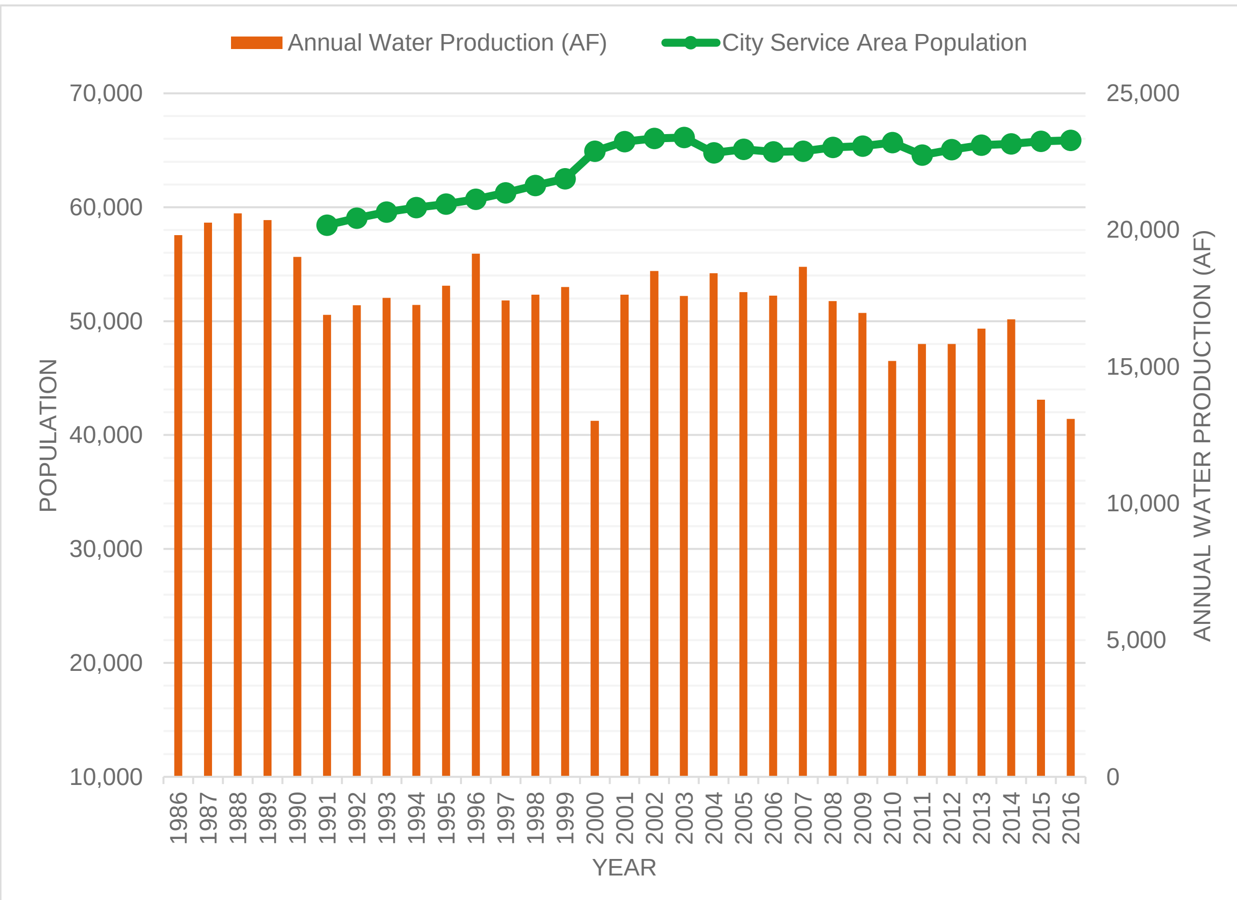


Figure 3-1: Historical City Service Area Population and Annual Water Production

3.2 Historical Water Consumption and Non-Revenue Water

The annual water production data was compared to water consumption records (extracted from the City's water billing system) to determine water that is not billed to customers. This NRW is the difference between production and billed authorized consumption. NRW generally includes unbilled authorized consumption (e.g. hydrant flushing, firefighting, construction, and water discharge-to-waste from well start-ups), real losses (e.g. leakage in mains and service lines, and storage tank overflows), and apparent losses (unauthorized consumption, metering inaccuracies, and systematic data handling errors).

Water consumption data from 2007 through 2016 included billed consumption for both potable and non-potable (recycled water) consumption. Non-potable consumption was removed for the analysis herein. The potable consumption data represented 25,897 water billing accounts throughout the service area.

Table 3-2 summarizes the historical NRW for 2007 through 2016 and NRW ranged from 2.1 percent to 7.2 percent, and averaged 5.1 percent. As discussed later in this report, the 10-year consumption data will be used to establish water demand factors for the range of land uses present in the City's water service area. Based on the assessment summarized in Table 3-2, the 10-year average NRW of 5.1 percent will be added to each demand factor to reflect total water production requirements.

Table 3-2: Historical Non-Revenue Water

Year	Annual Production (AFY)	Annual Consumption (AFY)	Non-Revenue Water	
			AFY	Percentage
2007	18,657	17,725	932	5.0
2008	17,405	17,035	370	2.1
2009	16,969	16,139	830	4.9
2010	15,205	14,490	715	4.7
2011	15,828	14,980	848	5.4
2012	15,830	14,934	896	5.7
2013	16,392	15,473	919	5.6
2014	16,730	15,810	920	5.5
2015	13,798	13,060	738	5.3
2016	13,094	12,148	946	7.2
Average	**15,991**	**15,179**	**812**	**5.1**

3.3 Water Demand Peaking Factors

Water demands vary on a seasonal and daily basis. The adequacy of existing infrastructure and the needed system improvements are based on analysis of the system during peak demand periods. The peak demands needed for the analysis include the average demand during maximum demand month (maximum month), the average demand during the maximum demand day during the year (maximum day), and the demand during the peak demand hour on the maximum demand day (peak hour).

3.3.1 Maximum Month Factor

The 1999 WMP found the maximum month to annual average peaking factor to range from 1.24 to 1.41, with an average of 1.33. Based on the 1999 analysis, a maximum month peaking factor of 1.4 was chosen as it was considered “realistic and conservative”.

For this plan, the City provided annual water production data, by month, for 2007 through 2016. Table 3-3 summarizes the monthly production data and the maximum month to annual average production analysis. Based on the recent 10-year annual water production data, the maximum month peaking factor ranged from 1.25 to 1.33, with an average of 1.29. To add a degree of conservatism, a maximum month peaking factor of 1.35 will be used in the current WMP.

The analysis in Table 3-3 shows that the maximum water demand month is typically July or August. The City indicated that the maximum water use month in 2013, October, occurred because Big Canyon Reservoir was filled that month and that the actual maximum demand month would have otherwise been July.

3.3.2 Maximum Day Factor

Since the City had not historically kept records of peak daily demands, the 1999 WMP used a maximum day demand (MDD) factor of 1.85 based on water usage records of other California water agencies. This factor was also chosen because it provided a degree of conservatism (the calculated peaking factor was 1.82 based on water use records of other water agencies).

As was the case in 1999, the City did not have sufficient water production information to determine the current MDD for this WMP. Although daily production data was available for the wells, corresponding data was not available for the imported water connections to provide a complete depiction of daily demands during the maximum demand month. Therefore, the peak day demand factor was determined by comparing the MDD factors (MDD divided by average day demand (ADD)) used by neighboring communities:

- MESA (2014 WMP): 1.5
- Huntington Beach (2012 WMP): 1.8
- LBCWD (2014 WMP): 1.67

Based on the above comparison, and consistent with the previous WMP, a maximum day peaking factor of 1.85 will be used in the current WMP as a conservative estimate.

Table 3-3: Determination of Maximum Month Demand Peaking Factor

Month	Total Production (AF)										Average (AF)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Jan	1,411	1,043	1,062	999	998	968	1,051	1,278	956	778	1,054
Feb	1,083	966	947	711	1,141	1,087	930	1,225	938	937	996
Mar	1,466	1,294	1,242	1,126	924	1,190	1,065	899	1,274	821	1,130
Apr	1,370	1,495	1,385	1,310	1,245	1,146	1,272	1,418	1,319	995	1,295
May	1,613	1,681	1,713	1,430	1,473	1,399	1,546	1,768	1,083	1,131	1,484
Jun	1,815	1,692	1,548	1,566	1,584	1,587	1,599	1,601	1,416	1,255	1,566
Jul	1,978	1,960	1,830	1,687	1,792	1,671	1,734	1,798	1,194	1,423	1,707
Aug	2,023	1,857	1,809	1,716	1,674	1,717	1,719	1,671	1,376	1,470	1,703
Sep	1,796	1,603	1,698	1,483	1,455	1,643	1,566	1,662	1,199	1,261	1,536
Oct	1,576	1,695	1,403	1,069	1,236	1,410	1,790*	1,330	1,099	1,233	1,384
Nov	1,406	1,307	1,131	976	1,075	1,185	1,294	1,172	1,067	866	1,148
Dec	1,121	814	1,202	1,131	1,232	826	828	911	877	924	987
Total (AFY)	**18,658**	**17,405**	**16,969**	**15,206**	**15,829**	**15,830**	**16,392**	**16,730**	**13,798**	**13,094**	**15,991**
Max Month (AF)	2,023	1,960	1,830	1,716	1,792	1,717	1,734**	1,798	1,416	1,470	1,751
Annual Avg. (mgd)	16.7	15.5	15.1	13.6	14.1	14.1	14.6	14.9	12.3	11.7	14.3
Max Month Avg. (mgd)	21.3	20.6	19.2	18.0	18.8	18.1	18.2**	18.9	15.4	15.4	18.5
Max Month Peaking Factor	**1.28**	**1.33**	**1.27**	**1.33**	**1.33**	**1.28**	**1.25***	**1.27**	**1.25**	**1.32**	**1.29**

*This month was not considered for the max month for 2013 since the Big Canyon Reservoir was filled after installation of a new cover

**Based on July production value

3.3.3 Peak Hour Factor

The City does not have historical records of peak hour demands (PHD). In the 1999 WMP, a PHD factor of 2.0 times the MDD (3.7 times the average day demand) was used based on water usage records of other California water agencies. This factor was chosen again as it provided a degree of conservatism.

For this WMP, the peak hour factor (PHD divided by average day demand) for the City was compared with the peak hour factors used by neighboring communities as listed below.

- MESA (2014 WMP): 2.25
- Huntington Beach (2012 WMP): 2.25
- LBCWD (2015 WMP): 2.3

Based on the above comparison and Arcadis' experience planning water system for many inland communities (which experience high peak hour to average day demand factor, 3.0+), the PHD factor of 3.7 used in 1999 for the entire system may be overly conservative for coastal communities.

Thus, new peak hour factors were calculated for each pressure zone based on SCADA data provided by the City for summer of 2017. SCADA data was provided for dates between July 18, 2017 and August 11, 2017, which are the high demand months for the City. This data was also used for model calibration. Based on the available flow and tank level data, peaking factors were calculated for each of the five pressure zones and adjusted during model calibration (Section 6.11). Table 3-4 summarizes the peak hour factor for each pressure zone.

Table 3-4: Peak Hour Factor by Pressure Zone

Pressure Zone	Peaking Factor
1	2.6
2	2.6
3	3.1
4	4.0
5	4.0

The factors shown in Table 3-4 are typical with larger zones having a lower peaking factor than smaller zones. This variation in peaking factors is due to the lack of diversity in customer types with Zones 4 and 5 having almost exclusively low-density residential housing. Zones 1, 2, and 3 include low to high-density housing as well as commercial, institutional, and mixed use land use types. These peak hour factors, in the form of diurnal curves, are used in the existing system analysis (Section 8).

4 WATER DEMAND PROJECTIONS

As described in Section 3, the City provided historical water consumption data for every billing account in the City's service area for a 10-year period (2007-2016). The data represents annual water consumption billed by the City and, when combined with a corresponding addition of NRW, provides an accurate representation of existing water demand at each corresponding water meter.

Although the City also provided a geographic information system (GIS) database of every water meter in the water service area, the meter database could not be adequately matched to the customer billing database. The two databases do not include a unique identifier for each water meter, the only common identifier was property addresses. An attempt was made to match the databases using addresses, but only 30 percent of the water meters could be matched to billing accounts.

Because of the low match results of meters to customer accounts, the methodology used in this WMP to project future water demands is to develop water demand factors based on areal use patterns, expressed as gallons per acre per day (gpad) for the range of land uses present in the water service area. These demand factors are then applied to existing and anticipated future land use acreages. The demand projection methodology provides water demands that are spatially distributed throughout the water service area which are sufficient for hydraulic modeling and determination of required system improvements.

4.1 Existing Water Demand by Customer Type

As noted in Section 3, water consumption data was provided for 26,524 water billing accounts in the City's water service area. The 10-year average water consumption of each water customer type was determined and is summarized in Table 4-1.

Table 4-1: Summary of Existing Water Consumption by Customer Type

10-Year Average Consumption			
Customer Type	**AFY**	**MGD**	**Percent**
Single-family Residential	6,845	6.12	45
Multi-family Residential	2,231	1.99	15
Commercial/Industrial	2,872	2.57	19
Institutional/Government	266	0.24	2
Irrigation	2,966	2.65	19
Total	**15,180**	**13.57**	**100**

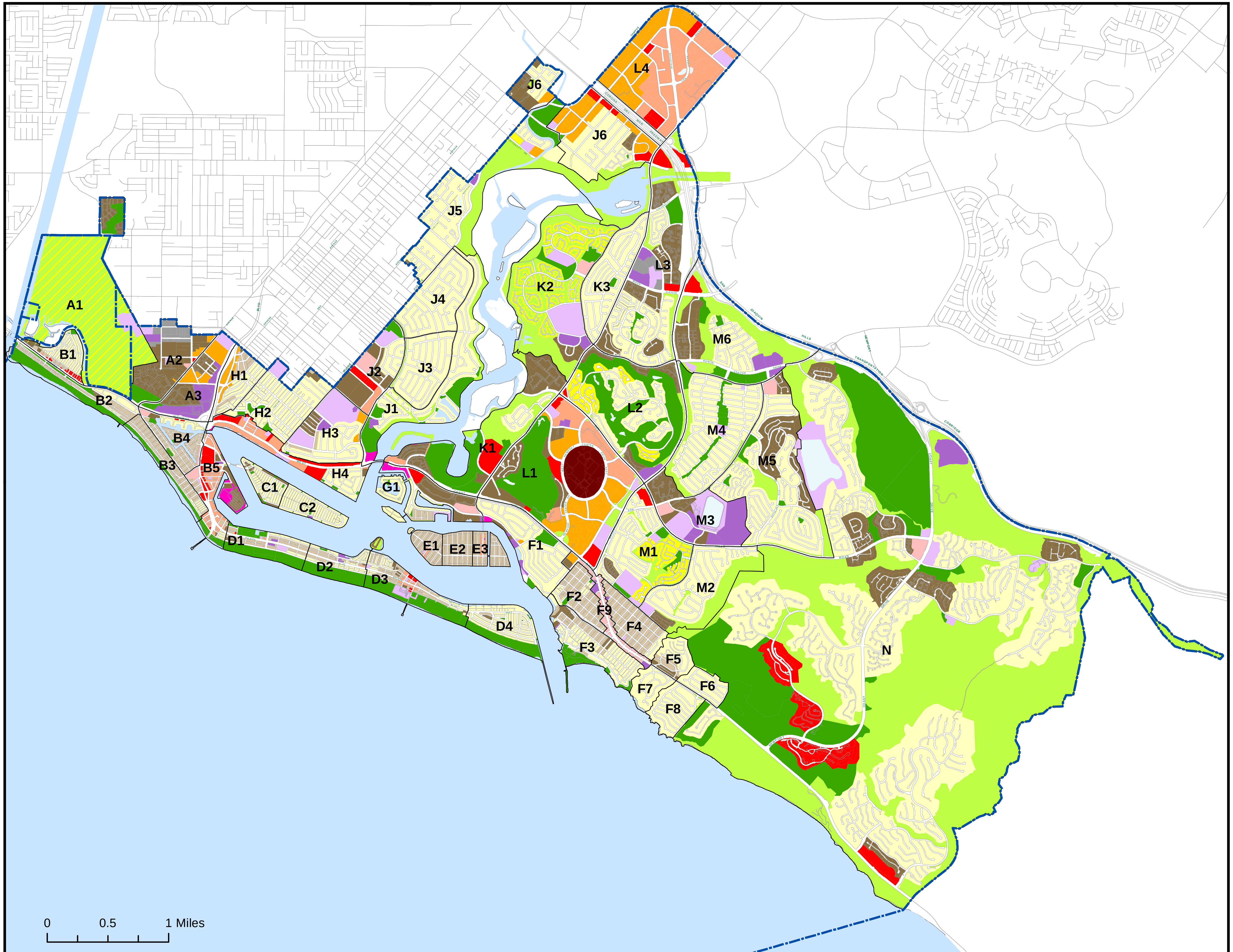
Approximately 60 percent of the City's potable water consumption is by residential customers, predominantly single-family residential. One fifth of the City's demand is irrigation customers such as golf courses, and another one fifth is from commercial customers.

4.2 Land Use Categories

The City provided GIS shapefiles for the Land Use Plan of the Newport Beach General Plan (2006). The Hybrid Land Use Map is shown on Figure 4-1. The land use plan map summarizes land use by classification which are assigned on a parcel-by-parcel basis.

The General Plan specifies 27 land use categories including various classes such as Residential, Commercial, and Industrial. Further, the General Plan is structured around 50 "Statistical Subareas" which are broken down by villages, special developments, and planned future development and/or redevelopment. As in the 1999 WMP, it was found that various land use categories, although equivalent in character, are not equivalent in density throughout the City's planning area. For example, a classification of Single Unit Residential Detached in one area of the City would have a density in dwelling units per acre (DU/ac) that is different for the same classification in another part of the City. In addition, 27 land use categories are cumbersome for water demand forecasting, particularly when vacant parcels and future development areas are limited, as they are in the City.

Thus, as in the 1999 WMP, it was necessary to develop a hybrid land use map that represents uniform residential land use classifications and, at the same time, reduces the number of land use categories for demand projection purposes. The range of residential densities was similar to the 1999 range and was verified by determining the actual residential densities in each General Plan residential area. Table 4-2 compares the 1999 WMP and 2006 General Plan land use categories and presents the recommended hybrid land uses for this WMP. Figure 4-2 illustrates the recommended hybrid land use map.



CITY of NEWPORT BEACH GENERAL PLAN

Figure 4-1

GENERAL PLAN OVERVIEW MAP

Residential Neighborhoods

- RS-D Single-Unit Residential Detached
- RS-A Single-Unit Residential Attached
- RT Two-Unit Residential
- RM Multiple Unit Residential
- RM-D Multiple-Unit Residential Detached
- RM/OS Multiple-Unit Residential / Open Space

Commercial Districts and Corridors

- CN Neighborhood Commercial
- CC Corridor Commercial
- CG General Commercial
- CV Visitor Serving Commercial
- CV-LV Visitor Serving Commercial Lido Village
- CM Recreational and Marine Commercial
- CR Regional Commercial

Commercial Office Districts

- CO-G General Commercial Office
- CO-M Medical Commercial Office
- CO-R Regional Commercial Office

Industrial Districts

- IG Industrial

Airport Supporting Districts

- AO Airport Office and Supporting Uses

Mixed -Use Districts

- MU-V Mixed Use Vertical
- MU-H Mixed Use Horizontal
- MU-W Mixed Use Water Related

Public, Semi-Public and Institutional

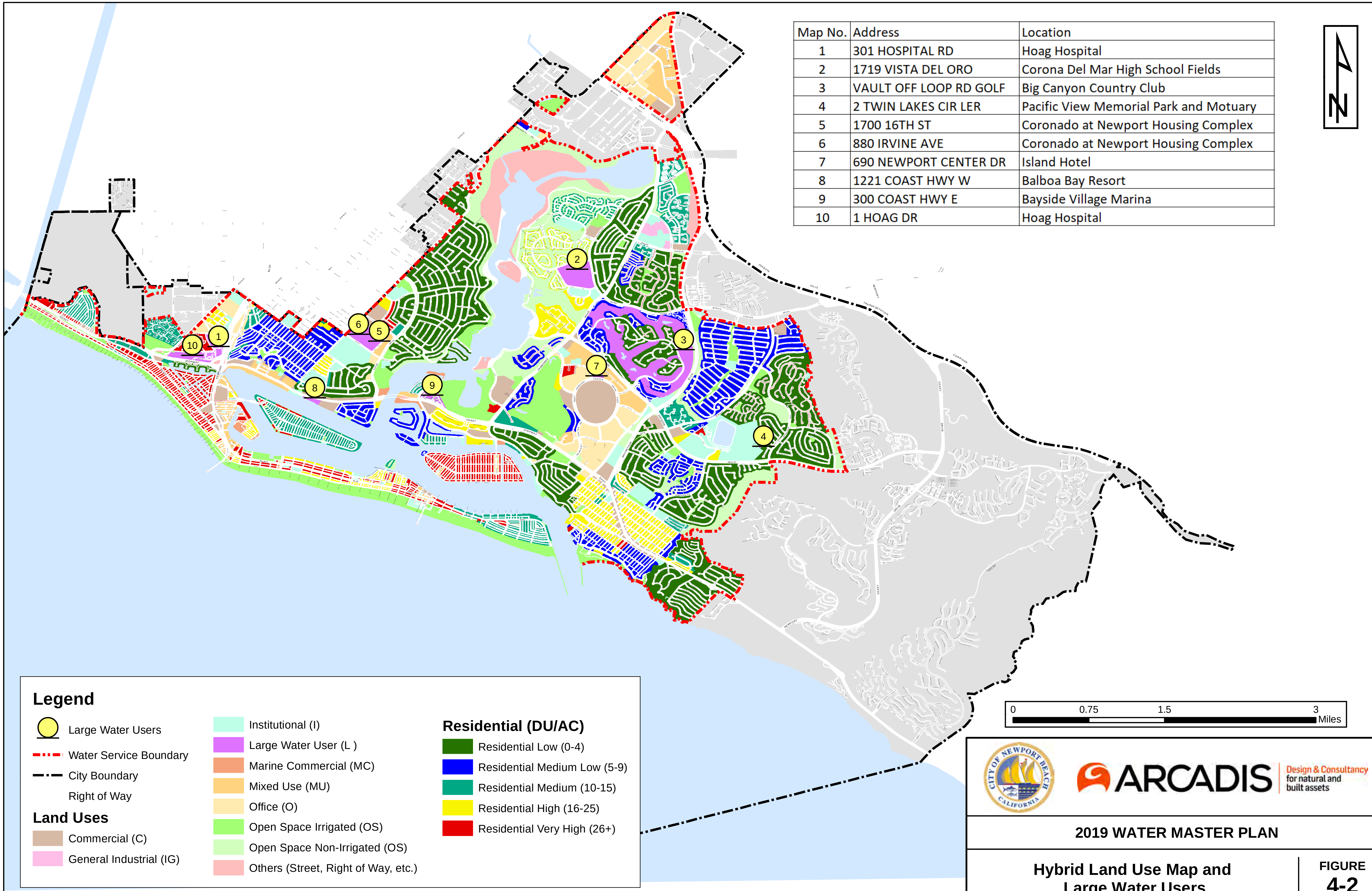
- PF Public Facilities
- PI Private Institutions
- PR Parks and Recreation
- OS Open Space
- OS(RV) Open Space / Residential Village (Residential uses, if not acquired as permanent open space)
- TS Tidelands and Submerged Lands
- City of Newport Beach Boundary
- Statistical Area Boundary

Table 4-2: Analysis of Land Use Classifications

1999 WMP			2006 General Plan			2019 WMP Land Use		
Classification	Symbol	DU/AC	Classification	Symbol	DU/AC	Classification	Symbol	DU/AC
Residential Family	RF	0-2	Single-Unit Residential Detached	RS-O	0-29.9	Residential Low	RL	0-4
Residential Low	RL	0-4	Single-Unit Residential Attached	RS-A	6-9.9			
Residential Medium Low	RML	5-9	Two-Unit Residential	RT	10-39.9	Residential Medium Low	RML	5-9
Residential Medium	RM	10-16	Multiple Unit Residential	RM	6-52	Residential Medium	RM	10-15
Residential High	RH	16-25	Multiple Unit Residential Detached	RM-O	10-19.9	Residential High	RH	16-25
			Multiple Unit Residential / Open Space	RM/OS	0.7	Residential Very High	RVH	>25
General Commercial	C		Neighborhood Commercial	CN		Commercial	C	
			Corridor Commercial	CC				
			General Commercial	CG				
			Visitor Serving Commercial	CV				
			Visitor Serving Commercial – Lido Village	CV-LV				
			Regional Commercial	CR				
Marine Commercial	CM		Recreation and Marine Commercial	CM		Marine Commercial	CM	

1999 WMP			2006 General Plan			2019 WMP Land Use		
Classification	Symbol	DU/AC	Classification	Symbol	DU/AC	Classification	Symbol	DU/AC
			General Commercial Office	CO-G		Office	O	
			Medical Commercial Office	CO-M				
			Regional Commercial Office	CO-R				
			Airport Office and Supporting Uses	AO				
			Mixed Use Vertical	MU-V		Mixed Use	MU	
			Mixed Use Horizontal	MU-H				
			Mixed Use Water Related	MU-W				
Governmental, Educational, Institutional	I		Public Facilities	PF		Institutional	I	
			Private Institutions	PI				
Industrial	IN		General Industrial	IG		General Industrial	IG	
Recreational, Environmental, Open Space	OS		Open Space	OS		Open Space (Irrigated)	OS	
			Open Space/Residential Village	OS (RV)				
			Parks and Recreation	PR				

1999 WMP			2006 General Plan			2019 WMP Land Use		
Classification	Symbol	DU/AC	Classification	Symbol	DU/AC	Classification	Symbol	DU/AC
			Tidelands and Submerged Lands	TS				
						Open Space (Non-Irrigated)	OS	
						Large Water User	L	



Map No.	Address	Location
1	301 HOSPITAL RD	Hoag Hospital
2	1719 VISTA DEL ORO	Corona Del Mar High School Fields
3	VAULT OFF LOOP RD GOLF	Big Canyon Country Club
4	2 TWIN LAKES CIR LER	Pacific View Memorial Park and Motuary
5	1700 16TH ST	Coronado at Newport Housing Complex
6	880 IRVINE AVE	Coronado at Newport Housing Complex
7	690 NEWPORT CENTER DR	Island Hotel
8	1221 COAST HWY W	Balboa Bay Resort
9	300 COAST HWY E	Bayside Village Marina
10	1 HOAG DR	Hoag Hospital

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Hybrid Land Use Map and Large Water Users

FIGURE 4-2

The residential land use categories selected are very similar to the categories used in 1999. However, as there was very little Residential Family, it was combined with Residential Low to create a single category spanning the range of development densities for the two sub categories. In addition, the 1999 WMP did not have residential densities over 25 DU/ac. The current City General Plan land use map has several residential areas that have densities higher than 25 DU/ac, so a new Residential Very High category was included.

The selected non-residential land use categories were also very similar, except for the following:

- The 1999 WMP did not use Office and Mixed Use categories. Since the current General Plan includes these categories, they were included in this WMP.
- The General Plan Open Space category includes non-irrigated open space and irrigated open space (parks, recreation, etc.). The current WMP includes both Open Space Not Irrigated and Open Space Irrigated to account for water use for irrigated areas.
- The 1999 WMP identified the top 22 largest water users and included them in the hydraulic model as point loads with their specific water demands. The current WMP includes 10 Large Water Users that could be identified and located from the billing and meter databases, and are shown on Figure 4-2 as point loads, and listed in Table 4-3. These Large Water Users account for approximately seven percent of the total existing water demand (10-year average).

Table 4-3: Large Water Users

I.D.	Description	10 -Year Average (AFY)
1	Hoag Hospital (301 Hospital Road)	157.3
2	Corona del Mar High School	155.4
3	Big Canyon Country Club	137.2
4	Pacific View Memorial Pak and Mortuary	130.0
5	Coronado at Newport Housing Complex (1700 16th Street)	92.2
6	Coronado at Newport Housing Complex (800 Irvine Avenue)	92.1
7	Island Hotel	89.4
8	Balboa Bay Resort	72.3
9	Bayside Village Marina	71.9
10	Hoag Hospital (1 Hoag Drive)	67.6
Total		**1,065.4**

4.3 Future Development Areas

The City is nearly built out within its water service area. The City provided information on planned future development and redevelopment areas as listed on Table 4-4 and shown on Figure 4-3.

Table 4-4: Future Development Areas

Future Development/Redevelopment	Anticipated Development Type and Size	Future Land Use Category (Existing)	Size (Acres)	Anticipated Development Period
Newport Harbor Yacht Club (PA2012-091)	Yacht Club: 20,500 sq. ft. (Demolished 2017)	Institutional (Institutional)	167.55	2019
Villas Fashion Island (Formerly San Joaquin Plaza Apartments) (PA2012-020)	241,711 sq. ft. of office (Demolished 2015)	Office (Institutional/Mixed Use)	6.06	2017-2018
Lido House Hotel at the former city hall complex (PA2013-217)	Demolished 2016	Commercial (Commercial)	4.17	2018
Westcliff Medical (PA2013-154)	25,336 sq. ft. Retail/office (Demolished 2016)	Commercial (Commercial)	7.70	2018
Newport Marina – ETCO Development (PA2001-210)	Commercial, Office, Marine: 44,300 sq. ft. (Demolished 2014)	Mixed Use (Mixed Use)	0.09	2017
Mariner’s Pointe (PA2010-114)	Commercial: 5,447 sq. ft. (Demolished 2016)	Commercial (Commercial)	0.77	2017
ENC Preschool (PA2015-079)	Vacant since 2007	Mixed Use (Office)	1.25	2022
Balboa Marina Expansion (PA2012-103) (PA2015-113)	Office and marina restrooms: 1,200 sq. ft.	Marine Commercial (Marine Commercial)	0.56	2019

Future Development/Redevelopment	Anticipated Development Type and Size	Future Land Use Category (Existing)	Size (Acres)	Anticipated Development Period
Lido Villas (DART) (PA2012-146)	Church: 8,961 sq. ft. Office Building: 32,469 sq. ft.	Residential Very High (Residential)	1.20	2022
Back Bay Landing (PA2011-216)	RV, Boat storage, 45 storage units, kayak/paddleboard rentals.	Mixed Use (Mixed Use)	12.74	2024
Plaza Corona del Mar (PA2010-061)	Vacant	Mixed Use (Mixed Use)	0.35	2022
Old Newport GPA Project (PA2008-047)	General/Medical Office:13,012 sq. ft. Residential: 1 du (Demolished 2015)	Commercial (Office)	0.14	2019
Hoag Memorial Hospital Presbyterian Master Plan Update Project (PA2007-073)	Vacant	Commercial (Large Water User)	17.53	Long term plans unknown. No new major development
Ullman Sail Lofts (PA2017-059)	Commercial: 9,962 sq. ft.	Mixed Use (Mixed Use)	0.13	2021
Newport Crossings	Retail: 22,976 sq. ft. Restaurant: 15,887 sq. ft. Medical Office: 5,467 sq. ft	Mixed Use (Mixed Use)	1.94	2023
ExplorOcean (PA2014-069)	Multi-Tenant Retail/Service: 26,219 sq. ft.	Institutional (Institutional/Mixed Use)	0.53	Project Status Questionable 2027?
Newport Dunes Hotel (PA2016-175)	None - Vacant area of Newport Dunes Resort	Commercial (Parks and Recreation)	69.41	2025

Future Development/Redevelopment	Anticipated Development Type and Size	Future Land Use Category (Existing)	Size (Acres)	Anticipated Development Period
Newport Village – Mariners Mile	Retail, Service Office: 65,604 sq. ft.	Mixed use (Commercial)	8.23	2023
Westcliff Mixed-Use Project	None	Mixed use (Commercial)	0.99	2023
Banning Ranch*	To be determined	Residential/Mixed use/Institutional/Open Space	-	Currently unknown

*Banning Ranch development is currently on hold due to the lack of the Coastal Development Permit.

Table 4-4 lists the Banning Ranch development as a potential future development. The Banning Ranch development is currently on hold due to the lack of a Coastal Development Permit. The current General Plan designation for the 401-acre Banning Ranch tract (Open Space/Residential Village) includes land uses for open space, restoration of wetlands and other habitat, and the development of a community park. Should the property not be acquired by the City, then the designation allows the development of an alternative planned residential community with “a maximum of 1,375 residential units, 75,000 square-feet of retail commercial, and 75 hotel rooms” (City of Newport Beach, 2006). City Planning staff indicated that it is still unknown if, or when, the City might acquire the Banning Ranch tract. To be conservative in sizing of nearby infrastructure, this WMP considers the water demands of the potential Banning Ranch development.

Map No.	Proposed Land Use	Future Land Use Category
1	Newport Harbor Yacht Club	Institution
2	Villas Fashion Island Apartments	Office
3	Lido House Hotel	Commercial
4	Westcliff Medical	Commercial
5	Newport Marina ETCO Development	Mixed Use
6	Mariner's Pointe	Commercial
7	Environmental Nature Center Preschool	Mixed Use
8	Balboa Marina Expansion	Marine Commercial
9	Lido Villas Townhomes	Residential Very High
10	Backbay Landing	Mixed Use
11	Plaza Corona Del Mar	Mixed Use
12	Old Newport Beach GPA Project	Commercial
13	Hoag Memorial Hospital Master Plan Update	Commercial
14	Ullman Sail Lofts	Mixed Use
15	Newport Crossing	Mixed Use
16	ExplorOcean	Institution
17	Newport Dunes Hotel	Commercial
18	Newport Village - Mariner's Mile	Mixed Use
19	Westcliff Mixed Use Project	Mixed Use
20	Banning Ranch	Residential/Mixed Use/Institutional/Open Space

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Future Development Areas

FIGURE 4-3

4.4 Land Use Demand Factors

As indicated previously, water demands are determined for existing and future development / redevelopment areas based on existing and planned land uses and land use-based water demand factors. Land use-based water demand factors were developed for each hybrid land use category by overlaying, in GIS, the hybrid land use map (Figure 4-2) on the map of the matched water meters and billing accounts. The matched meter and billing accounts were almost entirely within the residential land use categories-none were within the non-residential categories. Within the residential land uses, not every meter could be matched to a billing account. Thus, water demand factors were developed for the residential land use categories by identifying sample areas that had the most matched meters and customer accounts. The demand factors for non-residential land use categories were determined based on a review of factors used by other local communities and Arcadis's judgment and experience.

