# APPENDIX L

## Utility Reports

**APPENDIX L.1**

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**Water Supply Assessment**

# Cucamonga Valley Water District
# Water Supply Assessment

For the

Etiwanda Heights Neighborhood &

Conservation Plan (EHNCP)

(Annexation and Specific Plan)

City of Rancho Cucamonga, California

April 25, 2019

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# Abbreviations

| | |
|---|---|
| AF | Acre-Feet |
| AFY | Acre-Feet per year |
| CEQA | California Environmental Quality Act |
| CRA | Colorado River Aqueduct |
| CVWD | Cucamonga Valley Water District |
| DU | Dwelling Unit |
| EHNCP | Etiwanda Heights Neighborhood & Conservation Plan |
| EIR | Environmental Impact report |
| GPCD | Gallons per capita per day |
| GPD | gallons per day |
| GPM | gallons per minute |
| IEUA | Inland Empire Utilities Agency |
| MGD | Million Gallons per Day |
| MWD | Metropolitan Water District of Southern California |
| NA | Neighborhood Area of the EHNCP |
| SQFT | Square Feet |
| SWP | State Water Project |
| UWMP | Urban Water Management Plan |
| WSA | Water Supply Assessment |

# 1 Regulatory Background

**Senate Bill 610**

The State of California has enacted laws to ensure the increased water demands are adequately addressed and that a firm source of water supply is available prior to the approval of certain developments. These regulations include the California Water Code Division 6, Part 2.10, Sections 10910-10915 (Water Supply Planning to Support Existing and Planned Future Use) and Government Code Sections 65867.5 and 66473.7. These provisions of the California Water Code and the Government Code seek to promote collaborative planning between local water suppliers and cities and counties. These laws require detailed information regarding water availability to be provided to city and county land use planners prior to approval of land use development projects above defined threshold levels.

The Water Supply Assessment (WSA) has been prepared pursuant to the requirements of the California Water Code and the Government Code for the approach, required information, and criteria, confirming CVWD has sufficient water supplies to meet the projected demands of the EHNCP in addition to existing and planned future uses. The Urban Water Management Plan (UWMP) is a foundational document for compliance with the California water code and the government Code. The provisions of the California water Code and the Government Code identify the UWMP as a planning document which can be used by a water supplier to meet the standards set forth in both statutes. The water agency must determine whether projected water supplies are sufficient to meet the demand of a project, in addition to existing and planned future water uses. The lead agency for the preparation of an Environmental Impact Report (EIR) for a proposed project, is required under California Environmental Quality Act (CEQA) guidelines Article 7 EIR Process and Article 9 Contents of Environmental Impact Reports, to consult with the water agency serving a proposed project and to include in the EIR information provided by the water agency.

**Water Supply Planning Provisions**

CVWD's 2015 UWMP (June 2016), was prepared pursuant to California Water Code Division 6, Part 2.55, Section 10608 (Sustainable Water Use and Demand Reduction) and California Water Code Division 6, Part 2.6, Sections 10608-10656 (Urban Water Management Planning). The UWMP describes future water demands and future availability of the water supply sources used by CVWD. This UWMP document was used to prepare this WSA.

**California Water Code (Sections 10910-10915)**

California Water Code Division 6, Part 2.6, Section 10631, requires every urban water supplier to identify as part of its UWMP, the existing and planned sources of water available to the supplier in five-year increments to 20 years. Existing law prohibits an urban water supplier which fails to prepare or submit its UWMP to the Department of Water Resources from receiving financial or drought assistance from the state until the plan is submitted.

California Water Code Division 6, Part 2.10, Sections 10910-10915 requires a Water Supply Assessment (WSA) to provide a description of all water supply projects and programs which may be undertaken to meet total projected water use over the next 20 years to be included with the proposed project. The California Water Code requires a city or county which determines a project is subject to CEQA to identify any public water system which may supply water for proposed developments and to request those public water systems to prepare a WSA, including projects with proposed residential projects with an equivalence of 500 or more dwelling units. If the water demands have been accounted for in a recently adopted urban water management plan, the water supplier may incorporate information contained in that plan to satisfy certain requirements of a WSA. The California Water Code requires the assessment to include, along with other information, an identification of existing water supply entitlements, water rights, or water service contracts, relevant to the identified water supply for the proposed project and the quantities of water received in prior years pursuant to those entitlements, rights, and contracts.

**Government Code 66473.7**

Government Code 66473.7 prohibits approval of a tentative map, or a parcel map for which a tentative map was not required, or a development agreement for a subdivision of property of more than 500 dwelling units, except as identified, including the design of the subdivision or the type of improvement, unless the legislative body of a city or county of the designated advisory agency provides written verification from the applicable public water system that a sufficient water supply is available or, in addition, a specified finding is made by the local agency that sufficient water suppliers are, or will be, available prior to completion of the project. Sufficient water supply is the total water supply available during normal, single-dry, and multiple-dry years within a 20-year projection which will meet the projected demand of the Project, in addition to existing and planned future water uses.

**Government Code 65352.5.**

Government Code 66352.5 (a) requires that before a legislative body takes action to adopt or substantially amend a general plan, the planning agency shall refer the proposed action to: a public water system, as defined in Section 116275 of the Health and Safety Code, with 3,000 or more service connections, that serves water to customers within the area covered by the proposal. The public water system shall have at least 45 days to comment on the proposed plan, in accordance with subdivision (b), and to provide the planning agency with the information set forth in Section 65352.5.; any groundwater sustainability agency that has adopted a groundwater sustainability plan pursuant to Part 2.74 (commencing with Section 10720) of Division 6 of the Water Code or local agency that otherwise manages groundwater pursuant to other provisions of law or a court order, judgment, or decree within the planning area of the proposed general plan; the State Water Resources Control Board, if it has adopted an interim plan pursuant to Chapter 11 (commencing with Section 10735) of Part 2.74 of Division 6 of the Water Code that includes territory within the planning area of the proposed general plan.

# 2 Introduction

The purpose of this Water Supply Assessment (WSA) is to evaluate the water supply availability for the *Etiwanda Heights Neighborhood & Conservation Plan* (formerly called North East Sphere Annexation and Specific Plan) located within the service area of the Cucamonga Valley Water District (CVWD). This WSA shows that the CVWD has resources to meet the total projected water demands during normal, single dry, and multiple dry water years during a 20-year projection. The projections include this Project in addition to the water supplier's existing and planned future uses.

The *Etiwanda Heights Neighborhood & Conservation Plan* is considered to be a Project pursuant to the meanings identified in the Water Code § 10912(a). Potable water will be supplied by the Cucamonga Valley Water District (CVWD). CVWD meets the definition of a Public Water System as defined in the Water Code § 10912(c).

This WSA document incorporates water supply and demand projections from Cucamonga Valley Water District's adopted 2015 Urban Water Management Plan (UWMP), dated June 2016.

Information on the Etiwanda Heights Neighborhood & Conservation Plan is based on information provided in the Etiwanda Heights Neighborhood & Conservation Plan Notice of Preparation dated December 4, 2018 (herein referred to as the Specific Plan, the Plan, or EHNCP) with an updated program provided by Sargent Town Planning on March 6, 2019.

While the EHNCP is not explicitly discussed in the 2015 UWMP, it is explicitly addressed in the CVWD's 2017 Water System Master Plan, and shown to be in the Water Demand Projection calculations. The water demand projections in the Water System Master Plan are consistent with the Total Water Use projections in the 2015 UWMP. The demands considered in the Water System Master Plan for this plan area are referred to as the *SBC Area*. A comparison of the projected water demands is shown in Table *1*. The demands from 2015 are noted in the Water System Master Plan as a low-demand year due to state-wide water shortages and mandatory reductions on imported water.

**Table 1: Water Demand Projected (AFY)**

| YEAR | WATER SYSTEM MASTER PLAN | 2015 UWMP |
|---|---|---|
| 2015 | 38,730 | 41,436 |
| 2020 | 58,859 | 58,900 |
| 2025 | 61,298 | 61,300 |
| 2030 | 63,652 | 63,700 |
| 2035 | 63,652 | 63,700 |

## 2.1 Plan and Project Overview

The EHNCP covers 4,393.3 acres, the Plan Area covers both lands which are in currently within the City's municipal boundary (305.8 acres), and 4,087.6 acres which are within the unincorporated area of the County of San Bernardino. The adoption of the EHNCP will enable the annexation of this unincorporated area (4,087.6-acres) area into the City of Rancho Cucamonga. The EHNCP Plan Area is divided into two planning areas, the 3,565.5- acre Rural/Conservation Area (RCA) and 827.8-acre Neighborhood Area (NA) as shown in Figure 1. The Plan for the RCA allows up to a total of 100 new homes on privately owned land. New water and sewer service will not be extended into the RCA and any new homes built would require approval of private water well and septic systems. The 827.8-acre area to the south is designated by the Plan as the Neighborhood Area (NA). The NA will be planned for compact, sustainable, mixed-type neighborhoods and a mixed-use center of shops and restaurants for the surrounding Foothill Neighborhoods. The EHNCP includes a Conservation and Transfer of Development Rights program to facilitate the transfer of development rights from private property in the RCA to the NA to promote conservation of land and resources in the RCA. Accordingly, this WSA considers the water demand for 3,000 residential units and the other use that would be allowed by the EHNCP in the NA.

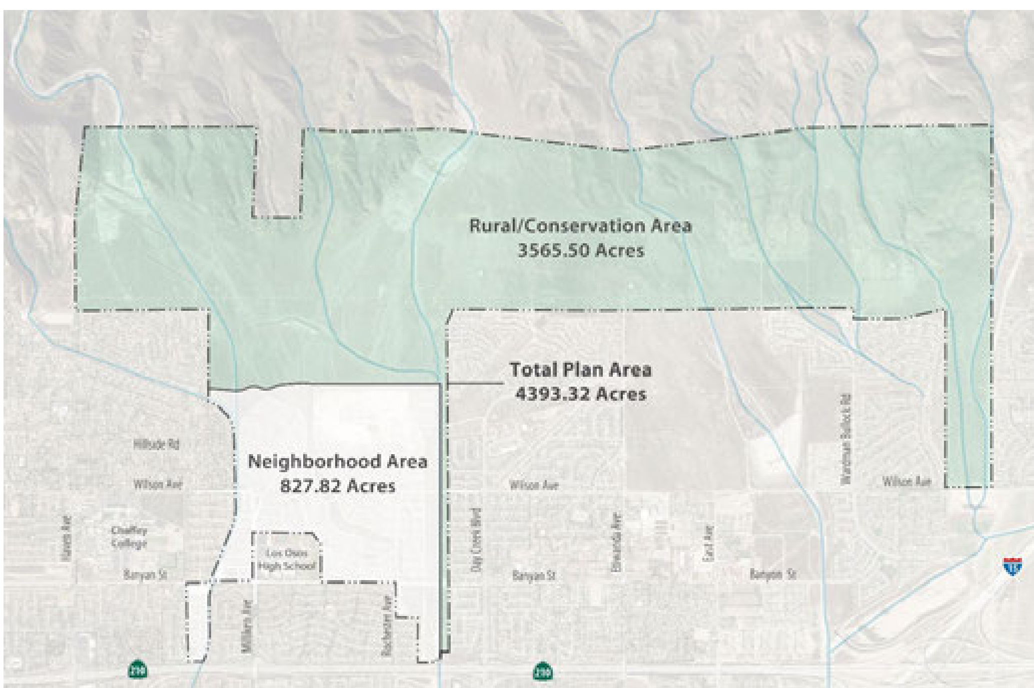


*Figure 1: Rural/Conservation Area and Neighborhood Areas of the EHNCP. (Provided by Sargent Town Planning 2/26/19)*

## 2.2 CVWD Service Area

CVWD serves a 47-square mile area which includes the City of Rancho Cucamonga, portions of the cities of Upland, Ontario, and Fontana, and some unincorporated area of San Bernardino County. CVWD's 2015 UWMP indicates that it currently provides water to a population of approximately 200,460 customers with over 48,000 water connections.

The 4,393 acre Etiwanda Heights Neighborhood & Conservation Plan Area includes 305 acres within the City of Rancho Cucamonga and 4,088 acres in the City's Sphere of Influence proposed for annexation to the City.

# 3 Cucamonga Valley Water District Water Supplies

CVWD's 2015 UWMP provides information regarding its water supply sources. While the 2015 UWMP makes projections only through the year 2035, the Water Supply Assessment is required to project out 20 years. To facilitate this, CVWD staff has extended projections to 2040. Where these projections are made (and are not in the 2015 UWMP) an asterisk is noted next to the year. CVWD's potable water supply sources include groundwater from the Chino Basin and the Cucamonga Basin, surface water from three (3) surface water sources, and imported water purchased from the Inland Empire Utilities Agency (IEUA). The District has rights to six sources of canyon/surface water supplies; however, only three of the sources are utilized. In addition, CVWD has the ability to receive potable water during emergencies through interconnections from the Fontana Water Company and the City of Upland. CVWD water supply sources are shown in Table *2*. The historical and projected volumes of water from each source are shown in Table *3*.

**Table 2: Water Supply Sources**

| SUPPLY | AFY | ENTITLEMENT | RIGHT | CONTRACT | EVER USED |
|---|---|---|---|---|---|
| IEUA Tier I Wholesale | 28,369 | Contract | | | YES |
| IEUA Tier II Wholesale | Contract, no official volumetric limit. | | | | YES |
| Chino Basin Groundwater (AFY) | 14,387 | | X | | YES |
| Cucamonga Basin Groundwater (AFY) | 15,471 | | X | | YES |
| Cucamonga Canyon Surface Water (AFY) | 3,650 | | X | | YES |
| Deer Canyon Surface Water | Limited by Facilities. ~ 2,570 Max Historical | | X | | YES |
| Day/East Canyon Surface Water | Limited by Facilities. ~ 9,000 Max Historical | | X | | YES |

**Table 3: Water Supply Quantities, AFY**

| SUPPLY | HISTORICAL | | | | PROJECTED | | | |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
| IEUA Tier I Wholesale | 28,109 | 20,368 | 13,195 | 28,369 | 28,369 | 28,369 | 28,369 | 28,369 |
| IEUA Tier II Wholesale | | | | 3,236 | 4,704 | 6,932 | 1,509 | 1,509 |
| Chino Basin Groundwater | 13,328 | 19,831 | 18,760 | 12,755 | 13,687 | 13,859 | 19,282 | 19,282 |
| Cucamonga Basin Groundwater | 7,518 | 3,848 | 8,439 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Cucamonga Canyon Surface Water | 0 | 46 | 363 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Day/East Canyon Surface Water | 6,374 | 162 | 498 | 3,400 | 3,400 | 3,400 | 3,400 | 3,400 |
| Deer Canyon Surface Water | 603 | 3,745 | 189 | 140 | 140 | 140 | 140 | 140 |
| TOTAL | 55,932 | 48,001 | 41,443 | 58,900 | 61,300 | 65,730 | 63,700 | 63,700 |

CVWD's water production capacity based on the CVWD 2015 UWMP is shown in Table *4* below. Water sources include groundwater wells, surface water, and MWD Tier I/Tier II purchases.

**Table 4: CVWD Water Production Capacity, AFY**

| | YEAR | | | | |
|---|---|---|---|---|---|
| SOURCE | 2020 | 2025 | 2030 | 2035 | 2040 |
| Groundwater | 45,252 | 45,252 | 45,252 | 45,252 | 45,252 |
| Canyon Water | 2,270 | 2,270 | 2,270 | 2,270 | 2,270 |
| Imported Water | 31,605 | 33,073 | 35,301 | 29,878 | 29,878 |
| Total Production Capacity | 79,127 | 80,595 | 82,823 | 77,400 | 77,400 |

CVWD's water system includes disinfection facilities and three treatment facilities to treat imported water from the SWP and water from the Cucamonga Canyon and Day/East Canyon sources. These facilities allow CVWD to treat and distribute potable water which complies with all state and federal safe drinking water regulations. Disinfection, but not treatment, is required for the water produced from Deer Canyon through Hermosa Tunnel because it is considered to be groundwater and meets State requirements.

## 3.1 Wholesale Water Supplies

CVWD purchases imported water from the Metropolitan Water District of Southern California (MWD). MWD is the largest wholesaler for domestic and municipal uses in California. MWD owns and operates the Colorado River Aqueduct (CRA) and is a contractor for water from the California State Water Project (SWP). MWD has 26-member agencies and consisting of 11 water districts, one county water authority, and 14 cities. CVWD purchases water from MWD through the Inland Empire Utilities Agency, which is a member agency of MWD.

CVWD purchases SWP water supplies using two separate connections. Historically, CVWD had a connection to receive Colorado River (CRA) water, however, the connection was removed due to the lack of treatment capabilities at the connection.

IEUA also provides recycled water to its member agencies for direct non-potable reuse and groundwater recharge. Recycled water is not considered as a source of supply for the Etiwanda Heights Neighborhood & Conservation Plan project because a system to deliver recycled water to the Plan Area is not in place at this time. Recycled water may become available for use at the site in the future. All demands have been conservatively projected as potable water demands in this WSA.

### 3.1.1 Wholesale Quantities Received in Prior Years

Imported water purchases are CVWD's most significant water source, and can range from 35-65 percent of the District's water. The average supply imported of water by percent from years 2006-2015 was 46.6%.

CVWD purchases SWP water, and does not purchase CRA water. There are two separate connections to the MWD; an 18-inch connection (CB7) and a 60-inch connection (CB16). The amount of water imported from year 2000 to year 2015 is shown in Table 5.

**Table 5: Wholesale Water Imports**

| CVWD Imported Water Supply (AF) | | | |
|---|---|---|---|
| Year | CB7 Connection | CB16 Connection | Total |
| 2005 | 0.1 | 28,108.5 | 28,108.6 |
| 2006 | 129.9 | 29,188.6 | 29,318.5 |
| 2007 | 1,085.5 | 34,955.2 | 36,040.7 |
| 2008 | 32.9 | 28,518.0 | 28,550.9 |
| 2009 | 706.4 | 19,392.6 | 20,099.0 |
| 2010 | 21.9 | 20,346.0 | 20,368.0 |
| 2011 | 0.0 | 20,899.6 | 20,899.6 |
| 2012 | 874.2 | 27,398.9 | 28,273.1 |
| 2013 | 16.0 | 25,747.6 | 25,763.6 |
| 2014 | 1,743.1 | 25,422.4 | 27,165.5 |
| 2015 | 71.4 | 13,123.4 | 13,194.8 |
| 2016 | 155 | 10,919 | 11,074 |

CVWD has the capacity to accept up to 71 MGD of MWD imported SWP water from IEUA for treatment and distribution. CVWD's Royer-Nesbit Water Treatment Plant is currently not in operation, and the Lloyd Michael Water Treatment Plant can accept up to 60 MGD.

CVWD has a Tier I allocation of 28,369 AFY, and projects to use the full allocation by year 2020. Imported water above CVWD's Tier I allocation shall be MWD replenishment water in the Chino Basin or Tier II imported water. CVWD can elect to purchase Tier II water from IEUA. The IEUA import projections for CVWD are shown in Table 6.

**Table 6: IEUA Import Projections**

| SOURCE | YEAR | | | | |
|---|---|---|---|---|---|
| | 2020 | 2025 | 2030 | 2035 | 2040 |
| Tier I imported water (AFY) | 28,369 | 28,369 | 28,369 | 28,369 | 28,369 |
| Tier II imported water or replenishment water (AFY) | 3,236 | 4,704 | 6,932 | 1,509 | 1,509 |
| Total Imported Water (AFY) | 31,605 | 33,073 | 35,301 | 29,878 | 29,878 |

## 3.2 Groundwater Supplies

CVWD receives groundwater through two different water basins: The Chino Basin and the Cucamonga Basin.

CVWD currently operates 12 active groundwater wells in the Chino Basin. CVWD plans to continue operating these wells and will construct replacement wells as necessary to maintain water production capacities required to meet customer demands. CVWD frequently inspects each well and performs routine maintenance and rehabilitation to ensure each well is running efficiently and correctly. According to the 2015 UWMP, CVWD's total pumping capacity in the Chino Basin is 27,017 gallons per minute (GPM). The calculated production capacity is 32,686 AFY, which assumes 75 percentage of the maximum pumping capacity to account for operation and maintenance downtime.

CVWD currently has two clusters of wells in the Cucamonga Basin. The Cucamonga Creek Cluster which is a group of 10 wells, and the Alta Loma Cluster, which is a group of 7 wells. The District can utilize up to 9 of the 17 total wells. The remaining 8 wells are not used due to high nitrate and/or DBCP concentrations. According to the CVWD 2015 UWMP, the calculated production capacity is 12,566 AFY, which assumes 75 percentage of maximum pumping capacity to account for operation and maintenance downtime.

The total ground water production capacity of the well improvements is shown in Table 7.

**Table 7: CVWD Groundwater Production Capacity**

| | |
|---|---|
| Chino Basin Wells Production Rate (AFY) | 32,686 |
| Cucamonga Basin Wells Production Capacity (AFY) | 12,566 |
| Total Groundwater Well Production Capacity (AFY) | 45,252 |

### 3.2.1 Chino Basin Groundwater Supply

The Chino Basin is one of the largest groundwater basins in Southern California and contains approximately 6,000,000 acre-feet of water. The basin is approximately 235 square miles of the upper Santa Ana River watershed and lies within portions of San Bernardino, Riverside, and Los Angeles counties.

The Chino groundwater subbasin underlies southeast Los Angeles County, northwest Riverside County, and southwest San Bernardino County. The subbasin is bound on the northwest by the San Jose fault, on the north by the Cucamonga fault and impermeable rocks of the San Gabriel Mountains, and on the east by the Rialto-Colton fault. The subbasin is bound on the southeast by the Jurupa Mountains, Pedley Hills, La Sierra Hills, and the approximate location of the Santa Ana River. The Chino fault and impermeable rocks of the Chino Hills and Puente Hills bound the southwest side of the basin. In some areas, the subbasin boundary coincides with the Chino Basin (1978) groundwater adjudication boundary. The boundary is defined by fifty-eight segments detailed in DWR Bulletin 118.

The groundwater rights for the Chino Basin were adjudicated in 1978 in the Chino Basin Judgement. This judgement established the Chino Basin Watermaster to administer the judgement and help manage the basin. The Chino Basin Watermaster consists of various entities which include cities, water districts, water companies, agricultural, commercial, and other private entities. The mission is to manage the Chino Groundwater Basin to the most beneficial manner and to equitably administer and enforce the provisions of the Chino Basin Judgement.

Management of the Basin is governed by the 2012 Restated Judgement, the 2000 Peace Agreement (as amended), the 2000 Optimum Basin Management Plan (OBMP), the OBMP Implementation Plan (as supplemented), the 2007 Peace II Agreement, the Watermaster Rules and Regulations (as amended), and related Court orders. Management of the basin is discussed in detail in the 2015 UWMP.

The 1978 Judgement established the safe yield of the Chino Basin as 140,000 AFY. The judgement also divided the water rights into three groups called pools. The pools and pumping rights are shown in Table *8*. Since the original agreement, the 2015 Safe Yield Reset Agreement has reduced the safe yield to 135,000 AFY.

**Table 8: Chino Basin Pumping Rights, 1978 Judgement**

| | |
|---|---|
| Overlying Agricultural Pool Committee | 82,800 AFY |
| Overlying Non-Agricultural Pool Committee | 7,366 AFY |
| Appropriative Pool Committee | 49,834 AFY |

As discussed in the 2015 UWMP, the CVWD is a member of the Appropriative Pool and owns appropriative rights to approximately 18.3% of the Operating Safe Yield of the total Chino Basin water rights. The Operating Safe Yield is determined annually be the Watermaster. In FY2014-2015, the operating safe yield was established as 54,834 AF, equating the CVWD's rights to 10,011 AF.

CVWD is authorized to produce groundwater annually in excess of their rights based on the operating safe yield. They must pay an assessment for the over-production. The payment is used to replenish the basin through imported surface water recharge purchased from IEUA. Appropriative parties also have access to the portion of the safe yield that is not produced by the Overlying Agricultural Pool.

The historical groundwater production from the Chino Basin is shown in Table *9*. Groundwater production projections for the Chino Basin are shown in Table *10*.

**Table 9: Chino Basin Historical Production, AFY**

| HISTORICAL PRODUCTION | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| **Chino Basin** | **19,831** | **19,380** | **15,041** | **18,437** | **13,626** | **18,760** |

**Table 10: Chino Basin Projections, AFY**

| **FUTURE PROJECTION** | **2020** | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|---|
| **Chino Basin** | **12,755** | **13,687** | **13,859** | **19,282** | **19,282** |

### 3.2.2 Cucamonga Basin Groundwater Supply

The Cucamonga Subbasin underlies the northern part of upper Santa Ana Valley. It is bounded on the north by contact of alluvium with the San Gabriel Mountains and on the west, east, and south by the Red Hill fault. This portion of the upper Santa Ana Valley is drained by Cucamonga and Deer Creeks to the Santa Ana River. Recharge to the basin includes infiltration of stream flow, percolation of rainfall to the valley floor, underflow from the San Gabriel Mountains, and return irrigation flow. Spreading grounds along Cucamonga Creek and near Red Hill and Alta Loma also contribute to storm flow recharge to the Basin.

As discussed in the 2015 UWMP, the Cucamonga basin was adjudicated by decree in 1958. There are three main water agencies that hold all of the adjudicated rights in the Basin by virtue of having acquired or otherwise succeeded to the original parties to the Decree. These agencies include the CVWD, The San Antonio Water Company, and the City of Upland. The court did not appoint an official Watermaster for the basin, although the Decree contains various provisions for the metering and recording of all water production, inspection of records, prohibitions against new water production, potential reductions in water production, and other protective measures. The existing parties to the Decree meet periodically, and joint efforts are currently underway to perform additional hydraulic investigations, update the safe yield of the basin, and develop management strategies.

The 1958 Decree allocates groundwater rights and the right to divert water from Cucamonga Creek, totaling approximately 22,721 AFY. However, several studies have been performed using varying base periods, varying geological boundaries, and other varying factors, which have indicated an estimated Basin yield between 13,800 AFY and 22,200 AFY. Historical production data and future projections show the total water production from the basin by CVWD is substantially below the allocated rights. CVWD has the right to produce 15,471 AFY, and additionally has the right to divert 3,620 AFY from Cucamonga Creek. Future projections estimate a production rate of 10,000 AFY. The pumping rights for the Cucamonga Basin are shown in Table *11*. The historical production and the future projection for production from the basin are shown in Table *12* and Table *13*, respectively.

**Table 11: Cucamonga Basin Pumping Rights, AFY**

| | |
|---|---|
| Groundwater Pumping Rights | 15,471 AFY |
| Cucamonga Creek Diversion Rights | 3,620 AFY |
| Cucamonga Basin Total Rights | 19,091 AFY |

**Table 12: Cucamonga Basin Historical Production, AFY**

| HISTORICAL PRODUCTION | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Cucamonga Basin | 3,848 | 3,645 | 6,028 | 6,523 | 10,724 | 8,439 |

**Table 13: Cucamonga Basin Projections, AFY**

| FUTURE PROJECTIONS | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|
| Cucamonga Basin | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |

## 3.3 Surface Water Supplies

CVWD's surface water supplies come from streams, springs, and tunnels located within the northern area of the District. These water sources are also referred to as *tunnel sources* or *canyon sources*. Surface water sources accounted for 6.5% of the total supply water for CVWD, based on 2006-2015 averages.

CVWD has rights to a total of 6 canyon sources, or tunnel sources of surface water. These are the Cucamonga Canyon, Day/East Canyon, Deer Canyon, Lytle Creek, Smith Canyon Group, and the Golf Course Tunnel. Currently, water is only utilized from three of the six sources: Cucamonga Canyon, Day/East Canyon, and Deer Canyon. Water supplies from the canyon/tunnel sources are heavily dependent on precipitation in the region.

In the 2015 UWMP, CVWD has two projection scenarios: one for normal conditions and one for dry conditions. Production during dry conditions is projected to be half the production during a normal year. Projected surface water production rates are shown in Table *14*.

### 3.3.1 Cucamonga Canyon

CVWD acquired the rights of the Ioamosa Water Company in 1970s, which included the Ioamosa Tunnel and rights to surface water in Cucamonga Canyon. The Cucamonga Canyon facilities include two diversion ponds and an inlet connecting to 3,300 lineal feet of 24-inch diameter transmission pipeline to Arthur H. Bridge Water Treatment Plant. The pond intake facilities are located in an unincorporated area of western San Bernardino County, north of the Rancho Cucamonga city boundary. CVWD owns rights to 250 miner's inches, which is equal to 3.24 million gallons per day (MGD).

**Table 14: Surface Water Production Projections, AFY**

| CANYON | 2020 | | 2025 | | 2030 | | 2035 | | 2040 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal | Dry | Normal | Dry | Normal | Dry | Normal | Dry | Normal | Dry |
| Cucamonga | 1,000 | 500 | 1,000 | 500 | 1,000 | 500 | 1,000 | 500 | 1,000 | 500 |
| Deer | 140 | 70 | 140 | 70 | 140 | 70 | 140 | 70 | 140 | 70 |
| Day/East | 3,400 | 1,700 | 3,400 | 1,700 | 3,400 | 1,700 | 3,400 | 1,700 | 3,400 | 1,700 |
| Total (AFY) | 4,540 | 2,270 | 4,540 | 2,270 | 4,540 | 2,270 | 4,540 | 2,270 | 4,540 | 2,270 |

### 3.3.2 Day/East Canyon

CVWD acquired the Etiwanda Water Company in 1979, and thereby acquired surface and subsurface water rights for both Day and East Etiwanda Canyons. The sources from the two canyons are considered together, and identified as Day/East Canyon. The canyons are located on the west and east end of the prolongation of Etiwanda Avenue. The facilities capture flows from four sources: Day Basin, east basin, Smith Tunnel, and Bee Tunnel. The flows are funneled into 14,600 lineal feet of 10-, 16-, and 18-inch diameter transmissions pipeline to Royer Nesbit Water Treatment Plant and the Lloyd Michael Water Treatment Plant. Rights for both canyons are appropriative and include all rights to both surface and subsurface flows.

### 3.3.3 Deer Canyon

CVWD acquired control and ownership of the Hermosa Water Company in the early 1970s, and thereby acquired surface and subsurface water rights for Deer Canyon. The improvements in Deer Canyon included the Hermosa Tunnel, Thayer Tunnel, and “A” Tunnel, falls, and a collection point in a side canyon known as Fan Canyon. Transmission mains conveyed the flows from these sources to a common collection point at a small reservoir located on the south side of Lemon Avenue, east of Archibald Avenue. The area known as Deer Canyon is located in the foothills generally north of Haven Avenue. In 2002, CVWD signed an agreement to sell the natural spring water production from Deer Canyon to Nestle Company. In 2005, Nestle completed a pipeline that conveys flows from Deer Canyon to their plant in the City of Ontario. Currently, the CVWD only captures flows from the Hermosa Tunnel in Deer Canyon. The flows are funneled into 1,310 lineal feet of 6-inch transmission pipe and conveyed to a reservoir for disinfection and distribution. The water from the Hermosa Tunnel is considered to be groundwater and meets State requirements.

# 4 Cucamonga Valley Water District Water Demands

## 4.1 CVWD Historical and Projected Data

Historical and projected data on population, water production, and water supplies have been based off the information made available in CVWD’s UWMP. CVWD’s historical water production is shown in Table *15*. The production quantities have ranged from 48,063 in year 2001 to 61,036 in year 2007. The actual and projected populations are shown in Table *16*. The actual and projected water use for the District is shown in Table *17*. CVWD’s service area is projected to experience build-out in the year 2030. CVWD estimated future population by using the current population density and the remaining buildable area in their service area. The City of Rancho Cucamonga 2010 General Plan includes a 2030 buildout population projection incorporated into the CVWD population projection. All population and water use projections beyond the year 2030 are constant. The climate data for the CVWD service area in 2015 is shown in Table *1*.

**Table 15: CVWD Historical Water Production**

| CALENDER YEAR | TOTAL PRODUCTION | | CALENDER YEAR | TOTAL PRODUCTION |
|---|---|---|---|---|
| 2000 | 50,717 | | 2009 | 54,821 |
| 2001 | 48,063 | | 2010 | 48,001 |
| 2002 | 52,409 | | 2011 | 49,844 |
| 2003 | 51,899 | | 2012 | 52,180 |
| 2004 | 54,826 | | 2013 | 52,549 |
| 2005 | 55,933 | | 2014 | 52,926 |
| 2006 | 57,967 | | 2015 | 41,443 |
| 2007 | 61,036 | | 2016 | 41,732 |
| 2008 | 57,496 | | 2017 | 45,143 |
| | | | 2018 | 45,877 |

**Table 16: Population, Actual and Projected**

| | ACTUAL | | | | PROJECTED | | | | |
|---|---|---|---|---|---|---|---|---|---|
| YEAR | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
| POPULATION | 148,159 | 179,523 | 185,606 | 200,466 | 209,707 | 219,118 | 228,200 | 228,200 | 228,200 |

**Table 17: Water Use Sectors, Actual and Projected**

| CUSTOMER TYPE | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Residential | 30,416 | 25,728 | 36,731 | 38,228 | 39,724 | 39,724 | 39,724 |
| Commercial | 2,034 | 2,004 | 2,553 | 2,657 | 2,761 | 2,761 | 2,761 |
| Industrial | 2,023 | 2,126 | 2,614 | 2,721 | 2,827 | 2,827 | 2,827 |
| Institutional | 542 | 648 | 736 | 765 | 795 | 795 | 795 |
| Irrigation | 10,252 | 8,039 | 12,529 | 13,040 | 13,550 | 13,550 | 13,550 |
| Agricultural | 33 | 33 | 41 | 0 | 0 | 0 | 0 |
| Construction | 68 | 137 | 162 | 43 | 44 | 44 | 44 |
| Water Transfers | 13 | 16 | 0 | 168 | 175 | 175 | 175 |
| Losses | 2,607 | 2,720 | 3,534 | 3,678 | 3,822 | 3,822 | 3,822 |
| TOTAL | 47,988 | 41,451 | 58,900 | 61,300 | 63,700 | 63,700 | 63,700 |

**Table 18: Climate Data**

| MONTH (FOR YEAR 2015) | MONTHLY AVERAGE RAINFALL (IN) | MONTHLY AVERAGE TEMPERATURES (deg F) | | |
|---|---|---|---|---|
| | | AVERAGE | MINIMUM | MAXIMUM |
| January | 0.94 | 59.2 | 46.8 | 71.4 |
| February | 1.66 | 62.1 | 48.9 | 75.2 |
| March | 0.19 | 66.7 | 53.1 | 80.6 |
| April | 0.50 | 65.5 | 53.1 | 77.9 |
| May | 0.94 | 64.6 | 54.5 | 74.8 |
| June | 0.01 | 76.5 | 62.8 | 90.1 |
| July | 0.60 | 77.4 | 65.1 | 89.8 |
| August | 0.00 | 81.5 | 67.5 | 95.4 |
| September | 1.72 | 80.6 | 67.8 | 93.2 |
| October | 0.67 | 74.7 | 62.8 | 86.5 |
| November | 0.45 | 58.8 | 44.4 | 73.0 |
| December | 1.00 | 53.1 | 40.3 | 65.7 |
| Annual | 8.68 | 68.39 | 55.59 | 81.13 |

The total projected water demands from the UWMP are shown in Table *19*. The projections in the table are taken from the 2015 UWMP and include an allowance for the North Eastern Annexation Project. The amount of water allocated by the UWMP is compared to the actual water use projections based on the Project's Water Master Plan in the next section.

**Table 19: CVWD Projected Water Supply**

| WATER SUPPLY | SOURCE | PROJECTED WATER SUPPLY (AF) | | | | |
|---|---|---|---|---|---|---|
| | | 2020 | 2025 | 2030 | 2035 | 2040 |
| | | Reasonably Available Volume | Reasonably Available Volume | Reasonably Available Volume | Reasonably Available Volume | Reasonably Available Volume |
| Groundwater | Chino Basin | 12,755 | 13,687 | 13,859 | 19,282 | 19,282 |
| Groundwater | Cucamonga Basin | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Purchased or Imported Water | MWD | 31,605 | 33,073 | 35,301 | 29,878 | 29,878 |
| Recycled Water | Inland Empire Utilities Agency | 1,600 | 1,800 | 2,000 | 2,000 | 2,000 |
| Surface Water | Cucamonga Canyon | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Surface Water | Deer Canyon | 140 | 140 | 140 | 140 | 140 |
| Surface Water | Day/East Canyon | 3,400 | 3,400 | 3,400 | 3,400 | 3,400 |
| | TOTAL | 60,500 | 63,100 | 65,700 | 65,700 | 65,700 |

## 4.2 EHNCP Water Demands

Projected water demands for the *Etiwanda Heights Neighborhood & Conservation Plan* (EHNCP) used in this WSA are taken from the Draft Etiwanda Heights Neighborhood & Conservation Plan Backbone Water and Sewer CGI dated March 5, 2019. The backbone plan includes commercial, school, and residential demands. EHNCP is estimated to include approximately 180,000 square feet of commercial development located within sustainable, mixed-use type of neighborhoods. The commercial development may include retail and restaurant spaces. Approximately 3,000 residential units would be allowed by the Plan. The residential units range from high-density residential areas with more than 8.5 dwelling units per acre to very low-density residential developments with less than 2 dwelling units per acre.

The residential projected water demand for the EHNCP was estimated in the EHNCP Backbone Plan using unit demand factors for the different residential types. The demand factor was multiplied by the number of associated dwelling units to determine the estimated water use in gallons per day (GPD). The water demands were based on dwelling unit type factors. These factors have a correlation to population.

The commercial, parks and school projected water demands were also estimated by using demand factors for the land use types, and were based on square feet of land use area. The unit demand factor was multiplied by the land use area in acres to determine the estimated water use in GPD.

Commercial developments were not separated based on use in the EHNCP Backbone Water Plan (e.g., retail vs. restaurant), as the detailed land use is not specified in the Specific Plan. A demand factor was applied to account for an average distribution of commercial water usage. The water use by category and total use for the EHNCP is shown in Table *20*. Water usage is shown in gallons per day (GPD) and acre- feet per year (AFY).

All water demand projections presented in this WSA are based on Average Day Demands.

**Table 20: EHNCP Water Demands**

| Development Type | Number of Units | Unit Demand | Demand (GPD) |
|---|---|---|---|
| High Density Residential | 565 | 300 gpd/du | 169,500 |
| Medium Density Residential | 899 + 100 = 999 | 500 gpd/du | 499,500 |
| Low Density Residential | 1047 | 630 gpd/du | 659,610 |
| Very Low Density Residential | 389 | 900 gpd/du | 350,100 |
| Development Type | Size (Ac) | Unit Demand | Demand (GPD) |
| Commercial | 13 | 2,000 gpd/acre | 26,000 |
| Parks | 85.2 | 3,000 gpd/acre | 255,450 |
| School (estimated) | 17.5 | 3,000 gpd/acre | 52,610 |
| Total NA Water Demand GPD | | | 2,012,780 |
| Total NA Water Demand AFY | | | 2,255 |

The CVWD 2015 UWMP addresses water demands based on the population projection in the City of Rancho Cucamonga General Plan. The EHNCP includes approximately 305 acres currently within the City of Rancho Cucamonga and 4,088 acres in the City's Sphere of Influence (SOI) proposed for annexation to the City. The City's General Plan would allow development of up to 660 residential units with an associated population of approximately 2,000 persons on the 305 acres currently within the City. The General Plan also projects development of 1,057 units in the City's SOI with an associated population of 3,400. The 4,088 acres proposed for annexation accounts for 69% of the 5,927 acres located in the City's SOI. Based on this percentage, the portion of the projected growth associated with the annexation area would be approximately 2,346 persons. The total population growth projected in the City's General Plan for the portion of the EHNCP in the City and portion of the SOI proposed for annexation is approximately 4,346 persons. The total increase in the City's population that would be associated with the EHNCP is 9,090, approximately 6,035 persons above the projections in the City's General Plan for the EHNCP. As the CVWD 2015 UWMP is based on the City's General Plan, this increase in population of 4,744 is also not accounted for in the 2015 CVWD UWMP.

CVWD also accounted for future development of the project area in their 2017 Water System Master Plan and have accounted for water use in the Neighborhood Area as well as overall growth for the entire service area as part of this long-term water plan. The CVWD Water System Master Plan identifies 1,408 AFY total demand for the Neighborhood Area, based on a development of 3,000 dwelling units (DUs) and an associated population of 5,430 residents. The Water System Master Plan calculated the water demand using a per unit population method. The gallons-per-day-per-capita (gpcd) water use was 231 GPCD.

While the number of dwelling units in the EHNCP of 3,000 is the same as the 3,000 dwelling units projected in the CVWD Water System Master Plan, the water demand estimate for the EHNPC is higher. This difference is the result of the differing water demand assumptions used for residential uses and because the EHNCP water demand estimate presented in Table 20 above includes demand for the commercial, school and park uses that would be permitted by the EHNCP.

Phasing - The NA is projected to be built out by 2033. The build-out will be 0% in 2020, 12% in 2025 (271 AC-FT/YR), 85% in 2030 (1917 AC-FT/YR), and 100% by 2035 (2,255 AC-FT/YR).

Based on these demands in the NA as compared to the 2017 CVWD Water System Master Plan, the total potable water demand increase that is assumed to be located within the NA is an additional 847 AFY (2,255-1,408). This equates to approximately 0.8% of the 2035 CVWD projected potable water demands. The amount will be less than 0.9% for all projected years from 2020 onward.

# 5 Future Supply

CVWD's sources of water supply include untreated imported water purchased through the IEUA, groundwater rights to the Chino and Cucamonga Basins, and surface water. Recycled water is also provided through the IEUA as is considered by in the CVWD 2015 UWMP as part of the *reasonably available* water sources. CVWD has historically met all of its water demands using these sources. The CVWD potable water supply for future normal years is shown in Table *21* with the additional demand from the EHNCP.

**Table 21: CVWD Future Potable Supply - Normal Years**

| Potable Water Supply & Demands (AFY) | | YEAR | | | | |
|---|---|---|---|---|---|---|
| | | 2020 | 2025 | 2030 | 2035 | 2040 |
| Water Demands | EHNCP Project Demands | 0 | 271 | 1,917 | 2,255 | 2,255 |
| | CVWD Total Potable Demands (Including EHNCP Project Demand -1,408 AF) | 58,900 | 61,300 | 63,700 | 63,700 | 63,700 |
| | EHNCP Project Demand – Surplus (Deficit) | 1,408 | 1,137 | (509) | (847) | (847) |
| | PROJECTED TOTAL DEMAND | 57,942 | 60,163 | 64,209 | 64,547 | 65,547 |
| Water Supply | Chino Basin | 12,755 | 13,687 | 13,859 | 19,282 | 19,282 |
| | Cucamonga Basin | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| | Surface Water | 4,540 | 4,540 | 4,540 | 4,540 | 4,540 |
| | IEUA Tier I Imported Water | 28,369 | 28,369 | 28,369 | 28,369 | 28,369 |
| | IEUA Tier II Imported Water | 3,236 | 4,704 | 7,441 | 2,356 | 2,356 |
| | TOTAL POTABLE SUPPLY | 58,900 | 61,300 | 64,209 | 64,547 | 64,547 |
| POTABLE WATER SUPPLY SURPLUS (DEFICIT) | | 1,408 | 1,137 | 0 | 0 | 0 |

Based on the water supply information in the 2015 UWMP, as updated for this WSA, CVWD's future water demands, including the additional demand from the EHNCP can be met by using existing sources of water. The 2015 UWMP identified a total demand of 63,700 AF. As shown in Table 21 above, the additional demand from the EHNCP would be met by pursuing Tier II imported water and by increasing production from the Cucamonga Basin.

The 2015 UWMP outlines supply and demand projections for Normal Year, Single Dry Year, and Multiple Dry Years. The supply and demand projections from the 2015 UWMP are included below.

### 5.1.1 Normal Year

The supply and demand for the normal year are summarized in Table 22. The table shows that CVWD is projected to have materially sufficient supply to meet demands.

**Table 22: Normal Year Supply**

| | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|
| Supply (AFY) | 58,900 | 61,300 | 64,209 | 64,547 | 64,547 |
| Demand (AFY) | 57,942 | 60,163 | 64,209 | 64,547 | 65,547 |
| Difference | 1,408 | 1,137 | 0 | 0 | 0 |

### 5.1.2 Single Dry Year

In a single dry year, the District's groundwater supply is not anticipated to be affected. The water supply is projected at the Dry Year conditions as shown in Table *23*. The difference from reduced canyon flows during a single dry year shall be made up from the District's stored groundwater from the Chino Basin and/or implementation of water shortage contingency plan (See Section 3.2).

**Table 23: Single Dry Year Supply**

| | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|
| Supply (AFY) | 58,900 | 61,571 | 65,615 | 65,955 | 65,955 |
| Demand (AFY) | 57,942 | 60,163 | 64,209 | 64,547 | 65,547 |
| Difference | 1,408 | 1,137 | 0 | 0 | 0 |

### 5.1.3 Multiple Dry Years

In multiple dry years, the District's surface water supplies are expected to be reduced. The water supply projected for multiple dry year conditions is shown in *Table 24.* There could also potentially be imported water restriction, such as those implemented in 2015.

To meet demand, the difference from reduced canyon flows, imported water restrictions and State mandated water reductions during a multi-dry year shall be made up from the District's stored groundwater from the Chino Basin, MWD Tier II imported water (if available), replenishment water (if available), and implementation of the water shortage contingency plan. In the projected supply, the District will utilize all its MWD Tier I allocation and the District will also pursue MWD Tier II water in order to meet any additional demand.

The Cucamonga water right is 15,471 AFY excluding the rights to divert. Also the District does not currently utilize its full rights to the Cucamonga Creek (3,620 AFY). Current infrastructure limits the amount of water which can be used. With additional improvements the District would be able to utilize its full rights.

**Table 24: Multiple Dry Years**

| YEAR | ITEM | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|
| 1 | Supply (AFY) | 58,900 | 61,571 | 65,615 | 65,955 | 65,955 |
| | Demand (AFY) | 57,942 | 60,163 | 64,209 | 64,547 | 65,547 |
| | Difference and (%) | 1,408 | 1,137 | 0 | 0 | 0 |
| 2 | Supply (AFY) | 58,900 | 61,571 | 65,615 | 65,955 | 65,955 |
| | Demand (AFY) | 57,942 | 60,163 | 64,209 | 64,547 | 65,547 |
| | Difference | 1,408 | 1,137 | 0 | 0 | 0 |
| 3 | Supply (AFY) | 58,900 | 61,571 | 65,615 | 65,955 | 65,955 |
| | Demand (AFY) | 57,942 | 60,163 | 64,209 | 64,547 | 65,547 |
| | Difference) | 1,408 | 1,137 | 0 | 0 | 0 |

### 5.1.4 Additional Available Water Supplies

Additional groundwater is available to CVWD from the Cucamonga Basin. According to the Section 5.2.2 of the 2015 UWMP, the District has the right to produce 15,471 AFY in addition to the 3,620 AFY from surface flows in Cucamonga Creek. Currently, as shown in Table 21 above, CVWD is planning to utilize only 10,000 AFY of groundwater from the Cucamonga Basin. A potential 2,566 AFY or more of groundwater could be evaluated for use if future population growth is higher than projected by CVWD. In addition, CVWD can meet any additional demands by pursuing additional MWD Tier II imported water.

# 6 References

## 6.1 Cucamonga Valley Water District 2015 Urban Water Management Plan

## 6.2 Chino Basin Judgement

## 6.3 Cucamonga Basin Judgement

## 6.4 Cucamonga Valley Water District 2017 Water System Management Plan

# APPENDIX L.2

## Backbone Water and Wastewater Plan of Service

# TECHNICAL MEMORANDUM

## Etiwanda Heights Neighborhood & Conservation Plan (EHNCP)

## (Annexation and Specific Plan)

## Backbone Water and Wastewater Plan of Service

Prepared for **Sargent Town Planning**

| Revision Date | Summary |
|---|---|
| 3/9/2019 | CGI Administrative Draft Report |
| 4/25/2019 | CGI Administrative Draft Report |
| | |
| | |

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# Table of Contents

# I. Introduction

Sargent Town Planning (Planner) contracted with Michael Baker International (MBI) in 2017 to prepare a master water and wastewater analysis for the proposed Plan known then as the North Eastern Sphere Annexation and Specific Plan. The City of Rancho Cucamonga initiated the Annexation and Specific Plan, and Sargent Town Planning was contracted by the City to accomplish this.

In 2018 the North Eastern Sphere Plan was rebooted with a new name (Etiwanda Heights Neighborhood & Conservation Plan - EHNCP) and a new civil engineering firm (Crabtree Group, Inc.). Crabtree Group, Inc. (CGI) has reviewed the 09/29/2017 MBI report and prepared this report for the EHNCP.

The EHNCP covers 4,393.3 acres, the Plan Area covers both lands which are in currently within the City's municipal boundary (305.8 acres), and 4,087.6 acres which are within the unincorporated area of the County of San Bernardino. The adoption of the EHNCP will enable the annexation of this unincorporated area (4,087.6-acres) into the City of Rancho Cucamonga. The Plan Area is divided into two unique areas. The 3,565.5-acre area to the north of the City's foothill neighborhoods is designated as a Rural/Conservation Area (RCA). The Plan for the RCA allows up to 100 new homes on private inholdings and is not contemplating any infrastructure improvements or annexation to the CVWD water district, but there is a possibility that those 100 units could transfer into the NA, so the 100 units are considered in this analysis. The 827.8-acre area to the south is designated by the Plan as the Neighborhood Area (NA). The NA will be planned for compact, sustainable, mixed-type neighborhoods and a mixed-use center for the surrounding Foothill Neighborhoods. The EHNCP with its RCA and NA is shown in Figure 1.

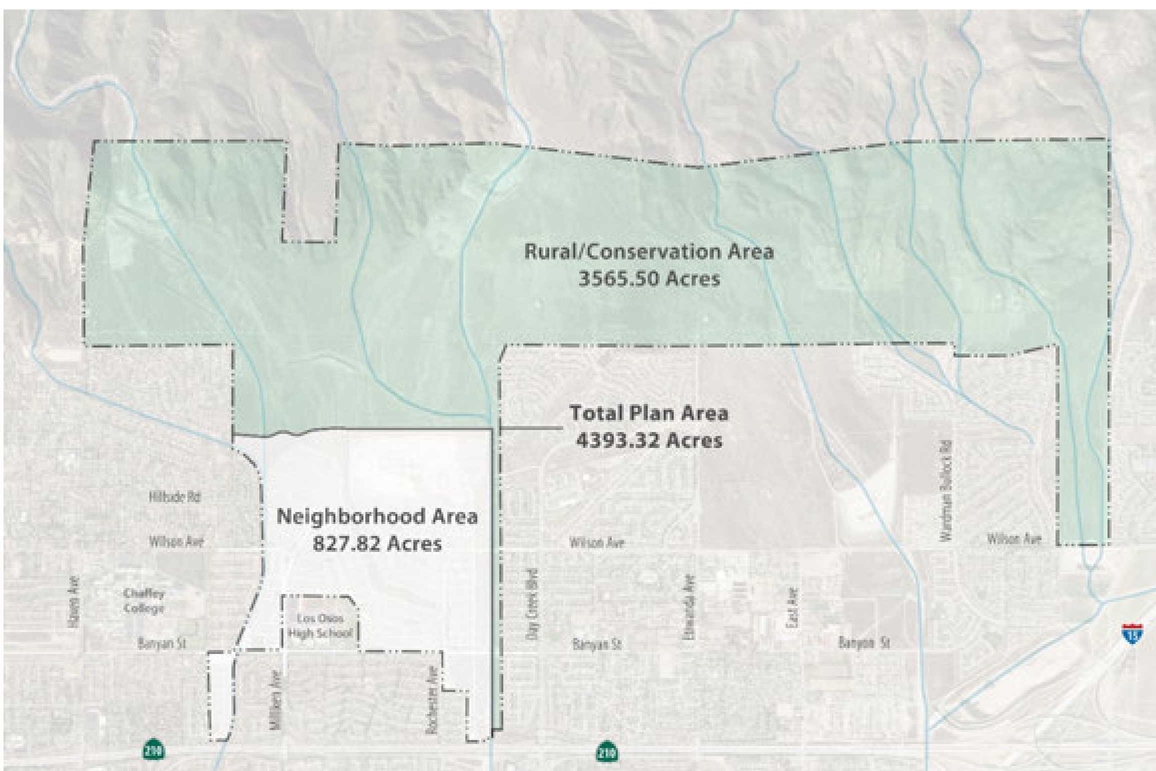


*Figure 1: Rural/Conservation Area and Neighborhood Areas. (Provided by Sargent Town Planning 2/26/19)*

The Plan for the proposed NA land use consists of single family residential of a variety of types, an area of shops/restaurants, a school, and open space network of neighborhood parks with a central greenway. The NA is bounded by the Rural Conservation Area to the north and the existing Rancho Cucamonga neighborhoods to the east, west, and south. The Neighborhood Area is shown in more detail in Figure 2.

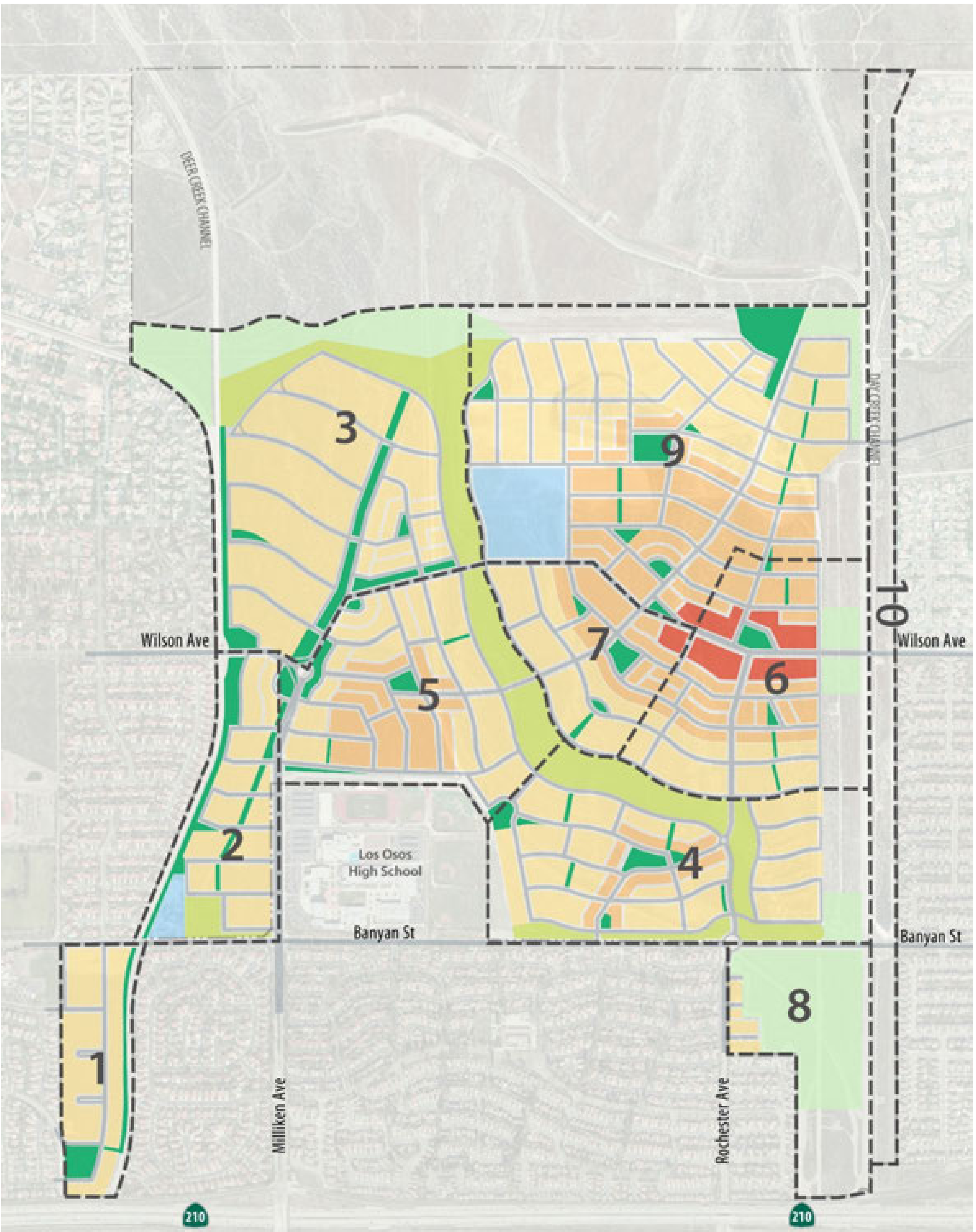


*Figure 2: Neighborhood Area Phasing/Regulating Plan (Provided by Sargent Town Planning 2/25/19)*

The water and sewer purveyor for the NA is Cucamonga Valley Water District (CVWD). This analysis used CVWD's planning and design criteria for water and sewer systems, where specified. The criteria guidelines are included in this report. The intent of this study is to provide the City with an overall assessment of the proposed backbone water and wastewater facilities necessary for the NA, sufficient for analysis of the Plan. This is a high-level analysis and further preliminary design analysis of sewer and water systems beyond what is presented in this report will be required to determine project-specific details for detailed water and sewer facility design for development approvals.

# II. Neighborhood Area Background and Context

The proposed land use for the Neighborhood Area of the EHNCP consists of a total of 2,900 residential units, 13 acres of shops and restaurants, and 17.5 acres of school/fire station. There are 167.2 acres of parks located within the NA.

The closest existing water and sewer infrastructure is located along the east, west and south sides of the NA. Currently, there are no utilities located to the north of the NA. The water that will supply the NA will be connected to three different pressure zones located at the NA boundary. They are Pressure Zone 4 on the southern boundary of the NA, Pressure Zone 5, and Pressure Zones 6. The main sewer lines that could serve the NA are in Milliken Avenue, Rochester Avenue, Day Creek Boulevard, and Lemon Avenue.

The following documents, exhibits, and correspondences (meetings/emails) were used as resources for determining demands, developing hydraulic models, and sewer calculations:

- Sargent Town Planning's North Eastern Sphere Annexation Specific Plan Memo dated 21 August 2017.
- CVWD's 2015 Urban Water Management Plan dated June 2016
- CVWD's existing Water Distribution System Hydraulic Model
- CVWD's Water Master Plan, Chapters 3 & 5, dated March 2017
- CVWD's Sewer Master Plan, Chapter 5, dated March 2017
- CVWD's approximate sewer modeling dated January 25, 2019
- Sargent Town Planning's Etiwanda Heights Neighborhood & Conservation Plan Site Plan, Phasing Plan, and Program dated February and March 2019.

# III. Land Use, Water Demands, and Wastewater Generation

## Land Use

The NA is located in the foothills between the existing neighborhoods of Rancho Cucamonga and the proposed RCA which backs up to the San Bernardino National Forest. The existing topography of the NA slopes relatively uniformly from the north to the south at about 5-6%. The site of an existing gravel open cut mine is in the proposed NA. The mine will be partially filled, and the area graded for development. The proposed land use for the 828-acre NA consists of 98.5 acres of public utilities easement areas, 99 acres of parks, 17.5 acres of Schools/Fire Stations, 13 acres (180,000 sf) of Shops/Restaurants, and 600 acres of residential area. The residential units consist of a mix of low density, medium density, and high density detached and attached single family homes. The NA Phasing/Regulating plan is shown in Figure 2.

The land use areas were used to determine the water use and wastewater generation. The CVWD water and sewer master plan sections provided did not specify water demand factors or wastewater generation factors. Conservative values were selected by MBI and CGI based on values typically used within the Inland Empire area. These values are shown in Table 1.

| Land Use Type | Water Use – Unit Demand Factors | | Wastewater – Unit Generation Factors | |
|---|---|---|---|---|
| | gpd/du | gpd/acre | gpd/du | gpd/acre |
| Very Low Density Residential (<2 DU/AC) | 900 | -- | 420 | -- |
| Low Density Residential (3-7 DU/AC) | 630 | -- | 350 | -- |
| Medium Density Residential (8-14 DU/AC) | 500 | -- | 200 | -- |
| High Density Residential (15+ DU/AC) | 300 | -- | 200 | -- |
| Commercial | -- | 2,000 | -- | 1,700 |
| Parks | -- | 3,000 | -- | -- |
| Schools | -- | 3,000 | -- | 1,000 |

*Table 1: Demand and Generation Unit Factors*

Dwelling unit (du) count was used as a basis for residential portions. Gross area was used as a basis for the commercial and school areas using values from Table 1

## Water Demands

For domestic water demand calculations, Maximum Day Demand and Peak Hour Demand peaking factors were applied using the values and curves in the existing CVWD system model. The diurnal demand curve in the existing model for Zones 4, 5, and 6 is shown in Figure 3. The Maximum Day Demand (MDD) peaking factor in the model is 1.6768, which is applied to the diurnal curves to determine the maximum day demand. The average day demands per land use type are summarized in Table 2.

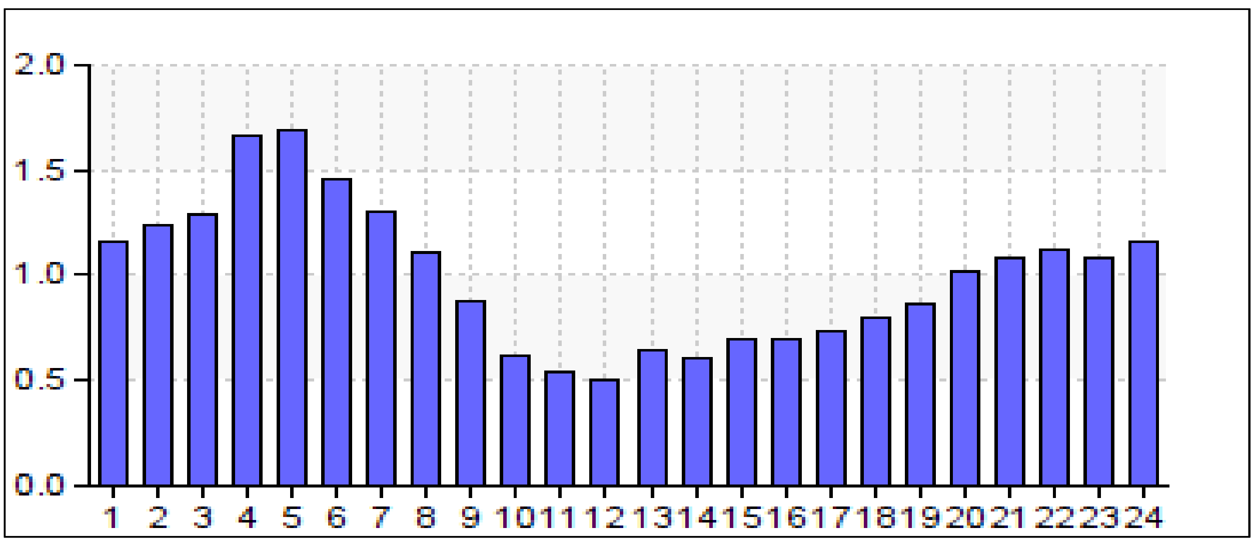


*Figure 3: CVWD Zone 4 Existing Daily Demand Curve*

| PHASE | GROSS PHASE AREA (ACRES) | AVG DU/ ACRE | DWEL-LING UNITS (#) | RESID. WATER DEMAND (gpd) | RESID. SEWER LOAD (gpd) | COMM-ERCIAL (acre) | COMM. WATER DEMAND (gpd) | COMM. SEWER LOAD (gpd) | PARKS (acre) | PARKS WATER DEMAND (gpd) | SCHOOL (acre) | SCHOOL WATER DEMAND (gpd) | SCHOOL SEWER LOAD (gpd) | TOTAL WATER DEMAND (gpd) | TOTAL SEWER LOAD (gpd) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 28.62 | 4.09 | 117 | 73,710 | 40,950 | | | | 2.25 | 6,750 | | | | 80,460 | 40,950 |
| 2 | 40.34 | 3.15 | 127 | 78,700 | 47,110 | | | - | 3.50 | 10,500 | 3.00 | 9,000 | 3,000 | 98,200 | 50,110 |
| 3 | 112.85 | 1.36 | 154 | 136,800 | 64,400 | | | | 8.6 | 25,800 | | | | 162,600 | 64,400 |
| 4 | 87.81 | 6.46 | 567 | 291,820 | 151,480 | | | | 9.3 | 27,900 | | | | 319,720 | 151,480 |
| 5 | 79.61 | 6.00 | 478 | 257,990 | 130,110 | | | | 7.5 | 22,500 | | | | 280,490 | 130,110 |
| 6 | 56.28 | 8.16 | 459 | 224,790 | 111,750 | 10.73 | 21,460 | 18,241 | 8.5 | 25,500 | | | | 271,750 | 129,991 |
| 7 | 44.52 | 6.31 | 281 | 143,700 | 74,340 | 1.32 | 2,640 | 2,244 | 4.5 | 13,500 | | | | 159,840 | 76,584 |
| 8 | 3.56 | 4.12 | 15 | 9,450 | 5,250 | | | | 30 | 90,000 | | | | 99,450 | 5,250 |
| 9 | 146.51 | 4.79 | 702 | 411,750 | 210,590 | 0.95 | 1,900 | 1,615 | 11.00 | 33,000 | 14.54 | 43,620 | 14,540 | 490,270 | 226,745 |
| RCA 100 | 0.00 | 8.00 | 100 | 50,000 | 20,000 | | - | - | 0.00 | - | | - | - | 50,000 | 20,000 |
| | **600.1** | | **3,000** | **1,678,710** | **855,980** | **13.0** | **26,000** | **22,100** | **85.2** | 255,450 | **17.5** | **52,620** | **17,540** | 2,012,780 | **895,620** |
| | | | | | | | | | **TOTAL WATER (gpm)** | | | | | **1,398** | |
| | | | | | | | | | **TOTAL WATER (AFY)** | | | | | **2,255** | |

*Table 2: Neighborhood Area Average Day Demands* Unit count from Sargent Town Planning dated, 6 March 2019.

The proposed water system concept was evaluated using velocity and pressure design requirements presented in CVWD's Water Master Plan by MBI for the previous design concept. This analysis identified an issue with pumping capacity but showed that pressure and velocity standards were met. (See Appendix A). The CVWD design criteria are summarized in Table 3: CVWD Water System Design Criteria. Fire flow requirements for each land use type also followed the criteria presented in CVWD's Water Master Plan, Chapter 5. The fire flow requirements are summarized in Table 4.

| | |
|---|---|
| Maximum Customer Service Pressure (without individual pressure regulator at meter) | 80 psi |
| Maximum Customer Service Pressure (with individual pressure regulator at meter) | 150 psi |
| Minimum Distribution System Pressure<br>• Daily Demands (Peak Hour)<br>• Maximum Day Demand Plus Fire Flow | <br>40 psi<br>20 psi |
| Minimum Pipeline Diameter | 8 inches |
| Hazen-Williams Coefficient "C" Factor | 130 (for new pipelines less than 20 years in age) |
| Maximum Pipeline Velocities<br>• Average Day Demands<br>• Maximum Day and Peak Hour Demands<br>• Fire Flow Demands | <br>Not to exceed 5.0 fps<br>Not to exceed 8.0 fps<br>May exceed 10 fps |

*Table 3: CVWD Water System Design Criteria*

| Structure | Flow (gpm) | Duration (hours) |
|---|---|---|
| Very Low and Low Density Residential | 1,250 | 2 |
| Medium Density Residential | 1,500 | 2 |
| High and Very High Density Residential | 2,500 | 3 |
| Commercial | 3,500 | 4 |
| Schools | 4,000 | 4 |

*Table 4: CVWD Fire Flow Requirements*

Domestic water pipelines are sized to ensure minimum pressures are met throughout the system while providing the required fire flows and adhering to CVWD's system criteria. The minimum pipe size used for the system is 8 inches in diameter. Fire flows are typically the determining factor in water main sizing. Fire flow for schools creates the highest demand for the water main distribution network. CGI's analysis of the new Plan identified the need for additional domestic and fire suppression storage capacity to level out the pumping capacity strain that was noted by MBI.

## Wastewater Generation

For wastewater generation, the Average Day and Peak Hour flow rates were calculated. A sewer model was not yet available from CVWD. A conservative peaking factor of 2.5 was assumed for all areas of the NA. Wastewater generation factors are from Table 1. The Average Day wastewater generation flows are shown in Table 2 and the Peak Hour flows in each area are summarized in Table 5.

| PEAK SEWER FLOW RATES BY PHASE USING: | | | 2.5 | PEAKING FACTOR | |
|---|---|---|---|---|---|
| PHASE | PEAK HOUR SEWER FLOW (gpm) | PEAK HOUR SEWER FLOW (c.f.s.) | TRUNK MAIN SIZE (in) | ASSUMED SLOPE (FT/100FT) | CAPACITY d/D - 0.5 (c.f.s) |
| 1 | 71 | 0.16 | 8 | 0.02 | 0.44 |
| 2 | 87 | 0.19 | 8 | 0.02 | 0.44 |
| 3 | 112 | 0.25 | 8 | 0.02 | 0.44 |
| 4 | 263 | 0.59 | 12 | 0.01 | 0.93 |
| 5 | 226 | 0.50 | 12 | 0.01 | 0.93 |
| 6 | 226 | 0.50 | 15 | 0.005 | 1.19 |
| 7 | 133 | 0.30 | 8 | 0.02 | 0.44 |
| 8 | 9 | 0.02 | 8 | 0.02 | 0.44 |
| 9 | 394 | 0.88 | 15 | 0.02 | 0.81 |
| RCA 100 | 35 | 0.08 | | | |
| **TOTAL** | | **3.46** | | | |
| | | | | | |
| Propose 21" PS 46, ASTM F679 SEWER TRUNK MAIN DOWN GREENWAY | | | | | |
| .025 SLOPE, d/D = 0.5 capacity = 6.00 c.f.s. providing an additional 2.61 c.f.s | | | | | |
| to the district. | | | | | |

[1] Lot count from Sargent Town Planning Memo Dated 18 Feb 2019.
[2] A peaking factor of 2.5 was used for all land use types.

*Table 5: Neighborhood Area Wastewater Generation*

The proposed system was evaluated using velocity and d/D ratio pressure design requirements presented in CVWD's Sewer Master Plan, Chapter 5 These design criteria are summarized in Table 6.

| Design Criteria | Requirement |
|---|---|
| Maximum d/D ratio for pipes less than or equal to 12 inches | 0.50 |
| Maximum d/D ratio for pipes greater than or equal to 15 inches | 0.75 |
| Minimum Pipe Diameter | 8-inch dia. |
| Gravity Sewer main – Minimum Peak Velocity | 2 ft/sec |
| Gravity Sewer Main – Maximum Velocity | 10 ft/sec |

*Table 6: Sewer Main Design Criteria*

# IV. EHNCP Domestic Water System Recommendations

## Overview and Water System Proposal

The analysis presented in this study assumes a complete Plan buildout using a public system delivery.
A map of the CVWD existing water system is shown in Figure 4. The overview of the proposed water system for the Neighborhood Area (NA) is shown in Figure 5.