The water meters were queried within the residential sampling areas and the water demand (consumption) summed for each sampling area. The total water demand was then divided by the sum of land use parcel acreages within the sample areas, giving the land use demand factors in gpad. The resulting residential demand factors (and non-residential demand factors discussed below) were applied to acreages of existing land uses to calculate an existing water demand. The total water demand (including the Large Water User demands and an adjustment for NRW) was compared to the recent 10-year average water demand (15,991 AFY) and the factors were adjusted as necessary to achieve an adequate match between the calculated and actual total water demands.

Table 4-5 presents a summary of the resulting residential land use-based water demand factors, as well as the comparable 1999 WMP demand factors.

Table 4-5: Residential Land Use-Based Water Demand Factors

Land Use Category	1999 Water Demand Factor (gpad)	Calculated Water Demand Factor Range (gpad)	Calculated Water Demand Factor Average (gpad)	2019 Demand Factor (gpad)
Residential Low	2,160	1,513 – 2,665	2,055	2,200
Residential Medium Low	2,693	2,458 – 3,310	2,770	2,700
Residential Medium	3,024	2,368 – 3,641	3,046	3,050
Residential High	3,226	2,914 – 4,087	3,526	3,500
Residential Very High	--	3,343 – 4,051	3,781	3,800

As discussed previously, the matched meter and billing accounts were almost entirely within the residential land use categories-none were within the non-residential categories. Thus, the demand factors for non-residential land use categories were determined by reviewing factors used by the City in the 1999 WMP, factors used by other local communities, and by supplementing with Arcadis's experience and judgment to arrive at a recommended demand factor.

Table 4-6 summarizes the factors used in the 1999 WMP, the range of typical demand factors for each non-residential land use category, and the recommended demand factor used in this current WMP.

Table 4-6: Non-Residential Land Use-Based Water Demand Factors

Category	1999 Master Plan Factor (gpad)	Range of Typical Local Factors (gpad)	Recommended Demand Factor (gpad)
Commercial	1,757	1,170 – 5,839	1,757
Marine Commercial	1,757	--	1,757
Office	--	850 – 2,050	2,000
Mixed Use	--	1,000 – 3,010	2,200
Institutional	1,757	1,044 – 3,143	1,757
General Industrial	1,757	196 - 955	1,000
Open Space Non-Irrigated	0	0	0
Open Space Irrigated	1,296	2,200 – 2,500	1,700

The recommended non-residential demand factors (and residential demand factors discussed above) were also applied to acreages of existing land uses to calculate an existing water demand. The total water demand (including the Large Water User demands and an adjustment for NRW) was compared to the recent 10-year average water demand and the factors adjusted as necessary to achieve an adequate match between the calculated and actual total water demands. Table 4-7 summarizes the existing land use categories and demand factors used to achieve an adequate match to the 10-year average City water demand.

Table 4-7: Calculation of Existing Water Demands

Land Use Category	Total Acreage	Demand Factors (gpad)	Demand Adjusted for Loss (AFY)
Residential Low	1,519	2,200	3,933
Residential Medium Low	695	2,700	2,209
Residential Medium	461	3,050	1,656
Residential High	380	3,500	1,564
Residential Very High	294	3,800	1,314
Commercial	287	1,757	594
Marine Commercial	53	1,757	109
Office	270	2,000	636
Mixed Use	225	2,200	584
Institutional	383	1,757	793
General Industrial	17	1,000	20
Open Space Irrigated	697	1,700	1,394
Open Space Non-Irrigated	817	0	0
Large Water User	304		1,120
Totals	**6,402**		**15,926**
10-Year Average Demand			**15,991**
Difference			**- 0.4%**

4.5 Projected Water Demands

As described above, existing water demands were calculated by multiplying the residential (Table 4-5) and non-residential (Table 4-6) demand factors to existing acreages of their corresponding land use categories. To estimate future projected water demand, the same demand factors[1] were applied to projected total acreage for each land use category. Projected total acreage was calculated using the hybrid land use (Figure 4-2) and future development areas (Figure 4-3). Projected demands for the large water users and from the Banning Ranch Development were then added to obtain the total projected build-out demand for the City.

As indicated previously, this Master Plan conservatively assumes that the Banning Ranch tract will develop as the alternative residential community described in Section 4.3. Since specific planning for the

[1] Commercial, Marine Commercial, and Institutional demand factors rounded up to 1,800 gpad for projected water demands in order to be conservative.

alternative land uses was not available, the following assumptions were made for estimating future water demands within the tract:

- With 401 acres and 1,375 dwelling units, the tract would fit into the Residential Low category (0-4 DU/ac).
- The 75,000 square feet of commercial space would occupy two acres for retail commercial use. It is assumed that five acres total will be used for commercial retail purposes and a hotel. To be conservative, the commercial and hotel uses will be modeled as a Mixed Use property category.
- The General Plan also envisions the building of schools. This WMP assumes that 10 acres will be set aside for schools and will be modeled as an Institutional land use category.
- The General Plan also envisions open space but provides no acreage estimation. To be conservative, open space will not be included in the water demand estimates for the tract.
- In summary, the water demand for the future Banning Ranch alternative land uses are estimated according to the following:
  - Residential Low – 386 acres
  - Mixed Use – 5 acres
  - Institutional – 10 acres
- Based on the above assumptions, an estimated future demand of 980 AFY is assumed for the Banning Ranch development. This estimate is similar to the 1999 WMP estimate of 1,000 AFY which was based on slightly higher acreages for the various land uses.

The projected water demands at build out are presented in Table 4-8.

Table 4-8: Projected Water Demands at Build Out

Land Use Category	Total Acreage	Demand Factors (gpad)	Demand Adjusted for Loss (AFY)
Residential Low	1,519	2,200	3,933
Residential Medium Low	695	2,700	2,209
Residential Medium	449	3,050	1,611
Residential High	378	3,500	1,557
Residential Very High	295	3,800	1,320
Commercial	366	1,800*	775
Marine Commercial	53	1,800*	112
Office	269	2,000	633
Mixed Use	248	2,200	642
Institutional	384	1,800*	813
General Industrial	17	1,000	20
Open Space irrigated	627	1,700	1,255
Open Space Non-irrigated	817	0	0
Large Water User	287	-	954
Subtotals	**6,402**		**15,834**
Banning Ranch**	401	-	984
Total	**6,803**		**16,818**

*Commercial, Marine Commercial, and Institutional demand factors rounded up to 1,800 for projected water demands in order to be conservative.

**Banning Ranch development is currently on hold due to the lack of the Coastal Development Permit.

5 EXISTING SYSTEM INFRASTRUCTURE

An overview of the City's existing water infrastructure is illustrated on Figure 5-1. The City's distribution system consists of over 300 miles of distribution mains and is divided into five main pressure zones (Zone 1 through Zone 5) with 16 minor subzones (Figure 5-2). Zones 1 and 2 are the largest and cover most of the system demands. Zones 3, 4 and 5 are smaller zones served by booster pumps. The system has four wells, three storage reservoirs, five pump stations, and multiple pressure reducing valves (PRV).

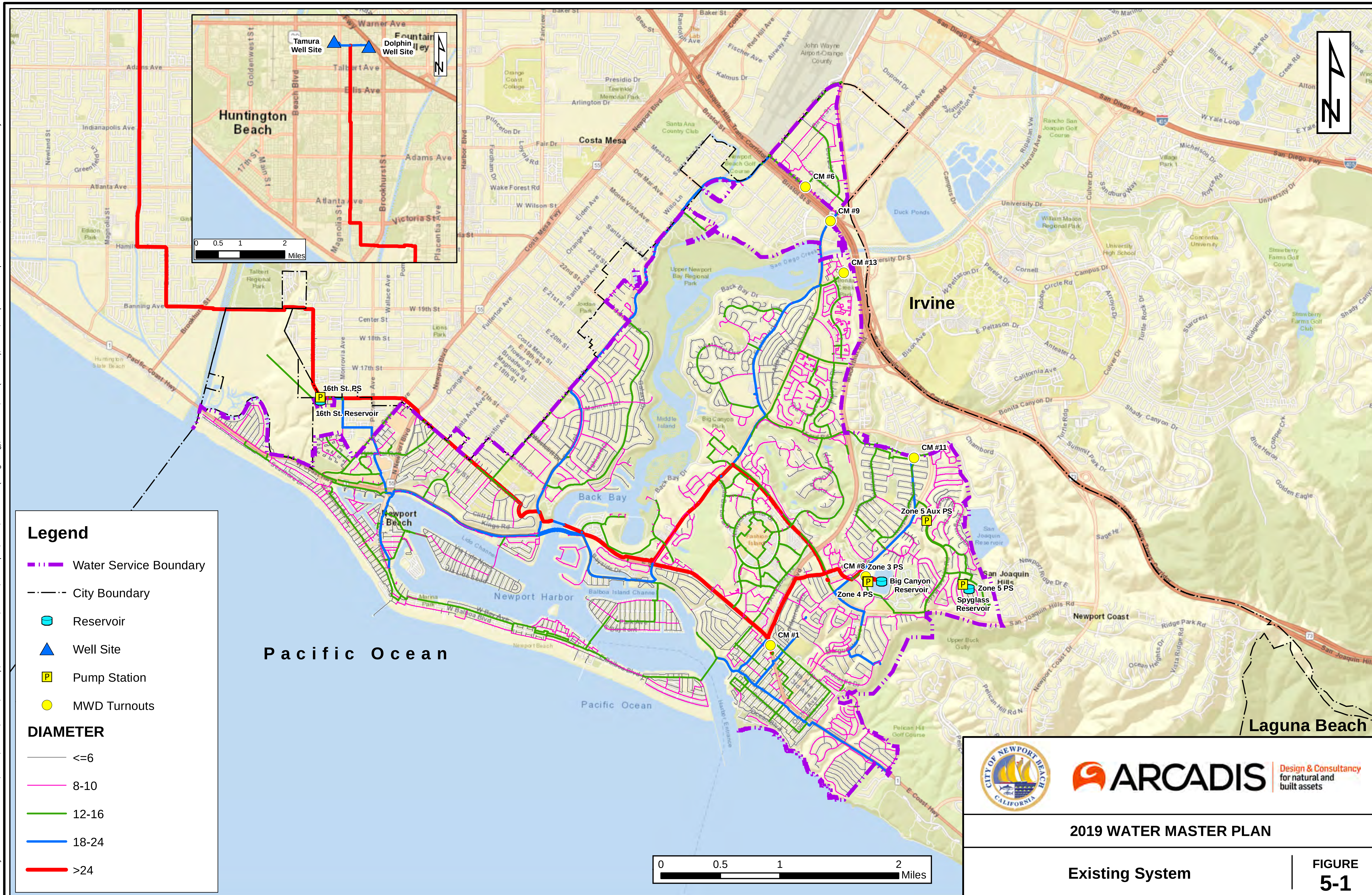
This section inventories these critical elements of the water system infrastructure along with their statuses and capacities as of 2017.

5.1 Wells

Section 2 (above) summarizes the City's groundwater supply and general water quality parameters. This groundwater is supplied by four wells located in Fountain Valley (Figure 5-1) and provides approximately 70 to 75 percent of the City's water. Table 5-1 summarizes the status, capacity in gallons per minute (gpm), and installation date for these wells.

Table 5-1: Existing Wells

Well	Well Designation	Operation Status	Capacity (gpm)	Head (ft)	Install Date
Tamura School	Deep	Active	3,200	335	1997
Tamura School	Shallow	Active	2,300	286	1997
Dolphin Avenue	Deep	Active	3,000	380	1997
Dolphin Avenue	Shallow	Active	2,400	275	1997



City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
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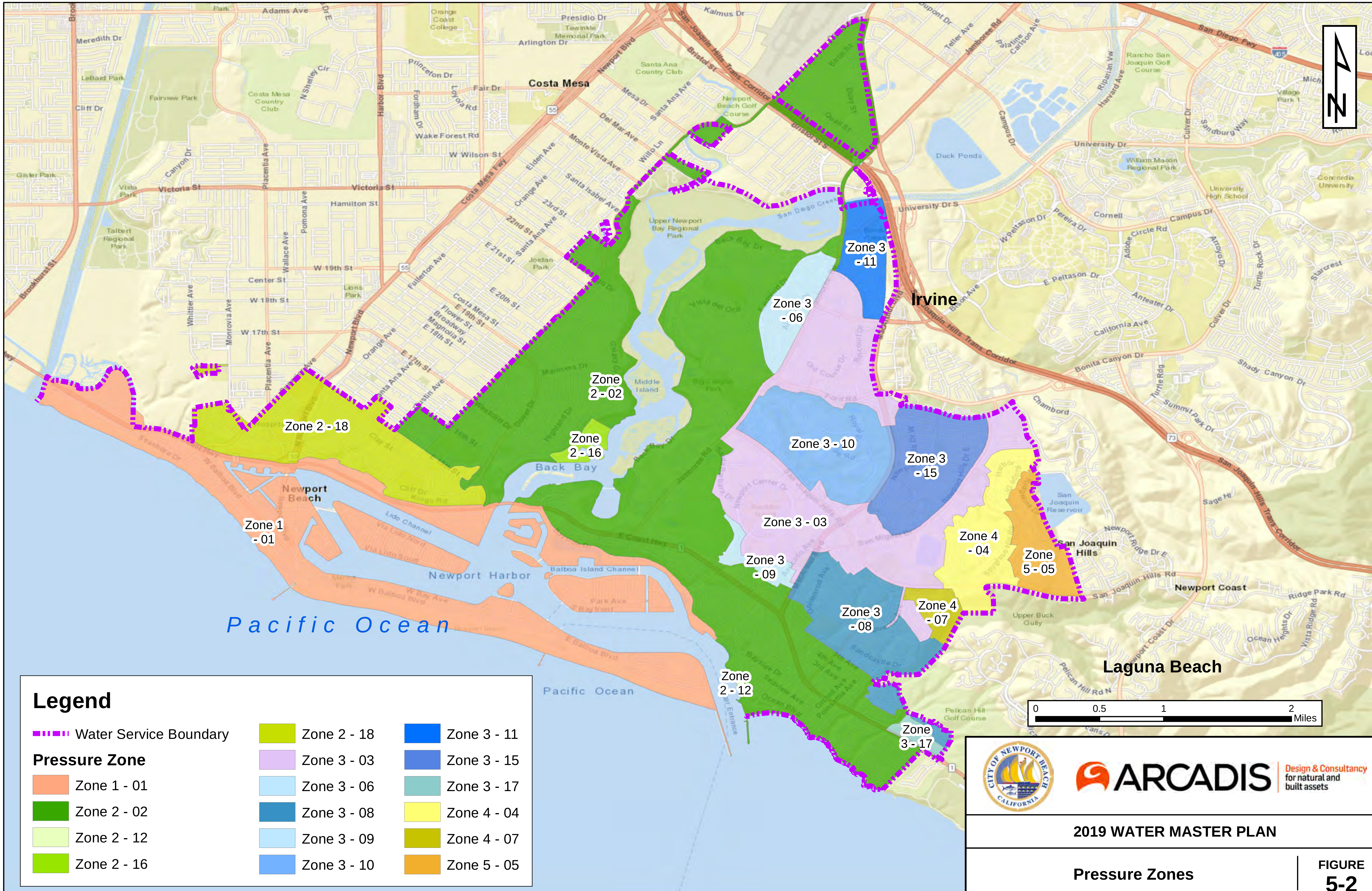

2019 WATER MASTER PLAN

Pressure Zones

FIGURE 5-2

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 5-2 Pressure Zones.mxd 4/3/2019 12:20:18 PM
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5.2 MWD Turnouts

The City supplements its groundwater supply with imported water supplied by MWD to meet demands. Table 5-2 below summarizes the six MWD turnouts with size, capacity and settings. The locations of these connections are shown on Figure 2-1. CM-8 and C-11 are actively used by the City to fill Big Canyon Reservoir (BCR) and to supplement groundwater supply. The remaining turnouts are for emergency situations.

Table 5-2: MWD Turnouts

Turnout Name	Size (in)	Capacity (cfs)	Source	To Zone	Control Mode	Pressure (psi) / HGL (ft)
CM-1	16	35.0	Orange County Feeder	2	Pressure with flow limited	75/ 283
CM-6	4 & 8	4.0	Orange County Feeder	2	Pressure with flow limited	110/ 305
CM-8	24	40.0	Orange County Feeder	2	Flow	-
CM-9	12	7.5	Orange County Feeder	2	Pressure	100/ 280
CM-11	16	30.0	Irvine Cross Feeder	3	Pressure	100/ 436
CM-13	4 & 8	7.5	Orange County Feeder	2 or 3	Pressure with flow limited	120/ 305

5.3 Storage Reservoirs

The City's distribution system has three storage reservoirs, including one large reservoir (BCR) with a floating cover and two concrete storage tanks listed in Table 5-3.

Table 5-3: Storage Reservoirs

Reservoir	Construction Type	Bottom Elevation (ft)	Height (ft)	Water Surface Elevation (ft)	Capacity (MG)
Big Canyon Reservoir	Covered Earth Embankment	264.5	38	302*	197.7
16th Street Reservoir	Below Grade Concrete Tank	75.5	27	-**	3
Spyglass Reservoir	Buried Cast-in-Place Concrete Tank	633	25	649***	1.5
Total Storage Capacity					**202.2**

Note: *average level maintained by City is 286 ft

**16th Street Reservoir is pumped to 301 ft

***average level maintained by the City

BCR is usually filled with water from CM-8. However, BCR also floats on the system, such that it can act as a supply to the distribution system (Zones 1 and 2) via gravity and can be filled with system water (from Zone 2) based on system demand. The 16th Street Reservoir is in Zone 2 and is filled with groundwater from the City's wells while Spyglass Reservoir is in Zone 4 and is filled by Zone 4 Pump Station with water from BCR.

5.4 Pump Stations

There are five pump stations in the City's distribution system listed in Table 5-4. The 16th Street pump station takes water from the 16th Street Reservoir and serves the demands in Zones 1 and Zone 2. It is also used to fill the BCR when the flow from the 16th Street Pump Station exceeds the demands in Zones 1 and 2.

Table 5-4: Pump Stations

Pump Station Name	Zone		Number of Pumps	Pump Number	Head (ft)	Capacity (gpm)	Size (HP)	Driver Type
	From	To						
Zone 3	2	3	4	1	188	2500	150	Elec.
				2	188	2500	150	Elec.
				3	190	5000	300	Elec.
				4	190	5000	300	Elec.
Zone 4	3	4	4	1	300	800	75	Elec.
				2	218	840	75	Elec.
				3	300	1600	150	Elec.
				4	266	1500	150	Gas Eng.
Zone 5	4	5	3	1	142	600	30	Elec.
				2	144	1250	60	Elec.
				3	144	1250	60	Elec.
Zone 5 Auxiliary (Hillsborough)	3	5	1	1	360	1500	250	Elec.
16th Street	Forebay	2	5	1	270	4000	300	Elec.
				2	270	4000	300	Elec.
				3	270	2800	350	Elec.
				4	270	2800	350	Elec.
				5	270	2800	350	Elec.

Zone 3 and Zone 4 pump stations pump water from BCR to Zone 3 and Zone 4, respectively. Zone 5 serves water from Spyglass Reservoir to Zone 5. Most motors at the pump stations have variable frequency drives (VFD).

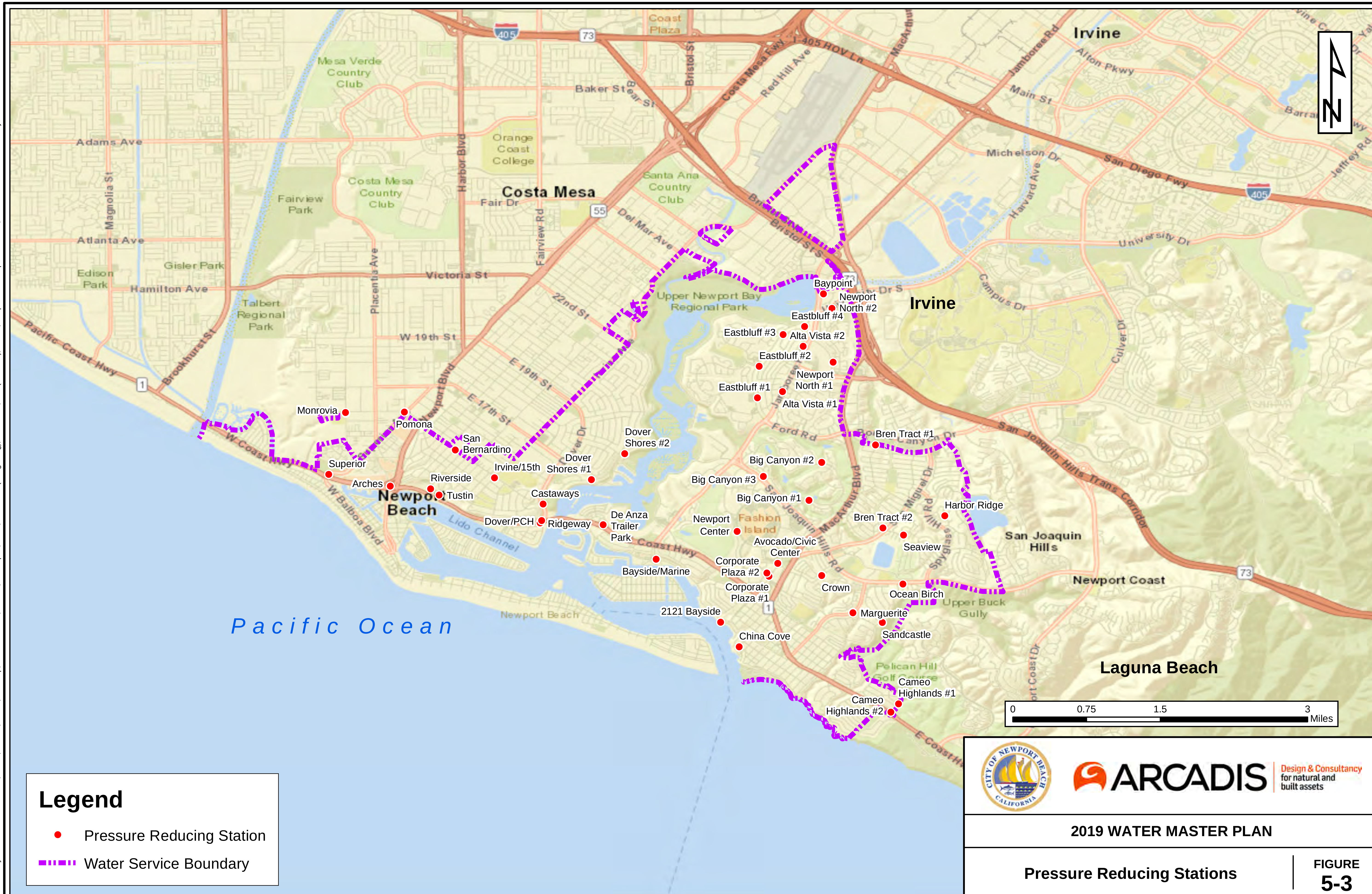
5.5 Pressure Reducing Stations

Pressure reducing stations (PRS) are structures containing PRVs that reduce pressure from a higher-pressure zone (higher elevation) to a lower-pressure zone (lower elevation). To manage pressure across the system, the City maintains 43 PRS as shown on Figure 5-3. Each station includes one or two PRVs resulting in a total of 65 PRVs. Table 5-5 summarizes these stations with valve sizes and settings as of 2017. The water system hydraulic profile is presented in Figure 5-4.

Table 5-5: Pressure Reducing Stations

Name	Mean Sea Level (ft)	Diameter (in)	Setting (psi)
Alta Vista #1	216	6	55
Alta Vista #2	173	6	68
Arches	5.4	8	67
Arches	5.4	12	67
Avocado/Civic Center	162	4	65
Avocado/Civic Center	162	12	65
Baypoint	27.6	6	95
2121 Bayside	4	8	63
2121 Bayside	4	12	63
Bayside/Marine	9.5	8	67
Bayside/Marine	9.5	12	67
Big Canyon #1	150	12	90
Big Canyon #1	150	4	90
Big Canyon #2	204	12	70
Big Canyon #2	204	4	70
Big Canyon #3	184	4	75
Big Canyon #3	184	8	75
Bren Tract #1	170	8	95
Bren Tract #2	260	4	55
Bren Tract #2	260	8	55
Cameo Highlands #1	180	8	55
Cameo Highlands #1	180	4	55
Cameo Highlands #2	153	3	90
Cameo Highlands #2	153	8	63
Castaways	11.9	12	110
China Cove	16	8	70
China Cove	16	4	70

Name	Mean Sea Level (ft)	Diameter (in)	Setting (psi)
Corporate Plaza #1	134	8	70
Corporate Plaza #2	134	8	65
Crown	262	6	50
	262	2	50
De Anza Trailer Park	17	6	60
Dover Shores #1	54	6	65
	54	8	65
Dover Shores #2	64.7	6	60
	64.7	4	60
Dover/PCH	2.4	6	62
	2.4	12	62
Eastbluff #1	123	4	75
Eastbluff #2	116	4	70
Eastbluff #3	98	4	85
Eastbluff #4	89	4	80
Harbor Ridge	491	4	75
	491	8	75
Irvine/15th	75.3	8	67
Marguerite	253	2	55
	253	6	55
Monrovia	105	12	51
Newport Center	165	8	60
	165	4	60
Newport North #1	116	4	55
	116	8	55
Newport North #2	24.3	4	97
	24.3	8	97
Ocean Birch	360	4	55
	360	8	55
Pomona	74.9	12	66
Ridgeway	2.4	8	65
Riverside	5.5	6	65
San Bernardino	86	8	60
Sandcastle	257	6	50
	257	2	50
Seaview	348	6	60
Superior	6.2	6	65
Tustin	6.8	6	65



2019 WATER MASTER PLAN

Pressure Reducing Stations

FIGURE 5-3

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\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 5-3 Pressure Reducing Stations.mxd 4/3/2019 1:21:39 PM
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2019 WATER MASTER PLAN

WATER SYSTEM HYDRAULIC PROFILE

FIGURE **5-4**

5.6 Distribution System Piping

The City's distribution system consists of approximately 300 miles of pipelines as list in Table 5-6. Their diameters range from 1-inch to 48 inches the majority being 6- and 8-inch diameter pipes.

Table 5-6: Distribution System Pipes (by Diameter)

Diameter (inch)	Length (miles)	Percentage
1	0.19	0.06
2	2.21	0.74
3	0.16	0.05
4	12.78	4.26
5	0.01	0.002
6	111.30	37.12
8	85.34	28.46
10	4.88	1.63
12	40.86	13.63
14	0.58	0.19
16	8.59	2.86
18	5.05	1.68
20	0.17	0.06
24	12.55	4.19
27	0.09	0.03
30	9.36	3.12
36	5.55	1.85
48	0.16	0.05
Total	**299.84**	**100**

Most distribution system material is asbestos cement pipe (ACP), followed by poly vinyl chloride (PVC) and ductile iron pipe (DIP) as listed in Table 5-7.

Table 5-7: Distribution System Pipes (by Material)

Material	Length (miles)	Percentage
Asbestos Cement Pipe (ACP)	196.37	65.5
Cast Iron Pipe (CI)	15.50	5.2
Copper Pipe (CU)	1.02	0.3
Ductile Iron Pipe (DIP)	26.46	8.8
Galvanized Steel Pipe (GS)	2.18	0.7
Gunited Steel Pipe (GUN)	0.33	0.1
High Density Polyethylene (HDPE)	0.00	0.002
Mortar Lined Cement Coated Steel Pipe (MLCCSP)	18.70	6.2
Poly Vinyl Chloride (PVC)	32.14	10.7
Reinforced Concrete Steel Cylinder Pipe (RCSCP)	6.40	2.1
Standard Steel Pipe (SSP)	0.45	0.2
Unknown Material (UNK)	0.28	0.12
Total	**299.84**	**100.0**

A more detailed analysis of pipe and their material characteristics can be found in Section 9.

6 HYDRAULIC MODEL DEVELOPMENT

For this WMP, a new GIS-integrated hydraulic model of the City's water system, which includes all pipelines, was developed by Sedaru using the Innovyze InfoWater software to analyze the water system conveyance and distribution system. Data from previous modeling and master planning efforts was used, along with projections of future water use and land use development to further help prioritize future facility needs.

The hydraulic model was developed using the City's GIS of its water infrastructure. After a detailed review of the GIS data, the following feature classes were used to build the model: WaterLine, WaterPoints, and WaterValve.

Much of the data presented in Section 5 of this WMP was used to build the model. The following sections describe the additional salient information used to develop the hydraulic model, including detailed information on the hydraulic parameters of the reservoirs, tanks, wells, pump stations, and pipes contained in the existing system.

6.1 Wells and Storage Reservoirs

The hydraulic model includes all three reservoirs in the system - BCR, Spyglass, and 16th Street. The dimensions of the reservoirs were set as per Table 5-3. BCR establishes the Zone 2 hydraulic grade line with a maximum water surface elevation of 302 ft. The City, however, maintains an average water level of 286 ft., which corresponds to approximately 98 million gallons (MG) of storage. Spyglass Reservoir (also known as Zone 4 Reservoir) establishes the Zone 4 hydraulic grade line at an average water surface elevation of 649 ft.

6.2 Wells

The City's four wells at Dolphin Avenue and Tamura School supply the 16th Street Reservoir. They are represented in the model as fixed-grade reservoirs.

6.3 Pressure Reducing Stations

It is important to accurately represent each PRS to best represent the flow and distribution of water through the City's system. The PRSs were modeled to include all the PRVs in each station along with appropriate piping layouts based on the City's GIS. Additional pipes and their corresponding junctions (or connections) were manually added to represent the entire facility (Note: GIS facility ID's (FID's) were used when possible to facilitate future model updates). The valve settings from Table 5-5 were used under both steady-state and extended period simulation (EPS) calibration.

6.4 Pump Stations

All five pump stations with their individual pumps were added to the model using the information in Table 5-4. Individual controls were added to the pumps after discussions with City staff and based on the previous hydraulic model. The 16th Street Pump Station is operated on a time-of-day basis to take advantage of lower off-peak power costs. The Zone 3 Pump Station is set to maintain 78 pounds per square inch (psi) in the pressure zone and the Zone 4 Pump Station is controlled by the level in Spyglass Reservoir. The VFDs at Zone 5 Pump Station is set at 65 psi. Zone 5 Auxiliary Pump Station is rarely used so the pumps at this station are normally off. The pressure/flow (pump) curves for individual pumps were also extracted from the previous hydraulic model and updated based on pump tests performed by the City in 2013.

6.5 Emergency Interconnections

As shown on Figure 2-1, there are multiple inter-agency emergency interconnections with IRWD and MESA. The City does not routinely use these interconnections; however, the interconnections were included in the model as fixed-grade reservoirs for future use if needed.

6.6 MWD Turnouts

Imported MWD water is delivered through six turnouts on the Orange County Feeder and East Orange County Feeder No. 2 and are designated as CM-1, CM-6, CM-8, CM-9, CM-11, and CM-13. The City normally takes all imported water from CM-8 and CM-11. These turnouts are represented in the model as fixed-grade reservoirs with a valve. The interconnection with LBCWD (CM-1A) is used to wheel water through the City's water system. LBCWD groundwater, pumped via City wells, is moved through the City's system to LBCWD's system using this interconnection. Therefore, this was modeled as a demand node.

6.7 Pipes

All pipes in the "WaterLine" layer from the City's GIS were imported into the model using InfoWater's GIS Exchange module. Some portions of transmission and distribution mains, including pipes to and from pumps and reservoirs, were not in the GIS and were manually added as they are necessary to accurately model the water system. Since an all-pipe model was developed, the pipes summarized in Section 5 were incorporated into the model.

6.7.1 Pipe Roughness Coefficients

Pipe roughness coefficients were used in the hydraulic model to account for friction losses, or the energy required to move water through the system pipelines. Commonly used pipe roughness coefficients that represent these friction losses are Hazen-Williams "C-factors". C-factor determination is guided by industry standards primarily based on pipeline size, material, and age, as well as field observations during model calibration.

The C-factors in Table 6-1: were used to estimate initial pipe roughness coefficients for all pipes in the model. If material, diameter, or age were unknown for a certain pipe, a C-factor of 120 was assumed. These initial C-factors were determined based on Arcadis' and Sedaru's extensive modeling and field experience with similar water distribution systems.

Table 6-1: Initial C-Factors

		Pipe Material										
Diameter (Inch)	**Age (Years)**	**ACP**	**CIP**	**CU**	**DIP**	**GS**	**GUN**	**HDPE**	**RCSCP**	**PVC**	**MLCCSP**	**SSP**
<10	**<15**	130	100	--	110	--	--	129	--	140	--	--
	15-75	124	95	130	105	--	130	--	120	140	135	--
	>75	117	90	--	99	99	--	--	--	--	--	110
10-18	**<15**	--	--	--	116	--	--	--	--	140	135	--
	15-75	130	100	--	110	--	--	--	120	140	135	110
	>75	--	95	--	105	--	--	--	--	140	--	--
>18	**<15**	--	--	--	--	--	--	--	--	--	135	--
	15-75	137	100	--	116	116	130	--	120	140	135	116
	>75	--	95	--	--	110	--	--	--	--	135	--

* Pipe with an unknown diameter, age, or material was assigned a C-factor of 120

6.8 Isolation Valves

All locations of isolation valves were identified in the City's geodatabase by using the WaterValve GIS feature class where the field "NormallyClosed" was set as Yes. These locations were reviewed and represented in the model as a closed pipe. Most of these locations in the model are at zone boundaries.