The proposed pipelines, storage tank and pump main for the NA include 8-inch, 10-inch, 12-inch and 16-inch diameter piping. Pipe sizes and alignments identified in this study are for preliminary planning and estimating only. The proposed backbone water trunk mains, pressure reducing valves, water tank storage and pump main connections are shown in Figure 6.

The NA will include two water pressure zones connected into Pressure Zone 4 and Pressure Zone 5. Wilson Blvd. will be the zone boundary between the two pressure zones in the NA.

Pressure zones 5 and 5C will also be interconnected in the center of the proposed NA.

It is recommended that 2M gallons of new storage be installed in Zone 6 to serve the new Plan loads. The recommended storage is one average day demand at 1.8 million gallons + 3000 gpm @ 2hr requires 360,000 gallons for fire flow. A 2.4-million-gallon tank at 90% full provides the necessary 2.2-million-gallon capacity. This will provide enough domestic and fire suppression capacity to support the new Plan area.

The proposed scenario is to install this additional storage capacity at the Indian Wells Place existing tank location with a 16-inch trunk main connection to Zone 5 within the NA. With this storage capacity, pumping from zone 4 can be timed for off peak periods reducing the issue discussed in the Water Demands section. An additional improvement would be to connect a pump main (6”) from the Haven Avenue Zone 6 Tank to the Indian Wells Zone 6 tank location.

The design specifics and optimization of this proposed concept will require more complete analysis in the preliminary subdivision design phase, to the satisfaction of CVWD. A more refined analysis should be performed to confirm the various elements, including:

- Final elevation and grades;
- Pipe corridors and sizes;
- Final connection points to off-site and on-site distribution piping;
- and Phasing.

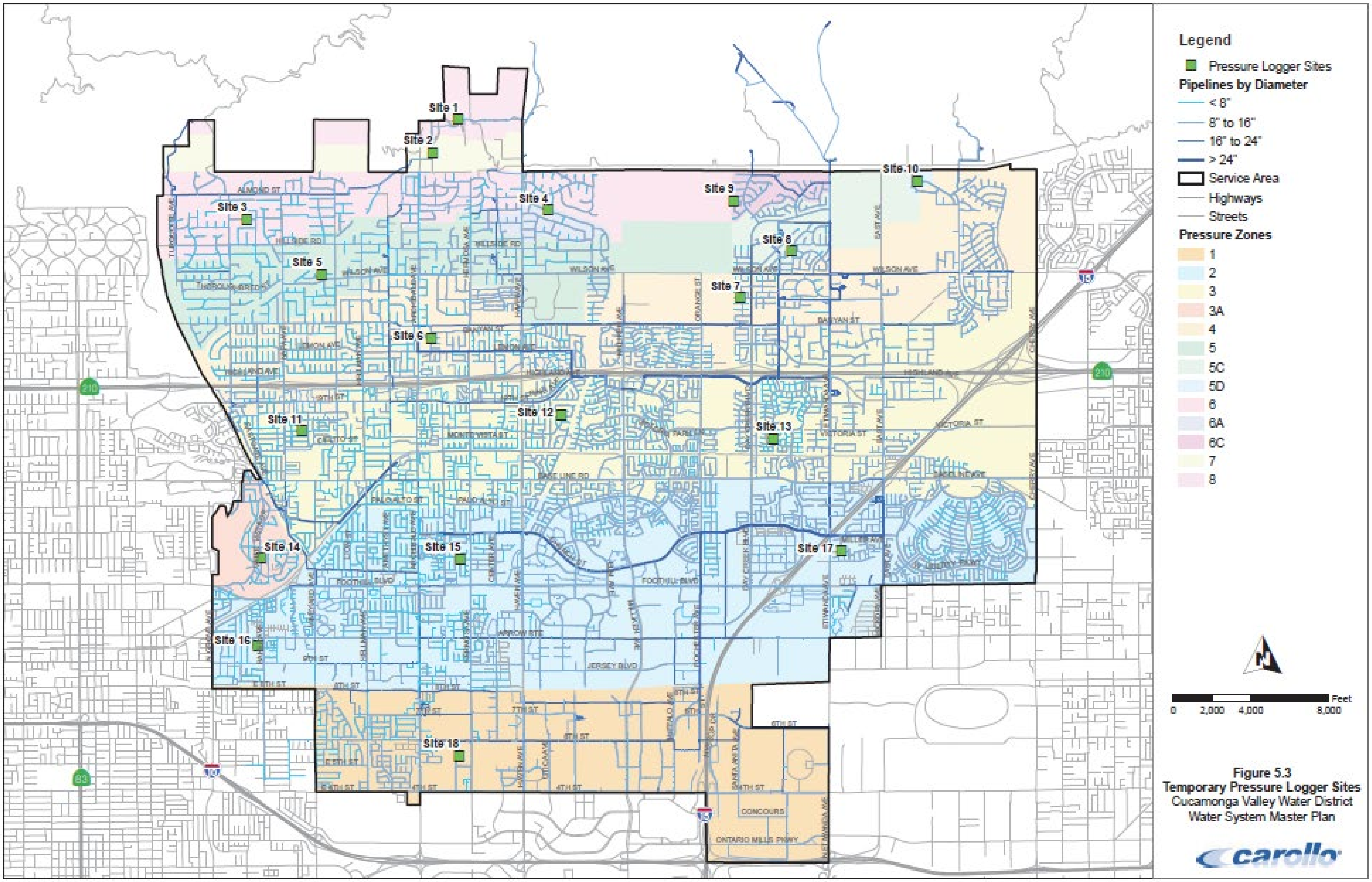


*Figure 4 – Map of Existing CVWD Water System*


*Figure 5 – Proposed Neighborhood Area Water Backbone Improvements*

### Impacts to Existing Water Infrastructure

MBI performed water model calculations and scenarios for the previous master plan that could be useful in performing a detailed analysis of the new Plan. While that exercise is beyond the needs of a Specific Plan analysis, those calculations can be found in the MBI Water and Sewer Master Plan report dated 9/29/2017. According to that MBI water modeling, the proposed Plan may have impacts to existing storage tanks 4B-1 and 4B-2, located north of Wilson Avenue on Mayberry Avenue. The tanks and pump station at this facility store water from Zone 4 and pump it to pressure Zone 5. The pump station is controlled by the level of Zone 5 storage tanks. During peak hour operations, the levels in tanks 4B-1 and 4B-2 are reduced to approximately 5 to 10% full. During fire flow events, the additional demands to the water system appear to impede the ability of Zone 4 to supply enough water to fill the reservoirs and the storage in the tanks is depleted. If additional storage is placed within Zone 4, it appears to further deplete the tank storage as an additional reservoir now "competes" for supply with the existing reservoirs. Additional pumping capacity from Zone 4 also further depletes storage in these tanks, as the pumps are also "competing" with the tanks for water. These potential impacts are addressed in the above Overview and Water System Proposal Section but will need to be further reviewed in a preliminary analysis done as part of a subdivision approval.

# V. EHNCP Wastewater System Recommendations

### Overview and Sewer Proposal

The overview of the proposed wastewater system for the Neighborhood Area is shown in Figure 6. Preliminary analysis conducted by CVWD shows that the existing wastewater collection system down stream of the NA to the south is not capable of accepting the overall new wastewater flows generated by the Plan without improvements. An overview map of that analysis is shown in Figure 7.

Preliminary evaluation of the sewer model shows that the Phase 1 connection would impact a few sections of the sewer main downstream by adding flow over capacity or at capacity. Preliminary analysis of the sewer model shows that the remaining phases will require a grid main system and trunk main system within the NA to collect the newly generated wastewater as shown in Figure 6 and a trunk main extension 2.5 miles south to Foothills Parkway utilizing the utility corridor running north-south. A 21-inch trunk main could carry the wastewater from the NA to an existing 27-inch CVWD trunk main with the necessary capacity to accept the wastewater flows; though the sections of existing sewer mains downstream of the 27-inch sewer main would flow at full capacity (d/D = 1.0) at Arrow Route This trunk main will provide for the full build-out of phases 2-9 and will provide CVWD with minimum of 2.78 c.f.s. capacity at a d/D of 0.5, which would assist the district with reducing area sewer mains that may be exceeding the d/D with values of 0.5 to 0.75 or higher. Any proposed new sewer main or upgrade to existing sewer mains has to consider the I-210 crossing.

The proposed gravity sewer lines for the NA include 8-inch, 10-inch, 12-inch, 15-inch, 18-inch and 21-inch diameter piping. Pipe sizes and alignments identified in this study are for preliminary planning and estimating only. The proposed backbone pipe sizes are shown in Figure 6. Peak Hour flow rates are provided in Table 7.

The slopes of the wastewater system generally follow the slope of the proposed grades from north to south. Gravity pipelines running west to east were placed at a minimum acceptable slope to account for the relatively flat east-west grades, and to allow crossing of storm water pipelines. The north south grades provide sufficient slopes to meet velocity requirements.

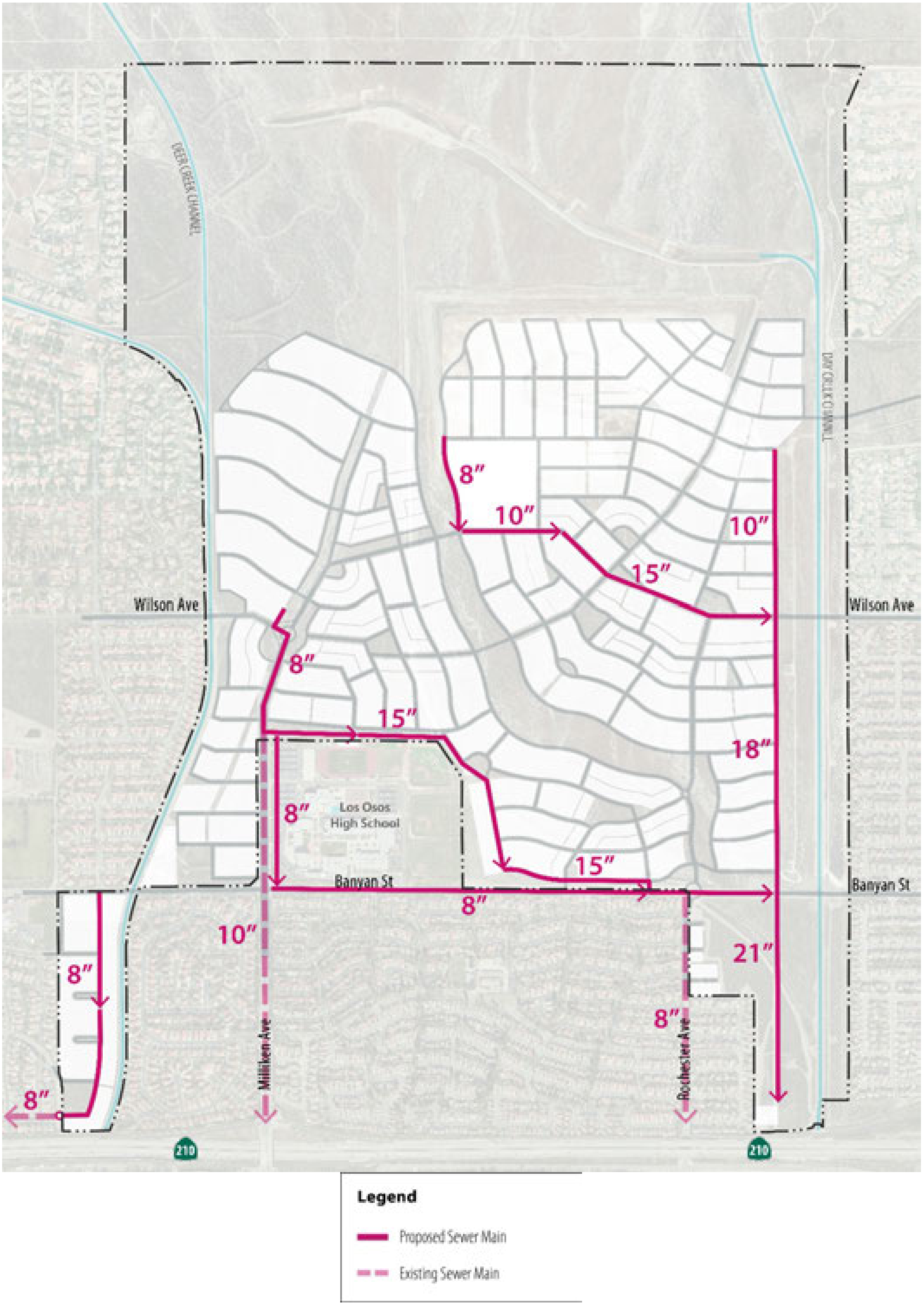


*Figure 6 – Proposed Backbone Wastewater System for NA*

| **PEAK SEWER FLOW RATES BY PHASE USING:** | | | **2.5** | **PEAKING FACTOR** | |
|---|---|---|---|---|---|
| **PHASE** | **PEAK HOUR SEWER FLOW (gpm)** | **PEAK HOUR SEWER FLOW (c.f.s.)** | **TRUNK MAIN SIZE (in)** | **ASSUMED SLOPE (FT/100FT)** | **CAPACITY d/D - 0.5 (c.f.s)** |
| 1 | 71 | 0.16 | 8 | 0.02 | 0.44 |
| 2 | 87 | 0.19 | 8 | 0.02 | 0.44 |
| 3 | 112 | 0.25 | 8 | 0.02 | 0.44 |
| 4 | 263 | 0.59 | 12 | 0.01 | 0.93 |
| 5 | 226 | 0.50 | 12 | 0.01 | 0.93 |
| 6 | 226 | 0.50 | 15 | 0.005 | 1.19 |
| 7 | 133 | 0.30 | 8 | 0.02 | 0.44 |
| 8 | 9 | 0.02 | 8 | 0.02 | 0.44 |
| 9 | 394 | 0.88 | 15 | 0.02 | 0.81 |
| RCA 100 | 35 | 0.08 | | | |
| **TOTAL** | | **3.46** | | | |
| | | | | | |
| Propose 21" PS 46, ASTM F679 SEWER TRUNK MAIN DOWN GREENWAY | | | | | |
| .025 SLOPE, d/D = 0.5 capacity = 6.00 c.f.s. providing an additional 2.61 c.f.s | | | | | |
| to the district. | | | | | |

*Table 7 – Peak Flow Rates by Phase w/d/D ratio for pipe size*

Once a more accurate sewer model is developed by CVWD, a more refined analysis of the gravity wastewater system should be performed to confirm the various elements, including:

- Final elevation and grades;
- Final pipe slopes;
- Pipe corridors and sizes;
- Final connection points to off-site and on-site distribution piping;
- Phasing.

The analysis presented in this study assumes a complete Plan buildout. CVWD is upgrading their sewer model of the existing wastewater collection system, so detailed analysis is not yet available. CVWD was able to provide an approximate analysis of existing trunk capacities, and EHNCP impacts on those facilities. Therefore, the analysis of the capacity of the existing CVWD system, connection points, and collection capacity are based on best available, but approximate, information.

## Impacts to Existing Infrastructure

The closest existing sewer systems occur along the southeastern and southwestern edge of the NA. To the east, an existing 8 to 12-inch sewer line extends north along Day Creek Boulevard. To the west, an existing 10-inch sewer line extends north along Milliken Avenue to the NA boundary. To the south, an existing

8-inch sewer extends to the NA boundary in Rochester Avenue. Based on preliminary analysis, it appears that the existing sewers will be insufficient to convey the wastewater flows for the whole NA. See Figure 7 for existing d/D approximate values.

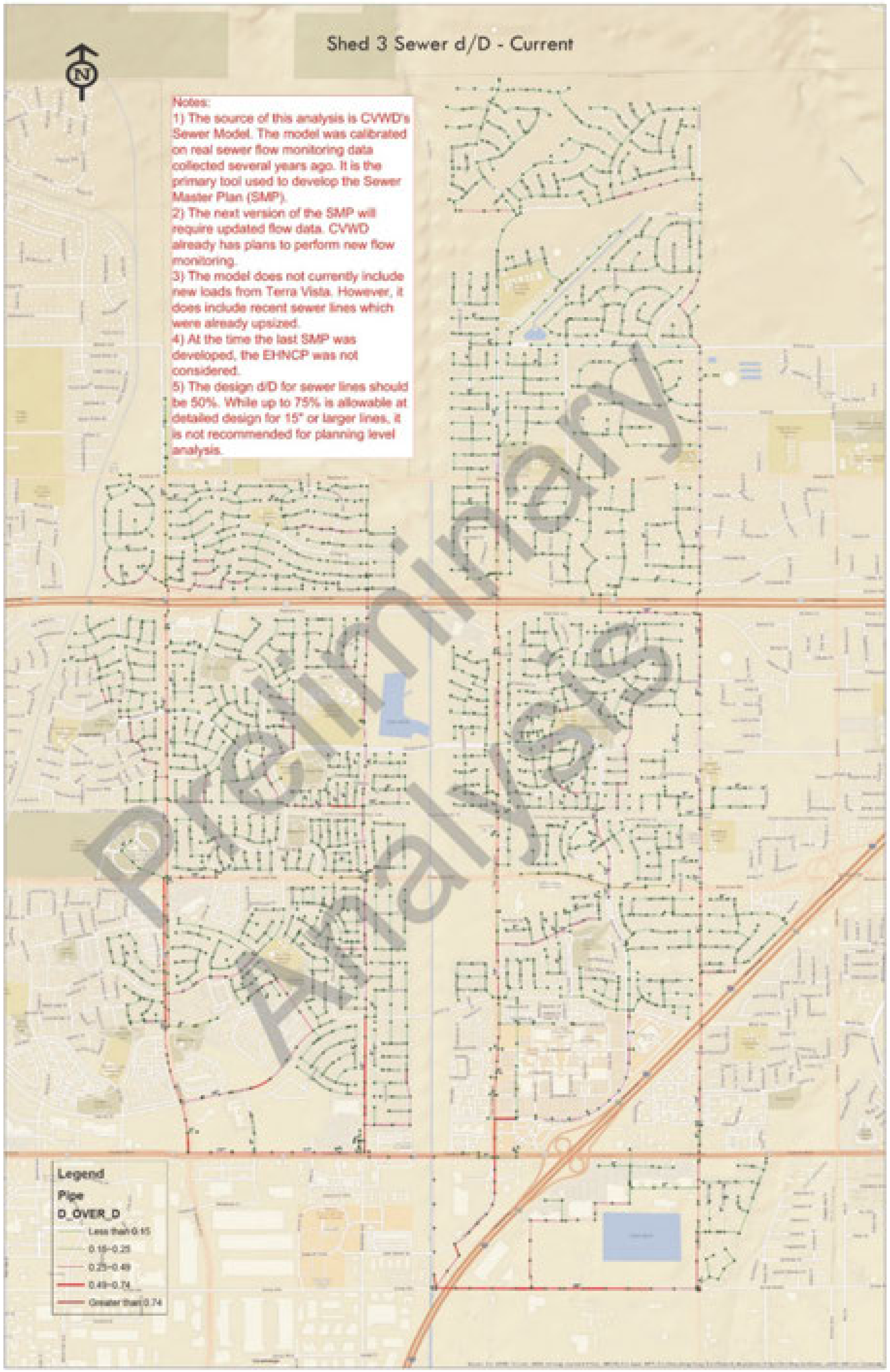


*Figure 7 – Approximate existing sewers d/D values per CVWD estimate 1/25/19.*

Furthermore, a preliminary model run was done by CVWD by projecting 580 gpm peak flow rate onto Milliken Ave and 770 gpm onto Rochester Avenue. See Figure 8.

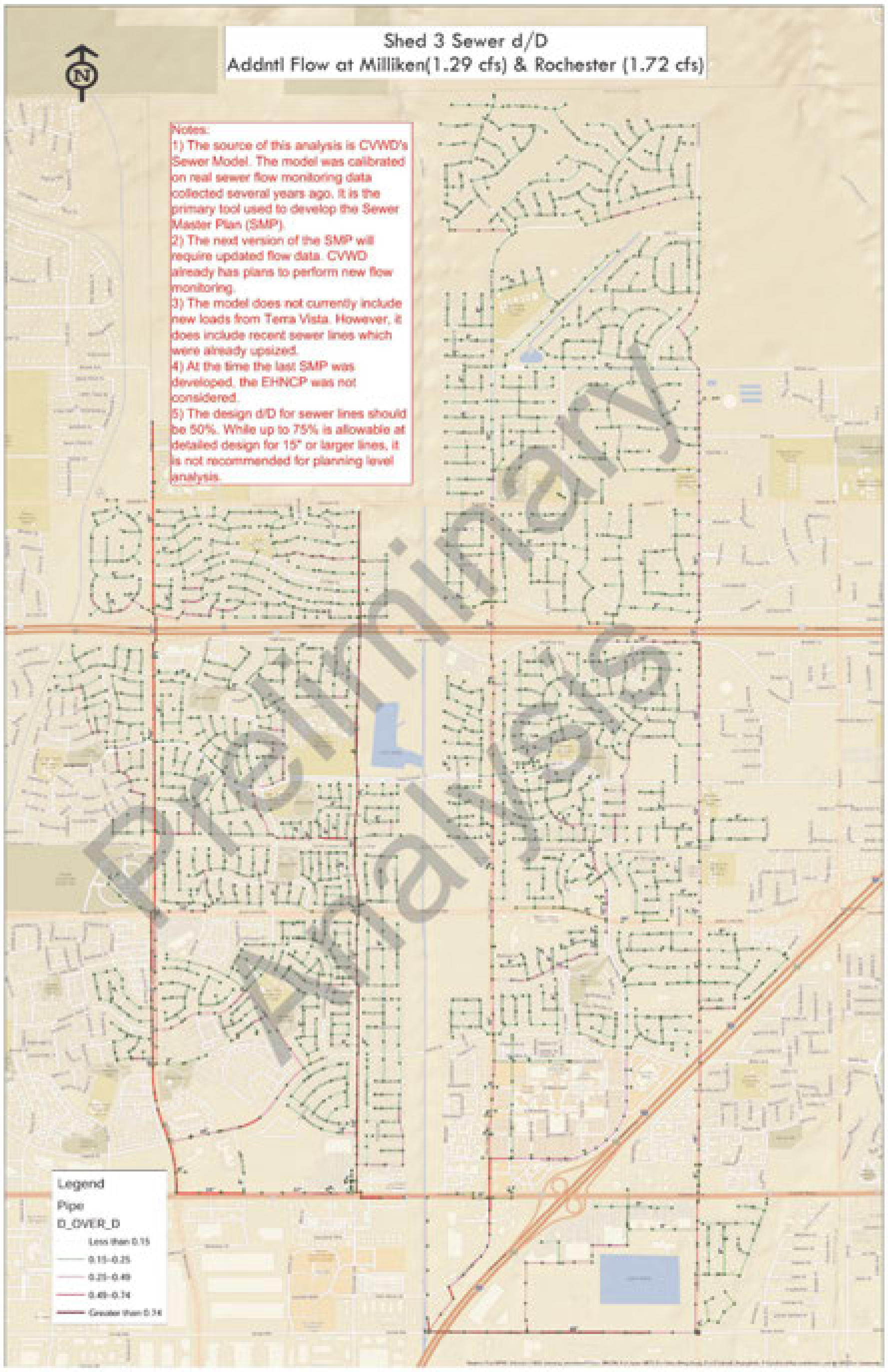


*Figure 8: Shed 3 Sewer d/D – Proposed 580 gpm onto Milliken and 770 gpm onto Rochester, per CVWD January 25, 2019.*

This analysis indicates that Milliken may already exceed recommended capacity south of Baseline Road, and Rochester Ave may already exceed recommended capacity south of Church Street, and Day Creek Blvd may already exceed recommended capacity south of Victoria Gardens Lane. The Overview and Proposal above provides the response to these impacts.

# Appendix A. MBI Water Modeling 09/29/17 Report

# TECHNICAL MEMORANDUM

## Sargent Town Planning

Northeastern Sphere Annexation
Master Water and Wastewater Plan of Service

| Revision Date | Summary |
|---|---|
| 9/29/2017 | Draft |
| | |
| | |
| | |

Michael Baker INTERNATIONAL

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Temecula, CA 92591-6022
(951) 676-8042

# Table of Contents

# I. Introduction

Michael Baker International was contracted by Sargent Town Planning (Developer) to prepare a master water and wastewater analysis for the proposed project known as the North Eastern Sphere Annexation (Project). The project will enable the annexation of a 4,388-acre area by the City of Rancho Cucamonga. The project area currently lies within an unincorporated area within the County of San Bernardino. This area is divided into two unique areas. The area to the north of the City's foothill neighborhoods is designated as a Conservation Priority Area by this project. This Conservation Priority Area will not have improvements, and is not considered in this analysis. The southern area of the project contains a 1,212-acre Development Priority Area. The Development Priority area will be planned for the construction of compact, sustainable, mixed-type neighborhoods and a mixed-use center for the surrounding Foothill Neighborhoods.

The proposed land use consists of single and multi-family residential, commercial, schools, and a large, undeveloped conservation area in the center of the project. The area is bounded by the Angeles National Forest to the north and the existing Rancho Cucamonga city limits to the east, west, and south. The project area is shown in Figure 1 (provided by Sargent Town Planning).


*Figure 1: Conservation and Development Priority Areas*

The water and sewer purveyor for this development is Cucamonga Valley Water District (CVWD). This analysis used CVWD's planning and design criteria for water and sewer systems, where specified. The criteria guidelines are included within Appendix D. The intent of this study is to provide the Applicant/Owner with an overall assessment of the proposed onsite backbone water and wastewater facilities necessary for the Project. Further preliminary design analysis may be required for detailed water facility design.

## II. Project Background

The proposed land use for the Project consists of a total of 3,807 residential units, 6.4 acres of proposed commercial development, and 15.7 acres of school development. There are 488.9 acres of undeveloped land located within the Development Priority area.

The closest existing water and sewer infrastructure is located along the east and west sides of the Project. Currently, there are no utilities located to the north of the project. The water that will supply the Project will be connected to five different pressure zones located at the project boundary. They are Pressure Zone 4 on the southern boundary of the site, Pressure Zones 5 and 5C, and Pressure Zones 6 and 6C.

The following documents, exhibits, and correspondences (meetings/emails) were used as resources for determining demands and developing hydraulic models:

- Sargent Town Planning's North Eastern Sphere Annexation Specific Plan Memo, dated 21 August 2017
- CVWD's 2015 Urban Water Management Plan dated June 2016
- CVWD's existing Water Distribution System Hydraulic Model
- CVWD's Water Master Plan, Chapters 3 & 5, dated March 2017
- CVWD's Sewer Master Plan, Chapter 5, dated March 2017

## III. Land Use, Water Demands, and Wastewater Generation

### Land Use

The project is located at the foothills of the Angeles National Forest. The existing topography of the area slopes relatively uniformly from the north to the south. In proposed Central Development Area will be located at the site of an existing gravel open cut mine. The mine will be filled and the area graded. The proposed land use for the 1,212-acre Development Priority Area consists of 488.9 acres of conservation area, 144.2 acres of public utilities and easement areas, and 578.8 acres of development area. The Project consists of 3,807 residential units and 279,982 square feet of non-residential development. The residential units consist of a mix of low density, medium density, and high density detached single family homes, in addition to townhouses and condominiums. The development site plan is shown in Figure 2.


*Figure 2: Project Site Plan (Provided by Sargent Town Planning)*

The land use areas were used to determine the water use and wastewater generation. The CVWD water and sewer master plan sections provided did not specify water demand factors or wastewater generation factors. Conservative values were selected by Michael Baker International based on values typically used within the Inland Empire area. These values are shown in Table 1.

*Table 1: Demand and Generation Unit Factors*

| Land Use Type | Water Use – Unit Demand Factors | | Wastewater – Unit Generation Factors | |
|---|---|---|---|---|
| | gpd/du | gpd/acre | gpd/du | gpd/acre |
| Very Low Density Residential (<2 DU/AC) | 900 | -- | 420 | -- |
| Low Density Residential (3-7 DU/AC) | 630 | -- | 350 | -- |
| Medium Density Residential (8-14 DU/AC) | 500 | -- | 200 | -- |
| High Density Residential (15+ DU/AC) | 300 | -- | 200 | -- |
| Commercial | -- | 2,000 | -- | 1,700 |
| Parks | -- | 3,000 | -- | -- |
| Schools | -- | 3,000 | -- | 1,000 |

Dwelling unit (du) count was used as a basis for residential portions of the development. Gross area was used as a basis for the commercial and school development areas. The commercial component for the Project Floor Area Ratios (FAR) used were as presented in the Specific Plan memo by Sargent Town Planning, Dated 21 August 2017. They are:

- FAR = 0.10 in the Wilson Town Center Area
- FAR = 0.03 in the College Center Area
- FAR = 0.20 in the Southeast Development Area

## Water Demands

For domestic water demand calculations, Maximum Day Demand and Peak Hour Demand peaking factors were applied using the values and curves in the existing CVWD system model. The diurnal demand curve in the existing model for Zones 4, 5, and 6 is shown in Figure 3. The Maximum Day Demand (MDD) peaking factor in the model is 1.6768, which is applied to the diurnal curves to determine the maximum day demand. The average day demands per development area are summarized in Table 2.

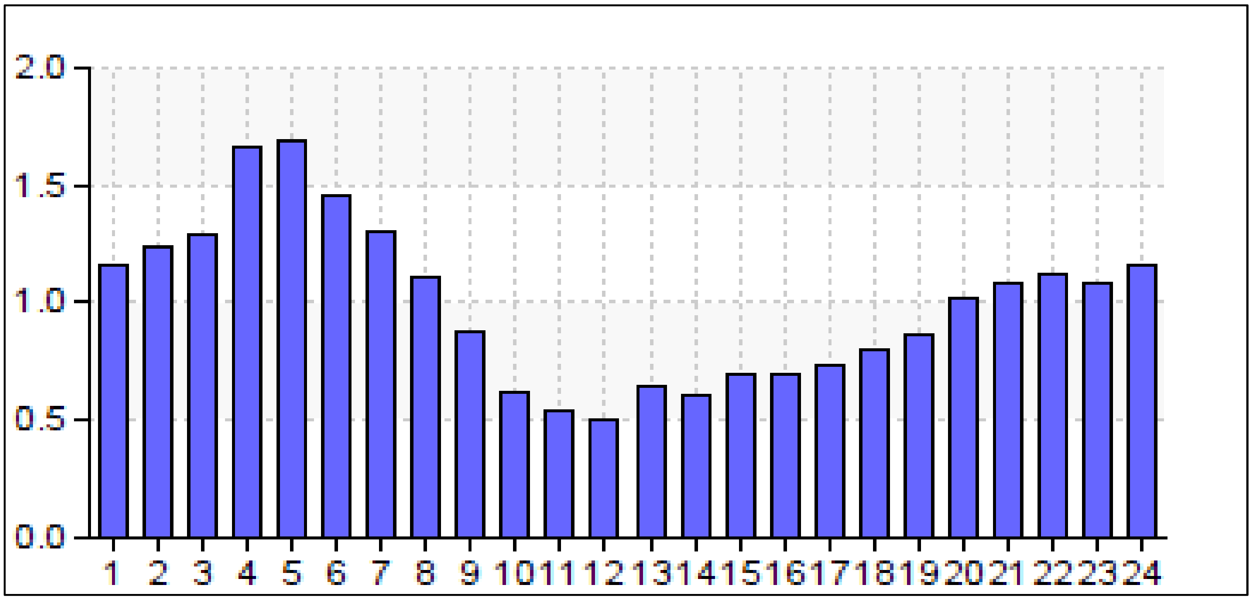



*Figure 3: CVWD Zone 4 Existing Demand Curve*

*Table 2: Development Priority Area Average Day Demands*

| Planning Area Land Use | Non-Residential (sqft) | Residential Dwelling Units[1] | Average Day Demand (gpm)[2] |
|---|---|---|---|
| **Central Development Area Total** | | | |
| Wilson Town Center | 166,116 | 763 | 164.3 |
| Wilson Neighborhood | 0 | 1,114 | 232.1 |
| Wilson Heights | 0 | 319 | 110.8 |
| **West Development Area Total** | | | |
| College Center | 52,769 | 404 | 142.0 |
| Southwest Neighborhood | 683,892 | 479 | 199.0 |
| Southwest Infill Neighborhood | 0 | 121 | 52.9 |
| Milliken Heights | 0 | 190 | 99.4 |
| **East Development Area Total** | | | |
| Southeast Neighborhood | 61,097 | 350 | 124.0 |
| Southeast Infill Neighborhood | 0 | 70 | 30.6 |
| **Total for All Areas** | **963,874** | **3,810** | **1,155.1** |

[1] Lot count from Sargent Town Planning Memo Dated 21 August 2017.

[2] Open Space and conservation areas will be native vegetation or use drought tolerant plants that will not require irrigation.

The proposed water system was evaluated using velocity and pressure design requirements presented in CVWD's Water Master Plan, Chapter 5. These design criteria are summarized in Table 3: CVWD Water System Design Criteria. Fire flow requirements for each development type also followed the criteria presented in CVWD's Water Master Plan, Chapter 5. The fire flow requirements are summarized in Table 4.

*Table 3: CVWD Water System Design Criteria*

| | |
|---|---|
| Maximum Customer Service Pressure (without individual pressure regulator at meter) | 80 psi |
| Maximum Customer Service Pressure (with individual pressure regulator at meter) | 150 psi |
| Minimum Distribution System Pressure<br>• Daily Demands (Peak Hour)<br>• Maximum Day Demand Plus Fire Flow | <br>40 psi<br>20 psi |
| Minimum Pipeline Diameter | 8 inch |
| Hazen-Williams Coefficient "C" Factor | 130 (for new pipelines less than 20 years in age) |
| Maximum Pipeline Velocities<br>• Average Day Demands<br>• Maximum Day and Peak Hour Demands<br>• Fire Flow Demands | <br>Not to exceed 5.0 fps<br>Not to exceed 8.0 fps<br>May exceed 10 fps |

*Table 4: CVWD Fire Flow Requirements*

| Structure | Flow (gpm) | Duration (hours) |
|---|---|---|
| Very Low and Low Density Residential | 1,250 | 2 |
| Medium Density Residential | 1,500 | 2 |
| High and Very High Density Residential | 2,500 | 3 |
| Commercial | 3,500 | 4 |
| Schools | 4,000 | 4 |

Domestic water pipelines are sized to ensure minimum pressures are met throughout the system while providing the required fire flows and adhering to CVWD's system criteria. The minimum pipe size used for the system is 8 inches in diameter.

## Wastewater Generation

For wastewater generation, the Average Day and Peak Hour flow rates were calculated. A sewer model was not provided by CVWD. A conservative peaking factor of 2.5 was assumed for all areas of the project. The Average Day and Peak Hour wastewater generation flows in each area are summarized in Table 5

*Table 5: Priority Development Area Wastewater Generation*

| Planning Area Land Use | Non-Residential (sqft) | Residential Dwelling Units[1] | Average Day Generation* (gpm) | Peak Hour Generation* (gpm)[2] |
|---|---|---|---|---|
| **Central Development Area Total** | | | | |
| Wilson Town Center | 166,116 | 763 | 111 | 277 |
| Wilson Neighborhood | 0 | 1,114 | 155 | 387 |
| Wilson Heights | 0 | 319 | 45 | 111 |
| **West Development Area Total** | | | | |
| College Center | 52,769 | 404 | 58 | 144 |
| Southwest Neighborhood | 683,892 | 479 | 78 | 194 |
| Southwest Infill Neighborhood | 0 | 121 | 30 | 74 |
| Milliken Heights | 0 | 190 | 51 | 127 |
| **East Development Area Total** | | | | |
| Southeast Neighborhood | 61,097 | 350 | 51 | 126 |
| Southeast Infill Neighborhood | 0 | 70 | 18 | 43 |
| **Total for All Areas** | 963,874 | 3,810 | 546 | 1,483 |

* Generation values are based on individual area calculations and rounded up to the nearest whole number.

[1] Lot count from Sargent Town Planning Memo Dated 21 August 2017.

[2] A peaking factor of 2.5 was used for all development areas.

The proposed system was evaluated using velocity and d/D ratio pressure design requirements presented in CVWD's Sewer Master Plan, Chapter 5 These design criteria are summarized in Table 6.

*Table 6: Sewer Main Design Criteria*

| Design Criteria | Requirement |
|---|---|
| Maximum d/D ratio for pipes less than or equal to 12 inches | 0.50 |
| Maximum d/D ration for pipes greater than or equal to 15 inches | 0.75 |
| Minimum Pipe Diameter | 8-inch dia. |
| Gravity Sewer main – Minimum Peak Velocity | 2 ft/sec |
| Gravity Sewer Main – Maximum Velocity | 10 ft/sec |

# IV. Project Domestic Water System Recommendations

## Overview

The overview of the proposed water system for the Development Priority Area is shown in Exhibit 1.

The proposed pipelines for the study area include 8-inch, 10-inch, and 12-inch diameter piping. Pipe sizes and alignments identified in this study are for preliminary planning and estimating only. The proposed pipe sizes are shown in Exhibit 2.

As part of this project, pressure zones 6 and 6C will be connected and supply water to the northern area of the project. A pressure reducing valve station (PRV) will be required to lower the static hydraulic grade line (HGL) of Zone 6 to match Zone 6C. The project area will be included within the HGL range of Zone 6C.

Pressure zones 5 and 5C will also be interconnected in the center of the proposed development. A PRV will not be required for this connection of the two systems, as the HGL of the two zones is similar. Furthermore, built-out scenarios in the District's water model show a connection between these two zones is planned.

Once a detailed site plan is developed, a more refined analysis should be performed to confirm the various elements, including:

- Final elevation and grades;
- Pipe corridors and sizes;
- Final connection points to off-site and on-site distribution piping;
- and Phasing.

The analysis presented in this study assumes a complete project buildout using a public system delivery. The system has been evaluated while operating in the existing CVWD system.

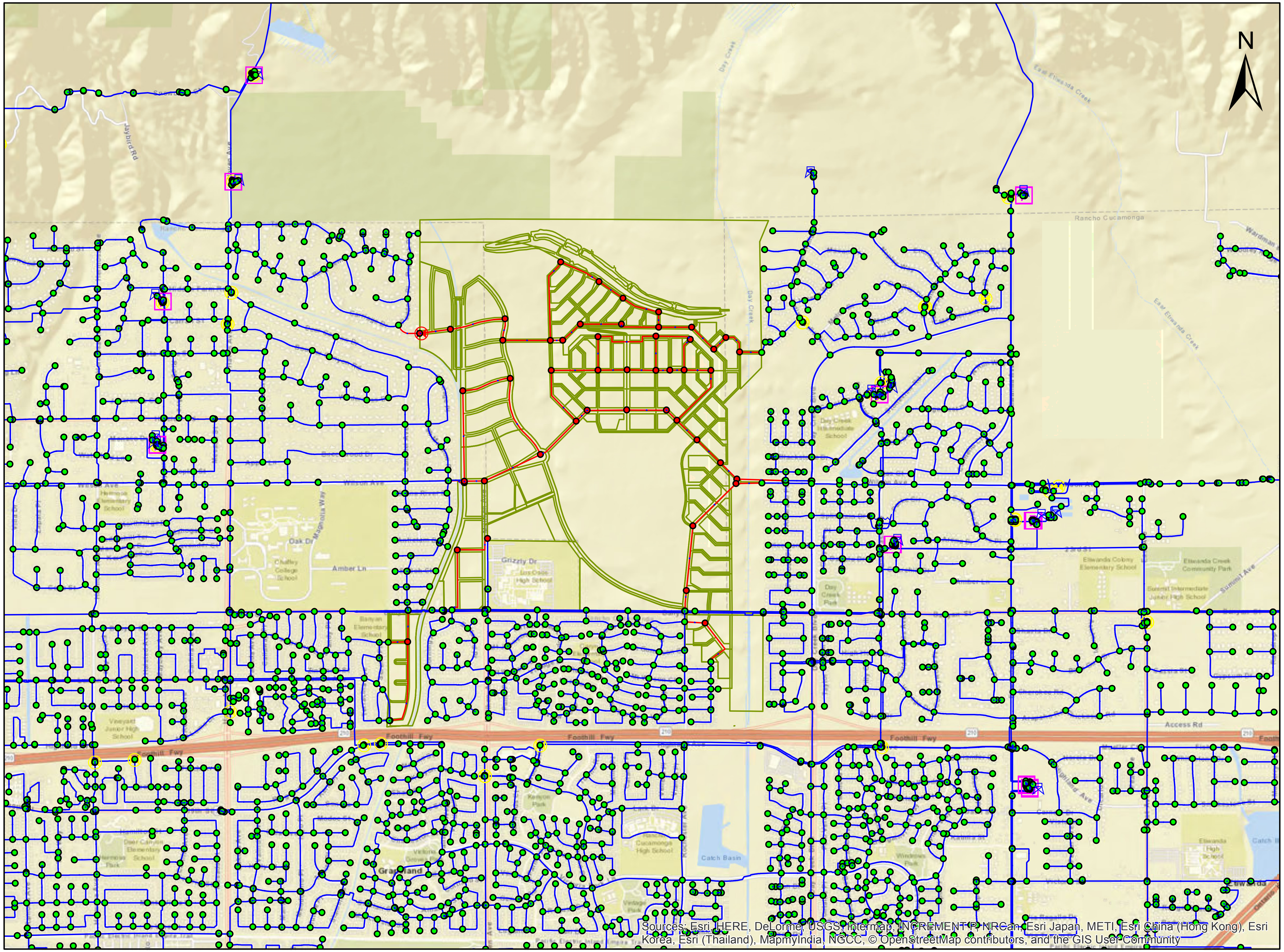
## Impacts to Existing Infrastructure

The proposed improvements appear to have impacts to existing storage tanks 4B-1 and 4B-2, located north of Wilson Avenue on Mayberry Avenue. The tanks and pump station at this facility store water from Zone 4, and pump it to pressure Zone 5. The pump station is controlled by the level of Zone 5 storage tanks.

During peak hour operations, the levels in tanks 4B-1 and 4B-2 are reduced to approximately 5 to 10% full. During fire flow events, the additional demands to the water system appear to impede the ability of Zone 4 to supply sufficient water to fill the reservoirs and the storage in the tanks is depleted.

If additional storage is placed within Zone 4, it appears to further deplete the tank storage as an additional reservoir now "competes" for supply with the existing reservoirs. Additional pumping capacity from Zone 4 also further depletes storage in these tanks, as the pumps are also "competing" with the tanks for water.

This concern will need to be discussed with the Cucamonga Valley Water District. The improvements to the water system will likely be outside the extents of the project, and may have already been addressed in the CVWD Water Master plan. The ability of the tanks to store water appears to decay in the model. The operation of the tanks should be verified with CVWD.




Miles
0 0.225 0.45 0.9 1.35 1.8

# Legend

## Junction

**TYPE**

- Existing System
- Proposed System

## Pipe

**TYPE**

- Existing System
- Proposed System

Exhibit 1

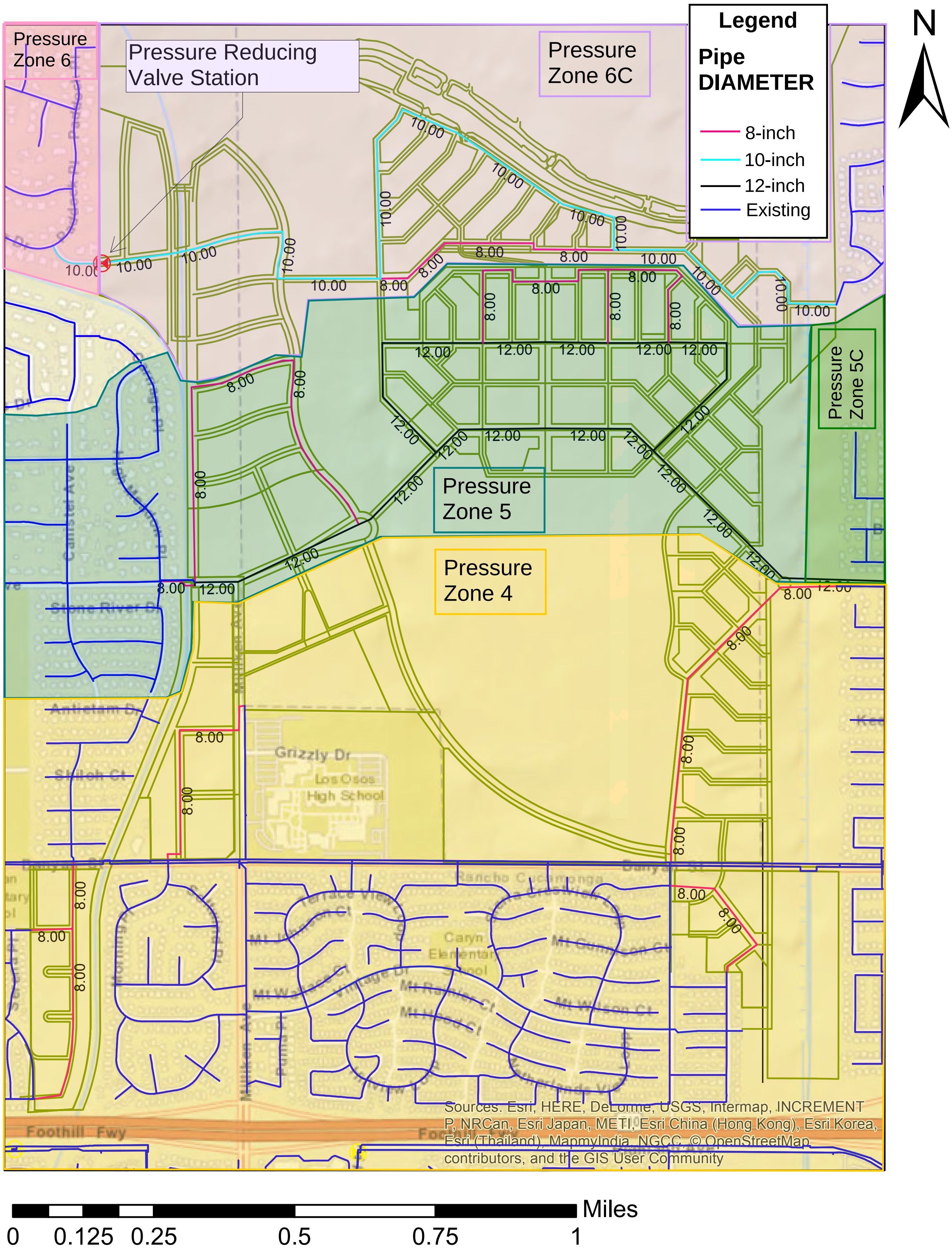

Legend
Pipe DIAMETER
8-inch
10-inch
12-inch
Existing
N
Pressure Zone 6
Pressure Reducing Valve Station
Pressure Zone 6C
Pressure Zone 5
Pressure Zone 5C
Pressure Zone 4
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community
Miles
0
0.125
0.25
0.5
0.75
1

Exhibit 2

The storage capacity of tank 4B-1 in the existing system is shown in Figure 4. The impacts to the tank during a commercial fire flow event at the proposed development (Scenario 7) is shown in Figure 5.

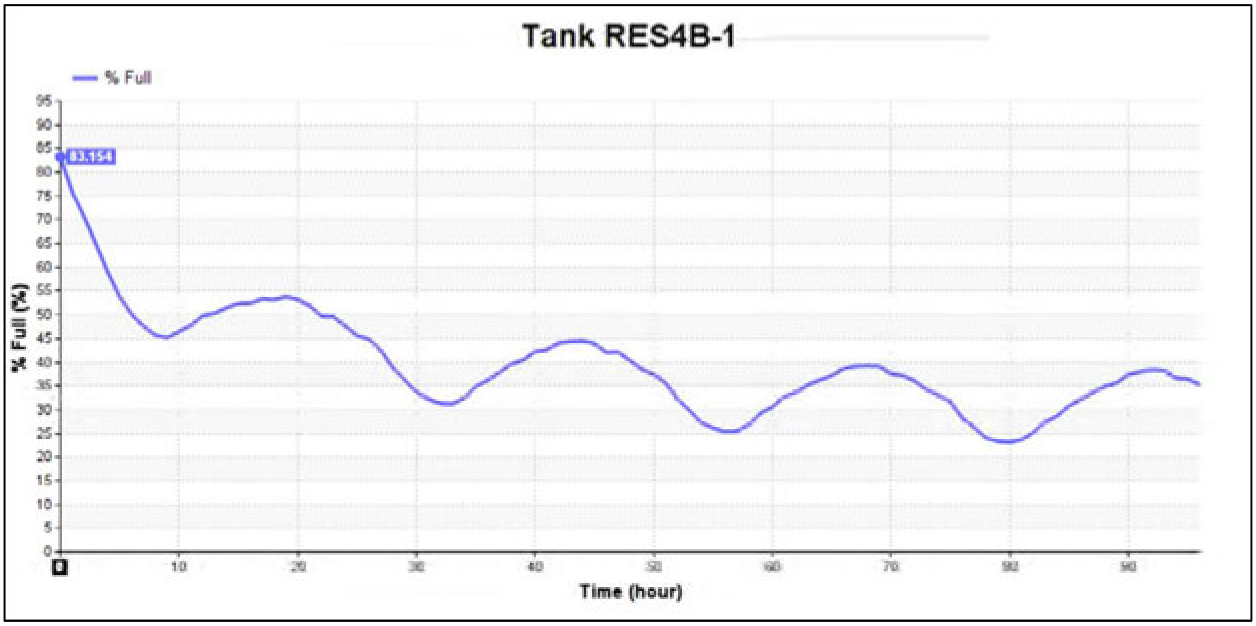



*Figure 4: Storage in Tank 4B-1 - Existing CVWD System without Proposed Improvements*

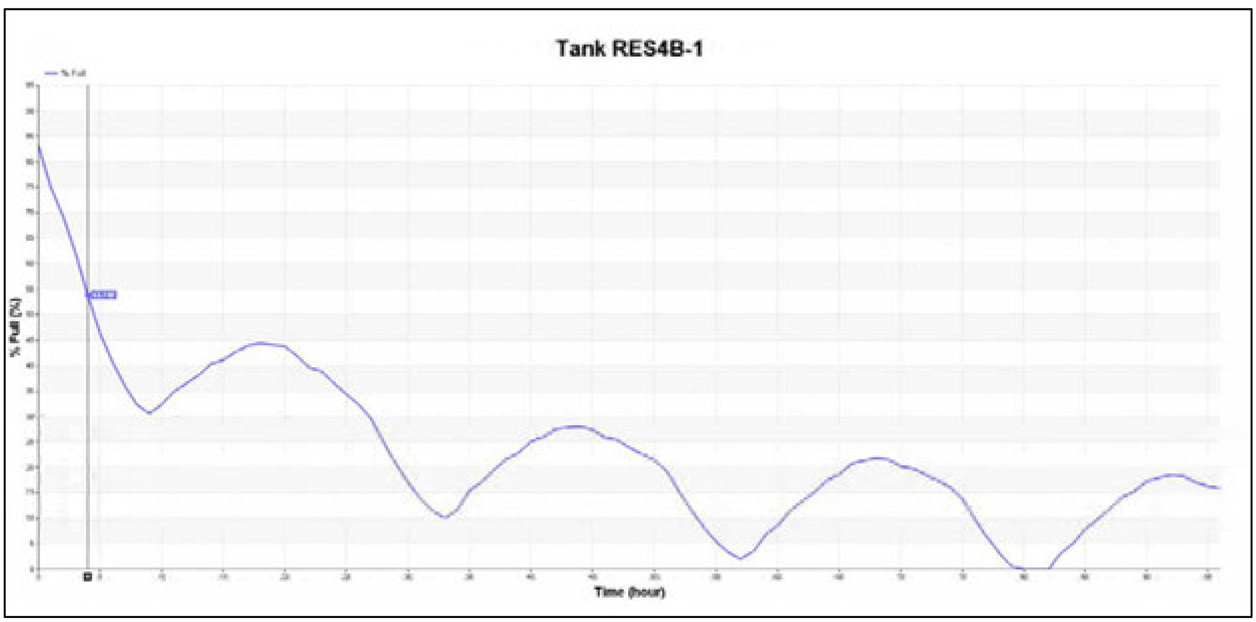



*Figure 5: Storage in Tank 4B-1 with Proposed Improvements and Fire Flow*

# V. Project Domestic Water System Model Results

The domestic water system hydraulic analysis was performed using the CVWD's existing hydraulic water system model. The model was analyzed using Innovyze's InfoWater Software.

The hydraulic model was created using the land use plan and pad elevations in the preliminary design. Junctions were placed at intersections to join two or more pipelines and for applying normal demands and fire flows for various scenario simulations. All pipelines used a Hazen Williams roughness coefficient of 130, which assumes use of PVC pipe and accounting for minor losses.

The Domestic Water System was evaluated using this layout and the following scenarios:

**Scenario 1:** The existing system at Peak Hour under Maximum Day Demand.

**Scenario 2:** The proposed development at Peak Hour under Maximum Day Demand.

**Scenario 3:** The proposed development isolated from Zone 6 at Peak Hour under Maximum Day Demand.

**Scenario 4:** The proposed development isolated from Zone 6C at Peak Hour under Maximum Day Demand.

**Scenario 5:** High Density Residential Fire Flow on Zone 6C in the project area at Peak Hour under Maximum Day Demand

**Scenario 6:** High Density Residential Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand

**Scenario 7:** Commercial Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand

**Scenario 8:** School Fire Flow

**Scenario 9:** Medium Density Fire Flow on Zone 5 in the southeast project area at Peak Hour under Maximum Day Demand

**Scenario 10:** Medium Density Fire Flow on Zone 5 in the southwest project area at Peak Hour under Maximum Day Demand

**Scenario 11:** Low Density Residential Fire Flows in the infill areas.

All scenarios were evaluated using the maximum day demand multiplier and demand patterns included with the CVWD model, and evaluated using a 96-hour extended period simulation. Each Scenario was primarily evaluated at Hour 4, where the Zone 4, 5, and 6 are experiencing 98% of the peak flow for those zones, and Zone 3 is experiencing a significantly larger peak flow.

The storage in the existing system reservoirs near the project area was reviewed during the analysis. An extended period simulation was ran for 96 hours with a 1 hour time step. The reservoirs were monitored for the percent full level in the tank. The reservoirs (tanks) included were:

- Reservoir 4B-1
- Reservoir 4B-2
- Reservoir 4C-1
- Reservoir 4C-2
- Reservoir 5B
- Reservoir 5C
- Reservoir 6B
- Reservoir 6C

The reservoir levels were plotted at percent full vs. time for the entire simulation. It is important to note that during the 96-hour extended period simulation, the fire flow demand is repeated by the modelling software during each 25-hour interval. The tank was considered to be sufficient if the storage capacity remained above 30% during the simulation. The reservoir level plots are provided in Appendix A. The water system model output data is provided in Appendix B.

### Scenario 1: Existing System: Maximum Day Demand at Peak Hour (Exhibit 3)

Scenario 1 runs the existing system model without changes, modifications, or additions as a datum point to build the proposed development system from.

The velocity and pressures in the existing system under Maximum Day Demand at Peak Hour is shown in Exhibit 3. Based on the results of the CVWD's existing model, the pressures in the vicinity of the project are typically within the range of 40 to 150 psi. The pipeline velocities are less than 5 feet per second. A few localized nodes appear to have pressures in excess of 150 psi. Pressures less than 20 psi were only observed at pump station facilities and not at system demand nodes.

The tank levels in the system appear to be adequate. However, Tanks 4B-1 and 4B-2 appear to decay over the 96-hour simulation. The low level in Tank 4B-1 is less than tan 25% full, and the low level in Tank 4B-2 is less than 30% full.

### Scenario 2: The proposed development at Peak Hour under Maximum Day Demand (Exhibit 4)

Scenario 2 runs the modified model that includes the proposed system improvements as shown in Exhibit 2. The scenario was run under Maximum Day Demand at Peak Hour. Fire flow was not included in this Scenario.

The velocity and pressures in the proposed system under Maximum Day Demand at Peak Hour is shown in Exhibit 4. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are within the range of 40 to 150 psi, meeting the pressure requirements. The pipeline velocities are less than 5 feet per second, meeting the velocity requirements.

Tank 4B-1 drops to approximately 10% of the full storage volume during peak hour demands. Tank 4B-2 drops to approximately 15% of the full storage volume during peak hour demands.

### Scenario 3: The proposed development isolated from Zone 6 at Peak Hour under Maximum Day Demand. (Exhibit 5)

Scenario 3 runs the modified model from Scenario 2 with the PRV station closed, isolating the proposed development from Zone 6. The intent of this scenario is to demonstrate that the connection to Zone 6C can supply sufficient flow to meet average day demands in the event the PRV station is offline. The scenario was run under Maximum Day Demand at Peak Hour.

The velocity and pressures in the proposed system under Maximum Day Demand at Peak Hour is shown in Exhibit 5. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are within the range of 40 to 150 psi, meeting the pressure requirements. The pipeline velocities are less than 5 feet per second, meeting the velocity requirements. Normal water supply did not appear to be impacted by isolation from Zone 6.

Tanks 4B-1 and 4B-2 have similar behavior under this scenario. Tank 4B-1 drops to approximately 15% of the full storage volume during peak hour demands. Tank 4B-2 drops to approximately 18% of the full storage volume during peak hour demands.

### Scenario 4: The proposed development isolated from Zone 6C at Peak Hour under Maximum Day Demand. (Exhibit 6)

Scenario 4 runs the modified model from Scenario 2 with the proposed system isolated from Zone 6C. The intent of this scenario is to demonstrate that the connection to Zone 6 can supply sufficient flow to meet average day demands in the event the line from Zone 6C must be shut down. The scenario was run under Maximum Day Demand at Peak Hour.

The velocity and pressures in the proposed system under Maximum Day Demand at Peak Hour is shown in Exhibit 6. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are within the range of 40 to 150 psi, meeting the 20 psi minimum. The pipeline velocities are less than 5 feet per second, meeting the velocity criteria. Normal water supply did not appear to be impacted by isolation from Zone 6C.

The storage volume in tanks 4B-1 and 4B-2 will be depleted during fire flow events in this scenario.

### Scenario 5: High Density Residential Fire Flow on Zone 6C in the project area at Peak Hour under Maximum Day Demand (Exhibit 7)

Scenario 5 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with a high density residential fire flow applied to junction J291. The fire flow scenario places an additional demand of 2,500 gpm for 3 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier.

The velocity and pressures in the proposed system under high density residential fire flow in Zone 6C is shown in Exhibit 7. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 40 psi, meeting the 20 psi minimum. The pipeline velocities are less than 10 feet per second, meeting the velocity criteria.

The storage volume in tanks 4B-1 and 4B-2 will be depleted during fire flow events in this scenario. The volume in tank 6B will be depleted to approximately 22% storage volume.

**Scenario 6: High Density Residential Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 8)**

Scenario 6 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with a high density residential fire flow applied to junction J331. The fire flow scenario places an additional demand of 2,500 gpm for 3 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier.

The velocity and pressures in the proposed system under high density residential fire flow in Zone 5 is shown in Exhibit 8. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 40 psi, meeting the 20 psi minimum. The pipeline velocities are less than 10 feet per second, meeting the velocity criteria.

Tank 4B-1 drops to approximately 3% of the full storage volume during peak hour demands. Tank 4B-2 drops to approximately 7% of the full storage volume during peak hour demands.

**Scenario 7: Commercial Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 9)**

Scenario 7 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with a commercial fire flow applied to junction J323. The fire flow scenario places an additional demand of 3,500 gpm for 4 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier.

The velocity and pressures in the proposed system under high density residential fire flow in Zone 5 is shown in Exhibit 9. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 20 psi, meeting the 20 psi minimum. The pipeline velocities are less than 10 feet per second, meeting the velocity criteria.

The storage volume in tanks 4B-1 and 4B-2 will be depleted during fire flow events in this scenario.

**Scenario 8: School Fire Flow on Zone 4 in area at Peak Hour under Maximum Day Demand (Exhibit 10)**

Scenario 8 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with a school fire flow applied to junction J10874. The fire flow scenario places an additional demand of 4,000 gpm for 4 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier. The node where the fire flow applied is in the existing system, located at the northwest corner of the existing Los Osos High School.

The velocity and pressures in the proposed system under school fire flow in Zone 5 is shown in Exhibit 10. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 40 psi, meeting the 20 psi minimum. The pipeline velocities are less than 5 feet per second, meeting the velocity criteria.

The storage volume in tanks 4B-1 and 4B-2 will be depleted during fire flow events in this scenario.

**Scenario 9: Medium Density Fire Flow on Zone 5 in the Southeast Area at Peak Hour under Maximum Day Demand (Exhibit 11)**

Scenario 9 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with a medium density residential fire flow applied to junction J307. The fire flow scenario places an additional demand of 1,500 gpm for 3 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier.

The velocity and pressures in the proposed system under medium density fire flow in Zone 5 is shown in Exhibit 11. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 40 psi, meeting the 20 psi minimum. The pipeline velocities are less than 10 feet per second, meeting the velocity criteria.

Tank 4B-1 drops to approximately 10% of the full storage volume during peak hour demands. Tank 4B-2 drops to approximately 15% of the full storage volume during peak hour demands.

**Scenario 10: Medium Density Fire Flow on Zone 5 in the West Area at Peak Hour under Maximum Day Demand (Exhibit 12)**

Scenario 10 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with a medium density residential fire flow applied to junction J267. The fire flow scenario places an additional demand of 1,500 gpm for 3 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier.

The velocity and pressures in the proposed system under medium density fire flow in Zone 5 is shown in Exhibit 12. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 40 psi, meeting the 20 psi minimum. The pipeline velocities are less than 10 feet per second, meeting the velocity criteria.

Tank 4B-1 drops to approximately 4% of the full storage volume during peak hour demands. Tank 4B-2 drops to approximately 9% of the full storage volume during peak hour demands.

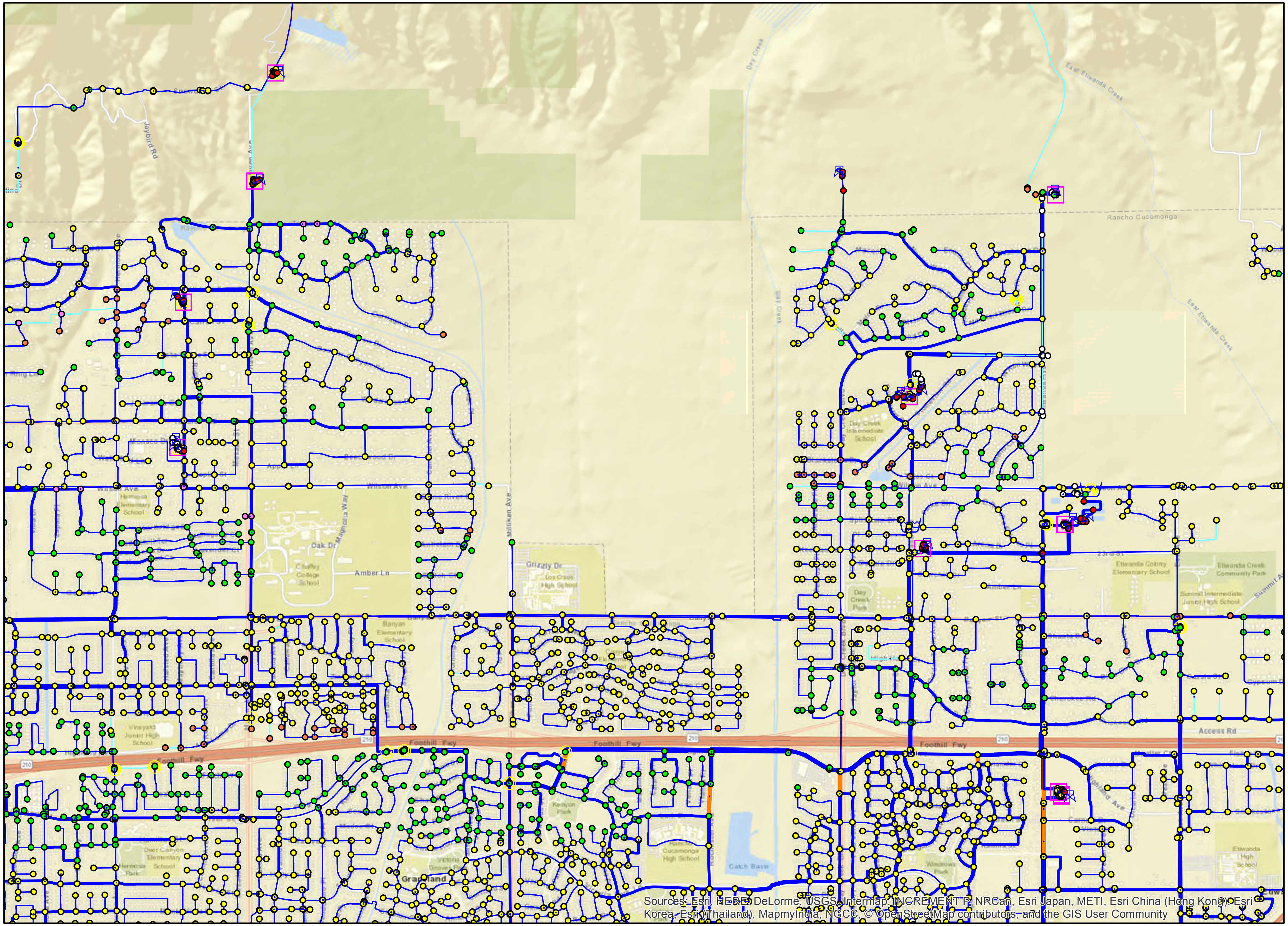
**Scenario 11: Low Density Residential Fire Flow in both Infill Areas; Concurrently (Exhibit 13)**

Scenario 11 runs the modified model that includes the proposed system improvements as shown in Exhibit 2 with low density residential fire flows concurrently applied to both junction J347 and J345. The fire flow scenario places an additional demand of 1,250 gpm for 3 hours, beginning at hour 4. The scenario was run using the Maximum Day Demand multiplier.

The velocity and pressures in the proposed system under low density fire flows in Zone 4 is shown in Exhibit 13. Based on the results of the modelling performed in this analysis, the pressures in the project area and surrounding vicinity are greater than 40 psi, meeting the 20 psi minimum. The pipeline velocities are less than 10 feet per second, meeting the velocity criteria.

Tank 4B-1 drops to approximately 5% of the full storage volume during peak hour demands. Tank 4B-2 drops to approximately 10% of the full storage volume during peak hour demands.