6.9 Elevations

Elevations were assigned to the model elements based on digital elevation model (DEM) data using Innovyze's Elevation Extraction tool. The model has two sources of elevation data: elevations assigned using United States Geological Survey (USGS) DEM and elevations assigned to network facilities from available City records. The DEM is brought into GIS and intersected with the model nodes to assign elevations that are in meters and then converted to feet (ft). When available, City data such as as-built drawings were used to update critical facilities such as tank base elevations, control valve elevations, and pump centerlines. In most cases the default is DEM unless otherwise changed based on more accurate information. Elevations range from 0 to 692 ft above mean sea level (msl), with over 80 percent of elevations lying below 200 ft.

6.10 Demand Allocations

Customer water use throughout the system is converted to model demands taken from the system at nodes (or junction points) along pipelines. Model demands were developed and allocated based upon a land-use parcel GIS feature class described in Section 4. Each parcel was given a unit demand factor based on the land-use category in gallons per minute per acre (gpm/ac) based on a 10-year average consumption. For each parcel, consumption was calculated by multiplying the unit demand factor by the acreage. Parcel centroids were then defined and used to spatially allocate the water use to the hydraulic model junctions, using parcel centroids as GIS meter point data and the InfoWater's demand allocator add-on tool. Demands were allocated to model junctions by pressure zone using the closest pipe methodology in the demand allocator.

6.11 Demand Patterns

A diurnal water use pattern represents typical daily fluctuation in customer water use over a 24-hour period. Patterns are necessary to accurately perform EPS analyses that simulate water system hydraulic performance over a 24-hour period. Diurnal curves were developed using the City's SCADA data for storage and incoming and outgoing flows for each pressure zone. A 15-minute increment was used to capture peak water use during the day and establish a more accurate diurnal pattern. The diurnal curves developed per zone for use during calibration can be seen in **Figure 6-1** below.

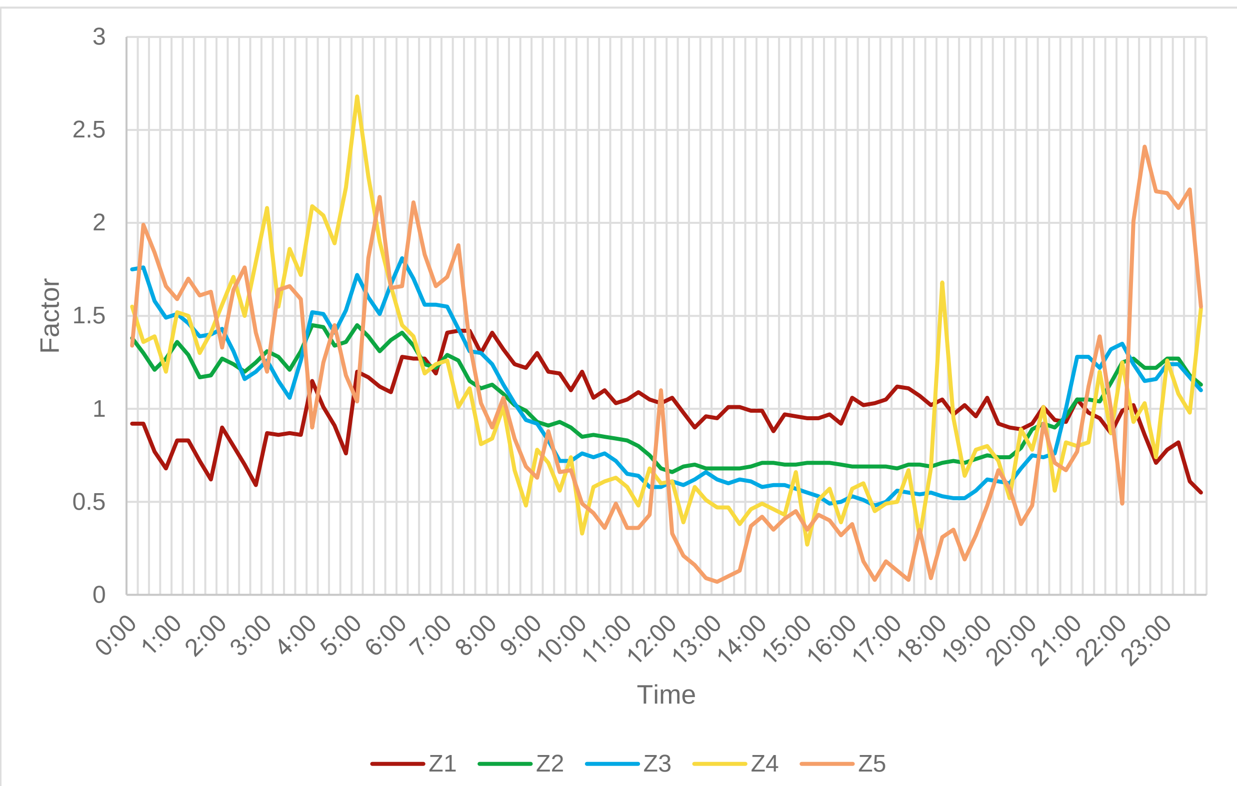


Figure 6-1: Diurnal Curves Per Pressure Zone

7 HYDRAULIC MODEL CALIBRATION

Water distribution models can be a useful tool for system planning, operations, and design efforts. Since the decisions that come from a modeling effort often result in infrastructure projects with significant expenditures, it is important that the model accurately represents the physical system and realistic facility operation. The calibration effort compares simulated results to actual measured data and makes necessary adjustments to achieve a reasonable match to produce a model that can be used with confidence to predict system performance for future planning. This section describes the criteria and general procedures used to calibrate the City's water model. The model was calibrated for steady-state and EPS conditions. The model results were compared against 10 fire hydrant flow tests for steady-state and 13 hydrant pressure recorder (HPR) locations for EPS. In addition, available SCADA data was used as an additional comparison for EPS model analysis.

7.1 Calibration Criteria

The goal of the steady-state calibration was for the pressure drop between static and residual at the modeled observation hydrants to match field pressure drop within +/-5 psi at 90 percent of the hydrant test locations. Similarly, the primary calibration targets for EPS calibration were to match field pressures within +/-5 psi at the HPR locations. Additional care was taken such that modeled flow, pressure, and tank levels followed the same general trend as the observed SCADA data. Calibration criteria are summarized in Table 7-1 and Table 7-2 below. These criteria are based on industry standards, American Water Works Association (AWWA) Manual of Practice 32, Computer Modeling of Water Distribution Systems recommendations and Arcadis's extensive experience.

The calibration exercise was performed through several iterations that progressively increased the accuracy of the results. If discrepancies between the model and the field results were identified, possible reasons for the differences were determined. These reasons are provided in the subsequent sections.

Table 7-1: Steady-State Calibration Criteria

Pressure Drop (psi)	
0 - 3	Excellent
3 - 5	Good
5 - 10	Fair

Table 7-2: EPS Calibration Criteria

Matching Level*
1 - Both trend and magnitude do not match/differ significantly
2 - Trend or magnitude somewhat match
3 - Trend and magnitude both somewhat match
4 - Trend or magnitude matches very well
5 - Trend and magnitude both match very well

*Matching level is an indicator of how well model results match field data in terms of trends, high and low range, slope of curves, etc. Match levels are ranked from 1 to 5. One is the lowest ranking and five is the highest.

7.2 Calibration Procedure, Setup and Results

After model construction, system controls and setpoints were added to accurately represent actual system operations based on observed HPR data, SCADA data and/or input from City operations staff. The calibration procedure was an iterative process to resolve differences between hydrant test, HPR, SCADA data and the model. After running model simulations, the results were compared graphically to the hydrant test, HPR, and SCADA data. Where obvious differences existed between the model and observed data, adjustments to pipe C-factors and distribution facility setpoints and controls were explored to model the system more accurately. The City's staff provided additional information when available to help reconcile the differences.

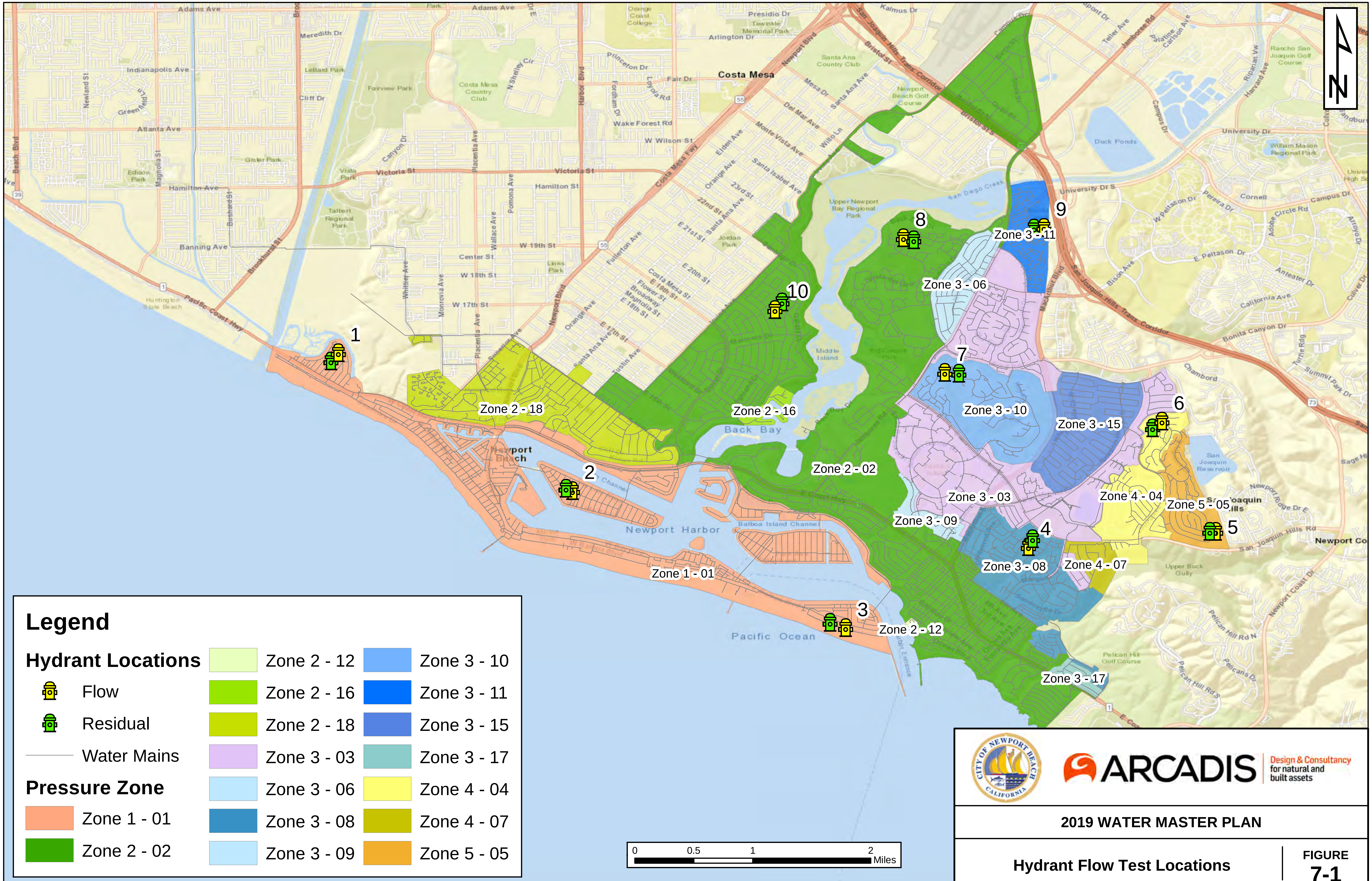
7.2.1 Calibration Setup

The City provided distribution system SCADA data for the hydrant testing period. The data included pressures, flows, and tank levels that were used in the model to set the boundary conditions to simulate actual system conditions during the calibration period. System demands for each zone were adjusted using a multiplier based on a general system diurnal curve to simulate the demands for that day. These demands are expected to approximate actual demands used for the calibration day. The multipliers used can be seen in Table 7-3 below.

Table 7-3: Demand Multipliers for Calibration

Zone	Demand Multipliers
1	1.21
2	1.21
3	1.23
4	1.57
5	1.41

For the EPS calibration scenario, the model was set up using 15-minute timesteps and 24-hour duration corresponding to July 19, 2017. The diurnal curves shown in **Figure 6-1** were applied to the demand nodes in each pressure zone.



2019 WATER MASTER PLAN

Hydrant Flow Test Locations

FIGURE 7-1

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\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 7-1 Hydrant Flow Test Locations.mxd 4/3/2019 1:28:53 PM
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7.2.2 Steady-State Calibration Results

Steady-state model calibration was performed using hydrant flow test data collected on July 18, 2017 and July 19, 2017. Figure 7-1 shows the location of hydrant flow tests. Appendix A shows the hydrant flow test results. For each test, there was a flow hydrant used to record flow and an observation hydrant used to record static and residual pressures. The summary of results of the steady-state calibration can be seen in Table 7-4 below. The pressure change as shown in the table is the difference between the static and residual pressure recorded at the observation hydrant.

Table 7-4: Steady-state Calibration Summary

Test ID	Flow Hyd. ID	Obs. Hyd. ID	Static Pressure (psi)		Pressure Drop (psi)		Difference (psi)	Matching Level
			Observed	Modeled	Observed	Modeled		
1	30	35	63.9	64.4	6.5	5	-1.50	Excellent
2	195	194	61.3	63.9	4.4	2.98	-1.42	Excellent
3	280	277	62.1	63.6	6.4	5.83	-0.57	Excellent
4	1855	1852	49.7	48.3	5.2	2.3	-2.90	Excellent
5	2418	2206	68.7	67	5	2.4	-2.60	Excellent
6	2141	2148	118.4	120.8	19.9	20.3	0.40	Excellent
7	1210	1213	106.9	110.4	8	8.95	0.95	Excellent
8	2295	922	84	84.3	1.9	2.46	0.58	Excellent
9	899	898	88.9	90.2	6.2	4.3	-1.90	Excellent
10	673	674	84	84.3	6.6	8.21	1.63	Excellent

Steady-state calibration results show excellent results at all ten hydrant test locations with the difference in pressure drop of 3 psi or less.

7.2.3 Extended Period Simulation Calibration Results

EPS model calibration was performed using HPR data at 13 locations and available SCADA data from July 19, 2017. The HPR locations are shown in Figure 7-2. The summary of EPS calibration results at the HPR locations can be seen in Table 7-5 below using the matching level described in Table 7-2. The summary of EPS calibration results at the SCADA locations can be seen in Table 7-6 below.

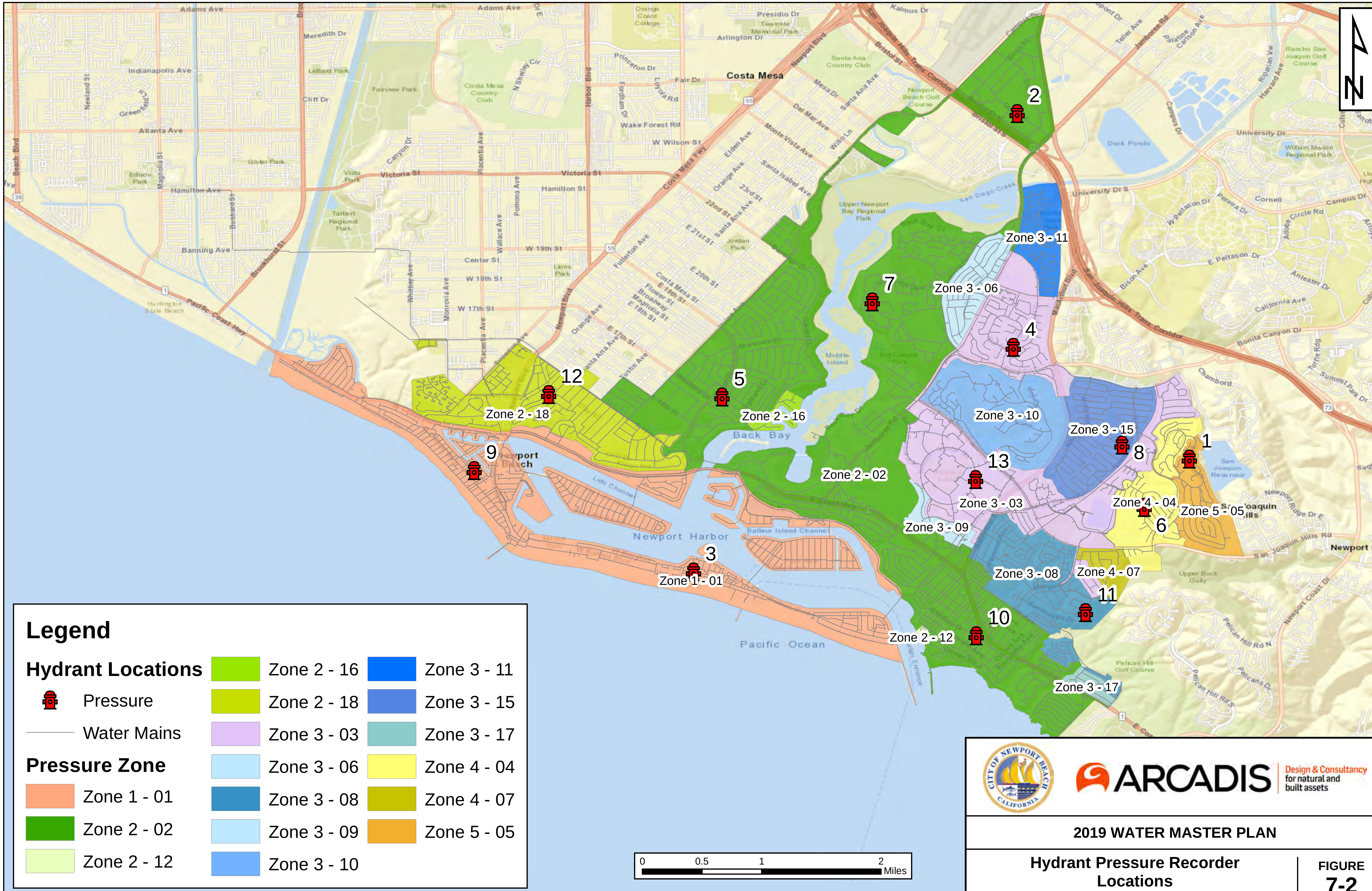
Table 7-5: EPS Calibration Results Summary (HPR locations)

HPR Location	Street	Zone	Matching Level
1	RIDGELINE DR	5	4
2	QUAIL ST	2	4
3	ISLAND AVE	1	5
4	OLD COURSE DR	3	5
5	WESTCLIFF DR	2	4
6	CARMEL BAY DR	4	5
7	VISTA DEL ORO	2	5
8	PORT SEABOURNE WAY	3	4
9	LAKE AVE	1	5
10	BAYSIDE DR	2	4
11	INLET ISLE DR	3	5
12	CATALINA DR	2	5
13	SAN NICOLAS DR	3	5

Table 7-6: EPS Calibration Results Summary (SCADA locations)

Facility Name	Matching Level
Zone 4 Tank	5
Discharge Pressure of PS3	5
Discharge Pressure of PS4	5
Discharge Pressure of PS5	5
Suction Pressure of PS5	5
Eff. Flow of PS3	5
Eff. Flow of PS4	5
Eff. Flow of PS5	5
Eff. Flow of 16th St PS	4
BCR Inf. Bypass Flow	3
BCR Eff. Flow	4
Arches Incoming Pressure	5
Arches Flow	4
Irvine Incoming Pressure	5
Irvine Flow	5
Marine Incoming Pressure	4
Marine Flow	-*
Monrovia Incoming Pressure	5
Monrovia Flow	4
Superior Incoming Pressure	5
Superior Flow	2
Bayside Incoming Pressure	4
Bayside Flow	2
San Bernardino Incoming Pressure	5
Pomona Incoming Pressure	5

* Flow data unavailable for calibration period



Legend

Hydrant Locations

- Pressure
- Water Mains

Pressure Zone

- Zone 1 - 01
- Zone 2 - 02
- Zone 2 - 12
- Zone 2 - 16
- Zone 2 - 18
- Zone 3 - 03
- Zone 3 - 06
- Zone 3 - 08
- Zone 3 - 09
- Zone 3 - 10
- Zone 3 - 11
- Zone 3 - 15
- Zone 3 - 17
- Zone 4 - 04
- Zone 4 - 07
- Zone 5 - 05

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Hydrant Pressure Recorder Locations

FIGURE 7-2

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 7-2 HPR Locations.mxd 4/3/2019 1:25:53 PM
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Observations

- EPS calibration results at the HPR locations show excellent results at 8 of the 13 locations and very good results at the remaining 5 locations.
- EPS calibration results at the SCADA locations overall show very good to excellent results with few exceptions as noted below.
    - Marine Flow: The PRV settings for Zone 1 were set up according to SCADA. With those settings, we were able to match flows at Arches, Superior and Bayside. The remaining flow is supplied by Marine PRV. However, SCADA shows zero flows at this PRV which indicates the SCADA recording might be in error. Different combinations of settings at Dover and Marine were modeled but none matched field measurements.
    - BCR Inf. Bypass Flow: There appears to be a slight shift in the diurnal pattern that causes a greater difference in flows over the EPS timesteps. When the overall average in the model is compared to the overall average in SCADA, the comparison shows a better match.
    - Superior Flow: It is expected for flow to vary through a PRV in response to system demands. However, at Superior flow remains constant indicating possible inaccuracies in measuring low flows or poor physical condition of the valve.
    - Bayside Flow: The actual demand directly served by the PRV may be higher than modeled or may have a different diurnal pattern than the rest of the zone.

Overall, the model results matched the measured data reasonably well, and the model can confidently be used as a tool to perform system evaluation and predict future hydraulic conditions. Detailed EPS comparison graphs for both the HPR and SCADA locations are shown in Appendix B.

8 HYDRAULIC SYSTEM ANALYSIS

The calibrated hydraulic model and design criteria were used to evaluate the existing and future system under current and build-out demands to assess system performance. Deficiencies, if any, were identified during this hydraulic analysis and were incorporated in the CIP development process.

8.1 System Performance and Design Criteria

The City has established performance and design criteria for its system as a standard against which water infrastructure can be evaluated as shown in Table 8-1. These were developed based on the criteria used in the 1999 WMP and 2008 Update. Criteria like fire flow, head loss, velocity and maximum pressure were also updated based on the City's design criteria. The peaking factors were updated based on values described in Section 3.3.

Table 8-1: System Performance and Design Criteria

Parameters		Criteria
Pipes	**Velocity**	< 8 ft/s for pipe <= 10 inch
		< 5 ft/s for pipe >= 12 inch
		10 ft/s during Fire Flow
	Head Loss	< 5 ft/1000 ft for all pipe sizes
Storage (per Zone)	**Regulatory Storage**	25% of MDD[1]
	Fire Storage	Depends on area of influence of Zone
	Emergency Storage*	Demand for 7 average days
System Pressure	**Maximum Pressure**	140 psi
	Peak Hour Demand	40 psi minimum
	Max Day + Fire Flow Demands	20 psi minimum
	Minimum Day Demand	60-90 psi
Wells	**Capacity of direct supply wells**	ADD[2]
Booster Pump Station Capacity	**Demand Conditions**	Assuming the largest pump within the station is out of service, the higher between the PHD[3] or MDD plus fire flow or MDD plus fire flow in case of available floating storage.
Peaking Factors	**Maximum Month**	1.35
	Maximum Day	1.85
	Peak Hour	Zones 1 & 2 – 2.6 Zone 3 – 3.1 Zones 4 & 5 – 4.0

Parameters		Criteria
Fire Flow	**Single Family**	1,000 gpm for 2 hours
	Community Facilities	1,500 gpm for 2 hours
	Multiple Family & Closely Built Residential (one & two stories)	2,000 gpm for 2 hours
	Multiple Family & Closely Built Residential (three stories or more)	2,500 gpm for 3 hours
	Multiple Family Attached Residential	3,000 gpm for 3 hours
	Commercial (up to two stories)	3,000 gpm for 3 hours
	Commercial (over two stories)	5,000 gpm for 5 hours
	High-Rise Residential	5,000 gpm for 5 hours
	Business Park/Industrial Park	5,000 gpm for 6 hours
	Regional Shopping Centers	6,000 gpm for 6 hours

Note: MDD = [1]Maximum Day Demand, [2]ADD = Average Day Demand, [3]PHD = Peak Hour Demand

*Emergency Storage is based on MWD Administrative Code Section 4503 b1

8.2 Existing System Analysis

The system was analyzed under existing demands against the criteria presented in Section 8.1. The system storage and pumping were compared against the criteria to identify any deficiencies. The distribution system was analyzed using the hydraulic model under ADD, MDD and fire flow scenarios.

8.2.1 Existing Storage and Pumping Analysis

System storage is used to meet operational daily demand fluctuations, fire flow and emergency storage in the event of a supply interruption. The sum of these storage values must be met by the available storage in each pressure zone or the ability to move sufficient flow from one zone to another. Sub-pressure zones that are hydraulically connected and are served by the same facilities are grouped together.

Table 8-2 details the storage calculations for each pressure zone and the additional capacity needed. Based on the calculation below, the City's available storage (202.5 MG) significantly exceeds the City's criteria (108.3 MG). Usually in a system with multiple pressure zones, the available storage in a zone is compared with the storage criteria. For the City, the storage analysis was not done on a zone-by-zone basis as the storage available in any zone can be used in other zones, except for the Zone 4 (Spyglass) reservoir.

Table 8-2: Existing System Storage Gap Analysis

Parameters	Existing
Average Day Demand (mgd)	14.3
Maximum Day Demand (mgd)	26.3
Peak Hour Demand (mgd)	56.9
Fire Flow (MG) – 6,000 gpm for 6 hours	2.2
Existing Storage Capacity (MG)	202.5
Storage Criteria	
Regulatory Storage Needed (MG)	6.6
Fire Storage Needed (MG)	2.2
Emergency Storage Needed (MG)	99.5
Total Storage Needed (MG)	108.3
Storage Excess (MG)	94.2

For the pumping analysis, the firm capacity (largest pump out of service) of a pump station in a pressure zone must be greater than the higher of the MDD plus fire flow or the PHD. Table 8-3 summarizes the pumping analysis by pressure zone. Zones 1 and 2 were combined as 16th Street Pump Station pumps to both these zones simultaneously. The analysis shows a small pumping deficiency (0.8 mgd) in Zones 1 and 2. This is not a true deficiency because when demands in Zones 1 and 2 exceeds the capacity of 16th Street, the water from BCR flows via gravity to make up the difference. This deficiency was further analyzed using the hydraulic model.

Table 8-3: Existing System Pumping Gap Analysis

Parameters	Zone 1 & 2	Zone 3	Zone 4	Zone 5
Average Demand (mgd)	9.3	4.1	0.59	0.26
Booster Capacity (mgd)	17.9	14.4	4.5	4.8
Pumping Criteria				
Maximum Day Demand (mgd)	17.1	7.6	1.1	0.5
Fire Flow (mgd)	1.5	2.2	0.5	0.5
Maximum. Day Demand + Fire Flow (mgd)	18.6	9.8	1.6	1.0
Peak Hour Demand (mgd)	24.1	12.7	2.4	1.0
Governing Flow (mgd)	18.6[1]	12.7	2.4	1.0
Pumping Excess (mgd)	(0.8)	1.7	2.2	3.8

Note:[1]MDD + Fire Flow is governing criteria due to the availability of floating storage at BCR

8.2.2 Maximum and Minimum Day Demand Analysis

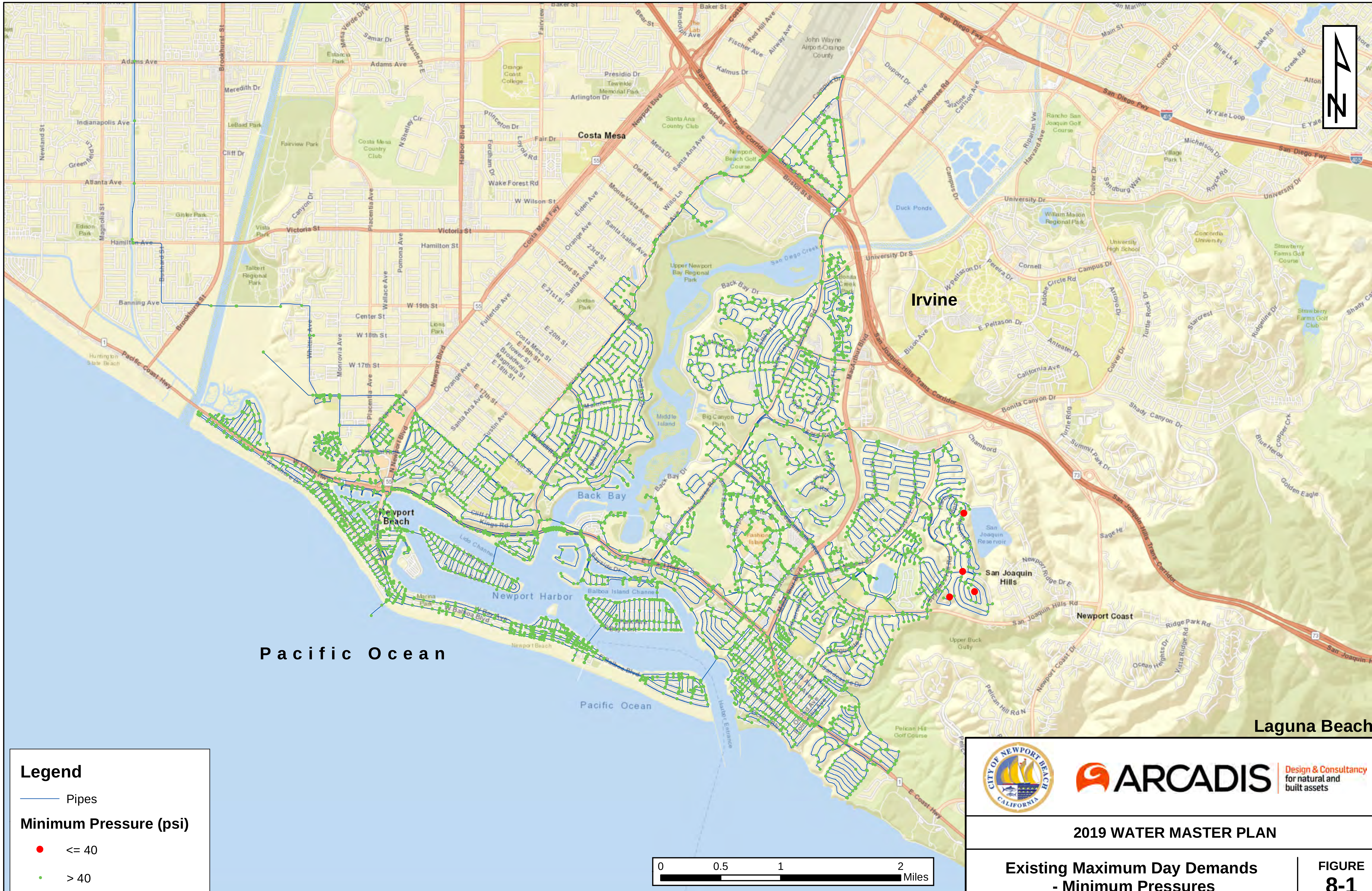
The calibrated model presented in Section 7 was used to analyze the hydraulics of the City's distribution system against the criteria presented in Section 8.1 to identify any deficiencies. Any improvements needed were included in the CIP development.

The distribution system was analysed under MDD to identify minimum pressures. Figure 8-1 shows four nodes in Zone 5 and one bordering Zone 5 Zone 4 with pressure marginally below 40 psi. These locations were further evaluated with help from the City's staff. All three locations are next to closed pressure zone division valves which the City intends to keep closed, and no low-pressure complaints have been received from these locations. It is recommended that the City monitor pressures at these locations and adjust operation if pressures decrease over time. No improvements are suggested to improve pressures at these locations.

No low pressures were seen in Zones 1, 3 and 4, hence the pumping deficit estimated in Section 8.2.1 is not a true deficiency and not improvements are recommended.

Figure 8-2 shows a small number of pipes across the City violating the velocity criteria. Figure 8-3 shows a small number of pipes with head losses greater than 5 feet per 1000 feet (ft/1000 ft). Usually, these velocity and head loss violations will result in low pressures. Since no low pressures are seen as a result of these velocities and head loss violations, no improvements are recommended for these pipes.

The distribution system was evaluated for high pressures during low demand periods greater than 140 psi using the minimum day demand scenario (0.66 times ADD) in the hydraulic model. There were a few locations with pressure greater than 140 psi as shown in Figure 8-4, with most on transmission pipes. These locations do not need any improvements as no customers are directly connected to these high-pressure pipes.



Legend

Pipes

Minimum Pressure (psi)

- <= 40
- > 40

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Existing Maximum Day Demands - Minimum Pressures

FIGURE **8-1**

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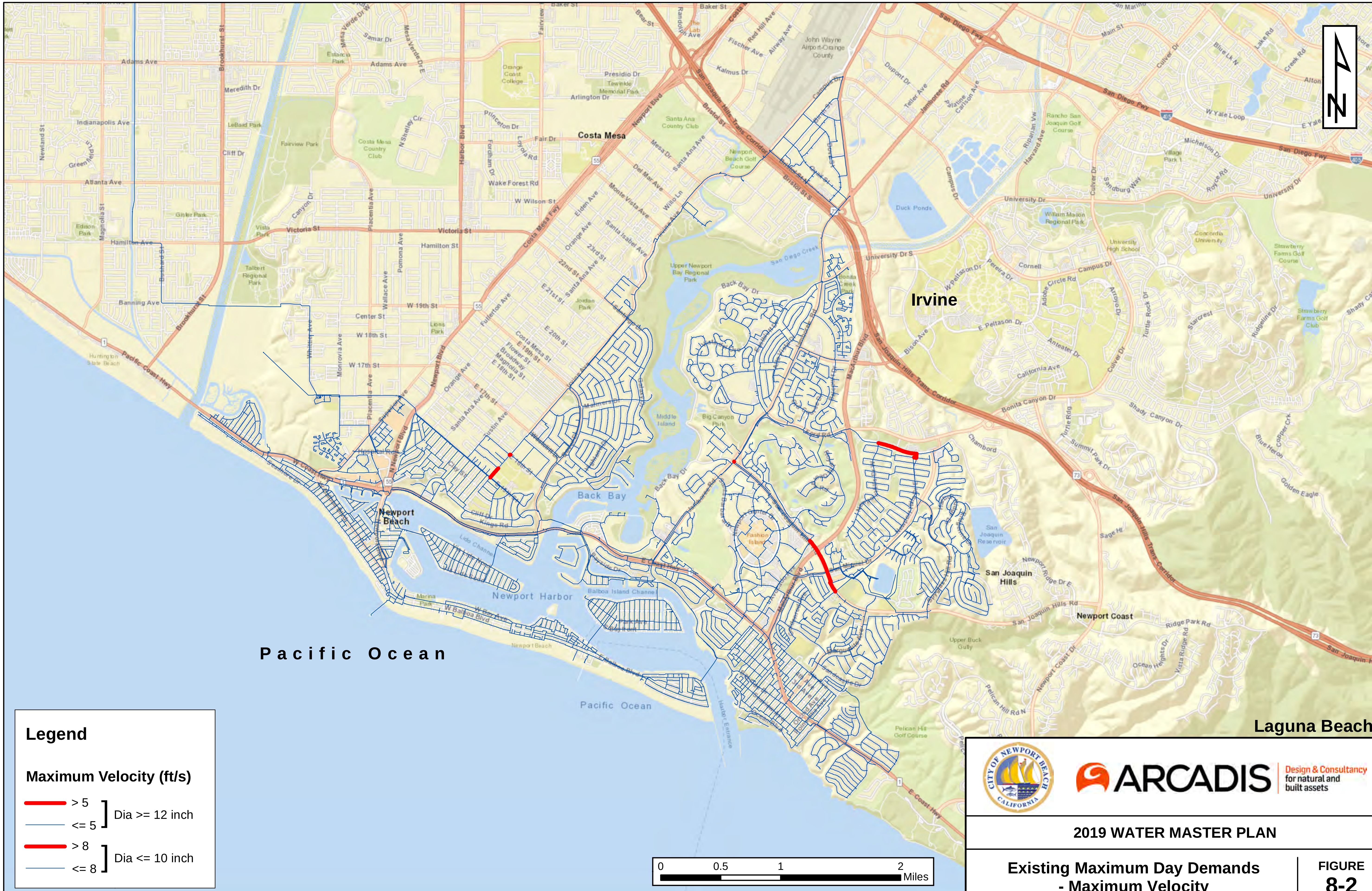
\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-1 Existing Maximum Day Demands - Minimum Pressures.mxd 4/3/2019 1:58:11 PM
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community



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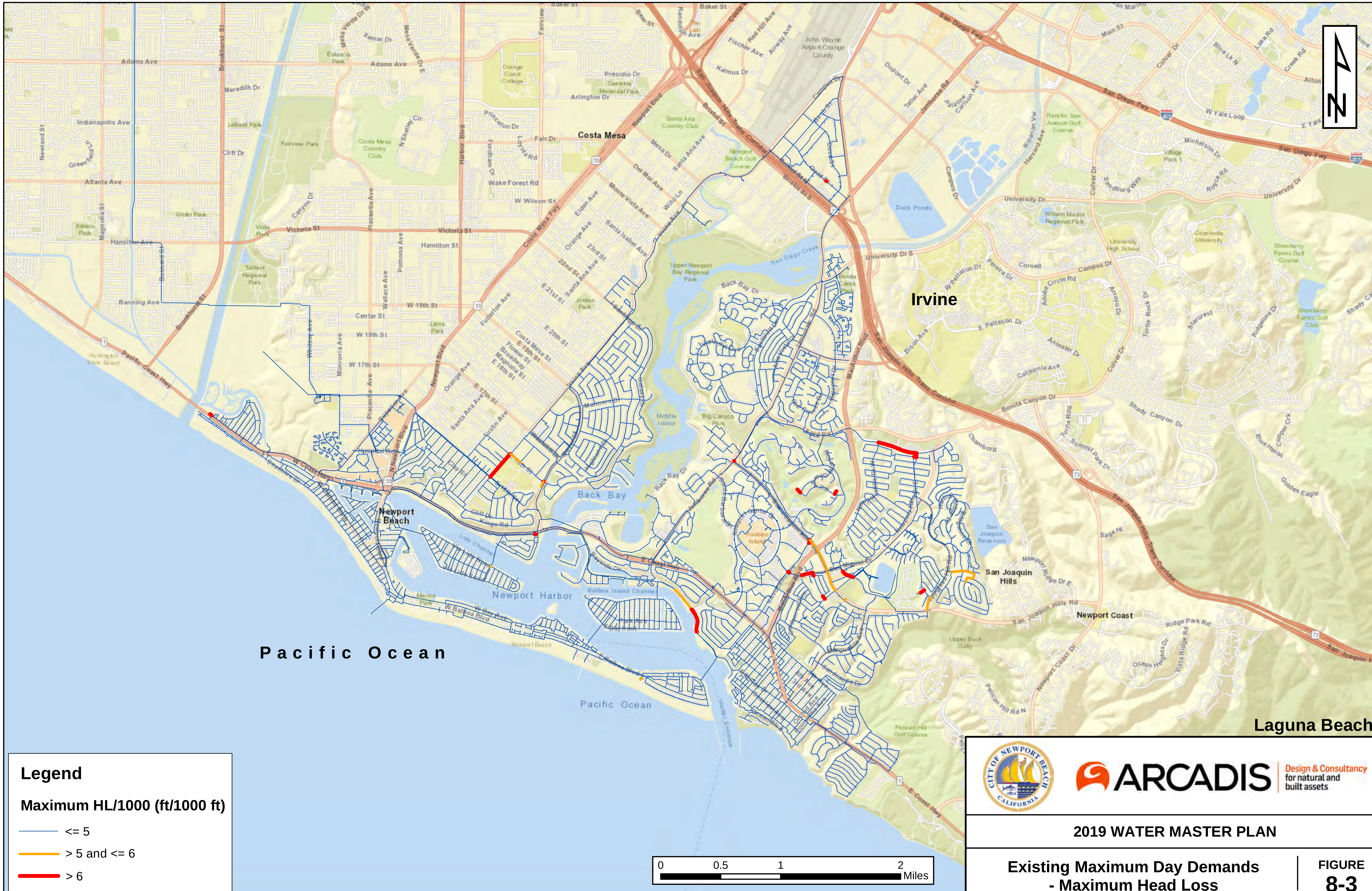
Existing Maximum Day Demands - Maximum Velocity

FIGURE 8-2

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-2 Existing Maximum Day Demands - Maximum Velocity.mxd 4/3/2019 1:53:33 PM



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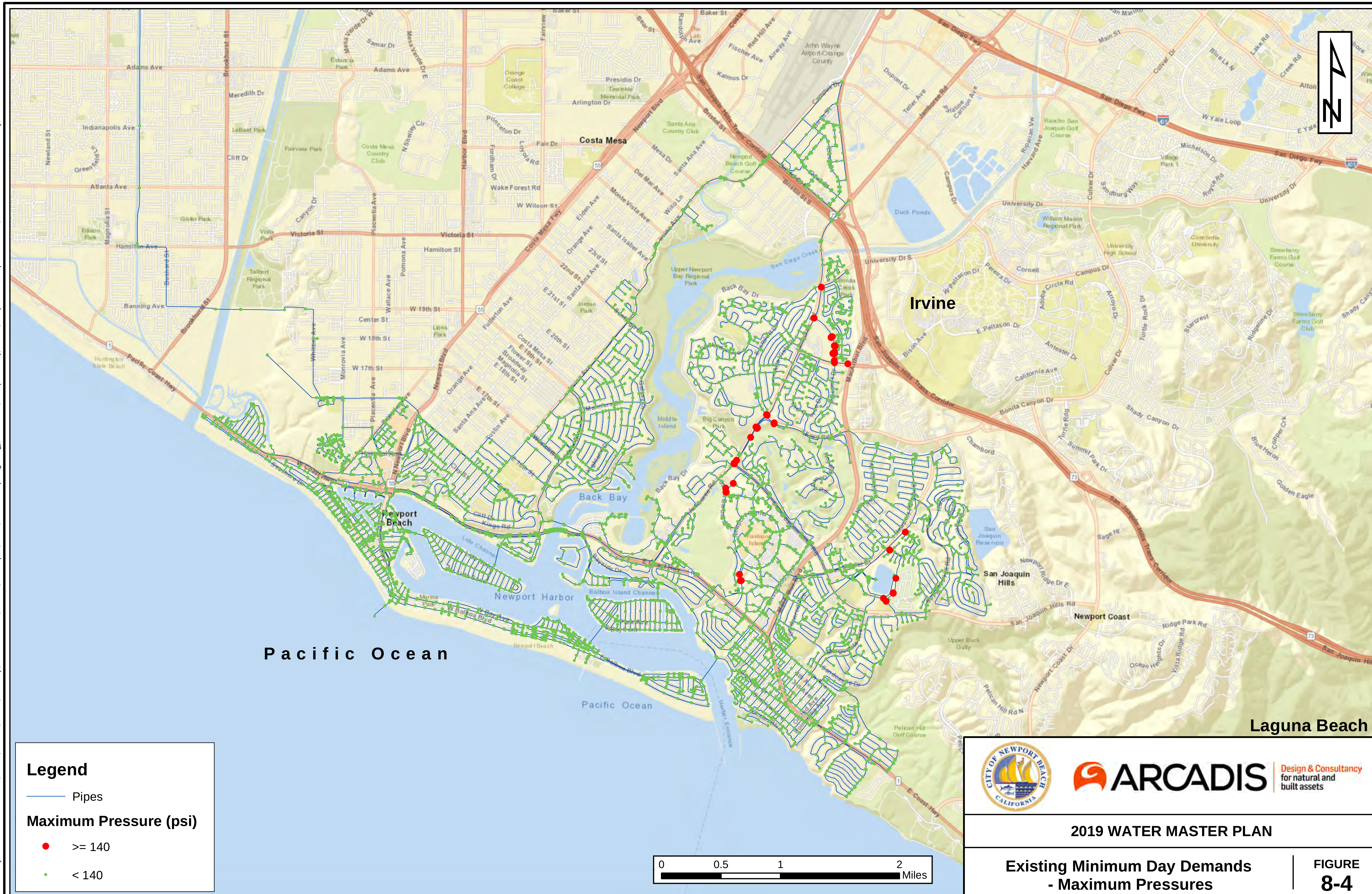
Existing Maximum Day Demands - Maximum Head Loss

FIGURE 8-3



City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-4 Existing Minimum Day Demands - Maximum Pressures.mxd 4/3/2019 2:05:49 PM
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8.2.3 Fire Flow Analysis

One of the most important capabilities of a distribution system is its ability to provide adequate flows for fire protection. Table 8-1 shows the City's required fire flow for each land use category. The available fire flow across the City was calculated at each node and compared with the requirement using the automated fire flow routine in the hydraulic model.

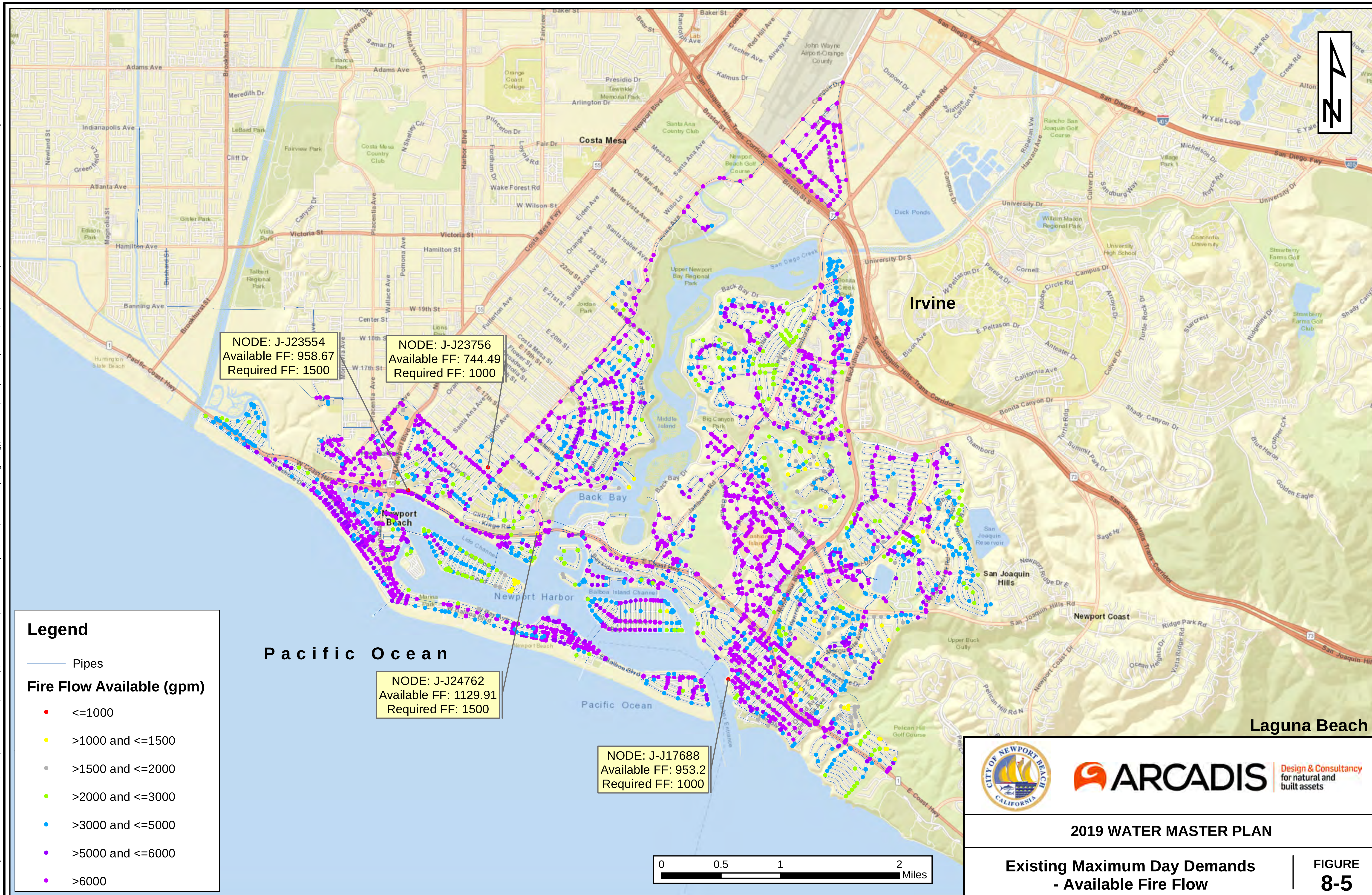
Only four locations shown on Figure 8-5 were identified where available fire flow at 20 psi residual pressure was less than the City's requirements. Three of the four locations have a 4- or 6-inch pipes serving the hydrant. Upsizing these pipes to 8 inches increases the available fire flow and exceeds the City's requirements (see projects P-8, P-12, and P-14 in section 12.2.3). The fourth location is adjacent to a pressure zone boundary valve which is closed. Under emergencies such as a fire, this valve can be opened to provide the required fire flow. Thus, no improvement is recommended for this site, but the City can consider the alternative of adding a PRS between the zones. The PRS would be set such that the valve would is normally closed (set at a lower pressure such as 20 to 30 psi) and open during a fire event or other high demand. After demand subsides the valve would auto close.

In addition to the automated fire flow, the City directed Arcadis to re-create the steady state fire flow analysis performed in the 1999 WMP to assess the system improvement since that study shown on Figure 8-6. Fire flow runs were performed at 25 locations to compare available fire flow with the target flows. Table 8-4 shows that the current system has improved fire flow availability at the 25 locations with only two deficient locations - Sandcastle / Key View and Harbor Island. Arcadis evaluated solutions to improve the available fire flow at these locations.

Table 8-4: Steady State Fire Flow Analysis

Zone	Location Description	Target Flow (gpm)	Available Fire Flow (gpm)	Deficiency (gpm)	
				Current Model	1999 WMP Model
3-03	Fashion Island	6,000	44,798	-	
1-01	13th Street / Bay	3,000	10,732	-	
2-02	MacArthur & Birch	5,000	20,812	-	
4-04	Harbor Ridge / Ridgeline	2,000	3,324	-	
1-01	Park Avenue / Jade Ave.	2,000	3,740	-	
1-01	Lido Isle	2,500	2,761	-	-1,025
2-18	Hoag Hospital	5,000	23,982	-	
3-10	Fontainbleau / Big Canyon Dr.	2,000	5,019	-	
2-02	Galaxy Drive / Mariners	2,000	5,940	-	

Zone	Location Description	Target Flow (gpm)	Available Fire Flow (gpm)	Deficiency (gpm)	
				Current Model	1999 WMP Model
3-06	Alta Vista / Celtis Pl.	2,000	3,430	-	
1-01	Balboa Boulevard / F St.	2,000	7,433	-	
1-01	Seashore / Summit St.	2,000	2,653	-	-86
4-07	Sandcastle / Key View	2,000	1,321	-679	-569
1-01	PCH / Colton	3,000	4,001	-	
2-02	Vista Del Oro / Mar Vista Dr.	2,000	8,883	-	
1-01	PCH	2,000	3,348	-	
1-01	PCH/Colton	2,000	3,795	-	-260
1-01	39th / River Ave.	3,000	12,211	-	
3-8	Sandpiper / Ebbtide	2,500	4,561	-	
1-01	Harbor Island	2,000	1,866	-134	-325
2-02	Galaxy Dr.	2,000	2,457	-	
5-05	Goleta Point Dr. / Rock Point Dr.	2,000	2,959	-	
2-02	PCH	5,000	8,620	-	
2-02	Morning Canyon Rd.	2,000	4,987	-	
2-02	Poinsettia Ave.	2,000	10,225	-	



City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-5 Existing Maximum Day Demand - Available Fire Flow.mxd 4/4/2019 11:18:22 AM
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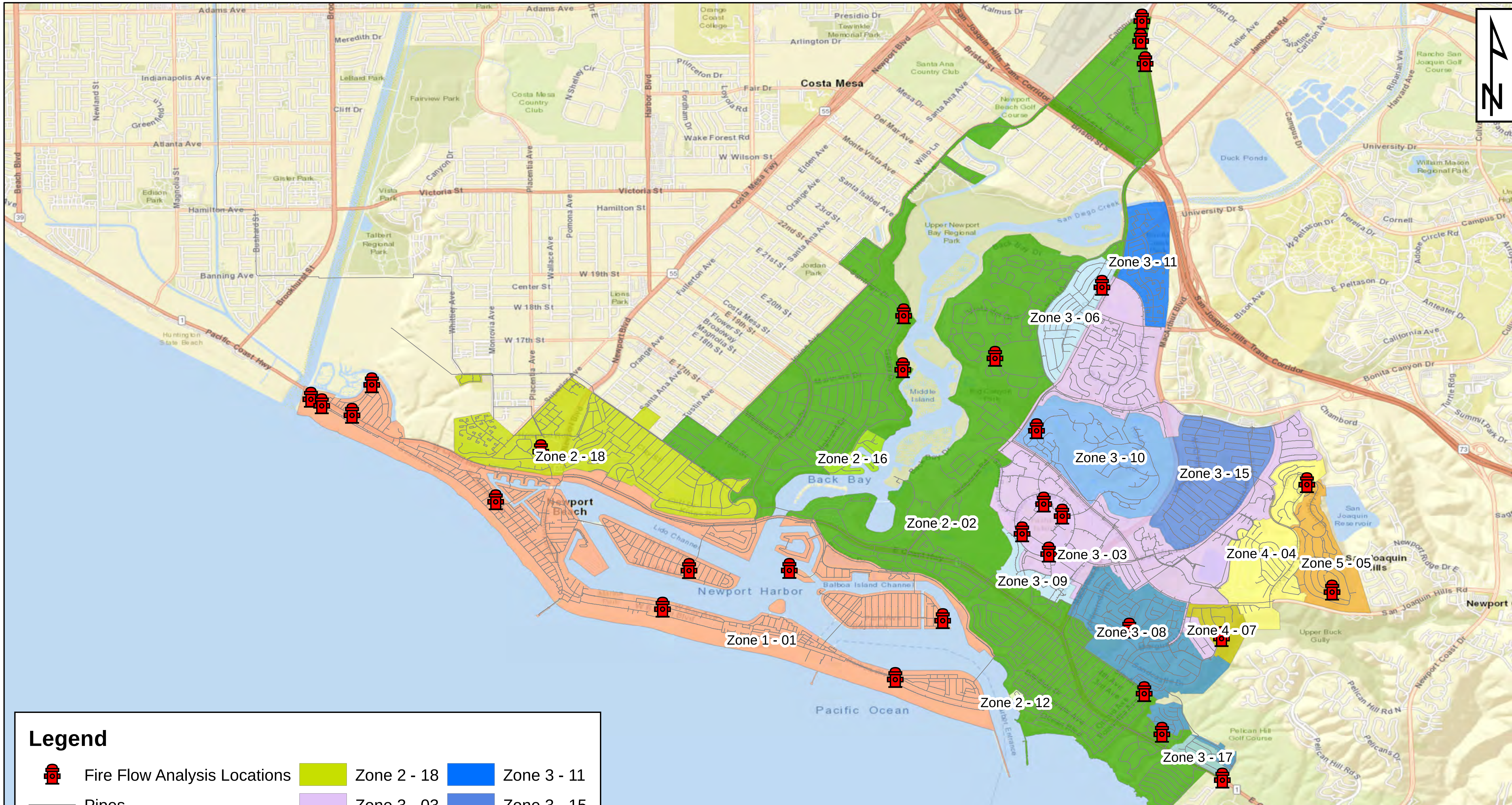

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Steady State Fire Flow Analysis Locations

FIGURE 8-6

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-6 Steady State Fire Flow Analysis Locations.mxd 4/3/2019 2:15:12 PM
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The City is planning a bay crossing project to address the fire flow deficiency (among other reasons) at Harbor Island by connecting the 8-inch pipeline on Harbor Island Road to the 8-inch pipeline on Linda Isle (shown as a red line on Figure 8-7).

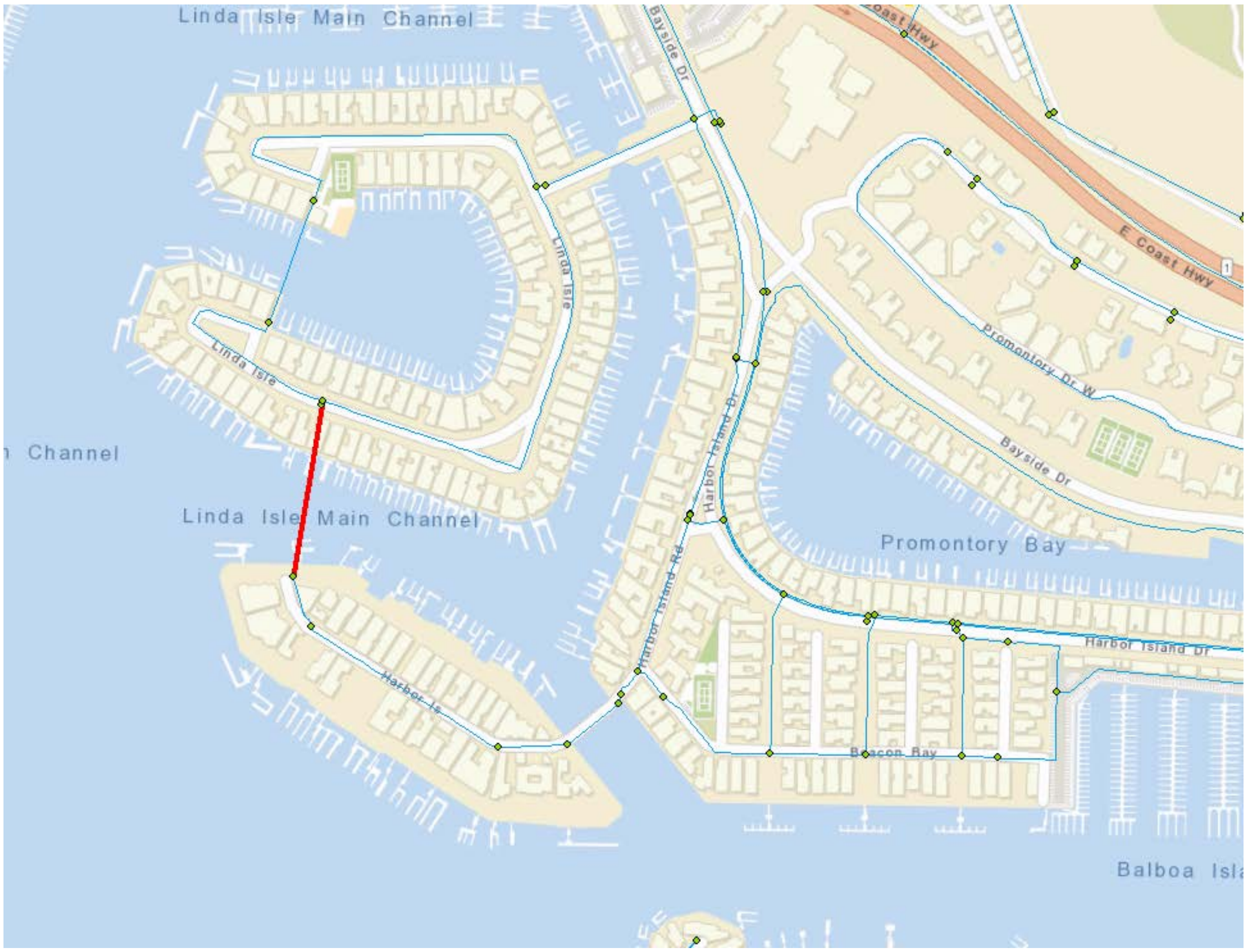


Figure 8-7: Proposed Harbor Island Improvement

An analysis was performed using the hydraulic model to address the fire flow deficiency at Sandcastle and Key View Drive in Zone 4. The 8-inch line along Ocean Birch Drive is the only source to Sandcastle and Key View Drive. Up-sizing this pipe to a 12 inch pipeline will increase the available fire flow at Sandcastle and Key View Drive to 2,700 gallon per minute (gpm) at 20 psi. Alternatively, the neighborhood around Sandcastle and Key View Drive can be converted from Zone 4 to Zone 3, which will increase the available fire flow at Sandcastle and Key View Drive to 3,008 gpm. This zone modification does cause a small increase (3-4 psi) in average pressures in this area (Figure 8-8). The zone modification will require the closing the Ocean Birch PRS and opening the closed valves on Keel Drive, Sand Castle Drive and Outrigger Drive.

Figure 8-8: Sandcastle/Key View Average Pressures - Current Configuration (Top) and Proposed Changes (Bottom)

8.3 Future System Analysis

Like the existing system analysis, the City's distribution system was analyzed under future build-out demands using the City's system performance criteria (Section 8.1). Build-out demands are described in Section 4.

8.3.1 Future Storage and Pumping Analysis

The City has sufficient available storage in the system under future build-out demands as shown in Table 8-5. Proper and regular maintenance of this available storage should suffice to maintain its reliability to the City. The City regularly uses underwater divers to inspect the 16th Street Reservoir and BCR.

Table 8-5: Future System Storage Analysis

Parameters	Future
Average Day Demand (mgd)	15.0
Maximum Day Demand (mgd)	27.8
Peak Hour Demand (mgd)	60.1
Fire Flow (MG) – 6,000 gpm for 6 hours	2.2
Existing Storage Capacity (MG)	202.5
Storage Criteria	
Regulatory Storage Needed (MG)	6.9
Fire Storage Needed (MG)	2.2
Emergency Storage Needed (MG)	105.1
Total Storage Needed (MG)	114.2
Storage Excess (MG)	88.3

The pumping analysis on Table 8-6 shows a deficit in available pumping in Zone 1 and 2 under future demands.

Table 8-6: Future System Pumping Analysis

Parameters	Zone 1 & 2	Zone 3	Zone 4	Zone 5
Average Demand (mgd)	10.0	4.1	0.59	0.26
Booster Capacity (mgd)	17.9	14.4	4.5	4.8
Pumping Criteria				
Maximum Day Demand (mgd)	18.6	7.6	1.1	0.5
Fire Flow (mgd)	1.5	2.2	0.5	0.5
Maximum. Day Demand + Fire Flow (mgd)	20.1	9.8	1.6	1.0
Peak Hour Demand (mgd)	26.1	12.8	2.4	1.0
Governing Flow (mgd)	20.1[1]	12.8	2.4	1.0
Pumping Excess (mgd)	(2.2)	1.6	2.2	3.8

[1]MDD + Fire Flow is governing criteria due to the availability of floating storage at BCR.

This deficit is similar to that seen under existing demands and strictly based on the system performance criteria. This deficit will be verified using hydraulic modeling under peak demand conditions before recommending any improvements.

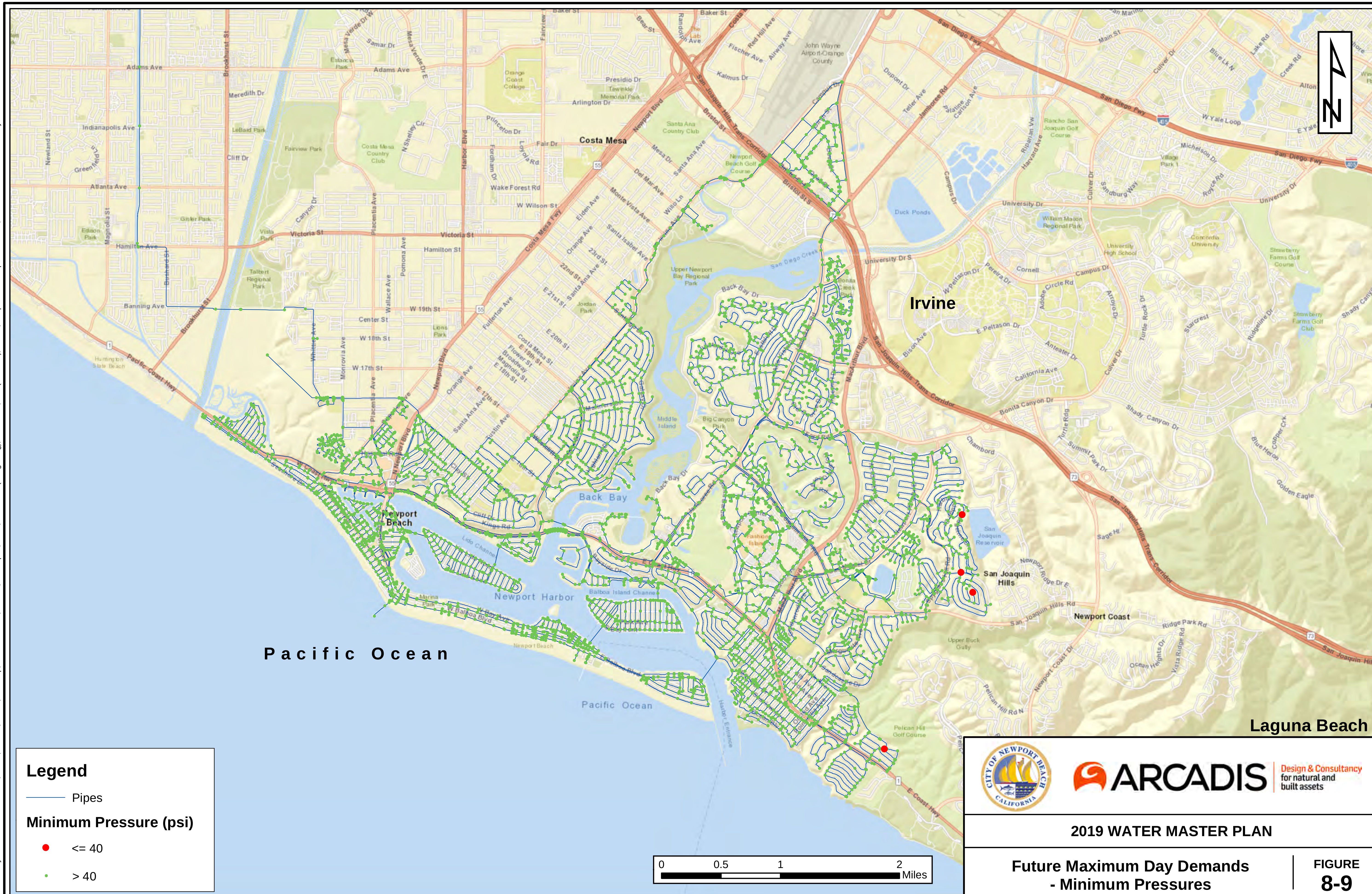
8.3.2 Maximum Day and Minimum Day Demand Analysis

The City's distribution system was analyzed using the hydraulic model under increased future build-out demands. The hydraulic model results were evaluated under the system performance criteria to identify low pressure, high pressure, high velocity and head losses. Improvements were then recommended for any identified violations of the system performance criteria.

Figure 8-9 shows the minimum pressures across the system under future MDD. The same three locations in Zone 5 are present again with a fourth location in Zone 3 showing low pressures. These locations are at dead-end zone boundaries near closed valves. Since pressures at these locations are just slightly (3-5 psi) below 40 psi, no improvements are recommended, but the City should monitor these areas for low pressure concerns. No low pressures were seen in Zones 1 and 2, as was the case the under existing demands, hence the pumping deficit estimated in Section 8.3.1 is not a true deficiency and no improvements are recommended.

Similar to the existing system analysis, some pipes violate the velocity (Figure 8-10) and head loss criteria (Figure 8-11) under future build-out demands. These do not cause any low pressures in the system, therefore no improvements are recommended.

Some nodes also violate the maximum pressure criteria under future minimum day demands (Figure 8-12). Most of these nodes are on transmission lines or are not directly connected to customers in the City. No improvements are recommended.