# Scenario 1: Existing System - Maximum Day Demand at Peak Hour




## Legend

### Junction

**PRESSURE**

- Less than 0
- Less than 20
- 20 - 40
- 40 - 80
- 80 - 150
- Above 150

### Pipe

**VELOCITY**

- less than 0.00
- 0.00 ~ 1.00
- 1.00 ~ 3.00
- 3.00 ~ 5.00
- 5.00 ~ 10.00
- 10.00 ~ 100.00

0 0.225 0.45 0.9 1.35 1.8 Miles

Exhibit 3

## Scenario 2: Proposed System - Maximum Day Demand at Peak Hour

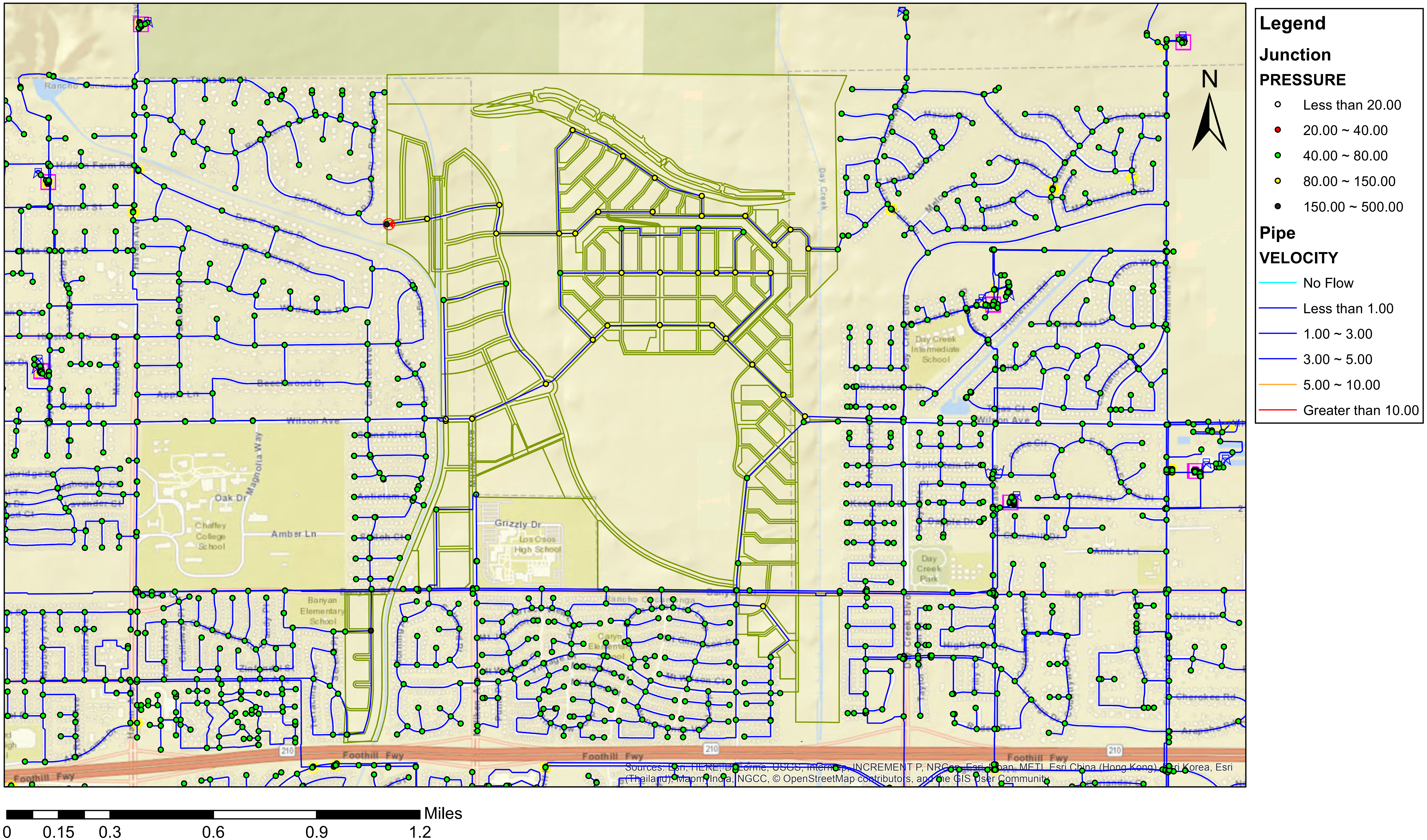
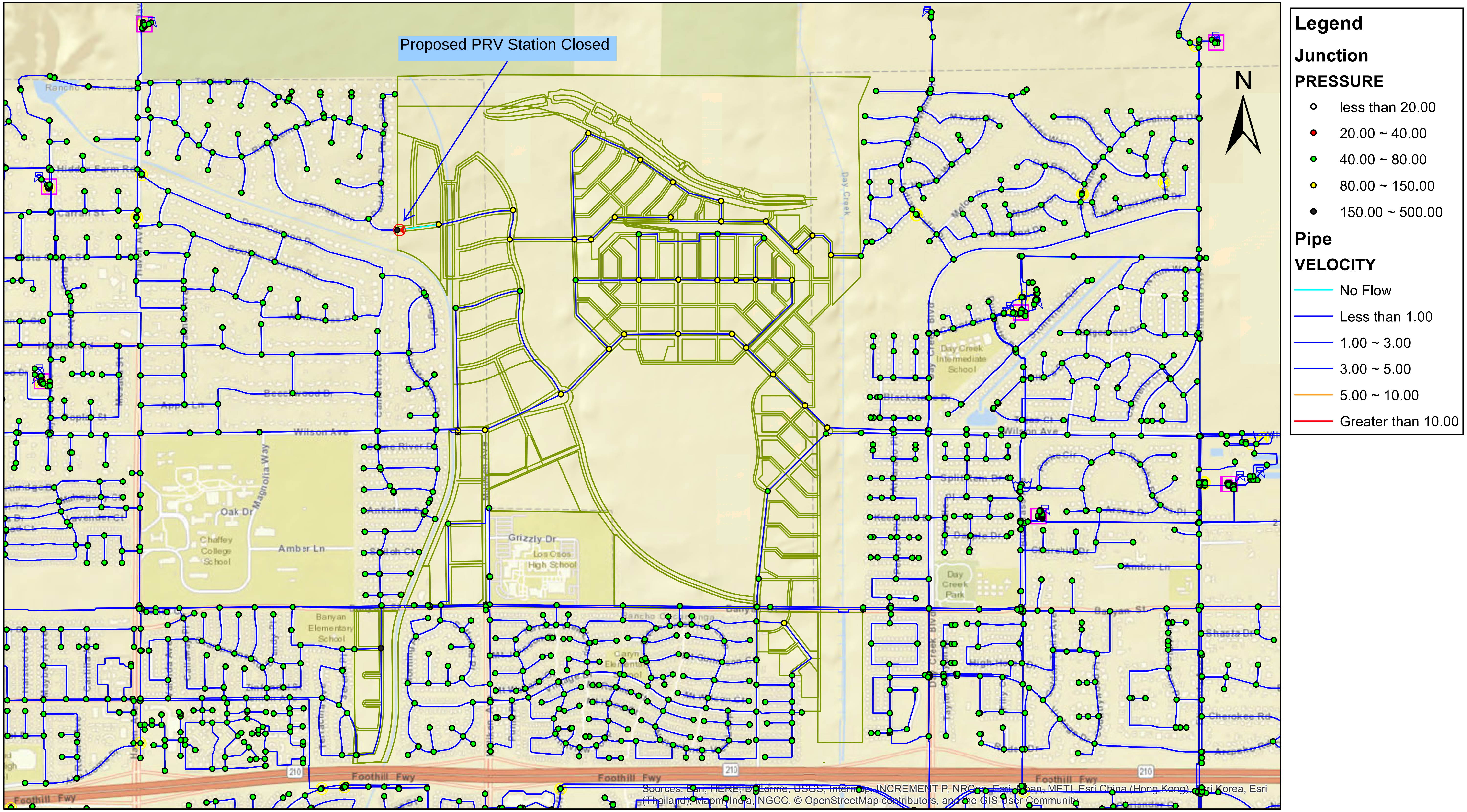



Exhibit 4

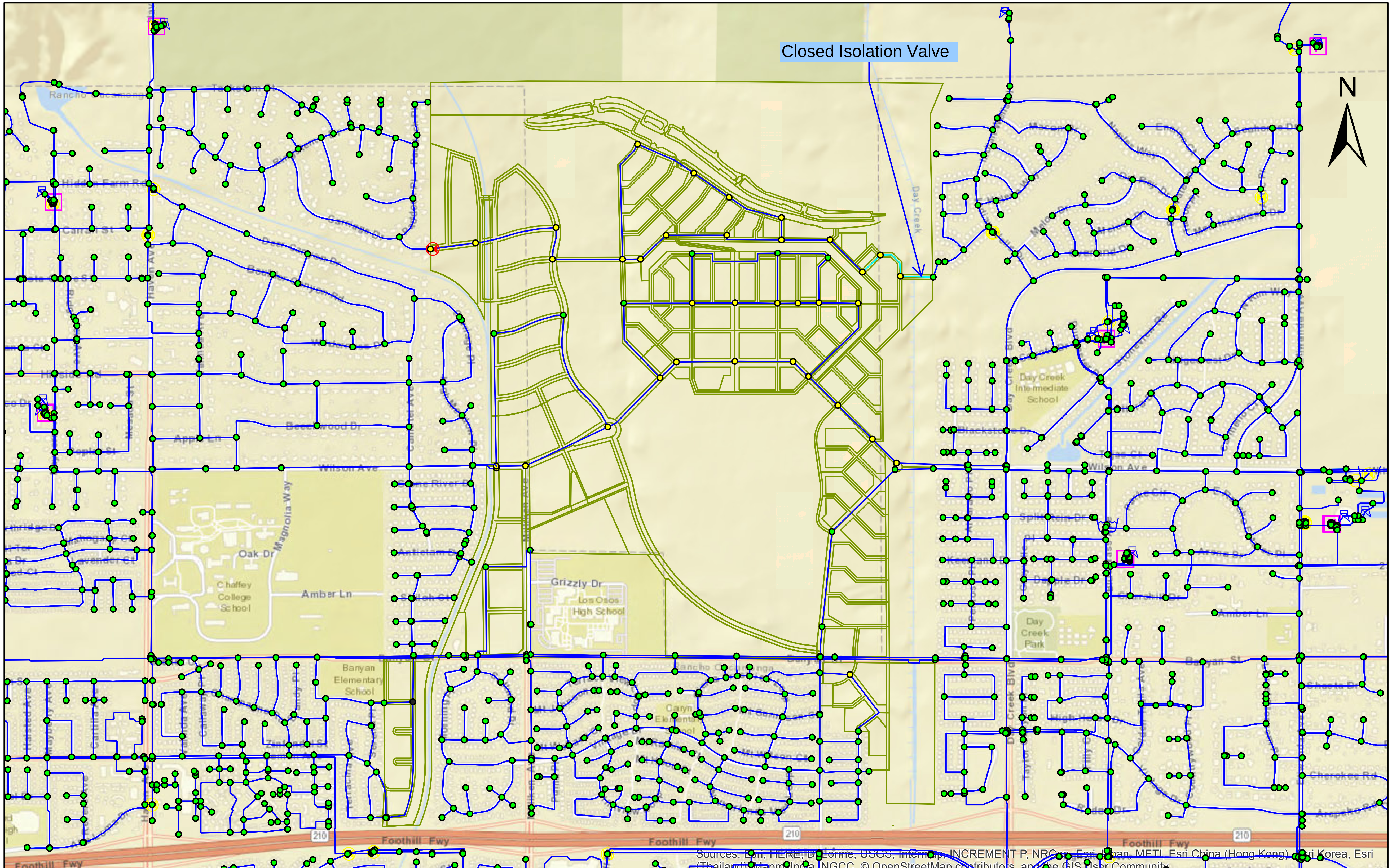
Scenario 3: Proposed System - Maximum Day Demand at Peak Hour; Zone 6 Isolation




Miles
0 0.15 0.3 0.6 0.9 1.2

Exhibit 5

# Scenario 4: Proposed System - Maximum Day Demand at Peak Hour; Zone 6C Isolation




**Legend**

**Junction**

**PRESSURE (PSI)**

- Less than 20.00
- 20.00 ~ 40.00
- 40.00 ~ 80.00
- 80.00 ~ 150.00
- Greater than 150.00

**Pipe**

**VELOCITY (FPS)**

- No Flow
- Less than 1.00
- 1.00 ~ 3.00
- 3.00 ~ 5.00
- 5.00 ~ 10.00
- Greater than 10.00

Miles
0 0.15 0.3 0.6 0.9 1.2

Exhibit 6

# Scenario 5: Proposed System - Maximum Day Demand at Peak Hour; High Density Residential Fire Flow Zone 6C

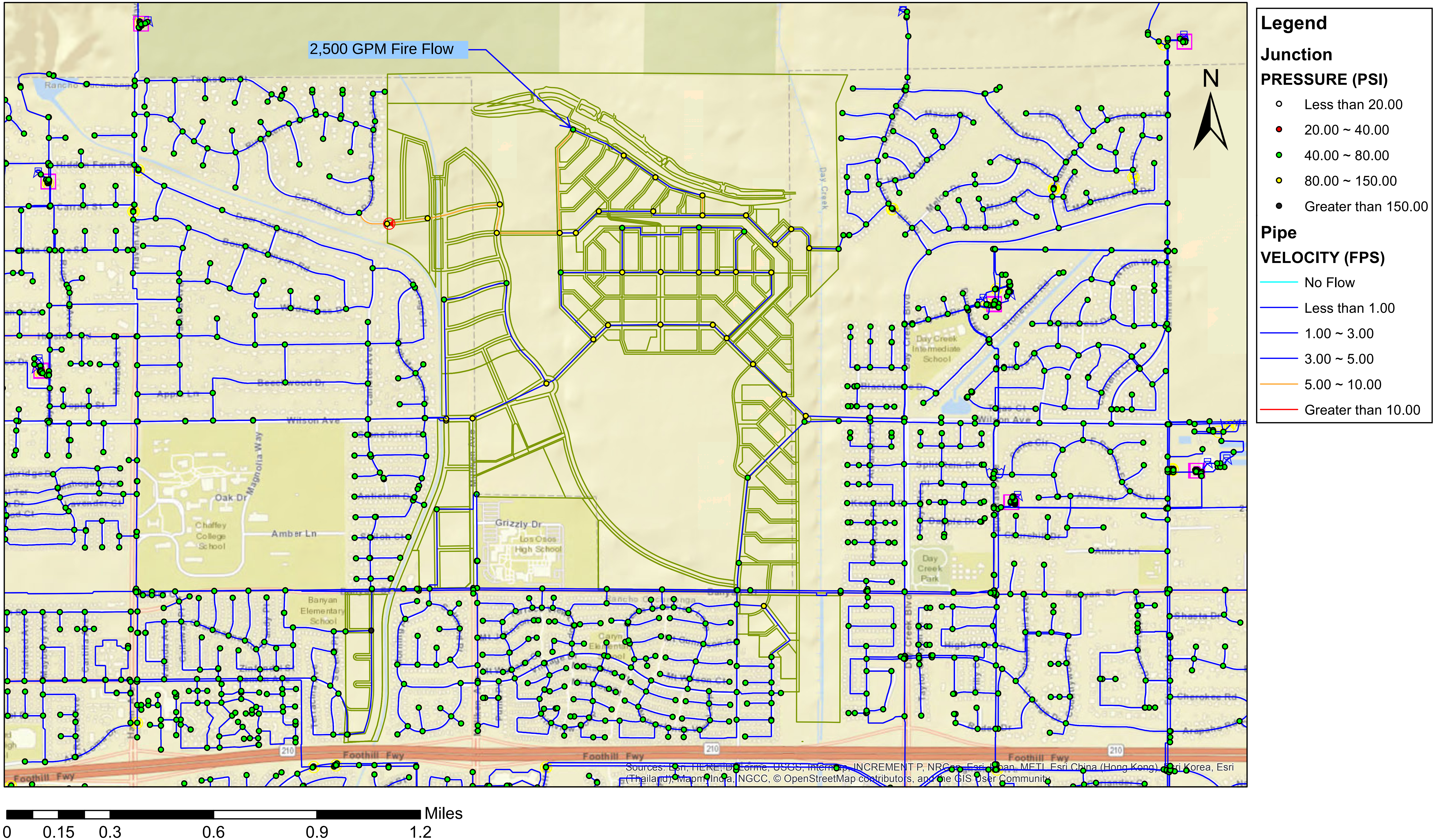
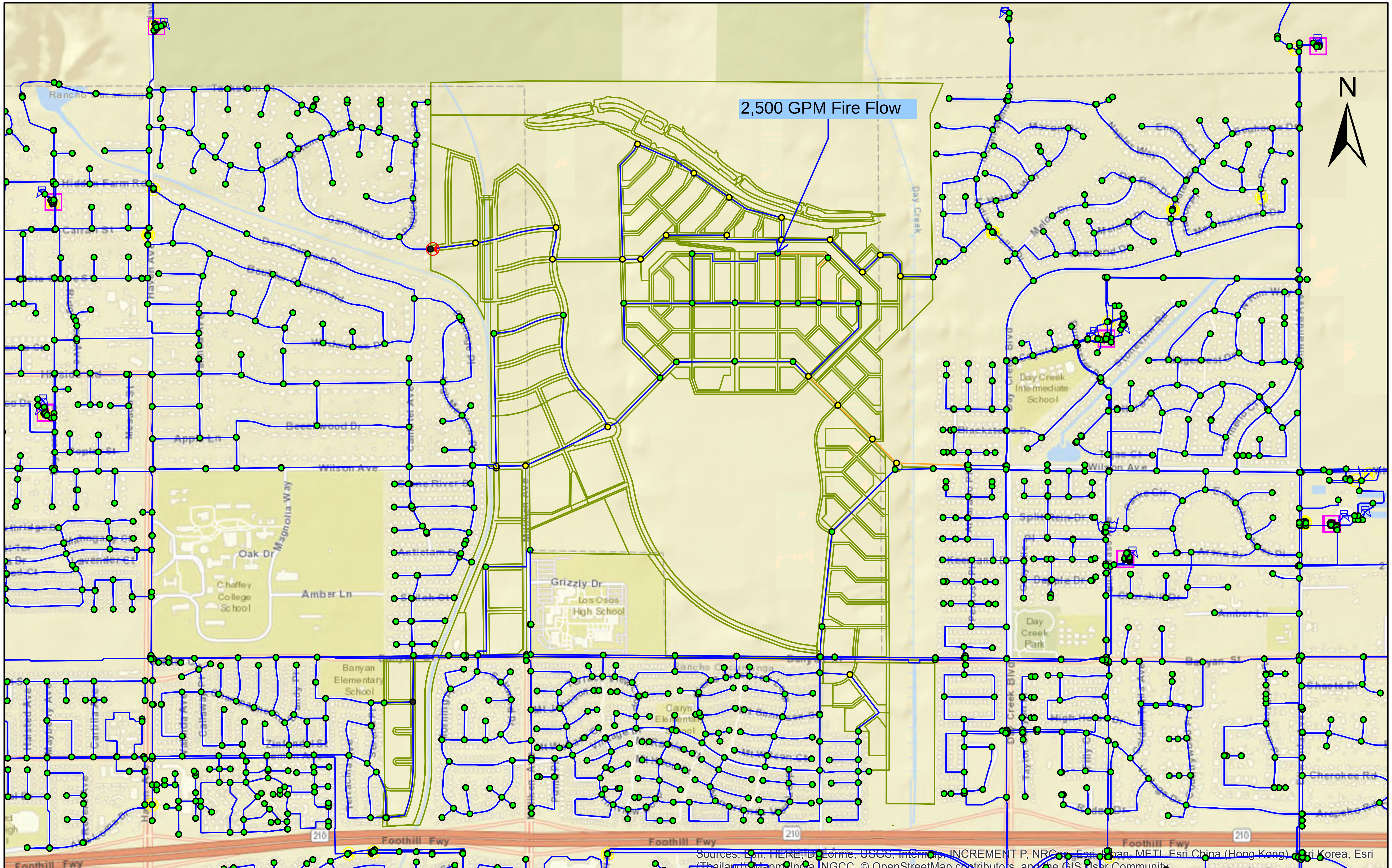



Exhibit 7

## Scenario 6: Proposed System - Maximum Day Demand at Peak Hour; High Density Residential Fire Flow Zone 5




**Legend**

**Junction**

**PRESSURE (PSI)**

- Less than 20.00
- 20.00 ~ 40.00
- 40.00 ~ 80.00
- 80.00 ~ 150.00
- Greater than 150.00

**Pipe**

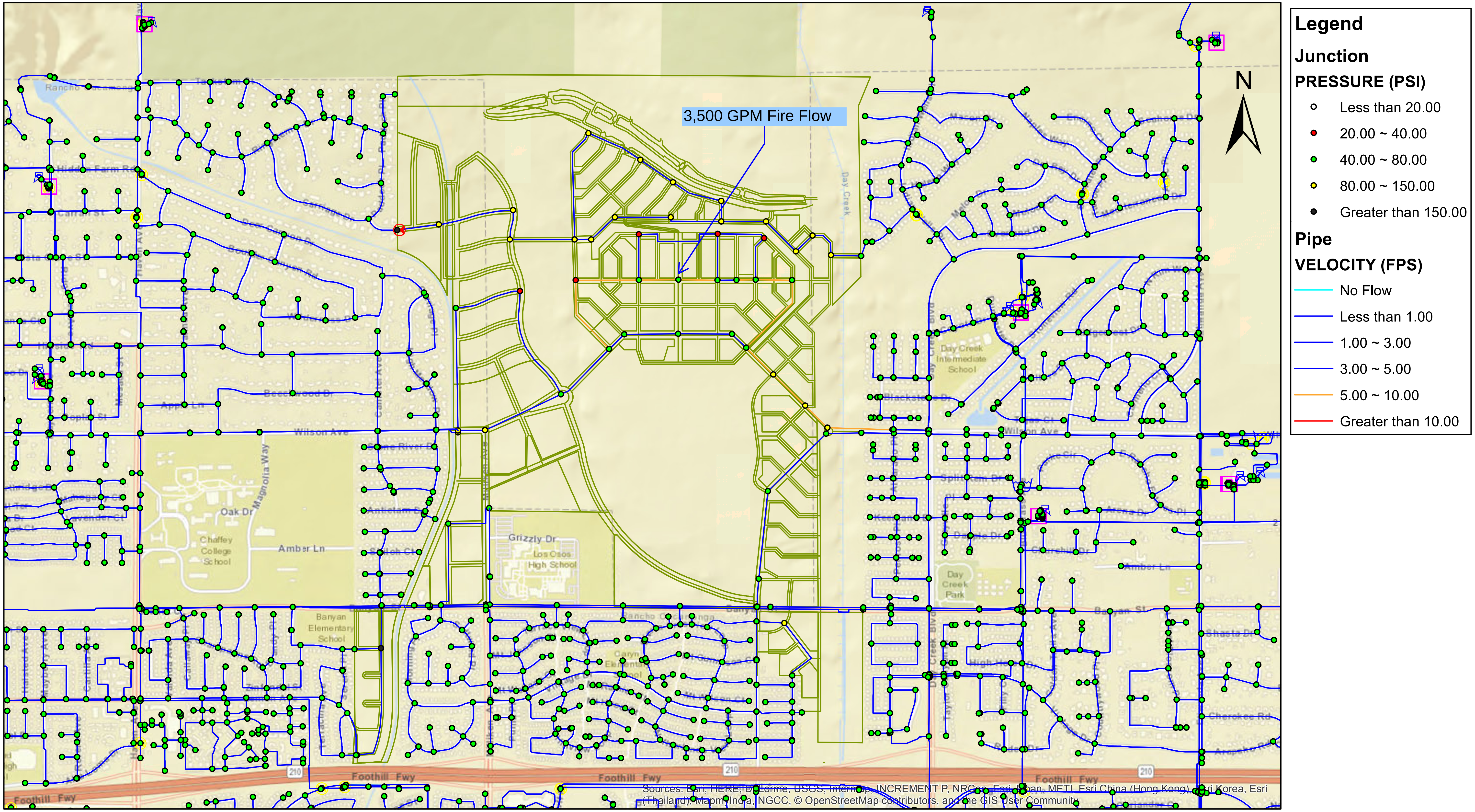
**VELOCITY (FPS)**

- No Flow
- Less than 1.00
- 1.00 ~ 3.00
- 3.00 ~ 5.00
- 5.00 ~ 10.00
- Greater than 10.00

0 0.15 0.3 0.6 0.9 1.2 Miles

Exhibit 8

## Scenario 7: Proposed System - Maximum Day Demand at Peak Hour; Commercial Fire Flow Zone 5



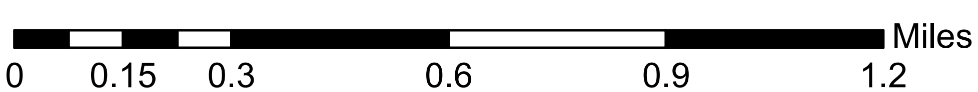




Exhibit 9

# Scenario 8: Proposed System - Maximum Day Demand at Peak Hour; School Fire Flow Zone 4

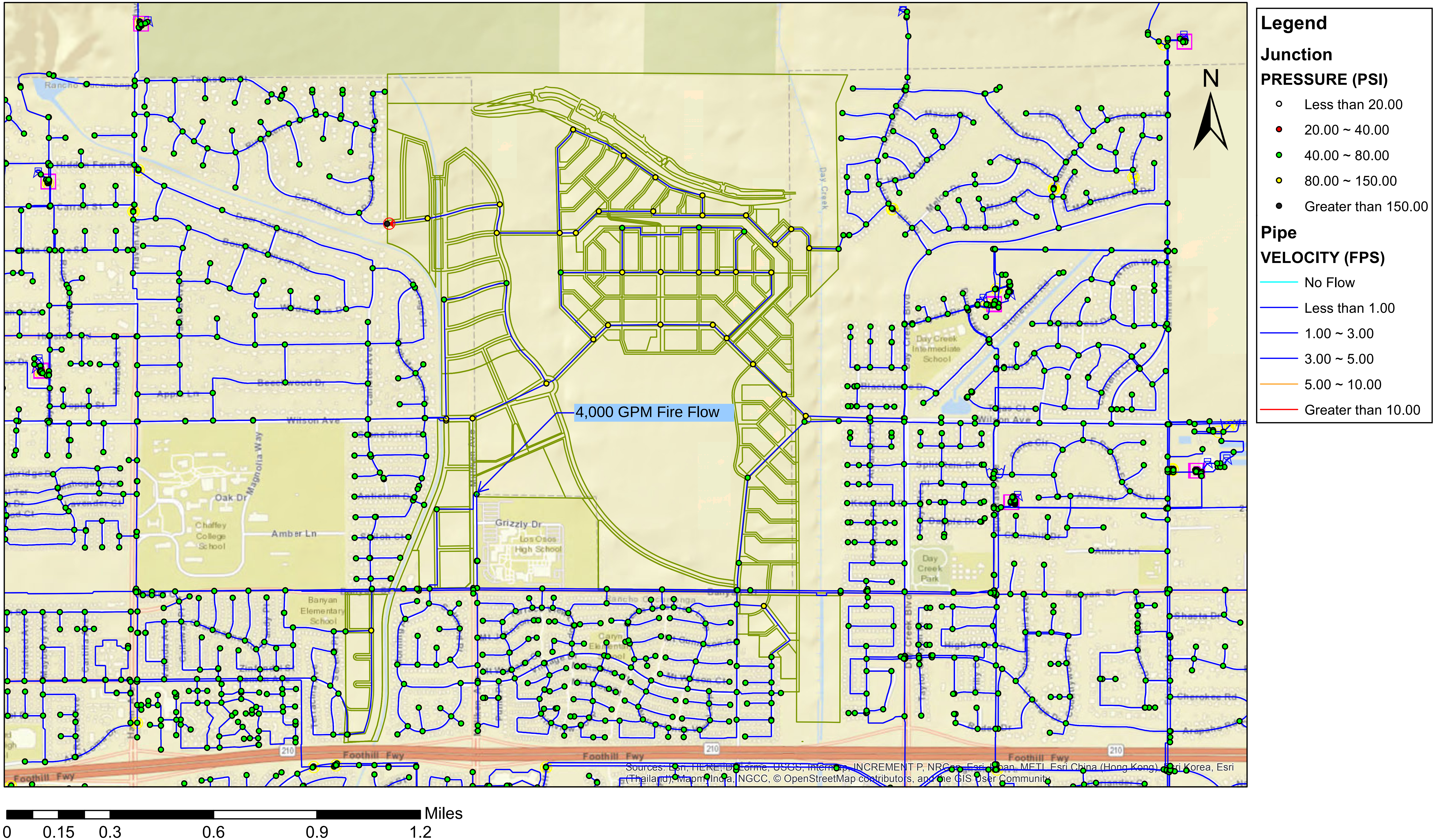
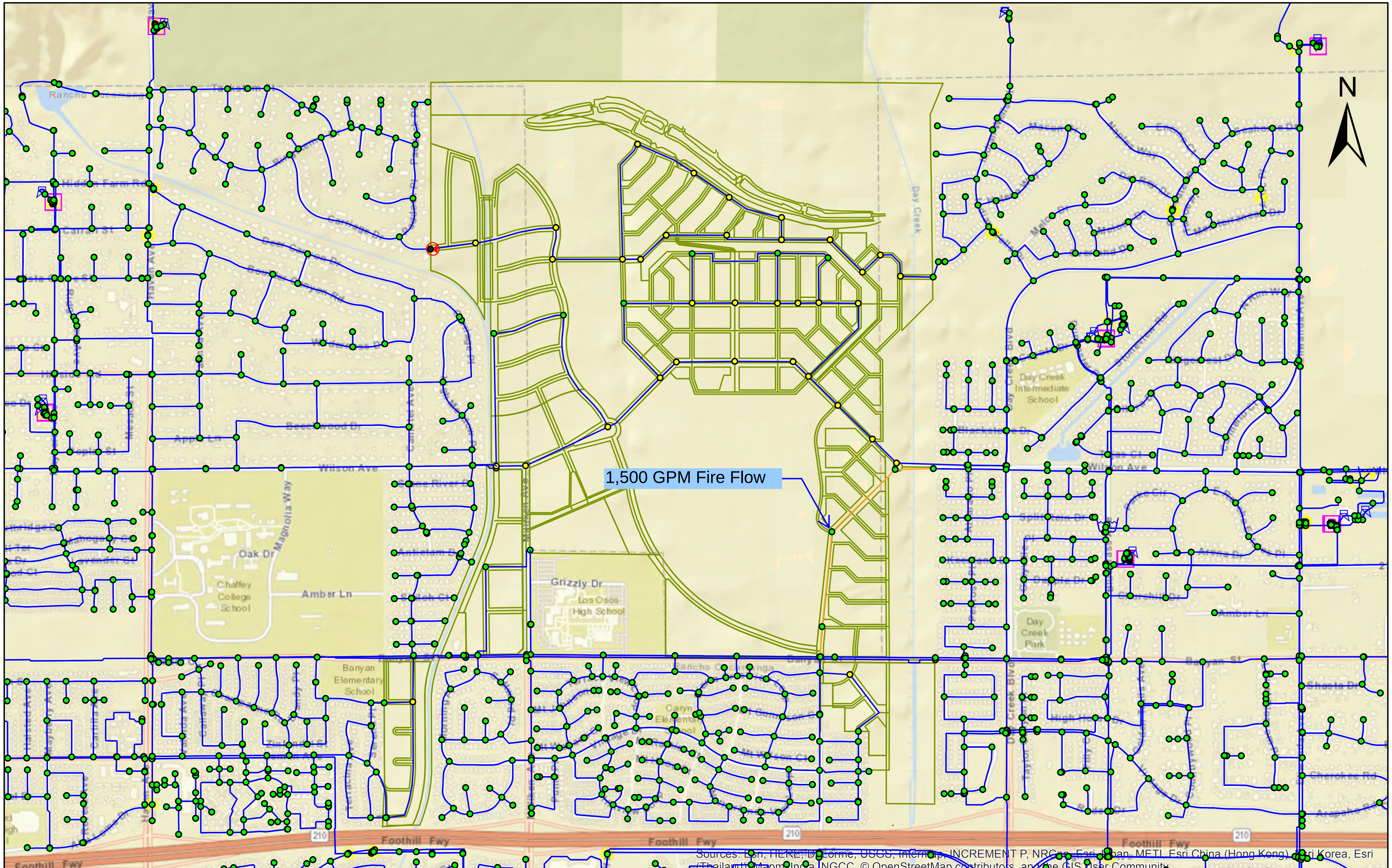



Exhibit 10

# Scenario 9: Proposed System - Maximum Day Demand at Peak Hour; Medium Density Fire Flow Zone 5




**Legend**

**Junction**

**PRESSURE (PSI)**

- Less than 20.00
- 20.00 ~ 40.00
- 40.00 ~ 80.00
- 80.00 ~ 150.00
- Greater than 150.00

**Pipe**

**VELOCITY (FPS)**

- No Flow
- Less than 1.00
- 1.00 ~ 3.00
- 3.00 ~ 5.00
- 5.00 ~ 10.00
- Greater than 10.00

0 0.15 0.3 0.6 0.9 1.2 Miles

Exhibit 11

# Scenario 10: Proposed System - Maximum Day Demand at Peak Hour; Medium Density Fire Flow Zone 5

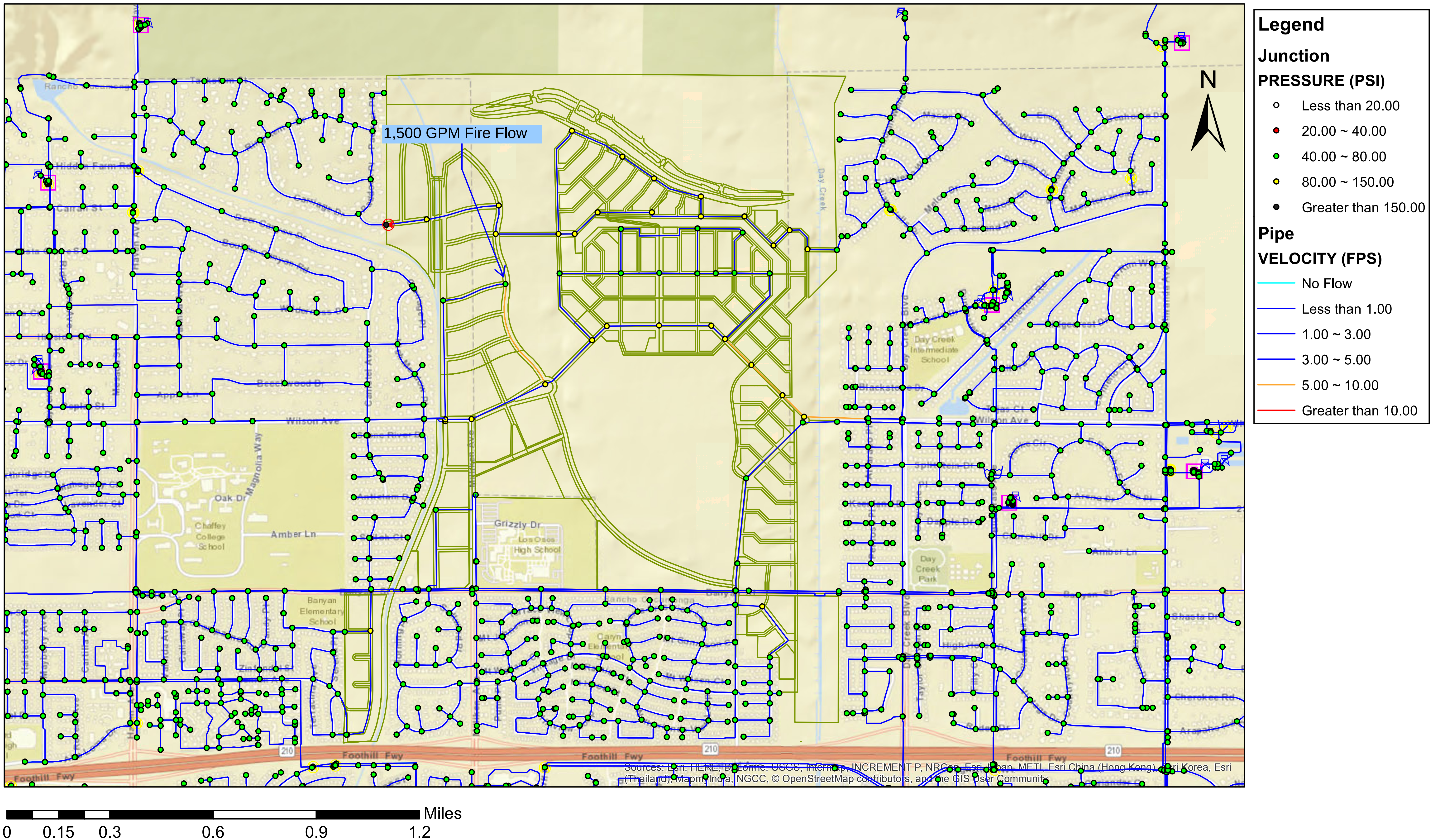
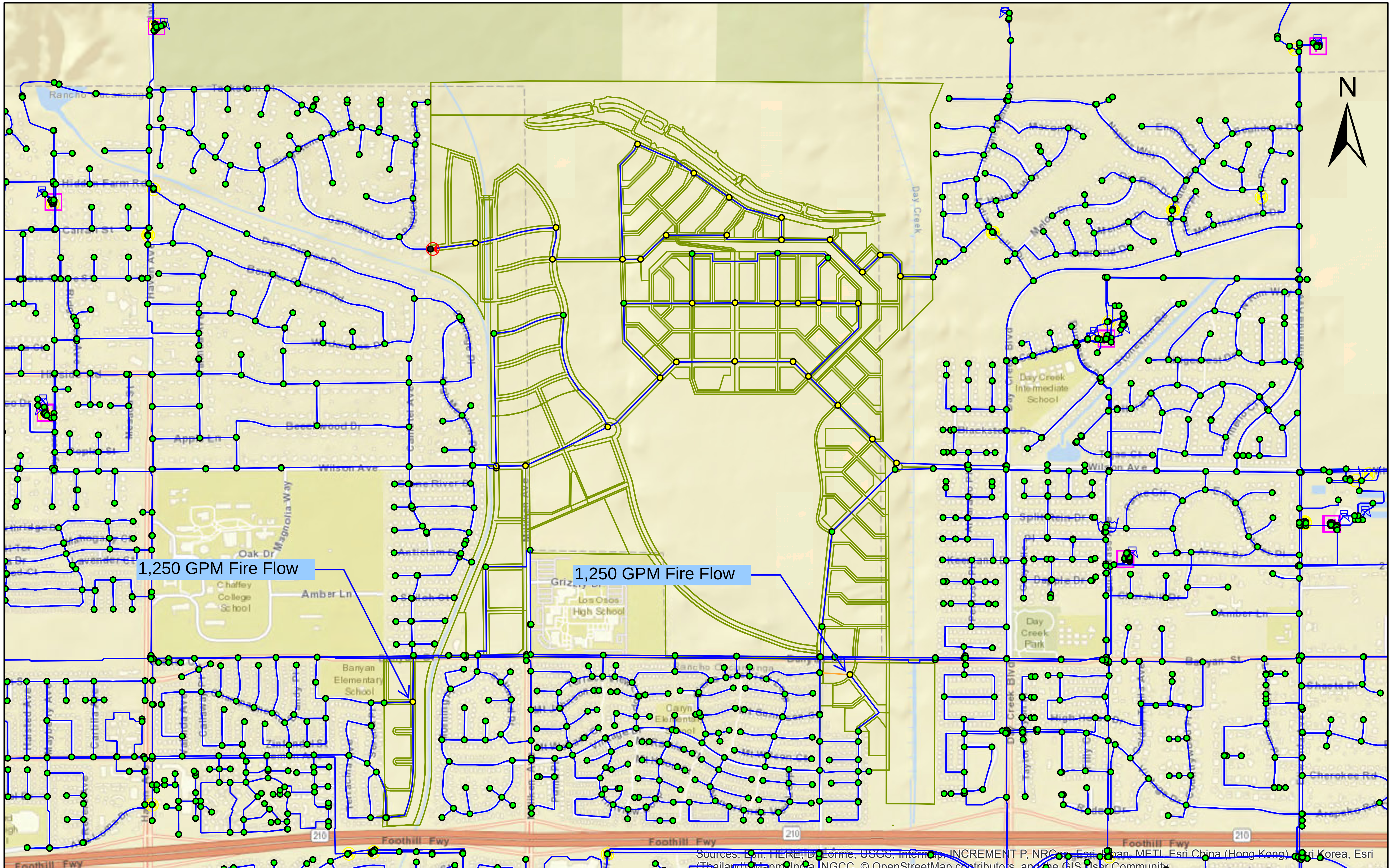



Exhibit 12

## Scenario 11: Proposed System - Maximum Day Demand at Peak Hour; Low Density Fire Flow Zone 4




**Legend**

**Junction**

**PRESSURE (PSI)**

- Less than 20.00
- 20.00 ~ 40.00
- 40.00 ~ 80.00
- 80.00 ~ 150.00
- Greater than 150.00

**Pipe**

**VELOCITY (FPS)**

- No Flow
- Less than 1.00
- 1.00 ~ 3.00
- 3.00 ~ 5.00
- 5.00 ~ 10.00
- Greater than 10.00

Miles
0 0.15 0.3 0.6 0.9 1.2

Exhibit 13

# IV. Project Wastewater System Recommendations

## Overview

The overview of the proposed wastewater system for the Development Priority Area is shown in Exhibit 14.

The proposed gravity sewer lines for the study area include 8-inch, 10-inch, 12-inch, and 15-inch diameter piping. Pipe sizes and alignments identified in this study are for preliminary planning and estimating only. The proposed pipe sizes are shown in Exhibit 2.

The slopes of the wastewater system generally follow the slope of the proposed grades from north to south. Gravity pipelines running east to west were placed at a minimum acceptable slope to account for the relatively flat east-west grades, and to allow crossing of storm water pipelines.

The model developed used an assumed minimum depth of 7-feet for the preliminary sewer system sizing. Deeper installation could be required if detailed design places smaller laterals at a larger depth, or if required to make a connection to the existing system.

Once a detailed site plan is developed, a more refined analysis of the gravity wastewater system should also be performed to confirm the various elements, including:

- Final elevation and grades;
- Final pipe slopes;
- Pipe corridors and sizes;
- Final connection points to off-site and on-site distribution piping;
- Phasing.

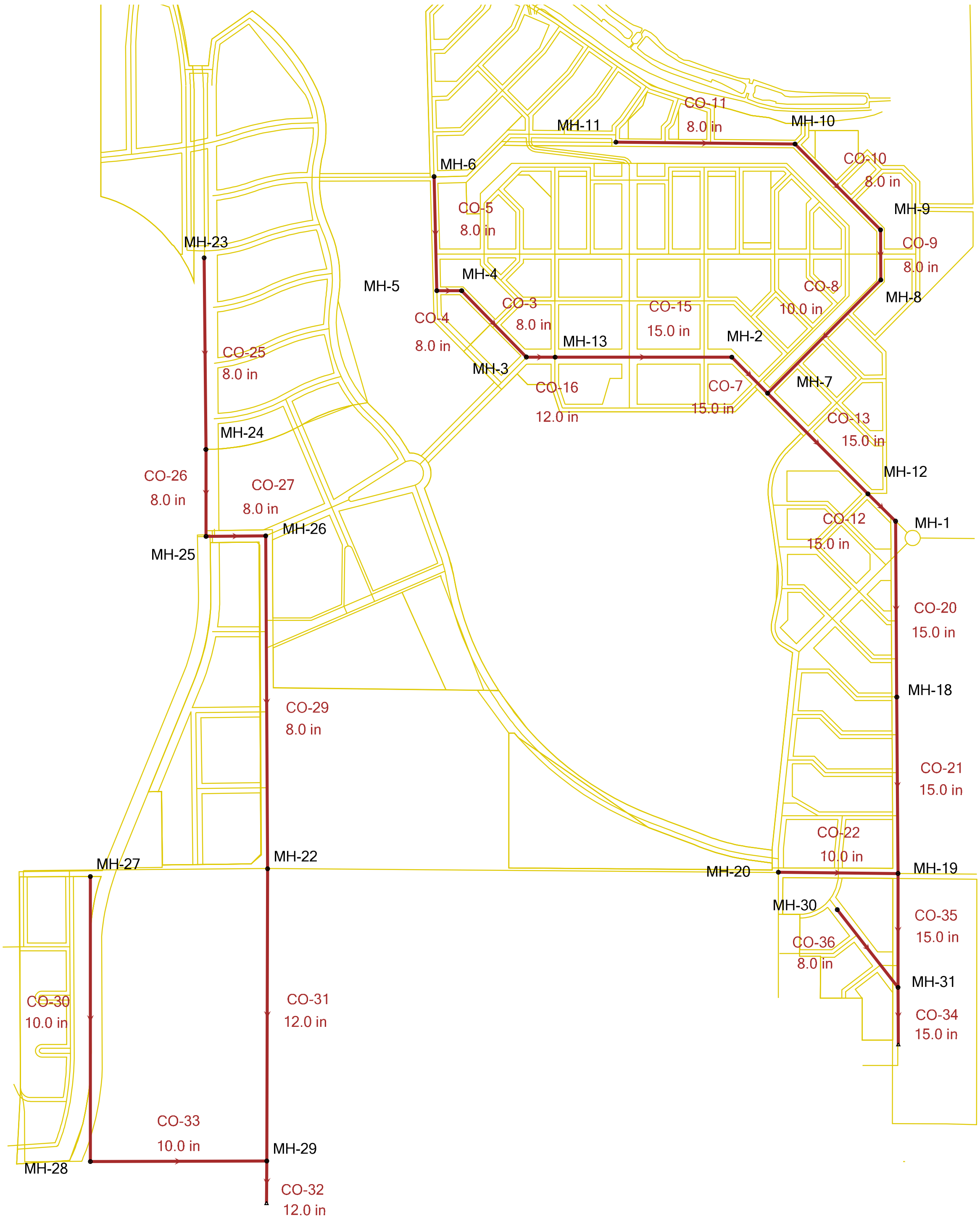
The analysis presented in this study assumes a complete project buildout. CVWD did not provide a model of the existing wastewater collection system. Therefore, the capacity of the existing CVWD system, connection points, and treatment capacity could not be evaluated.

## Impacts to Existing Infrastructure

The closest existing sewer systems occur along the southeastern and southwestern edge of the Project area. To the east, an existing 8-inch sewer line extends north along Day Creek Boulevard and then west towards the project area along Wilson Ave. To the west, an existing 10-inch sewer line extends north along Milliken Avenue to the project area boundary. Based on preliminary analysis, it appears that these existing sewers along the project will not be sufficient to convey the project wastewater flows.

A tie-in location will need to be discussed with the Cucamonga Valley Water District. The use of a lift station could be required if a suitable tie-in location is not within a feasible location for gravity flow.

# Proposed Wastewater System




# Exhibit 14

# V. Project Wastewater System Model Results

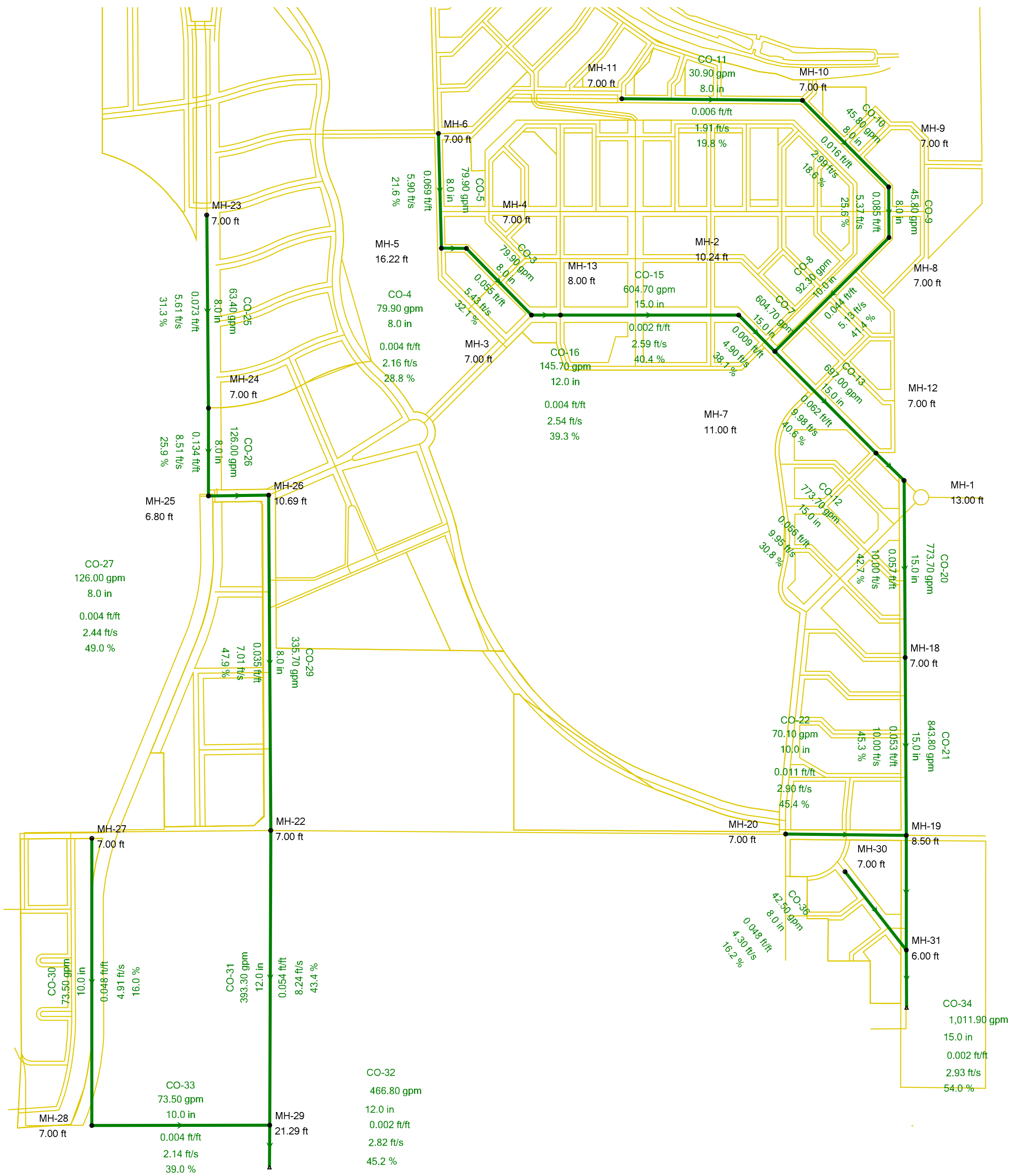
The gravity wastewater collection system analysis was performed using Bently SewerCAD CONNECT Edition, as CVWD's sewer model was not provided for our use. Elevations were based on preliminary grading plans.

Manholes were placed at intersections to join two or more pipelines, at changes in direction, and at collection locations. Intermediate manholes were not included in this preliminary analysis. The wastewater system was evaluated using peak flow conditions. Gravity flow calculations were computed by the software using Manning's formula using default values for PVC pipe and an "n value" of 0.010. This "n-value" is a conservative value that accounts for pipelines ageing and pitting over time.

The final discharge flows were determined to be 1,011.9 gpm on the eastern side of the project and 466.80 on the western side of the project, for a total of 1,478.7 gpm during peak flow. The layout shown in Exhibit 15 shows the approximate discharge location and amount of flow. The final locations can be adjusted based on the location of existing wastewater infrastructure. However, changing he location is not expected to have significant impacts on the pipe sizes within the project area.

The model output data is provided in Appendix C.

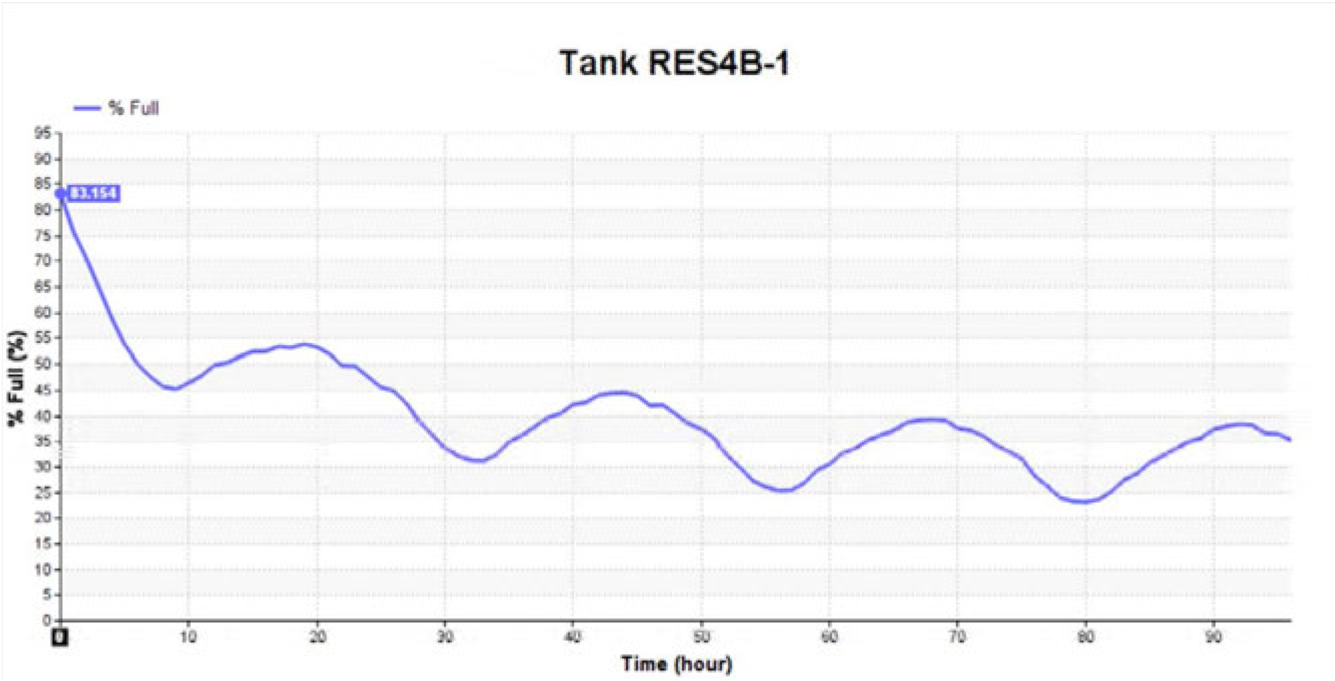
# Proposed Wastewater System
# Layout and Details

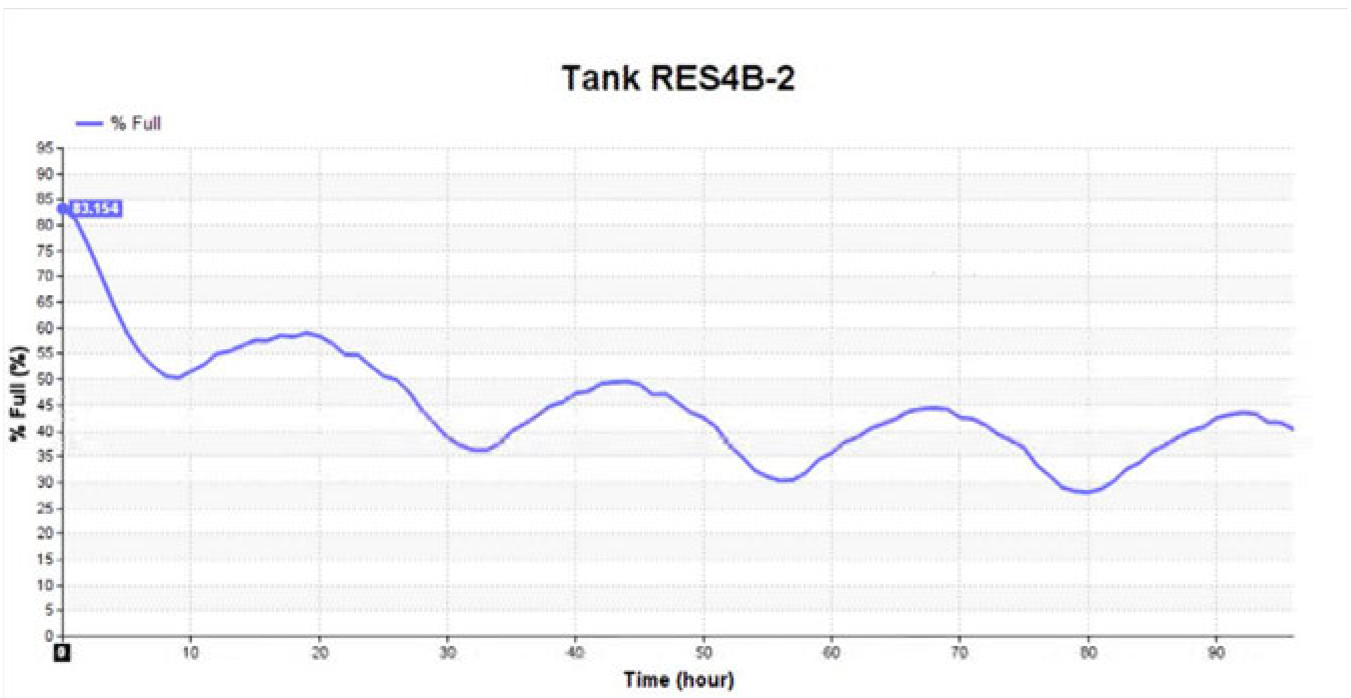



# Exhibit 15

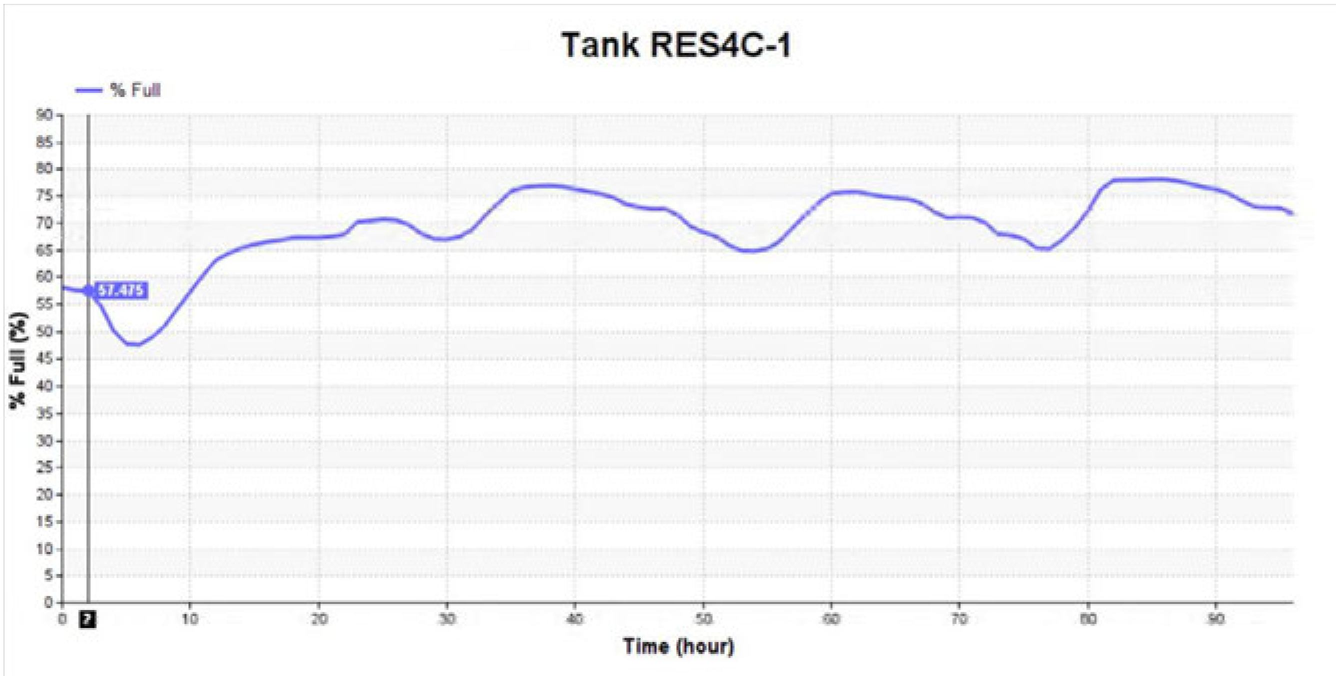
# Appendix A – Reservoir Level Charts

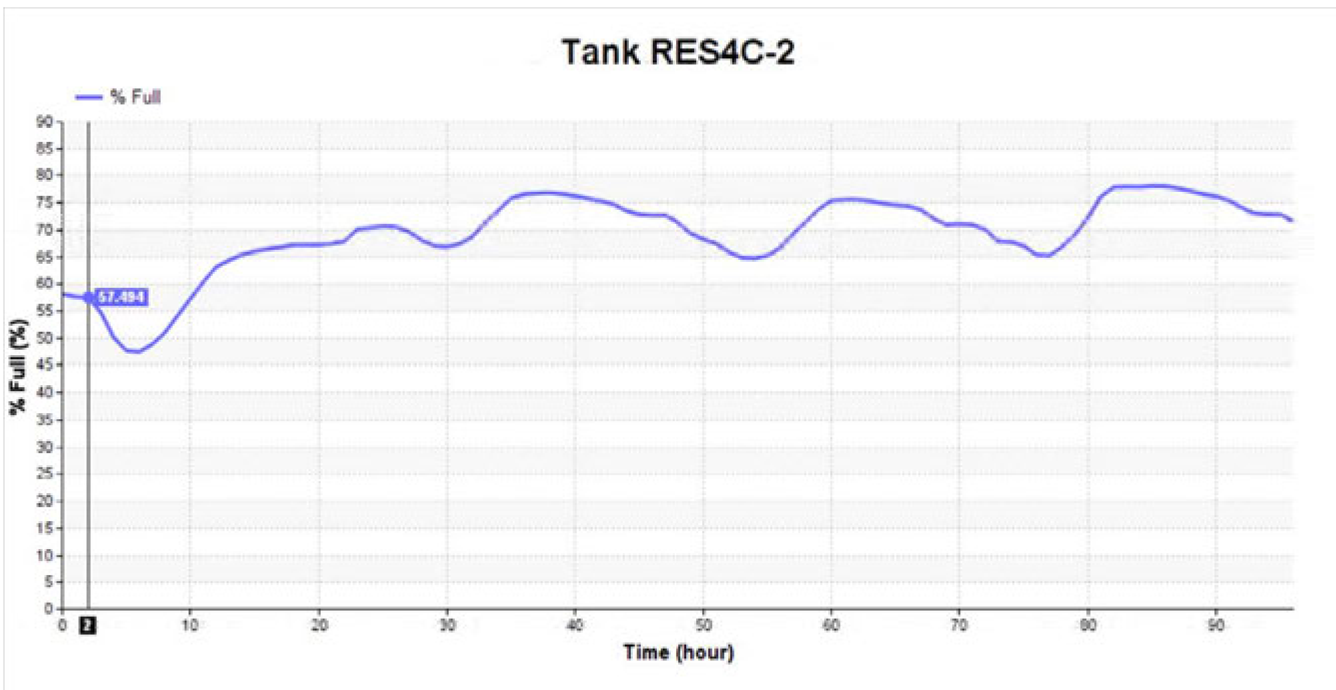
**Scenario 1: Existing System: Maximum Day Demand at Peak Hour (Exhibit 3)**



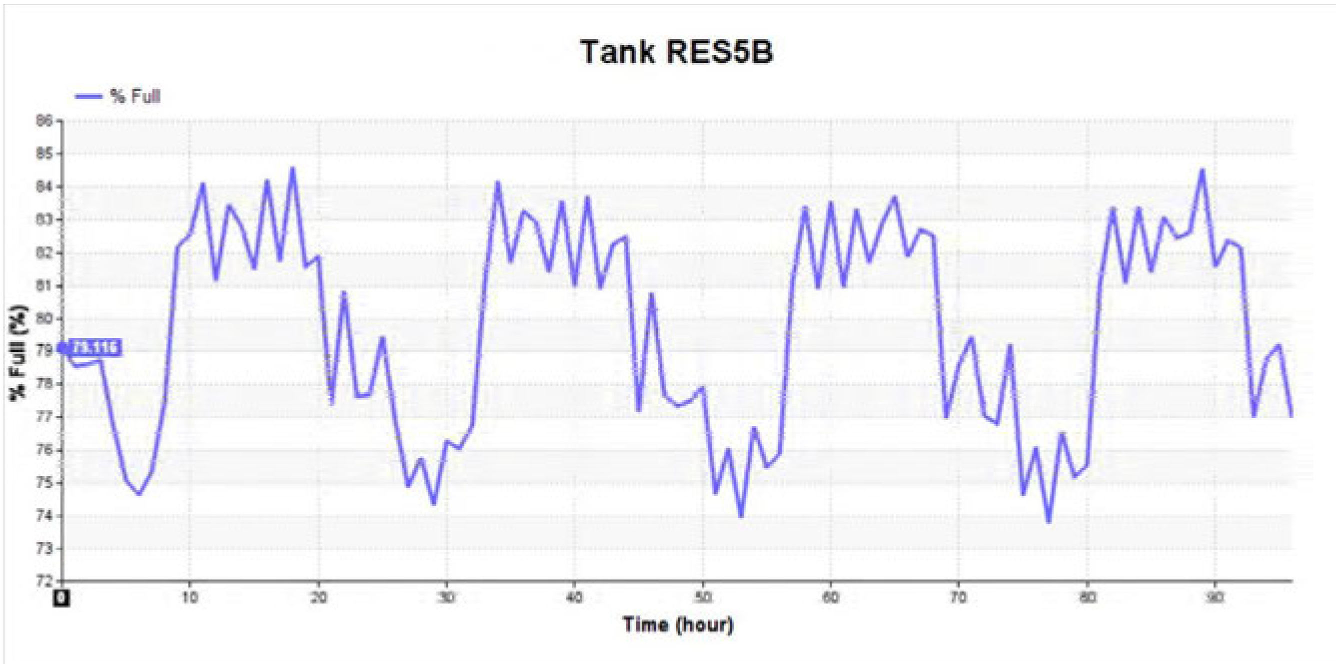



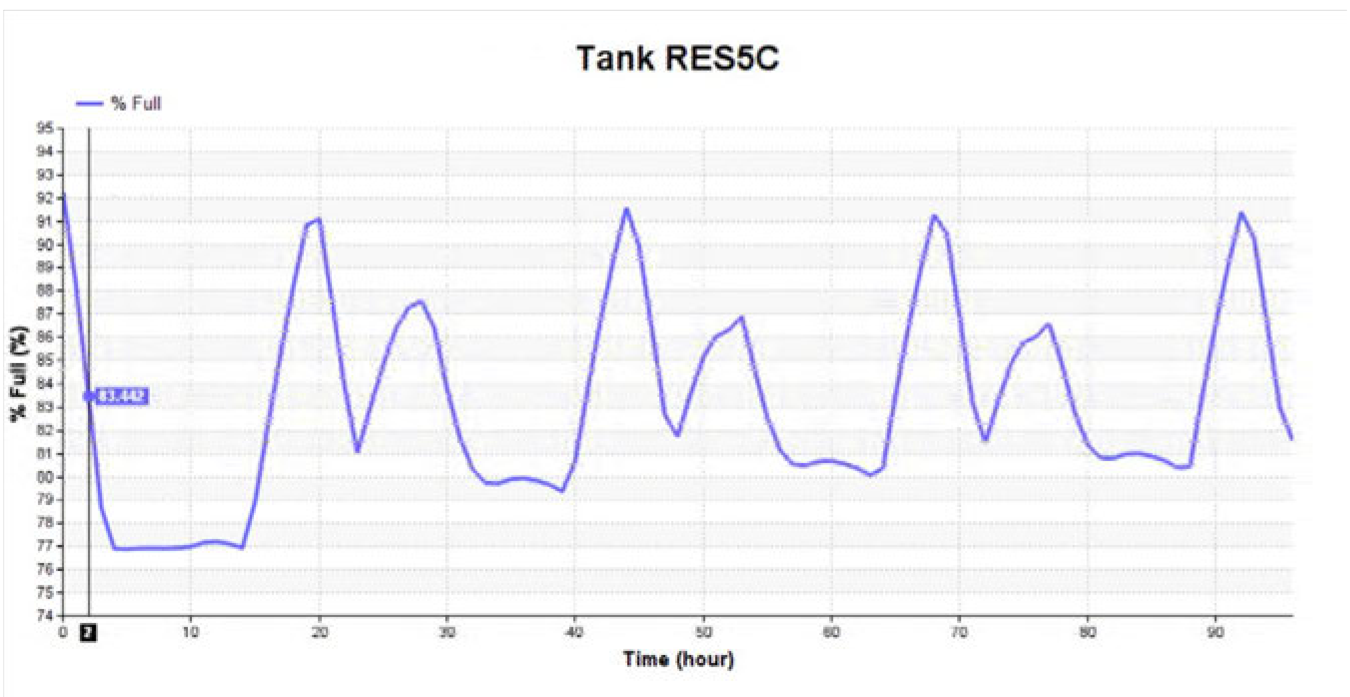
**Scenario 1: Existing System: Maximum Day Demand at Peak Hour (Exhibit 3)**



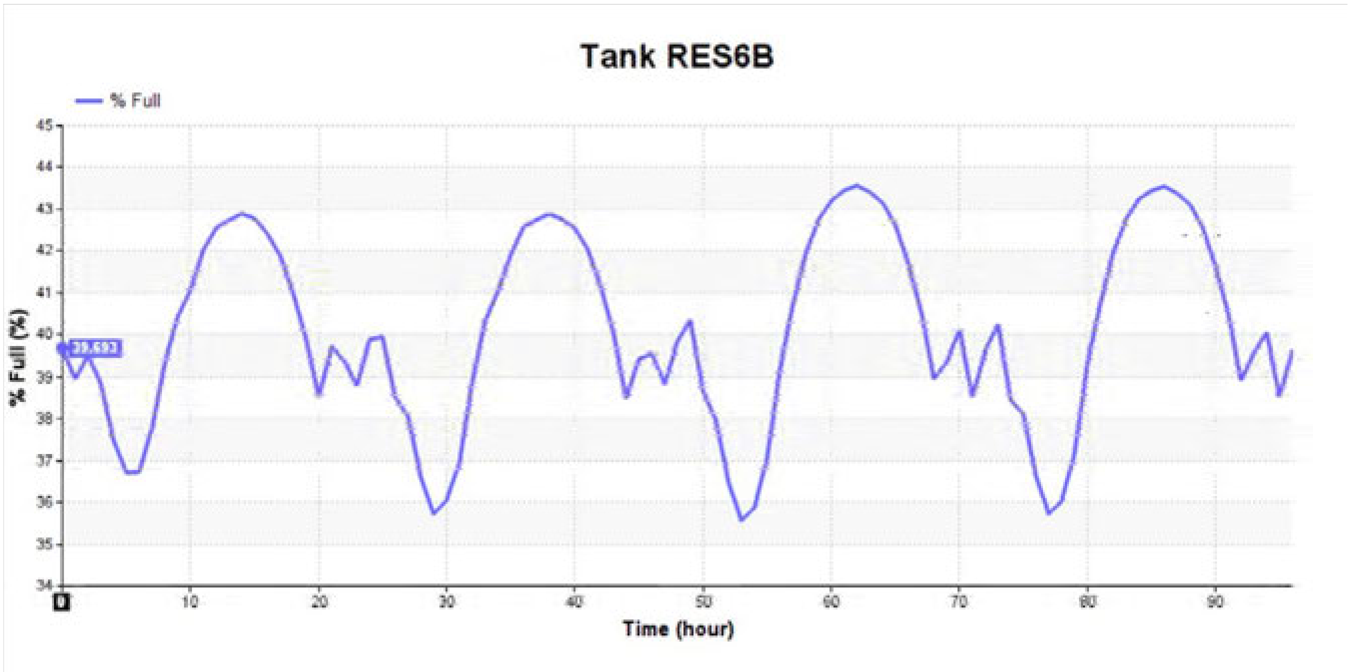



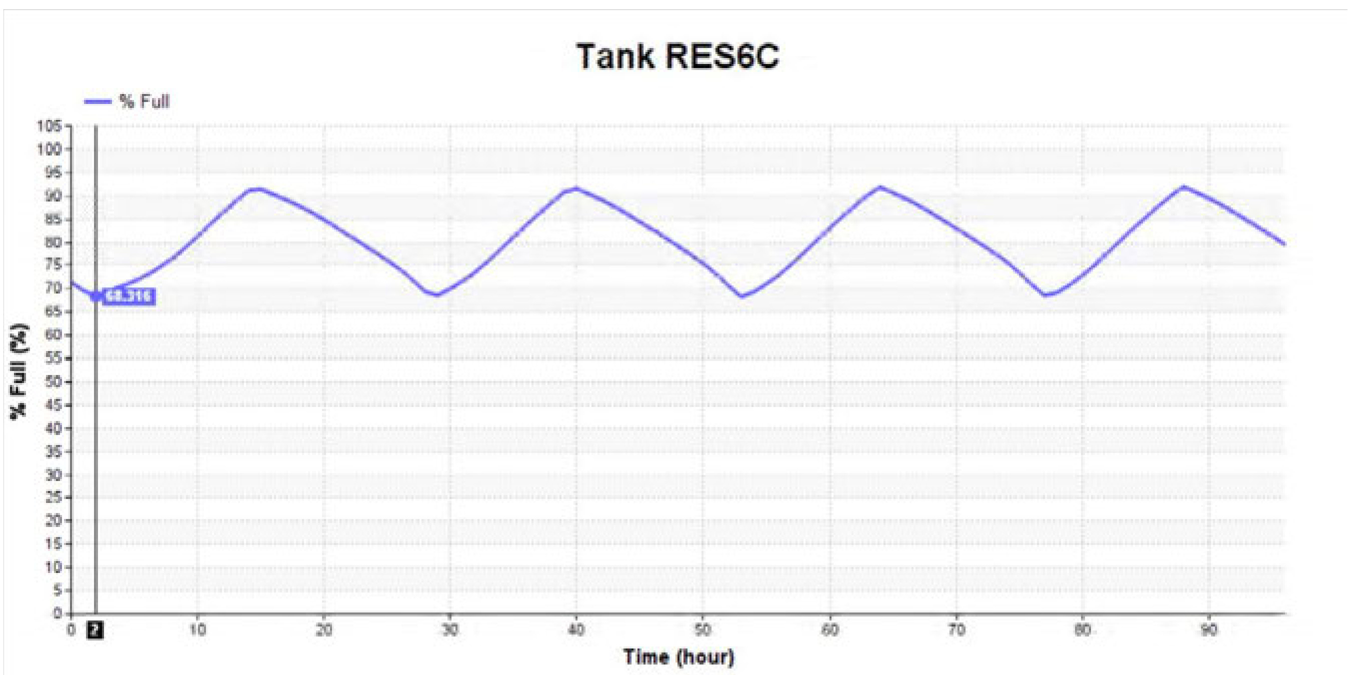
**Scenario 1: Existing System: Maximum Day Demand at Peak Hour (Exhibit 3)**