City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-9 Future Maximum Day Demands - Minimum Pressures.mxd 4/3/2019 2:22:19 PM
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Future Maximum Day Demands - Maximum Velocity

FIGURE 8-10

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\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-10 Future Maximum Day Demands - Maximum Velocity.mxd 4/3/2019 2:36:15 PM
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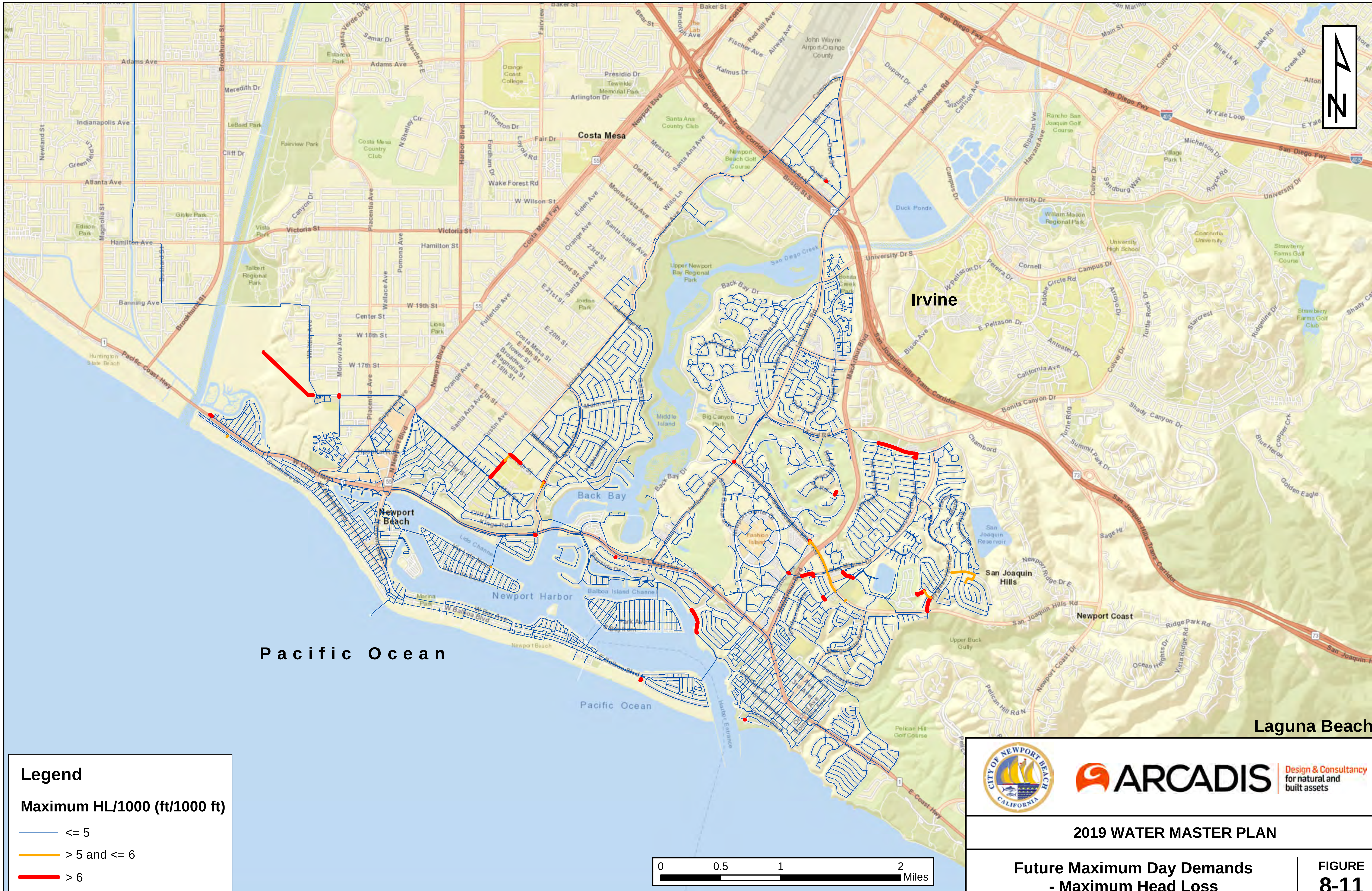

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Future Maximum Day Demands - Maximum Head Loss

FIGURE 8-11

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-11 Future Maximum Day Demands - Maximum Headloss.mxd 4/3/2019 2:37:16 PM
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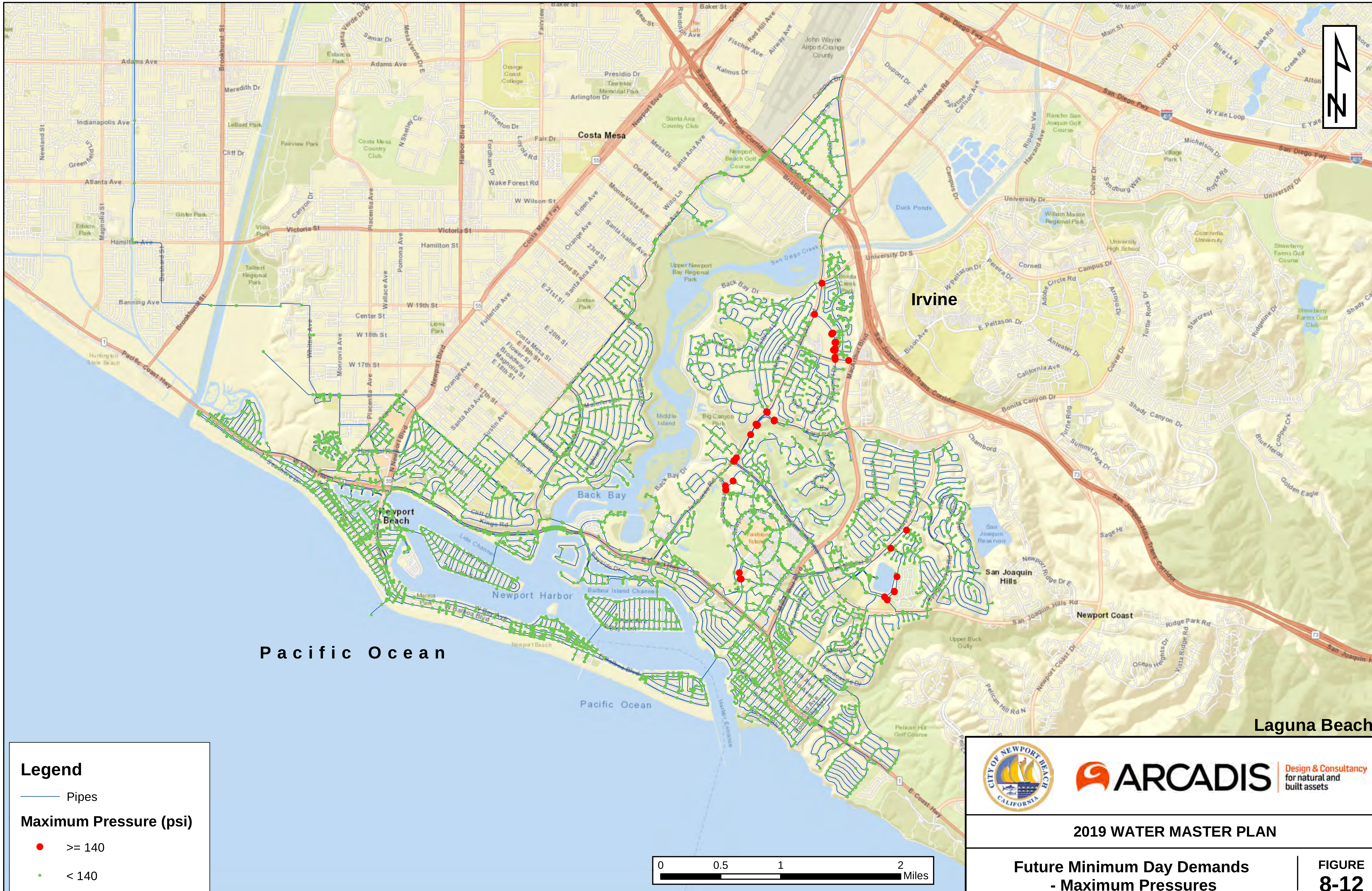

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Future Minimum Day Demands - Maximum Pressures

FIGURE 8-12

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-12 Future Minimum Day Demands - Maximum Pressures.mxd 4/3/2019 2:38:01 PM
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8.3.3 Fire Flow Demand Analysis

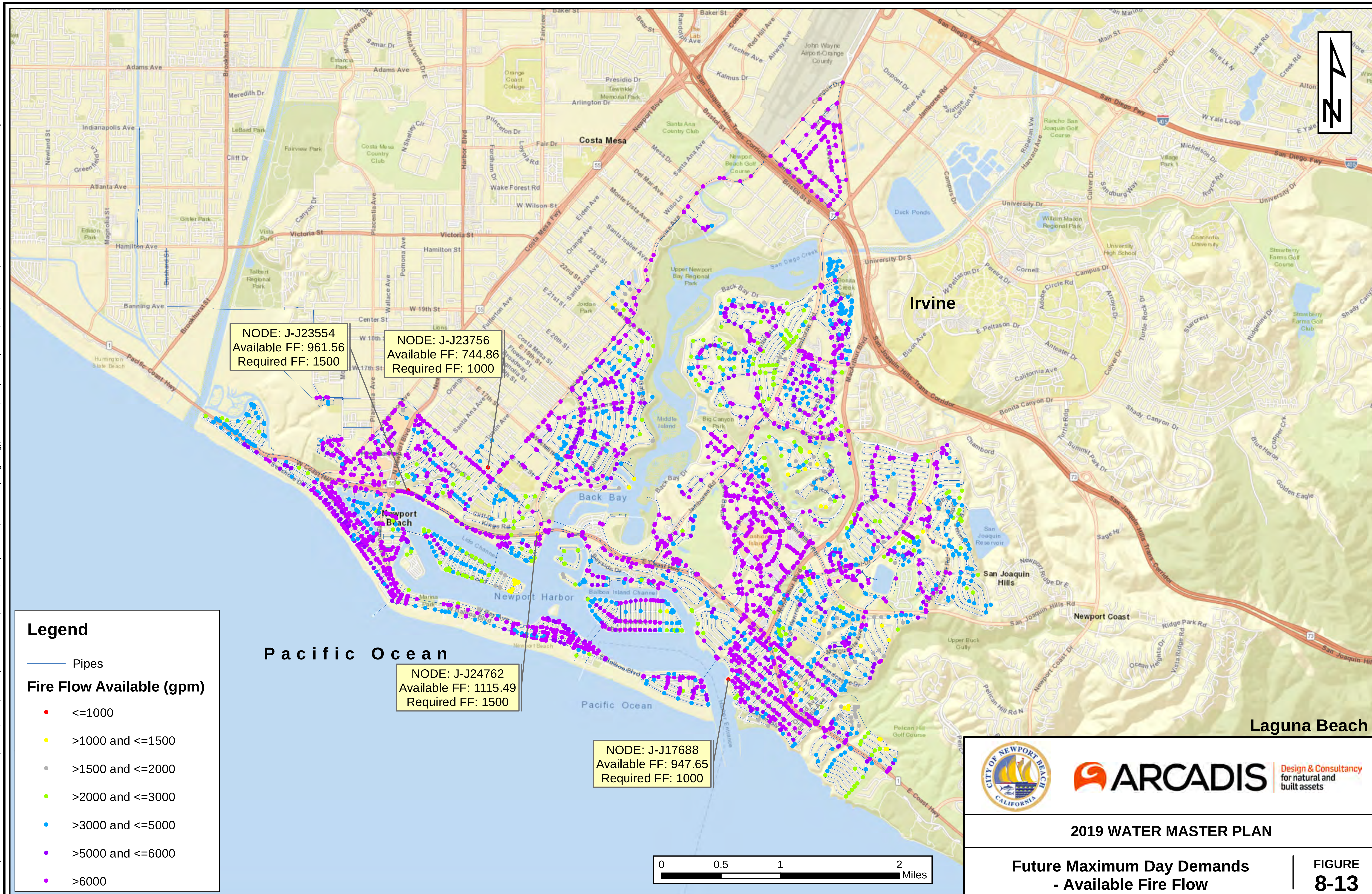
Future fire flow analysis was performed using the hydraulic model under future maximum day demands. The same four nodes, as found in the existing system analysis, were found deficient in this analysis (Figure 8-13). Upsizing these pipes to 8 inches will meet the deficiency and meet the City's fire flow criteria.

8.4 System Improvements

Hydraulic modeling of the City's distribution system under existing and future build-out demands revealed the necessity for very few improvements. These improvements mainly involved upsizing three pipes from 4 or 6 inches to 8 inches to meet fire flow criteria (Table 8-7). These pipes are also shown in Figure 8-14.

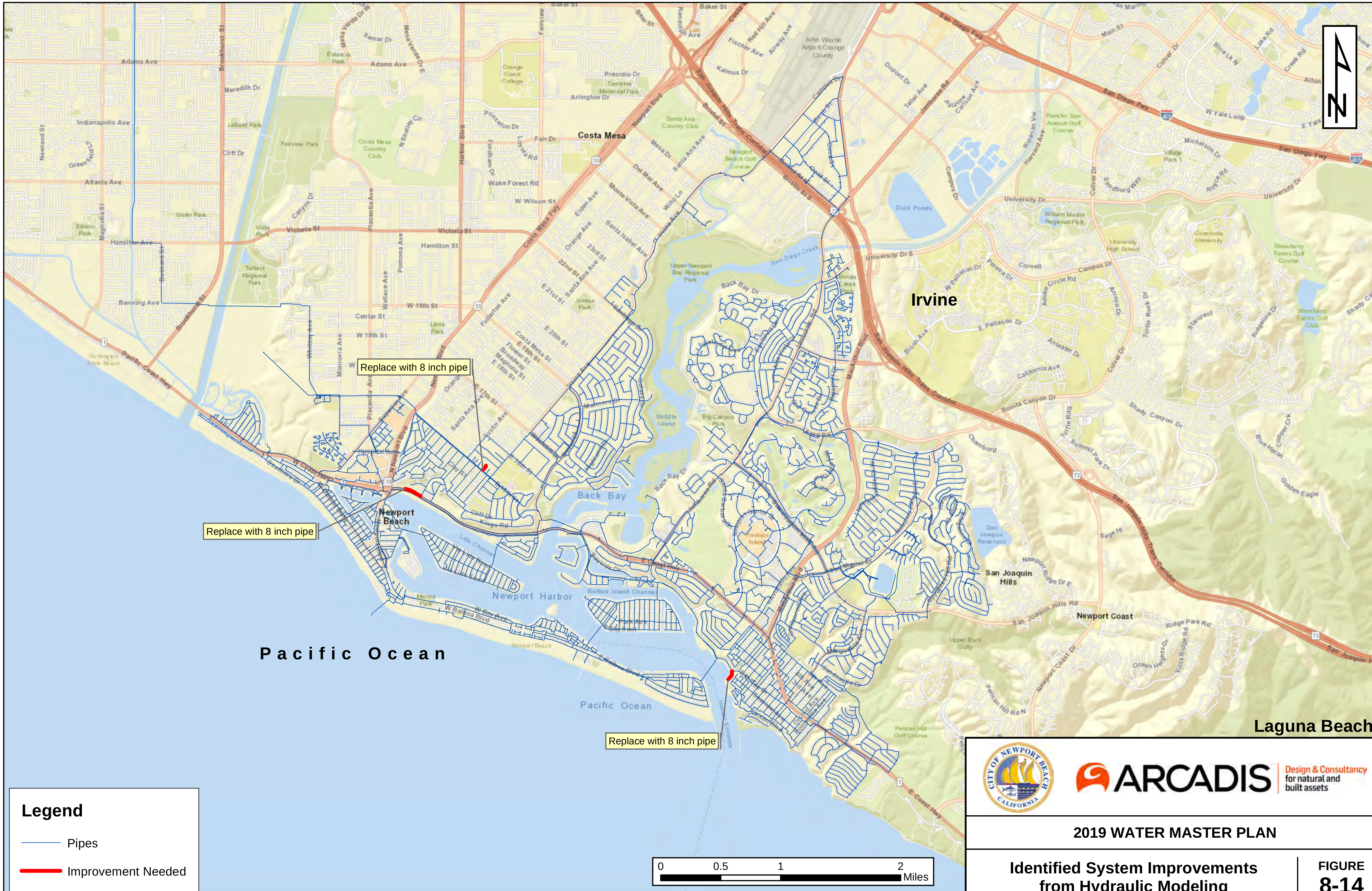
Table 8-7: Suggested System Improvements from Hydraulic Modeling

Pipe ID	Current Pipe Size (in)	Recommended Pipe Size (in)	Reason
02_02_3487	4	8	Fire flow
01_01_0873	6	8	Fire flow
02_02_0918	4	8	Fire flow



City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-13 Future Maximum Day Demands - Available Fire Flow.mxd 4/4/2019 11:40:57 AM
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 8-14 Suggested System Improvements from Hydraulic Modeling.mxd 4/3/2019 2:41:59 PM
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community



2019 WATER MASTER PLAN

Identified System Improvements from Hydraulic Modeling

FIGURE 8-14

9 RISK ANALYSIS METHODOLOGY

Developing a water system CIP is more than identifying hydraulic deficiencies using models, developing improvements for these deficiencies, and then collating them into a list with costs resulting in a CIP. One must take a more holistic approach to assessing its infrastructure to include all its assets and evaluate them for performance and condition, and then develop a CIP based on identifying which of its facilities are the most critical and which of them are in an unserviceable condition. The City and its leaders, with their foresight, decided to take this more holistic approach to update this WMP and develop its 30-year CIP by including an assessment of all facilities and pipes.

Arcadis used a risk-based approach to create the City's 30-year CIP. Both horizontal (pipelines) and vertical facilities were analyzed using the industry standard risk method to determine their replacement priority in the CIP. To identify projects that should be incorporated into the City's CIP, a field assessment was performed to evaluate all vertical facilities and a desktop analysis was performed on all pipes within the distribution system.

Information from both efforts was combined to assess the physical condition, performance, and impact of failure of the City's individual assets. The scoring of an asset's physical and performance condition is represented as Likelihood of Failure (LoF) and impact to the City if a failure were to occur is referred to as Consequence of Failure (CoF). The LoF and CoF were used to calculate the risk score for each individual asset. This risk assessment approach follows the Environmental Protection Agency's guidelines for Asset Management and recommendations from other Asset Management organizations, such as the International Standards Organization (ISO) 55000 standard for management of physical assets and the International Infrastructure Maintenance Manual (IIMM).

This section outlines the methodology and criteria used to assess both the horizontal and vertical assets in the City. The results of the analysis are described in Section 10 and Section 11, followed by the recommended CIP in Section 12.

9.1 Pipeline (Horizontal Asset) Assessment Methodology

The distribution system (horizontal) assets are distributed across the City's service area and cover items associated with water transmission and distribution. For this master plan, assessment was performed only on system pipes (distribution and transmission) and not on their appurtenances along these pipes. The City provided Arcadis the data for its pipes in a GIS database.

An asset's risk was determined by quantifying the LoF score (1-5) based on its physical and performance condition and the CoF score (1-5) based on the impact of the asset failure on the City's water operations and ability to serve its customers. Physical condition was defined as the current state of operation and repair of an asset that is influenced by age, breaks, historical maintenance, and operating environment. The physical condition was inferred using the pipe characteristics such as age (install year), number of breaks, and material, as documented in the City's GIS. Performance condition was assigned based on how well assets are accomplishing their designed tasks. This was inferred from the hydraulic analysis of the pipes presented in Section 8. CoF was assigned through proximity analysis of pipes to environmentally sensitive areas, critical customers, and pipe characteristics. The risk of an asset (1 through 25) was calculated as the product of the LoF multiplied by the CoF.

Risk Score = Likelihood of Failure (LoF) x Consequence of Failure (CoF)

9.1.1 Likelihood of Failure for Horizontal Assets

Each pipe segment in the City's GIS has a unique identifier and an LoF score was assigned to each pipe segment in the City's GIS. The LoF score for each segment was estimated using desktop analysis of the City's historical breaks. The historical breaks were analyzed to create pipe cohorts and develop decay curves for each cohort, which were then used to predict the Estimated Useful Life (EUL) of the pipe segment. A cohort is a group of pipes that are predicted to deteriorate over time at the same rate. LoF analysis used a decay curve to quantify a score of 1 (excellent condition) to 5 (very poor condition). An LoF score was assigned to each pipe segment by comparing the current age of a pipe to its EUL on the decay curve to calculate a percentage that was then equated to a LoF score. The decay curves and the results of the LoF analysis are presented in Section 11.

9.1.2 Consequence of Failure for Horizontal Assets

The CoF of horizontal assets was scored using a similar 1 to 5 scale, as was used for the LoF. The CoF evaluation is based on a Triple Bottom Line (TBL) approach to cover the social, environmental, and economic impacts of pipe failures. The City and Arcadis worked together to select factors specific to the City covering each of these TBL areas. The economic factors included pipe diameter and maximum system pressures; the social factors included service impacts to critical, high demand customers and adjacency to major roadways; the environmental factors included adjacency to water bodies or environmentally sensitive areas. The overall CoF score is the maximum score for any one of the factors assigned to a pipe. The evaluation and scoring for each CoF factor are shown in Table 9-1.

Table 9-1: Consequence of Failure Criteria for Pipes

CoF Criteria	Measure	1	2	3	4	5
Economic	Diameter	<= 8 inch	10-16 inch	18 - 24 inch	27 – 30 inch	>= 36 inch
Economic	Maximum Operating Pressure	< 100 psi		100-120 psi		> 120 psi
Social	Roadways	Off-Road	Minor Road intersect	Major Road within 50 ft	Major Road Intersect, Highway – within 50 ft	Highway Intersect
Social	Critical/Vulnerable Customers	NA	Public Facilities	Schools & Tourism	Dialysis Centers and Large Volume Users	Hospitals and Nursing Homes
Environmental	Proximity to Water Body, Bay, or Environmentally Sensitive Area				Within 50 ft	Crossing

9.2 Facility (Vertical Asset) Assessment Methodology

A vertical asset for this master plan was defined as a single item that relates to the storage, transmission, or distribution of potable water. The vertical assets in the City include valves, pumps, buildings, storage reservoirs, and flowmeters. Arcadis worked with the City to create a complete inventory of all assets within their system. This weeklong effort included the physical assessment of the assets, photo documentation, and categorization of the assets.

To catalogue assets within the system, hierarchies were developed for vertical assets. Hierarchies help filter and find asset records within the database and allow information to be summarized at various hierarchical levels. For vertical assets, a seven-tiered system was used to store component information and accommodate the variety of assets seen in the City's system (Figure 9-1). Asset attributes and physical condition assessment criteria were also defined for each asset classification. The classifications include structural, electrical, and mechanical.

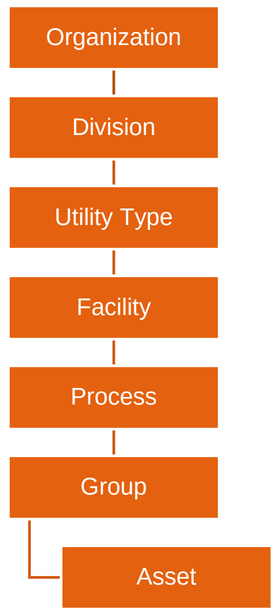


Figure 9-1: Asset Hierarchy

9.2.1 Likelihood of Failure for Vertical Assets

Vertical assets were evaluated for LoF. Similar to the pipe assessment, the assessment is comprised of physical and performance condition. The physical condition of a vertical asset is scored on a 1 to 5 scale using visual inspection, staff knowledge of the asset, and maintenance records. A description of scores is shown below in Table 9-2. These general descriptions apply across mechanical, electrical, and structural classifications. Detailed inspection criteria for the three disciplines are provided in Appendix C.

Table 9-2: LoF Physical Condition Scoring Criteria for Facilities

Score	Description
1 – Very Good Condition	Fully operable, well maintained, and consistent with current standards. New or like new equipment with little wear shown and no further action required.
2 – Minor Defects Only	Sound and well maintained but may be showing slight signs of early wear. Delivering full efficiency with little or no performance deterioration. Only minor renewal or rehabilitation may be needed in the near term.
3 – Maintenance Required	Functionally sound and acceptable. Showing normal signs of wear. May have minor failures or diminished efficiency with some performance deterioration or increases in maintenance costs. Moderate renewal or rehabilitation needed in near term.
4 – Requires Renewal	Functions but requires a high level of maintenance to remain operational. Shows abnormal wear and is likely to cause significant performance deterioration in the near term. Replacement or major rehabilitation needed in the near term.
5 – Asset Unserviceable	Effective life exceeded and/or excessive maintenance cost incurred. An increased risk of breakdown, imminent failure, or complete failure of asset. No additional life expectancy with immediate replacement needed.

The performance condition of an asset was determined through identified hydraulic deficiencies, staff knowledge, age, and maintenance history. The performance score takes account of failure modes other than mortality, which is recorded as physical condition. The scoring is rated 1 to 5 and definitions for each score is presented in Table 9-3. The performance criteria (failure modes) are shown in Table 9-4.

Table 9-3: Performance Condition Scoring for Facilities

Score	Description
1 – Very Good Condition	Capacity exceeds maximum designed flow and adequate standby or emergency protection provided. Overall performance excellent and meets all expected future requirements
2 – Minor Defects Only	Meets all design and legal / regulatory requirements. May have minor risk under extreme conditions. Overall performance excellent and will likely meet expected future requirements.
3 – Maintenance Required	Current performance is acceptable but would likely not meet future additional requirements or increased demand (e.g. capacity, level of service goals and/or future regulatory requirements).
4 – Requires Renewal	Current performance is marginal and will not meet future additional requirements or increased demand (e.g. capacity, level of service goals and/or future regulatory requirements).
5 – Asset Unserviceable	Current performance unacceptable and does not meet currently required performance criteria (e.g. capacity, level of service goals and/or future regulatory requirements).

Table 9-4: Performance Condition Scoring Criteria for Facilities

Criteria	Condition	1	2	3	4	5
Capacity	Ability to meet current capacity	Average – Yes*	Average – Yes*	Average – Yes*	Average – Yes**	Average – No**
		Peak – Yes*	Peak – Yes**	Peak – No**	Peak – No**	Peak Max Day – No**
	Ability to meet future capacity	Average – Yes*	Average – Yes*	Average – Yes**	Average – No*	Average – No**
		Peak – Yes*	Peak – No*	Peak – No**	Peak – No**	Peak Max Day – No**
Regulatory	Ability to meet current regulations and utility goals	Yes	Yes	Yes	Yes – with some modifications required	No
	Ability to meet future regulations and utility goals	Yes	Yes – with some modification s required	No	No	No
Reliability	Average time equipment is available when needed	99-100%	95-99%	90-94%	85-89%	< 84%
		(4 days O/S)	(up to 18 days O/S)	(up to 36 days O/S)	(up to 55 days O/S)	(over 55 days per year)
O&M Issues	Frequency of O&M Issues (Excluding Breakdowns)	None	Very Infrequently (Quarterly)	Infrequently (Monthly)	Frequently (Weekly)	Very Frequently (Daily)
Obsolescence	Equipment Technology	Technology Best Available/ State of the Art	Technology Industry Standard/ “Tried and True”	Technology Considered Appropriate	Technology Nearly Obsolete	Technology Obsolete / Out of Date

* - with one unit out of service

** - with all units in service

O/S – out of service

The LoF score used in the risk assessment is the highest value of the physical and performance scores. This provides the City with the conservative risk evaluation for assets and supports planning of repair or replacement regardless of the failure mode.

9.2.2 Consequence of Failure for Vertical Assets

The CoF for a vertical asset is the qualified social, environmental, or financial impact to the City of an asset failure. Scores were determined through interviews with staff, permit requirements, and field observations. CoF was scored using weighted criteria that are outlined below in Table 9-5. Scoring is based on the 1 to 5 scale.

Table 9-5: Consequence of Failure Scoring Criteria

Criteria	Weight	1	3	5
Safety $CoF_{(safe)}$	**30%**	No Impact	Failure creates potential for minor injury to employee or public	Deficiency creates potential for severe injury to employee or public
Level of Service $CoF_{(Los)}$	**30%**	No Impact	Impact will occur if no response is made within 8 hours	Immediate and/or widespread impact.
Regulatory Compliance $CoF_{(Comp)}$	**20%**	No Impact	Impact will occur if no response is made within 8 hours	Immediate and/or widespread impact
O&M Impacts $CoF_{(O\&M)}$	**10%**	No Impact	Moderate O&M Cost/Effort	Large O&M Cost/Effort
Backup Power $CoF_{(Backup)}$	**10%**	Full generator backup available	Mobile generator ready	No ability for backup power connection

10 FACILITY ASSESSMENT

The list and details of all the City's facilities were summarized in Section 5. Every asset that is a part of the City's water system was visually inspected to help prioritize their rehabilitation or replacement and inclusion in the CIP.

The sites inspected include the City's interconnections and turnouts with other agencies, five pump stations, three reservoirs, two well buildings, and 43 PRS, accounting for 734 assets in total. The complete list of these assets is shown in Appendix D.

10.1 Likelihood of Failure for Vertical Assets

10.1.1 Physical Condition Score

The physical condition was assessed and scored based on the mechanical, structural, or electrical criteria established and shown in Appendix D. The results for the assessment are shown on Figure 10-1.

Seventy-seven percent of inspected assets scored either very good condition or minor defects only. Nineteen percent received a score of maintenance required leaving only three percent of assets requiring renewal or being unserviceable. These 25 assets are shown in Appendix E. Among the seven assets that are unserviceable, four locations are represented: the CM-9 turnout, the Irvine/U10_036 valve, the IRWD-7 interconnect, and the Zone 5 auxiliary pump station. The complete set of photos for each asset taken during the physical condition assessment is attached to this WMP in a flash drive.

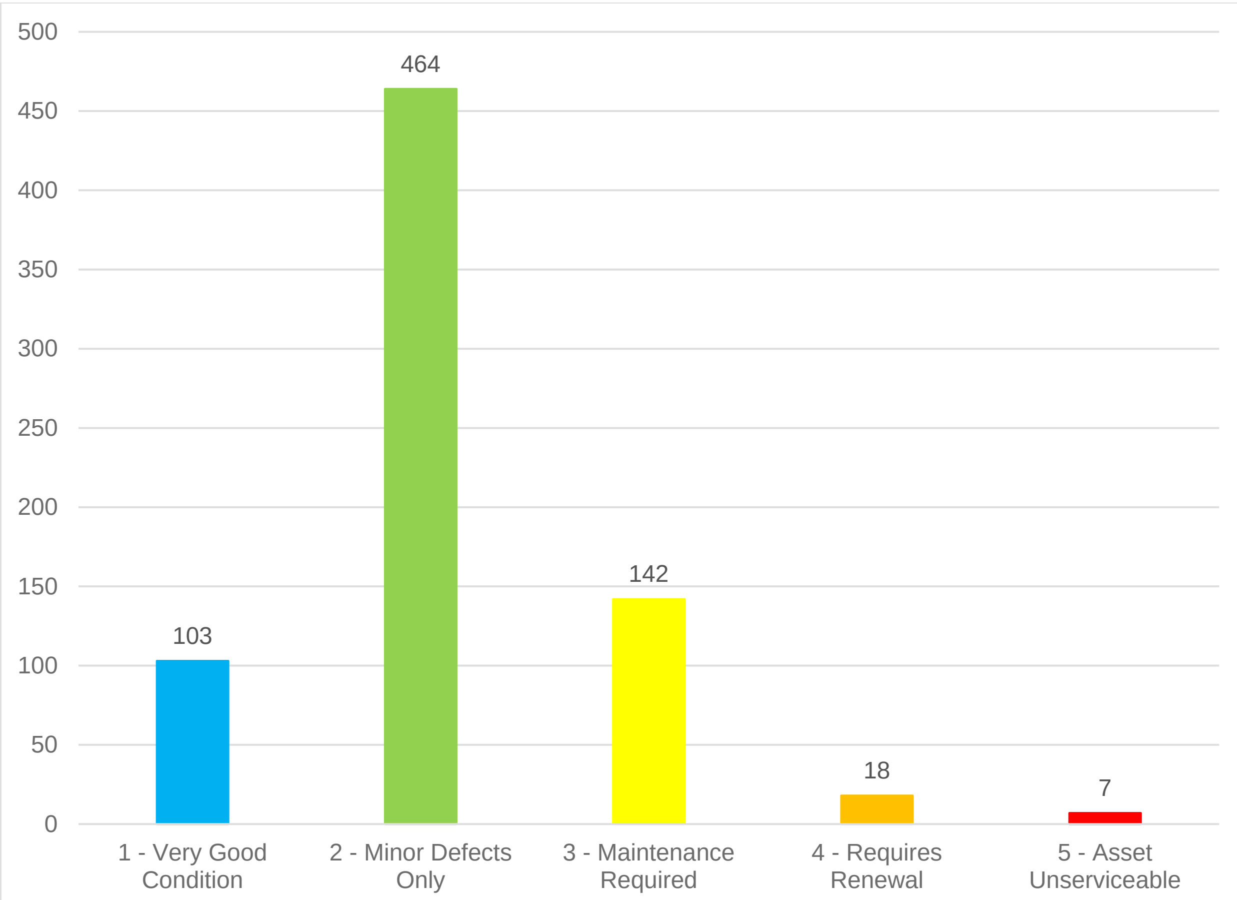


Figure 10-1: Summary of Physical Condition Score for Facilities

10.1.2 Performance Condition Score

The performance of the facilities was evaluated based on hydraulics evaluations (Section 8) and interviews with the City's staff. Ninety-one percent of the inspected assets scored in the very good condition to minor defects only range for their performance condition. Six percent require maintenance and three percent require renewal. The two assets deemed unserviceable were the pump and motor located at the Zone 5 Auxiliary Pump Station due to missing bolts and equipment, high pressures, safety concerns, and the assets proximity to the electric panel. Figure 10-2 summarizes the performance condition of each asset.

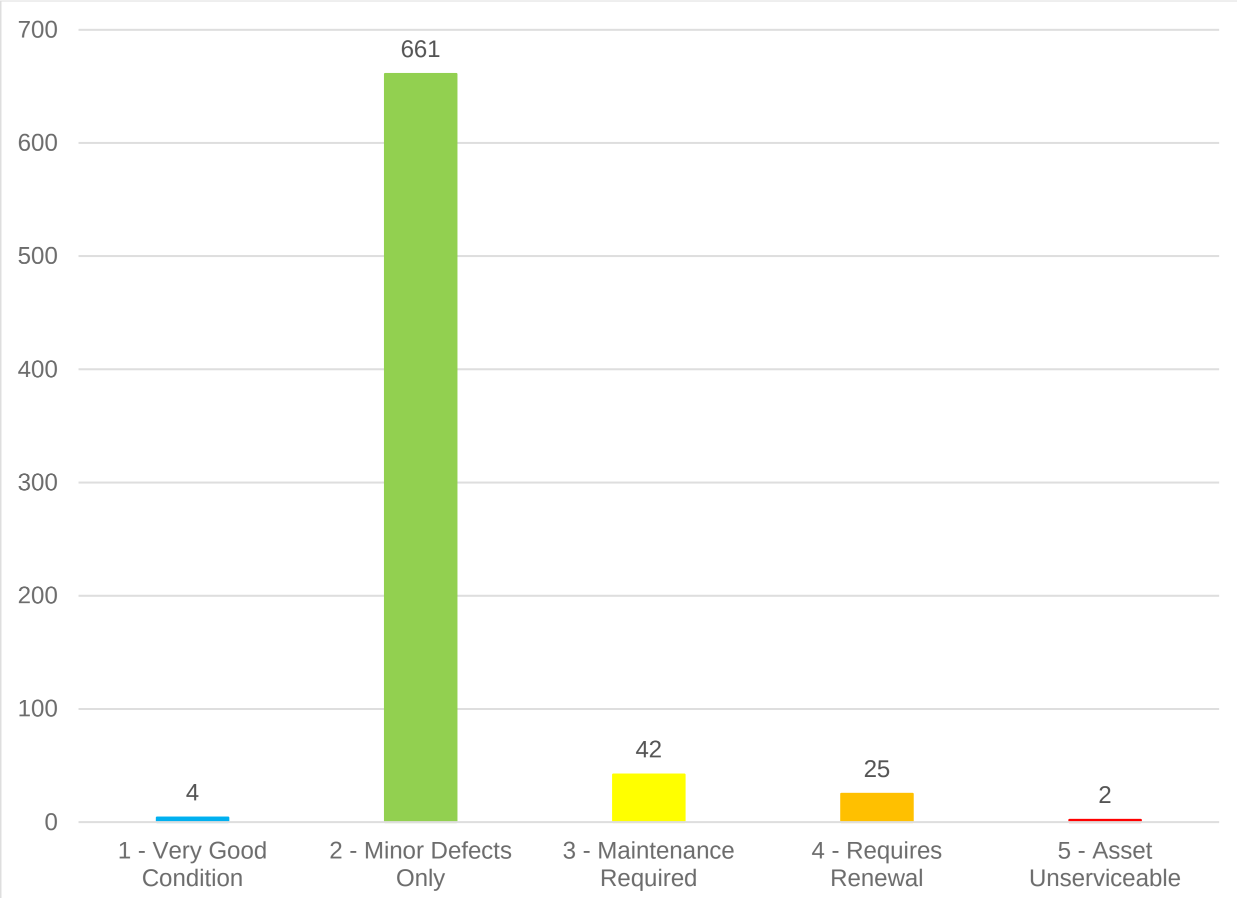


Figure 10-2: Summary of Performance Condition Score for Facilities

10.1.3 Final LoF Score

The final LoF score for the 734 assets was calculated by taking the highest values for the physical and performance condition for each asset. Figure 10-3 summarizes the LoF scores for all assets.

Seventy percent of the 734 assets have a very good condition or minor defects only LoF score. Twenty-three percent of assets need maintenance and six percent require renewal. All assets ranking in the asset unserviceable category are discussed in Section 10.1.1 and 10.1.2.

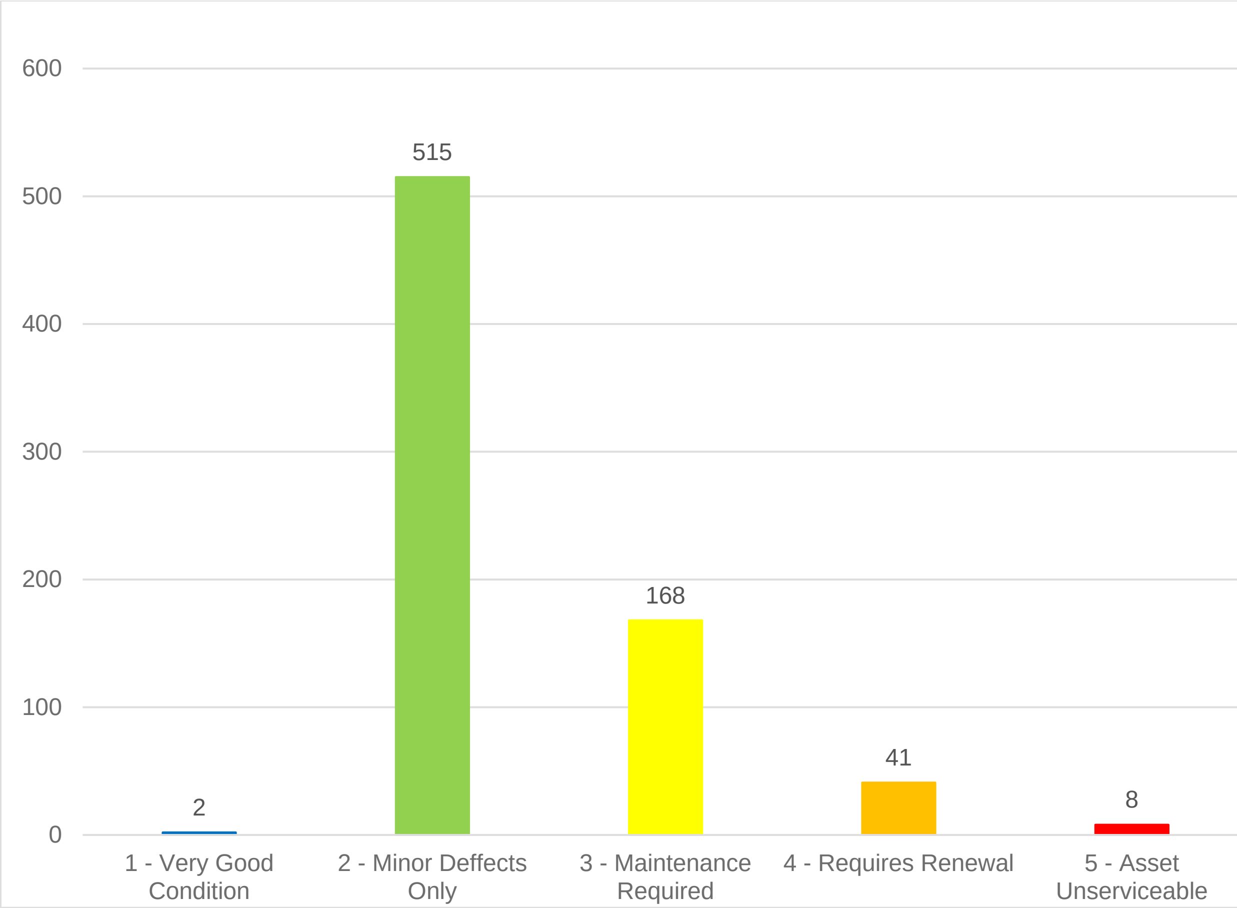


Figure 10-3: Summary of LoF Score for Facilities

10.2 Consequence of Failure for Vertical Assets

The CoF analysis was performed on the inspected assets using the criteria described in Section 9. Ninety-eight percent of the City's assets were assigned a low to medium consequence score as most of the assets have redundancies in the system, see Figure 10-4. All sixteen assets with a high consequence are located at the 16th Street Reservoir and Pump Station. As the first major pump station and reservoir after the City's wells, the assets within the facility play a crucial role in the operation of the City's water system. No assets were scored as very high consequence. Detailed CoF score for each asset is provided in Appendix F.

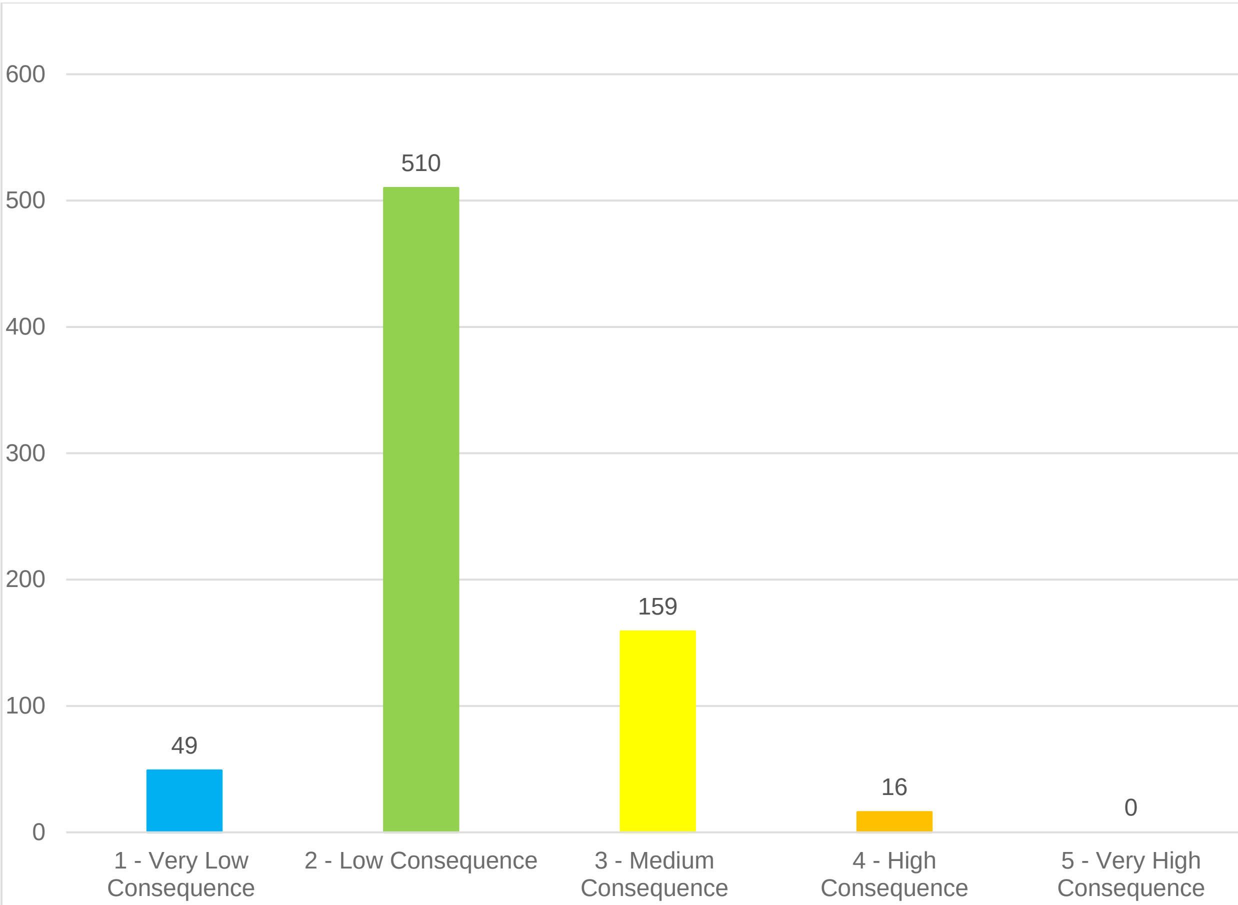


Figure 10-4: Summary of CoF Scores for Facilities

10.3 Risk for Vertical Assets

The risk for each of the evaluated assets was calculated by multiplying its LoF and CoF scores. The summary of the calculated risk scores are provided on Figure 10-5. There are no high or very high-risk assets in the inspected facilities. Only three assets were identified to have moderate risk, which were prioritized to be included in the City's CIP. This includes the Zone 5 Auxiliary Pump Station pump and motor and the Zone 4 pump 4 that runs on an old motor and requires renewal. The details of the risk score are provided in Appendix F.

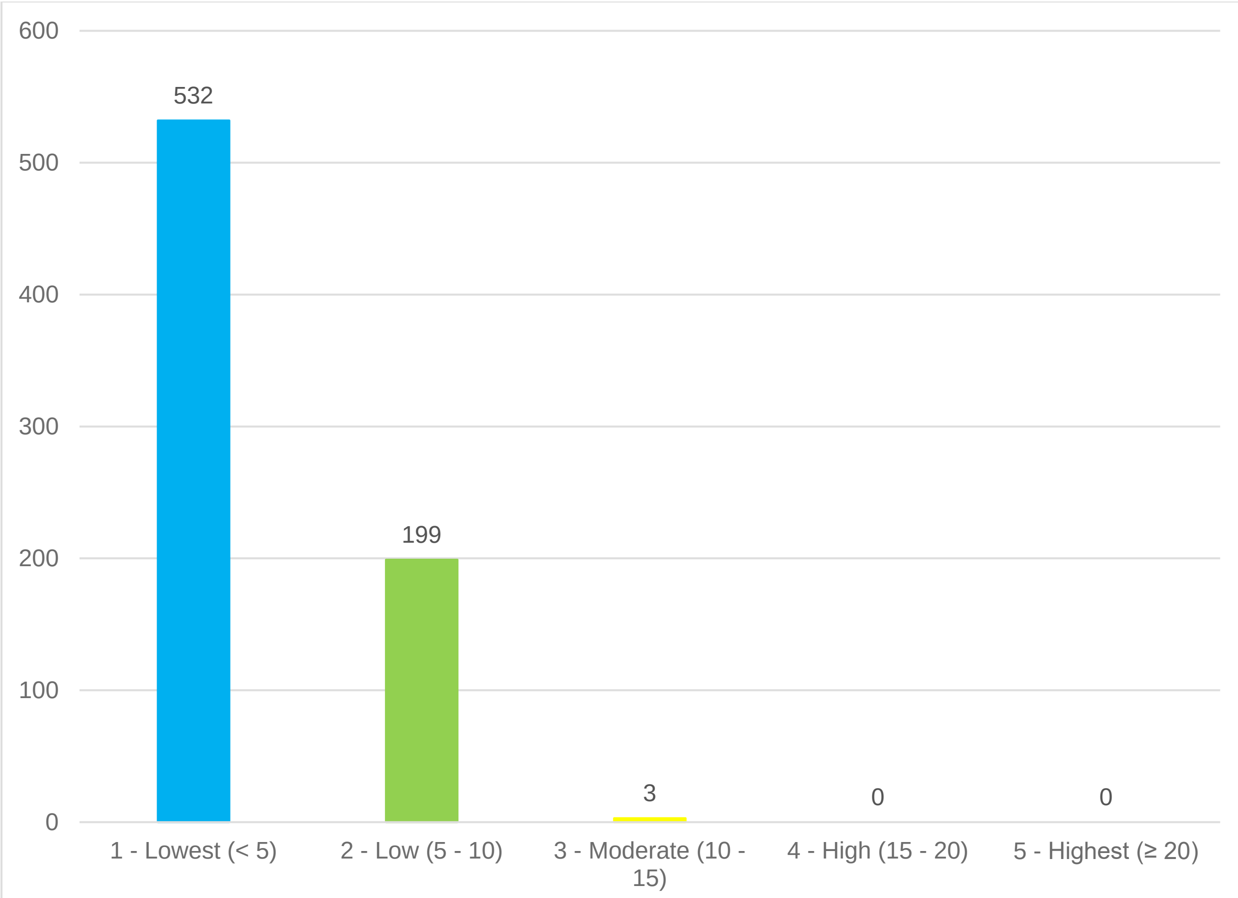


Figure 10-5: Summary of Facilities Risk Scores

10.4 Vertical Assets for CIP Inclusion

After completing the facility assessment, the Zone 5 Auxiliary Pump Station and Zone 4 Pump Station had assets with the highest risks scores. Projects were developed for the two locations and included in the CIP to help the City lower the overall risk as measured from this condition assessment. Descriptions of these projects are provided in Section 12.

11 WATER MAIN ASSESSMENT

11.1 Likelihood of Failure for Horizontal Assets

The City's water mains were assessed using the risk framework and criteria described in Section 9. The assessment resulted in a risk score being assigned to every pipe, which then included in the development of a prioritized 30-year CIP. This section describes the desktop analysis of the City's break data, identification of pipe cohorts, and development of EULs to assign a LoF score for each pipe segment. The section also describes the CoF score for the pipe segments and finally the calculation of risk scores.

11.1.1 Break Data Analysis

The LoF analysis began with the City's break data. Section 5 summarizes the City's distribution system in terms of diameter and material. The system is mainly comprised of 6- and 8-inch pipes (66 percent) and most of those are AC pipes (65 percent).

During the evaluation of the pipe attribute data in GIS, it was noted that there were some anomalies in the assigned pipe materials related to their installation dates and some missing data. For example, some PVC pipes had install dates before 1970 or AC pipes had install dates within the last couple decades. These pipe materials were suspect as these materials would not have been installed during those periods. There were also some duplicate pipe IDs. The GIS data was then corrected by the City to address these anomalies and a new pipe data set was provided, which was used for replacement planning and break analysis.

Based on the data provided by the City, the system experienced 113 breaks from 2007 to 2017, see Figure 11-1, and 78 of these breaks were on AC pipes, see Figure 11-2. This resulted in a systemwide average break rate of 5 breaks/100 miles/year taken from the most recent four years of data. These rates put the City among the top percent of utilities in the Western United States in terms of their pipe breaks.

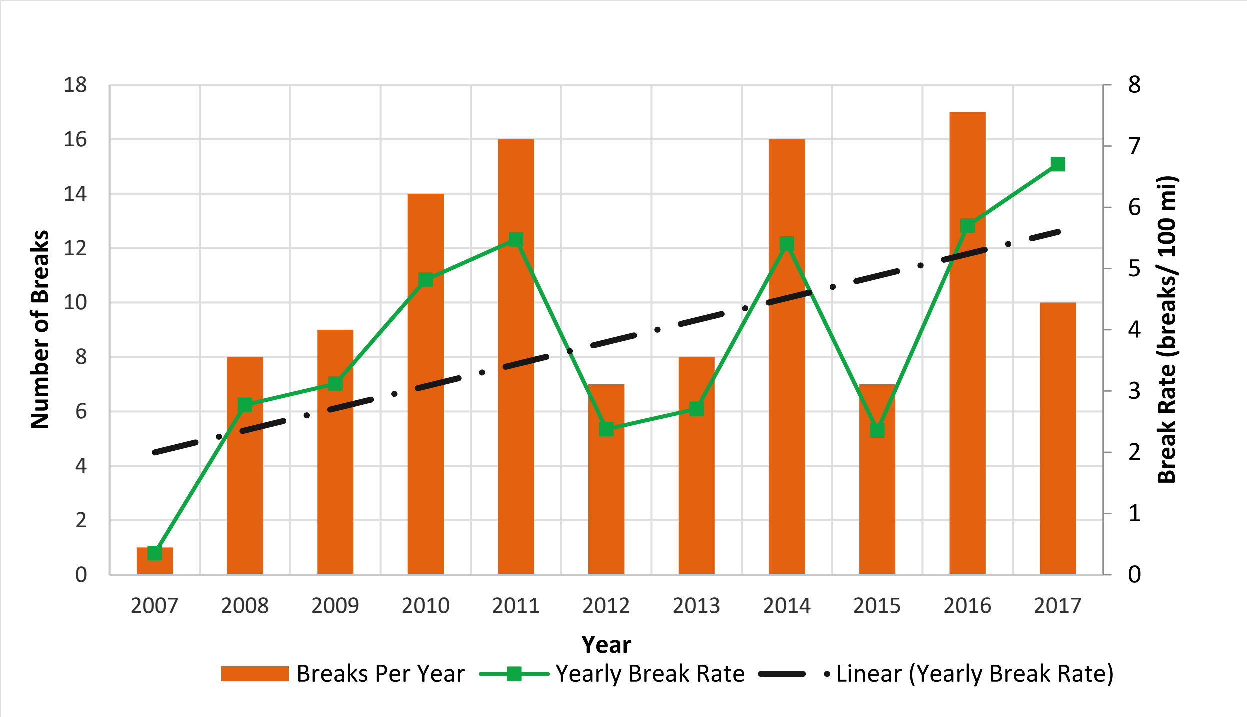


Figure 11-1: Number of Breaks by Year on All Pipes

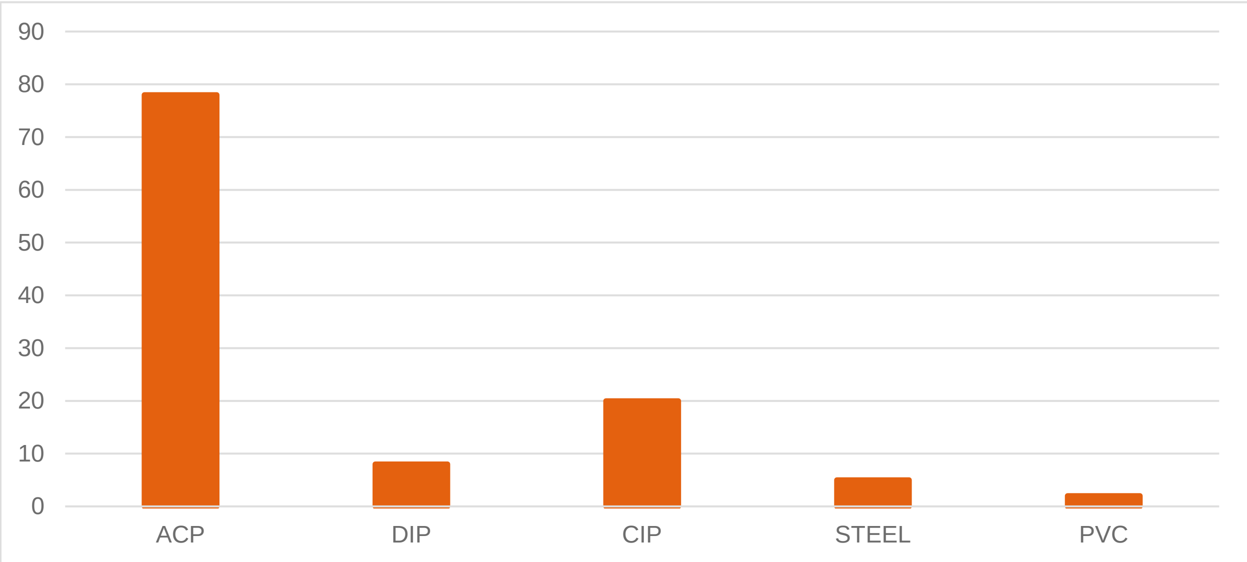


Figure 11-2: Number of Breaks by Material

Since most of the breaks (78 out of 133) were on AC pipes, cohort analysis was performed using the break data and focused only on AC pipe performance. Industry standard EUL information was used for the remaining materials.

Two cohorts within AC pipes were identified based on install year. Based on our experience and published literature, the break rate is expected to rise exponentially, which is observed in the pre-1960 pipe and break rates, but is not noticeably evident in the post-1960 division. For this reason, an EUL of 85 was assigned to pipes installed before 1960, since the exponential rise in break rate was seen in the data, and an EUL of 110 was assigned to pipe installed more recently than 1960 as the industry standard.

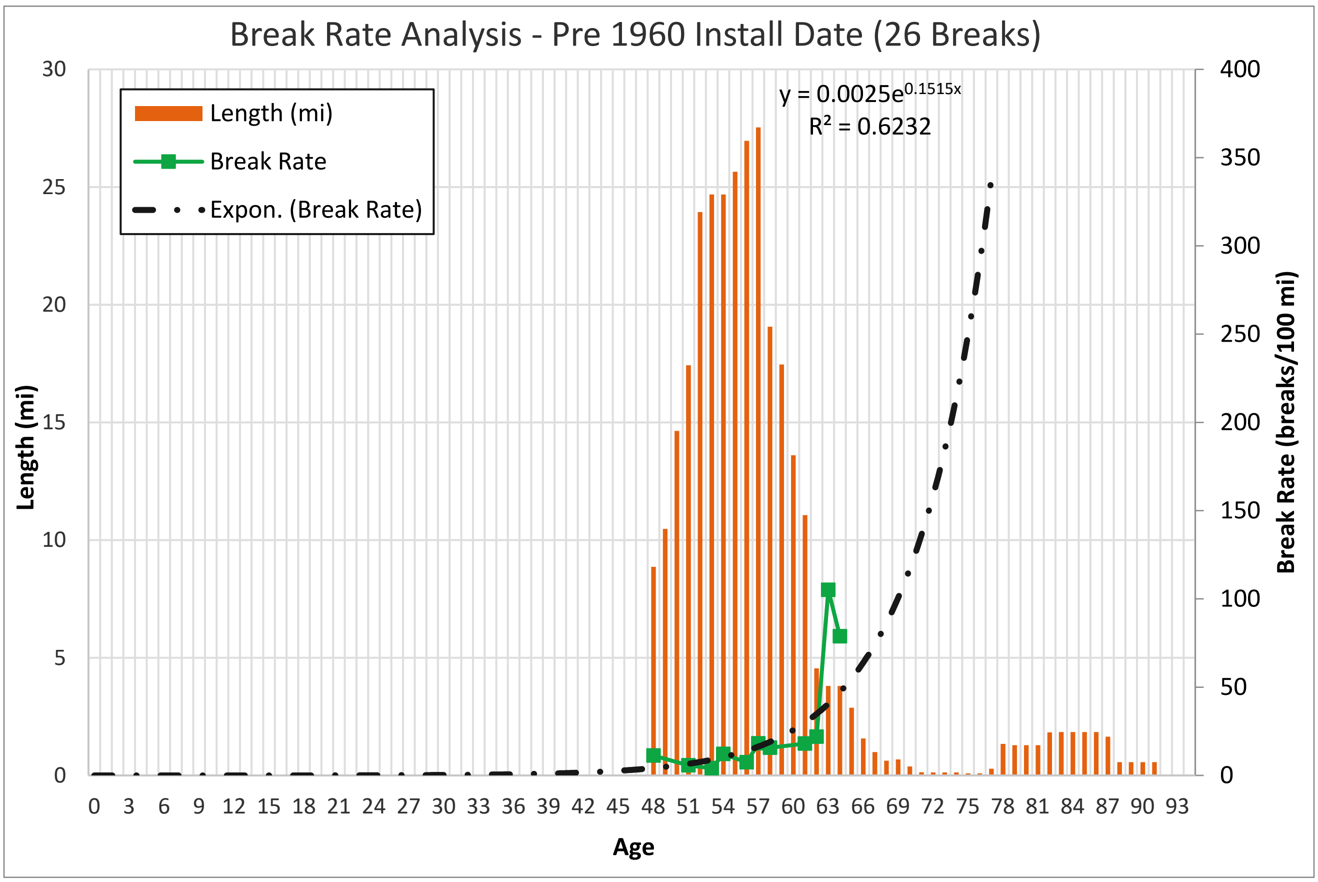


Figure 11-3: AC Pipe Break Rate Analysis Pre-1960

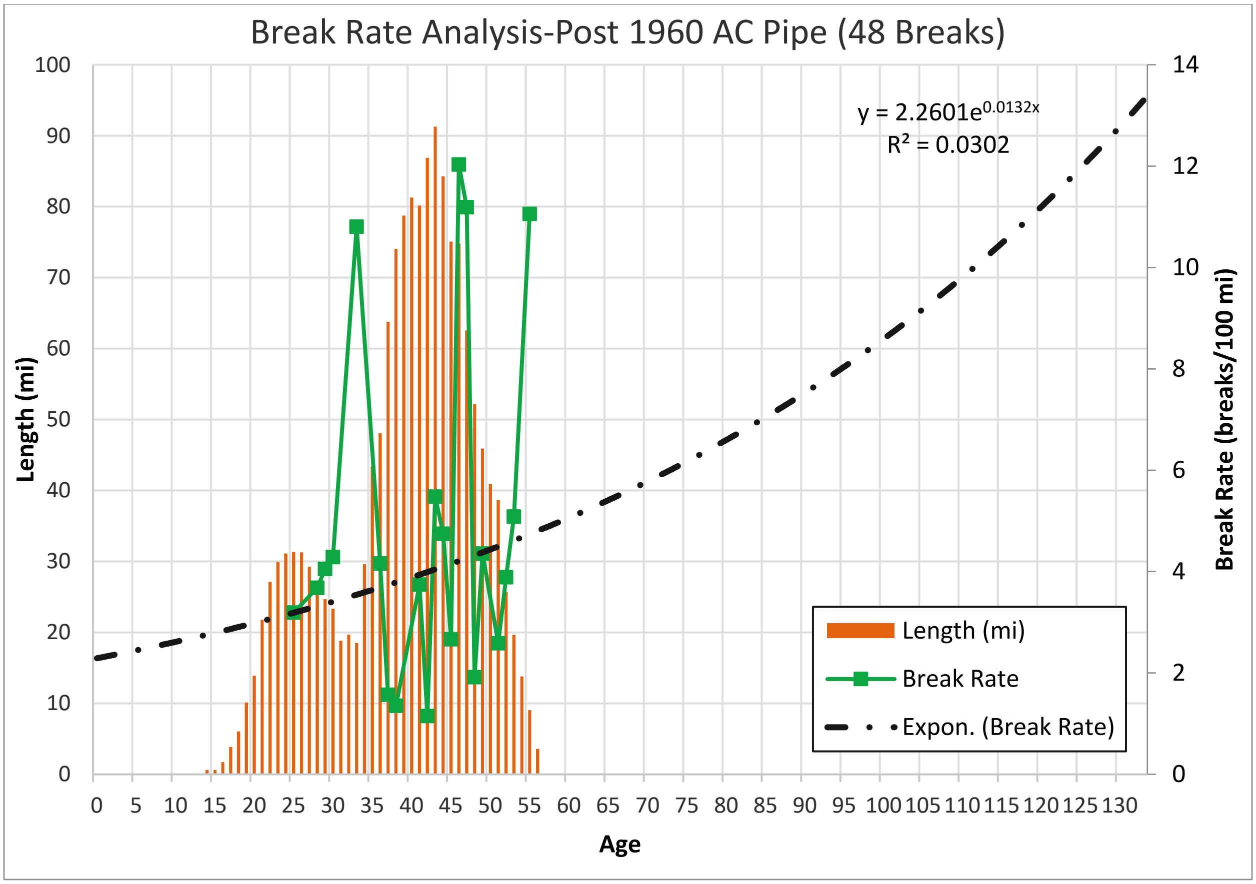


Figure 11-4: AC Pipe Break Rate Analysis Post 1960

No clear cohorts were revealed with respect to diameter when looking at breaks on AC pipes. Thus, with a very low number of breaks and no clear trend, all AC pipes were analyzed as a single cohort. To create the deterioration curve for the AC pipes cohort, the break data were plotted, and an exponential curve was fit to the known AC pipe break points (Figure 11-4).

Based on our experience and published literature, the break rate is expected to rise exponentially as the age of the pipe increases, but this trend is not apparent on Figure 11-4 due to the low number of breaks in the system.

Since patterns cannot be observed through break analysis to establish an EUL for the post 1960 AC pipe, and break data for other pipe materials is minimal or non-existent, information was used from the AWWA report “Buried No Longer: Confronting America’s Water Infrastructure Challenge”. The study provides projections for average water main estimated service lives for pipe of different materials and utility size. Table 11-1 presents the pipe material with its assigned EUL and Figure 11-5 shows the decay curves for these EULs for each material.

Table 11-1: EUL by Material

Pipe Material	EUL (years)
Asbestos Cement (Pre-1960)	80
Asbestos Cement (Post 1960)	110
Cast Iron	105
Copper	65
Ductile Iron	110
Galvanized Steel	50
Gunited Steel	95
High Density Polyethylene	70
Mortar Lined Cement Coated	95
Poly Vinyl Chloride	70
Reinforced Concrete Steel	75
Standard Steel	95
Unknown	90

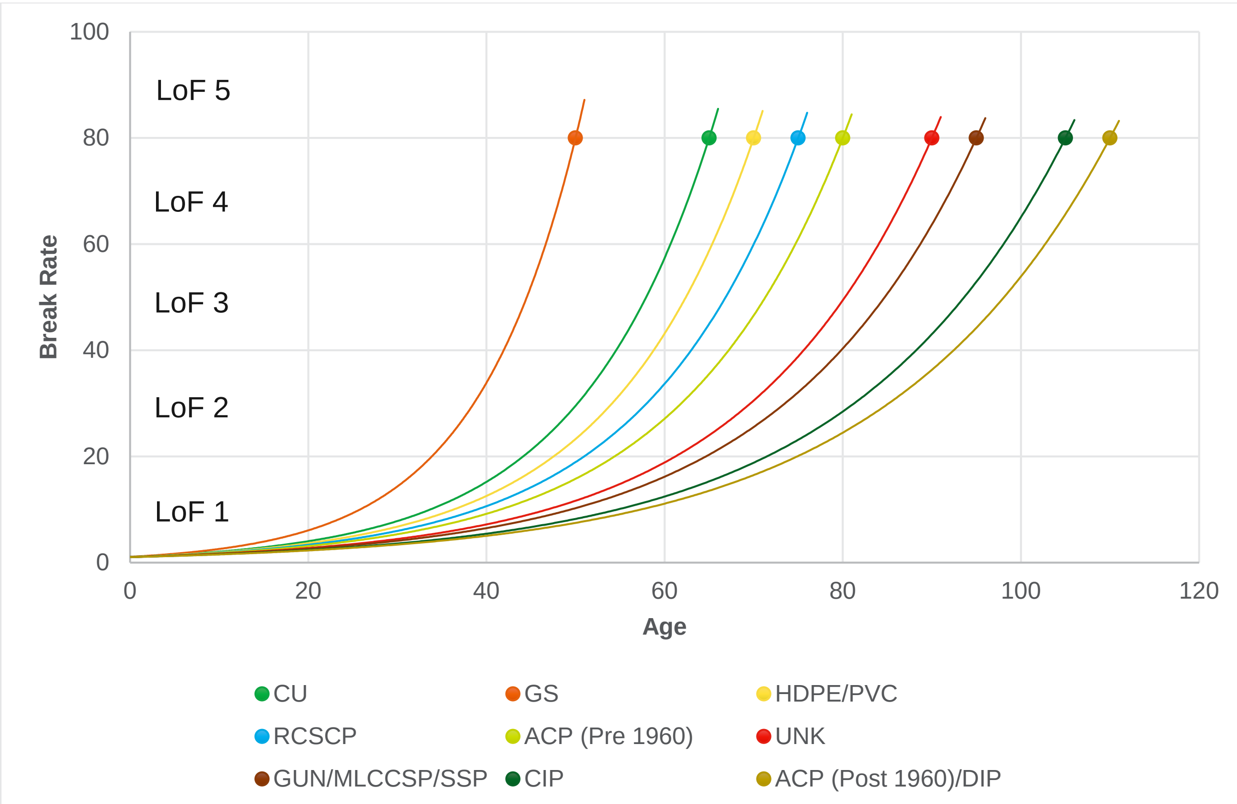


Figure 11-5: LoF Based on EULs Curves

11.1.2 Likelihood of Failure

Physical condition score was assigned to each pipe segment using the EUL estimates for each material. Using Figure 11-5, age of the pipe was converted to a condition score (1 through 5) and assigned to each pipe in GIS. The pipe segments were also assigned a performance score. This score was assigned based on the hydraulic constraints and improvements identified in Section 5. The pipes identified for improvements were given a performance score of 5 and remaining pipes were assigned a performance score of 1. The higher number between the physical condition and the performance condition score was used as the LoF to determine risk. Table 11-2 shows the breakdown of the LoF scores.