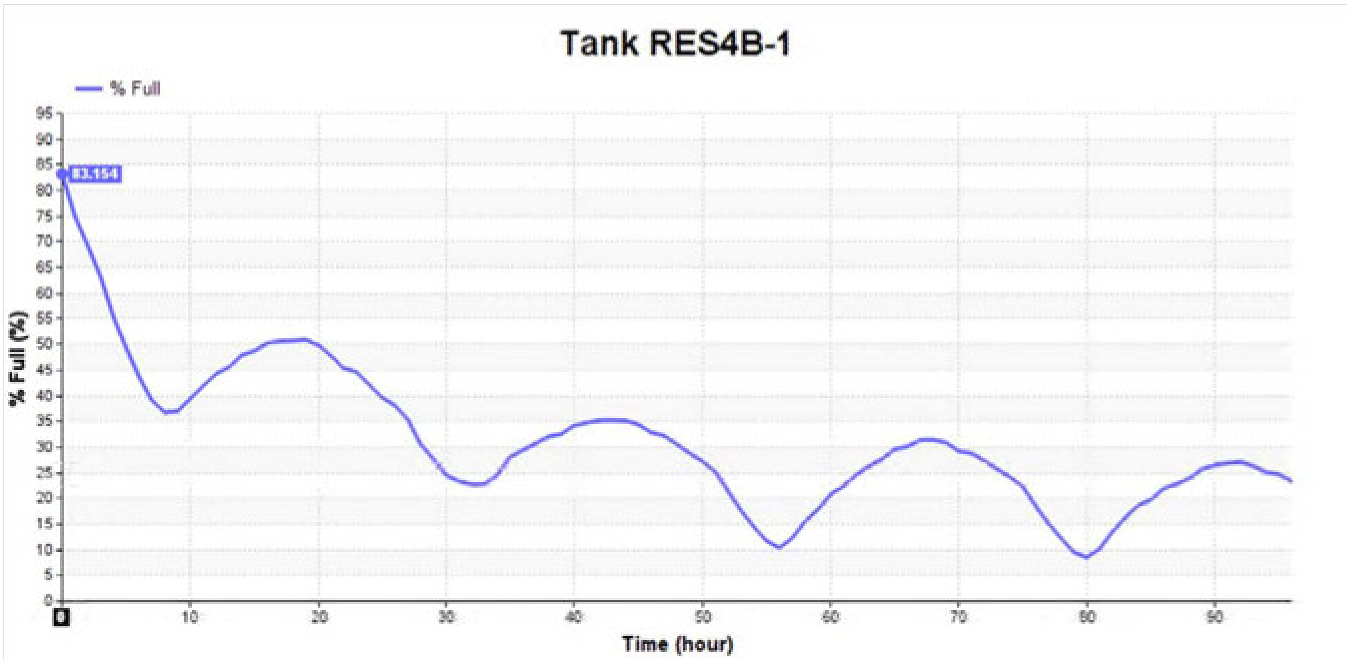



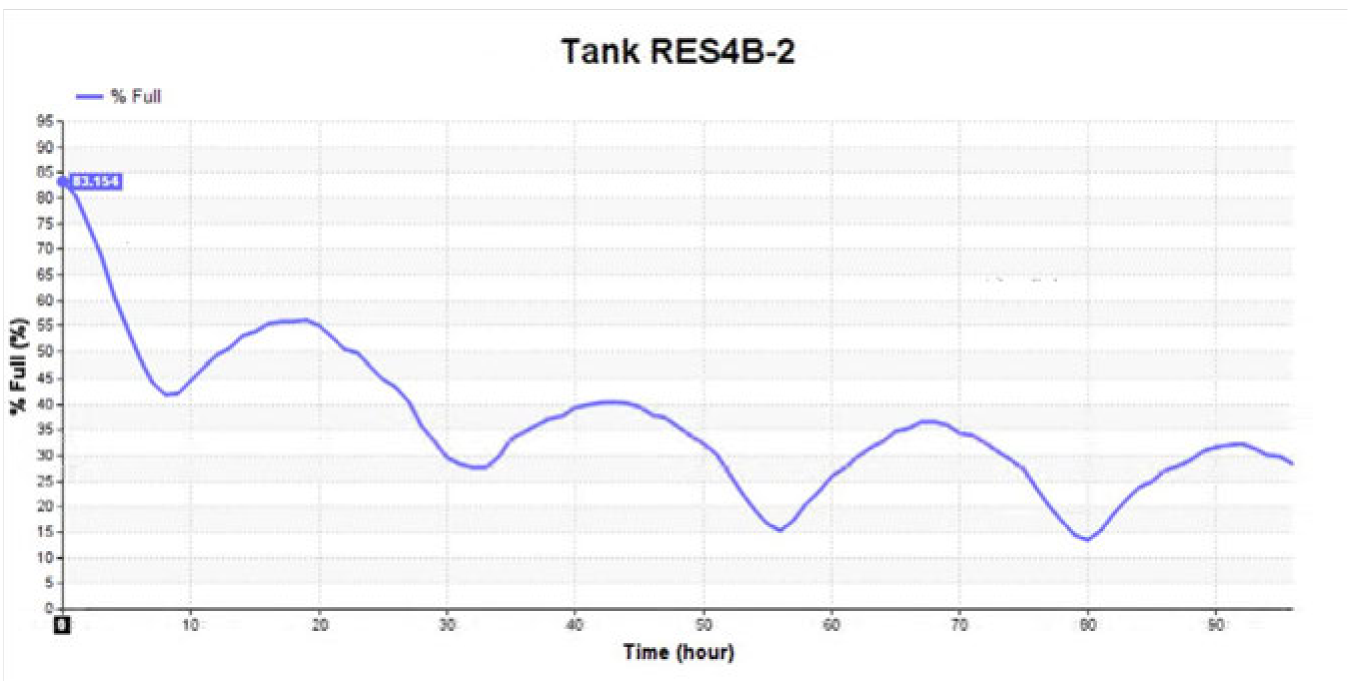
**Scenario 1: Existing System: Maximum Day Demand at Peak Hour (Exhibit 3)**



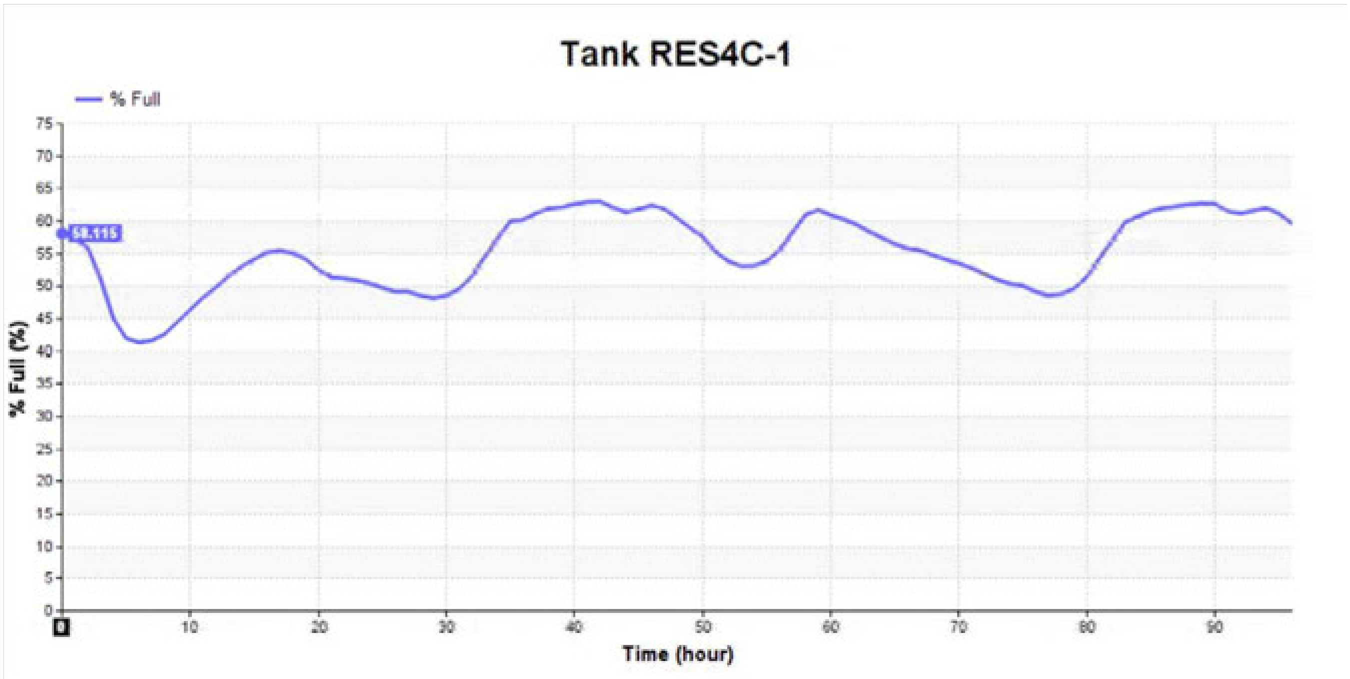



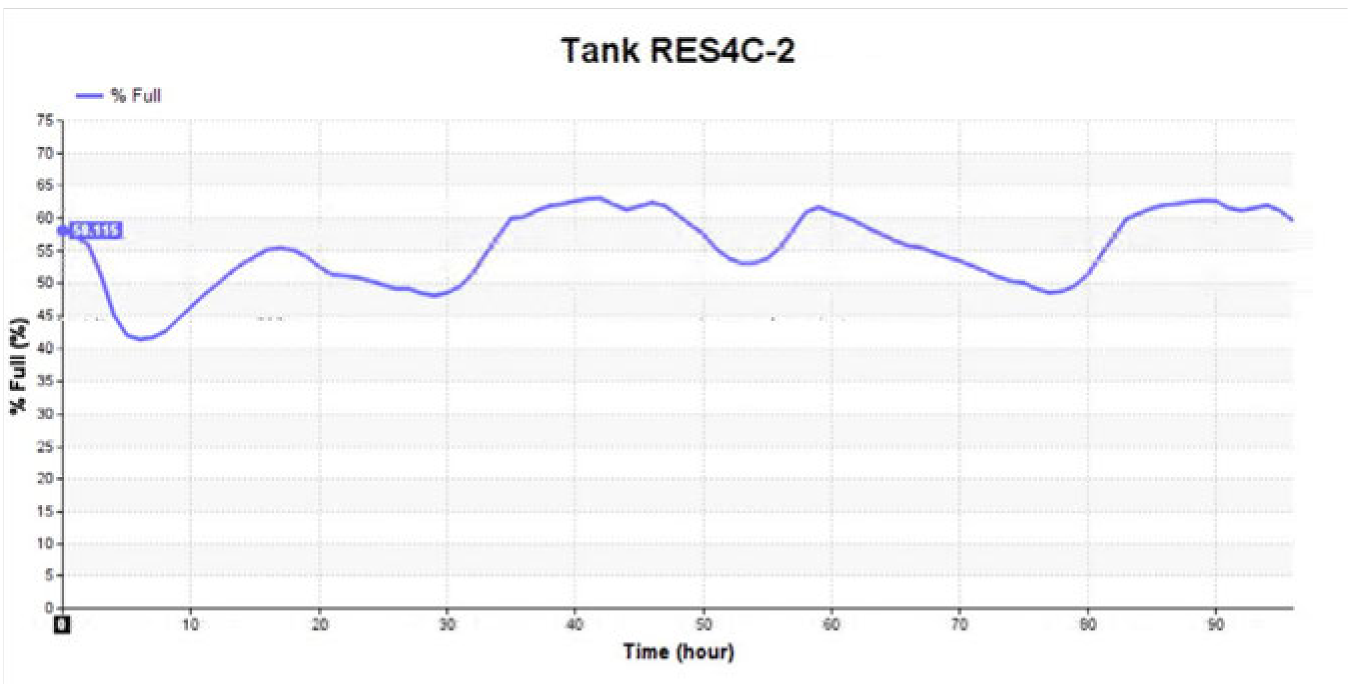
**Scenario 2: The proposed development at Peak Hour under Maximum Day Demand (Exhibit 4)**



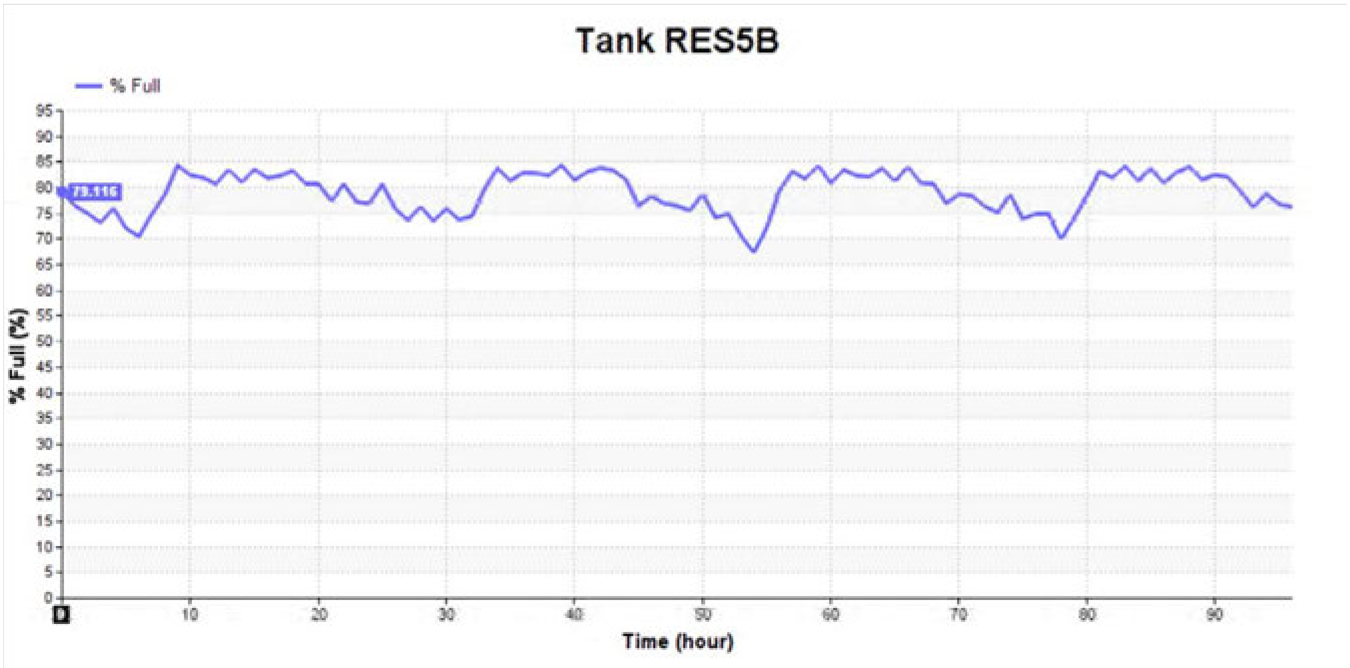



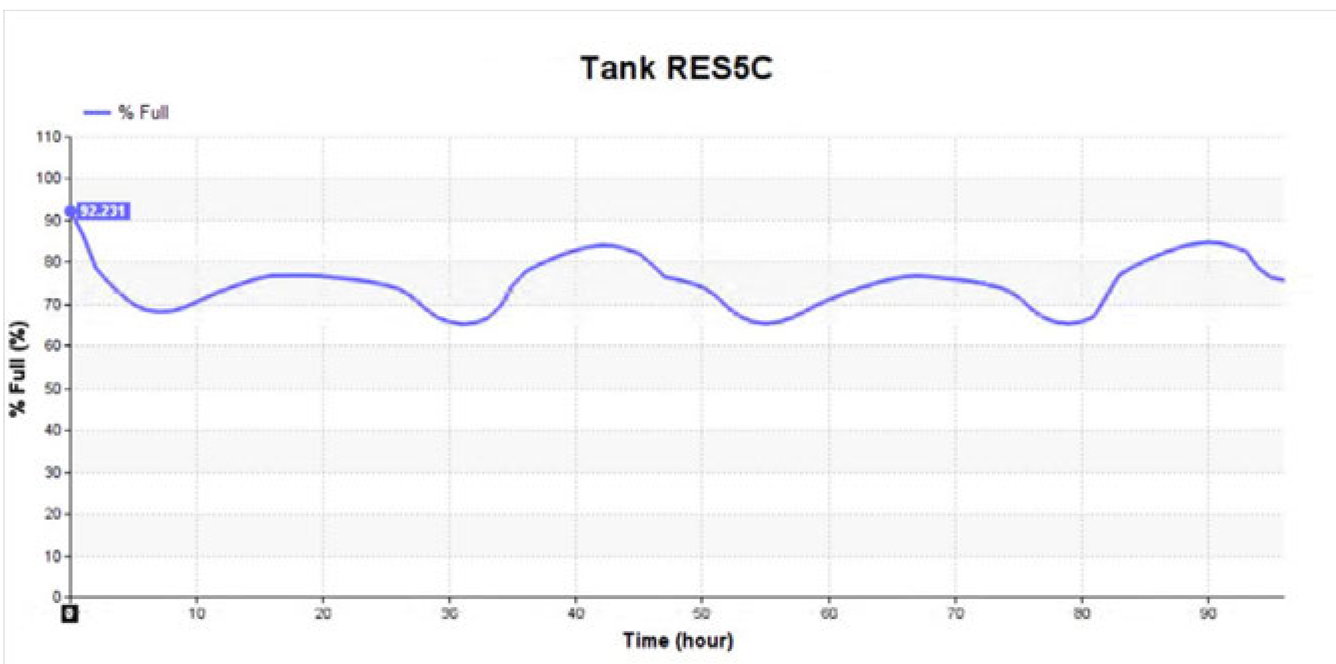
**Scenario 2: The proposed development at Peak Hour under Maximum Day Demand (Exhibit 4)**



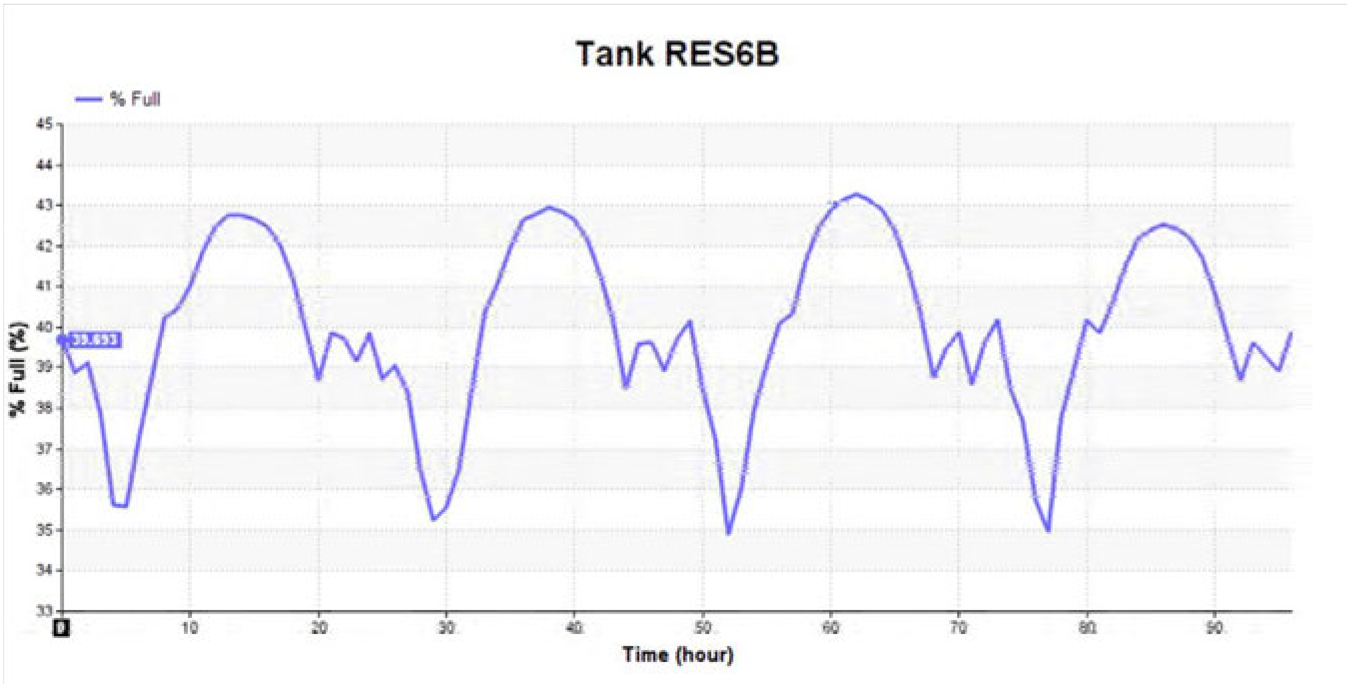



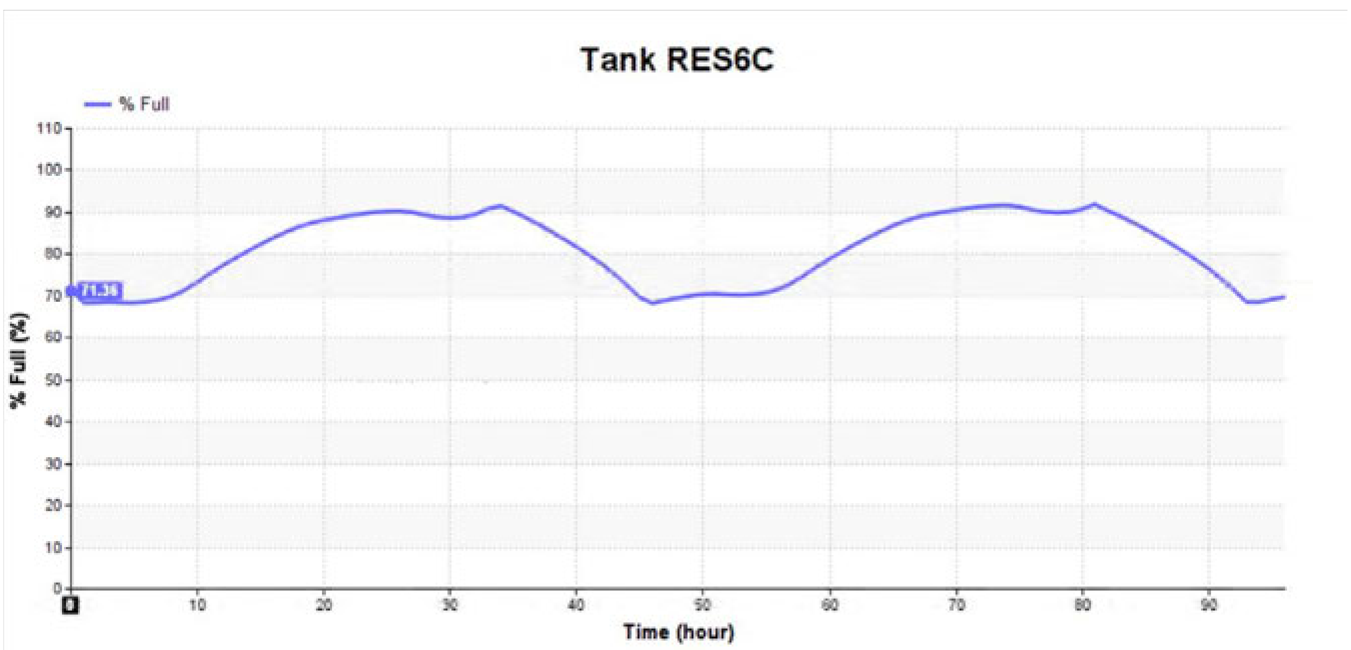
**Scenario 2: The proposed development at Peak Hour under Maximum Day Demand (Exhibit 4)**



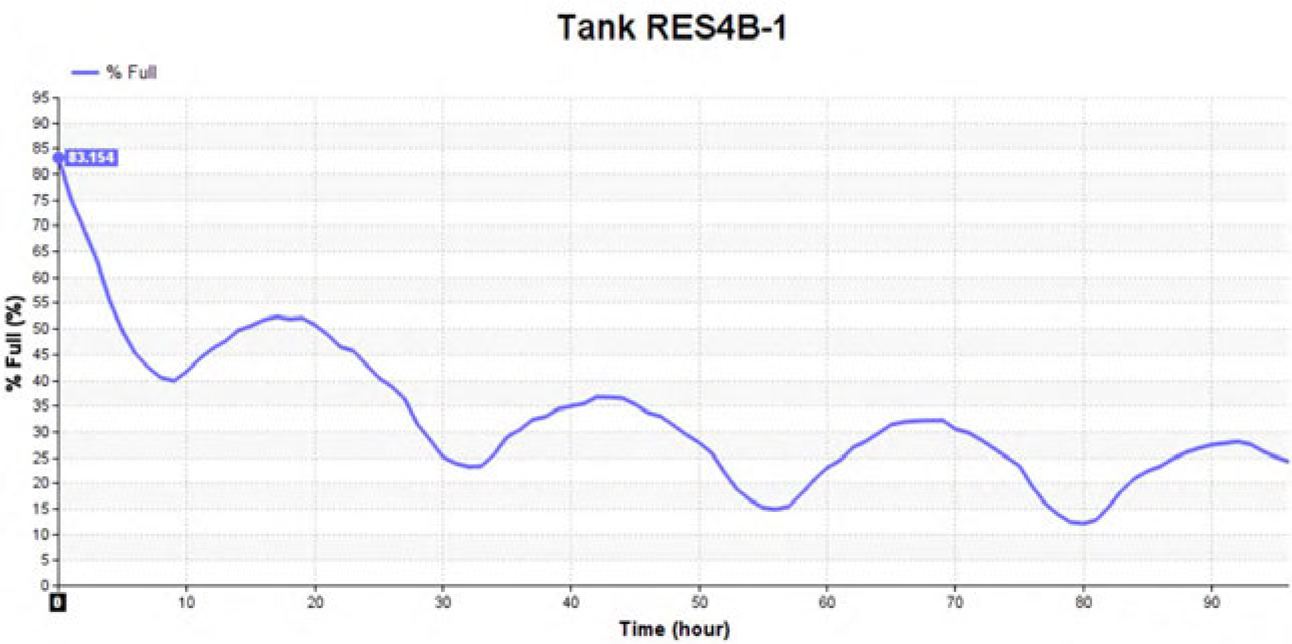



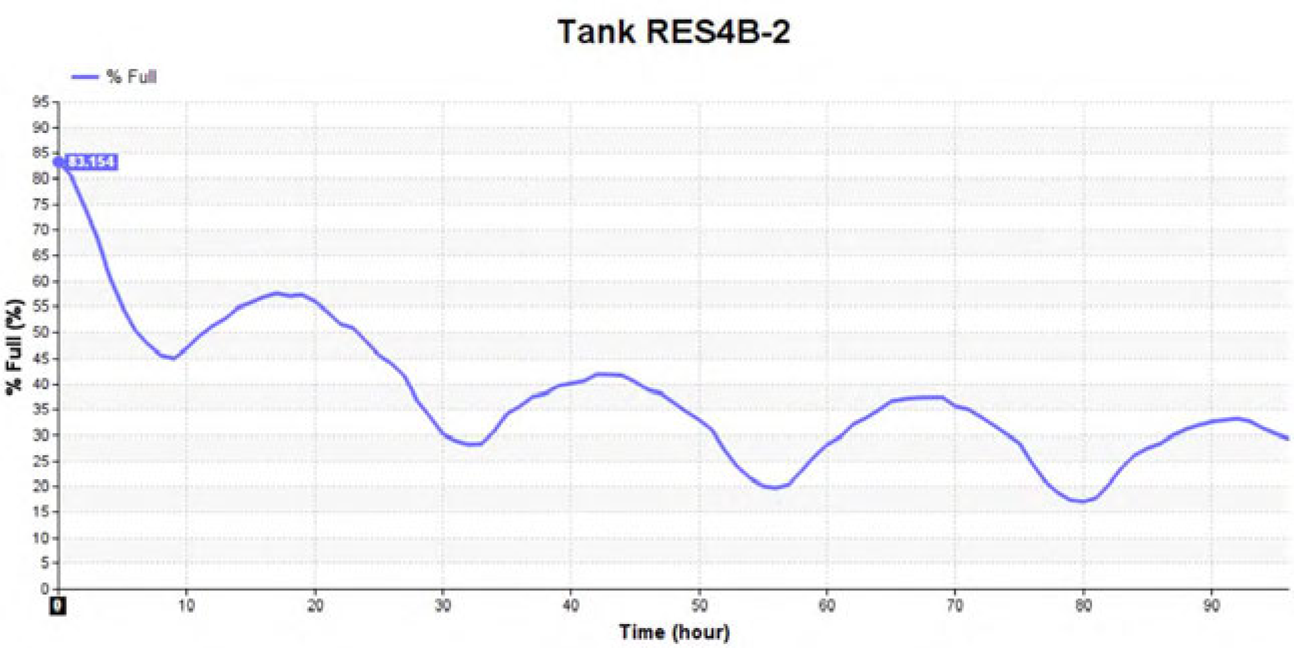
**Scenario 2: The proposed development at Peak Hour under Maximum Day Demand (Exhibit 4)**



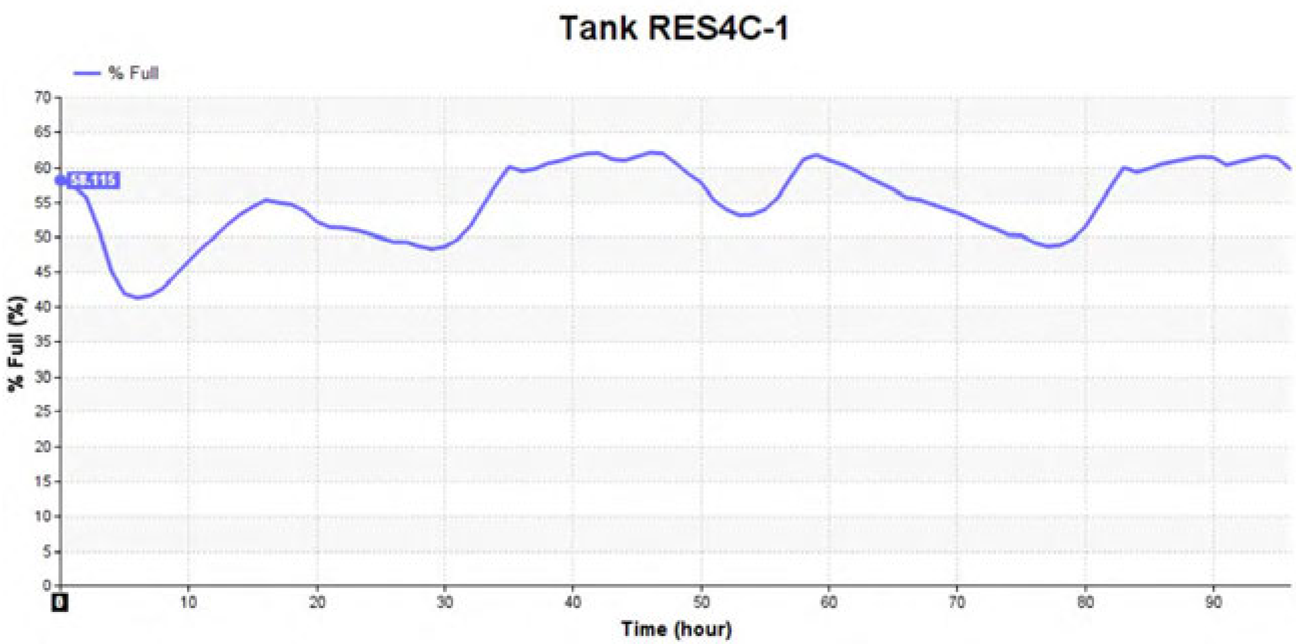



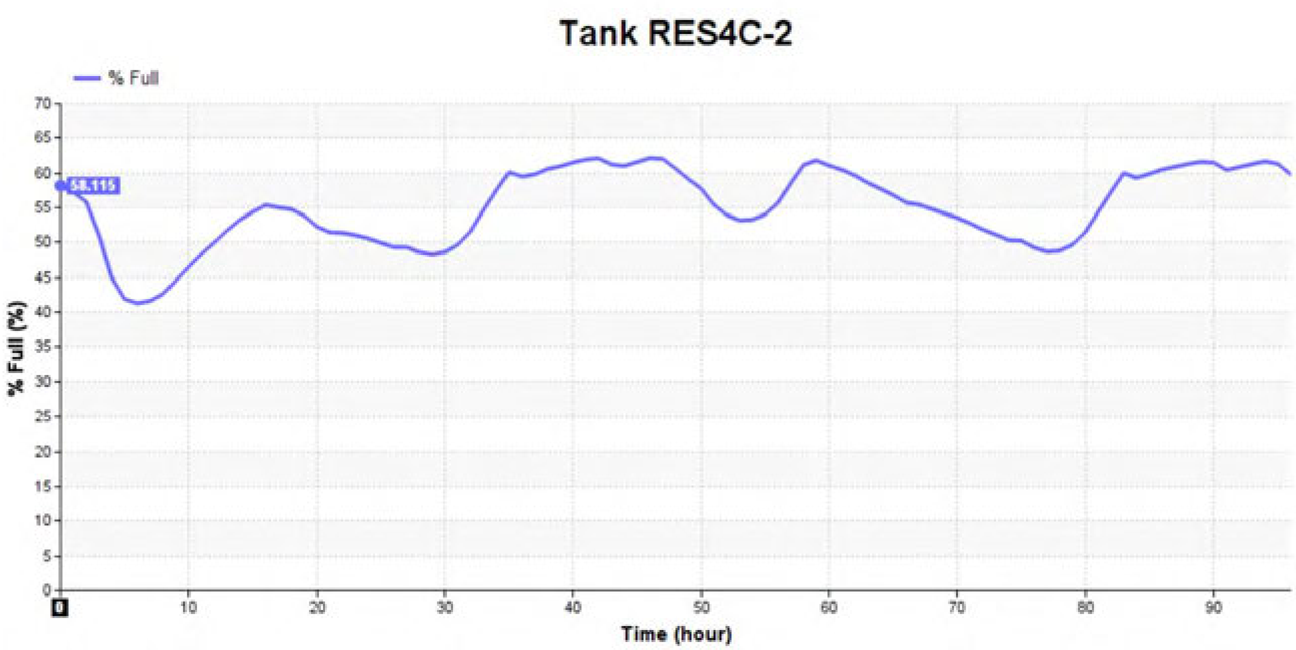
**Scenario 3: The proposed development isolated from Zone 6 at Peak Hour under Maximum Day Demand. (Exhibit 5)**



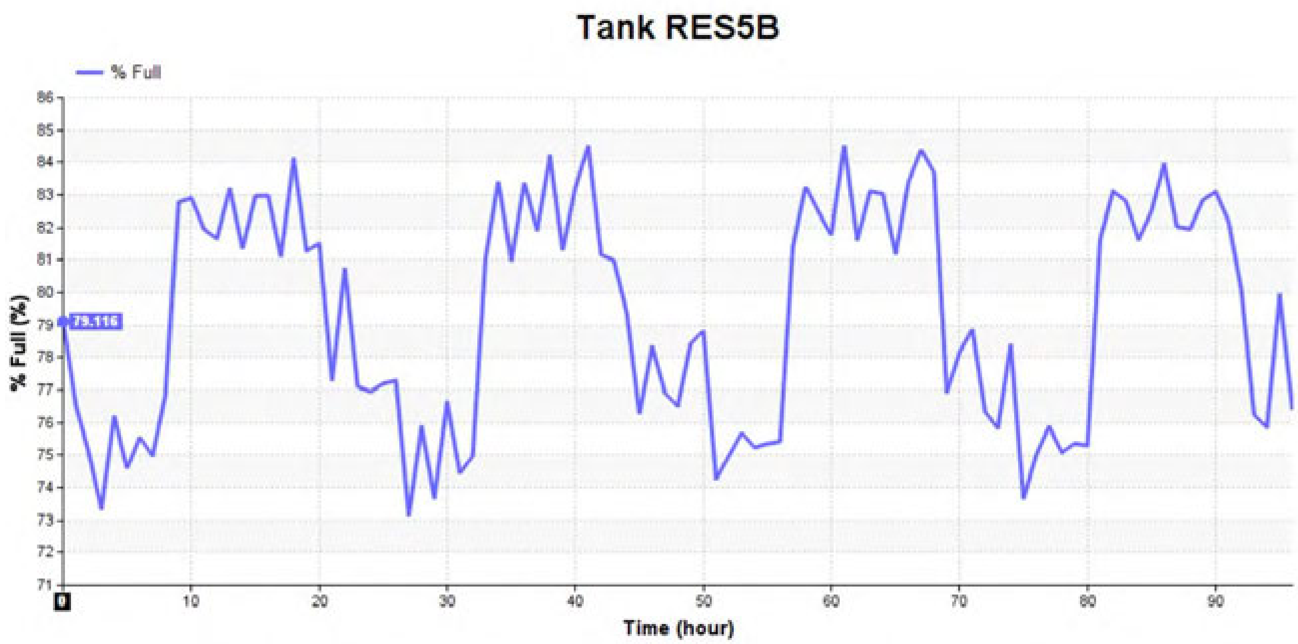



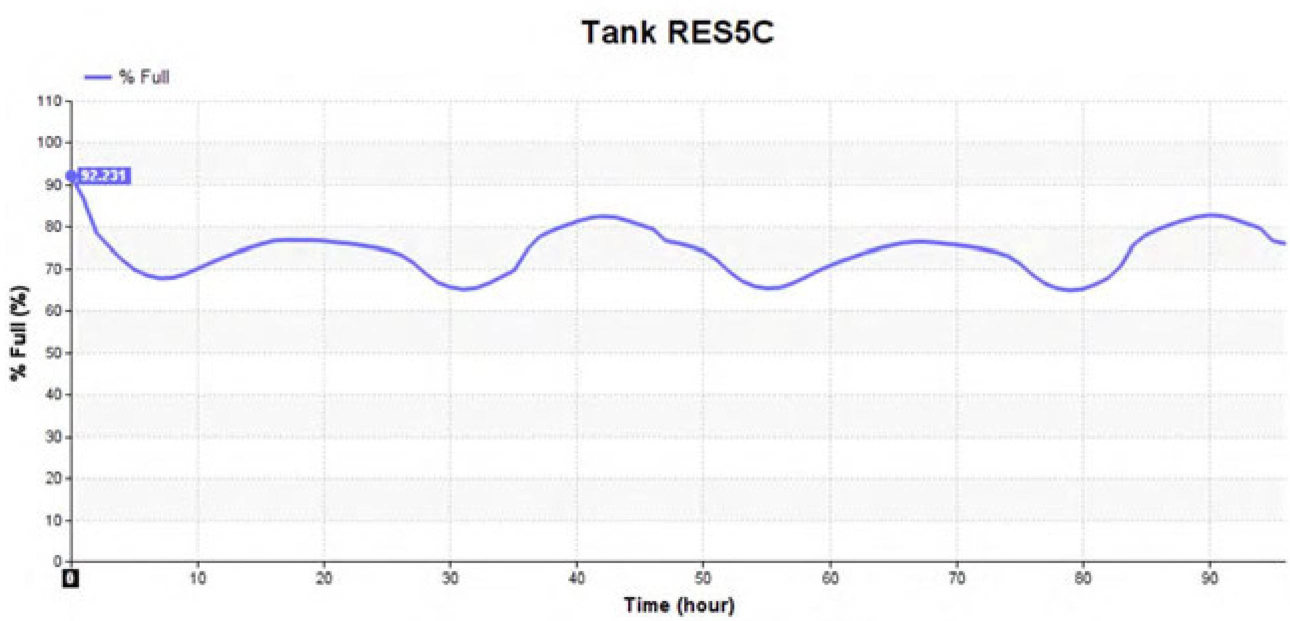
**Scenario 3: The proposed development isolated from Zone 6 at Peak Hour under Maximum Day Demand. (Exhibit 5)**



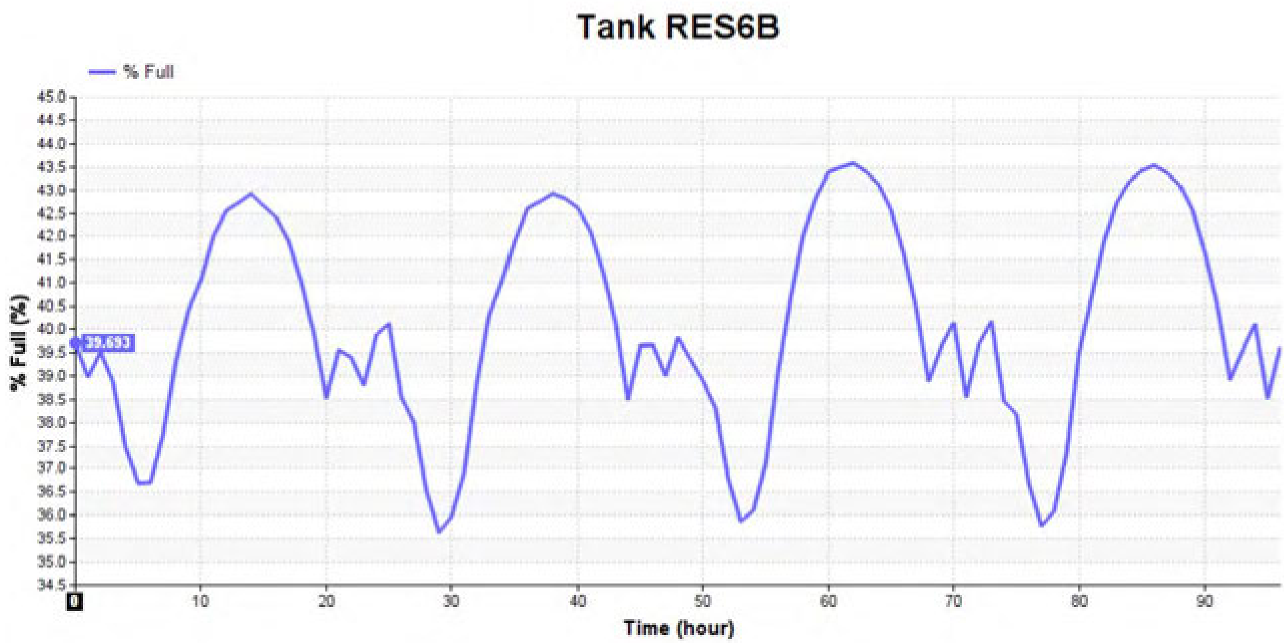



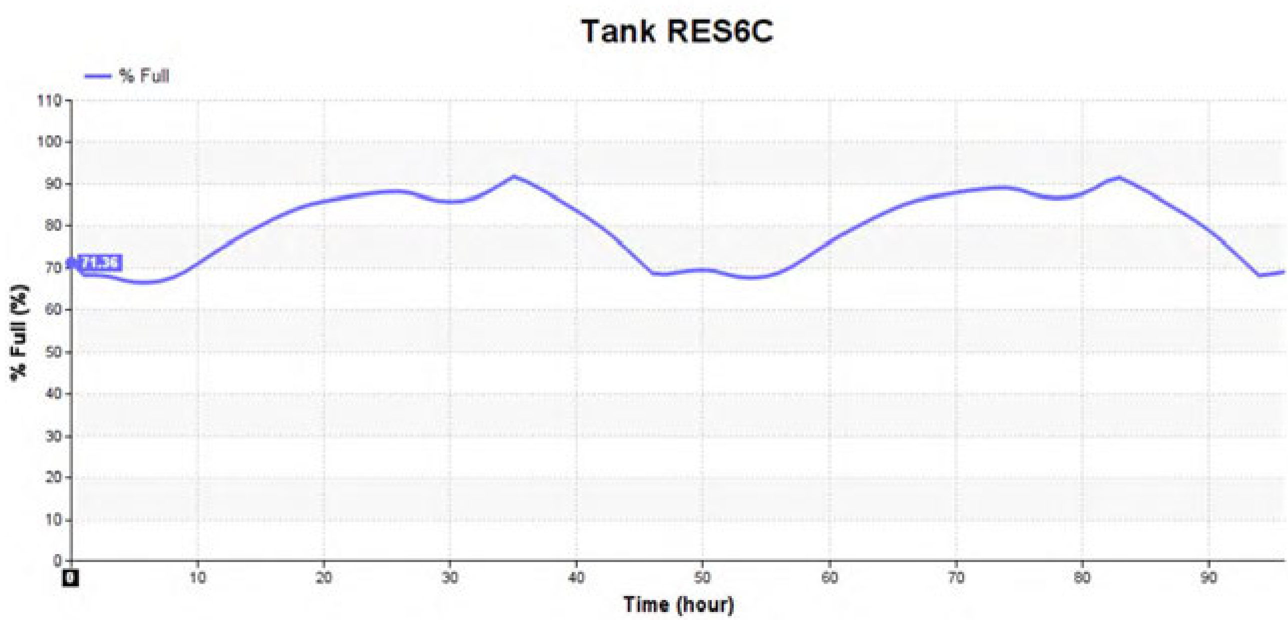
**Scenario 3: The proposed development isolated from Zone 6 at Peak Hour under Maximum Day Demand. (Exhibit 5)**



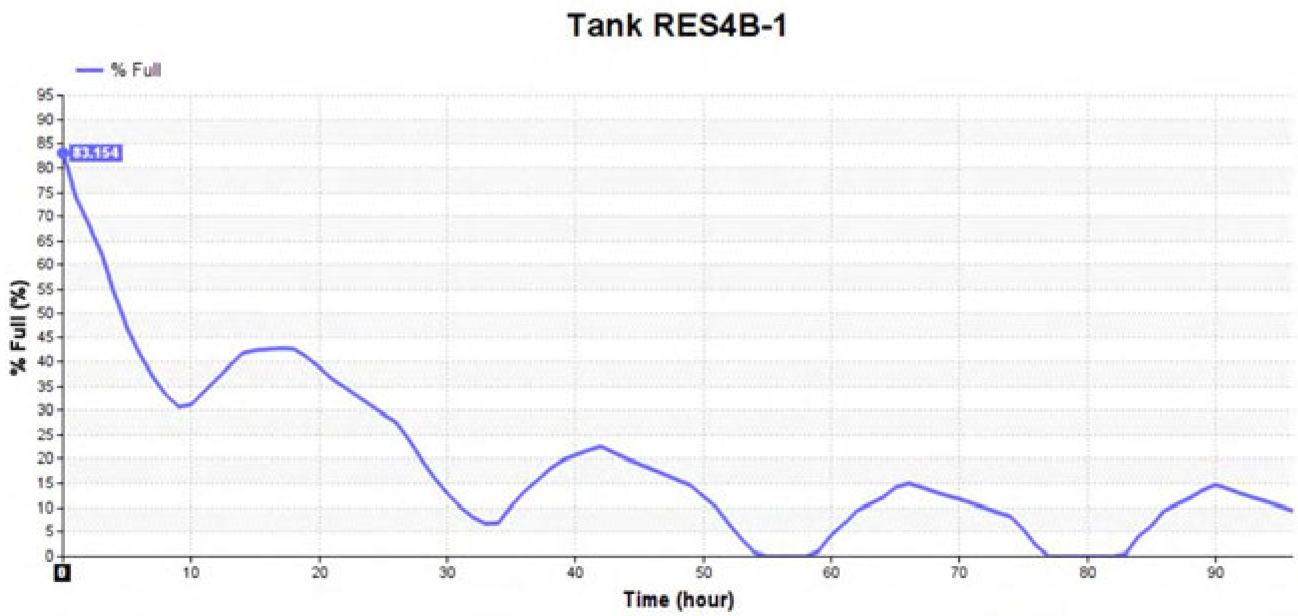



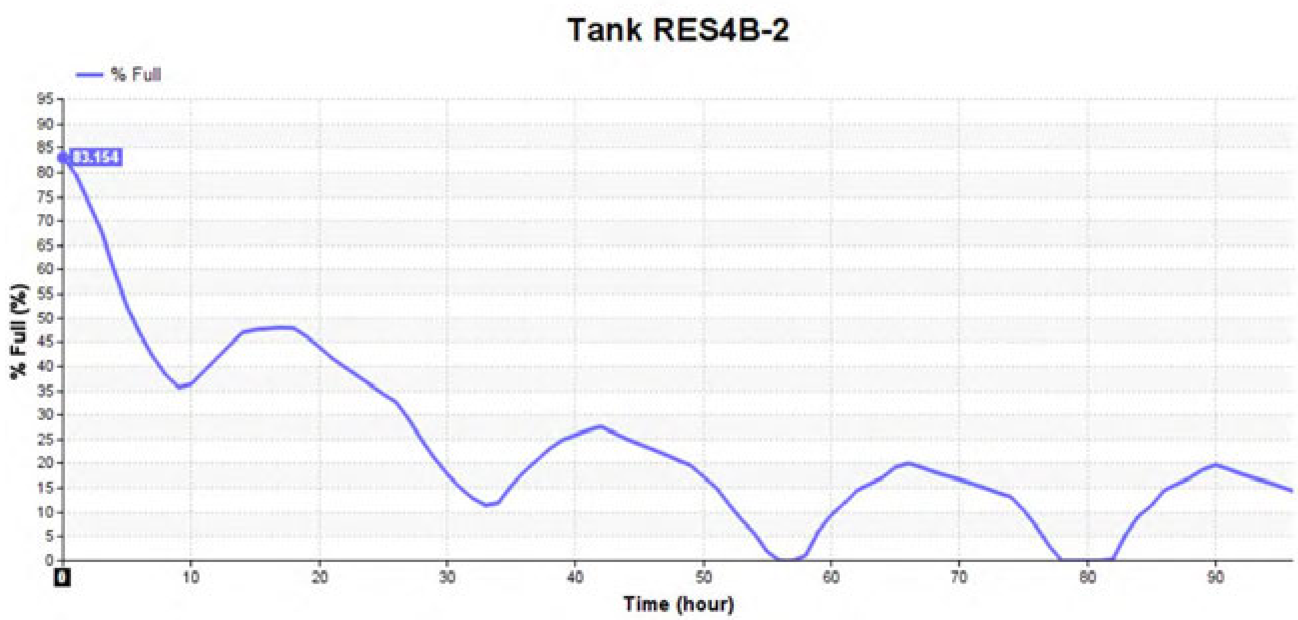
**Scenario 3: The proposed development isolated from Zone 6 at Peak Hour under Maximum Day Demand. (Exhibit 5)**



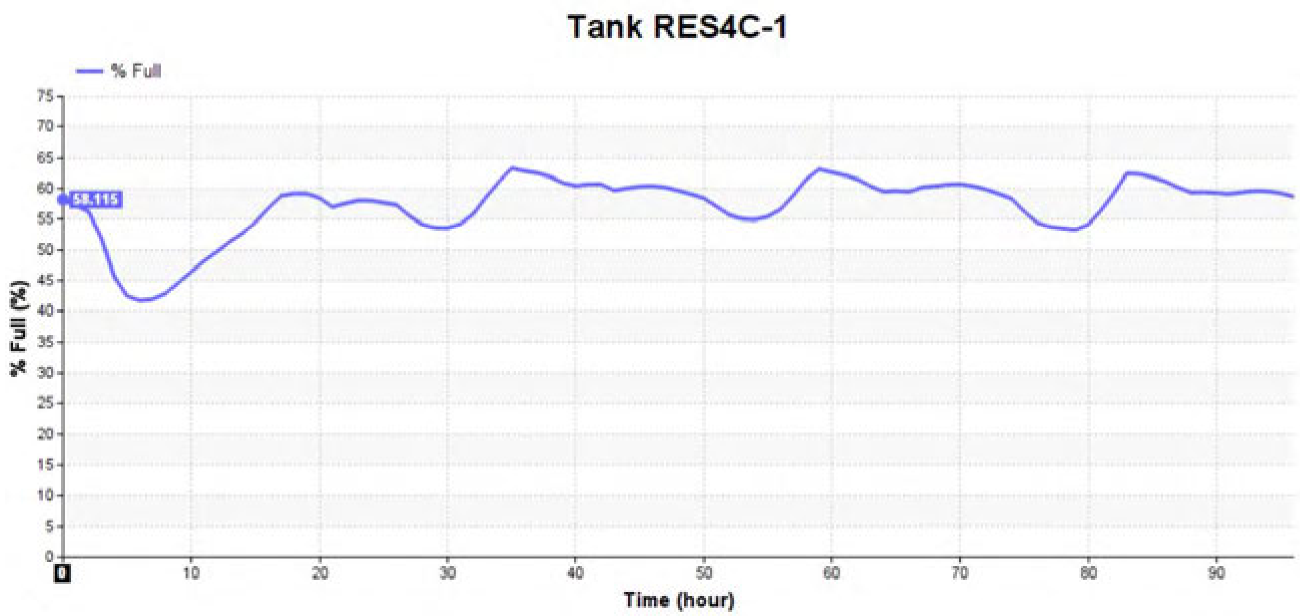



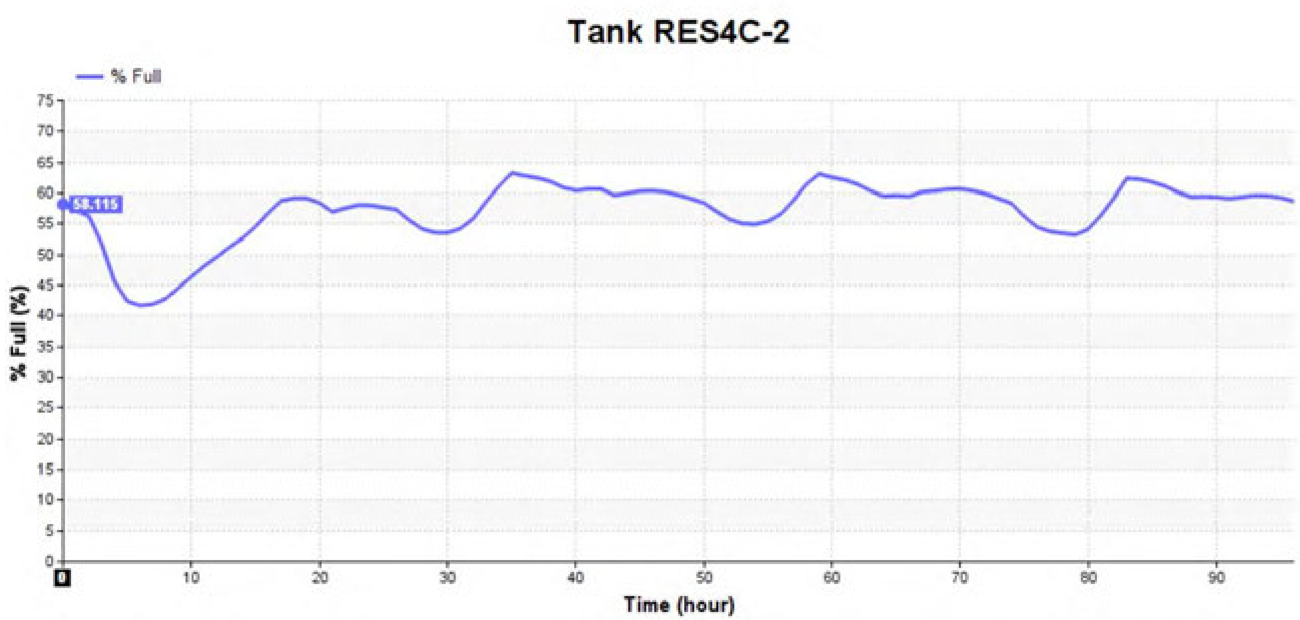
**Scenario 4: The proposed development isolated from Zone 6C at Peak Hour under Maximum Day Demand. (Exhibit 6)**



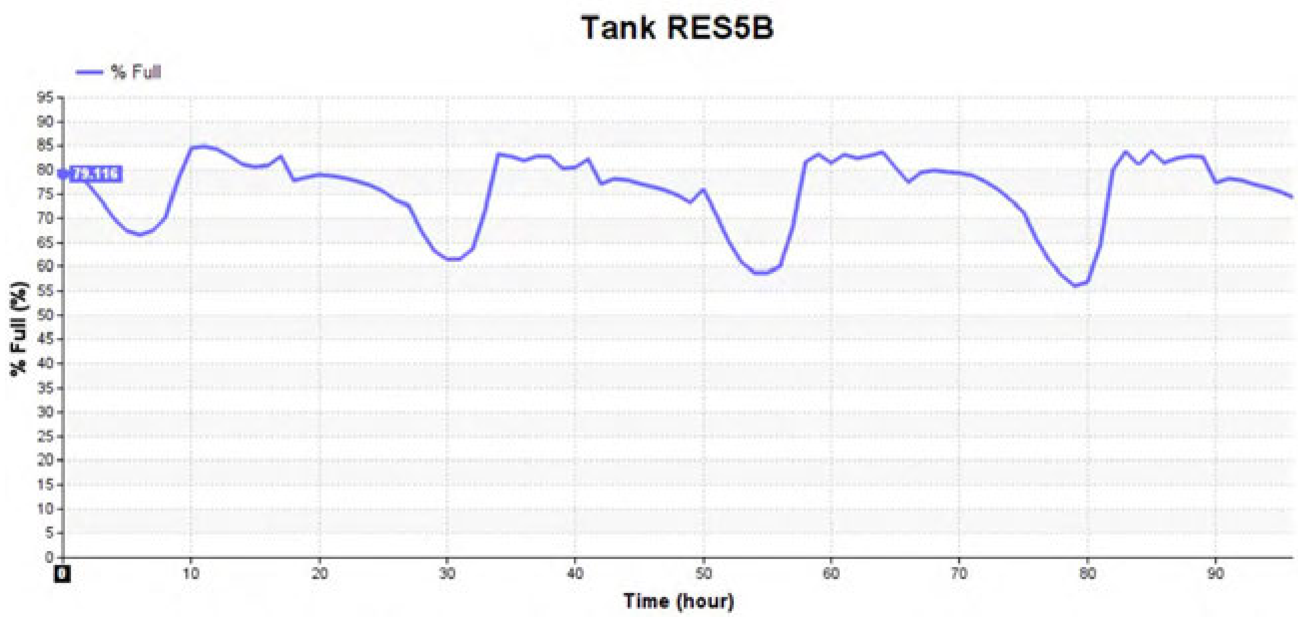



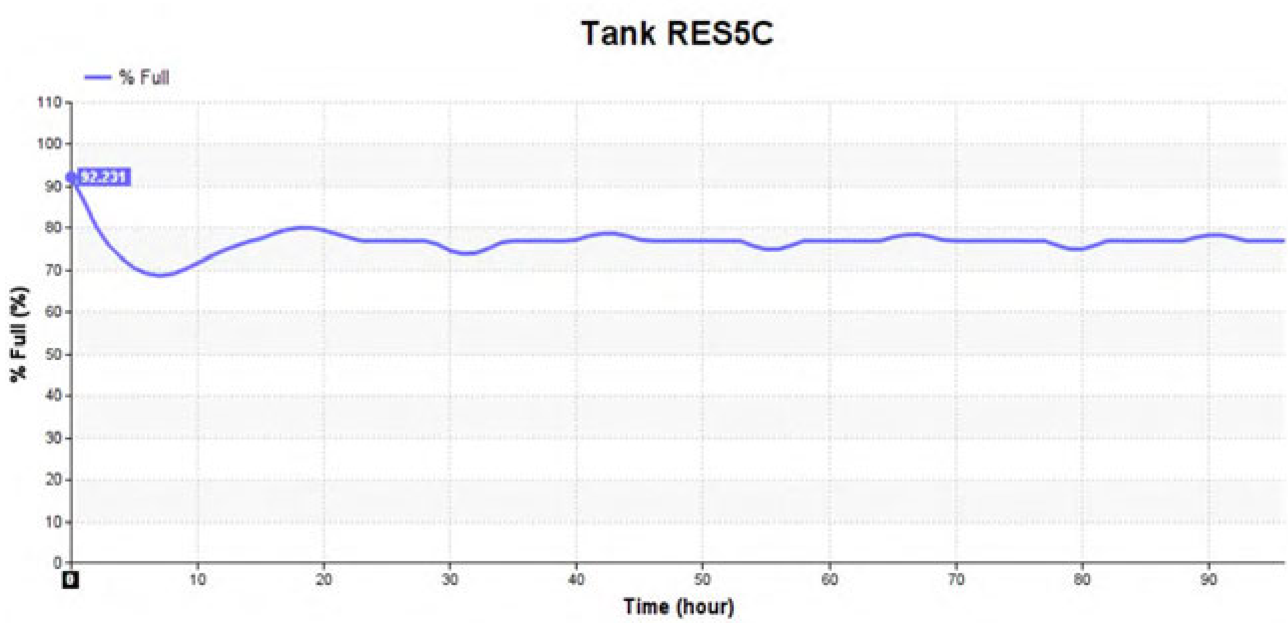
**Scenario 4: The proposed development isolated from Zone 6C at Peak Hour under Maximum Day Demand. (Exhibit 6)**



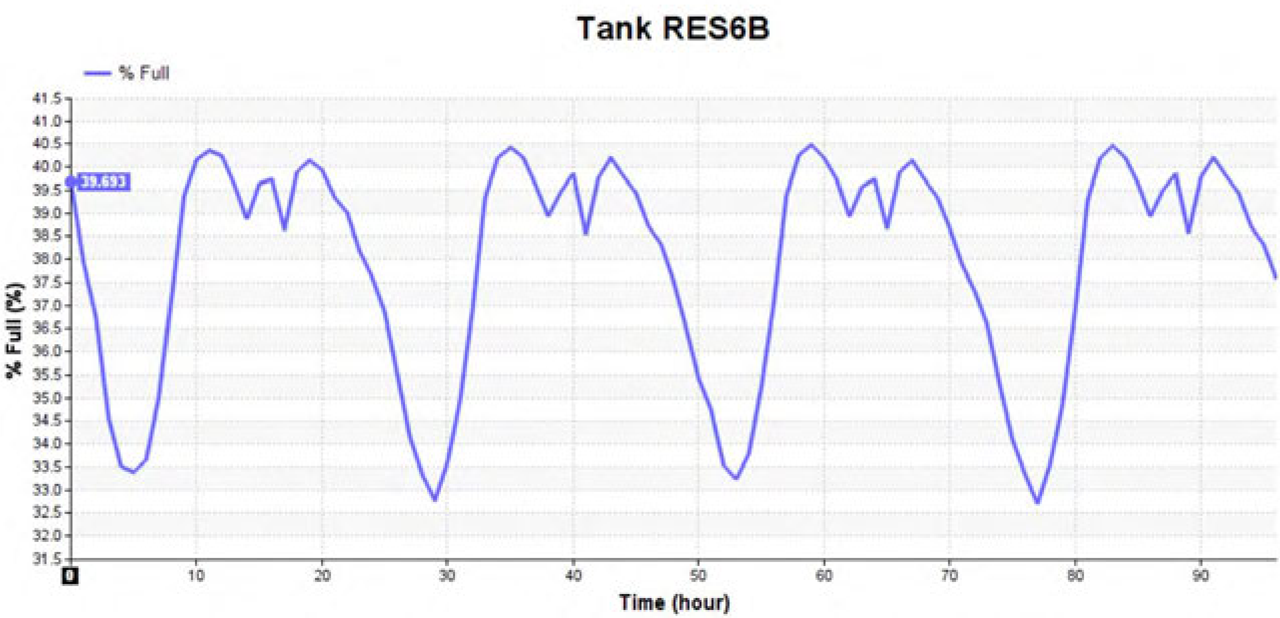



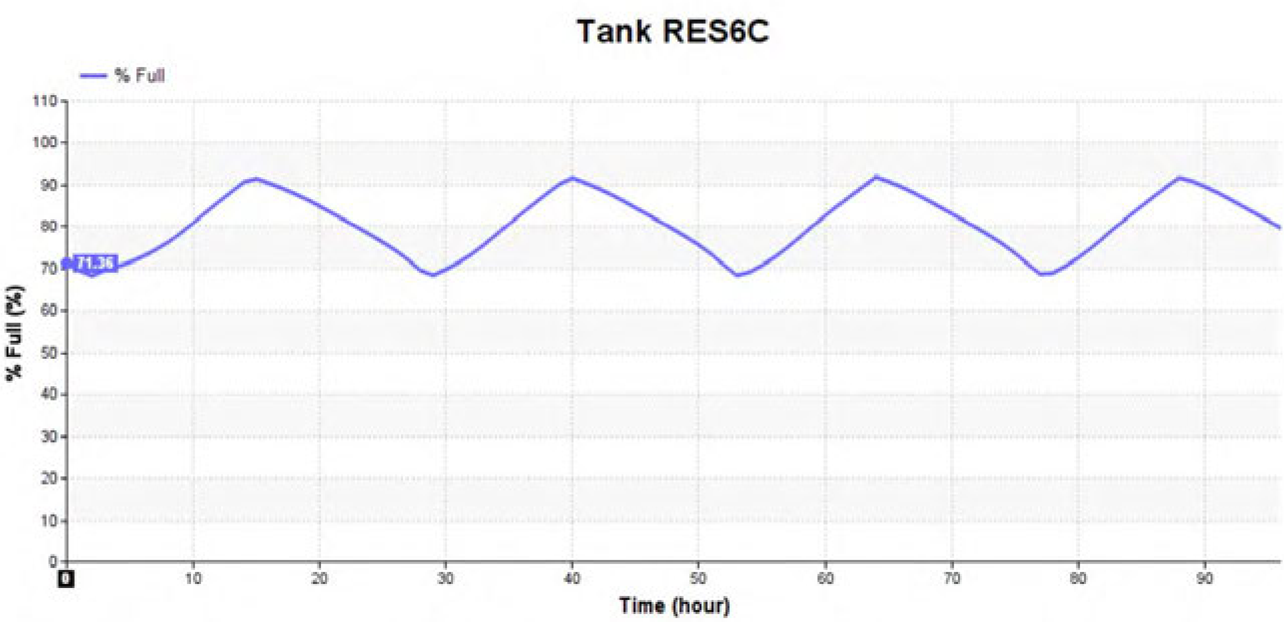
**Scenario 4: The proposed development isolated from Zone 6C at Peak Hour under Maximum Day Demand. (Exhibit 6)**



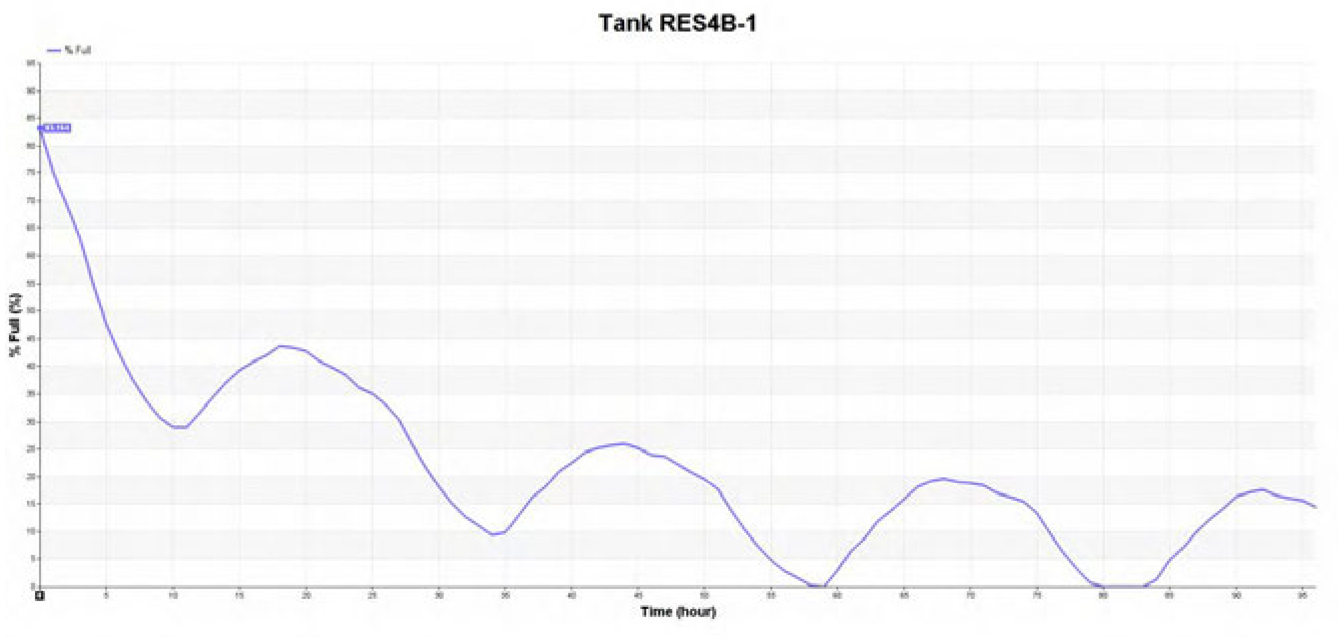



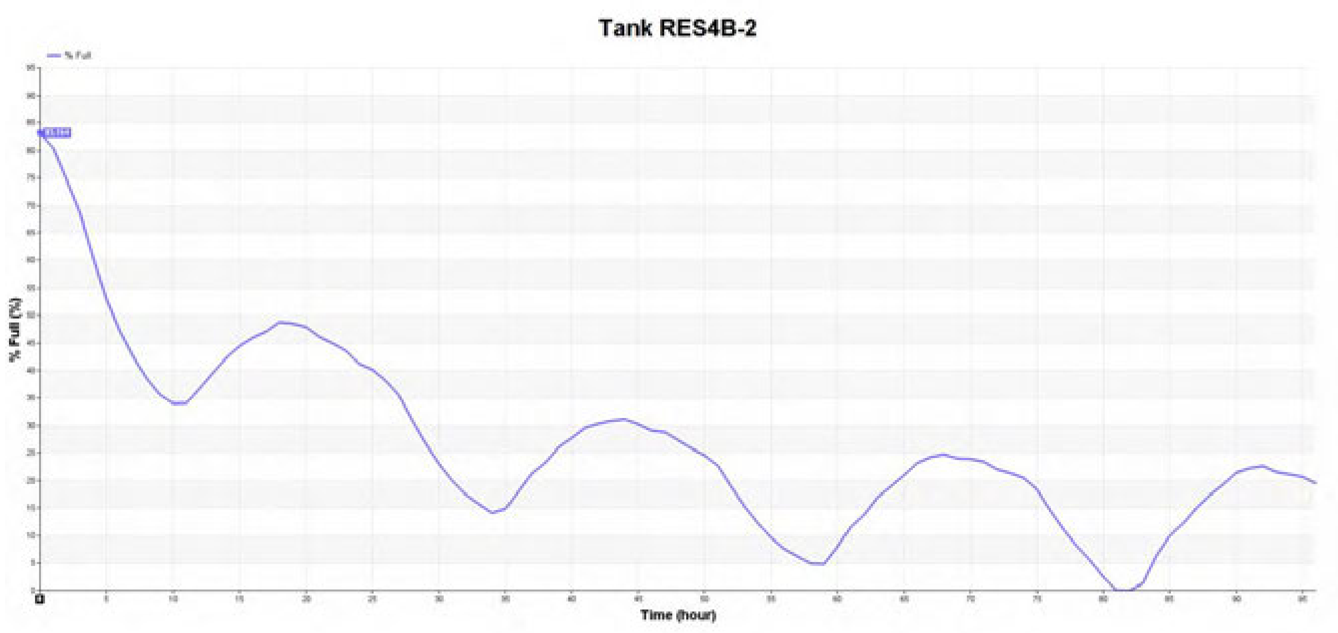
**Scenario 4: The proposed development isolated from Zone 6C at Peak Hour under Maximum Day Demand. (Exhibit 6)**



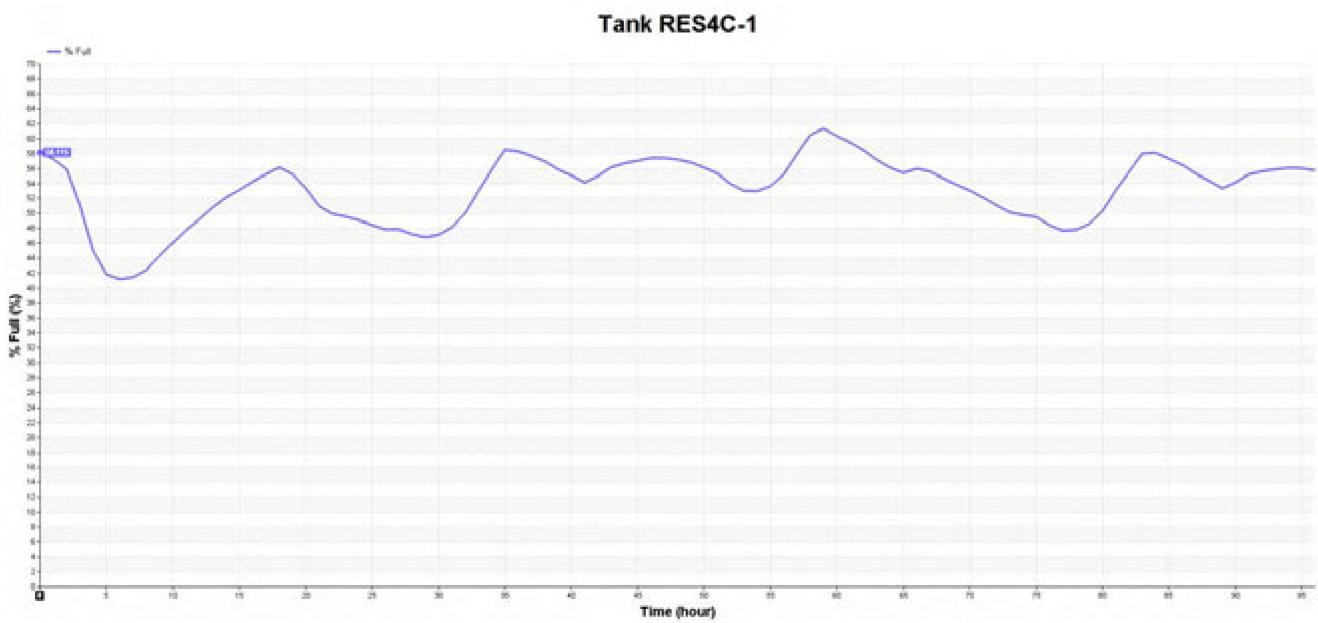



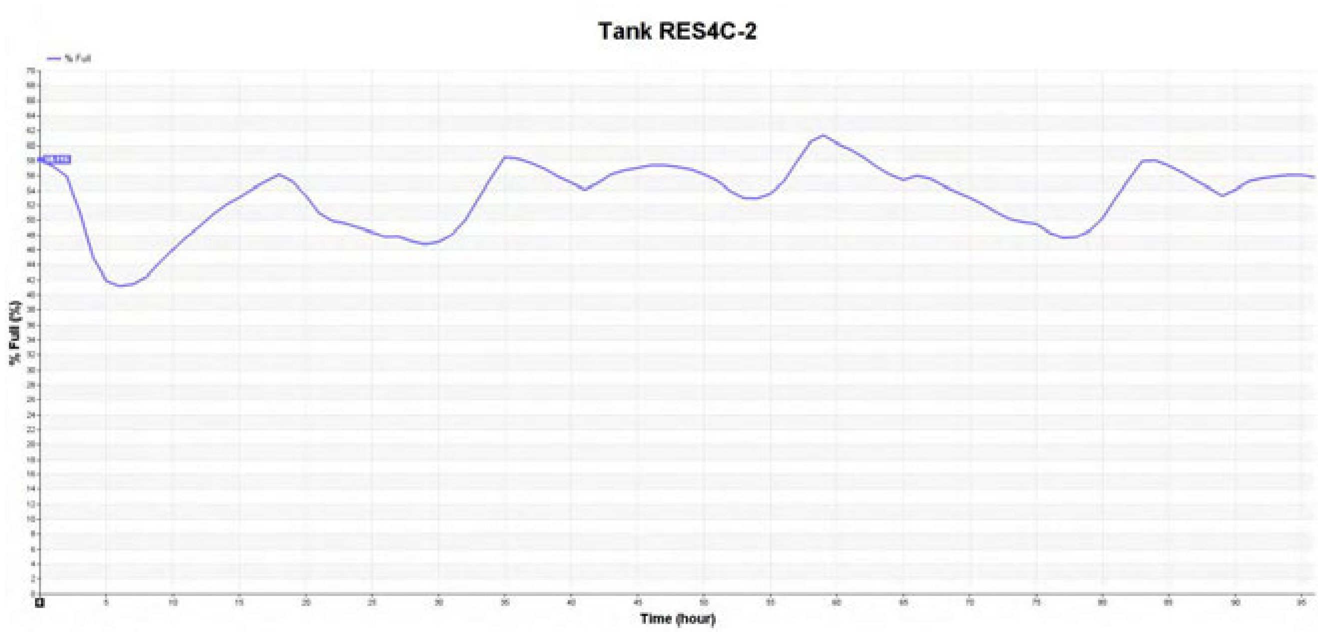
**Scenario 5: High Density Residential Fire Flow on Zone 6C in the project area at Peak Hour under Maximum Day Demand (Exhibit 7)**



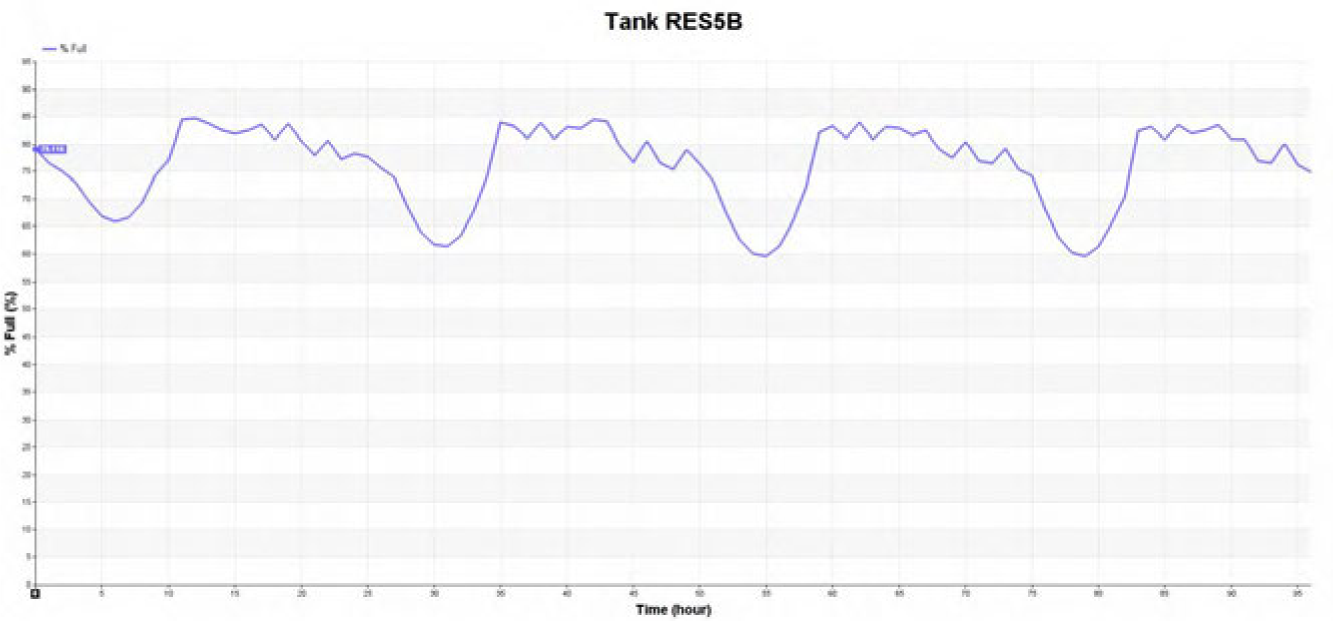



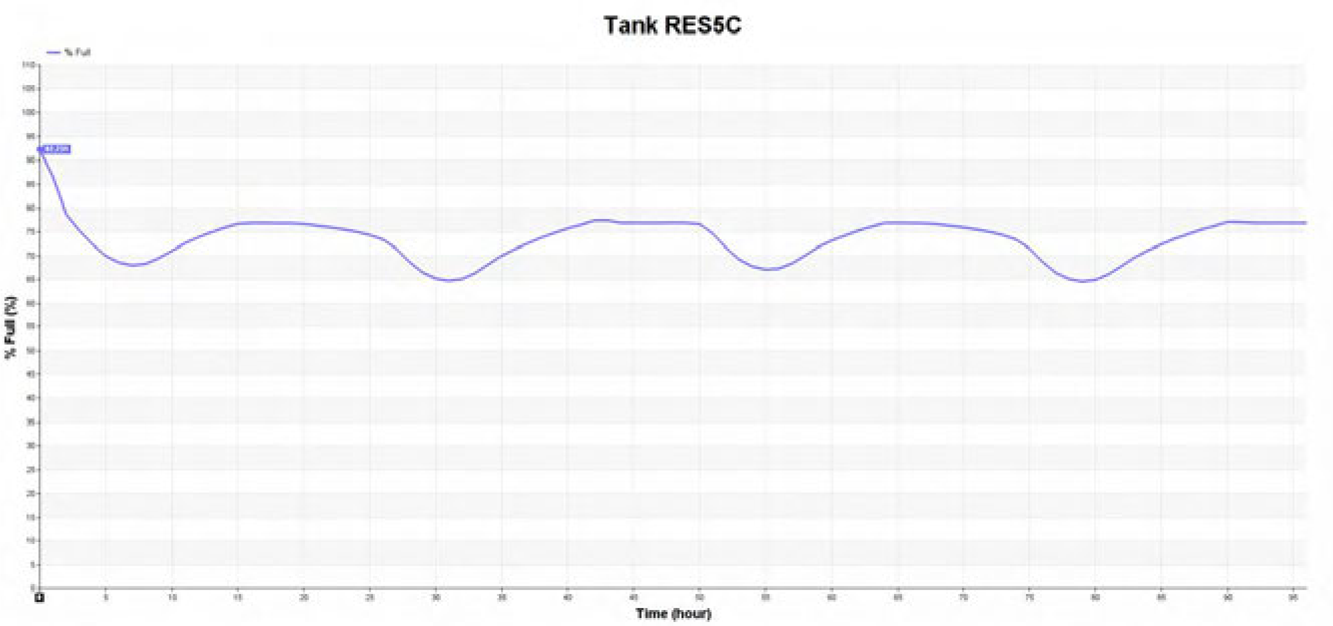
**Scenario 5: High Density Residential Fire Flow on Zone 6C in the project area at Peak Hour under Maximum Day Demand (Exhibit 7)**



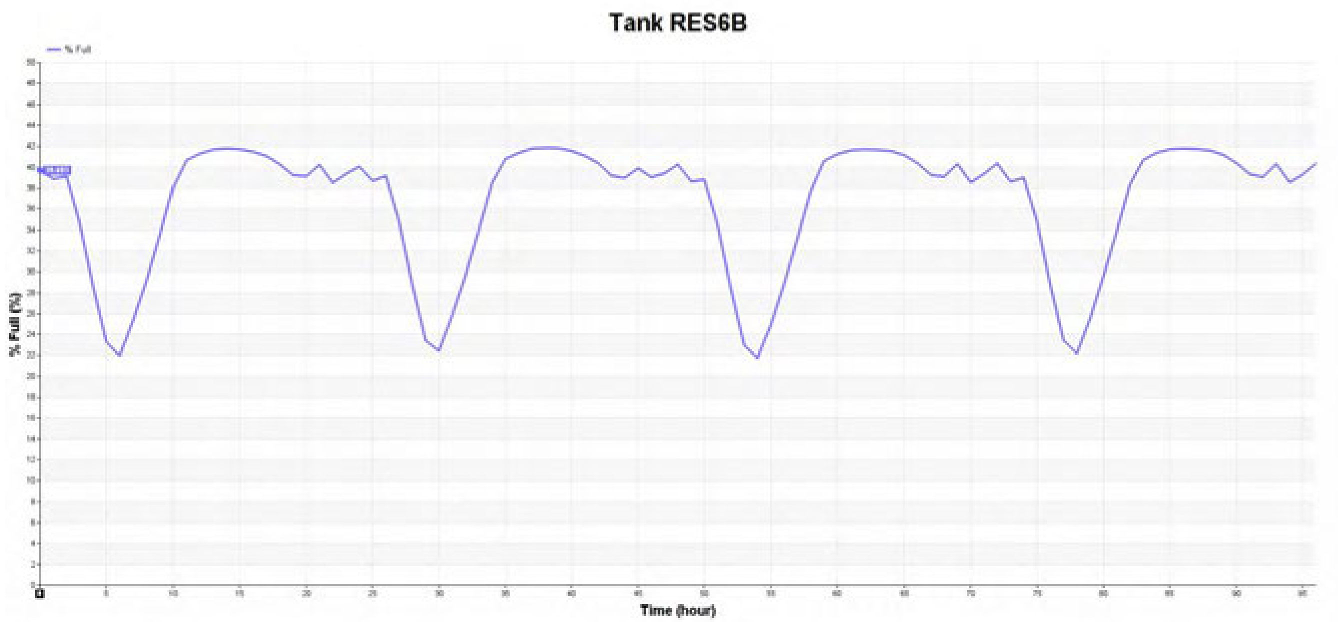



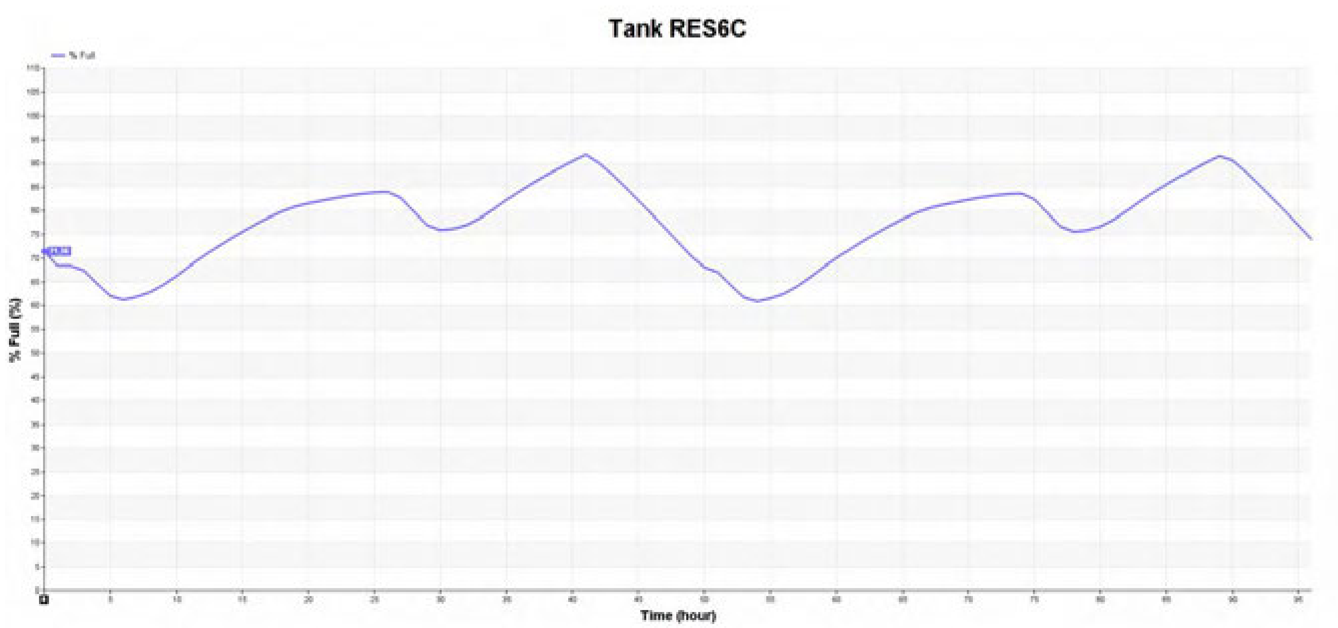
**Scenario 5: High Density Residential Fire Flow on Zone 6C in the project area at Peak Hour under Maximum Day Demand (Exhibit 7)**



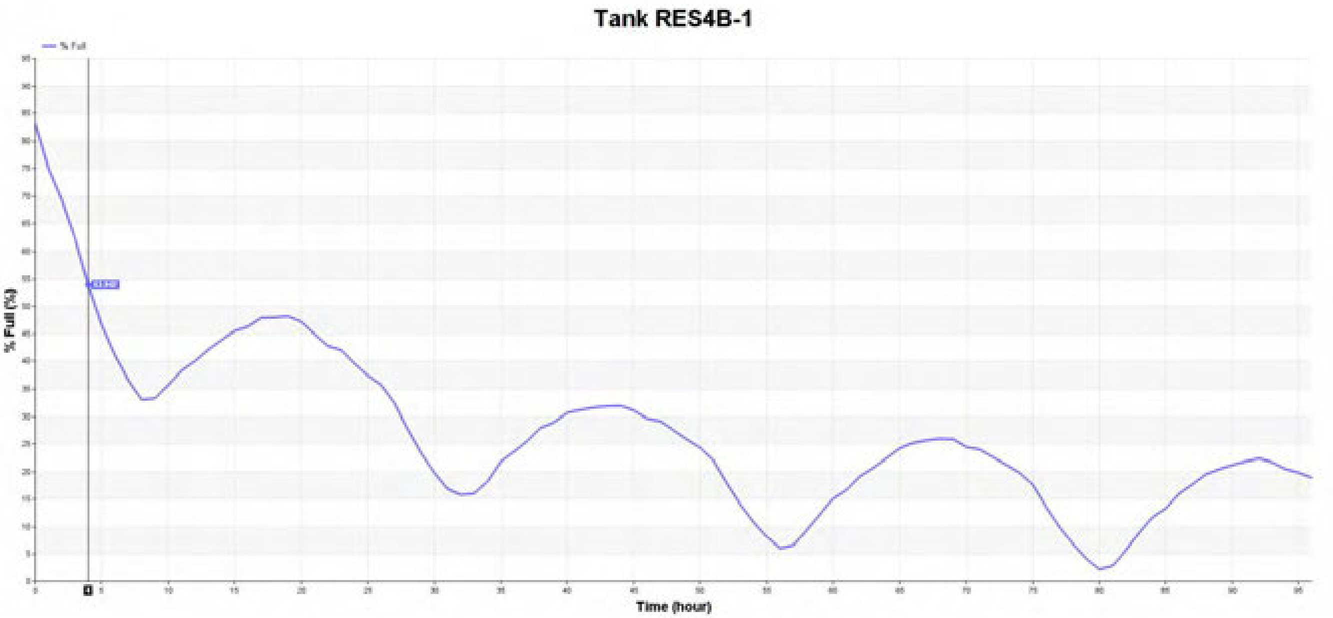



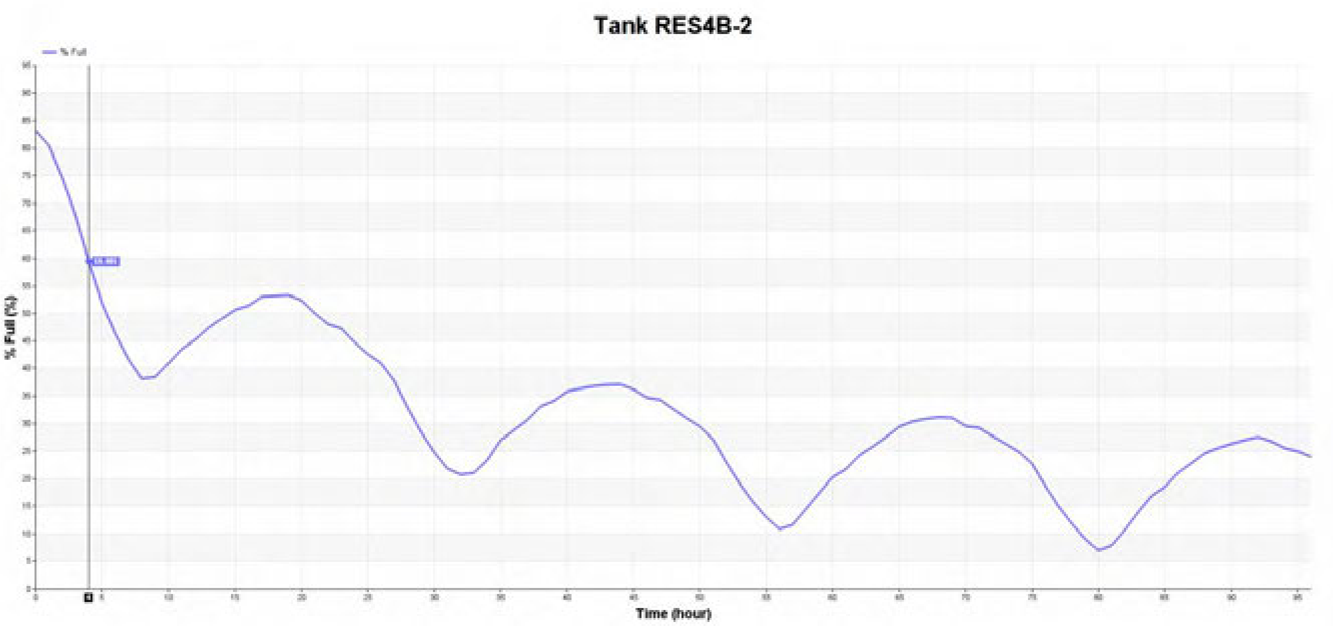
**Scenario 5: High Density Residential Fire Flow on Zone 6C in the project area at Peak Hour under Maximum Day Demand (Exhibit 7)**



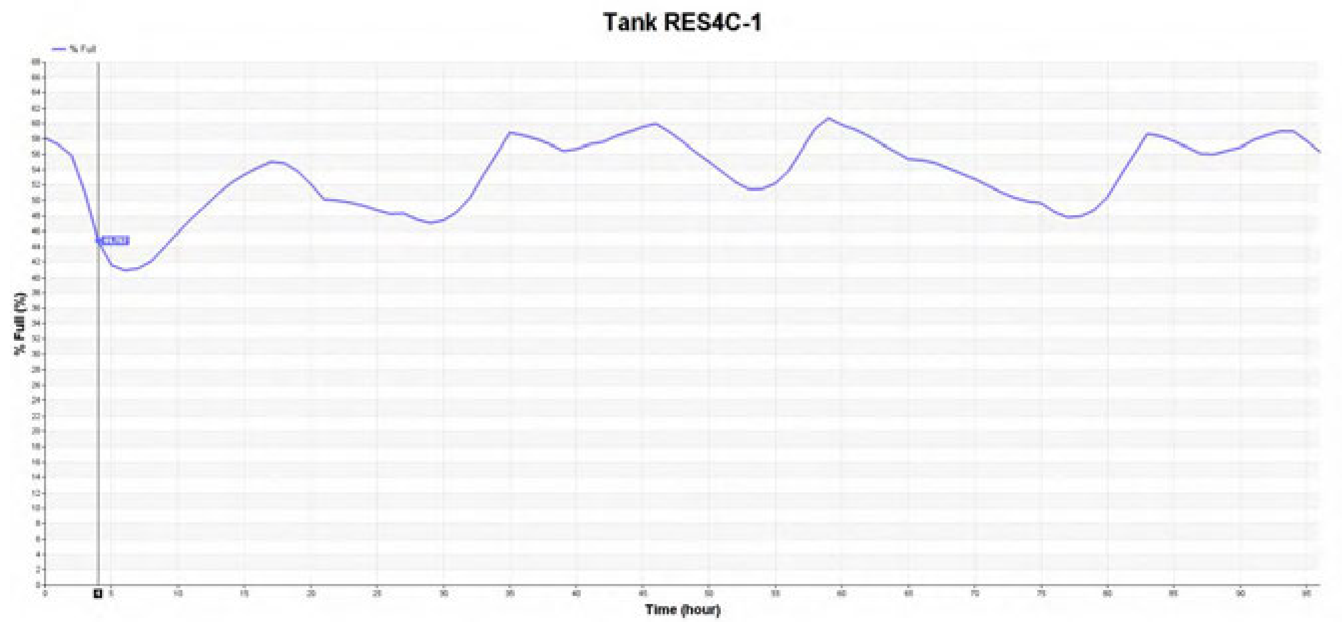



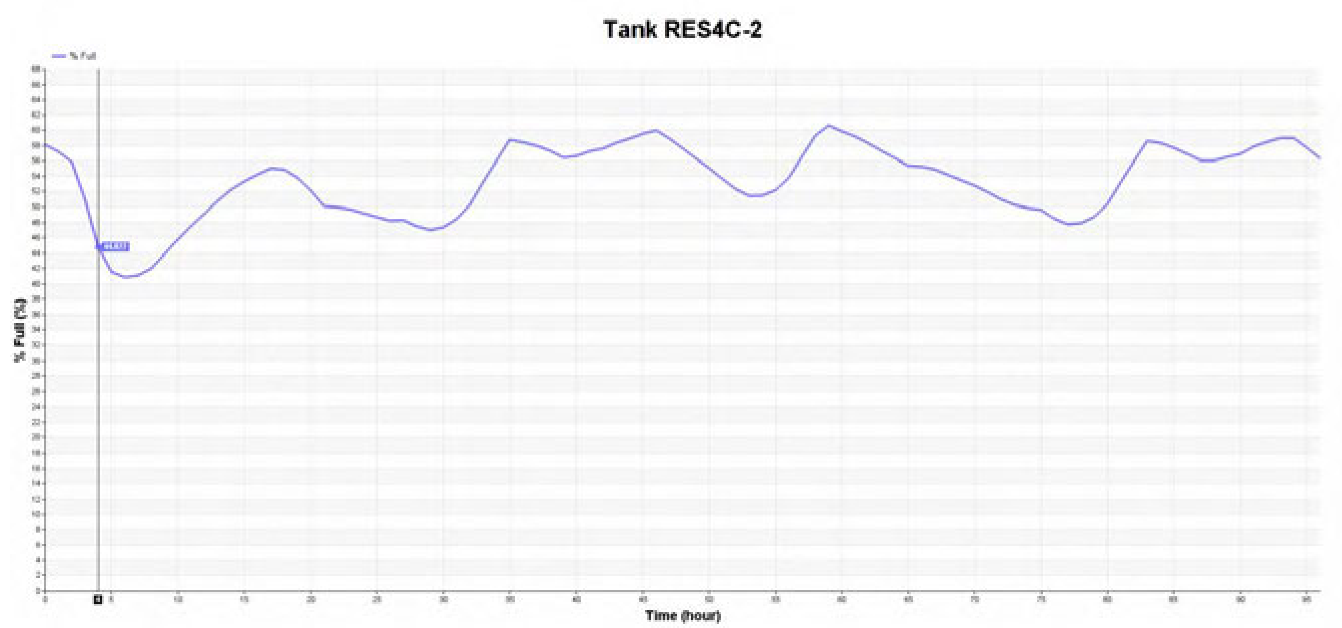
**Scenario 6: High Density Residential Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 8)**



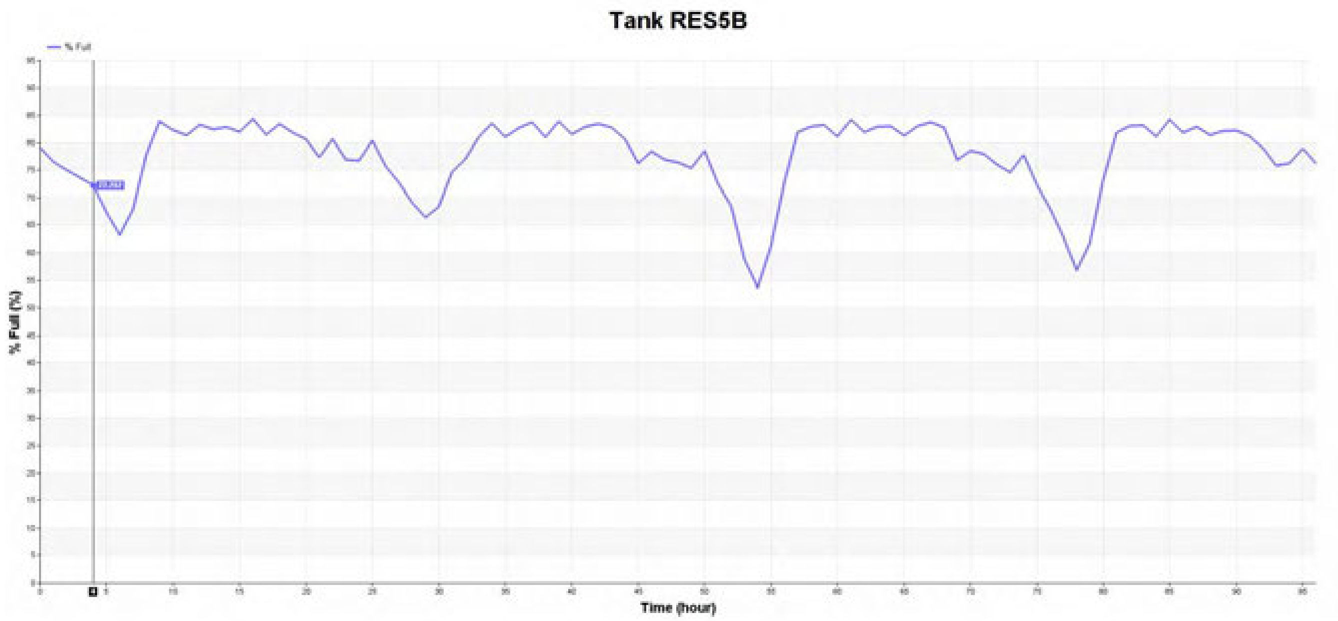



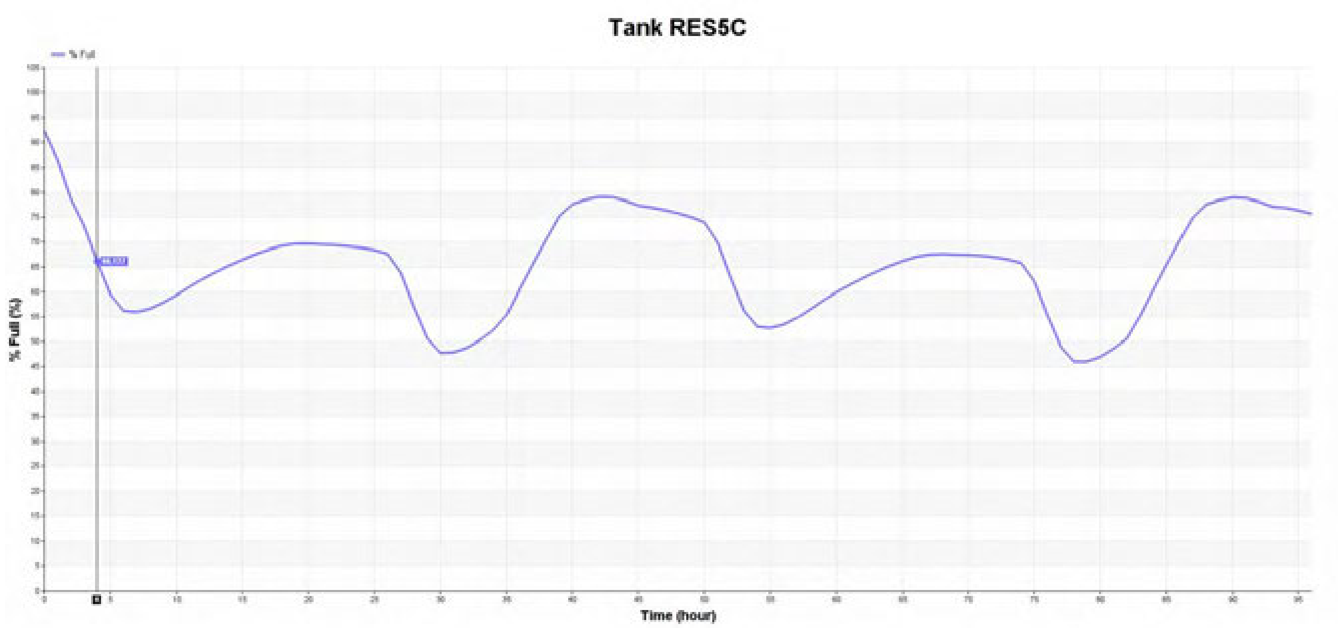
**Scenario 6: High Density Residential Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 8)**



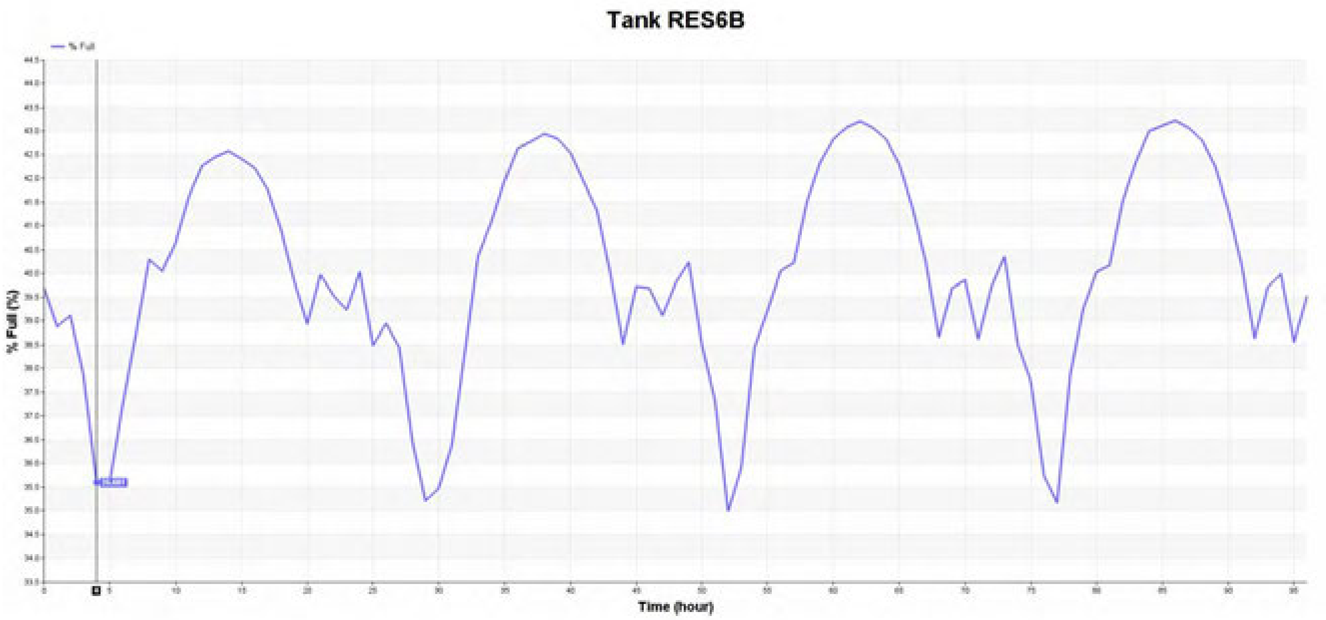



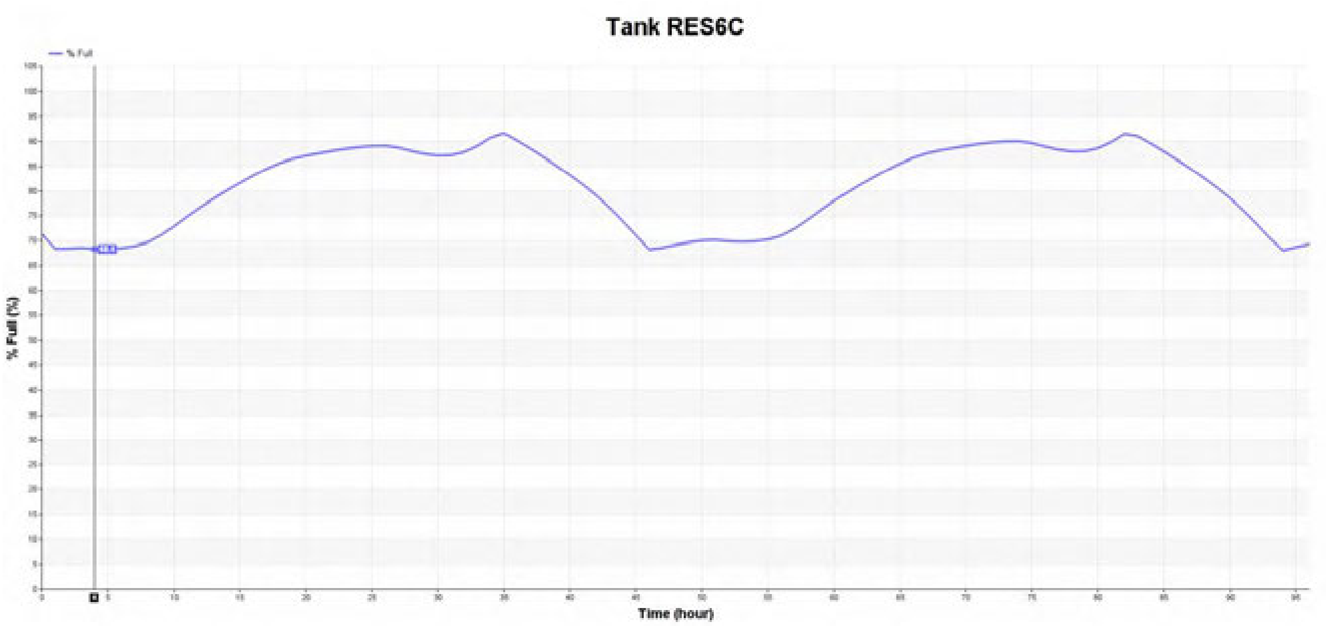
**Scenario 6: High Density Residential Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 8)**



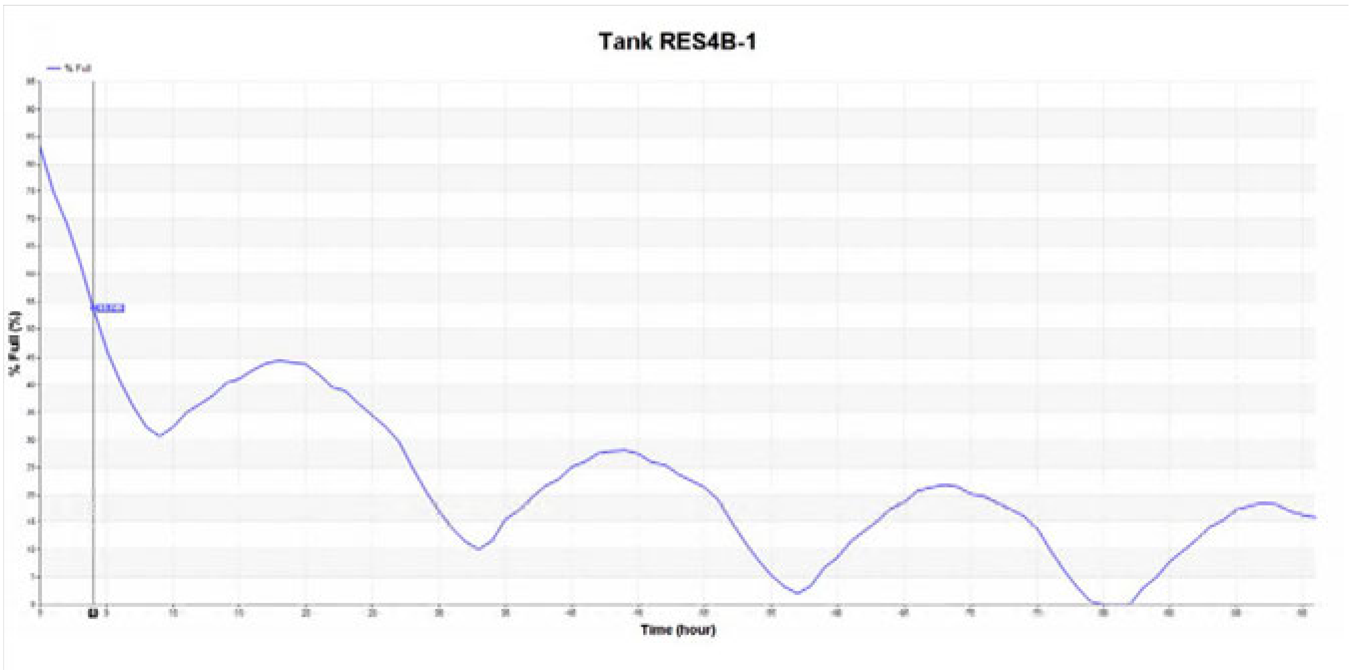



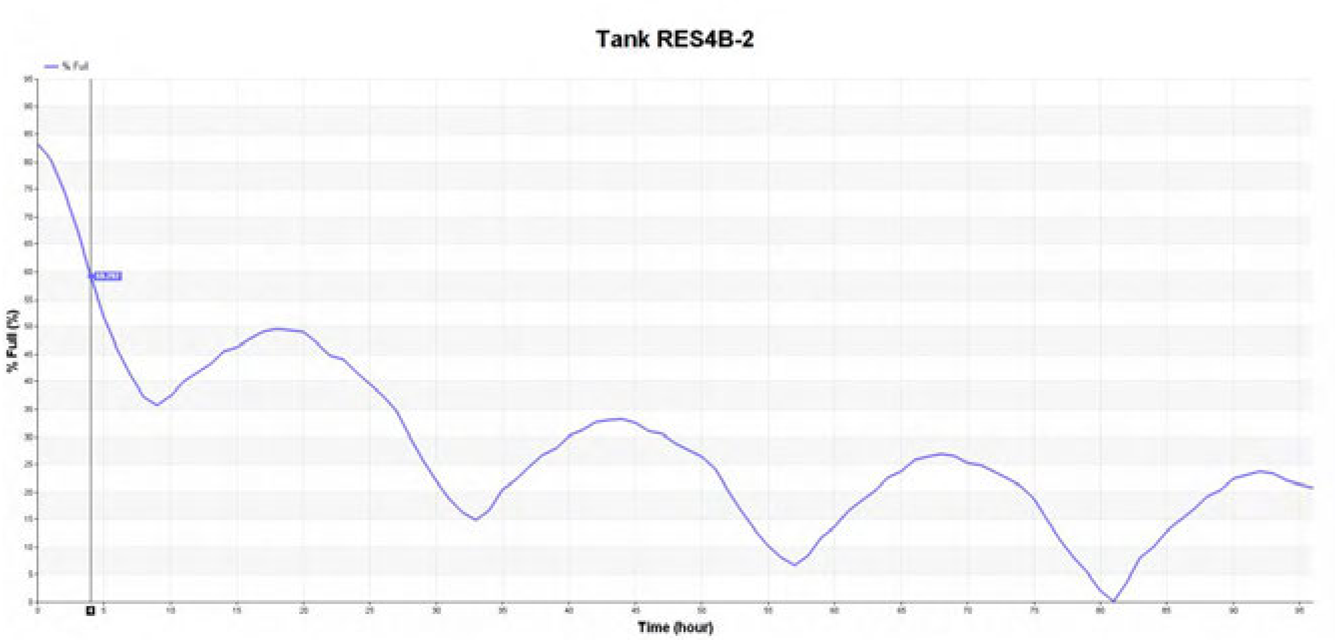
**Scenario 6: High Density Residential Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 8)**



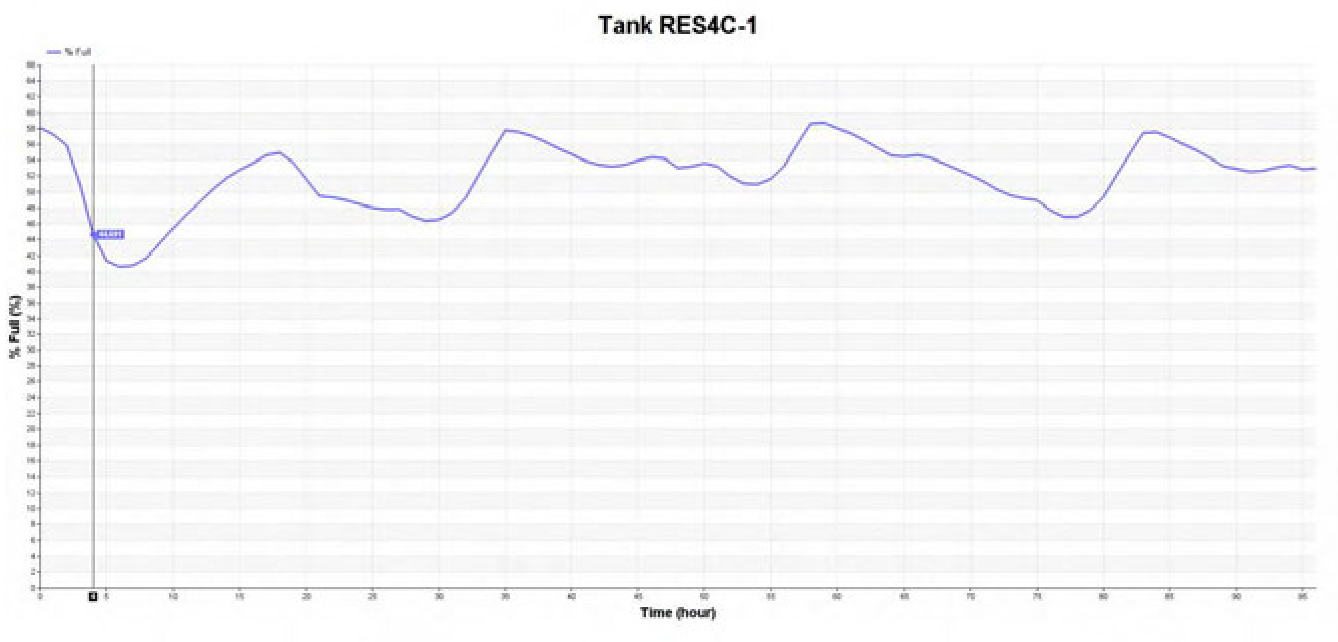



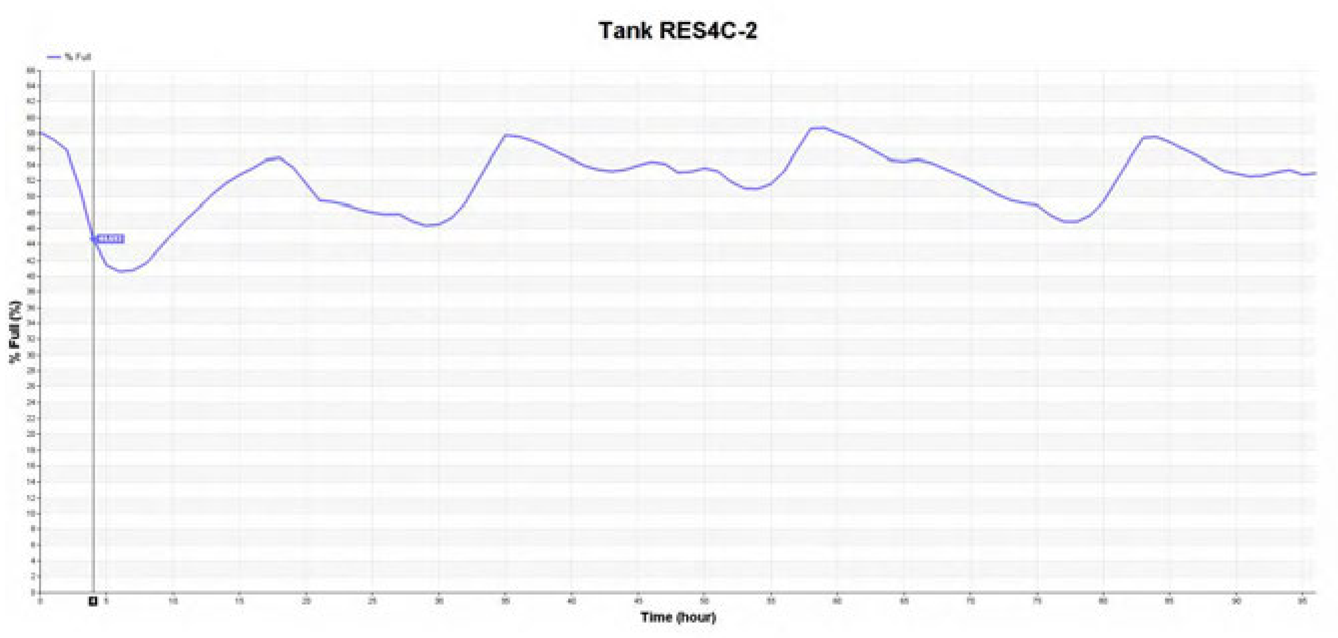
**Scenario 7: Commercial Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 9)**



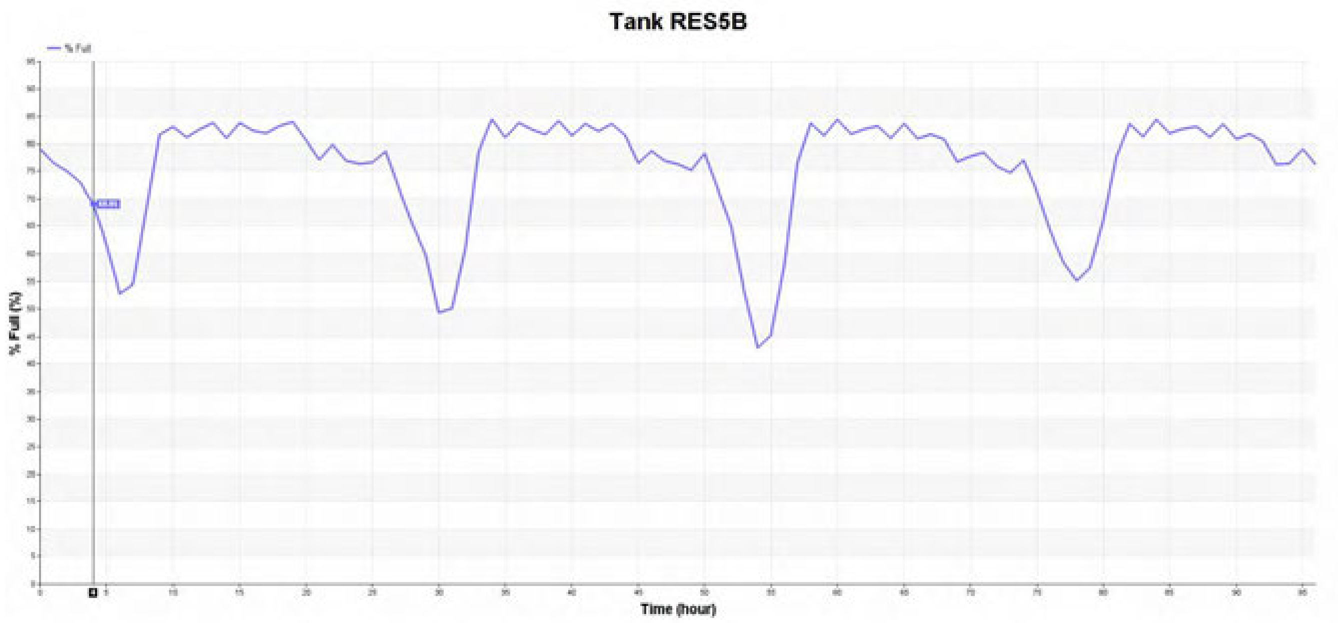



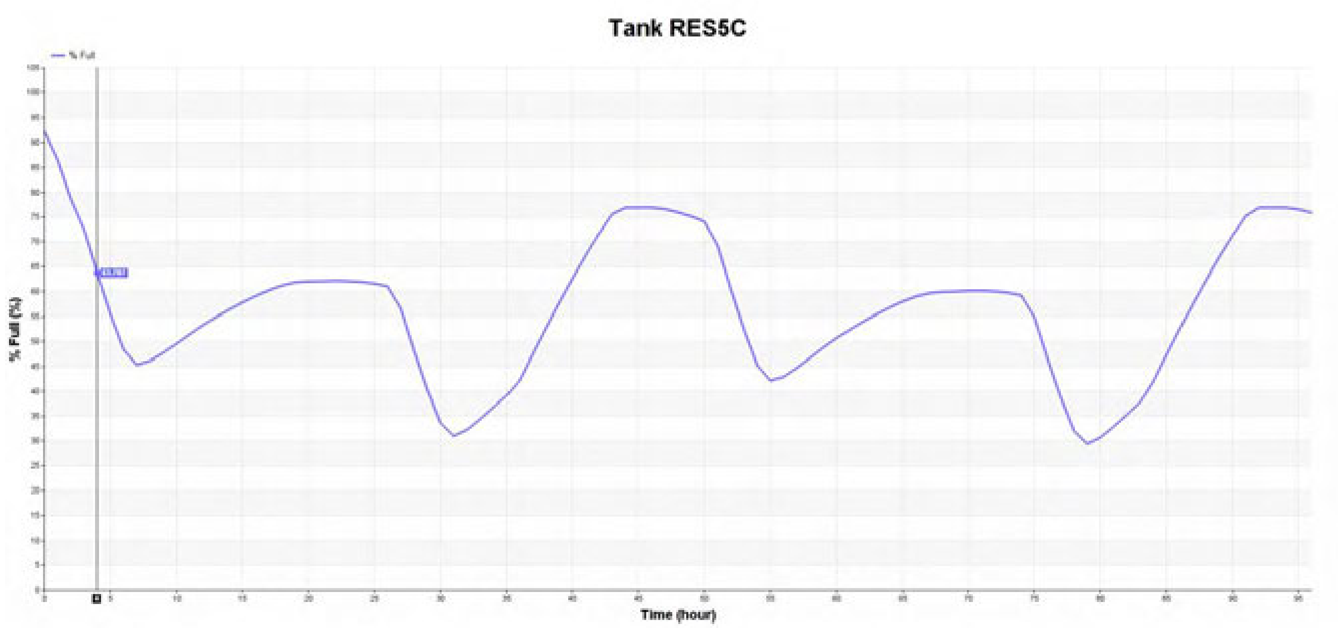
**Scenario 7: Commercial Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 9)**



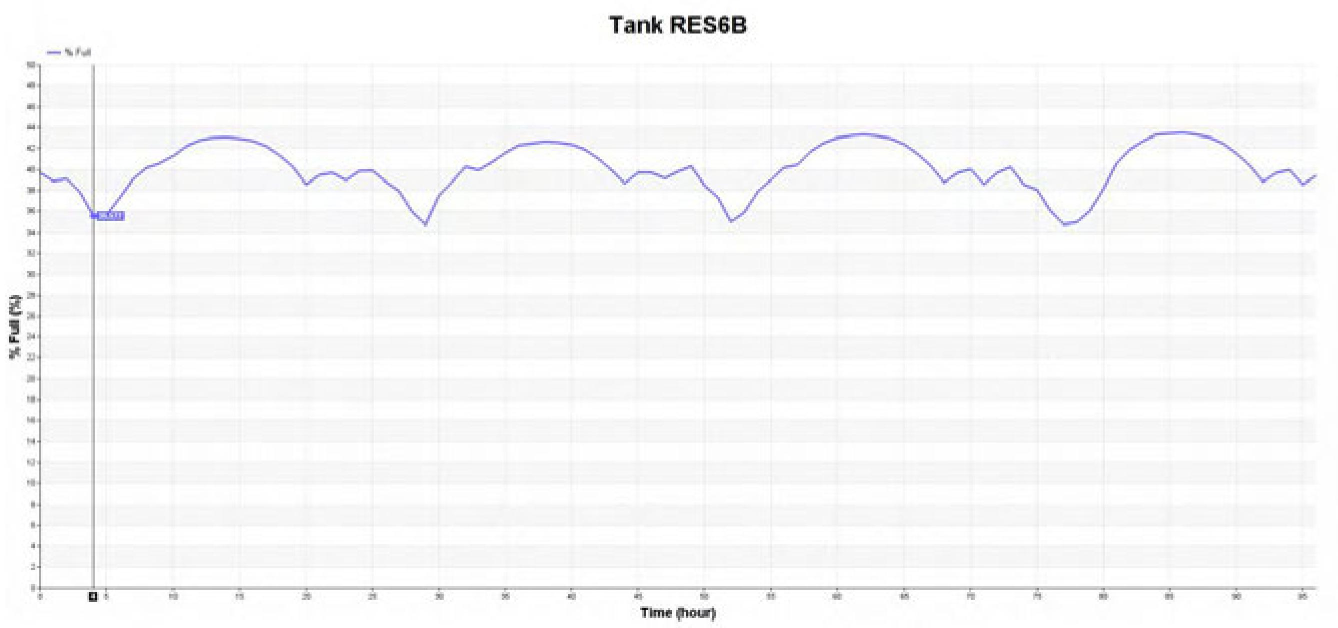



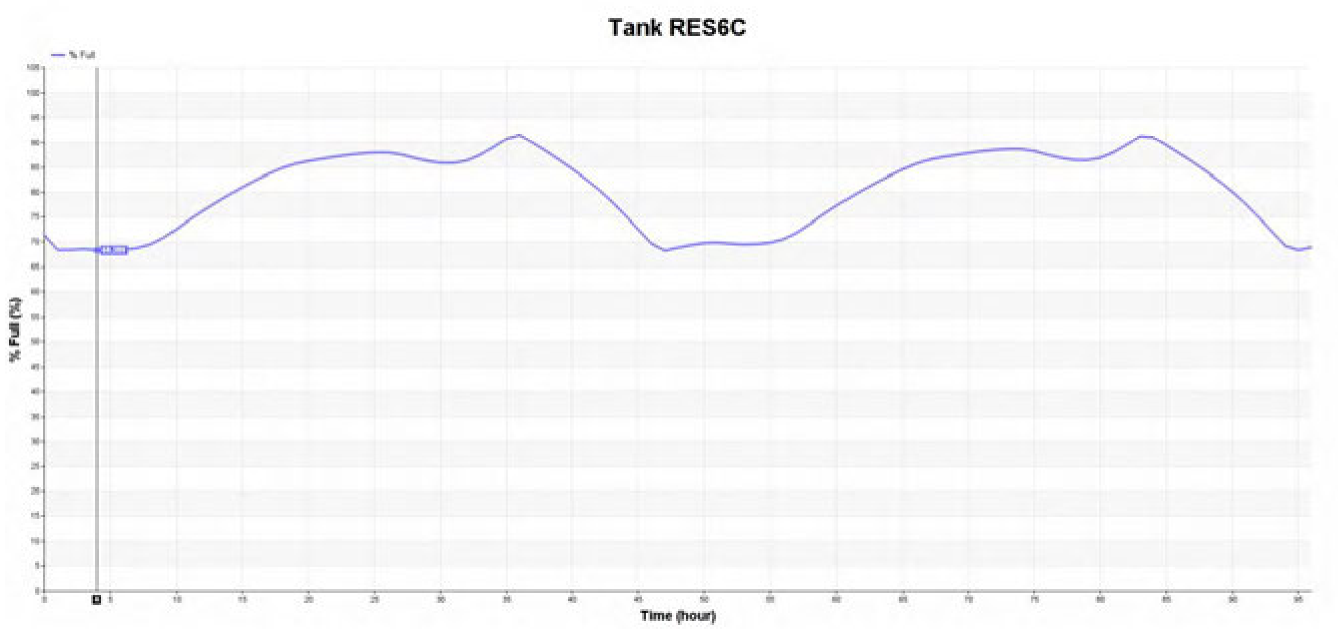
**Scenario 7: Commercial Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 9)**



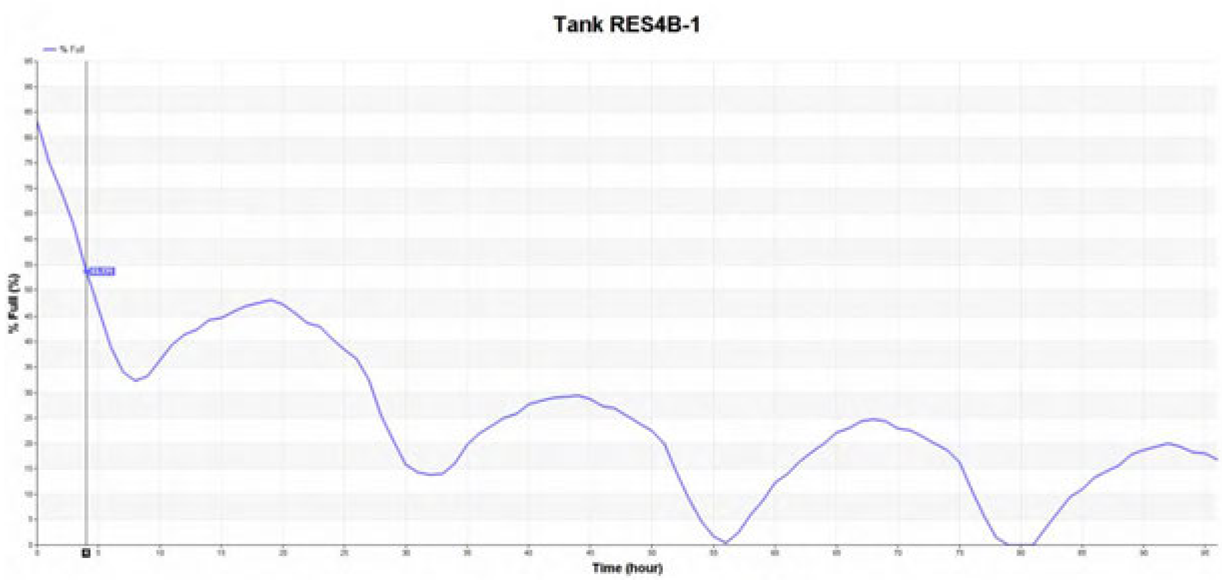



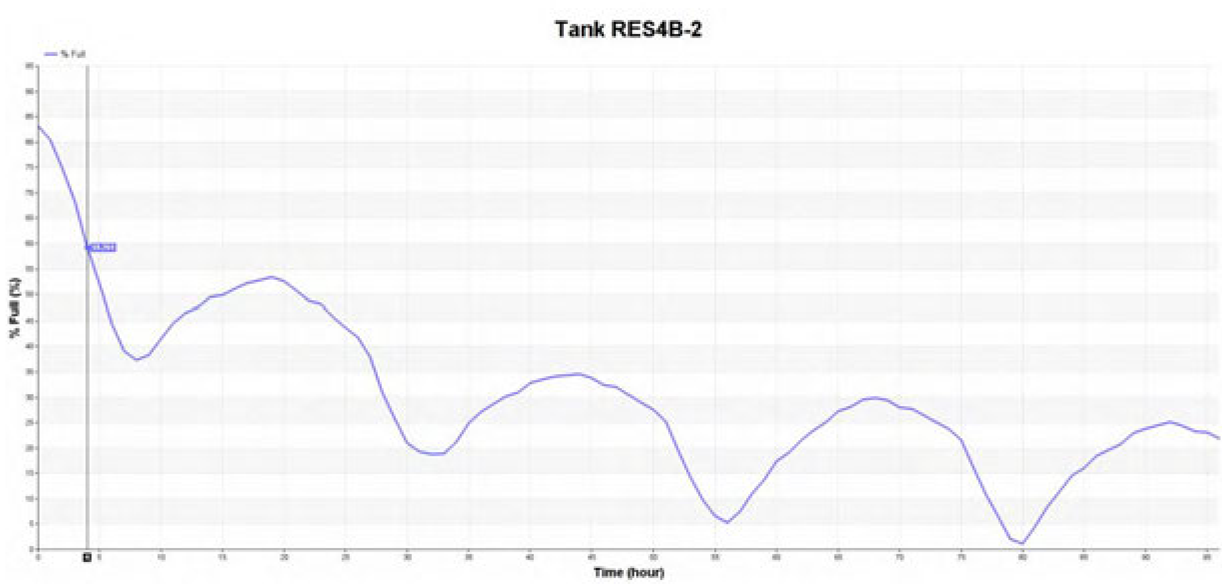
**Scenario 7: Commercial Fire Flow on Zone 5 in the project area at Peak Hour under Maximum Day Demand (Exhibit 9)**



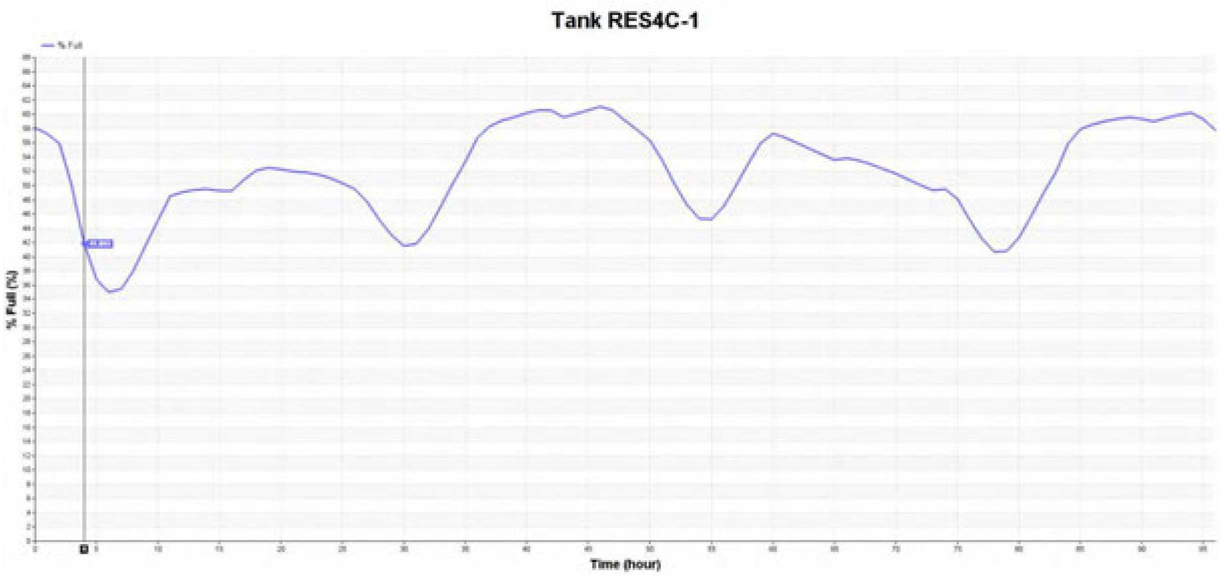



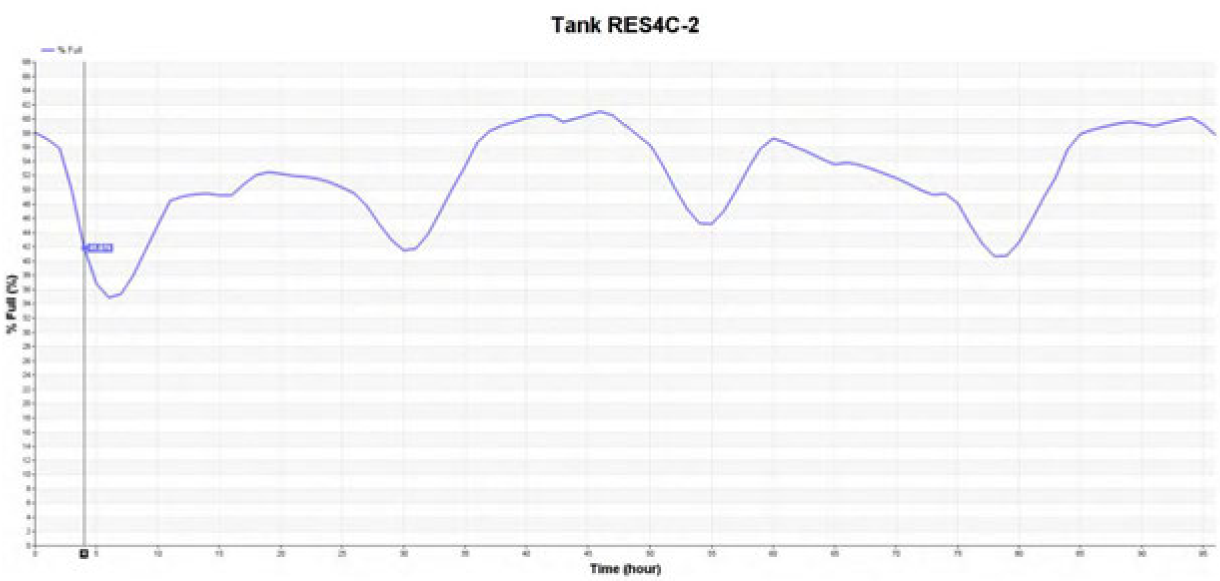
**Scenario 8: School Fire Flow on Zone 4 in area at Peak Hour under Maximum Day Demand (Exhibit 10)**