Table 11-2: LoF Score Breakdown

LoF	Physical Condition Score	Performance Condition Score	Segments	Miles	Percentage
1 – Very Low	1	0	9,589	281.2	94.4
2 - Low	2	0	233	9.7	3.3
3 - Medium	3	0	556	2.2	0.7
4 - High	4	0	28	1.9	0.6
5 - Very High	1	5	20	0.8	0.3
	2	5	1	0.1	0.03
	5	5	115	2.1	0.7

The majority of the City's pipes were installed in the second half of the 20th century, and hence most of them are predicted to be in excellent condition (94.4 percent). The pipes with a LoF of 5 were identified during the hydraulic analysis using the model and account for 1 percent of the system (Figure 11-6).

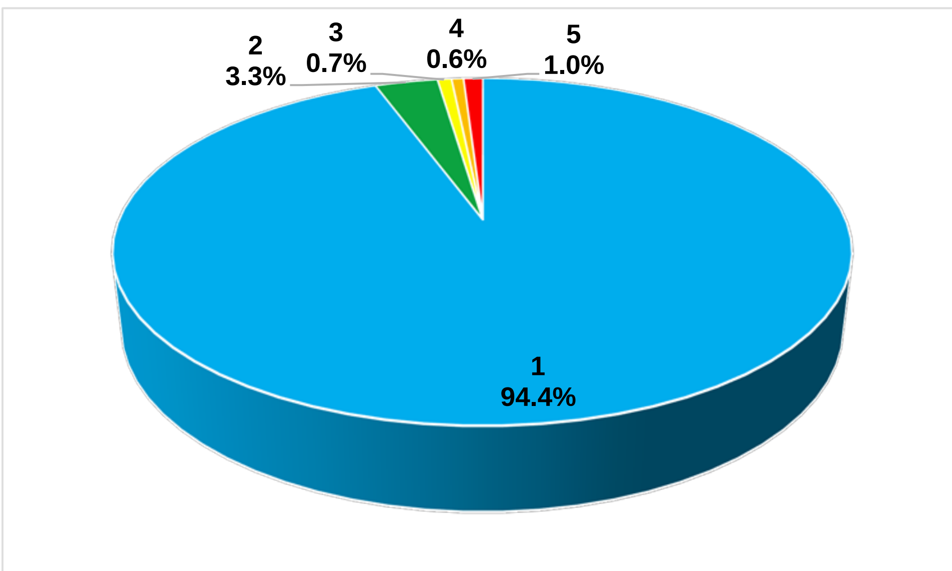


Figure 11-6: Summary of LoF Scores

11.2 Consequence of Failure for Horizontal Assets

The TBL approach, as described in Section 9.1.2, was used to assign CoF scores for each pipe segment using GIS tools. To evaluate each individual criterion, GIS calculated the proximity to roads and environmentally sensitive areas, identified pipes that served critical customers, and related the pressure output from the model to pipes. Each pipe was given a CoF score from 1 through 5 based on the highest score among the different criteria. The results are summarized in Table 11-3 and Figure 11-7.

Table 11-3: CoF Score Breakdown

Risk	Pipes	Miles	Percentage
1 – Very Low	4435	109.1	36.6
2 - Low	1679	65.8	22.1
3 - Medium	2484	66.1	22.2
4 - High	718	26.6	8.9
5 – Very High	726	30.4	10.2

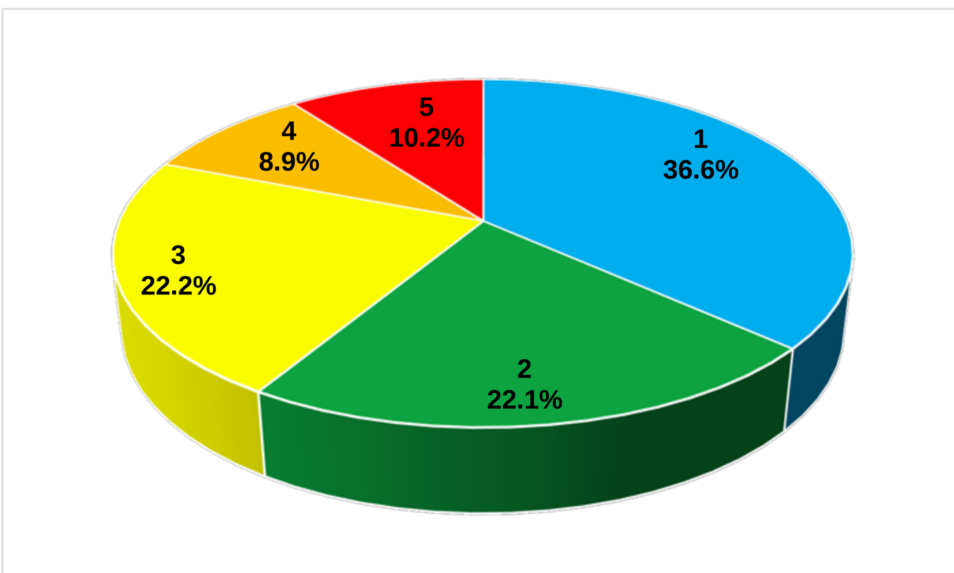
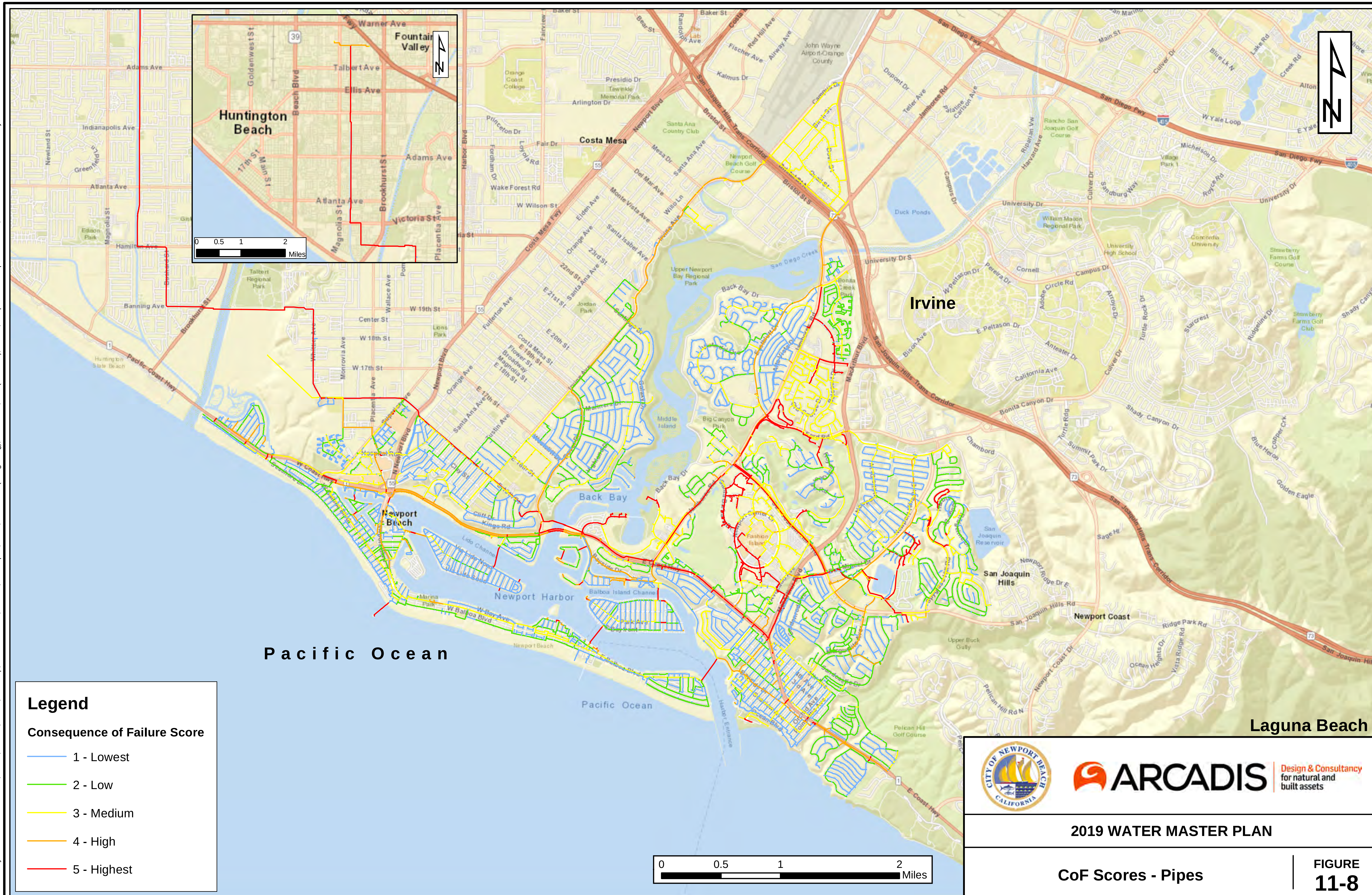


Figure 11-7: Summary of CoF Scores

Figure 11-8 shows the location of the highest CoF pipes. Only 10 percent of the City's pipes are critical.



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CoF Scores - Pipes

FIGURE 11-8

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 11-8 CoF Scores - Pipes.mxd 4/3/2019 2:48:37 PM
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11.3 Risk for Horizontal Assets

Arcadis' Renewal and Replacement Planning System (RRPS) was used to assign risk score to the pipes. The CoF and LoF scores were calculated and stored in the RRPS database. The final risk score ranging from 1 through 25 was assigned to the pipes by multiplying the CoF and LoF. Table 11-4 and Figure 11-9 summarize the results. Overall the system has only 3.3 percent of its pipes at an elevated risk score greater than 5. While this shows that the City's system is at low risk overall, as pipes continue to age, the risk score will continue to rise. Therefore, the riskiest pipes will be targeted in the CIP, followed by older pipes that will eventually raise the risk score. Figure 11-10 shows the location of pipes at the highest risk.

Table 11-4: Risk Score Breakdown

Risk	Segments of Pipes	Pipe Length (miles	Percentage of Pipe Length
1-2 (Very Low)	5,954	171.5	57.6
3-4 (Low)	3,092	86.7	29.1
5 (Medium)	787	30.1	10.1
6-15 (High)	171	7.4	2.5
16-25 (Very High)	38	2.3	0.8

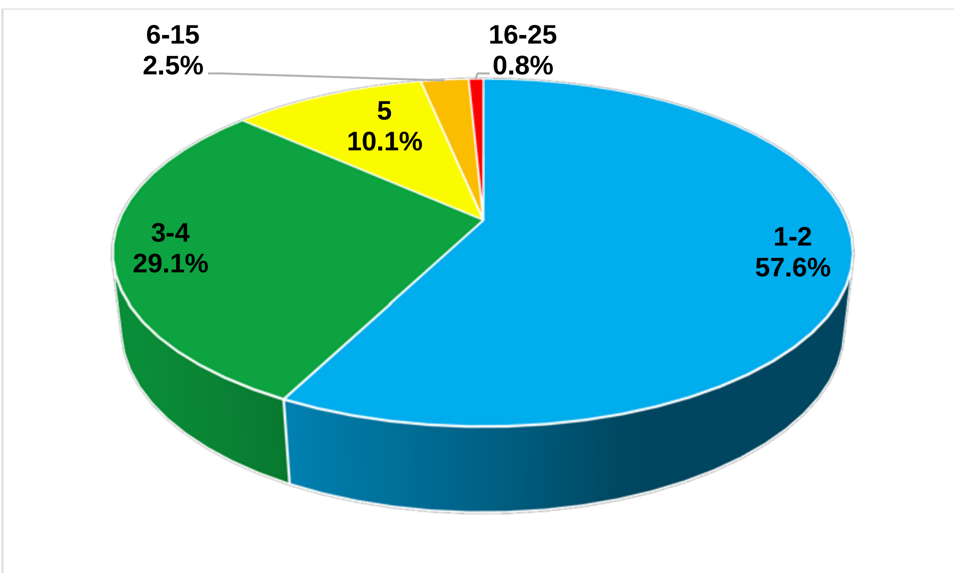
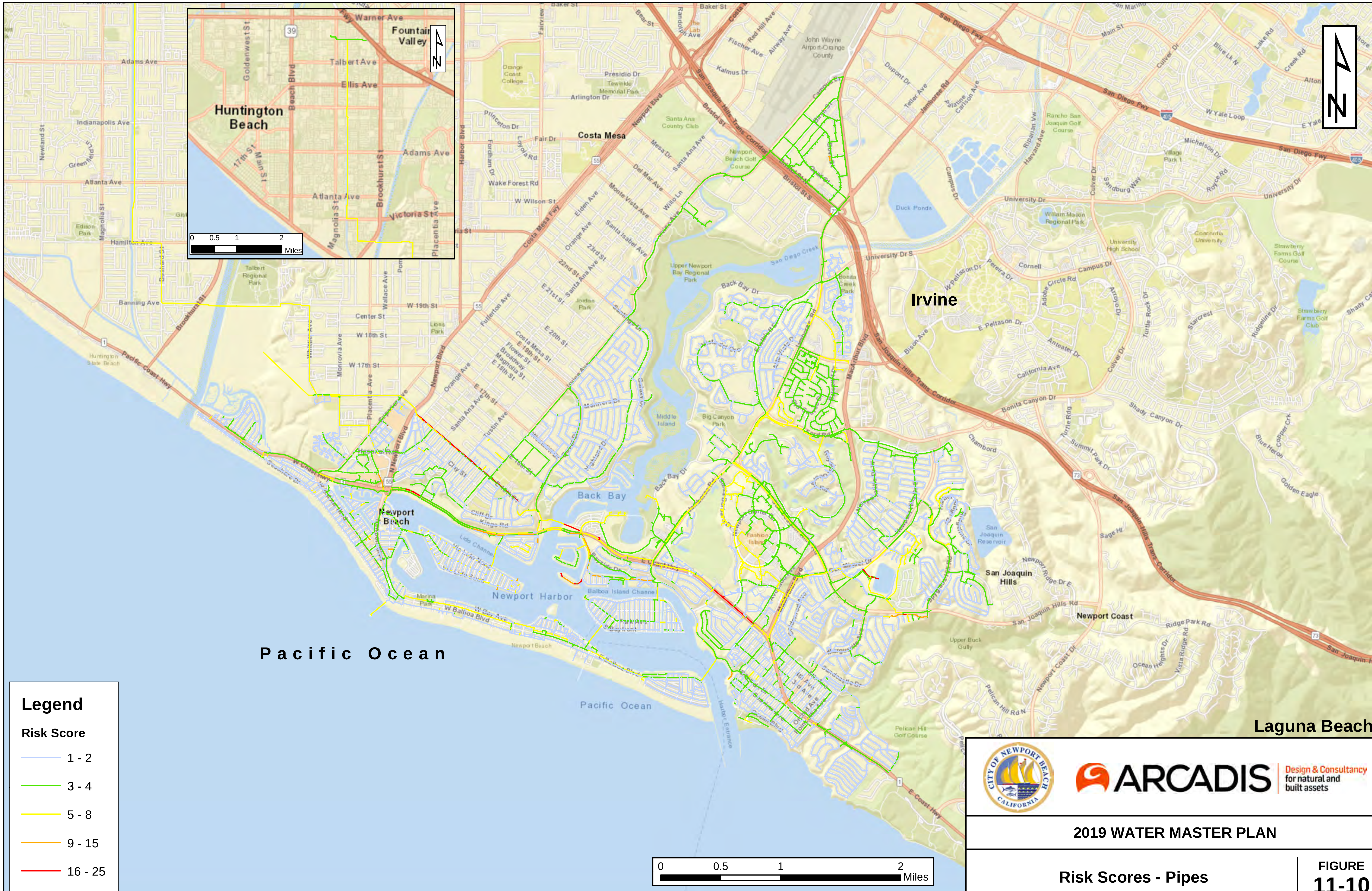


Figure 11-9: Summary of Pipeline Risk Scores



2019 WATER MASTER PLAN

Risk Scores - Pipes

FIGURE 11-10

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 11-10 Risk Scores - Pipes.mxd 4/3/2019 2:48:51 PM
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

12 CAPITAL IMPROVEMENT PROGRAM

12.1 Basis for Cost Estimates

Capital cost estimates were developed for the CIP projects described below. The cost estimates presented are based on available bid tabs, recent projects with similar components, manufacturer's budget estimates, standard construction cost estimating manuals, and engineering judgment. The level of accuracy for the cost estimates corresponds to a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International. This level of engineering cost estimating is approximate and generally made without detailed engineering data and site layouts, but is appropriate for preliminary budget-level estimating. The accuracy range of a Class 4 estimate is minus 15 percent to plus 20 percent in the best case, and minus 30 percent to plus 50 percent in the worst case.

Appendix G contains unit cost information and other assumptions used in this master plan. Unit capital costs include materials of construction, installation, and contractor costs (overhead, profit, bonding, mobilization). All costs also include a 20 percent factor for engineering and construction administration and 30 percent for project contingencies. All costs are in June 2018 dollars referenced to an Engineering News Record Construction Cost Index (ENR CCI) of 11,068.

12.2 30-Year Capital Improvement Program

The City has requested 30 years of CIP projects be outlined based on the risk analysis performed as part of this WMP as well as internally developed projects. This includes pipeline replacements, system maintenance, and facility replacement projects. Table 12-1 presents the CIP projects for the next 30 years. Some improvement costs are assigned to a single fiscal year, others are spread across multiple fiscal years for larger projects or to account for planning costs incurred the year before construction begins. An annual escalation is factored into the CIP costs of 2.5 percent each year. Project locations are shown for facilities projects on Figure 12-1, for PRSs on Figure 12-2, and for pipelines on Figure 12-4. The following sections provide further details of the facilities projects (represented with an "F-" prefix), PRS projects (represented with an "S-" prefix), and pipeline projects (represented with a "P-" prefix) in the City's CIP.

Table 12-1 CIP Projects

Project No.	Project Title	Budget Without Escalation	Year 0 2018/2019	Year 1 2019/2020	Year 2 2020/2021	Year 3 2021/2022	Year 4 2022/2023	Year 5 2023/2024	Year 6 2024/2025	Year 7 2025/2026	Year 8 2026/2027	Year 9 2027/2028	Year 10 2028/2029
Facilities Projects													
F-1	Spyglass Hill Reservoir Mixing System (19W15)	$ 100,000	$ 100,000										
F-2	Utilities Yard Spill Control Valve/Tipping Floor (18W14)	$ 170,000	$ 170,000										
F-3	Water Well Rehabilitation (19W04)	$ 6,900,000	$ 500,000				$ 442,000	$ 453,000	$ 464,000	$ 476,000			
F-4	Utilities Yard Backup Generators Final Design (18W13)	$ 850,000	$ 150,000		$ 736,000								
F-5	Transmission Main Valve Replacement (18W12)	$ 4,000,000	$ 1,000,000	$ 1,538,000	$ 1,576,000								
F-6	16th Street Pump Station Upgrades	$ 1,400,000		$ 200,000	$ 1,261,000								
F-7	Advanced Metering Infrastructure (19W12)	$ 14,500,000	$ 3,300,000		$ 3,257,000	$ 3,339,000							
F-8	Zone 5 Auxiliary (Hillsborough) Pump Station Rehabilitation (19W14)	$ 650,000			$ 100,000	$ 593,000							
F-9	Cathodic Protection	$ 1,050,000				$ 377,000							
F-10	Zone 3 and Zone 4 Pump Station Upgrades	$ 1,400,000					$ 773,000	$ 792,000					
F-11	CM-9 Replacement	$ 500,000							$ 580,000				
F-12	BCR 2-24", Check Valve, 30" and 48" Basement Valve Replacement	$ 500,000									$ 610,000		
F-13	New Wells and Pipeline (2,600' of 20") in Fountain Valley	$ 8,000,000											
F-14	Big Canyon Reservoir Cover Replacement	$ 4,531,000											
F-15	Distribution Valve Replacement Program	$ 3,000,000	$ 100,000	$ 100,000	$ 103,000	$ 106,000	$ 108,000	$ 111,000	$ 114,000	$ 116,000	$ 119,000	$ 122,000	$ 125,000
F-16	Water System Rehabilitation (19W05)	$ 10,500,000	$ 350,000	$ 350,000	$ 359,000	$ 368,000	$ 377,000	$ 387,000	$ 396,000	$ 406,000	$ 417,000	$ 427,000	$ 438,000
F-17	Water Valve Grade Adjustments (19R06)	$ 2,400,000	$ 80,000	$ 80,000	$ 82,000	$ 85,000	$ 87,000	$ 89,000	$ 91,000	$ 93,000	$ 96,000	$ 98,000	$ 100,000
Pressure Reducing Stations													
S-1	Alta Vista #1 PRS Relocation (19W13)	$ 300,000	$ 100,000	$ 205,000									
S-2	2121 Bayside Drive PRS Rebuild	$ 271,000			$ 285,000								
S-3	Dover Dr/PCH - Replace valves and upgrade electrical	$ 136,000				$ 147,000							
S-4	15th Street/Irvine Ave #2 PRS (Proposed New Station)	$ 300,000								$ 357,000			
S-5	15th Street/Irvine Ave #1 PRS Replacement	$ 200,000								$ 238,000			
Pipeline Replacment and Relining Projects													
P-1	Balboa Island Water Main Replacement (Phase 2)	$ 2,500,000	$ 2,500,000										
P-2A	Bay Crossings - Subaqueous Final Design (16W12)	$ 906,000	$ 906,000										
P-3	Lido Island Outer Ring (6")	$ 2,900,000		$ 200,000	$ 2,837,000								
P-4	Corte Portal/Corte Portofino Intersection (6")	$ 30,000			$ 32,000								
P-5	Irvine Terrace West (6") - Jamboree Rd to Malabar Dr/El Paseo Dr	$ 2,800,000			$ 250,000	$ 2,747,000							
P-2B	Bay Crossings - Subaqueous (BC-01, BC-02 and BC-06)	$ 6,812,000					$ 7,520,000						
P-6	Bay Crossings - CIPP (BC-5 and BC-15)	$ 689,000					$ 150,000	$ 610,000					
P-7	PCH (30") - MacArthur Blvd to Jamboree Rd Relining	$ 4,100,000						$ 4,639,000					
P-8	Irvine Terrace East (6") - Malabar Dr/El Paseo Dr to Avocado Ave	$ 3,900,000						$ 250,000	$ 4,233,000				
P-9	15th Street (30") - Newport Blvd to Kings Pl Relining	$ 3,900,000							$ 4,523,000				
P-10	15th Street (12") - Newport Blvd to Irvine Ave	$ 1,500,000							$ 1,740,000				
P-11	Bay Crossings - HDD (BC-12, BC-17, SA-01)	$ 3,523,000							$ 450,000	$ 3,653,000			
P-12	Harbor Island Dr (6" and 24") - PCH to End	$ 5,000,000								$ 5,944,000			
P-13	PCH (6",8", and 24") - Newport Blvd to Tustin Ave	$ 2,200,000									$ 2,681,000		
P-14	Hoag Hospital (8" and 24") - Newport Blvd to Sunset Park Lane	$ 1,200,000									$ 1,463,000		
P-15	PCH (upsize 6" to 8" and replace 24") - Tustin Ave to Dover Dr	$ 6,200,000										$ 7,743,000	
P-16	Bay Ave (8", 14", and 16") - 19th St to Cypress Street	$ 4,900,000											$ 6,273,000
P-17	Balboa Blvd (6' , 10", and 12") - Main St to Seville Ave	$ 2,500,000											
P-18	Lido Island Westside (4", 6", and 10")	$ 2,700,000											
P-19	Balboa Island Water Main Replacement (Phase 3)	$ 2,000,000											
P-20	Lido Island Eastside (4", 6", and 8")	$ 2,800,000											
P-21	16th St, Monrovia Ave, 15th St and Placentia Ave (14 " and 24")	$ 4,200,000											
P-22	Eastbluff Dr (18") - Jamboree Rd to Cacao St	$ 4,200,000											
P-23	Eastbluff Dr and Jamboree Rd (18" and 20") - Cacao St to SR 73	$ 4,600,000											
P-24	Jamboree Rd (18" and 30") - Bayside Dr to San Joaquin Hills Rd	$ 6,200,000											
P-25	San Joaquin Hills Rd (10" and 16") - Jamboree to Crown Dr	$ 4,600,000											
P-26	San Joaquin Hills Rd (30") - Jamboree Rd to San Miguel Dr Relining	$ 4,300,000											
P-27	Bay Crossing Upper Bay (BC-09) (24" and 30")	$ 1,400,000											
P-28	Corona Highlands Parallel Pipeline (New Pipe Installation)	$ 980,000											
P-29	Asbestos Cement Pipe (Type 1) Replacement Program	$ 10,000,000											
	Total	**$ 165,198,000**	**$ 9,256,000**	**$ 2,673,000**	**$ 10,878,000**	**$ 7,762,000**	**$ 9,457,000**	**$ 7,331,000**	**$ 12,591,000**	**$ 11,283,000**	**$ 5,386,000**	**$ 8,390,000**	**$ 6,936,000**
	Total with Escalation (Year 1 thru Year 30)	**$ 216,715,000**											
	Annual Average with Escalation (Year 1 thru Year 30)	**$ 7,223,833**											

Table 12-1 CIP Projects

Project No.	Project Title	Budget Without Escalation	Year 11 2029/2030	Year 12 2030/2031	Year 13 2031/2032	Year 14 2032/2033	Year 15 2033/2034	Year 16 2034/2035	Year 17 2035/2036	Year 18 2036/2037	Year 19 2037/2038	Year 20 2038/2039
Facilities Projects												
F-1	Spyglass Hill Reservoir Mixing System (19W15)	$ 100,000										
F-2	Utilities Yard Spill Control Valve/Tipping Floor (18W14)	$ 170,000										
F-3	Water Well Rehabilitation (19W04)	$ 6,900,000	$ 525,000	$ 538,000	$ 552,000	$ 566,000				$ 624,000	$ 640,000	$ 656,000
F-4	Utilities Yard Backup Generators Final Design (18W13)	$ 850,000										
F-5	Transmission Main Valve Replacement (18W12)	$ 4,000,000										
F-6	16th Street Pump Station Upgrades	$ 1,400,000										
F-7	Advanced Metering Infrastructure (19W12)	$ 14,500,000				$ 1,767,000	$ 1,811,000	$ 1,856,000	$ 1,903,000			
F-8	Zone 5 Auxiliary (Hillsborough) Pump Station Rehabilitation (19W14)	$ 650,000										
F-9	Cathodic Protection	$ 1,050,000			$ 483,000							
F-10	Zone 3 and Zone 4 Pump Station Upgrades	$ 1,400,000										
F-11	CM-9 Replacement	$ 500,000										
F-12	BCR 2-24", Check Valve, 30" and 48" Basement Valve Replacement	$ 500,000										
F-13	New Wells and Pipeline (2,600' of 20") in Fountain Valley	$ 8,000,000	$ 3,499,000	$ 3,587,000	$ 3,677,000							
F-14	Big Canyon Reservoir Cover Replacement	$ 4,531,000					$ 3,282,000	$ 3,364,000				
F-15	Distribution Valve Replacement Program	$ 3,000,000	$ 129,000	$ 132,000	$ 135,000	$ 138,000	$ 142,000	$ 145,000	$ 149,000	$ 153,000	$ 156,000	$ 160,000
F-16	Water System Rehabilitation (19W05)	$ 10,500,000	$ 449,000	$ 460,000	$ 471,000	$ 483,000	$ 495,000	$ 507,000	$ 520,000	$ 533,000	$ 546,000	$ 560,000
F-17	Water Valve Grade Adjustments (19R06)	$ 2,400,000	$ 103,000	$ 105,000	$ 108,000	$ 111,000	$ 114,000	$ 116,000	$ 119,000	$ 122,000	$ 125,000	$ 128,000
Pressure Reducing Stations												
S-1	Alta Vista #1 PRS Relocation (19W13)	$ 300,000										
S-2	2121 Bayside Drive PRS Rebuild	$ 271,000										
S-3	Dover Dr/PCH - Replace valves and upgrade electrical	$ 136,000										
S-4	15th Street/Irvine Ave #2 PRS (Proposed New Station)	$ 300,000										
S-5	15th Street/Irvine Ave #1 PRS Replacement	$ 200,000										
Pipeline Replacment and Relining Projects												
P-1	Balboa Island Water Main Replacement (Phase 2)	$ 2,500,000										
P-2A	Bay Crossings - Subaqueous Final Design (16W12)	$ 906,000										
P-3	Lido Island Outer Ring (6")	$ 2,900,000										
P-4	Corte Portal/Corte Portofino Intersection (6")	$ 30,000										
P-5	Irvine Terrace West (6") - Jamboree Rd to Malabar Dr/El Paseo Dr	$ 2,800,000										
P-2B	Bay Crossings - Subaqueous (BC-01, BC-02 and BC-06)	$ 6,812,000										
P-6	Bay Crossings - CIPP (BC-5 and BC-15)	$ 689,000										
P-7	PCH (30") - MacArthur Blvd to Jamboree Rd Relining	$ 4,100,000										
P-8	Irvine Terrace East (6") - Malabar Dr/El Paseo Dr to Avocado Ave	$ 3,900,000										
P-9	15th Street (30") - Newport Blvd to Kings Pl Relining	$ 3,900,000										
P-10	15th Street (12") - Newport Blvd to Irvine Ave	$ 1,500,000										
P-11	Bay Crossings - HDD (BC-12, BC-17, SA-01)	$ 3,523,000										
P-12	Harbor Island Dr (6" and 24") - PCH to End	$ 5,000,000										
P-13	PCH (6",8", and 24") - Newport Blvd to Tustin Ave	$ 2,200,000										
P-14	Hoag Hospital (8" and 24") - Newport Blvd to Sunset Park Lane	$ 1,200,000										
P-15	PCH (upsize 6" to 8" and replace 24") - Tustin Ave to Dover Dr	$ 6,200,000										
P-16	Bay Ave (8", 14", and 16") - 19th St to Cypress Street	$ 4,900,000										
P-17	Balboa Blvd (6' , 10", and 12") - Main St to Seville Ave	$ 2,500,000	$ 3,281,000									
P-18	Lido Island Westside (4", 6", and 10")	$ 2,700,000			$ 3,722,000							
P-19	Balboa Island Water Main Replacement (Phase 3)	$ 2,000,000				$ 2,826,000						
P-20	Lido Island Eastside (4", 6", and 8")	$ 2,800,000				$ 3,957,000						
P-21	16th St, Monrovia Ave, 15th St and Placentia Ave (14 " and 24")	$ 4,200,000					$ 6,083,000					
P-22	Eastbluff Dr (18") - Jamboree Rd to Cacao St	$ 4,200,000						$ 6,235,000				
P-23	Eastbluff Dr and Jamboree Rd (18" and 20") - Cacao St to SR 73	$ 4,600,000							$ 7,000,000			
P-24	Jamboree Rd (18" and 30") - Bayside Dr to San Joaquin Hills Rd	$ 6,200,000										
P-25	San Joaquin Hills Rd (10" and 16") - Jamboree to Crown Dr	$ 4,600,000										
P-26	San Joaquin Hills Rd (30") - Jamboree Rd to San Miguel Dr Relining	$ 4,300,000										
P-27	Bay Crossing Upper Bay (BC-09) (24" and 30")	$ 1,400,000										
P-28	Corona Highlands Parallel Pipeline (New Pipe Installation)	$ 980,000										
P-29	Asbestos Cement Pipe (Type 1) Replacement Program	$ 10,000,000										
	Total	**$ 165,198,000**	**$ 7,986,000**	**$ 4,822,000**	**$ 9,148,000**	**$ 9,848,000**	**$ 11,927,000**	**$ 12,223,000**	**$ 9,691,000**	**$ 1,432,000**	**$ 1,467,000**	**$ 1,504,000**
	Total with Escalation (Year 1 thru Year 30)	**$ 216,715,000**										
	Annual Average with Escalation (Year 1 thru Year 30)	**$ 7,223,833**										