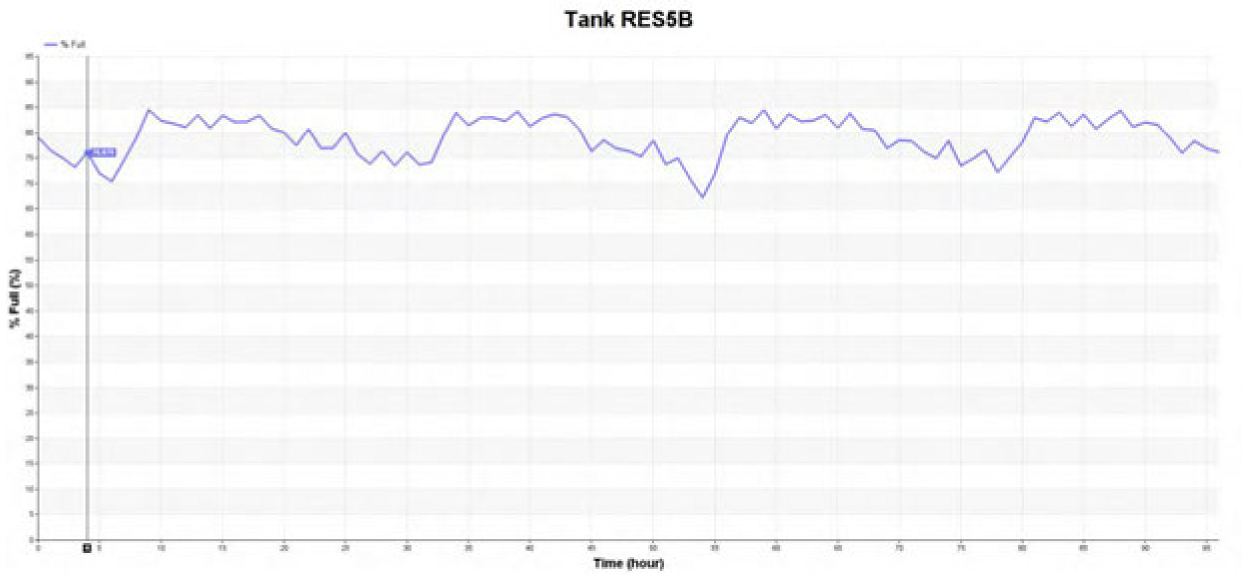



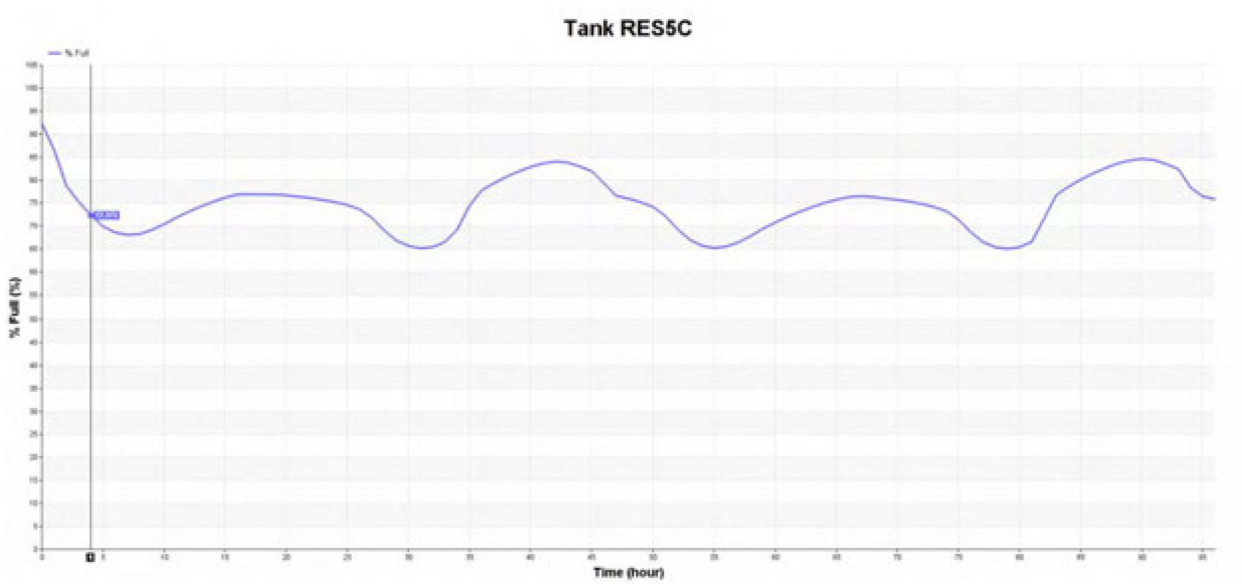
**Scenario 8: School Fire Flow on Zone 4 in area at Peak Hour under Maximum Day Demand (Exhibit 10)**



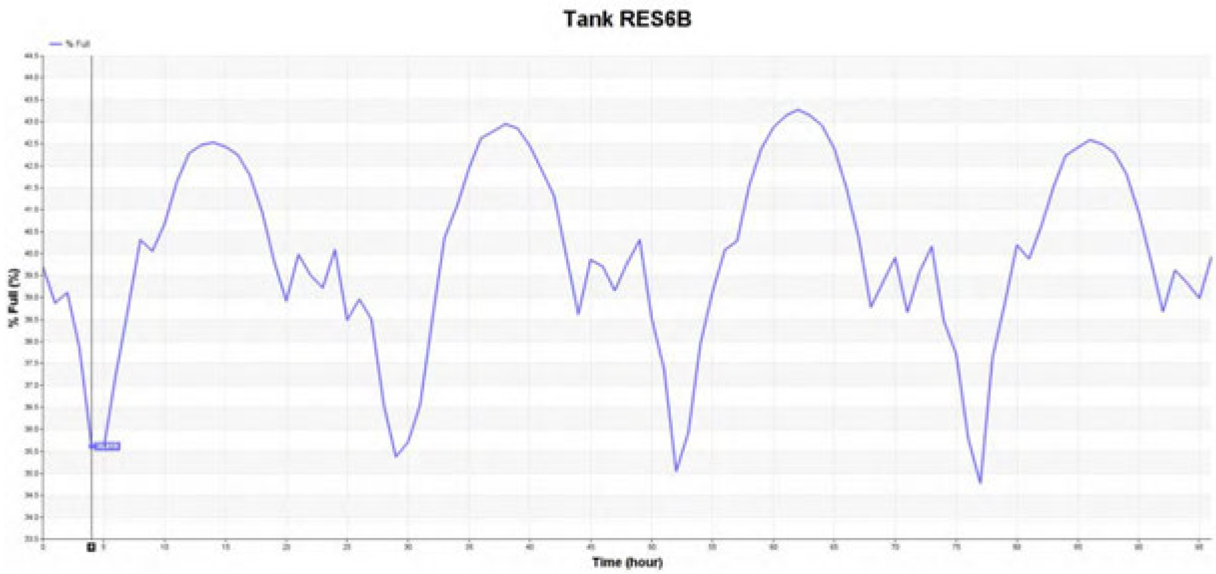



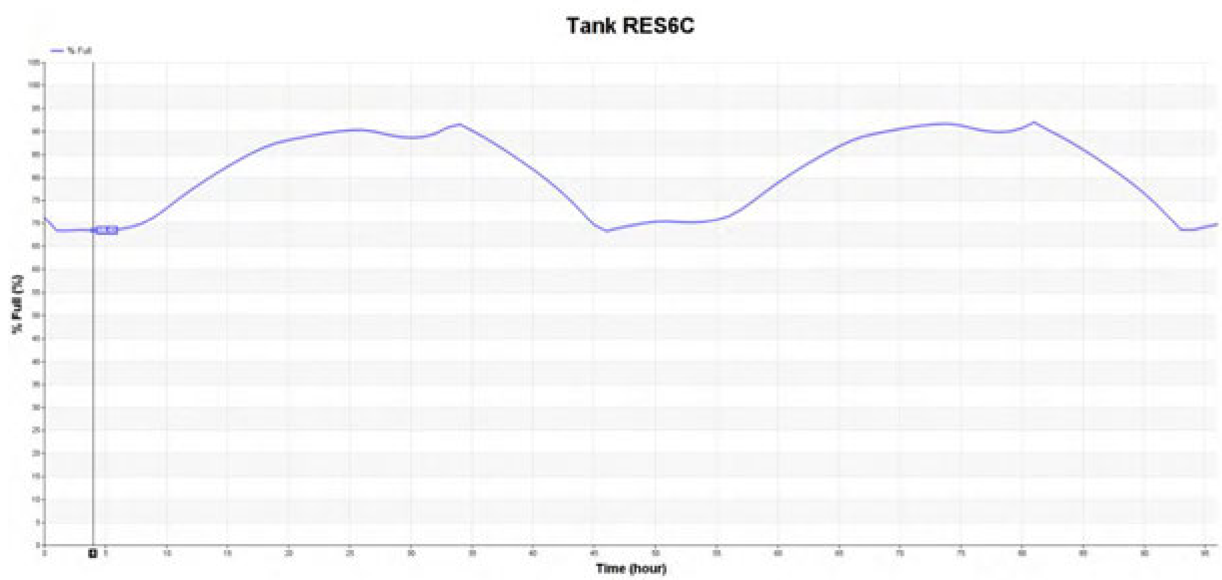
**Scenario 8: School Fire Flow on Zone 4 in area at Peak Hour under Maximum Day Demand (Exhibit 10)**



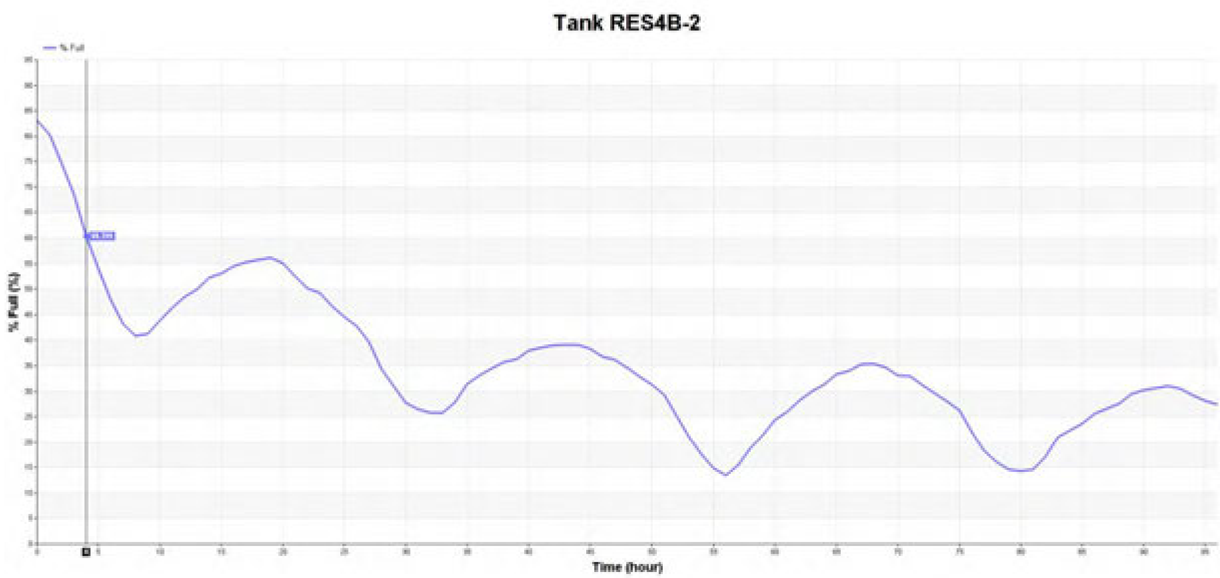



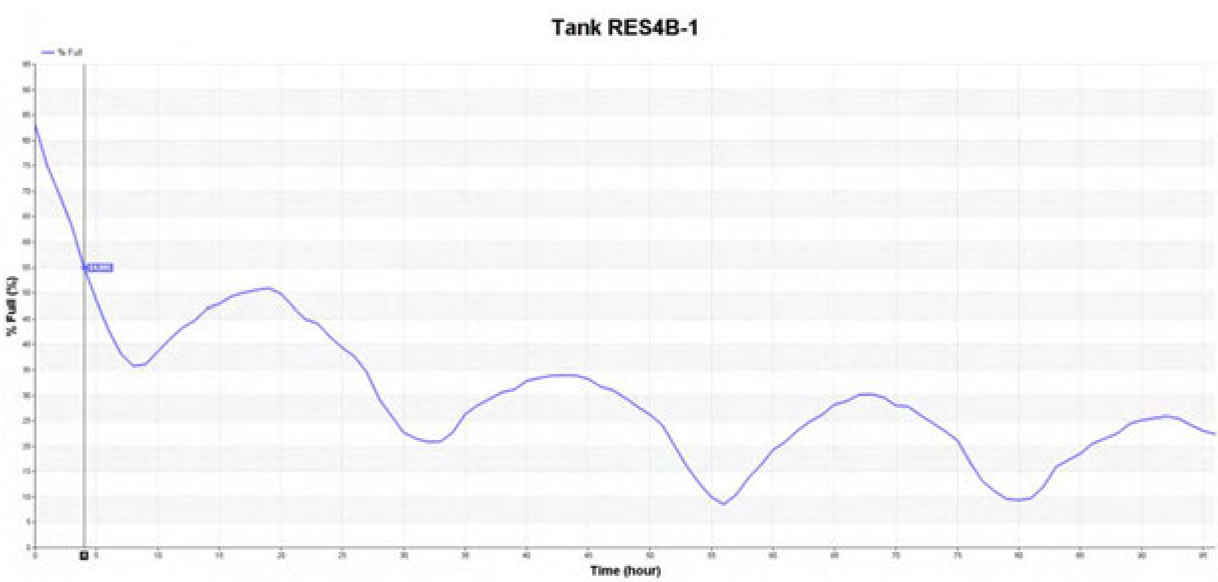
**Scenario 8: School Fire Flow on Zone 4 in area at Peak Hour under Maximum Day Demand (Exhibit 10)**



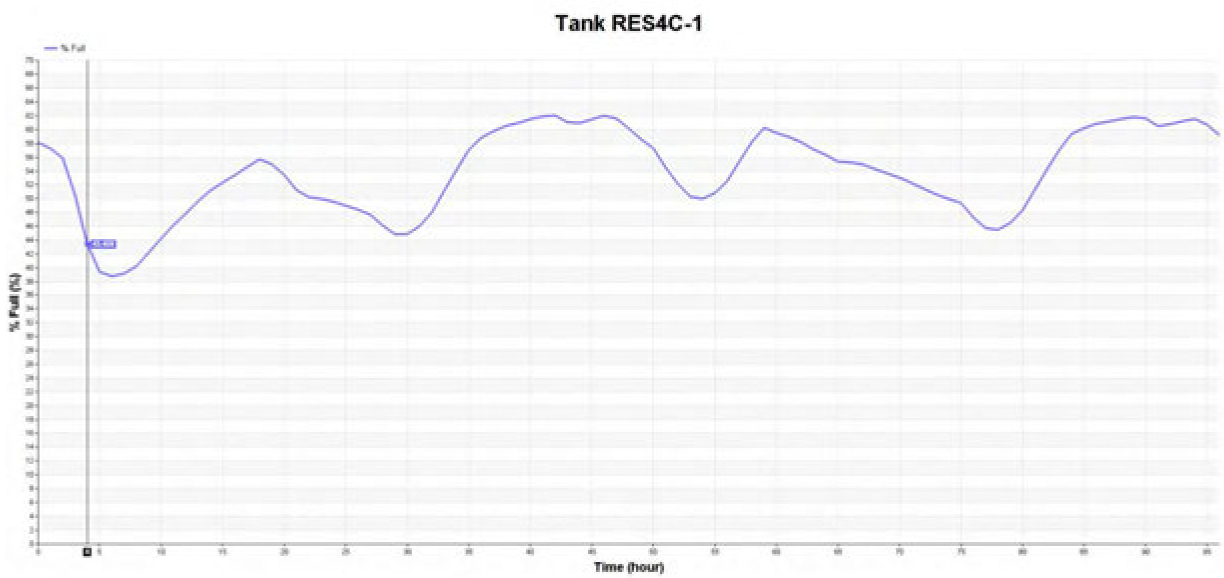



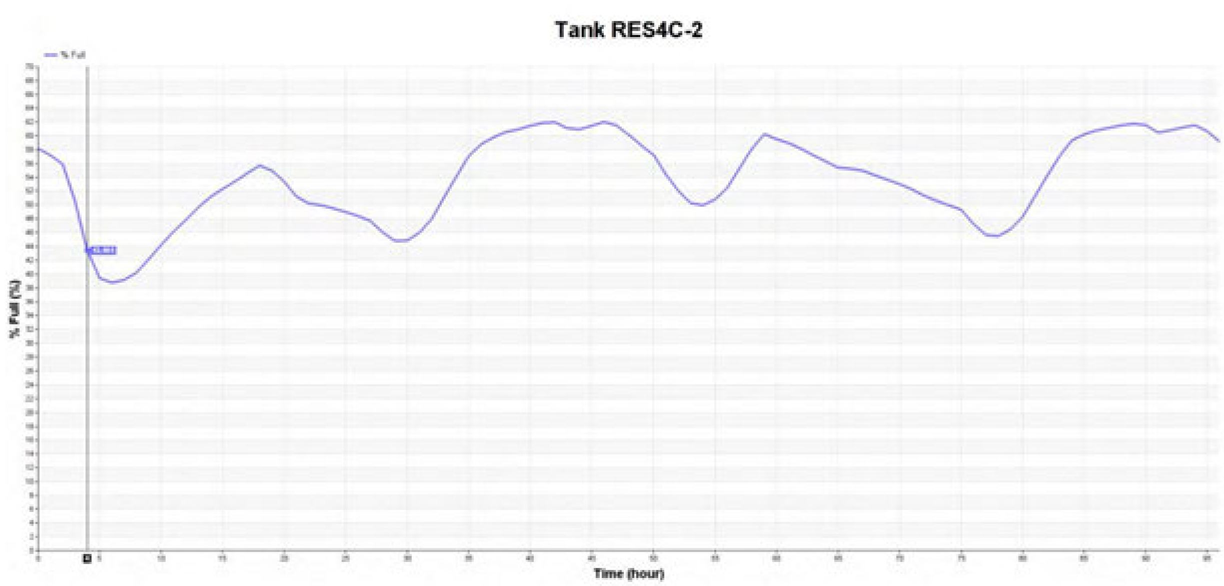
**Scenario 9: Medium Density Fire Flow on Zone 5 in the Southeast Area at Peak Hour under Maximum Day Demand (Exhibit 11)**



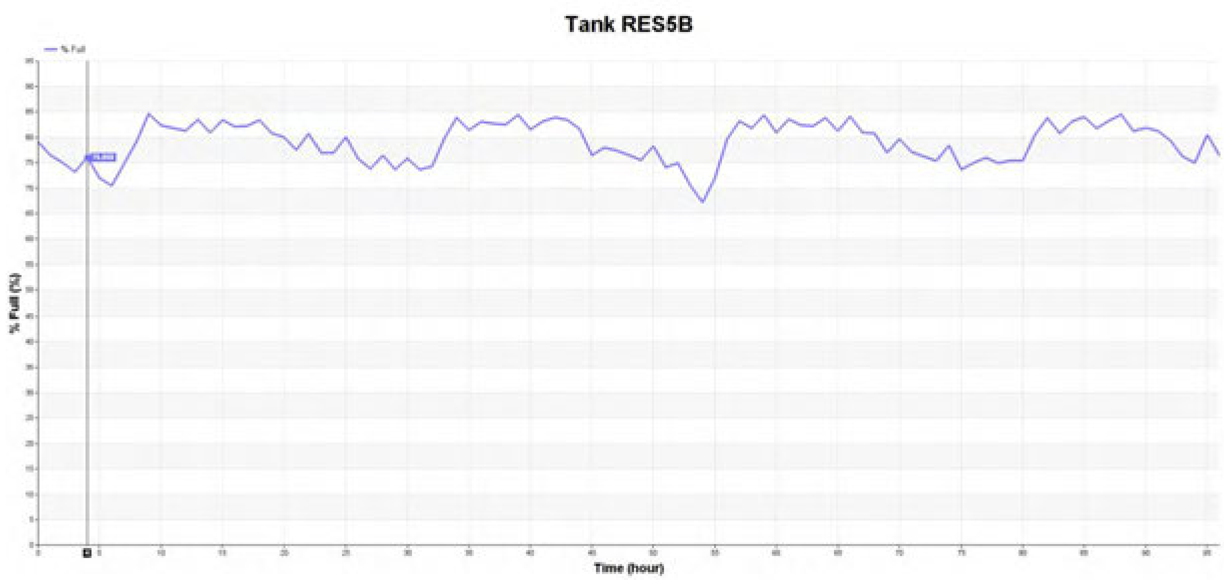



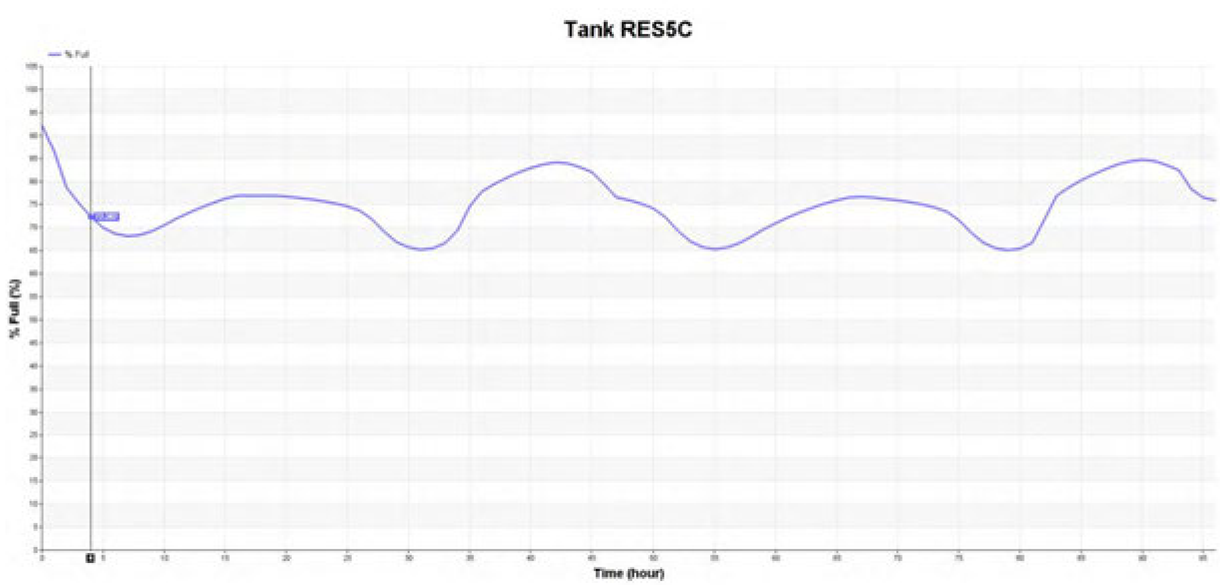
**Scenario 9: Medium Density Fire Flow on Zone 5 in the Southeast Area at Peak Hour under Maximum Day Demand (Exhibit 11)**



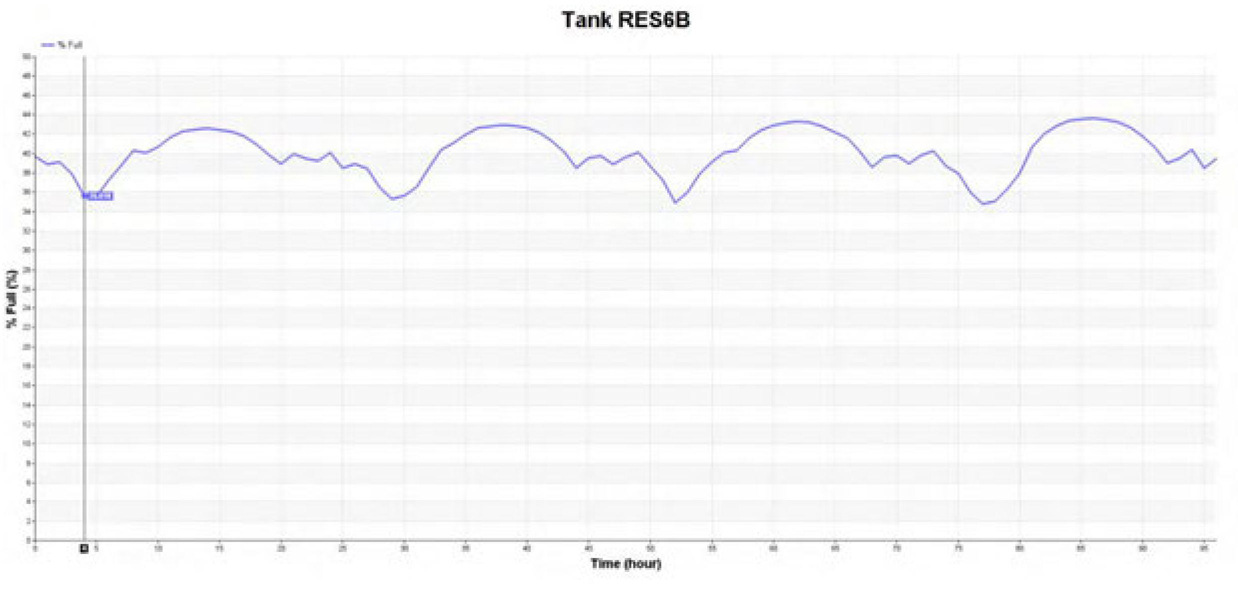



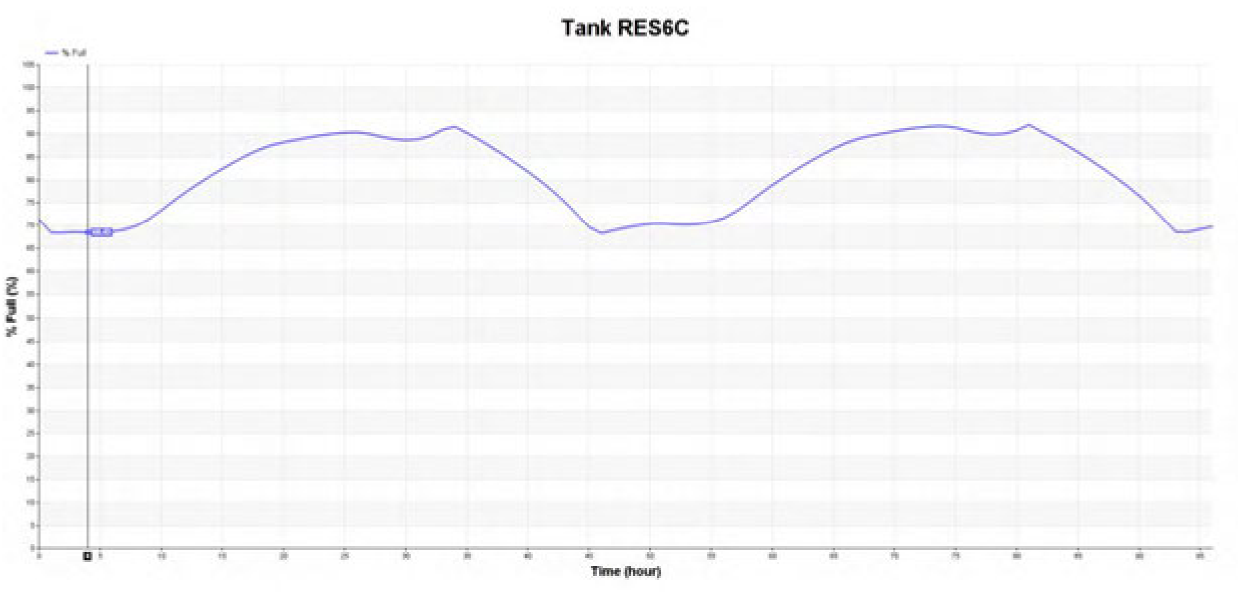
**Scenario 9: Medium Density Fire Flow on Zone 5 in the Southeast Area at Peak Hour under Maximum Day Demand (Exhibit 11)**



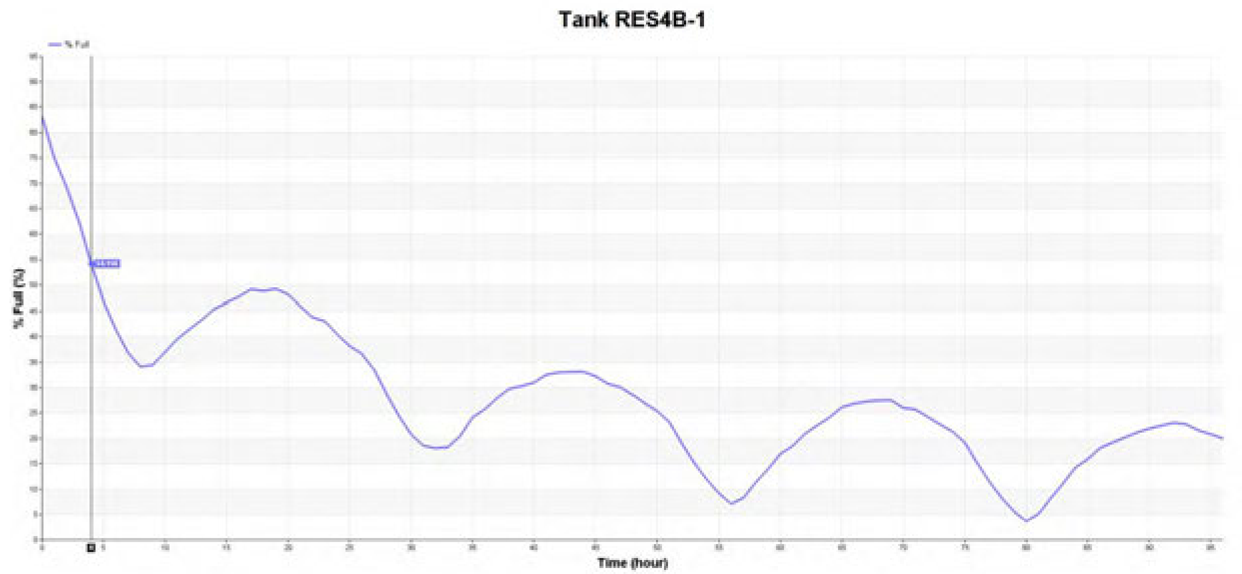



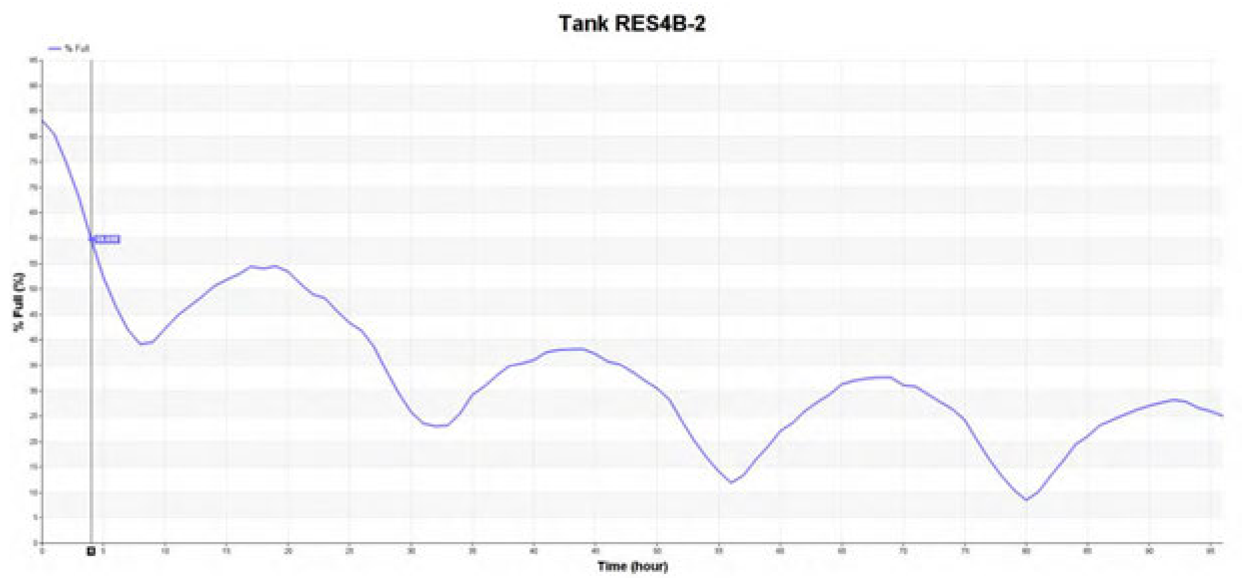
**Scenario 9: Medium Density Fire Flow on Zone 5 in the Southeast Area at Peak Hour under Maximum Day Demand (Exhibit 11)**



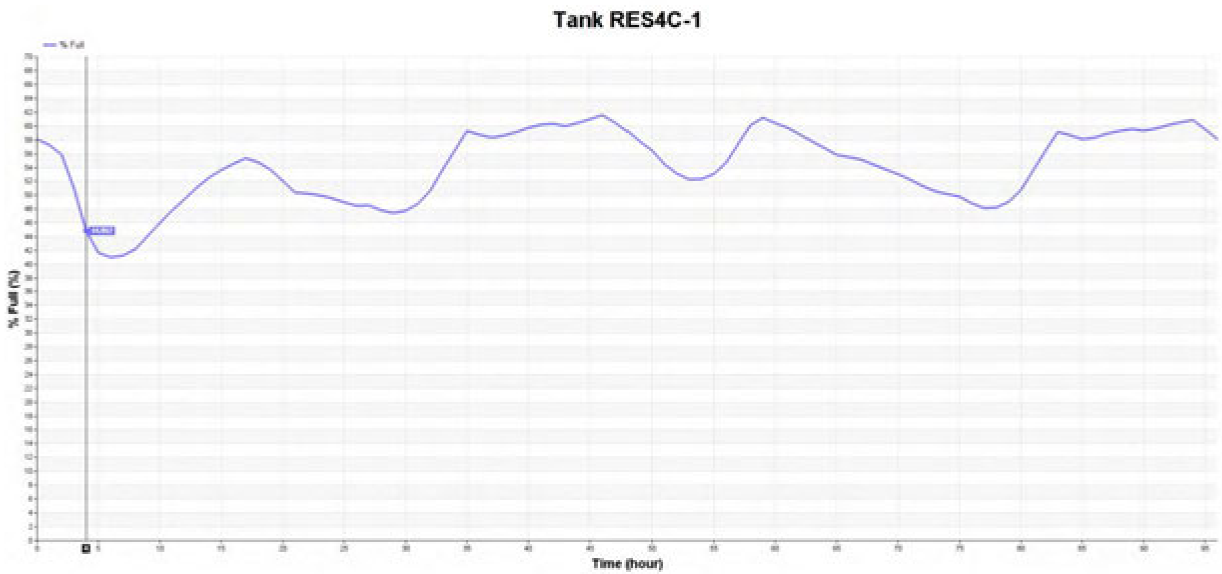



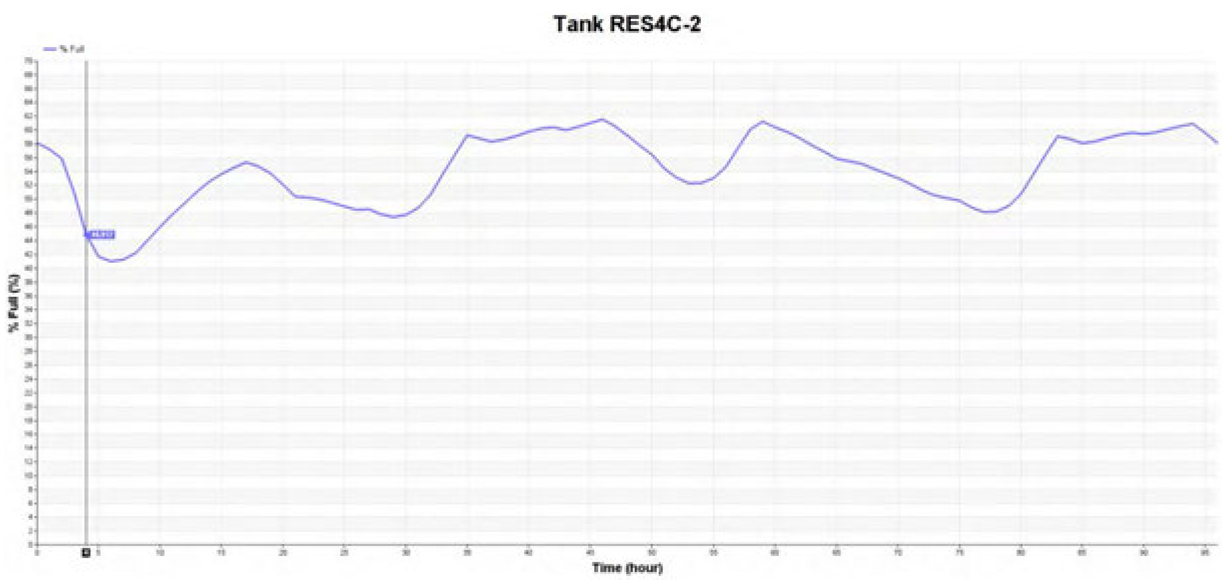
**Scenario 10: Medium Density Fire Flow on Zone 5 in the West Area at Peak Hour under Maximum Day Demand (Exhibit 12)**



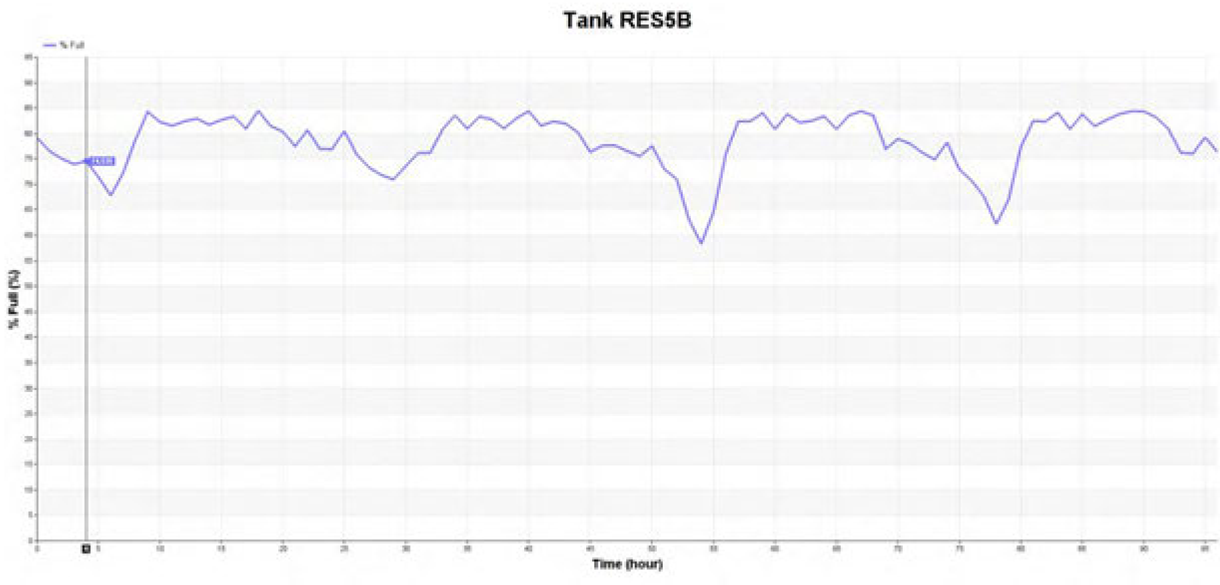



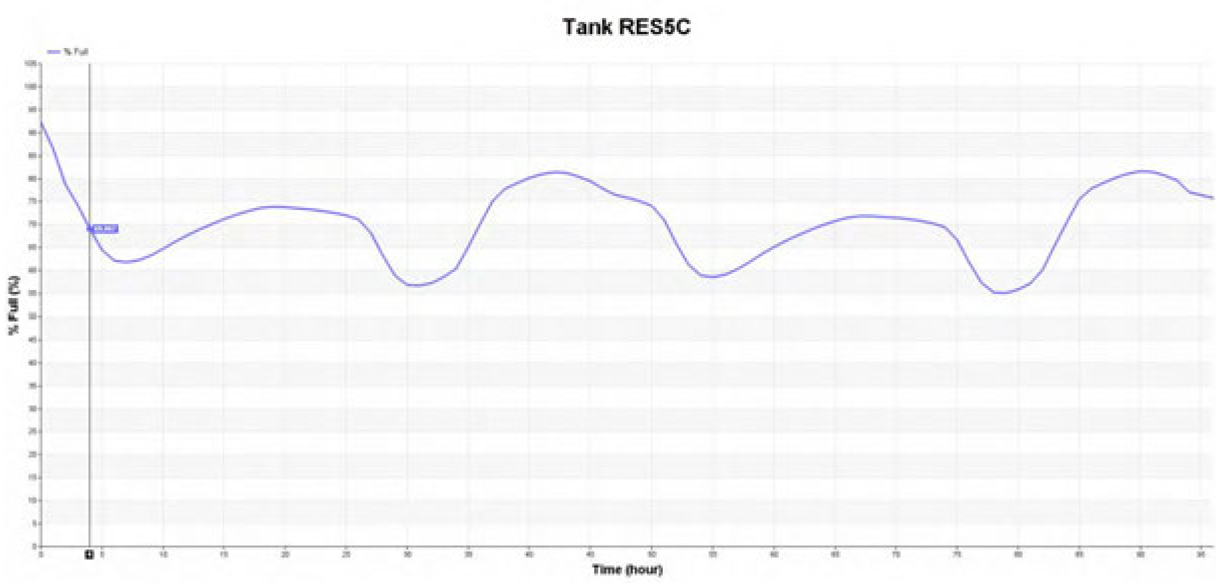
**Scenario 10: Medium Density Fire Flow on Zone 5 in the West Area at Peak Hour under Maximum Day Demand (Exhibit 12)**



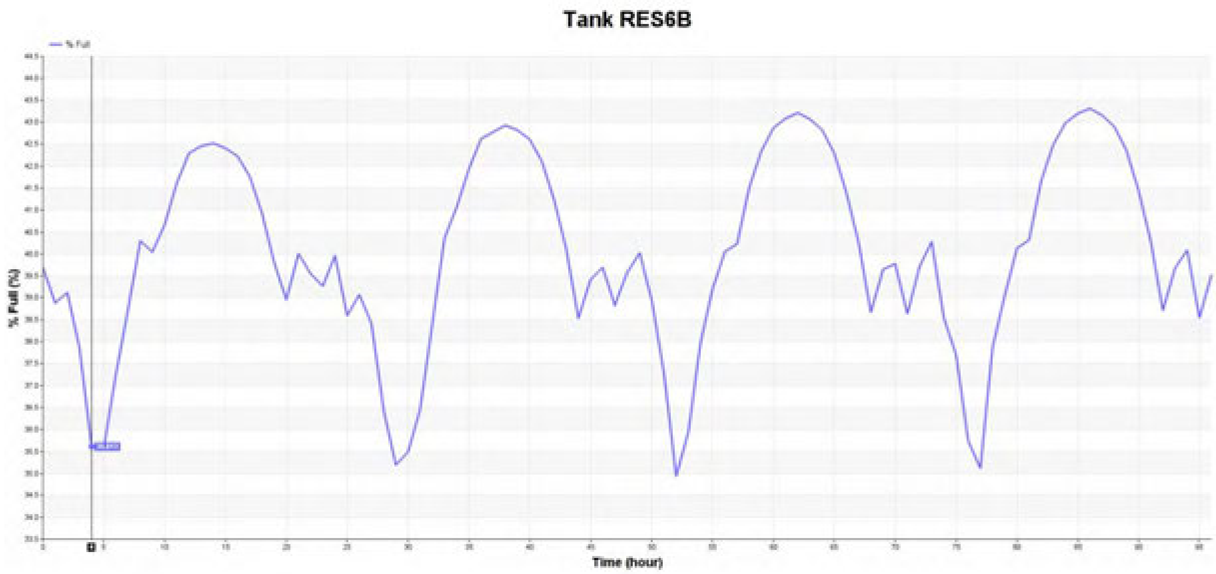



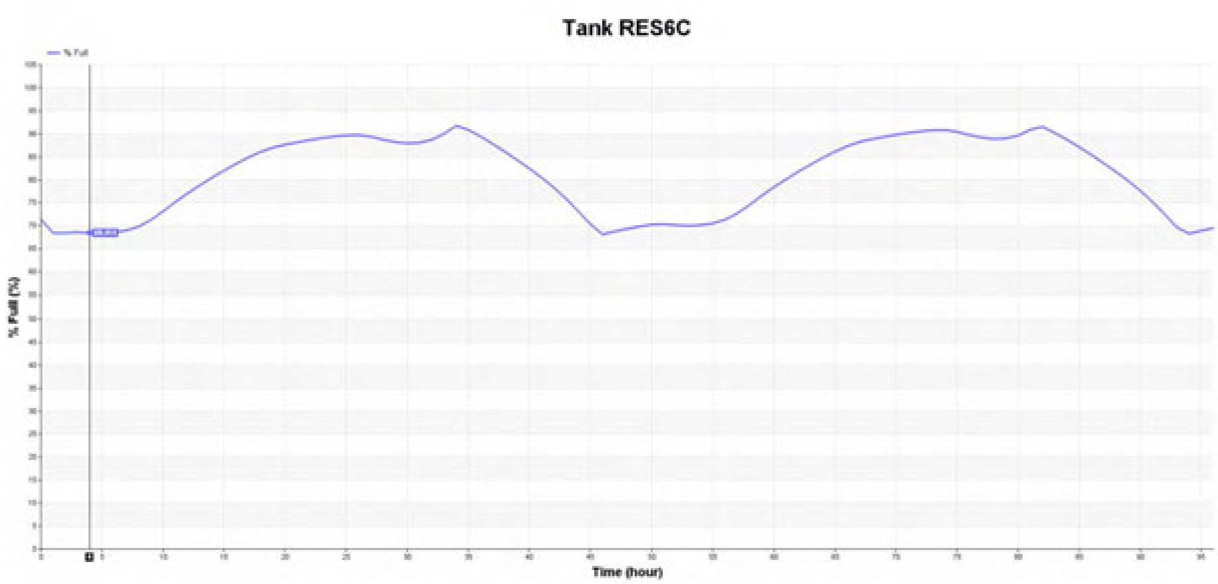
**Scenario 10: Medium Density Fire Flow on Zone 5 in the West Area at Peak Hour under Maximum Day Demand (Exhibit 12)**



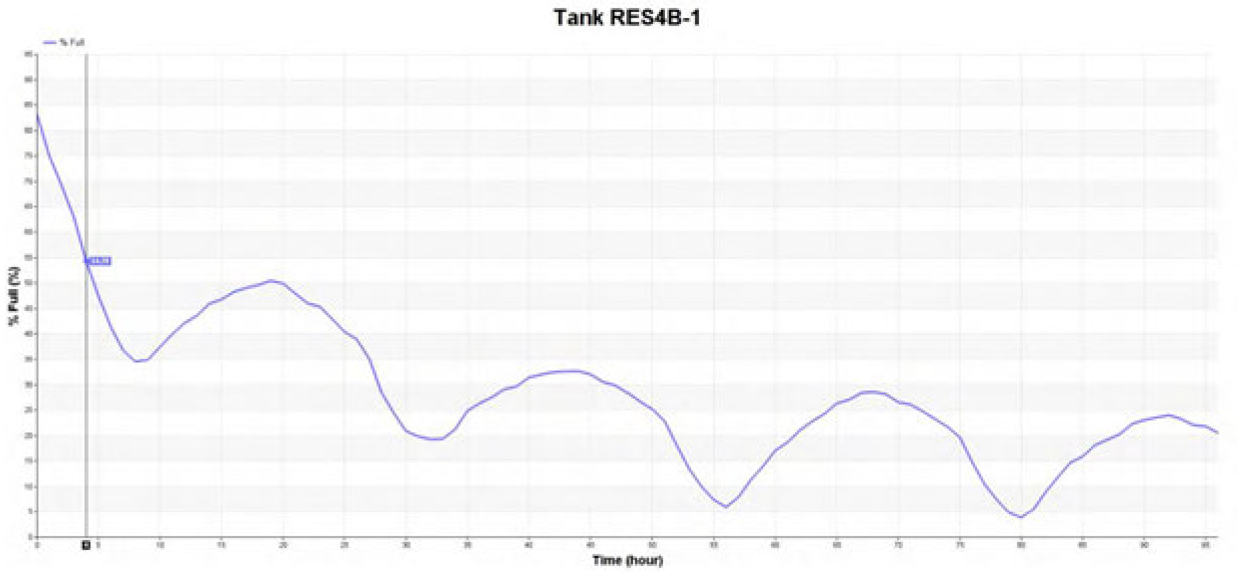



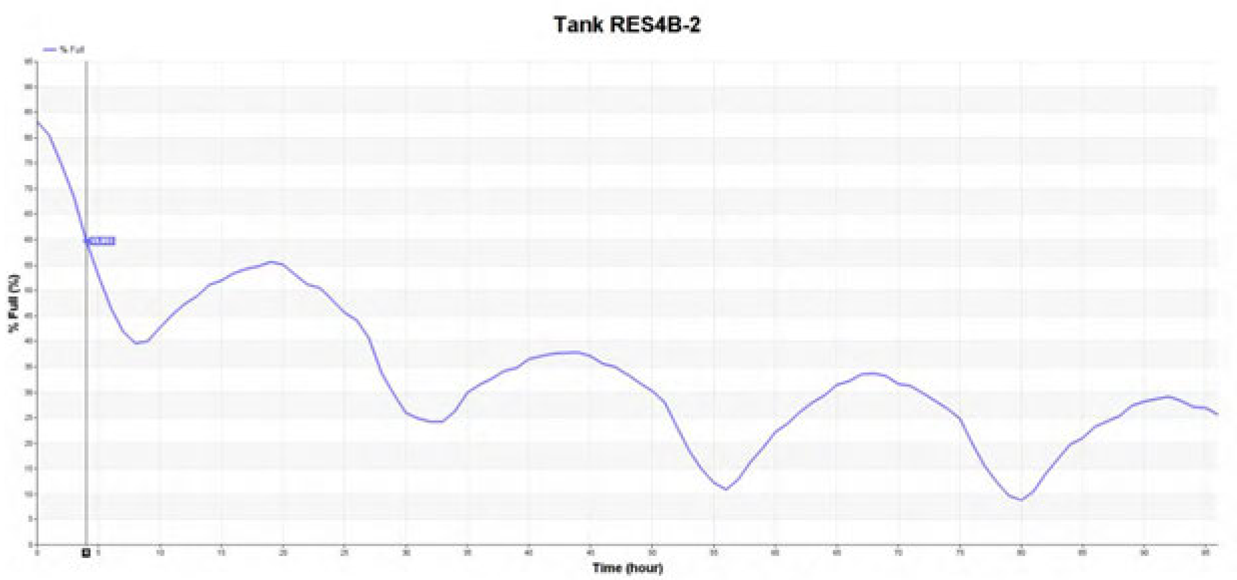
**Scenario 10: Medium Density Fire Flow on Zone 5 in the West Area at Peak Hour under Maximum Day Demand (Exhibit 12)**



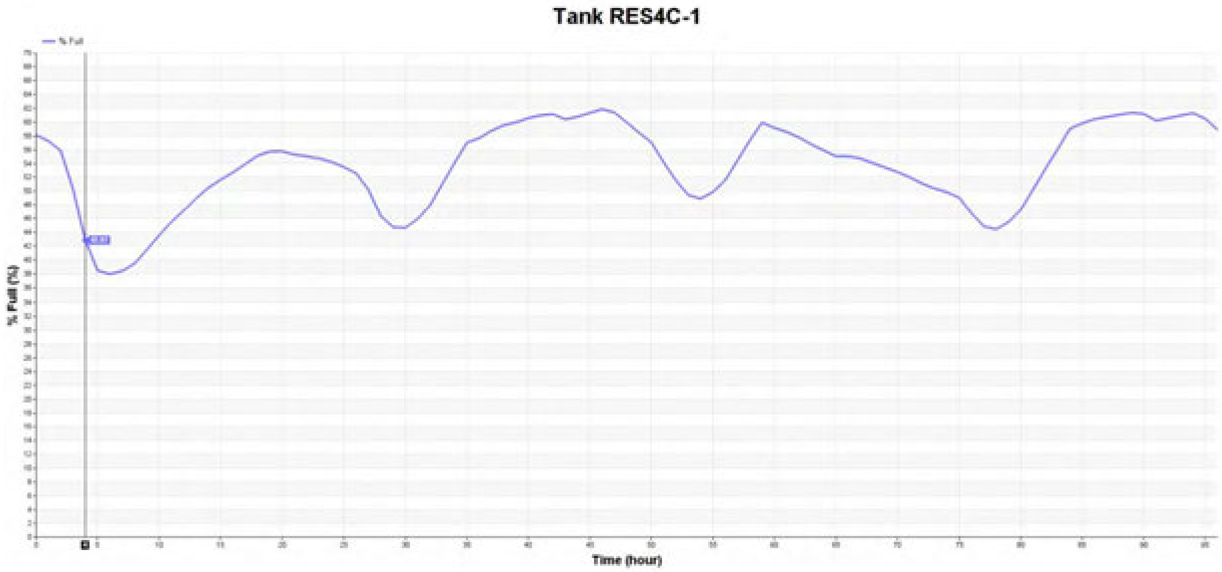



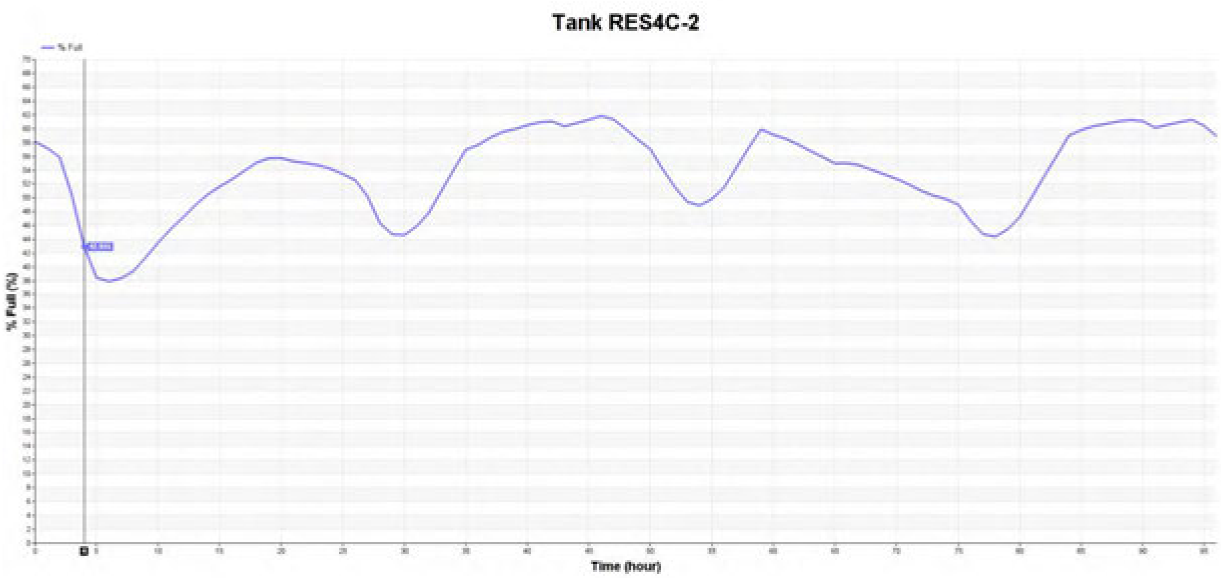
**Scenario 11: Low Density Residential Fire Flow in both Infill Areas; Concurrently (Exhibit 13)**



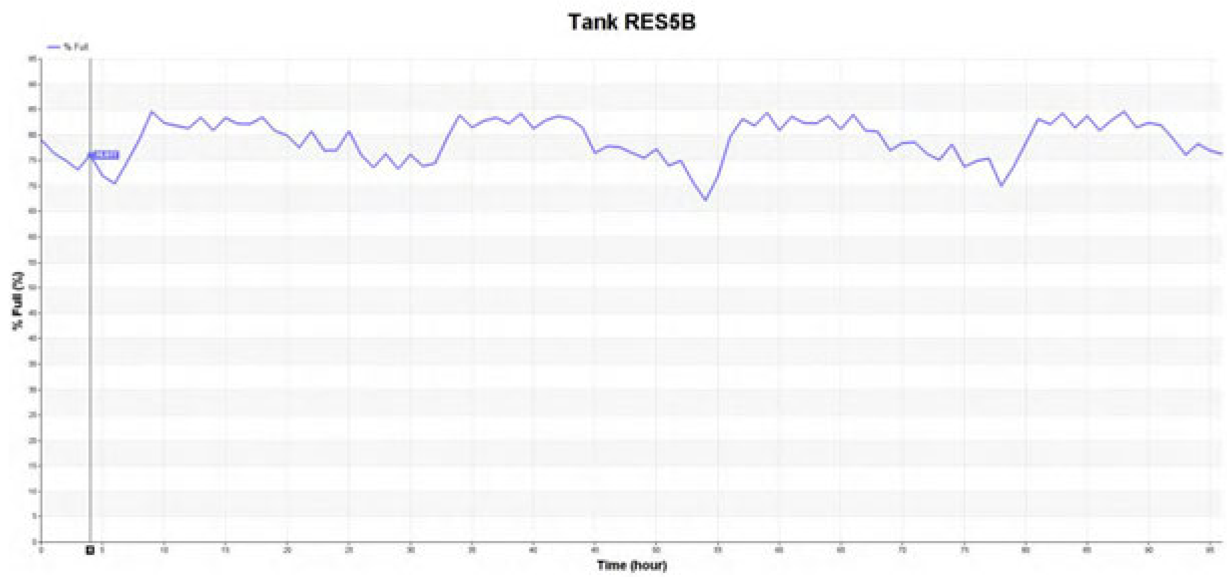



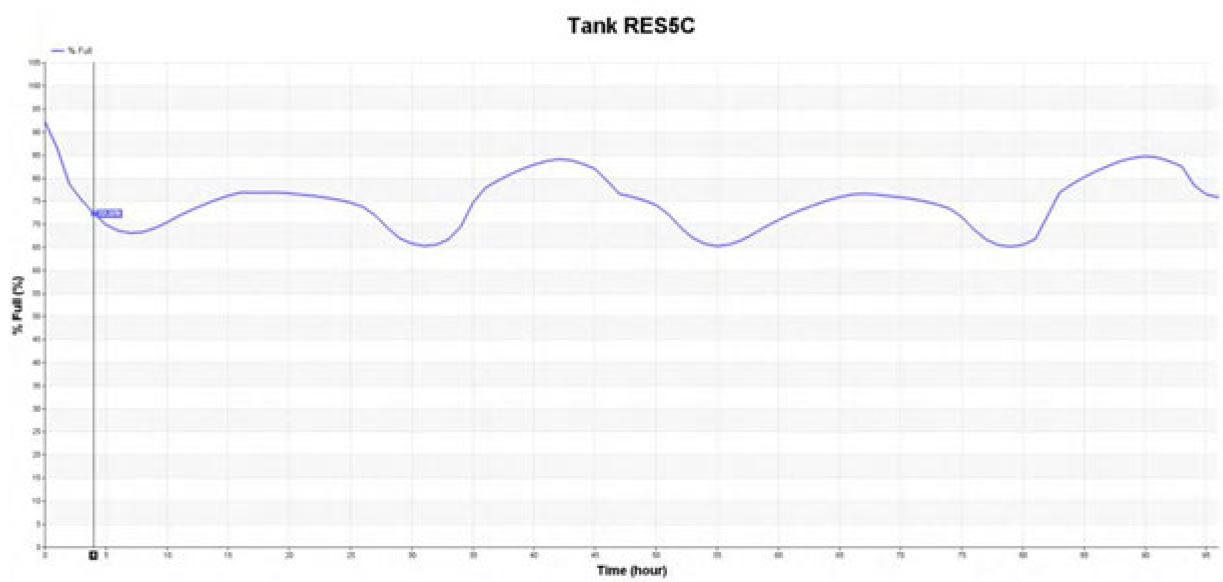
**Scenario 11: Low Density Residential Fire Flow in both Infill Areas; Concurrently (Exhibit 13)**



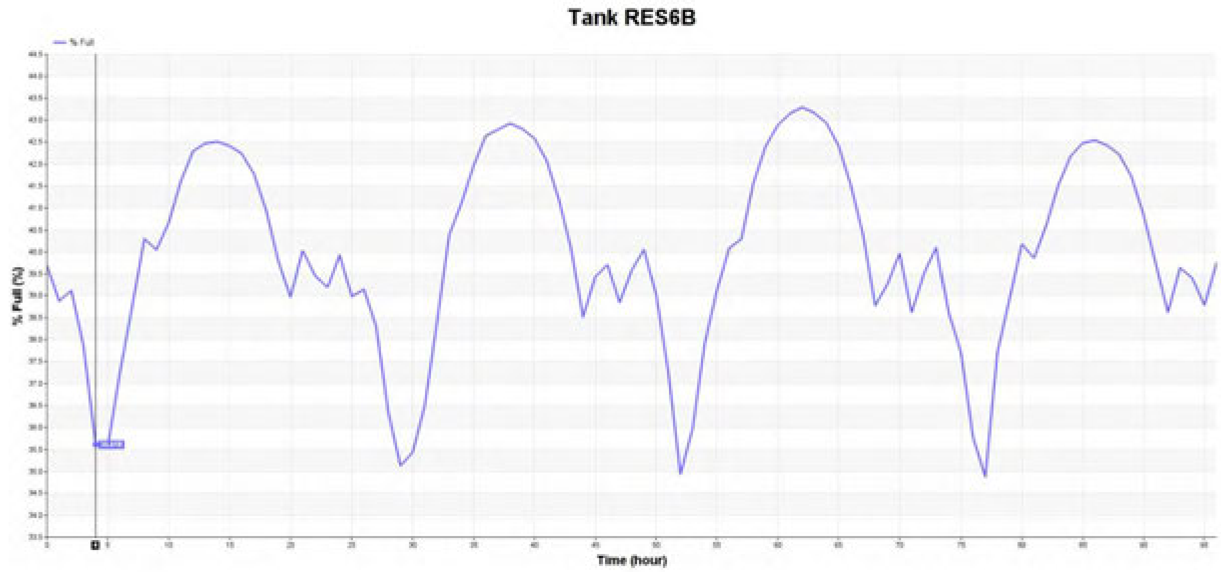



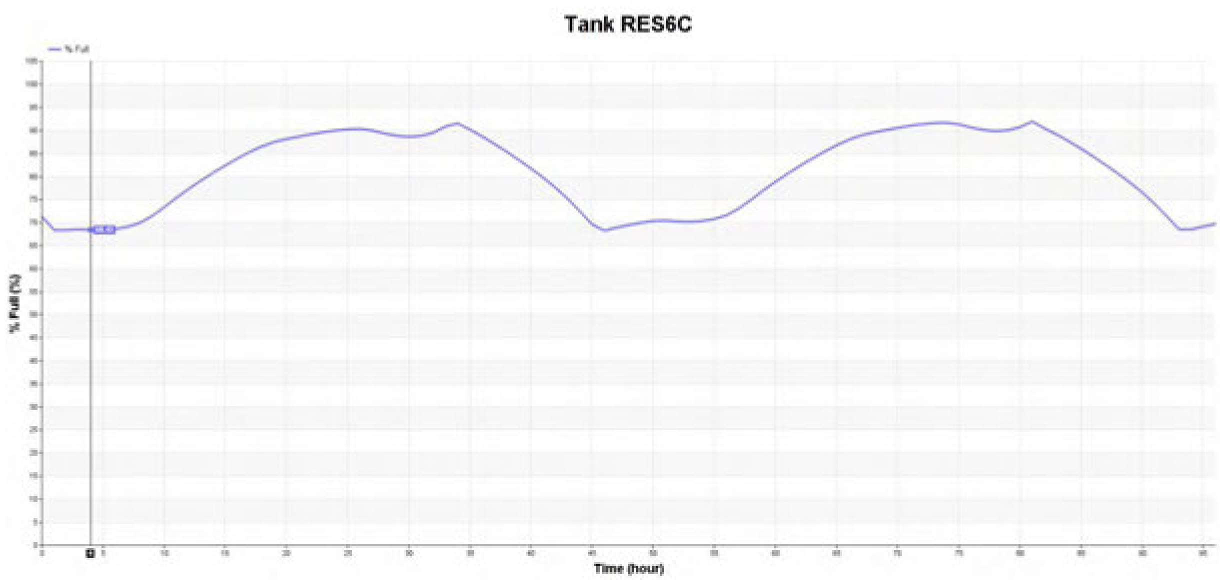
**Scenario 11: Low Density Residential Fire Flow in both Infill Areas; Concurrently (Exhibit 13)**



**Scenario 11: Low Density Residential Fire Flow in both Infill Areas; Concurrently (Exhibit 13)**



# Appendix B – Water Model Output

| Block Number | Land Use Description | Residential Density (DU/ACRE) | Square Feet | dwelling units (DU) | Average Day | | | | Max Day | | Peak Hour | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (gpd/du) | (gpd/acre) | (gpd) | (gpm) | peaking factor | X avg. (gpm) | peaking factor | X avg. (gpm) |
| **Central Development Area - Wilson Town Center** | | | **166,116** | **763** | | | | **164.3** | | | | |
| TC-D01 | High Density Residential | 20 | -- | 69 | 300 | -- | 20,700 | 14.4 | 1.8 | 25.9 | 2.4 | 34.5 |
| TC-D01 | Commercial | -- | 15000 | -- | -- | 2,000 | 689 | 0.5 | 1.9 | 0.9 | 2.5 | 1.2 |
| TC-D02 | High Density Residential | 20 | -- | 69 | 300 | -- | 20,700 | 14.4 | 1.8 | 25.9 | 2.4 | 34.5 |
| TC-D02 | Commercial | -- | 15000 | -- | -- | 2,000 | 689 | 0.5 | 1.9 | 0.9 | 2.5 | 1.2 |
| TC-D03 | High Density Residential | 20 | -- | 74 | 300 | -- | 22,200 | 15.4 | 1.8 | 27.8 | 2.4 | 37.0 |
| TC-D03 | Commercial | -- | 16134 | -- | -- | 2,000 | 741 | 0.5 | 1.9 | 1.0 | 2.5 | 1.3 |
| TC-D04 | High Density Residential | 20 | -- | 36 | 300 | -- | 10,800 | 7.5 | 1.8 | 13.5 | 2.4 | 18.0 |
| TC-D04 | Commercial | -- | 7758 | -- | -- | 2,000 | 357 | 0.2 | 1.9 | 0.5 | 2.5 | 0.6 |
| TC-D05 | High Density Residential | 20 | -- | 35 | 300 | -- | 10,500 | 7.3 | 1.8 | 13.1 | 2.4 | 17.5 |
| TC-D05 | Commercial | -- | 7583 | -- | -- | 2,000 | 349 | 0.2 | 1.9 | 0.5 | 2.5 | 0.6 |
| TC-D06 | High Density Residential | 20 | -- | 50 | 300 | -- | 15,000 | 10.4 | 1.8 | 18.8 | 2.4 | 25.0 |
| TC-D06 | Commercial | -- | 10843 | -- | -- | 2,000 | 498 | 0.3 | 1.9 | 0.7 | 2.5 | 0.9 |
| TC-D07 | High Density Residential | 20 | -- | 80 | 300 | -- | 24,000 | 16.7 | 1.8 | 30.0 | 2.4 | 40.0 |
| TC-D07 | Commercial | -- | 17500 | -- | -- | 2,000 | 804 | 0.6 | 1.9 | 1.1 | 2.5 | 1.4 |
| TC-D08 | High Density Residential | 20 | -- | 80 | 300 | -- | 24,000 | 16.7 | 1.8 | 30.0 | 2.4 | 40.0 |
| TC-D08 | Commercial | -- | 17500 | -- | -- | 2,000 | 804 | 0.6 | 1.9 | 1.1 | 2.5 | 1.4 |
| TC-D09 | High Density Residential | 20 | -- | 83 | 300 | -- | 24,900 | 17.3 | 1.8 | 31.1 | 2.4 | 41.5 |
| TC-D09 | Commercial | -- | 17974 | -- | -- | 2,000 | 826 | 0.6 | 1.9 | 1.1 | 2.5 | 1.4 |
| TC-D10 | High Density Residential | 20 | -- | 17 | 300 | -- | 5,100 | 3.5 | 1.8 | 6.4 | 2.4 | 8.5 |
| TC-D10 | Commercial | -- | 3670 | -- | -- | 2,000 | 169 | 0.1 | 1.9 | 0.2 | 2.5 | 0.3 |
| TC-D11 | High Density Residential | 20 | -- | 59 | 300 | -- | 17,700 | 12.3 | 1.8 | 22.1 | 2.4 | 29.5 |
| TC-D11 | Commercial | -- | 12868 | -- | -- | 2,000 | 591 | 0.4 | 1.9 | 0.8 | 2.5 | 1.0 |
| TC-D12 | High Density Residential | 20 | -- | 72 | 300 | -- | 21,600 | 15.0 | 1.8 | 27.0 | 2.4 | 36.0 |
| TC-D12 | Commercial | -- | 15750 | -- | -- | 2,000 | 724 | 0.5 | 1.9 | 1.0 | 2.5 | 1.3 |
| TC-D13 | High Density Residential | 20 | -- | 39 | 300 | -- | 11,700 | 8.1 | 1.8 | 14.6 | 2.4 | 19.5 |
| TC-D13 | Commercial | -- | 8536 | -- | -- | 2,000 | 392 | 0.3 | 1.9 | 0.5 | 2.5 | 0.7 |
| **Central Development Area - Wilson Neighborhood** | | | **0** | **1,114** | | | | **232.1** | | | | |
| TC-N01 | High Density Residential | 18 | -- | 60 | 300 | -- | 18,000 | 12.5 | 1.8 | 22.5 | 2.4 | 30.0 |
| TC-N02 | High Density Residential | 18 | -- | 34 | 300 | -- | 10,200 | 7.1 | 1.8 | 12.8 | 2.4 | 17.0 |
| TC-N03 | High Density Residential | 18 | -- | 56 | 300 | -- | 16,800 | 11.7 | 1.8 | 21.0 | 2.4 | 28.0 |
| TC-N04 | High Density Residential | 18 | -- | 52 | 300 | -- | 15,600 | 10.8 | 1.8 | 19.5 | 2.4 | 26.0 |
| TC-N05 | High Density Residential | 18 | -- | 47 | 300 | -- | 14,100 | 9.8 | 1.8 | 17.6 | 2.4 | 23.5 |
| TC-N06 | High Density Residential | 18 | -- | 47 | 300 | -- | 14,100 | 9.8 | 1.8 | 17.6 | 2.4 | 23.5 |
| TC-N07 | High Density Residential | 18 | -- | 52 | 300 | -- | 15,600 | 10.8 | 1.8 | 19.5 | 2.4 | 26.0 |
| TC-N08 | High Density Residential | 18 | -- | 52 | 300 | -- | 15,600 | 10.8 | 1.8 | 19.5 | 2.4 | 26.0 |
| TC-N09 | High Density Residential | 18 | -- | 52 | 300 | -- | 15,600 | 10.8 | 1.8 | 19.5 | 2.4 | 26.0 |
| TC-N10 | High Density Residential | 18 | -- | 46 | 300 | -- | 13,800 | 9.6 | 1.8 | 17.3 | 2.4 | 23.0 |
| TC-N11 | High Density Residential | 18 | -- | 23 | 300 | -- | 6,900 | 4.8 | 1.8 | 8.6 | 2.4 | 11.5 |
| TC-N12 | High Density Residential | 18 | -- | 43 | 300 | -- | 12,900 | 9.0 | 1.8 | 16.1 | 2.4 | 21.5 |
| TC-N13 | High Density Residential | 18 | -- | 73 | 300 | -- | 21,900 | 15.2 | 1.8 | 27.4 | 2.4 | 36.5 |
| TC-N14 | High Density Residential | 18 | -- | 35 | 300 | -- | 10,500 | 7.3 | 1.8 | 13.1 | 2.4 | 17.5 |
| TC-N15 | High Density Residential | 18 | -- | 58 | 300 | -- | 17,400 | 12.1 | 1.8 | 21.8 | 2.4 | 29.0 |
| TC-N16 | High Density Residential | 18 | -- | 35 | 300 | -- | 10,500 | 7.3 | 1.8 | 13.1 | 2.4 | 17.5 |
| TC-N17 | High Density Residential | 18 | -- | 48 | 300 | -- | 14,400 | 10.0 | 1.8 | 18.0 | 2.4 | 24.0 |
| TC-N18 | High Density Residential | 18 | -- | 19 | 300 | -- | 5,700 | 4.0 | 1.8 | 7.1 | 2.4 | 9.5 |
| TC-N19 | High Density Residential | 18 | -- | 61 | 300 | -- | 18,300 | 12.7 | 1.8 | 22.9 | 2.4 | 30.5 |
| TC-N20 | High Density Residential | 18 | -- | 41 | 300 | -- | 12,300 | 8.5 | 1.8 | 15.4 | 2.4 | 20.5 |
| TC-N21 | High Density Residential | 18 | -- | 35 | 300 | -- | 10,500 | 7.3 | 1.8 | 13.1 | 2.4 | 17.5 |
| TC-N22 | High Density Residential | 18 | -- | 35 | 300 | -- | 10,500 | 7.3 | 1.8 | 13.1 | 2.4 | 17.5 |
| TC-N23 | High Density Residential | 18 | -- | 41 | 300 | -- | 12,300 | 8.5 | 1.8 | 15.4 | 2.4 | 20.5 |
| TC-N24 | High Density Residential | 18 | -- | 69 | 300 | -- | 20,700 | 14.4 | 1.8 | 25.9 | 2.4 | 34.5 |
| **Central Development Area - Wilson Heights** | | | **0** | **319** | | | | **110.8** | | | | |
| TC-H01 | Medium Density Residential | 10 | -- | 24 | 500 | -- | 12000 | 8.3 | 1.7 | 14.2 | 2.3 | 19.2 |
| TC-H02 | Medium Density Residential | 10 | -- | 41 | 500 | -- | 20500 | 14.2 | 1.7 | 24.2 | 2.3 | 32.7 |
| TC-H03 | Medium Density Residential | 10 | -- | 26 | 500 | -- | 13000 | 9.0 | 1.7 | 15.3 | 2.3 | 20.8 |
| TC-H04 | Medium Density Residential | 10 | -- | 28 | 500 | -- | 14000 | 9.7 | 1.7 | 16.5 | 2.3 | 22.4 |
| TC-H05 | Medium Density Residential | 10 | -- | 41 | 500 | -- | 20500 | 14.2 | 1.7 | 24.2 | 2.3 | 32.7 |
| TC-H06 | Medium Density Residential | 10 | -- | 33 | 500 | -- | 16500 | 11.5 | 1.7 | 19.5 | 2.3 | 26.4 |
| TC-H07 | Medium Density Residential | 10 | -- | 37 | 500 | -- | 18500 | 12.8 | 1.7 | 21.8 | 2.3 | 29.5 |
| TC-H08 | Medium Density Residential | 10 | -- | 26 | 500 | -- | 13000 | 9.0 | 1.7 | 15.3 | 2.3 | 20.8 |
| TC-H09 | Medium Density Residential | 10 | -- | 20 | 500 | -- | 10000 | 6.9 | 1.7 | 11.8 | 2.3 | 16.0 |
| TC-H10 | Medium Density Residential | 10 | -- | 13 | 500 | -- | 6500 | 4.5 | 1.7 | 7.7 | 2.3 | 10.4 |
| TC-H11 | Medium Density Residential | 10 | -- | 30 | 500 | -- | 15000 | 10.4 | 1.7 | 17.7 | 2.3 | 24.0 |
| **West Development Area - College Center** | | | **52,769** | **404** | | | | **142.0** | | | | |
| EN01 | Medium Density Residential | 10 | -- | 111 | 500 | -- | 55,500 | 38.5 | 1.7 | 65.5 | 2.3 | 88.6 |
| EN01 | Commercial | -- | 14558 | -- | -- | 2000 | 669 | 0.5 | 1.9 | 0.9 | 2.5 | 1.2 |
| EN02 | Medium Density Residential | 10 | -- | 73 | 500 | -- | 36,500 | 25.3 | 1.7 | 43.1 | 2.3 | 58.3 |
| EN02 | Commercial | -- | 9487 | -- | -- | 2000 | 436 | 0.3 | 1.9 | 0.6 | 2.5 | 0.8 |
| EN03 | Medium Density Residential | 10 | -- | 48 | 500 | -- | 24,000 | 16.7 | 1.7 | 28.3 | 2.3 | 38.3 |
| EN03 | Commercial | -- | 6325 | -- | -- | 2000 | 291 | 0.2 | 1.9 | 0.4 | 2.5 | 0.5 |
| EN04 | Medium Density Residential | 10 | -- | 87 | 500 | -- | 43,500 | 30.2 | 1.7 | 51.4 | 2.3 | 69.5 |
| EN04 | Commercial | -- | 11317 | -- | -- | 2000 | 520 | 0.4 | 1.9 | 0.7 | 2.5 | 0.9 |
| EN05 | Medium Density Residential | 10 | -- | 85 | 500 | -- | 42,500 | 29.5 | 1.7 | 50.2 | 2.3 | 67.9 |
| EN05 | Commercial | -- | 11082 | -- | -- | 2000 | 509 | 0.4 | 1.9 | 0.7 | 2.5 | 0.9 |
| **West Development Area - Southwest Neighborhood** | | | **683,892** | **479** | | | | **199.0** | | | | |
| EN06 | Medium Density Residential | 10 | -- | 55 | 500 | -- | 27,500 | 19.1 | 1.7 | 32.5 | 2.3 | 43.9 |
| EN07 | Medium Density Residential | 10 | -- | 56 | 500 | -- | 28,000 | 19.4 | 1.7 | 33.1 | 2.3 | 44.7 |
| EN08 | Medium Density Residential | 10 | -- | 51 | 500 | -- | 25,500 | 17.7 | 1.7 | 30.1 | 2.3 | 40.7 |
| EN09 | Medium Density Residential | 10 | -- | 56 | 500 | -- | 28,000 | 19.4 | 1.7 | 33.1 | 2.3 | 44.7 |
| EN10 | Medium Density Residential | 10 | -- | 59 | 500 | -- | 29,500 | 20.5 | 1.7 | 34.8 | 2.3 | 47.1 |
| EN11 | Medium Density Residential | 10 | -- | 202 | 500 | -- | 101,000 | 70.1 | 1.7 | 119.2 | 2.3 | 161.3 |
| C01 | School | -- | 683892 | -- | -- | 3000 | 47,100 | 32.7 | 2.1 | 68.7 | 2.7 | 88.3 |
| **West Development Area - Southwest Infill Neighborhood** | | | **0** | **121** | | | | **52.9** | | | | |
| IN01 | Low Density Residential | 6 | -- | 22 | 630 | -- | 13,860 | 9.6 | 1.6 | 15.4 | 2.2 | 21.2 |
| IN02 | Low Density Residential | 6 | -- | 51 | 630 | -- | 32,130 | 22.3 | 1.6 | 35.7 | 2.2 | 49.1 |
| IN03 | Low Density Residential | 6 | -- | 48 | 630 | -- | 30,240 | 21.0 | 1.6 | 33.6 | 2.2 | 46.2 |
| **West Development Area - Milliken Heights** | | | **0** | **190** | | | | **99.4** | | | | |
| NE01 | Very Low Density Residential | 2 | -- | 13 | 900 | -- | 11,700 | 8.1 | 1.5 | 12.2 | 2.1 | 17.1 |
| NE02 | Very Low Density Residential | 2 | -- | 17 | 900 | -- | 15,300 | 10.6 | 1.5 | 15.9 | 2.1 | 22.3 |
| NE03 | Very Low Density Residential | 2 | -- | 20 | 900 | -- | 18,000 | 12.5 | 1.5 | 18.8 | 2.1 | 26.3 |
| NE04 | Very Low Density Residential | 2 | -- | 14 | 900 | -- | 12,600 | 8.8 | 1.5 | 13.1 | 2.1 | 18.4 |
| NE05 | Very Low Density Residential | 2 | -- | 12 | 900 | -- | 10,800 | 7.5 | 1.5 | 11.3 | 2.1 | 15.8 |
| NE06 | Very Low Density Residential | 2 | -- | 11 | 900 | -- | 9,900 | 6.9 | 1.5 | 10.3 | 2.1 | 14.4 |
| NE07 | Low Density Residential | 4 | -- | 27 | 630 | -- | 17,010 | 11.8 | 1.6 | 18.9 | 2.2 | 26.0 |
| NE08 | Low Density Residential | 4 | -- | 28 | 630 | -- | 17,640 | 12.3 | 1.6 | 19.6 | 2.2 | 27.0 |
| NE09 | Low Density Residential | 4 | -- | 29 | 630 | -- | 18,270 | 12.7 | 1.6 | 20.3 | 2.2 | 27.9 |
| NE10 | Low Density Residential | 4 | -- | 11 | 630 | -- | 6,930 | 4.8 | 1.6 | 7.7 | 2.2 | 10.6 |
| NE11 | Low Density Residential | 4 | -- | 8 | 630 | -- | 5,040 | 3.5 | 1.6 | 5.6 | 2.2 | 7.7 |
| **East Development Area - Southeast Neighborhood** | | | **61,097** | **350** | | | | **124.0** | | | | |
| EN12 | Medium Density Residential | 10 | -- | 31 | 500 | -- | 15,500 | 10.8 | 1.7 | 18.3 | 2.3 | 24.8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EN13 | Medium Density Residential | 10 | -- | 18 | 500 | -- | 9,000 | 6.3 | 1.7 | 10.6 | 2.3 | 14.4 |
| EN14 | Medium Density Residential | 10 | -- | 18 | 500 | -- | 9,000 | 6.3 | 1.7 | 10.6 | 2.3 | 14.4 |
| EN15 | Medium Density Residential | 10 | -- | 22 | 500 | -- | 11,000 | 7.6 | 1.7 | 13.0 | 2.3 | 17.6 |
| EN16 | Medium Density Residential | 10 | -- | 7 | 500 | -- | 3,500 | 2.4 | 1.7 | 4.1 | 2.3 | 5.6 |
| EN17 | Medium Density Residential | 10 | -- | 28 | 500 | -- | 14,000 | 9.7 | 1.7 | 16.5 | 2.3 | 22.4 |
| EN18 | Medium Density Residential | 10 | -- | 23 | 500 | -- | 11,500 | 8.0 | 1.7 | 13.6 | 2.3 | 18.4 |
| EN19 | Medium Density Residential | 10 | -- | 18 | 500 | -- | 9,000 | 6.3 | 1.7 | 10.6 | 2.3 | 14.4 |
| EN20 | Medium Density Residential | 10 | -- | 37 | 500 | -- | 18,500 | 12.8 | 1.7 | 21.8 | 2.3 | 29.5 |
| EN21 | Medium Density Residential | 10 | -- | 47 | 500 | -- | 23,500 | 16.3 | 1.7 | 27.7 | 2.3 | 37.5 |
| EN22 | Medium Density Residential | 10 | -- | 48 | 500 | -- | 24,000 | 16.7 | 1.7 | 28.3 | 2.3 | 38.3 |
| EN23 | Medium Density Residential | 10 | -- | 53 | 500 | -- | 26,500 | 18.4 | 1.7 | 31.3 | 2.3 | 42.3 |
| EN24 | Commercial | -- | 31175 | -- | -- | 2000 | 1,432 | 1.0 | 1.9 | 1.9 | 2.5 | 2.5 |
| EN25 | Commercial | -- | 29922 | -- | -- | 3000 | 2,061 | 1.4 | 1.9 | 2.7 | 2.5 | 3.6 |
| **East Development Area - Southeast Infill Neighborhood** | | | **0** | **70** | | | | **30.6** | | | | |
| IN04 | Low Density Residential | 6 | -- | 13 | 630 | -- | 8,190 | 5.7 | 1.6 | 9.1 | 2.2 | 12.5 |
| IN05 | Low Density Residential | 6 | -- | 26 | 630 | | 16,380 | 11.4 | 1.6 | 18.2 | 2.2 | 25.0 |
| IN06 | Low Density Residential | 6 | -- | 15 | 630 | | 9,450 | 6.6 | 1.6 | 10.5 | 2.2 | 14.4 |
| IN07 | Low Density Residential | 6 | -- | 16 | 630 | | 10,080 | 7.0 | 1.6 | 11.2 | 2.2 | 15.4 |

SCENARIO 2 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 53.49 | 2,005.00 | 2,250.78 | 106.5 |
| J271 | 1.95 | 1,990.90 | 2,250.80 | 112.61 |
| J273 | 52.32 | 1,959.80 | 2,250.81 | 126.09 |
| J267 | 0 | 1,932.80 | 2,076.14 | 62.11 |
| J265 | 87.72 | 1,900.50 | 2,076.27 | 76.16 |
| J10612 | 0 | 1,781.49 | 2,077.34 | 128.19 |
| J257 | 70.02 | 1,778.50 | 2,076.93 | 129.31 |
| J259 | 11.77 | 1,779.00 | 2,077.34 | 129.27 |
| J269 | 344.67 | 1,820.30 | 2,075.92 | 110.76 |
| J261 | 78.19 | 1,860.20 | 2,075.70 | 93.38 |
| J291 | 43.76 | 2,046.00 | 2,250.89 | 88.78 |
| J293 | 24.31 | 1,955.81 | 2,250.87 | 127.85 |
| J297 | 52.32 | 1,912.80 | 2,075.46 | 70.48 |
| J303 | 0 | 1,849.80 | 2,075.70 | 97.88 |
| J309 | 41.24 | 1,985.30 | 2,250.94 | 115.1 |
| J311 | 42.4 | 1,964.66 | 2,251.01 | 124.08 |
| J315 | 0 | 1,869.10 | 2,075.34 | 89.36 |
| J323 | 160.28 | 1,869.10 | 2,075.31 | 89.35 |
| J329 | 76.64 | 1,901.00 | 2,075.25 | 75.5 |
| J255 | 0 | 1,858.90 | 2,075.70 | 93.94 |
| J275 | 0 | 1,940.40 | 2,250.92 | 134.55 |
| J277 | 0 | 1,959.70 | 2,251.00 | 126.22 |
| J279 | 0 | 1,957.20 | 2,251.14 | 127.36 |
| J285 | 0 | 1,965.60 | 2,252.41 | 124.28 |
| J287 | 0 | 1,939.00 | 2,252.86 | 136 |
| J295 | 0 | 1,953.17 | 2,251.28 | 129.17 |
| J299 | 0 | 1,886.80 | 2,075.46 | 81.75 |
| J301 | 0 | 1,843.00 | 2,075.72 | 100.84 |
| J305 | 0 | 1,750.00 | 1,868.00 | 51.13 |
| J313 | 42.4 | 1,961.44 | 2,251.18 | 125.55 |
| J317 | 0 | 1,871.00 | 2,075.31 | 88.53 |
| J319 | 0 | 1,877.00 | 2,075.35 | 85.94 |
| J321 | 107.95 | 1,873.70 | 2,075.31 | 87.36 |
| J325 | 89.47 | 1,781.08 | 2,075.90 | 127.74 |
| J331 | 61.08 | 1,902.20 | 2,075.26 | 74.99 |
| J333 | 49.02 | 1,912.00 | 2,075.26 | 70.74 |
| J341 | 91.42 | 1,773.00 | 2,076.22 | 131.38 |
| J243 | 0 | 1,845.30 | 2,075.71 | 99.84 |
| J253 | 0 | 1,750.00 | 2,076.55 | 141.49 |
| J281 | 17.51 | 1,948.30 | 2,251.68 | 131.45 |
| J283 | 54.27 | 1,939.00 | 2,252.10 | 135.67 |
| J307 | 145.1 | 1,704.00 | 1,867.65 | 70.91 |
| J343 | 141.02 | 1,677.92 | 1,867.71 | 82.24 |
| J345 | 59.71 | 1,603.00 | 1,867.78 | 114.73 |

| | | | | |
|---|---|---|---|---|
| J347 | 102.9 | 1,492.02 | 1,868.44 | 163.1 |
| J72264 | 10.16 | 2,020.59 | 2,378.52 | 155.09 |
| J339 | 112.04 | 1,697.00 | 1,868.17 | 74.17 |
| J10874 | 46.1 | 1,716.66 | 1,868.18 | 65.65 |
| J276 | 12.22 | 1,868.09 | 2,096.89 | 99.14 |

SCENARIO 2 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | 35.81 | 0.15 | 0.01 | 0.01 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | 37.76 | 0.15 | 0.01 | 0.01 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | 90.08 | 0.37 | 0.07 | 0.07 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | 68.71 | 0.44 | 0.13 | 0.13 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | 68.71 | 0.44 | 0.22 | 0.13 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 156.43 | 1 | 1.07 | 0.59 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 199.19 | 1.27 | 0.31 | 0.92 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -609.97 | 1.73 | 0.41 | 1.02 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -199.19 | 0.57 | 0 | 0.12 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -539.95 | 1.53 | 1.01 | 0.81 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | -263.99 | 0.75 | 0.21 | 0.21 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 80.04 | 0.51 | 0.08 | 0.17 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 80.04 | 0.51 | 0.04 | 0.17 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | 34.35 | 0.14 | 0.02 | 0.01 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 80.04 | 0.51 | 0.14 | 0.17 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | -78.11 | 0.32 | 0.05 | 0.05 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -251.84 | 0.71 | 0.24 | 0.2 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -119.35 | 0.49 | 0.07 | 0.12 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -161.75 | 0.66 | 0.17 | 0.21 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -199.52 | 0.57 | 0.12 | 0.13 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 29.33 | 0.08 | 0 | 0 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -130.94 | 0.37 | 0.03 | 0.06 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 68.57 | 0.44 | 0.09 | 0.13 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -8.07 | 0.05 | 0 | 0 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 66.04 | 0.19 | 0.01 | 0.02 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | -12.15 | 0.03 | 0 | 0 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | -12.15 | 0.03 | 0 | 0 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 80.04 | 0.51 | 0.14 | 0.17 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 66.04 | 0.19 | 0 | 0.02 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 255.44 | 0.72 | 0.26 | 0.2 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 255.44 | 0.72 | 0.11 | 0.2 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 106.01 | 0.68 | 0.15 | 0.29 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 106.01 | 0.68 | 0.35 | 0.29 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -204.15 | 0.83 | 0.1 | 0.32 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 188.25 | 0.53 | 0.03 | 0.12 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 80.3 | 0.23 | 0.01 | 0.02 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 321.48 | 0.91 | 0.18 | 0.31 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 50.96 | 0.33 | 0.05 | 0.07 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 67.19 | 0.43 | 0.08 | 0.12 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -18.18 | 0.12 | 0.01 | 0.01 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 410.96 | 1.17 | 0.32 | 0.49 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 502.38 | 1.43 | 0.36 | 0.71 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 502.38 | 1.43 | 0.33 | 0.71 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 355.97 | 1.45 | 0.41 | 0.91 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 355.97 | 1.45 | 0.45 | 0.91 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 355.97 | 1.45 | 0.31 | 0.91 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 301.7 | 1.23 | 0.42 | 0.67 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 284.2 | 1.16 | 0.4 | 0.6 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 39.09 | 0.25 | 0.06 | 0.05 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 180.11 | 1.15 | 0.32 | 0.76 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 38.97 | 0.25 | 0.05 | 0.04 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 98.69 | 0.63 | 0.1 | 0.25 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | 22.22 | 0.14 | 0.01 | 0.02 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 19.85 | 0.13 | 0.02 | 0.01 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -100.52 | 0.64 | 0.16 | 0.26 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 27.84 | 0.11 | 0 | 0.01 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 17.68 | 0.07 | 0 | 0 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 91.37 | 0.58 | 0.29 | 0.22 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -20.67 | 0.13 | 0.01 | 0.01 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 17.68 | 0.07 | 0 | 0 | Open |

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,238.26 | 101.07 |
| J271 | 2.83 | 1,990.90 | 2,238.32 | 107.21 |
| J273 | 76.23 | 1,959.80 | 2,238.35 | 120.69 |
| J267 | 0 | 1,932.80 | 2,076.86 | 62.42 |
| J265 | 127.8 | 1,900.50 | 2,076.83 | 76.4 |
| J10612 | 0 | 1,781.49 | 2,077.27 | 128.16 |
| J257 | 102.02 | 1,778.50 | 2,077.13 | 129.4 |
| J259 | 11.77 | 1,779.00 | 2,077.27 | 129.24 |
| J269 | 502.15 | 1,820.30 | 2,076.91 | 111.19 |
| J261 | 113.92 | 1,860.20 | 2,077.87 | 94.32 |
| J291 | 63.76 | 2,046.00 | 2,238.60 | 83.46 |
| J293 | 35.42 | 1,955.81 | 2,238.54 | 122.51 |
| J297 | 76.23 | 1,912.80 | 2,077.04 | 71.16 |
| J303 | 0 | 1,849.80 | 2,077.17 | 98.52 |
| J309 | 60.08 | 1,985.30 | 2,238.73 | 109.81 |
| J311 | 61.78 | 1,964.66 | 2,238.89 | 118.82 |
| J315 | 0 | 1,869.10 | 2,077.00 | 90.08 |
| J323 | 233.5 | 1,869.10 | 2,077.00 | 90.08 |
| J329 | 111.65 | 1,901.00 | 2,076.91 | 76.22 |
| J255 | 0 | 1,858.90 | 2,077.36 | 94.66 |
| J275 | 0 | 1,940.40 | 2,238.64 | 129.23 |
| J277 | 0 | 1,959.70 | 2,238.83 | 120.95 |
| J279 | 0 | 1,957.20 | 2,239.16 | 122.17 |
| J285 | 0 | 1,965.60 | 2,242.01 | 119.77 |
| J287 | 0 | 1,939.00 | 2,243.00 | 131.72 |
| J295 | 0 | 1,953.17 | 2,239.49 | 124.06 |
| J299 | 0 | 1,886.80 | 2,077.77 | 82.75 |
| J301 | 0 | 1,843.00 | 2,078.90 | 102.21 |
| J305 | 0 | 1,750.00 | 1,862.12 | 48.58 |
| J313 | 61.78 | 1,961.44 | 2,239.27 | 120.38 |
| J317 | 0 | 1,871.00 | 2,077.08 | 89.29 |
| J319 | 0 | 1,877.00 | 2,077.30 | 86.79 |
| J321 | 157.28 | 1,873.70 | 2,077.14 | 88.15 |
| J325 | 130.35 | 1,781.08 | 2,080.75 | 129.84 |
| J331 | 88.98 | 1,902.20 | 2,076.98 | 75.73 |
| J333 | 71.41 | 1,912.00 | 2,077.04 | 71.51 |
| J341 | 133.19 | 1,773.00 | 2,083.39 | 134.49 |
| J243 | 0 | 1,845.30 | 2,078.62 | 101.1 |
| J253 | 0 | 1,750.00 | 2,085.63 | 145.43 |
| J281 | 25.5 | 1,948.30 | 2,240.39 | 126.56 |
| J283 | 79.06 | 1,939.00 | 2,241.33 | 131 |
| J307 | 211.4 | 1,704.00 | 1,860.77 | 67.93 |
| J343 | 205.45 | 1,677.92 | 1,860.76 | 79.22 |
| J345 | 87 | 1,603.00 | 1,860.58 | 111.61 |
| J347 | 149.91 | 1,492.02 | 1,860.93 | 159.85 |

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|---|---|---|---|---|
| J72264 | 14.81 | 2,020.59 | 2,377.64 | 154.71 |
| J339 | 163.23 | 1,697.00 | 1,861.13 | 71.12 |
| J10874 | 67.16 | 1,716.66 | 1,861.18 | 62.62 |

SCENARIO 3 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | 77.93 | 0.32 | 0.06 | 0.05 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | 80.76 | 0.33 | 0.03 | 0.06 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | 156.99 | 0.64 | 0.19 | 0.2 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | -30.62 | 0.2 | 0.03 | 0.03 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -30.62 | 0.2 | 0.05 | 0.03 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 97.18 | 0.62 | 0.44 | 0.24 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 115.28 | 0.74 | 0.11 | 0.33 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -341.88 | 0.97 | 0.14 | 0.35 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -115.28 | 0.33 | 0 | 0.04 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -239.86 | 0.68 | 0.23 | 0.18 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 292.91 | 0.83 | 0.26 | 0.26 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 126.89 | 0.81 | 0.19 | 0.4 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 126.89 | 0.81 | 0.1 | 0.4 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | 65.52 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 126.89 | 0.81 | 0.32 | 0.4 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | -129.28 | 0.53 | 0.12 | 0.14 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -178.41 | 0.51 | 0.13 | 0.1 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -189.36 | 0.77 | 0.17 | 0.28 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -251.14 | 1.03 | 0.37 | 0.48 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -102.18 | 0.29 | 0.04 | 0.04 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 202.88 | 0.58 | 0.08 | 0.13 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -30.63 | 0.09 | 0 | 0 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 71.55 | 0.46 | 0.09 | 0.14 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -40.1 | 0.26 | 0.07 | 0.05 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 585.23 | 1.66 | 0.75 | 0.94 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 471.32 | 1.34 | 0.2 | 0.63 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 471.32 | 1.34 | 0.51 | 0.63 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 126.89 | 0.81 | 0.33 | 0.4 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 585.23 | 1.66 | 0.28 | 0.94 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 560.65 | 1.59 | 1.13 | 0.87 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 560.65 | 1.59 | 0.47 | 0.87 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 220.02 | 1.4 | 0.58 | 1.11 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 220.02 | 1.4 | 1.35 | 1.11 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -312.91 | 1.28 | 0.22 | 0.72 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 434.68 | 1.23 | 0.16 | 0.54 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 277.4 | 0.79 | 0.07 | 0.24 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,145.88 | 3.25 | 1.85 | 3.26 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 74.53 | 0.48 | 0.1 | 0.15 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 125.97 | 0.8 | 0.27 | 0.39 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -54.56 | 0.35 | 0.06 | 0.08 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,276.24 | 3.62 | 2.64 | 3.98 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 1,409.42 | 4 | 2.45 | 4.79 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 1,409.42 | 4 | 2.24 | 4.79 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 544.37 | 2.22 | 0.9 | 2 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 544.37 | 2.22 | 0.99 | 2 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 544.37 | 2.22 | 0.68 | 2 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 465.31 | 1.9 | 0.94 | 1.49 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 439.8 | 1.8 | 0.9 | 1.35 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | -8.62 | 0.06 | 0 | 0 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 196.83 | 1.26 | 0.37 | 0.9 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 63.31 | 0.4 | 0.12 | 0.11 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 150.31 | 0.96 | 0.23 | 0.55 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -28.06 | 0.18 | 0.01 | 0.02 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 60.35 | 0.39 | 0.18 | 0.1 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -238.32 | 1.52 | 0.81 | 1.28 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 14.81 | 0.06 | 0 | 0 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 0 | 0 | 0 | 0 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 117.07 | 0.75 | 0.46 | 0.34 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -46.16 | 0.29 | 0.05 | 0.06 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 0 | 0 | 0 | 0 | Closed |

SCENARIO 4 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,249.59 | 105.98 |
| J271 | 2.83 | 1,990.90 | 2,247.90 | 111.36 |
| J273 | 76.23 | 1,959.80 | 2,247.24 | 124.55 |
| J267 | 0 | 1,932.80 | 2,078.28 | 63.04 |
| J265 | 127.8 | 1,900.50 | 2,078.26 | 77.02 |
| J10612 | 0 | 1,781.49 | 2,078.77 | 128.81 |
| J257 | 102.02 | 1,778.50 | 2,078.60 | 130.03 |
| J259 | 11.77 | 1,779.00 | 2,078.77 | 129.89 |
| J269 | 502.15 | 1,820.30 | 2,078.31 | 111.8 |
| J261 | 113.92 | 1,860.20 | 2,079.14 | 94.87 |
| J291 | 63.76 | 2,046.00 | 2,245.55 | 86.47 |
| J293 | 35.42 | 1,955.81 | 2,246.22 | 125.83 |
| J297 | 76.23 | 1,912.80 | 2,078.35 | 71.73 |
| J303 | 0 | 1,849.80 | 2,078.50 | 99.1 |
| J309 | 60.08 | 1,985.30 | 2,245.37 | 112.69 |
| J311 | 61.78 | 1,964.66 | 2,245.31 | 121.61 |
| J315 | 0 | 1,869.10 | 2,078.31 | 90.65 |
| J323 | 233.5 | 1,869.10 | 2,078.30 | 90.65 |
| J329 | 111.65 | 1,901.00 | 2,078.21 | 76.78 |
| J255 | 0 | 1,858.90 | 2,078.68 | 95.23 |
| J275 | 0 | 1,940.40 | 2,246.12 | 132.47 |
| J277 | 0 | 1,959.70 | 2,245.94 | 124.03 |
| J279 | 0 | 1,957.20 | 2,245.61 | 124.97 |
| J285 | 0 | 1,965.60 | 2,245.20 | 121.15 |
| J287 | 0 | 1,939.00 | 2,245.20 | 132.68 |
| J295 | 0 | 1,953.17 | 2,245.30 | 126.58 |
| J299 | 0 | 1,886.80 | 2,079.02 | 83.29 |
| J301 | 0 | 1,843.00 | 2,080.09 | 102.73 |
| J305 | 0 | 1,750.00 | 1,862.72 | 48.84 |
| J313 | 61.78 | 1,961.44 | 2,245.30 | 123 |
| J317 | 0 | 1,871.00 | 2,078.37 | 89.85 |
| J319 | 0 | 1,877.00 | 2,078.58 | 87.34 |
| J321 | 157.28 | 1,873.70 | 2,078.43 | 88.71 |
| J325 | 130.35 | 1,781.08 | 2,081.82 | 130.31 |
| J331 | 88.98 | 1,902.20 | 2,078.27 | 76.29 |
| J333 | 71.41 | 1,912.00 | 2,078.32 | 72.07 |
| J341 | 133.19 | 1,773.00 | 2,084.30 | 134.89 |
| J243 | 0 | 1,845.30 | 2,079.83 | 101.62 |
| J253 | 0 | 1,750.00 | 2,086.42 | 145.77 |
| J281 | 25.5 | 1,948.30 | 2,245.24 | 128.66 |
| J283 | 79.06 | 1,939.00 | 2,245.20 | 132.68 |
| J307 | 211.4 | 1,704.00 | 1,861.52 | 68.25 |
| J343 | 205.45 | 1,677.92 | 1,861.52 | 79.55 |
| J345 | 87 | 1,603.00 | 1,861.40 | 111.96 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,492.02 | 1,861.96 | 160.3 |
| J72264 | 14.81 | 2,020.59 | 2,360.27 | 147.18 |
| J339 | 163.23 | 1,697.00 | 1,861.99 | 71.49 |
| J10874 | 67.16 | 1,716.66 | 1,862.04 | 62.99 |

SCENARIO 4 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -466.44 | 1.91 | 1.7 | 1.5 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -463.61 | 1.89 | 0.65 | 1.48 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -387.38 | 1.58 | 1.02 | 1.06 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | -23.57 | 0.15 | 0.02 | 0.02 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -23.57 | 0.15 | 0.03 | 0.02 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 104.23 | 0.67 | 0.51 | 0.28 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 126 | 0.8 | 0.13 | 0.39 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -376.59 | 1.07 | 0.17 | 0.42 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -126 | 0.36 | 0 | 0.05 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -274.57 | 0.78 | 0.29 | 0.23 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 251.15 | 0.71 | 0.2 | 0.2 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | -124.72 | 0.8 | 0.19 | 0.39 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | -124.72 | 0.8 | 0.1 | 0.39 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -227.24 | 0.93 | 0.66 | 0.4 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | -124.72 | 0.8 | 0.31 | 0.39 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 163.48 | 0.67 | 0.19 | 0.22 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -195.02 | 0.55 | 0.15 | 0.12 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | 103.4 | 0.42 | 0.05 | 0.09 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | 41.62 | 0.17 | 0.01 | 0.02 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -118.79 | 0.34 | 0.05 | 0.05 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 188.6 | 0.54 | 0.07 | 0.12 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -44.91 | 0.13 | 0 | 0.01 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 73.88 | 0.47 | 0.1 | 0.15 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -37.77 | 0.24 | 0.06 | 0.04 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 560.09 | 1.59 | 0.69 | 0.87 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 446.17 | 1.27 | 0.18 | 0.57 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 446.17 | 1.27 | 0.46 | 0.57 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | -124.72 | 0.8 | 0.32 | 0.39 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 560.09 | 1.59 | 0.26 | 0.87 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 544.03 | 1.54 | 1.07 | 0.82 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 544.03 | 1.54 | 0.44 | 0.82 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 206.75 | 1.32 | 0.52 | 0.99 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 206.75 | 1.32 | 1.2 | 0.99 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -20.15 | 0.08 | 0 | 0 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 420.59 | 1.19 | 0.15 | 0.51 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 263.32 | 0.75 | 0.06 | 0.21 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,104.12 | 3.13 | 1.73 | 3.04 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 74.72 | 0.48 | 0.1 | 0.15 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 123.44 | 0.79 | 0.26 | 0.38 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -52.02 | 0.33 | 0.05 | 0.08 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,234.47 | 3.5 | 2.48 | 3.74 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 1,367.66 | 3.88 | 2.32 | 4.53 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 1,367.66 | 3.88 | 2.12 | 4.53 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 0 | 0 | 0 | 0 | Closed |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 0 | 0 | 0 | 0 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 0 | 0 | 0 | 0 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | -79.06 | 0.32 | 0.04 | 0.06 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | -104.57 | 0.43 | 0.06 | 0.09 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 4.65 | 0.03 | 0 | 0 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 210.1 | 1.34 | 0.42 | 1.02 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 62.13 | 0.4 | 0.11 | 0.11 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 149.13 | 0.95 | 0.22 | 0.54 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -16.9 | 0.11 | 0 | 0.01 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 52.22 | 0.33 | 0.14 | 0.08 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -219.03 | 1.4 | 0.69 | 1.1 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 559.18 | 2.28 | 1.06 | 2.1 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 544.37 | 2.22 | 0.06 | 2 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 119.79 | 0.76 | 0.48 | 0.36 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -43.44 | 0.28 | 0.05 | 0.05 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 544.37 | 2.22 | 1.19 | 2 | Open |

SCENARIO 5 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,238.66 | 101.24 |
| J271 | 2.83 | 1,990.90 | 2,217.45 | 98.16 |
| J273 | 76.23 | 1,959.80 | 2,209.19 | 108.06 |
| J267 | 0 | 1,932.80 | 2,078.13 | 62.97 |
| J265 | 127.8 | 1,900.50 | 2,078.11 | 76.96 |
| J10612 | 0 | 1,781.49 | 2,078.61 | 128.74 |
| J257 | 102.02 | 1,778.50 | 2,078.44 | 129.97 |
| J259 | 11.77 | 1,779.00 | 2,078.61 | 129.82 |
| J269 | 502.15 | 1,820.30 | 2,078.16 | 111.73 |
| J261 | 113.92 | 1,860.20 | 2,078.99 | 94.8 |
| J291 | 2,563.70 | 2,046.00 | 2,170.45 | 53.93 |
| J293 | 35.42 | 1,955.81 | 2,192.52 | 102.57 |
| J297 | 76.23 | 1,912.80 | 2,078.20 | 71.67 |
| J303 | 0 | 1,849.80 | 2,078.35 | 99.03 |
| J309 | 60.08 | 1,985.30 | 2,176.41 | 82.81 |
| J311 | 61.78 | 1,964.66 | 2,180.87 | 93.68 |
| J315 | 0 | 1,869.10 | 2,078.16 | 90.58 |
| J323 | 233.5 | 1,869.10 | 2,078.15 | 90.58 |
| J329 | 111.65 | 1,901.00 | 2,078.06 | 76.72 |
| J255 | 0 | 1,858.90 | 2,078.53 | 95.17 |
| J275 | 0 | 1,940.40 | 2,192.28 | 109.14 |
| J277 | 0 | 1,959.70 | 2,191.82 | 100.58 |
| J279 | 0 | 1,957.20 | 2,191.01 | 101.31 |
| J285 | 0 | 1,965.60 | 2,201.66 | 102.29 |
| J287 | 0 | 1,939.00 | 2,205.57 | 115.51 |
| J295 | 0 | 1,953.17 | 2,190.24 | 102.72 |
| J299 | 0 | 1,886.80 | 2,078.87 | 83.23 |
| J301 | 0 | 1,843.00 | 2,079.94 | 102.67 |
| J305 | 0 | 1,750.00 | 1,862.61 | 48.79 |
| J313 | 61.78 | 1,961.44 | 2,187.42 | 97.92 |
| J317 | 0 | 1,871.00 | 2,078.22 | 89.79 |
| J319 | 0 | 1,877.00 | 2,078.43 | 87.28 |
| J321 | 157.28 | 1,873.70 | 2,078.28 | 88.64 |
| J325 | 130.35 | 1,781.08 | 2,081.67 | 130.24 |
| J331 | 88.98 | 1,902.20 | 2,078.12 | 76.22 |
| J333 | 71.41 | 1,912.00 | 2,078.17 | 72 |
| J341 | 133.19 | 1,773.00 | 2,084.16 | 134.82 |
| J243 | 0 | 1,845.30 | 2,079.68 | 101.56 |
| J253 | 0 | 1,750.00 | 2,086.28 | 145.71 |
| J281 | 25.5 | 1,948.30 | 2,194.63 | 106.74 |
| J283 | 79.06 | 1,939.00 | 2,198.97 | 112.65 |
| J307 | 211.4 | 1,704.00 | 1,861.42 | 68.21 |
| J343 | 205.45 | 1,677.92 | 1,861.42 | 79.51 |
| J345 | 87 | 1,603.00 | 1,861.30 | 111.92 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,492.02 | 1,861.89 | 160.26 |
| J72264 | 14.81 | 2,020.59 | 2,260.90 | 104.13 |
| J339 | 163.23 | 1,697.00 | 1,861.90 | 71.45 |
| J10874 | 67.16 | 1,716.66 | 1,861.95 | 62.95 |

SCENARIO 5 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -1,825.36 | 7.46 | 21.21 | 18.78 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -1,822.52 | 7.44 | 8.26 | 18.72 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -1,746.29 | 7.13 | 16.66 | 17.3 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | -23.76 | 0.15 | 0.02 | 0.02 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -23.76 | 0.15 | 0.03 | 0.02 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 104.05 | 0.66 | 0.5 | 0.28 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 125.73 | 0.8 | 0.13 | 0.39 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -375.74 | 1.07 | 0.17 | 0.41 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -125.73 | 0.36 | 0 | 0.05 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -273.73 | 0.78 | 0.29 | 0.23 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 252.18 | 0.72 | 0.2 | 0.2 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | -204.15 | 1.3 | 0.47 | 0.96 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | -204.15 | 1.3 | 0.24 | 0.96 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -1,506.72 | 6.15 | 22.07 | 13.16 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | -204.15 | 1.3 | 0.78 | 0.96 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | -1,056.98 | 4.32 | 5.95 | 6.83 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -194.62 | 0.55 | 0.15 | 0.12 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -1,117.05 | 4.56 | 4.46 | 7.56 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -1,178.83 | 4.82 | 6.56 | 8.35 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -118.39 | 0.34 | 0.05 | 0.05 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 188.94 | 0.54 | 0.07 | 0.12 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -44.56 | 0.13 | 0 | 0.01 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 73.83 | 0.47 | 0.1 | 0.15 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -37.82 | 0.24 | 0.06 | 0.04 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 560.72 | 1.59 | 0.7 | 0.87 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 446.8 | 1.27 | 0.18 | 0.57 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 446.8 | 1.27 | 0.46 | 0.57 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | -204.15 | 1.3 | 0.8 | 0.96 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 560.72 | 1.59 | 0.26 | 0.87 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 544.43 | 1.54 | 1.07 | 0.82 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 544.43 | 1.54 | 0.45 | 0.82 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 205.3 | 1.31 | 0.51 | 0.97 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 205.3 | 1.31 | 1.19 | 0.97 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -1,240.61 | 5.07 | 2.81 | 9.18 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 420.94 | 1.19 | 0.15 | 0.51 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 263.66 | 0.75 | 0.06 | 0.21 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,105.15 | 3.14 | 1.73 | 3.05 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 74.72 | 0.48 | 0.1 | 0.15 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 123.5 | 0.79 | 0.26 | 0.38 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -52.09 | 0.33 | 0.05 | 0.08 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,235.50 | 3.5 | 2.49 | 3.75 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 1,368.69 | 3.88 | 2.32 | 4.53 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 1,368.69 | 3.88 | 2.12 | 4.53 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 1,141.03 | 4.66 | 3.54 | 7.87 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 1,141.03 | 4.66 | 3.91 | 7.87 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 1,141.03 | 4.66 | 2.69 | 7.86 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 1,061.96 | 4.34 | 4.34 | 6.89 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 1,036.46 | 4.23 | 4.4 | 6.58 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 6.1 | 0.04 | 0 | 0 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 211.55 | 1.35 | 0.43 | 1.03 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 62.04 | 0.4 | 0.11 | 0.11 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 149.04 | 0.95 | 0.22 | 0.54 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -16.04 | 0.1 | 0 | 0.01 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 51.76 | 0.33 | 0.14 | 0.08 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -217.71 | 1.39 | 0.68 | 1.09 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 1,918.09 | 7.84 | 10.36 | 20.58 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 1,903.29 | 7.77 | 0.59 | 20.28 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 119.99 | 0.77 | 0.48 | 0.36 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -43.23 | 0.28 | 0.05 | 0.05 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 1,903.29 | 7.77 | 12.13 | 20.29 | Open |

SCENARIO 6 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,250.57 | 106.41 |
| J271 | 2.83 | 1,990.90 | 2,250.39 | 112.44 |
| J273 | 76.23 | 1,959.80 | 2,250.33 | 125.89 |
| J267 | 0 | 1,932.80 | 2,029.41 | 41.86 |
| J265 | 127.8 | 1,900.50 | 2,030.30 | 56.24 |
| J10612 | 0 | 1,781.49 | 2,034.45 | 109.61 |
| J257 | 102.02 | 1,778.50 | 2,032.64 | 110.12 |
| J259 | 11.77 | 1,779.00 | 2,034.43 | 110.68 |
| J269 | 502.15 | 1,820.30 | 2,027.86 | 89.94 |
| J261 | 113.92 | 1,860.20 | 2,026.52 | 72.06 |
| J291 | 63.76 | 2,046.00 | 2,250.23 | 88.49 |
| J293 | 35.42 | 1,955.81 | 2,250.30 | 127.6 |
| J297 | 76.23 | 1,912.80 | 2,019.15 | 46.08 |
| J303 | 0 | 1,849.80 | 2,025.60 | 76.18 |
| J309 | 60.08 | 1,985.30 | 2,250.23 | 114.79 |
| J311 | 61.78 | 1,964.66 | 2,250.25 | 123.74 |
| J315 | 0 | 1,869.10 | 2,014.63 | 63.06 |
| J323 | 233.5 | 1,869.10 | 2,013.92 | 62.75 |
| J329 | 111.65 | 1,901.00 | 2,007.53 | 46.16 |
| J255 | 0 | 1,858.90 | 2,025.86 | 72.34 |
| J275 | 0 | 1,940.40 | 2,250.31 | 134.28 |
| J277 | 0 | 1,959.70 | 2,250.34 | 125.93 |
| J279 | 0 | 1,957.20 | 2,250.38 | 127.03 |
| J285 | 0 | 1,965.60 | 2,251.25 | 123.77 |
| J287 | 0 | 1,939.00 | 2,251.64 | 135.47 |
| J295 | 0 | 1,953.17 | 2,250.42 | 128.8 |
| J299 | 0 | 1,886.80 | 2,018.48 | 57.06 |
| J301 | 0 | 1,843.00 | 2,027.79 | 80.07 |
| J305 | 0 | 1,750.00 | 1,862.54 | 48.76 |
| J313 | 61.78 | 1,961.44 | 2,250.34 | 125.18 |
| J317 | 0 | 1,871.00 | 2,013.60 | 61.79 |
| J319 | 0 | 1,877.00 | 2,014.60 | 59.62 |
| J321 | 157.28 | 1,873.70 | 2,014.01 | 60.79 |
| J325 | 130.35 | 1,781.08 | 2,035.13 | 110.08 |
| J331 | 2,588.92 | 1,902.20 | 1,996.77 | 40.98 |
| J333 | 71.41 | 1,912.00 | 2,005.25 | 40.41 |
| J341 | 133.19 | 1,773.00 | 2,044.59 | 117.68 |
| J243 | 0 | 1,845.30 | 2,027.45 | 78.93 |
| J253 | 0 | 1,750.00 | 2,051.92 | 130.82 |
| J281 | 25.5 | 1,948.30 | 2,250.68 | 131.02 |
| J283 | 79.06 | 1,939.00 | 2,250.98 | 135.18 |
| J307 | 211.4 | 1,704.00 | 1,861.35 | 68.18 |
| J343 | 205.45 | 1,677.92 | 1,861.35 | 79.48 |
| J345 | 87 | 1,603.00 | 1,861.23 | 111.89 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,492.02 | 1,861.80 | 160.23 |
| J72264 | 14.81 | 2,020.59 | 2,371.42 | 152.01 |
| J339 | 163.23 | 1,697.00 | 1,861.82 | 71.42 |
| J10874 | 67.16 | 1,716.66 | 1,861.87 | 62.92 |

SCENARIO 6 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -137.82 | 0.56 | 0.18 | 0.16 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -134.98 | 0.55 | 0.07 | 0.15 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -58.76 | 0.24 | 0.03 | 0.03 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | 196.01 | 1.25 | 0.89 | 0.89 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | 196.01 | 1.25 | 1.55 | 0.89 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 323.82 | 2.07 | 4.13 | 2.26 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 431.6 | 2.75 | 1.3 | 3.85 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -1,350.28 | 3.83 | 1.79 | 4.42 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -431.6 | 1.22 | 0.01 | 0.54 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -1,248.27 | 3.54 | 4.78 | 3.82 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | -942.13 | 2.67 | 2.26 | 2.27 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 42.66 | 0.27 | 0.03 | 0.05 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 42.66 | 0.27 | 0.01 | 0.05 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -65.99 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 42.66 | 0.27 | 0.04 | 0.05 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 2.23 | 0.01 | 0 | 0 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -1,485.24 | 4.21 | 6.46 | 5.27 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -57.85 | 0.24 | 0.02 | 0.03 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -119.62 | 0.49 | 0.09 | 0.12 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -1,409.01 | 4 | 4.52 | 4.78 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | -435.31 | 1.23 | 0.32 | 0.54 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -668.81 | 1.9 | 0.71 | 1.2 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 740.2 | 4.72 | 7.11 | 10.46 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | 628.55 | 4.01 | 10.76 | 7.73 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 657.03 | 1.86 | 0.93 | 1.16 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 543.11 | 1.54 | 0.25 | 0.82 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 543.11 | 1.54 | 0.66 | 0.82 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 42.66 | 0.27 | 0.04 | 0.05 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 657.03 | 1.86 | 0.34 | 1.16 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 1,753.75 | 4.98 | 9.31 | 7.17 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 1,753.75 | 4.98 | 3.88 | 7.17 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 205.84 | 1.31 | 0.51 | 0.98 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 205.84 | 1.31 | 1.19 | 0.98 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -181.4 | 0.74 | 0.08 | 0.26 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 891.67 | 2.53 | 0.59 | 2.05 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 734.39 | 2.08 | 0.4 | 1.43 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 2,410.78 | 6.84 | 7.34 | 12.93 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 1,169.70 | 7.47 | 16.84 | 24.42 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 862.08 | 5.5 | 9.35 | 13.88 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -790.67 | 5.05 | 8.49 | 11.82 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 2,541.13 | 7.21 | 9.45 | 14.26 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 2,674.32 | 7.59 | 8.02 | 15.67 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 2,674.32 | 7.59 | 7.33 | 15.67 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 328.62 | 1.34 | 0.35 | 0.78 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 328.62 | 1.34 | 0.39 | 0.78 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 328.62 | 1.34 | 0.27 | 0.78 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 249.56 | 1.02 | 0.3 | 0.47 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 224.06 | 0.92 | 0.26 | 0.39 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 5.56 | 0.04 | 0 | 0 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 211.01 | 1.35 | 0.43 | 1.02 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 62.08 | 0.4 | 0.11 | 0.11 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 149.08 | 0.95 | 0.22 | 0.54 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -16.42 | 0.1 | 0 | 0.01 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 51.94 | 0.33 | 0.14 | 0.08 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -218.26 | 1.39 | 0.69 | 1.09 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 230.55 | 0.94 | 0.2 | 0.41 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 215.75 | 0.88 | 0.01 | 0.36 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 119.9 | 0.77 | 0.48 | 0.36 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -43.33 | 0.28 | 0.05 | 0.05 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 215.75 | 0.88 | 0.22 | 0.36 | Open |

SCENARIO 7 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,250.57 | 106.41 |
| J271 | 2.83 | 1,990.90 | 2,250.39 | 112.44 |
| J273 | 76.23 | 1,959.80 | 2,250.33 | 125.89 |
| J267 | 0 | 1,932.80 | 2,001.57 | 29.8 |
| J265 | 127.8 | 1,900.50 | 2,003.26 | 44.53 |
| J10612 | 0 | 1,781.49 | 2,009.53 | 98.81 |
| J257 | 102.02 | 1,778.50 | 2,006.61 | 98.84 |
| J259 | 11.77 | 1,779.00 | 2,009.50 | 99.88 |
| J269 | 502.15 | 1,820.30 | 1,998.64 | 77.27 |
| J261 | 113.92 | 1,860.20 | 1,995.04 | 58.42 |
| J291 | 63.76 | 2,046.00 | 2,250.23 | 88.49 |
| J293 | 35.42 | 1,955.81 | 2,250.30 | 127.6 |
| J297 | 76.23 | 1,912.80 | 1,981.98 | 29.97 |
| J303 | 0 | 1,849.80 | 1,993.80 | 62.4 |
| J309 | 60.08 | 1,985.30 | 2,250.23 | 114.79 |
| J311 | 61.78 | 1,964.66 | 2,250.25 | 123.74 |
| J315 | 0 | 1,869.10 | 1,973.47 | 45.22 |
| J323 | 3,733.49 | 1,869.10 | 1,968.49 | 43.07 |
| J329 | 111.65 | 1,901.00 | 1,973.38 | 31.36 |
| J255 | 0 | 1,858.90 | 1,994.15 | 58.6 |
| J275 | 0 | 1,940.40 | 2,250.31 | 134.28 |
| J277 | 0 | 1,959.70 | 2,250.34 | 125.93 |
| J279 | 0 | 1,957.20 | 2,250.38 | 127.03 |
| J285 | 0 | 1,965.60 | 2,251.24 | 123.77 |
| J287 | 0 | 1,939.00 | 2,251.63 | 135.46 |
| J295 | 0 | 1,953.17 | 2,250.42 | 128.8 |
| J299 | 0 | 1,886.80 | 1,982.75 | 41.57 |
| J301 | 0 | 1,843.00 | 1,996.68 | 66.59 |
| J305 | 0 | 1,750.00 | 1,862.51 | 48.75 |
| J313 | 61.78 | 1,961.44 | 2,250.34 | 125.18 |
| J317 | 0 | 1,871.00 | 1,972.97 | 44.18 |
| J319 | 0 | 1,877.00 | 1,976.94 | 43.3 |
| J321 | 157.28 | 1,873.70 | 1,974.76 | 43.79 |
| J325 | 130.35 | 1,781.08 | 2,007.23 | 97.99 |
| J331 | 88.98 | 1,902.20 | 1,973.46 | 30.88 |
| J333 | 71.41 | 1,912.00 | 1,974.92 | 27.26 |
| J341 | 133.19 | 1,773.00 | 2,020.58 | 107.28 |
| J243 | 0 | 1,845.30 | 1,996.23 | 65.4 |
| J253 | 0 | 1,750.00 | 2,030.78 | 121.66 |
| J281 | 25.5 | 1,948.30 | 2,250.68 | 131.02 |
| J283 | 79.06 | 1,939.00 | 2,250.98 | 135.18 |
| J307 | 211.4 | 1,704.00 | 1,861.31 | 68.16 |
| J343 | 205.45 | 1,677.92 | 1,861.32 | 79.46 |
| J345 | 87 | 1,603.00 | 1,861.19 | 111.88 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,492.02 | 1,861.77 | 160.21 |
| J72264 | 14.81 | 2,020.59 | 2,371.39 | 152 |
| J339 | 163.23 | 1,697.00 | 1,861.79 | 71.4 |
| J10874 | 67.16 | 1,716.66 | 1,861.84 | 62.9 |

SCENARIO 7 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -137.88 | 0.56 | 0.18 | 0.16 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -135.05 | 0.55 | 0.07 | 0.15 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -58.82 | 0.24 | 0.03 | 0.03 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | 276.85 | 1.77 | 1.69 | 1.69 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | 276.85 | 1.77 | 2.94 | 1.69 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 404.66 | 2.58 | 6.24 | 3.42 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 554.18 | 3.54 | 2.07 | 6.12 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -1,748.06 | 4.96 | 2.89 | 7.13 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -554.18 | 1.57 | 0.02 | 0.85 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -1,646.04 | 4.67 | 7.97 | 6.38 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | -1,420.75 | 4.03 | 4.83 | 4.86 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 42.63 | 0.27 | 0.03 | 0.05 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 42.63 | 0.27 | 0.01 | 0.05 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -66.02 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 42.63 | 0.27 | 0.04 | 0.05 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 2.26 | 0.01 | 0 | 0 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -2,059.35 | 5.84 | 11.83 | 9.66 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -57.82 | 0.24 | 0.02 | 0.03 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -119.59 | 0.49 | 0.09 | 0.12 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -1,983.12 | 5.63 | 8.51 | 9.01 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 1,818.92 | 5.16 | 4.48 | 7.67 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -1,914.57 | 5.43 | 4.98 | 8.44 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 68.56 | 0.44 | 0.09 | 0.13 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -43.1 | 0.28 | 0.08 | 0.05 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 752.52 | 2.13 | 1.2 | 1.5 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 638.6 | 1.81 | 0.34 | 1.1 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 638.6 | 1.81 | 0.89 | 1.1 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 42.63 | 0.27 | 0.04 | 0.05 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 752.52 | 2.13 | 0.44 | 1.5 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 2,179.69 | 6.18 | 13.93 | 10.73 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 2,179.69 | 6.18 | 5.81 | 10.73 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 205.85 | 1.31 | 0.51 | 0.98 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 205.85 | 1.31 | 1.19 | 0.98 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -181.37 | 0.74 | 0.08 | 0.26 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 1,802.75 | 5.11 | 2.18 | 7.55 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 1,645.47 | 4.67 | 1.79 | 6.37 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 2,932.21 | 8.32 | 10.55 | 18.58 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | -173.45 | 1.11 | 0.49 | 0.71 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 376.94 | 2.41 | 2.02 | 3 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -305.53 | 1.95 | 1.46 | 2.03 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 3,062.56 | 8.69 | 13.36 | 20.14 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 3,195.75 | 9.07 | 11.15 | 21.8 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 3,195.75 | 9.07 | 10.19 | 21.8 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 328.56 | 1.34 | 0.35 | 0.78 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 328.56 | 1.34 | 0.39 | 0.78 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 328.56 | 1.34 | 0.27 | 0.78 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 249.5 | 1.02 | 0.3 | 0.47 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 224 | 0.92 | 0.26 | 0.39 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 5.55 | 0.04 | 0 | 0 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 211 | 1.35 | 0.43 | 1.02 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 62.09 | 0.4 | 0.11 | 0.11 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 149.08 | 0.95 | 0.22 | 0.54 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -16.43 | 0.1 | 0 | 0.01 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 51.94 | 0.33 | 0.14 | 0.08 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -218.28 | 1.39 | 0.69 | 1.09 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 230.61 | 0.94 | 0.2 | 0.41 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 215.81 | 0.88 | 0.01 | 0.36 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 119.9 | 0.77 | 0.48 | 0.36 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -43.33 | 0.28 | 0.05 | 0.05 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 215.81 | 0.88 | 0.22 | 0.36 | Open |

SCENARIO 8 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,250.57 | 106.41 |
| J271 | 2.83 | 1,990.90 | 2,250.40 | 112.44 |
| J273 | 76.23 | 1,959.80 | 2,250.33 | 125.89 |
| J267 | 0 | 1,932.80 | 2,076.82 | 62.4 |
| J265 | 127.8 | 1,900.50 | 2,076.79 | 76.39 |
| J10612 | 0 | 1,781.49 | 2,077.24 | 128.15 |
| J257 | 102.02 | 1,778.50 | 2,077.09 | 129.38 |
| J259 | 11.77 | 1,779.00 | 2,077.23 | 129.23 |
| J269 | 502.15 | 1,820.30 | 2,076.87 | 111.17 |
| J261 | 113.92 | 1,860.20 | 2,077.83 | 94.3 |
| J291 | 63.76 | 2,046.00 | 2,250.23 | 88.49 |
| J293 | 35.42 | 1,955.81 | 2,250.30 | 127.6 |
| J297 | 76.23 | 1,912.80 | 2,077.00 | 71.15 |
| J303 | 0 | 1,849.80 | 2,077.13 | 98.5 |
| J309 | 60.08 | 1,985.30 | 2,250.23 | 114.79 |
| J311 | 61.78 | 1,964.66 | 2,250.25 | 123.74 |
| J315 | 0 | 1,869.10 | 2,076.97 | 90.07 |
| J323 | 233.5 | 1,869.10 | 2,076.96 | 90.07 |
| J329 | 111.65 | 1,901.00 | 2,076.87 | 76.21 |
| J255 | 0 | 1,858.90 | 2,077.32 | 94.64 |
| J275 | 0 | 1,940.40 | 2,250.31 | 134.28 |
| J277 | 0 | 1,959.70 | 2,250.34 | 125.93 |
| J279 | 0 | 1,957.20 | 2,250.38 | 127.04 |
| J285 | 0 | 1,965.60 | 2,251.25 | 123.77 |
| J287 | 0 | 1,939.00 | 2,251.64 | 135.47 |
| J295 | 0 | 1,953.17 | 2,250.42 | 128.8 |
| J299 | 0 | 1,886.80 | 2,077.73 | 82.73 |
| J301 | 0 | 1,843.00 | 2,078.86 | 102.2 |
| J305 | 0 | 1,750.00 | 1,860.29 | 47.79 |
| J313 | 61.78 | 1,961.44 | 2,250.34 | 125.18 |
| J317 | 0 | 1,871.00 | 2,077.04 | 89.28 |
| J319 | 0 | 1,877.00 | 2,077.26 | 86.77 |
| J321 | 157.28 | 1,873.70 | 2,077.11 | 88.14 |
| J325 | 130.35 | 1,781.08 | 2,080.71 | 129.83 |
| J331 | 88.98 | 1,902.20 | 2,076.94 | 75.71 |
| J333 | 71.41 | 1,912.00 | 2,077.00 | 71.49 |
| J341 | 133.19 | 1,773.00 | 2,083.35 | 134.48 |
| J243 | 0 | 1,845.30 | 2,078.58 | 101.08 |
| J253 | 0 | 1,750.00 | 2,085.59 | 145.41 |
| J281 | 25.5 | 1,948.30 | 2,250.68 | 131.02 |
| J283 | 79.06 | 1,939.00 | 2,250.98 | 135.18 |
| J307 | 211.4 | 1,704.00 | 1,856.65 | 66.14 |
| J343 | 205.45 | 1,677.92 | 1,855.80 | 77.08 |
| J345 | 87 | 1,603.00 | 1,854.40 | 108.93 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,592.00 | 1,857.21 | 114.91 |
| J72264 | 14.81 | 2,020.59 | 2,371.45 | 152.03 |
| J339 | 163.23 | 1,697.00 | 1,846.60 | 64.82 |
| J10874 | 4,067.17 | 1,716.66 | 1,843.22 | 54.84 |

SCENARIO 8 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -137.66 | 0.56 | 0.18 | 0.16 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -134.82 | 0.55 | 0.07 | 0.15 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -58.59 | 0.24 | 0.03 | 0.03 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | -30.65 | 0.2 | 0.03 | 0.03 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -30.65 | 0.2 | 0.05 | 0.03 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 97.16 | 0.62 | 0.44 | 0.24 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 115.24 | 0.74 | 0.11 | 0.33 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -341.74 | 0.97 | 0.14 | 0.35 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -115.24 | 0.33 | 0 | 0.04 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -239.73 | 0.68 | 0.23 | 0.18 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 293.07 | 0.83 | 0.26 | 0.26 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 42.73 | 0.27 | 0.03 | 0.05 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 42.73 | 0.27 | 0.01 | 0.05 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -65.9 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 42.73 | 0.27 | 0.04 | 0.05 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 2.14 | 0.01 | 0 | 0 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -178.34 | 0.51 | 0.13 | 0.1 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -57.93 | 0.24 | 0.02 | 0.03 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -119.71 | 0.49 | 0.09 | 0.12 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -102.11 | 0.29 | 0.03 | 0.04 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 202.93 | 0.58 | 0.08 | 0.13 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -30.57 | 0.09 | 0 | 0 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 71.54 | 0.46 | 0.09 | 0.14 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -40.11 | 0.26 | 0.07 | 0.05 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 585.33 | 1.66 | 0.75 | 0.94 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 471.41 | 1.34 | 0.2 | 0.63 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 471.41 | 1.34 | 0.51 | 0.63 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 42.73 | 0.27 | 0.04 | 0.05 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 585.33 | 1.66 | 0.28 | 0.94 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 560.71 | 1.59 | 1.13 | 0.87 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 560.71 | 1.59 | 0.47 | 0.87 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 376.04 | 2.4 | 1.57 | 2.99 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 376.04 | 2.4 | 3.64 | 2.99 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -181.49 | 0.74 | 0.08 | 0.26 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 434.73 | 1.23 | 0.16 | 0.54 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 277.46 | 0.79 | 0.07 | 0.24 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,146.04 | 3.25 | 1.85 | 3.26 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 74.53 | 0.48 | 0.1 | 0.15 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 125.98 | 0.8 | 0.27 | 0.39 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -54.57 | 0.35 | 0.06 | 0.08 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,276.39 | 3.62 | 2.64 | 3.98 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 1,409.58 | 4 | 2.45 | 4.79 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 1,409.58 | 4 | 2.24 | 4.79 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 328.79 | 1.34 | 0.35 | 0.79 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 328.79 | 1.34 | 0.39 | 0.78 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 328.79 | 1.34 | 0.27 | 0.78 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 249.72 | 1.02 | 0.3 | 0.47 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 224.22 | 0.92 | 0.26 | 0.39 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | -164.64 | 1.05 | 0.85 | 0.65 | Open |
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 40.81 | 0.26 | 0.02 | 0.05 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 120.72 | 0.77 | 0.39 | 0.36 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 207.72 | 1.33 | 0.41 | 0.99 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | 15.13 | 0.1 | 0 | 0.01 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 38.07 | 0.24 | 0.08 | 0.04 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -172.85 | 1.1 | 0.45 | 0.71 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 230.39 | 0.94 | 0.2 | 0.41 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 215.59 | 0.88 | 0.01 | 0.36 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 606.34 | 3.87 | 9.66 | 7.23 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | 443.11 | 2.83 | 3.38 | 4.05 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 215.59 | 0.88 | 0.21 | 0.36 | Open |

SCENARIO 9 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,250.57 | 106.41 |
| J271 | 2.83 | 1,990.90 | 2,250.40 | 112.44 |
| J273 | 76.23 | 1,959.80 | 2,250.33 | 125.89 |
| J267 | 0 | 1,932.80 | 2,076.83 | 62.41 |
| J265 | 127.8 | 1,900.50 | 2,076.80 | 76.39 |
| J10612 | 0 | 1,781.49 | 2,077.25 | 128.15 |
| J257 | 102.02 | 1,778.50 | 2,077.10 | 129.39 |
| J259 | 11.77 | 1,779.00 | 2,077.25 | 129.23 |
| J269 | 502.15 | 1,820.30 | 2,076.88 | 111.18 |
| J261 | 113.92 | 1,860.20 | 2,077.84 | 94.3 |
| J291 | 63.76 | 2,046.00 | 2,250.23 | 88.49 |
| J293 | 35.42 | 1,955.81 | 2,250.30 | 127.6 |
| J297 | 76.23 | 1,912.80 | 2,077.01 | 71.15 |
| J303 | 0 | 1,849.80 | 2,077.14 | 98.51 |
| J309 | 60.08 | 1,985.30 | 2,250.23 | 114.79 |
| J311 | 61.78 | 1,964.66 | 2,250.25 | 123.74 |
| J315 | 0 | 1,869.10 | 2,076.98 | 90.07 |
| J323 | 233.5 | 1,869.10 | 2,076.98 | 90.07 |
| J329 | 111.65 | 1,901.00 | 2,076.88 | 76.21 |
| J255 | 0 | 1,858.90 | 2,077.34 | 94.65 |
| J275 | 0 | 1,940.40 | 2,250.31 | 134.28 |
| J277 | 0 | 1,959.70 | 2,250.34 | 125.93 |
| J279 | 0 | 1,957.20 | 2,250.38 | 127.04 |
| J285 | 0 | 1,965.60 | 2,251.25 | 123.77 |
| J287 | 0 | 1,939.00 | 2,251.64 | 135.47 |
| J295 | 0 | 1,953.17 | 2,250.42 | 128.8 |
| J299 | 0 | 1,886.80 | 2,077.75 | 82.74 |
| J301 | 0 | 1,843.00 | 2,078.87 | 102.2 |
| J305 | 0 | 1,750.00 | 1,852.97 | 44.62 |
| J313 | 61.78 | 1,961.44 | 2,250.34 | 125.18 |
| J317 | 0 | 1,871.00 | 2,077.05 | 89.28 |
| J319 | 0 | 1,877.00 | 2,077.28 | 86.78 |
| J321 | 157.28 | 1,873.70 | 2,077.12 | 88.14 |
| J325 | 130.35 | 1,781.08 | 2,080.73 | 129.83 |
| J331 | 88.98 | 1,902.20 | 2,076.95 | 75.72 |
| J333 | 71.41 | 1,912.00 | 2,077.01 | 71.5 |
| J341 | 133.19 | 1,773.00 | 2,083.37 | 134.48 |
| J243 | 0 | 1,845.30 | 2,078.60 | 101.09 |
| J253 | 0 | 1,750.00 | 2,085.61 | 145.42 |
| J281 | 25.5 | 1,948.30 | 2,250.68 | 131.02 |
| J283 | 79.06 | 1,939.00 | 2,250.98 | 135.18 |
| J307 | 1,711.47 | 1,704.00 | 1,834.75 | 56.65 |
| J343 | 205.45 | 1,677.92 | 1,851.14 | 75.06 |
| J345 | 87 | 1,603.00 | 1,858.57 | 110.74 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,592.00 | 1,859.99 | 116.12 |
| J72264 | 14.81 | 2,020.59 | 2,371.45 | 152.03 |
| J339 | 163.23 | 1,697.00 | 1,859.56 | 70.44 |
| J10874 | 67.16 | 1,716.66 | 1,859.57 | 61.92 |

SCENARIO 9 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -137.66 | 0.56 | 0.18 | 0.16 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -134.82 | 0.55 | 0.07 | 0.15 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -58.59 | 0.24 | 0.03 | 0.03 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | -30.69 | 0.2 | 0.03 | 0.03 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -30.69 | 0.2 | 0.05 | 0.03 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 97.12 | 0.62 | 0.44 | 0.24 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 115.18 | 0.74 | 0.11 | 0.33 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -341.53 | 0.97 | 0.14 | 0.35 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -115.18 | 0.33 | 0 | 0.04 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -239.51 | 0.68 | 0.22 | 0.18 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 293.32 | 0.83 | 0.26 | 0.26 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 42.73 | 0.27 | 0.03 | 0.05 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 42.73 | 0.27 | 0.01 | 0.05 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -65.9 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 42.73 | 0.27 | 0.04 | 0.05 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 2.14 | 0.01 | 0 | 0 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -178.24 | 0.51 | 0.13 | 0.1 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -57.93 | 0.24 | 0.02 | 0.03 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -119.71 | 0.49 | 0.09 | 0.12 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -102.01 | 0.29 | 0.03 | 0.04 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 203.02 | 0.58 | 0.08 | 0.13 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -30.48 | 0.09 | 0 | 0 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 71.53 | 0.46 | 0.09 | 0.14 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -40.13 | 0.26 | 0.07 | 0.05 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 585.48 | 1.66 | 0.75 | 0.94 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 471.56 | 1.34 | 0.2 | 0.63 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 471.56 | 1.34 | 0.51 | 0.63 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 42.73 | 0.27 | 0.04 | 0.05 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 585.48 | 1.66 | 0.28 | 0.94 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 560.81 | 1.59 | 1.13 | 0.87 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 560.81 | 1.59 | 0.47 | 0.87 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 897.2 | 5.73 | 7.84 | 14.94 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 897.2 | 5.73 | 18.23 | 14.94 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -181.49 | 0.74 | 0.08 | 0.26 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 434.82 | 1.23 | 0.16 | 0.54 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 277.54 | 0.79 | 0.07 | 0.24 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,146.29 | 3.25 | 1.85 | 3.26 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 74.52 | 0.48 | 0.1 | 0.15 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 125.99 | 0.8 | 0.27 | 0.39 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -54.58 | 0.35 | 0.06 | 0.08 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,276.65 | 3.62 | 2.64 | 3.98 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 1,409.84 | 4 | 2.45 | 4.79 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 1,409.84 | 4 | 2.24 | 4.79 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 328.79 | 1.34 | 0.35 | 0.79 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 328.79 | 1.34 | 0.39 | 0.78 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 328.79 | 1.34 | 0.27 | 0.78 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 249.72 | 1.02 | 0.3 | 0.47 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 224.22 | 0.92 | 0.26 | 0.39 | Open |
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 814.26 | 5.2 | 16.39 | 12.48 | Open |

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|---|---|---|---|---|---|---|---|---|---|---|
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 1,019.71 | 6.51 | 7.87 | 18.94 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 50.78 | 0.32 | 0.08 | 0.07 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 137.77 | 0.88 | 0.19 | 0.46 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -5.19 | 0.03 | 0 | 0 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 46.31 | 0.3 | 0.11 | 0.06 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -201.41 | 1.29 | 0.59 | 0.94 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 230.39 | 0.94 | 0.2 | 0.41 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 215.59 | 0.88 | 0.01 | 0.36 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 147.87 | 0.94 | 0.71 | 0.53 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -15.36 | 0.1 | 0.01 | 0.01 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 215.59 | 0.88 | 0.21 | 0.36 | Open |