Table 12-1 CIP Projects

Project No.	Project Title	Budget Without Escalation	Year 21 2039/2040	Year 22 2040/2041	Year 23 2041/2042	Year 24 2042/2043	Year 25 2043/2044	Year 26 2044/2045	Year 27 2045/2046	Year 28 2046/2047	Year 29 2047/2048	Year 30 2048/2049
Facilities Projects												
F-1	Spyglass Hill Reservoir Mixing System (19W15)	$ 100,000										
F-2	Utilities Yard Spill Control Valve/Tipping Floor (18W14)	$ 170,000										
F-3	Water Well Rehabilitation (19W04)	$ 6,900,000	$ 672,000				$ 742,000	$ 761,000	$ 780,000	$ 799,000		
F-4	Utilities Yard Backup Generators Final Design (18W13)	$ 850,000										
F-5	Transmission Main Valve Replacement (18W12)	$ 4,000,000										
F-6	16th Street Pump Station Upgrades	$ 1,400,000										
F-7	Advanced Metering Infrastructure (19W12)	$ 14,500,000										
F-8	Zone 5 Auxiliary (Hillsborough) Pump Station Rehabilitation (19W14)	$ 650,000										
F-9	Cathodic Protection	$ 1,050,000			$ 618,000							
F-10	Zone 3 and Zone 4 Pump Station Upgrades	$ 1,400,000										
F-11	CM-9 Replacement	$ 500,000										
F-12	BCR 2-24", Check Valve, 30" and 48" Basement Valve Replacement	$ 500,000										
F-13	New Wells and Pipeline (2,600' of 20") in Fountain Valley	$ 8,000,000										
F-14	Big Canyon Reservoir Cover Replacement	$ 4,531,000										
F-15	Distribution Valve Replacement Program	$ 3,000,000	$ 164,000	$ 168,000	$ 173,000	$ 177,000	$ 181,000	$ 186,000	$ 191,000	$ 195,000	$ 200,000	$ 205,000
F-16	Water System Rehabilitation (19W05)	$ 10,500,000	$ 574,000	$ 588,000	$ 603,000	$ 618,000	$ 634,000	$ 649,000	$ 666,000	$ 682,000	$ 699,000	$ 717,000
F-17	Water Valve Grade Adjustments (19R06)	$ 2,400,000	$ 132,000	$ 135,000	$ 138,000	$ 142,000	$ 145,000	$ 149,000	$ 153,000	$ 156,000	$ 160,000	$ 164,000
Pressure Reducing Stations												
S-1	Alta Vista #1 PRS Relocation (19W13)	$ 300,000										
S-2	2121 Bayside Drive PRS Rebuild	$ 271,000										
S-3	Dover Dr/PCH - Replace valves and upgrade electrical	$ 136,000										
S-4	15th Street/Irvine Ave #2 PRS (Proposed New Station)	$ 300,000										
S-5	15th Street/Irvine Ave #1 PRS Replacement	$ 200,000										
Pipeline Replacment and Relining Projects												
P-1	Balboa Island Water Main Replacement (Phase 2)	$ 2,500,000										
P-2A	Bay Crossings - Subaqueous Final Design (16W12)	$ 906,000										
P-3	Lido Island Outer Ring (6")	$ 2,900,000										
P-4	Corte Portal/Corte Portofino Intersection (6")	$ 30,000										
P-5	Irvine Terrace West (6") - Jamboree Rd to Malabar Dr/El Paseo Dr	$ 2,800,000										
P-2B	Bay Crossings - Subaqueous (BC-01, BC-02 and BC-06)	$ 6,812,000										
P-6	Bay Crossings - CIPP (BC-5 and BC-15)	$ 689,000										
P-7	PCH (30") - MacArthur Blvd to Jamboree Rd Relining	$ 4,100,000										
P-8	Irvine Terrace East (6") - Malabar Dr/El Paseo Dr to Avocado Ave	$ 3,900,000										
P-9	15th Street (30") - Newport Blvd to Kings Pl Relining	$ 3,900,000										
P-10	15th Street (12") - Newport Blvd to Irvine Ave	$ 1,500,000										
P-11	Bay Crossings - HDD (BC-12, BC-17, SA-01)	$ 3,523,000										
P-12	Harbor Island Dr (6" and 24") - PCH to End	$ 5,000,000										
P-13	PCH (6",8", and 24") - Newport Blvd to Tustin Ave	$ 2,200,000										
P-14	Hoag Hospital (8" and 24") - Newport Blvd to Sunset Park Lane	$ 1,200,000										
P-15	PCH (upsize 6" to 8" and replace 24") - Tustin Ave to Dover Dr	$ 6,200,000										
P-16	Bay Ave (8", 14", and 16") - 19th St to Cypress Street	$ 4,900,000										
P-17	Balboa Blvd (6' , 10", and 12") - Main St to Seville Ave	$ 2,500,000										
P-18	Lido Island Westside (4", 6", and 10")	$ 2,700,000										
P-19	Balboa Island Water Main Replacement (Phase 3)	$ 2,000,000										
P-20	Lido Island Eastside (4", 6", and 8")	$ 2,800,000										
P-21	16th St, Monrovia Ave, 15th St and Placentia Ave (14 " and 24")	$ 4,200,000										
P-22	Eastbluff Dr (18") - Jamboree Rd to Cacao St	$ 4,200,000										
P-23	Eastbluff Dr and Jamboree Rd (18" and 20") - Cacao St to SR 73	$ 4,600,000										
P-24	Jamboree Rd (18" and 30") - Bayside Dr to San Joaquin Hills Rd	$ 6,200,000	$ 10,414,000									
P-25	San Joaquin Hills Rd (10" and 16") - Jamboree to Crown Dr	$ 4,600,000			$ 8,118,000							
P-26	San Joaquin Hills Rd (30") - Jamboree Rd to San Miguel Dr Relining	$ 4,300,000				$ 7,778,000						
P-27	Bay Crossing Upper Bay (BC-09) (24" and 30")	$ 1,400,000							$ 2,727,000			
P-28	Corona Highlands Parallel Pipeline (New Pipe Installation)	$ 980,000									$ 2,006,000	
P-29	Asbestos Cement Pipe (Type 1) Replacement Program	$ 10,000,000	$ 1,680,000	$ 1,722,000	$ 1,765,000	$ 1,809,000	$ 1,854,000	$ 1,901,000	$ 1,948,000	$ 1,997,000	$ 2,047,000	$ 2,098,000
	Total	**$ 165,198,000**	**$ 13,636,000**	**$ 2,613,000**	**$ 11,415,000**	**$ 10,524,000**	**$ 3,556,000**	**$ 3,646,000**	**$ 6,465,000**	**$ 3,829,000**	**$ 5,112,000**	**$ 3,184,000**
	Total with Escalation (Year 1 thru Year 30)	**$ 216,715,000**										
	Annual Average with Escalation (Year 1 thru Year 30)	**$ 7,223,833**										

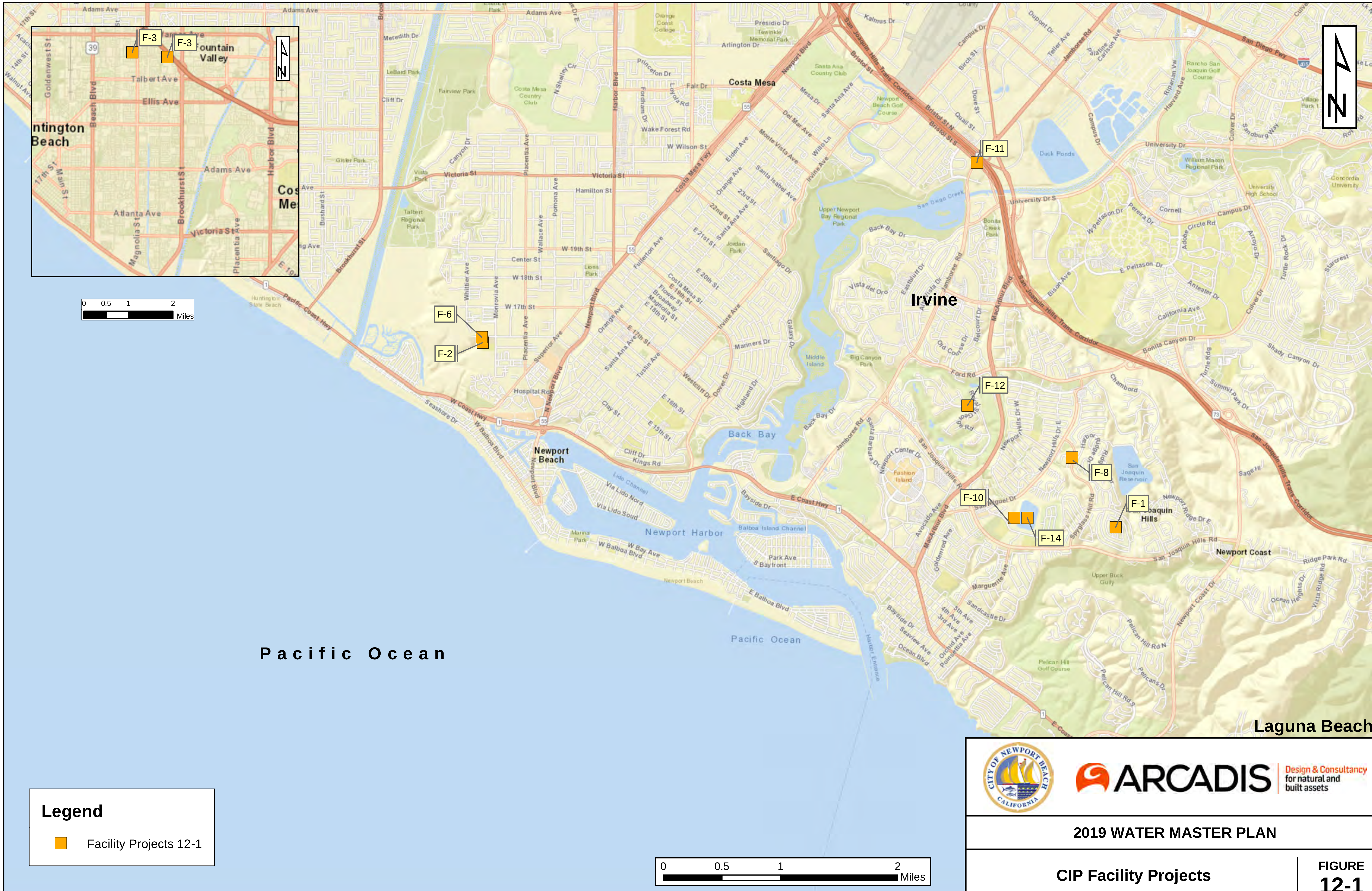
12.2.1 Facilities Projects

Figure 12-1 shows facilities projects the City has included in their CIP that covers items like facility improvements, system wide rehabilitation programs, and distribution system upgrades that fall outside of pipeline replacements or specific PRS projects. The inclusion of these projects is based on the risk assessment and discussion with the City that also helped prioritize the projects within the CIP. Below are the 17 facilities projects covered in the City's CIP.

- F-1: The City will install a mixing device at Spyglass Reservoir to improve water circulation at the 1.5 MG facility.
- F-2: The City currently has a temporary containment solution to receive chemicals at the 16th Street Reservoir, a permanent concrete offloading containment area will be built to capture any spills.
- F-3: Approximately every seven years, the City needs to provide well rehabilitation to maintain production and efficiency to recapture original well production. These projects may include pump and motor rebuild, new column piping, wire brushing, mechanical development, air bursting, chemical development (although seldom), testing, downwell video survey, spinner survey, and pumping development for each of the four City wells.
- F-4: A feasibility study and subsequent design of back-up generators at the 16th Street Reservoir and Pump Station for emergency power will be studied by a consultant and installed two years following.
- F-5: The City is targeting large valves for replacement.
- F-6: Upgrades to the 16th Street Pump Station pumps.
- F-7: multi-year project to replace almost 26,700 water meters in the City with automated meters will provide more accurate water consumption data.
- F-8: Due to the pump station's age, the Zone 5 Auxiliary Pump Station will be rehabilitated with a new pump, motor, and VFD to provide better efficiency.
- F-9: To help combat further ferrous pipeline corrosion, every ten years the City will implement a cathodic protection program by replacing sacrificial anodes.
- F-11: Due to elevated risk, the City will replace the CM-9 connection in coordination with MWD.
- F-10: Upgrades to the Zone 3 and 4 Pump Stations including the replacement of roof hatches, doors, and manhole lids at each station, and a new roof structure and generator at the Zone 4 Pump Station to replace outdated equipment.
- F-12: As BCR provides much of the City water storage capacity, new, larger isolation valves at the site need to be replaced due to age and risk.
- F-13: An additional well in Fountain Valley including a pipeline connection to the existing well transmission main would provide redundancy for the wells providing water to the City.
- F-14: Due to an expected useful life of around 25 years for a reservoir cover, the City will be

replacing the cover at BCR in this 30-year CIP.

- F-15: The City is targeting distribution valves for replacement.
- F-16: The City has a general program to investigate and construct pipelines and valves in need of rehabilitation or replacement.
- F-17: The City will raise water valve boxes to grade and improve access covers on existing valves with priority given to areas with street resurfacing and reconstruction.



Legend

- Facility Projects 12-1

2019 WATER MASTER PLAN

CIP Facility Projects

FIGURE 12-1

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: SShrotriya Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 12-1 CIP Miscellaneous Projects.mxd 4/4/2019 3:47:36 PM
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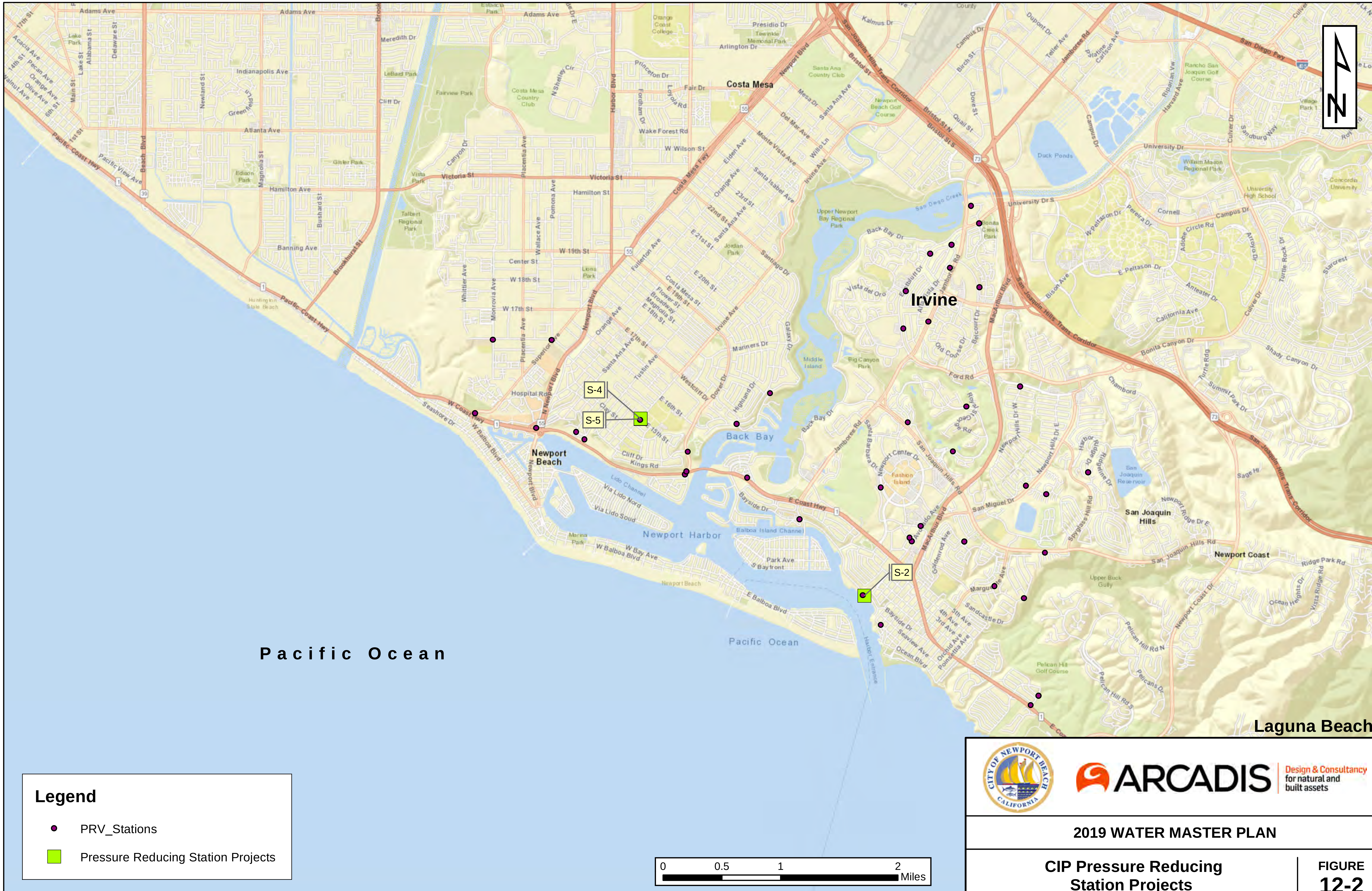
12.2.2 Pressure Reducing Station Projects

With 43 PRSs in the City's distribution network, the City needs to be proactive in their maintenance of these structures. The five PRS projects that have been placed in the CIP include the replacement of four current locations and the installation of a new station to improve system operations.

- S-1: The relocation of Alta Vista #1 PRS that will lower maintenance costs due to flooding by nearby irrigation and improve access for operations by moving it away from the high traffic area it is currently in.
- S-2: The 2121 Bayside Drive PRS will be rebuilt due to age.
- S-3: The Dover Dr. / PCH PRS needs valve replacements and an electrical system upgrade at the PRS.
- S-4: A new 15th Street / Irvine Ave #2 PRS will be installed.
- S-5: The 15th Street / Irvine Ave #1 PRS will be replaced due to age.



Legend

- PRV_Stations
- Pressure Reducing Station Projects

2019 WATER MASTER PLAN

CIP Pressure Reducing Station Projects

FIGURE 12-2

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: SShrotriya Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 12-2 CIP Pressure Reducing Stations Projects.mxd 4/4/2019 3:48:41 PM
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

12.2.3 Pipeline Projects

The City's 30-year CIP for pipeline replacement was developed using Arcadis's RRPS. RRPS is a GIS-based tool used to develop capital projects and is designed for distributed assets. Using the inputs of LoF, CoF, and replacement pipe cost, RRPS can plan for the renewal and replacement of pipes under budget constraints or to target a system wide break rate goal. The pipes identified for renewal and replacement within RRPS based on higher risk scores were grouped together into projects based on geography for the City to evaluate and prioritize in the CIP. Some projects include a design cost before the pipe replacement will occur.

With this approach, a total of 28 pipe renewal or replacement projects are included in the CIP. For larger pipes on main streets, the City has requested pipe relining to be considered. These projects are estimated at 70 percent of the cost of a full replacement and was applied to projects P-06, P-08, and P-25. The projects were first prioritized in the CIP based on the mitigation of risk in the system, but after discussion with the City, projects were reordered to reflect areas the City will target for pipeline replacement first. The expected rise in break rate and overall system risk was recalculated in RRPS for the City using the CIP. This is shown on Figure 12-3 with the budget for pipeline projects also represented. Only the final project, P-28, is not included in the break analysis as the City will need to identify which AC pipes will be replaced when beginning the project in the future. Figure 12-4 shows the location of the projects and the final yearly fiscal budget is shown in Figure 12-5.

- P-1: Replacement of deteriorated distribution and transmission mains on Balboa Island on Park Avenue, Alley No. 402A, and Alley No. 402B
- P-2A: Final design, environmental clearance, and permitting for the upcoming replacement of bay and channel crossings
- P-2: Bay Crossing – Subaqueous pipes at BC-01, BC-02, BC-06
- P-3: Lido Island Outer Ring replacement of 6-inch pipe. Corte Portofino Intersection new 6-inch pipe due to break on previous pipe
- P-4: Irvine Terrace West 6-inch from Jamboree Road to Malabar Drive and Paseo Drive
- P-5: Bay Crossing – CIPP at BC-05 and BC-15
- P-6: Relining on PCH of the 30-inch main from MacArthur Boulevard to Jamboree Road
- P-7: Irvine Terrace East 6-inch pipe replacement from Malabar Driver and Paseo Drive to Avocado Drive
- P-8: Relining of 30-inch pipeline on 15th Street from Newport Boulevard to Kinds Place
- P-9: Replacement of 12-inch pipeline on 15th Street from Newport Boulevard to Irvine Avenue
- P-10: Bay Crossings – HDD at BC-12, BC-17, and SA-01
- P-11: 6- and 24-inch pipeline replacement on Harbor Island Drive from PCH to the end of Harbor Island Drive
- P-12: 6-, 8-, and 24-inch pipeline replacement on PCH from Newport Boulevard to Dover Drive

- P-13: Hoag Hospital 8- and 24-inch lines from 19th Street to Cypress Street
- P-14: Upsizing 6-inch to 8-inch pipe and replacing 24-inch pipe along PCH from Tustin Avenue to Dover Drive
- P-15: 8-, 14-, and 16-inch pipe replacement on Bay Avenue from 19th Street to Cypress Street
- P-16: 6-, 8-, and 12-inch pipeline replacement on Balboa Boulevard from Main Street to Seville Avenue
- P-17: 4-,6-, and 8-inch replacement of the west side of Lido Island
- P-18: Phase 3 of the Balboa Island Water Main Replacement
- P-19: 4-,6-, and 8-inch replacement of the east side of Lido Island
- P-20: 14- and 24-inch replacement along 16th Street, Monrovia Avenue, 15th Street, and Placentia Avenue
- P-21: 18-inch replacement along Eastbluff Drive from Jamboree Road to Cacao Street
- P-22: 18- and 20-inch replacement along Eastbluff Drive from Cacao Street to State Route 73
- P-23: 18- and 30-inch replacement on Jamboree Road from Bayside Drive to San Joaquin Hills Road
- P-24: 10- and 16-inch replacement on San Joaquin Hills Road from Jamboree Road to Crown Drive
- P-25: 30-inch relining on San Joaquin Hills Road from Jamboree Road to San Miguel Drive
- P-26: Bay Crossing Upper Bay at BC-09 of 24- and 30-inch pipe
- P-27: Corona Highlands Parallel Pipe Installation for redundancy in the system
- P-28: Program to replace Type 1 AC pipe installed before 1965

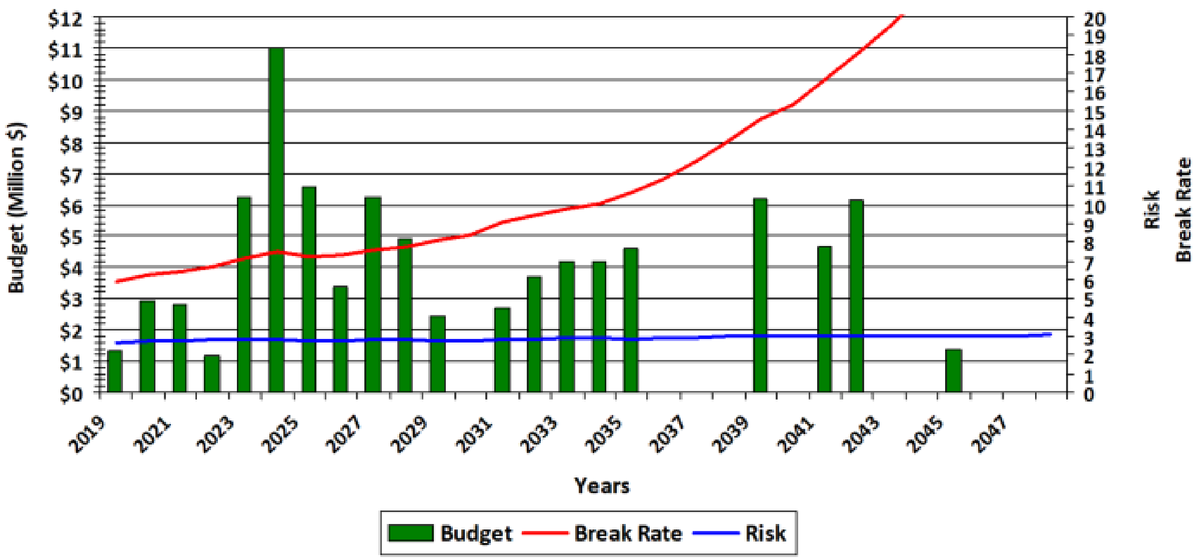
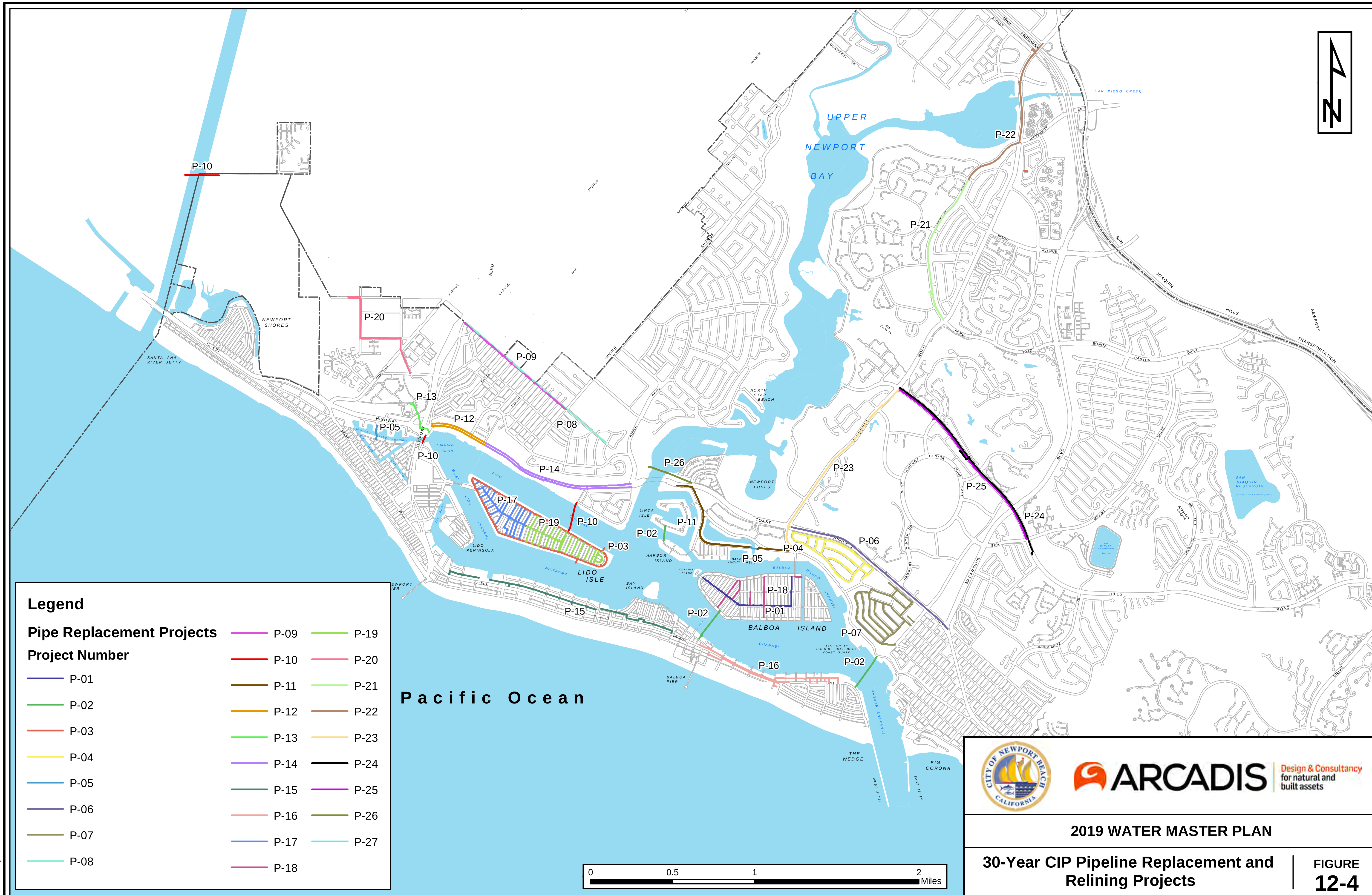


Figure 12-3: Break Rate (breaks/100 miles/year) after 30 years of CIP Completion



2019 WATER MASTER PLAN

30-Year CIP Pipeline Replacement and Relining Projects

FIGURE 12-4

City: Newport Beach, CA Div/Group:WTR Created By: KHernandez Last Saved By: KHernandez Project: Newport Beach Water Master Plan (Project # 05317005.0000)
\\arcadis-us.com\officedata\LosAngeles-CA\projects\5317 - Newport Beach\005 - Water Master Plan\GIS\MXD\Report Figures\Figure 12-4 CIP Pipe Replacement Projects v2.mxd 4/5/2019 2:52:38 PM
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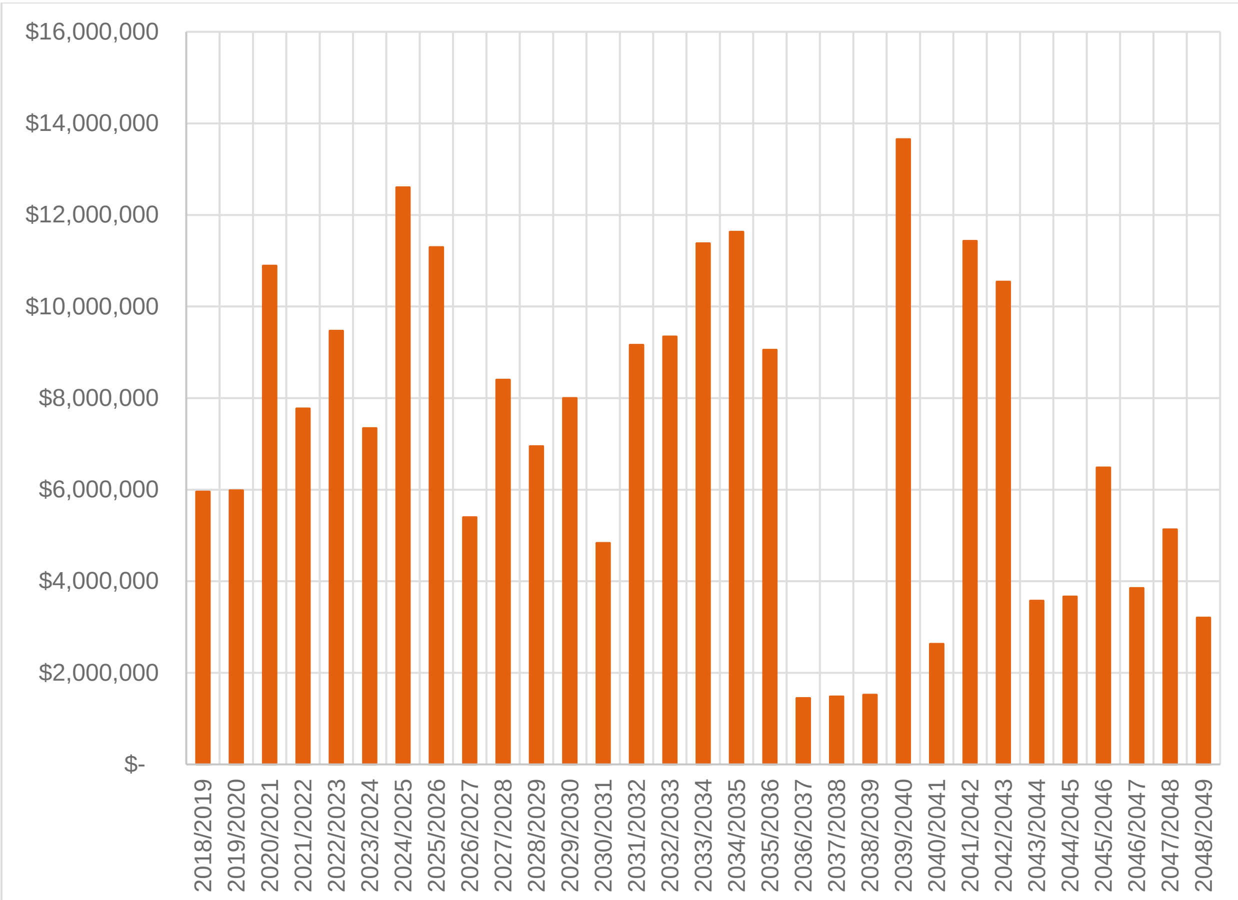

Figure 12-5: Yearly CIP Spend by Fiscal Year

13 GENERAL RECOMMENDATIONS

Through developing the WMP, implementing the projects outlined in the CIP can be supported with continued effort by the City. This includes the following actions that can be implemented to support items in the CIP.

- The City should use the updated distribution system model from this WMP and keep it up-to-date through coordination with field staff and the City's GIS department.
- The 30-year CIP should be updated to reflect completed, postponed, or new projects as future conditions warrant.
- The risk calculation for the City's assets can be updated with regular visual inspections to better understand the appropriate replacement of aging assets in the City's system.
- By beginning to perform analysis of water main breaks in this WMP, the City can continue to collect information on breaks and conduct physical and analytical studies on pipe wall thickness degradation to better establish a water main's estimated useful life. This information can feed into the planned replacement projects and help the City prioritize future work.

14 REFERENCES

City of Newport Beach. 2006. General Plan Chapter 3 Land Use Element <http://www.newportbeachca.gov/government/departments/community-development/planning-division/general-plan-codes-and-regulations/general-plan>

City of Newport Beach. 2016. 2015 Urban Water Management Plan.

AWWA. 2018. M32 Computer Modeling of Water Distribution Systems 4th edition

APPENDIX A

Fireflow Field Testing Results

APPENDIX B

Hydraulic Model Calibration Results

APPENDIX C

Detailed Mechanical, Electrical, and Structural Inspection Criteria for Facilities

APPENDIX D

List of Assets Inspected as Part of Facilities Assessment

APPENDIX E

25 Assets Requiring Renewal or Unserviceable Based on Physical Condition

APPENDIX F

Risk Scores For Vertical Assets

APPENDIX G

Unit Cost Information

ARCADIS
Design & Consultancy
for natural and
built assets