SCENARIO 10 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,250.57 | 106.41 |
| J271 | 2.83 | 1,990.90 | 2,250.40 | 112.44 |
| J273 | 76.23 | 1,959.80 | 2,250.33 | 125.89 |
| J267 | 1,500.07 | 1,932.80 | 2,025.33 | 40.09 |
| J265 | 127.8 | 1,900.50 | 2,032.69 | 57.28 |
| J10612 | 0 | 1,781.49 | 2,051.79 | 117.12 |
| J257 | 102.02 | 1,778.50 | 2,051.44 | 118.27 |
| J259 | 11.77 | 1,779.00 | 2,051.78 | 118.2 |
| J269 | 502.15 | 1,820.30 | 2,050.73 | 99.84 |
| J261 | 113.92 | 1,860.20 | 2,055.00 | 84.41 |
| J291 | 63.76 | 2,046.00 | 2,250.23 | 88.49 |
| J293 | 35.42 | 1,955.81 | 2,250.30 | 127.6 |
| J297 | 76.23 | 1,912.80 | 2,053.03 | 60.76 |
| J303 | 0 | 1,849.80 | 2,052.98 | 88.04 |
| J309 | 60.08 | 1,985.30 | 2,250.23 | 114.79 |
| J311 | 61.78 | 1,964.66 | 2,250.25 | 123.74 |
| J315 | 0 | 1,869.10 | 2,053.14 | 79.74 |
| J323 | 233.5 | 1,869.10 | 2,053.22 | 79.78 |
| J329 | 111.65 | 1,901.00 | 2,053.13 | 65.92 |
| J255 | 0 | 1,858.90 | 2,053.54 | 84.34 |
| J275 | 0 | 1,940.40 | 2,250.31 | 134.28 |
| J277 | 0 | 1,959.70 | 2,250.34 | 125.93 |
| J279 | 0 | 1,957.20 | 2,250.38 | 127.04 |
| J285 | 0 | 1,965.60 | 2,251.25 | 123.77 |
| J287 | 0 | 1,939.00 | 2,251.64 | 135.47 |
| J295 | 0 | 1,953.17 | 2,250.42 | 128.8 |
| J299 | 0 | 1,886.80 | 2,055.10 | 72.93 |
| J301 | 0 | 1,843.00 | 2,057.52 | 92.95 |
| J305 | 0 | 1,750.00 | 1,862.57 | 48.77 |
| J313 | 61.78 | 1,961.44 | 2,250.34 | 125.18 |
| J317 | 0 | 1,871.00 | 2,053.54 | 79.09 |
| J319 | 0 | 1,877.00 | 2,054.10 | 76.74 |
| J321 | 157.28 | 1,873.70 | 2,053.75 | 78.01 |
| J325 | 130.35 | 1,781.08 | 2,061.77 | 121.62 |
| J331 | 88.98 | 1,902.20 | 2,053.43 | 65.53 |
| J333 | 71.41 | 1,912.00 | 2,053.62 | 61.36 |
| J341 | 133.19 | 1,773.00 | 2,067.42 | 127.57 |
| J243 | 0 | 1,845.30 | 2,056.84 | 91.66 |
| J253 | 0 | 1,750.00 | 2,071.94 | 139.49 |
| J281 | 25.5 | 1,948.30 | 2,250.68 | 131.02 |
| J283 | 79.06 | 1,939.00 | 2,250.98 | 135.18 |
| J307 | 211.4 | 1,704.00 | 1,861.37 | 68.19 |
| J343 | 205.45 | 1,677.92 | 1,861.38 | 79.49 |
| J345 | 87 | 1,603.00 | 1,861.25 | 111.9 |

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|---|---|---|---|---|
| J347 | 149.91 | 1,592.00 | 1,861.83 | 116.92 |
| J72264 | 14.81 | 2,020.59 | 2,371.43 | 152.02 |
| J339 | 163.23 | 1,697.00 | 1,861.85 | 71.43 |
| J10874 | 67.16 | 1,716.66 | 1,861.90 | 62.93 |

SCENARIO 10 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -137.74 | 0.56 | 0.18 | 0.16 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -134.91 | 0.55 | 0.07 | 0.15 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -58.68 | 0.24 | 0.03 | 0.03 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | 612.43 | 3.91 | 7.36 | 7.37 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -887.64 | 5.67 | 25.39 | 14.65 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 740.23 | 4.72 | 19.09 | 10.46 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 333.31 | 2.13 | 0.81 | 2.39 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -550.07 | 1.56 | 0.34 | 0.84 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -333.31 | 0.95 | 0.01 | 0.32 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -448.05 | 1.27 | 0.72 | 0.57 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 941.73 | 2.67 | 2.26 | 2.27 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 42.69 | 0.27 | 0.03 | 0.05 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 42.69 | 0.27 | 0.01 | 0.05 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -65.95 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 42.69 | 0.27 | 0.04 | 0.05 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 2.19 | 0.01 | 0 | 0 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | 107.4 | 0.3 | 0.05 | 0.04 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -57.89 | 0.24 | 0.02 | 0.03 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -119.67 | 0.49 | 0.09 | 0.12 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | 183.63 | 0.52 | 0.1 | 0.11 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 438.05 | 1.24 | 0.32 | 0.55 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | 204.55 | 0.58 | 0.08 | 0.13 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 20.92 | 0.13 | 0.01 | 0.01 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -90.73 | 0.58 | 0.3 | 0.21 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 948.25 | 2.69 | 1.84 | 2.3 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 834.33 | 2.37 | 0.56 | 1.81 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 834.33 | 2.37 | 1.46 | 1.81 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 42.69 | 0.27 | 0.04 | 0.05 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 948.25 | 2.69 | 0.68 | 2.3 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 846.45 | 2.4 | 2.42 | 1.86 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 846.45 | 2.4 | 1.01 | 1.86 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 205.77 | 1.31 | 0.51 | 0.98 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 205.77 | 1.31 | 1.19 | 0.98 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -181.44 | 0.74 | 0.08 | 0.26 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 673 | 1.91 | 0.35 | 1.22 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 515.73 | 1.46 | 0.21 | 0.74 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,794.70 | 5.09 | 4.25 | 7.49 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 77.68 | 0.5 | 0.11 | 0.16 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 173.45 | 1.11 | 0.48 | 0.71 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -102.04 | 0.65 | 0.19 | 0.27 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,925.06 | 5.46 | 5.65 | 8.52 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 2,058.25 | 5.84 | 4.94 | 9.65 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 2,058.25 | 5.84 | 4.51 | 9.65 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 328.7 | 1.34 | 0.35 | 0.78 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 328.7 | 1.34 | 0.39 | 0.78 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 328.7 | 1.34 | 0.27 | 0.78 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 249.64 | 1.02 | 0.3 | 0.47 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 224.14 | 0.92 | 0.26 | 0.39 | Open |
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | 5.63 | 0.04 | 0 | 0 | Open |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 211.08 | 1.35 | 0.43 | 1.02 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | 62.08 | 0.4 | 0.11 | 0.11 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 149.08 | 0.95 | 0.22 | 0.54 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | -16.37 | 0.1 | 0 | 0.01 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | 51.92 | 0.33 | 0.14 | 0.08 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -218.19 | 1.39 | 0.69 | 1.09 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 230.47 | 0.94 | 0.2 | 0.41 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 215.67 | 0.88 | 0.01 | 0.37 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 119.92 | 0.77 | 0.48 | 0.36 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -43.31 | 0.28 | 0.05 | 0.05 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 215.67 | 0.88 | 0.21 | 0.36 | Open |

SCENARIO 11 JUNCTION REPORT

| ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|
| J327 | 77.93 | 2,005.00 | 2,250.57 | 106.41 |
| J271 | 2.83 | 1,990.90 | 2,250.40 | 112.44 |
| J273 | 76.23 | 1,959.80 | 2,250.33 | 125.89 |
| J267 | 0 | 1,932.80 | 2,076.83 | 62.41 |
| J265 | 127.8 | 1,900.50 | 2,076.80 | 76.39 |
| J10612 | 0 | 1,781.49 | 2,077.24 | 128.15 |
| J257 | 102.02 | 1,778.50 | 2,077.10 | 129.38 |
| J259 | 11.77 | 1,779.00 | 2,077.24 | 129.23 |
| J269 | 502.15 | 1,820.30 | 2,076.88 | 111.18 |
| J261 | 113.92 | 1,860.20 | 2,077.84 | 94.3 |
| J291 | 63.76 | 2,046.00 | 2,250.23 | 88.49 |
| J293 | 35.42 | 1,955.81 | 2,250.30 | 127.6 |
| J297 | 76.23 | 1,912.80 | 2,077.01 | 71.15 |
| J303 | 0 | 1,849.80 | 2,077.14 | 98.51 |
| J309 | 60.08 | 1,985.30 | 2,250.23 | 114.79 |
| J311 | 61.78 | 1,964.66 | 2,250.25 | 123.74 |
| J315 | 0 | 1,869.10 | 2,076.98 | 90.07 |
| J323 | 233.5 | 1,869.10 | 2,076.97 | 90.07 |
| J329 | 111.65 | 1,901.00 | 2,076.88 | 76.21 |
| J255 | 0 | 1,858.90 | 2,077.33 | 94.65 |
| J275 | 0 | 1,940.40 | 2,250.31 | 134.28 |
| J277 | 0 | 1,959.70 | 2,250.34 | 125.93 |
| J279 | 0 | 1,957.20 | 2,250.38 | 127.04 |
| J285 | 0 | 1,965.60 | 2,251.25 | 123.77 |
| J287 | 0 | 1,939.00 | 2,251.64 | 135.47 |
| J295 | 0 | 1,953.17 | 2,250.42 | 128.8 |
| J299 | 0 | 1,886.80 | 2,077.74 | 82.74 |
| J301 | 0 | 1,843.00 | 2,078.87 | 102.2 |
| J305 | 0 | 1,750.00 | 1,862.14 | 48.59 |
| J313 | 61.78 | 1,961.44 | 2,250.34 | 125.18 |
| J317 | 0 | 1,871.00 | 2,077.05 | 89.28 |
| J319 | 0 | 1,877.00 | 2,077.27 | 86.78 |
| J321 | 157.28 | 1,873.70 | 2,077.12 | 88.14 |
| J325 | 130.35 | 1,781.08 | 2,080.72 | 129.83 |
| J331 | 88.98 | 1,902.20 | 2,076.95 | 75.72 |
| J333 | 71.41 | 1,912.00 | 2,077.01 | 71.5 |
| J341 | 133.19 | 1,773.00 | 2,083.36 | 134.48 |
| J243 | 0 | 1,845.30 | 2,078.59 | 101.09 |
| J253 | 0 | 1,750.00 | 2,085.60 | 145.42 |
| J281 | 25.5 | 1,948.30 | 2,250.68 | 131.02 |
| J283 | 79.06 | 1,939.00 | 2,250.98 | 135.18 |
| J307 | 211.4 | 1,704.00 | 1,859.76 | 67.49 |
| J343 | 205.45 | 1,677.92 | 1,859.49 | 78.67 |
| J345 | 1,337.05 | 1,603.00 | 1,851.63 | 107.73 |

| | | | | |
|---|---|---|---|---|
| J347 | 1,399.96 | 1,592.00 | 1,853.49 | 113.3 |
| J72264 | 14.81 | 2,020.59 | 2,371.45 | 152.03 |
| J339 | 163.23 | 1,697.00 | 1,859.80 | 70.54 |
| J10874 | 67.16 | 1,716.66 | 1,859.81 | 62.03 |

SCENARIO 11 PIPE REPORT

| ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| P1629 | J271 | J327 | 1,129.72 | 10 | 130 | -137.66 | 0.56 | 0.18 | 0.16 | Open |
| P1627 | J273 | J271 | 441.22 | 10 | 130 | -134.82 | 0.55 | 0.07 | 0.15 | Open |
| P1631 | J293 | J273 | 963.31 | 10 | 130 | -58.59 | 0.24 | 0.03 | 0.03 | Open |
| P1605 | J265 | J267 | 999.18 | 8 | 130 | -30.68 | 0.2 | 0.03 | 0.03 | Open |
| P1607 | J267 | J269 | 1,733.52 | 8 | 130 | -30.68 | 0.2 | 0.05 | 0.03 | Open |
| P1603 | J259 | J265 | 1,824.06 | 8 | 130 | 97.13 | 0.62 | 0.44 | 0.24 | Open |
| DM57022 | J10638 | J10612 | 338.47 | 8 | 130 | 115.2 | 0.74 | 0.11 | 0.33 | Open |
| P1593 | J257 | J259 | 405.28 | 12 | 130 | -341.59 | 0.97 | 0.14 | 0.35 | Open |
| P1595 | J259 | J10612 | 27.83 | 12 | 130 | -115.2 | 0.33 | 0 | 0.04 | Open |
| P1601 | J269 | J257 | 1,250.11 | 12 | 130 | -239.57 | 0.68 | 0.22 | 0.18 | Open |
| P1643 | J303 | J269 | 995.15 | 12 | 130 | 293.25 | 0.83 | 0.26 | 0.26 | Open |
| P1623 | J277 | J275 | 483.51 | 8 | 130 | 42.73 | 0.27 | 0.03 | 0.05 | Open |
| P1625 | J275 | J293 | 249.2 | 8 | 130 | 42.73 | 0.27 | 0.01 | 0.05 | Open |
| P1633 | J291 | J293 | 1,676.65 | 10 | 130 | -65.9 | 0.27 | 0.07 | 0.04 | Open |
| P1635 | J295 | J279 | 808.71 | 8 | 130 | 42.73 | 0.27 | 0.04 | 0.05 | Open |
| P1637 | J291 | J309 | 872.3 | 10 | 130 | 2.14 | 0.01 | 0 | 0 | Open |
| P1649 | J297 | J303 | 1,224.29 | 12 | 130 | -178.27 | 0.51 | 0.13 | 0.1 | Open |
| P1657 | J309 | J311 | 589.42 | 10 | 130 | -57.93 | 0.24 | 0.02 | 0.03 | Open |
| P1659 | J311 | J313 | 784.61 | 10 | 130 | -119.71 | 0.49 | 0.09 | 0.12 | Open |
| P1663 | J315 | J297 | 944.45 | 12 | 130 | -102.04 | 0.29 | 0.03 | 0.04 | Open |
| P1665 | J317 | J323 | 583.61 | 12 | 130 | 203 | 0.58 | 0.08 | 0.13 | Open |
| P1671 | J323 | J315 | 590.32 | 12 | 130 | -30.51 | 0.09 | 0 | 0 | Open |
| P1681 | J315 | J329 | 679.1 | 8 | 130 | 71.53 | 0.46 | 0.09 | 0.14 | Open |
| P1687 | J329 | J331 | 1,392.04 | 8 | 130 | -40.12 | 0.26 | 0.07 | 0.05 | Open |
| P1587 | J243 | J261 | 800.67 | 12 | 130 | 585.44 | 1.66 | 0.75 | 0.94 | Open |
| P1591 | J255 | J303 | 310.08 | 12 | 130 | 471.52 | 1.34 | 0.2 | 0.63 | Open |
| P1597 | J261 | J255 | 804.96 | 12 | 130 | 471.52 | 1.34 | 0.51 | 0.63 | Open |
| P1621 | J279 | J277 | 833.33 | 8 | 130 | 42.73 | 0.27 | 0.04 | 0.05 | Open |
| P1641 | J301 | J243 | 294.88 | 12 | 130 | 585.44 | 1.66 | 0.28 | 0.94 | Open |
| P1645 | J301 | J299 | 1,297.94 | 12 | 130 | 560.78 | 1.59 | 1.13 | 0.87 | Open |
| P1647 | J299 | J319 | 541.48 | 12 | 130 | 560.78 | 1.59 | 0.47 | 0.87 | Open |
| P1651 | J46074 | J305 | 524.78 | 8 | 130 | 299.36 | 1.91 | 1.03 | 1.96 | Open |
| P1653 | J305 | J307 | 1,219.82 | 8 | 130 | 299.36 | 1.91 | 2.39 | 1.96 | Open |
| P1661 | J313 | J295 | 306.43 | 10 | 130 | -181.49 | 0.74 | 0.08 | 0.26 | Open |
| P1667 | J319 | J321 | 288.46 | 12 | 130 | 434.8 | 1.23 | 0.16 | 0.54 | Open |
| P1669 | J321 | J317 | 281.04 | 12 | 130 | 277.52 | 0.79 | 0.07 | 0.24 | Open |
| P1673 | J325 | J301 | 567.66 | 12 | 130 | 1,146.22 | 3.25 | 1.85 | 3.26 | Open |
| P1683 | J317 | J331 | 689.59 | 8 | 130 | 74.52 | 0.48 | 0.1 | 0.15 | Open |
| P1685 | J319 | J333 | 673.54 | 8 | 130 | 125.99 | 0.8 | 0.27 | 0.39 | Open |
| P1689 | J331 | J333 | 717.72 | 8 | 130 | -54.58 | 0.35 | 0.06 | 0.08 | Open |
| P1697 | J341 | J325 | 663.01 | 12 | 130 | 1,276.58 | 3.62 | 2.64 | 3.98 | Open |
| P1585 | J46068 | J253 | 511.58 | 12 | 130 | 1,409.77 | 4 | 2.45 | 4.79 | Open |
| P1589 | J253 | J341 | 467.73 | 12 | 130 | 1,409.77 | 4 | 2.24 | 4.79 | Open |
| P1611 | J289 | J287 | 450.17 | 10 | 130 | 328.79 | 1.34 | 0.35 | 0.79 | Open |
| P1613 | J287 | J285 | 497.33 | 10 | 130 | 328.79 | 1.34 | 0.39 | 0.78 | Open |
| P1615 | J285 | J283 | 341.82 | 10 | 130 | 328.79 | 1.34 | 0.27 | 0.78 | Open |
| P1617 | J283 | J281 | 630.5 | 10 | 130 | 249.72 | 1.02 | 0.3 | 0.47 | Open |
| P1619 | J281 | J295 | 667.94 | 10 | 130 | 224.22 | 0.92 | 0.26 | 0.39 | Open |
| P1699 | J343 | J307 | 1,313.02 | 8 | 130 | -87.96 | 0.56 | 0.27 | 0.2 | Open |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| P1655 | J45422 | J343 | 415.38 | 8 | 130 | 117.49 | 0.75 | 0.14 | 0.35 | Open |
| P1703 | J345 | J68488 | 1,063.68 | 8 | 130 | -440.63 | 2.81 | 4.26 | 4 | Open |
| P1701 | J45396 | J345 | 415.09 | 8 | 130 | 896.42 | 5.72 | 6.19 | 14.92 | Open |
| P1705 | J13710 | J347 | 393.14 | 8 | 130 | 430.27 | 2.75 | 1.51 | 3.83 | Open |
| P1707 | J347 | J70348 | 1,817.62 | 8 | 130 | -207.56 | 1.32 | 1.81 | 0.99 | Open |
| P1709 | J347 | J11656 | 629.32 | 8 | 130 | -762.12 | 4.86 | 6.95 | 11.04 | Open |
| DM5403 | J8470 | J72264 | 503.16 | 10 | 130 | 230.39 | 0.94 | 0.2 | 0.41 | Open |
| P1677 | J72264 | V5 | 29.33 | 10 | 130 | 215.58 | 0.88 | 0.01 | 0.36 | Open |
| P1693 | J11752 | J339 | 1,336.00 | 8 | 130 | 147.71 | 0.94 | 0.71 | 0.53 | Open |
| P1695 | J339 | J10874 | 835.26 | 8 | 130 | -15.52 | 0.1 | 0.01 | 0.01 | Open |
| P1715 | V5 | J327 | 597.82 | 10 | 130 | 215.58 | 0.88 | 0.21 | 0.36 | Open |

# Appendix C – Sewer Model Output

| Block Number | Land Use Description | Residential Density (DU/ACRE) | Square Feet | dwelling units (DU) | Average Day | | | | Peak Hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (gpd/du) | (gpd/acre) | (gpd) | (gpm) | peaking factor | X avg. (gpm) |
| **Central Development Area - Wilson Town Center** | | | **166,116** | **763** | | | | **111** | | **277** |
| TC-D01 | High Density Residential | 20 | -- | 69 | 200 | -- | 13,800 | 9.6 | 2.5 | 24.0 |
| TC-D01 | Commercial | -- | 15000 | -- | -- | 1,700 | 586 | 0.4 | 2.5 | 1.0 |
| TC-D02 | High Density Residential | 20 | -- | 69 | 200 | -- | 13,800 | 9.6 | 2.5 | 24.0 |
| TC-D02 | Commercial | -- | 15000 | -- | -- | 1,700 | 586 | 0.4 | 2.5 | 1.0 |
| TC-D03 | High Density Residential | 20 | -- | 74 | 200 | -- | 14,800 | 10.3 | 2.5 | 25.7 |
| TC-D03 | Commercial | -- | 16134 | -- | -- | 1,700 | 630 | 0.4 | 2.5 | 1.1 |
| TC-D04 | High Density Residential | 20 | -- | 36 | 200 | -- | 7,200 | 5.0 | 2.5 | 12.5 |
| TC-D04 | Commercial | -- | 7758 | -- | -- | 1,700 | 303 | 0.2 | 2.5 | 0.5 |
| TC-D05 | High Density Residential | 20 | -- | 35 | 200 | -- | 7,000 | 4.9 | 2.5 | 12.2 |
| TC-D05 | Commercial | -- | 7583 | -- | -- | 1,700 | 296 | 0.2 | 2.5 | 0.5 |
| TC-D06 | High Density Residential | 20 | -- | 50 | 200 | -- | 10,000 | 6.9 | 2.5 | 17.4 |
| TC-D06 | Commercial | -- | 10843 | -- | -- | 1,700 | 424 | 0.3 | 2.5 | 0.7 |
| TC-D07 | High Density Residential | 20 | -- | 80 | 200 | -- | 16,000 | 11.1 | 2.5 | 27.8 |
| TC-D07 | Commercial | -- | 17500 | -- | -- | 1,700 | 683 | 0.5 | 2.5 | 1.2 |
| TC-D08 | High Density Residential | 20 | -- | 80 | 200 | -- | 16,000 | 11.1 | 2.5 | 27.8 |
| TC-D08 | Commercial | -- | 17500 | -- | -- | 1,700 | 683 | 0.5 | 2.5 | 1.2 |
| TC-D09 | High Density Residential | 20 | -- | 83 | 200 | -- | 16,600 | 11.5 | 2.5 | 28.8 |
| TC-D09 | Commercial | -- | 17974 | -- | -- | 1,700 | 702 | 0.5 | 2.5 | 1.2 |
| TC-D10 | High Density Residential | 20 | -- | 17 | 200 | -- | 3,400 | 2.4 | 2.5 | 5.9 |
| TC-D10 | Commercial | -- | 3670 | -- | -- | 1,700 | 144 | 0.1 | 2.5 | 0.3 |
| TC-D11 | High Density Residential | 20 | -- | 59 | 200 | -- | 11,800 | 8.2 | 2.5 | 20.5 |
| TC-D11 | Commercial | -- | 12868 | -- | -- | 1,700 | 503 | 0.3 | 2.5 | 0.9 |
| TC-D12 | High Density Residential | 20 | -- | 72 | 200 | -- | 14,400 | 10.0 | 2.5 | 25.0 |
| TC-D12 | Commercial | -- | 15750 | -- | -- | 1,700 | 615 | 0.4 | 2.5 | 1.1 |
| TC-D13 | High Density Residential | 20 | -- | 39 | 200 | -- | 7,800 | 5.4 | 2.5 | 13.5 |
| TC-D13 | Commercial | -- | 8536 | -- | -- | 1,700 | 334 | 0.2 | 2.5 | 0.6 |
| **Central Development Area - Wilson Neighborhood** | | | **0** | **1,114** | | | | **155** | | **387** |
| TC-N01 | High Density Residential | 18 | -- | 60 | 200 | -- | 12,000 | 8.3 | 2.5 | 20.8 |
| TC-N02 | High Density Residential | 18 | -- | 34 | 200 | -- | 6,800 | 4.7 | 2.5 | 11.8 |
| TC-N03 | High Density Residential | 18 | -- | 56 | 200 | -- | 11,200 | 7.8 | 2.5 | 19.4 |
| TC-N04 | High Density Residential | 18 | -- | 52 | 200 | -- | 10,400 | 7.2 | 2.5 | 18.1 |
| TC-N05 | High Density Residential | 18 | -- | 47 | 200 | -- | 9,400 | 6.5 | 2.5 | 16.3 |
| TC-N06 | High Density Residential | 18 | -- | 47 | 200 | -- | 9,400 | 6.5 | 2.5 | 16.3 |
| TC-N07 | High Density Residential | 18 | -- | 52 | 200 | -- | 10,400 | 7.2 | 2.5 | 18.1 |
| TC-N08 | High Density Residential | 18 | -- | 52 | 200 | -- | 10,400 | 7.2 | 2.5 | 18.1 |
| TC-N09 | High Density Residential | 18 | -- | 52 | 200 | -- | 10,400 | 7.2 | 2.5 | 18.1 |
| TC-N10 | High Density Residential | 18 | -- | 46 | 200 | -- | 9,200 | 6.4 | 2.5 | 16.0 |
| TC-N11 | High Density Residential | 18 | -- | 23 | 200 | -- | 4,600 | 3.2 | 2.5 | 8.0 |
| TC-N12 | High Density Residential | 18 | -- | 43 | 200 | -- | 8,600 | 6.0 | 2.5 | 14.9 |
| TC-N13 | High Density Residential | 18 | -- | 73 | 200 | -- | 14,600 | 10.1 | 2.5 | 25.3 |
| TC-N14 | High Density Residential | 18 | -- | 35 | 200 | -- | 7,000 | 4.9 | 2.5 | 12.2 |
| TC-N15 | High Density Residential | 18 | -- | 58 | 200 | -- | 11,600 | 8.1 | 2.5 | 20.1 |
| TC-N16 | High Density Residential | 18 | -- | 35 | 200 | -- | 7,000 | 4.9 | 2.5 | 12.2 |
| TC-N17 | High Density Residential | 18 | -- | 48 | 200 | -- | 9,600 | 6.7 | 2.5 | 16.7 |
| TC-N18 | High Density Residential | 18 | -- | 19 | 200 | -- | 3,800 | 2.6 | 2.5 | 6.6 |
| TC-N19 | High Density Residential | 18 | -- | 61 | 200 | -- | 12,200 | 8.5 | 2.5 | 21.2 |
| TC-N20 | High Density Residential | 18 | -- | 41 | 200 | -- | 8,200 | 5.7 | 2.5 | 14.2 |
| TC-N21 | High Density Residential | 18 | -- | 35 | 200 | -- | 7,000 | 4.9 | 2.5 | 12.2 |
| TC-N22 | High Density Residential | 18 | -- | 35 | 200 | -- | 7,000 | 4.9 | 2.5 | 12.2 |
| TC-N23 | High Density Residential | 18 | -- | 41 | 200 | -- | 8,200 | 5.7 | 2.5 | 14.2 |
| TC-N24 | High Density Residential | 18 | -- | 69 | 200 | -- | 13,800 | 9.6 | 2.5 | 24.0 |
| **Central Development Area - Wilson Heights** | | | **0** | **319** | | | | **45** | | **111** |
| TC-H01 | Medium Density Residential | 10 | -- | 24 | 200 | -- | 4,800 | 3.3 | 2.5 | 8.3 |
| TC-H02 | Medium Density Residential | 10 | -- | 41 | 200 | -- | 8,200 | 5.7 | 2.5 | 14.2 |
| TC-H03 | Medium Density Residential | 10 | -- | 26 | 200 | -- | 5,200 | 3.6 | 2.5 | 9.0 |
| TC-H04 | Medium Density Residential | 10 | -- | 28 | 200 | -- | 5,600 | 3.9 | 2.5 | 9.7 |
| TC-H05 | Medium Density Residential | 10 | -- | 41 | 200 | -- | 8,200 | 5.7 | 2.5 | 14.2 |
| TC-H06 | Medium Density Residential | 10 | -- | 33 | 200 | -- | 6,600 | 4.6 | 2.5 | 11.5 |
| TC-H07 | Medium Density Residential | 10 | -- | 37 | 200 | -- | 7,400 | 5.1 | 2.5 | 12.8 |
| TC-H08 | Medium Density Residential | 10 | -- | 26 | 200 | -- | 5,200 | 3.6 | 2.5 | 9.0 |
| TC-H09 | Medium Density Residential | 10 | -- | 20 | 200 | -- | 4,000 | 2.8 | 2.5 | 6.9 |
| TC-H10 | Medium Density Residential | 10 | -- | 13 | 200 | -- | 2,600 | 1.8 | 2.5 | 4.5 |
| TC-H11 | Medium Density Residential | 10 | -- | 30 | 200 | -- | 6,000 | 4.2 | 2.5 | 10.4 |
| **West Development Area - College Center** | | | **52,769** | **404** | | | | **58** | | **144** |
| EN01 | Medium Density Residential | 10 | -- | 111 | 200 | -- | 22,200 | 15.4 | 2.5 | 38.5 |
| EN01 | Commercial | -- | 14558 | -- | -- | 1,700 | 569 | 0.4 | 2.5 | 1.0 |
| EN02 | Medium Density Residential | 10 | -- | 73 | 200 | -- | 14,600 | 10.1 | 2.5 | 25.3 |
| EN02 | Commercial | -- | 9487 | -- | -- | 1,700 | 371 | 0.3 | 2.5 | 0.6 |
| EN03 | Medium Density Residential | 10 | -- | 48 | 200 | -- | 9,600 | 6.7 | 2.5 | 16.7 |
| EN03 | Commercial | -- | 6325 | -- | -- | 1,700 | 247 | 0.2 | 2.5 | 0.4 |
| EN04 | Medium Density Residential | 10 | -- | 87 | 200 | -- | 17,400 | 12.1 | 2.5 | 30.2 |
| EN04 | Commercial | -- | 11317 | -- | -- | 1,700 | 442 | 0.3 | 2.5 | 0.8 |
| EN05 | Medium Density Residential | 10 | -- | 85 | 200 | -- | 17,000 | 11.8 | 2.5 | 29.5 |
| EN05 | Commercial | -- | 11082 | -- | -- | 1,700 | 433 | 0.3 | 2.5 | 0.8 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **West Development Area - Southwest Neighborhood** | | | **683,892** | **479** | | | | **78** | | **194** |
| EN06 | Medium Density Residential | 10 | -- | 55 | 200 | -- | 11,000 | 7.6 | 2.5 | 19.1 |
| EN07 | Medium Density Residential | 10 | -- | 56 | 200 | -- | 11,200 | 7.8 | 2.5 | 19.4 |
| EN08 | Medium Density Residential | 10 | -- | 51 | 200 | -- | 10,200 | 7.1 | 2.5 | 17.7 |
| EN09 | Medium Density Residential | 10 | -- | 56 | 200 | -- | 11,200 | 7.8 | 2.5 | 19.4 |
| EN10 | Medium Density Residential | 10 | -- | 59 | 200 | -- | 11,800 | 8.2 | 2.5 | 20.5 |
| EN11 | Medium Density Residential | 10 | -- | 202 | 200 | -- | 40,400 | 28.1 | 2.5 | 70.1 |
| C01 | School | -- | 683892 | -- | -- | 1000 | 15,700 | 10.9 | 2.5 | 27.3 |
| **West Development Area - Southwest Infill Neighborhoc** | | | **0** | **121** | | | | **30** | | **74** |
| IN01 | Low Density Residential | 6 | -- | 22 | 350 | -- | 7,700 | 5.3 | 2.5 | 13.4 |
| IN02 | Low Density Residential | 6 | -- | 51 | 350 | -- | 17,850 | 12.4 | 2.5 | 31.0 |
| IN03 | Low Density Residential | 6 | -- | 48 | 350 | -- | 16,800 | 11.7 | 2.5 | 29.2 |
| **West Development Area - Milliken Heights** | | | **0** | **190** | | | | **51** | | **127** |
| NE01 | Very Low Density Residential | 2 | -- | 13 | 420 | -- | 5,460 | 3.8 | 2.5 | 9.5 |
| NE02 | Very Low Density Residential | 2 | -- | 17 | 420 | -- | 7,140 | 5.0 | 2.5 | 12.4 |
| NE03 | Very Low Density Residential | 2 | -- | 20 | 420 | -- | 8,400 | 5.8 | 2.5 | 14.6 |
| NE04 | Very Low Density Residential | 2 | -- | 14 | 420 | -- | 5,880 | 4.1 | 2.5 | 10.2 |
| NE05 | Very Low Density Residential | 2 | -- | 12 | 420 | -- | 5,040 | 3.5 | 2.5 | 8.8 |
| NE06 | Very Low Density Residential | 2 | -- | 11 | 420 | -- | 4,620 | 3.2 | 2.5 | 8.0 |
| NE07 | Low Density Residential | 4 | -- | 27 | 350 | -- | 9,450 | 6.6 | 2.5 | 16.4 |
| NE08 | Low Density Residential | 4 | -- | 28 | 350 | -- | 9,800 | 6.8 | 2.5 | 17.0 |
| NE09 | Low Density Residential | 4 | -- | 29 | 350 | -- | 10,150 | 7.0 | 2.5 | 17.6 |
| NE10 | Low Density Residential | 4 | -- | 11 | 350 | -- | 3,850 | 2.7 | 2.5 | 6.7 |
| NE11 | Low Density Residential | 4 | -- | 8 | 350 | -- | 2,800 | 1.9 | 2.5 | 4.9 |
| **East Development Area - Southeast Neighborhood** | | | **61,097** | **350** | | | | **51** | | **126** |
| EN12 | Medium Density Residential | 10 | -- | 31 | 200 | -- | 6,200 | 4.3 | 2.5 | 10.8 |
| EN13 | Medium Density Residential | 10 | -- | 18 | 200 | -- | 3,600 | 2.5 | 2.5 | 6.3 |
| EN14 | Medium Density Residential | 10 | -- | 18 | 200 | -- | 3,600 | 2.5 | 2.5 | 6.3 |
| EN15 | Medium Density Residential | 10 | -- | 22 | 200 | -- | 4,400 | 3.1 | 2.5 | 7.6 |
| EN16 | Medium Density Residential | 10 | -- | 7 | 200 | -- | 1,400 | 1.0 | 2.5 | 2.4 |
| EN17 | Medium Density Residential | 10 | -- | 28 | 200 | -- | 5,600 | 3.9 | 2.5 | 9.7 |
| EN18 | Medium Density Residential | 10 | -- | 23 | 200 | -- | 4,600 | 3.2 | 2.5 | 8.0 |
| EN19 | Medium Density Residential | 10 | -- | 18 | 200 | -- | 3,600 | 2.5 | 2.5 | 6.3 |
| EN20 | Medium Density Residential | 10 | -- | 37 | 200 | -- | 7,400 | 5.1 | 2.5 | 12.8 |
| EN21 | Medium Density Residential | 10 | -- | 47 | 200 | -- | 9,400 | 6.5 | 2.5 | 16.3 |
| EN22 | Medium Density Residential | 10 | -- | 48 | 200 | -- | 9,600 | 6.7 | 2.5 | 16.7 |
| EN23 | Medium Density Residential | 10 | -- | 53 | 200 | -- | 10,600 | 7.4 | 2.5 | 18.4 |
| EN24 | Commercial | -- | 31175 | -- | -- | 1700 | 1,217 | 0.8 | 2.5 | 2.1 |
| EN25 | Commercial | -- | 29922 | -- | -- | 1700 | 1,168 | 0.8 | 2.5 | 2.0 |
| **East Development Area - Southeast Infill Neighborhood** | | | **0** | **70** | | | | **18** | | **43** |
| IN04 | Low Density Residential | 6 | -- | 13 | 350 | -- | 4,550 | 3.2 | 2.5 | 7.9 |
| IN05 | Low Density Residential | 6 | -- | 26 | 350 | -- | 9,100 | 6.3 | 2.5 | 15.8 |
| IN06 | Low Density Residential | 6 | -- | 15 | 350 | -- | 5,250 | 3.6 | 2.5 | 9.1 |
| IN07 | Low Density Residential | 6 | -- | 16 | 350 | -- | 5,600 | 3.9 | 2.5 | 9.7 |

SEWER PIPE REPORT

| LABEL | DIAMETER (IN) | FLOW (GPM) | VELOCITY (FT/S) | d/D |
|---|---|---|---|---|
| CO-25 | 8 | 63.4 | 5.61 | 31.3 |
| CO-26 | 8 | 126 | 8.51 | 25.9 |
| CO-27 | 8 | 126 | 2.44 | 49 |
| CO-29 | 8 | 335.7 | 7.01 | 47.9 |
| CO-31 | 12 | 393.3 | 8.24 | 43.4 |
| CO-30 | 10 | 73.5 | 4.91 | 16 |
| CO-33 | 10 | 73.5 | 2.14 | 39 |
| CO-32 | 12 | 466.8 | 2.82 | 45.2 |
| CO-36 | 8 | 42.5 | 4.3 | 16.2 |
| CO-22 | 10 | 70.1 | 2.9 | 45.4 |
| CO-11 | 8 | 30.9 | 1.91 | 19.8 |
| CO-10 | 8 | 45.8 | 2.99 | 18.6 |
| CO-9 | 8 | 45.8 | 5.37 | 25.6 |
| CO-8 | 10 | 92.3 | 5.13 | 41.4 |
| CO-5 | 8 | 79.9 | 5.9 | 21.6 |
| CO-4 | 8 | 79.9 | 2.16 | 28.8 |
| CO-3 | 8 | 79.9 | 5.43 | 32.1 |
| CO-16 | 12 | 145.7 | 2.54 | 39.3 |
| CO-15 | 15 | 604.7 | 2.59 | 40.4 |
| CO-7 | 15 | 604.7 | 4.9 | 38.1 |
| CO-13 | 15 | 697 | 9.98 | 40.6 |
| CO-12 | 15 | 773.7 | 9.95 | 30.8 |
| CO-20 | 15 | 773.7 | 10 | 42.7 |
| CO-21 | 15 | 843.8 | 10 | 45.3 |
| CO-35 | 15 | 969.4 | 9.98 | 35.1 |
| CO-34 | 15 | 1,011.90 | 2.93 | 54 |

SEWER NODE REPORT

| LABEL | HYDRAULIC GRADE (FT) | FLOW DEPTH IN PIPE (FT) |
|---|---|---|
| MH-23 | 1,928.17 | 0.17 |
| MH-24 | 1,818.24 | 0.24 |
| MH-25 | 1,726.44 | 0.24 |
| MH-26 | 1,724.72 | 0.41 |
| MH-22 | 1,633.39 | 0.39 |
| MH-27 | 1,623.17 | 0.17 |
| MH-28 | 1,515.17 | 0.17 |
| MH-29 | 1,509.19 | 0.48 |
| O-2 | 1,508.35 | 0.43 |
| MH-30 | 1,590.74 | 0.14 |
| MH-20 | 1,606.17 | 0.17 |
| MH-11 | 1,950.32 | 0.12 |
| MH-10 | 1,941.45 | 0.15 |
| MH-9 | 1,926.15 | 0.15 |
| MH-8 | 1,892.50 | 0.2 |
| MH-6 | 1,946.39 | 0.19 |
| MH-5 | 1,883.98 | 0.19 |
| MH-4 | 1,883.19 | 0.19 |
| MH-3 | 1,843.23 | 0.23 |
| MH-13 | 1,842.55 | 0.55 |
| MH-2 | 1,840.22 | 0.46 |
| MH-7 | 1,836.49 | 0.49 |
| MH-12 | 1,766.82 | 0.52 |
| MH-1 | 1,749.52 | 0.52 |
| MH-18 | 1,670.15 | 0.55 |
| MH-19 | 1,596.09 | 0.59 |
| MH-31 | 1,546.95 | 0.75 |
| O-1 | 1,546.08 | 0.6 |

# Appendix D – Water and Sewer Master Plan Excerpts

# WATER DEMANDS

This chapter describes the District's existing and projected future water demands. The existing water demand section consists of a discussion of the historical potable water consumption, historical potable water production, and the identification of water loss and peaking factors (PFs). The future potable water demand section consists of the potable water demand projection through year 2030. The potable water section is concluded with a discussion on water conservation measures and the anticipated impacts these measures will have on the District's future water demands.

## 3.1 EXISTING AND HISTORICAL WATER DEMANDS

Water demands represent water that leaves the distribution system through metered or unmetered connections, or at pipe joints (leaks) or breaks. Water demands occur throughout the distribution system based on the number and type of consumers in each location. Currently, the District's meters are read on a bi-monthly basis. The District began the installation of a smart grid and has completed approximately 80 percent of the grid. The smart grid is anticipated for completion in fiscal year 2017 to 2018. At that time, the District's consumption will be billed on a monthly basis. With the installation of smart meters, the District will be able to improve the accuracy of the meter reads to understand the diurnal patterns on how the system operates. In addition, the District will be able to reduce staff time required for manual reads and will be able to receive hourly meter reads that are reported daily. Since the smart grid is not complete and the on-going drought does not represent average conditions, the historical water consumption presented in this chapter does not use data from the smart meters. This section includes a description of the historical potable water consumption, historical potable water production, the estimated amount of water loss, and PFs.

### 3.1.1 Historical Water Consumption

The District provided customer consumption data for the years 2000 through 2015 categorized by meter type. The meter types were further categorized into customer class based on usage type. The consumption data for the five recent years for each customer class is summarized in Table 3.1 and graphically presented on Figure 3.1. As shown in Table 3.1, consumption decreased significantly in year 2015 due to state conservation regulations. Since year 2015 is not representative of a typical year, existing demands refer to an average of year 2012 through year 2014, which equates to approximately 49,234 afy (44 mgd).

| Table 3.1 | Annual Historical Consumption by Customer Class<br>Water System Master Plan<br>Cucamonga Valley Water District | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Annual Demand by Customer Class(1) (afy) | | | | | | | | |
| Year | Residential | Commercial | Industrial | Institutional | Irrigation | Agricultural | Construction | Water Transfers | Total Annual Demand(2) (afy) |
| 2005 | 33,810 | 2,421 | 2,417 | 814 | 11,123 | 18 | 549 | 482 | **51,634** |
| 2006 | 36,248 | 2,584 | 2,732 | 546 | 12,109 | 18 | 536 | 165 | **54,939** |
| 2007 | 37,659 | 2,595 | 2,489 | 871 | 14,040 | 22 | 529 | 165 | **58,370** |
| 2008 | 36,053 | 2,482 | 2,574 | 637 | 13,450 | 16 | 334 | 0 | **55,547** |
| 2009 | 34,195 | 2,206 | 2,142 | 641 | 12,260 | 49 | 129 | 206 | **51,829** |
| 2010 | 30,416 | 2,034 | 2,023 | 541 | 10,252 | 33 | 68 | 13 | **45,381** |
| 2011 | 31,162 | 2,213 | 2,048 | 594 | 10,259 | 37 | 85 | 0 | **46,398** |
| 2012 | 32,400 | 2,140 | 2,313 | 658 | 11,109 | 38 | 98 | 0 | **48,756** |
| 2013 | 32,344 | 2,206 | 2,203 | 625 | 11,378 | 32 | 98 | 0 | **48,885** |
| 2014 | 32,473 | 1,889 | 2,280 | 561 | 11,781 | 32 | 261 | 784 | **50,060** |
| 2015 | 25,728 | 2,004 | 2,126 | 648 | 8,039 | 33 | 137 | 16 | **38,730** |

Notes:
(1) Source:Data for years 2000-2015 provided by District by meter type. Meter type classification was consolidated from the 23 classifications used by the District (CVWD, 2015a).
(2) Annual Demand does not include water losses.

The twenty-three meter type classifications were summarized into eight customer categories and are summarized as follows:

- **Residential Accounts:** This category includes Residential (R), Multi Dwelling (M), Trailer Park (T), and Residential (CAP) (RD).
- **Commercial Accounts:** This category includes Commercial Business (B), Restaurant (F), Gas Station (G), Hospital/Rest Home (H), Laundromat (L), Church (J), Medical/Physical Offices (P), and Car Wash (W).
- **Industrial Accounts:** This category includes Industrial (I).
- **Institutional Accounts:** This category includes City Domestic Accounts (CR), District (DB), and School (S).
- **Irrigation Accounts:** This category includes Interruptible Government Rate (IG), Golf Course (K), Parks (N), Landscape/Parkway (Q), and City Landscape/Parkway (RC).
- **Agriculture Accounts:** This category includes Agriculture (A).
- **Construction Accounts:** This category includes Construction (C).
- **Water Transfers:** This category includes Interconnection (IN).

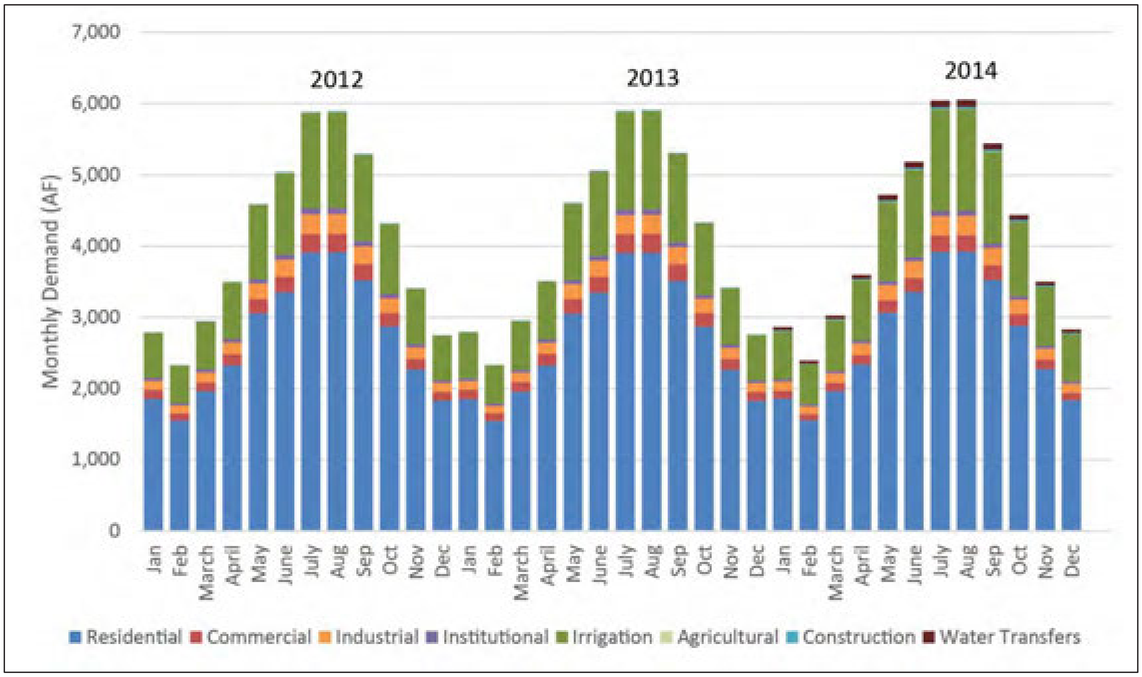


***Figure 3.1 Monthly Demand by Customer Class***

As shown on Figure 3.1, demands are highest in July and August when the temperature is much warmer and lowest in the cooler months from December through March. Seasonal peaking is most pronounced in the residential and irrigation usage types. Based on the *District Water Supply Master Plan*, much of this seasonal variability is due to outdoor usage (Wildermuth, 2014). The 3-year average breakdown of all of the District's demand by customer class for years 2012 to 2014 is illustrated on Figure 3.2.

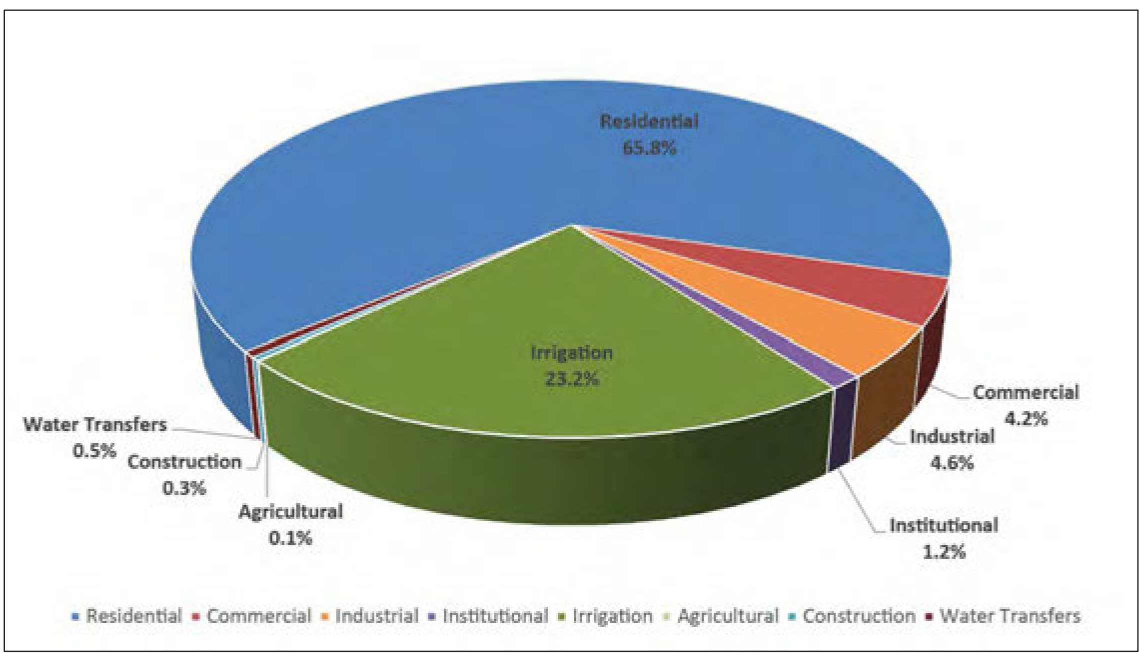


***Figure 3.2 3-Year Average (2012-2014) Potable Water Demand by Customer Class***

As listed in Table 3.1 and shown on Figure 3.2, the District's residential demand contributes to the majority of the potable water demands at 65.8 percent of the District's demands and amounting to an average of about 32,405 afy (or 28.9 mgd). Irrigation is the next largest water consumer with approximately 23.2 percent of the District's water demand, resulting in an average demand of about 11,423 afy (or 10.2 mgd) in years 2012 to 2014.

### 3.1.2 Number of Water Meters

The District provided the number of meters per meter type, which included a total of 47,987 meters in 2015. These meter types were grouped into the customer class identified in Section 3.1.1. A breakdown range of the number of meters by customer class for years 2012 to 2014 is included in Table 3.2. As listed in Table 3.2, the majority (91.2 percent) of the meters are residential meters, ranging from 43,365 meters in year 2012 to 43,664 meters in 2014. Irrigation meters account for approximately 4.2 percent of the District's meters, ranging from 1,982 meters in 2013 to 1,987 meters in 2014.

**Table 3.2 Number of Meters in 2012 to 2014 by Customer Category**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Customer Category | Category Abbreviation | Range of Number of Meters(1) | Percentage of Meters | Percentage of Consumption |
|---|---|---|---|---|
| Residential | R | 43,365 - 43,664 | 91.2% | 65.8% |
| Commercial | C | 1,503 - 1,519 | 3.2% | 4.2% |
| Industrial | I | 507 - 510 | 1.1% | 4.6% |
| Institutional | IN | 103 - 105 | 0.2% | 1.2% |
| Irrigation | IR | 1,982 - 1,987 | 4.2% | 23.2% |
| Agricultural | A | 7 | <0.1% | 0.1% |
| Construction | CO | 61 - 66 | 0.1% | 0.3% |
| Water Transfers | WT | 4 | <0.1% | 0.5% |
| **Total** | **N/A** | **47,540 - 47,865** | **100%** | **100%** |

Notes:
(1) Number of meters provided by the District. (CVWD, 2015a).

## 3.2 HISTORICAL WATER SUPPLY

The District obtains potable water from three sources:

- Groundwater from the Chino Basin and Cucamonga Basin.
- Canyon/Surface Supplies from streams, springs, and tunnels located within the northern area of the District.
- Imported water from Metropolitan Water District of Southern California (MWD) via IEUA.

The historical potable water production from 2005 through 2014 is presented by water source in Table 3.3 and is illustrated on Figure 3.3.

**Table 3.3 Historical Annual Supply by Source**
**Water System Master Plan**
**Cucamonga Valley Water District**

| | Annual Supply[1] (afy) | | | | |
|---|---|---|---|---|---|
| **Year** | **Groundwater** | **Canyon/Surface Water** | **Imported Water** | **Inter-Connection[2]** | **Total** |
| 2005 | 20,846 | 6,978 | 28,109 | (391) | 55,541 |
| 2006 | 23,311 | 5,347 | 29,318 | (165) | 57,812 |
| 2007 | 21,800 | 3,194 | 36,041 | (165) | 60,870 |
| 2008 | 23,682 | 5,263 | 28,551 | 45 | 57,540 |
| 2009 | 29,900 | 4,821 | 20,099 | (112) | 54,708 |
| 2010 | 23,679 | 3,954 | 20,368 | (13) | 47,988 |
| 2011 | 23,026 | 5,919 | 20,900 | 0 | 49,844 |
| 2012 | 21,069 | 2,838 | 28,273 | 0 | 52,180 |
| 2013 | 24,959 | 1,825 | 25,764 | 0 | 52,548 |
| 2014 | 24,350 | 1,410 | 27,165 | (680) | 52,246 |
| 2015 | 27,198 | 1,050 | 13,195 | (8) | 41,436 |
| **Average** | 23,984 | 3,873 | 25,253 | (135) | 52,974 |
| **Percent** | 36-66% | 3-13% | 32-59% | <0.1% | N/A |

Notes:
(1) Based on District production data for January 1990 to March 2016 (CVWD, 2015c).
(2) Interconnection includes purchases (+) and sales (-) between District and FWC.

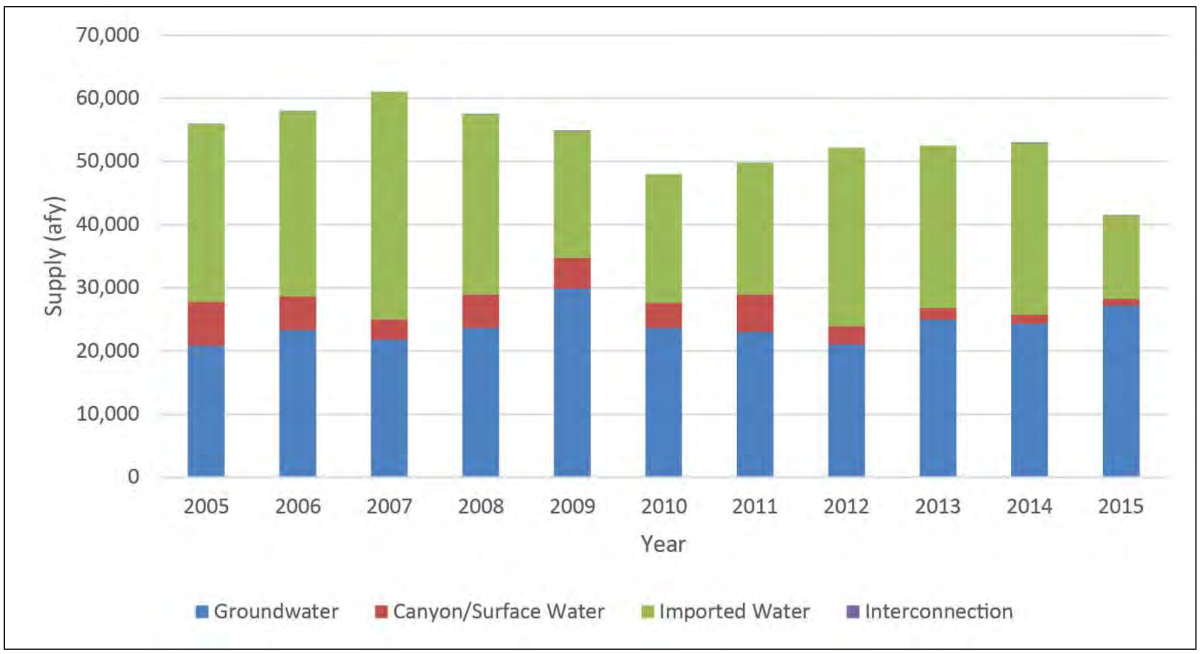


***Figure 3.3 Annual Supply by Source***

### 3.2.1 Groundwater

The District obtains water from two basins: Chino Basin and Cucamonga Basin. The northwestern portion of the District's service area overlies the Cucamonga Basin, while the southern and eastern portion of the District overlies the Chino Basin.

In the Chino Basin, the District has 12 active wells with a total pumping capacity of 27,020 gpm (32,700 afy at 75 percent operational capacity). In the Cucamonga Basin, the District has 17 wells with a total pumping capacity of 24,400 gpm (29,500 afy at 75 percent operational capacity). Due to groundwater contamination in the Cucamonga Basin, production in this basin has been limited to 7,000 gpm. As a result of recent improvements (blending at Reservoir 3 field and granular activated carbon treatment at Well 19), production has increased to as high as 10,400 gpm. 11,377 afy (or 7,053 gpm) as a result of restrictions on the following wells:

- High Nitrate Contamination (non-operational):
  - Wells 15, 20, 21, 34.
- High Nitrate Contamination (blending):
  - Wells 17, 23.
- High-Moderate Nitrate Contamination (emergency operation only):
  - Wells 8, 10, 12, 22.
- Moderate Nitrate Contamination (limited operation through blending):
  - Wells 31 and 33.

The capacities of the groundwater wells are described in further detail in Chapter 4.

### 3.2.2 Canyon/Surface Supplies

As the most cost effective supply source, the District receives surface supplies from the northern area of the District from three main sources: Cucamonga Canyon, Day/East Etiwanda Canyons, and Deer Canyon.

### 3.2.3 Imported Water

The District purchases imported water from IEUA, which is a member agency of MWD. Imported water serves as the District's largest water supply.

As listed in Table 3.3 and shown on Figure 3.3, the District’s water supply gradually increased between 2005 and 2007 and decreased between 2008 and 2011 with the lowest supplies of 47,988 afy in 2010, which may be attributed to the recession. The water supply has remained fairly steady between 2012 and 2014, but decreased significantly in 2015. This decrease is a result of a mandated 15 percent reduction in imported water supply by MWD. Due to this restriction and the drought, the District reduced imported water supply from 27,165 afy in 2014 to 13,195 afy in 2015.

Historically, imported water from MWD via IEUA accounted for the majority of the District's potable supplies, accounting for a maximum of 59 percent of the supplies between 2005 and 2015. Due to the MWD mandate, groundwater contributed significantly more than imported water to the District's supplies at a maximum of 66 percent in 2015. Canyon/surface water supplied the least amount, with a maximum of about 13 percent of the supplies between 2005 and 2015.

## 3.3 UNACCOUNTED FOR WATER

The difference between water production (or supply) and consumption (billed to customers) is defined as unaccounted-for-water, or water loss. Water loss may be attributed to leaking pipes, unmetered or unauthorized water use, inaccurate meters or meter reads, treatment losses, or other events causing water to be withdrawn from the system and not measured. Specific events that cause water loss include reservoir drainage for repairs, flushing for water quality purposes, hydrant flushing, sewer cleaning, street cleaning, and firefighting. The District's estimated unaccounted for potable water for the years 2005 through 2014 is summarized in Table 3.4.

**Table 3.4 Estimated Unaccounted for Water**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Year | Demand (afy) | Supply (afy) | Unaccounted for Water (afy) | Unaccounted for Water (%) |
|---|---|---|---|---|
| 2005 | 51,634 | 55,541 | 3,908 | 7.0% |
| 2006 | 54,939 | 57,812 | 2,874 | 5.0% |
| 2007 | 58,370 | 60,870 | 2,500 | 4.1% |
| 2008 | 55,547 | 57,540 | 1,993 | 3.5% |
| 2009 | 51,829 | 54,708 | 2,879 | 5.3% |
| 2010 | 45,381 | 47,988 | 2,608 | 5.4% |
| 2011 | 46,398 | 49,844 | 3,446 | 6.9% |
| 2012 | 48,756 | 52,180 | 3,424 | 6.6% |
| 2013 | 48,885 | 52,548 | 3,663 | 7.0% |
| 2014 | 50,060 | 52,246 | 2,186 | 4.2% |
| 2015 | 38,730 | 41,436 | 2,706 | 6.5% |
| **Average** | **50,048** | **52,974** | **2,926** | **5.6%** |
| **2016 WMP Recommended** | **N/A** | **N/A** | **N/A** | **6.0%** |

Notes:
(1) Consumption data from Table 3.1 and supply data from Table 3.3.

As shown in Table 3.4, the amount of potable water loss was the greatest in 2005 at approximately 7.0 percent and improved significantly in 2008 to 3.5 percent. It has since increased with the highest potable water loss of 7.0 percent in 2013, but improved to 4.2 percent in 2014. According to American Water Works Associate (AWWA) standards, the water loss for well-operated systems is typically less than 10 percent. As shown in Table 3.4, the District's unaccounted for potable water for years 2005 through 2014 is within the typical range of water losses for well-operated systems based on AWWA standards. The average unaccounted for potable water for 2005 to 2015 is about 5.6 percent. For the purpose of this master plan, it is recommended to use 6 percent for modeling and analysis.

### 3.3.1 Potable Water Peaking Factors

PFs are typically used to determine the water demands for conditions other than Average Day Demand (ADD). PFs account for fluctuations in demands on a seasonal or hourly basis. For example, during hot summer days, water use is typically higher than on a cold winter day due to increased irrigation demands.

Common PFs include factors for Maximum Day Demands (MDD) and Minimum Day Demands (MinDD). PFs are determined using the water system demands for a selected period and dividing the quantity by the ADDs. The MDD factor, for example, is determined by comparing the water demands for the day of the year with the highest daily water demand to the ADD. The two types of PFs used in this WMP are:

1. Monthly Peaking Factors.
2. Daily Peaking Factors.

These PFs not only reflect a different time scale, but are often calculated using different data sources. The District's PFs and data used to establish these are discussed below.

#### 3.3.1.1 Monthly Peaking Factors

Monthly PFs represent the seasonal demand variation on a monthly basis, such as the Maximum Month Demand (MMD) and Minimum Month Demand (MinMD) factors. In absence of daily production data for an entire calendar year, these factors can often easily be established from monthly production (or supply) summaries or historical billing data. The District's monthly PFs are based on monthly production and summarized in Table 3.5.

**Table 3.5 Monthly Peaking Factor(1)**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Year | AAD(2) (mgd) | MMD Month | MMD (mgd) | MinMD (mgd) | MMD PF(3) | MinMD PF(4) |
|---|---|---|---|---|---|---|
| 2005 | 49.6 | July | 72.2 | 25.2 | 1.5 | 0.5 |
| 2006 | 51.6 | July | 76.1 | 26.4 | 1.5 | 0.5 |
| 2007 | 54.3 | July | 74.7 | 28.5 | 1.4 | 0.5 |
| 2008 | 51.4 | July | 70.6 | 26.0 | 1.4 | 0.5 |
| 2009 | 48.8 | July | 68.1 | 26.0 | 1.4 | 0.5 |
| 2010 | 42.8 | August | 64.0 | 19.7 | 1.5 | 0.5 |
| 2011 | 44.5 | July | 64.3 | 27.5 | 1.4 | 0.6 |
| 2012 | 46.6 | August | 67.8 | 24.8 | 1.5 | 0.5 |
| 2013 | 46.9 | July | 62.6 | 27.0 | 1.3 | 0.6 |
| 2014 | 46.6 | July | 62.0 | 23.4 | 1.3 | 0.5 |
| 2015 | 37.0 | August | 44.3 | 27.7 | 1.2 | 0.7 |
| **Average** | **47.3** | **N/A** | **66.1** | **25.7** | **1.4** | **0.5** |
| **2016 WMP** | **N/A** | **N/A** | **N/A** | **N/A** | **1.5** | **0.5** |

Notes:
(1) Source: Historical production data for the period 1990-March 2016 (CVWD, 2016c).
(2) AAD: Annual Average Demand.
(3) MMD PF calculated as the MMD divided by average annual demand.
(4) MinMD PF calculated as the MinMD divided by average annual demand.

As shown in Table 3.5, the MMD typically occurs during July and August when temperatures are typically high. The PFs used in the 2016 WMP for MMD and MinMD conditions are 1.5 and 0.5, respectively. These factors represent typical values observed by many other water agencies in Southern California.

#### 3.3.1.2 Daily Peaking Factors

Historical supply records are typically used to determine the seasonal demand factors, such as MDD/ADD or MinDD/ADD. The maximum day PF represents the ratio of the largest daily demand observed in one year to the ADD for the same year. This factor can then be applied to the ADD of future planning years to project maximum day water demands. The estimated MDD is commonly used to establish water supply, storage, and pumping capacity requirements.

Historical water production for maximum days in years 2001 to 2015 was provided by the District and used to establish the District's MDD PF. The maximum day production was divided by the average day production of the same year to obtain a ratio that represents the MDD seasonal PF. The District's MDD and MinDD PF are summarized in Table 3.6.

**Table 3.6 Maximum Day Demand Peaking Factors**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Year | AAD[(1)(2)] (afy) | Day of Maximum Demand | MDD (mgd)[(2)] | MDD PF[(3)] |
|---|---|---|---|---|
| 2005 | 55,541 | July 22 | 79.9 | 1.6 |
| 2006 | 57,996 | July 18 | 84.0 | 1.6 |
| 2007 | 61,183 | August 22 | 82.9 | 1.5 |
| 2008 | 58,175 | May 15 | 90.2 | 1.7 |
| 2009 | 55,393 | July 20 | 79.2 | 1.6 |
| 2010 | 48,616 | August 26 | 72.4 | 1.7 |
| 2011 | 50,745 | July 11 | 71.0 | 1.6 |
| 2012 | 53,316 | August 7 | 74.9 | 1.6 |
| 2013 | 53,954 | July 10 | 68.8 | 1.4 |
| 2014 | 53,868 | July 1 | 71.9 | 1.5 |
| 2015 | 42,662 | July 1 | 51.8 | 1.4 |
| **Average** | **53,768** | **N/A** | **75.2** | **1.6** |
| **2016 WMP** | **N/A** | **N/A** | **N/A** | **1.6** |

Notes:
(1) AAD: Annual Average Demand.
(2) Daily production data for years 2001 to 2015 provided by District (CVWD, 2016b).
(3) MDD PF calculated as the MDD/ADD.

As shown in Table 3.6, the MDD PF varied from 1.4 in 2013 and 2015 to 1.7 in 2008. It should be noted that 2015 was overall a low demand year, due to statewide water shortages and accompanied by mandatory reductions on imported water, resulting in a lower MDD PF. The calculated average MDD PF of 1.6 is used for this master plan and planning purposes. This PF is conservative, yet realistic, as it is likely that future water restrictions will occur with the continued water supply challenges in California.

### 3.3.2 Water Demand Forecasting

There are many different demand forecasting methods that range in both detail and scope. Based on a review of the District's water demand forecasting methodologies, it was determined that the most accurate potable water demand forecasting method for this water master plan was a combination of population and land use. Long-term demands were developed using a per unit population based methodology, while a land use based projection was used to project the demands of the new Empire Lakes development. Since the SBC area development does not have details on the other uses, a per unit population based methodology was used to capture the projected demand.

Long-term potable water demand forecasting utilized population projections to project future water use. An average per capita water use expressed in gallons per capita per day (gpcd) was developed by examining historical demands. Based on an evaluation of the 10-year averages from 1995 to 2010 for the average demand per person, or per capita demand, a maximum of 289.3 gpcd was found in 1995 to 2004 and used as the baseline for the per capita demand in this WMP. In order to achieve a 20 percent reduction in gallons per capita day by 2020 as written under SBx7-7, the average per capita demand was a target of 231 gpcd for 2020 and subsequent planning years.

### 3.3.3 New Developments Demand Projections

In order to develop near-term demand projections (up to the year 2020), the new development projects that would have a significant impact on water demands were identified and described in Chapter 2. Of the two identified large developments, Empire Lakes Golf Course is anticipated to be completed by year 2023 with some start up by year 2020 and is thus included in the near term demand projections, while the SBC area development is anticipated to be completed by year 2025 and is included in the long-term demand projections.

The Empire Lakes Golf Course development involves the conversion of a golf course that is typically irrigated with recycled water to a high density residential area. Likewise, the SBC area development involves the conversion of an open space area. The future demand of the new developments was estimated according to the number of dwelling units and projected number of residents in each development as estimated by the District. For the Empire Lakes Golf Course development and the SBC area development, the District estimated approximately 3,450 dwelling units and 3,000 dwelling units, respectively. This equates to approximately 5,000 residents in the Empire Lakes Golf Course development and 5,430 residents in the SBC area development.

The estimated demands are presented in Table 3.7. As listed in this table, it is estimated that the District's service area will experience a total demand increase of approximately 2,854 afy (or 2.5 mgd). Under MDD conditions, these developments are estimated to add 4,566 afy (or 4.1 mgd) of water demand to the system. Though the District does anticipate smaller new developments throughout the service area, the developments in Table 3.7 were identified to have the largest impact.

| **Table 3.7** | **New Developments Demand Projections<br>Water System Master Plan<br>Cucamonga Valley Water District** | |
|---|---|---|
| **Future Development Name** | **Development Size** | **Annual Demand (afy)** |
| Empire Lakes | 3,450 du = 5,000 residents | 1,446 |
| SBC area | 3, 000 du = 5,430 residents | 1,408 |
| **Total** | **10,430 residents** | **2,854** |

Notes:
(1) Residential demands for both developments based on target per capita demand of 231 gpcd. Empire Lakes annual demand also estimated demands for the transit area, mixed-use space, and open space as identified in the Water Supply Assessment (Stetson, 2015).

### 3.3.4 Long-Term Demand Projections

To develop long-term demand projections, per unit forecasting was used to combine population growth with average consumption to yield total demand. As discussed previously, to represent the District's per capita usage, a targeted per capita demand of 231 gpcd was used for years 2020 and beyond. Long-term demand projections based on population projections presented in Chapter 2 are listed in Table 3.8.

**Table 3.8 Water Demand Projections**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Year(1) | Population(2) | Per Capita Water Use(2) (gpcd) | Annual Demand(3) (afy) | Recycled Water - Groundwater Offset(4) (afy) | Total Annual Demand(5) (afy) | Average Day Demand (mgd) | Maximum Day Demand(6) (mgd) |
|---|---|---|---|---|---|---|---|
| 2015 | 200,466 | 173 | 38,730 | 0 | 38,730 | 34.6 | 55.3 |
| 2020 | 209,707 | 231 | 54,359 | 4,500 | 58,859 | 52.6 | 84.1 |
| 2025 | 219,118 | 231 | 56,798 | 4,500 | 61,298 | 54.7 | 87.6 |
| 2030 | 228,200 | 231 | 59,152 | 4,500 | 63,652 | 56.8 | 90.9 |

Notes:
(1) Year 2015 annual demands are actuals.
(2) Population projections and per capita water use obtained from District's 2015 Urban Water Master Plan (UWMP) (Civiltec, 2016).
(3) Annual Demand based on population projections and per capita demand of 231 gpcd. This does not include recycled water groundwater offset or water loss.
(4) The recycled water groundwater offset is assumed to contribute to conservation and is therefore deducted from the per capita demand calculation.
(5) The total annual demand includes recycled water groundwater offset, but does not include water loss.
(6) MDD estimated using an assumed MDD/ADD factor of 1.6.

As listed in Table 3.8, demand is projected to increase from approximately 38,730 afy in 2015 to over 63,000 afy in 2030. The Average Day Demand (ADD) and Maximum Day Demand (MDD) in year 2030 are projected to increase accordingly to approximately 56.8 mgd and 90.9 mgd respectively. Though population increases at a steady rate, demands decrease between 2015 and 2020 due to the 20 percent conservation written in SBX7x7. Since the baseline daily gpcd (year 1995-2004) is 290 gpcd, a 20 percent conservation by year 2020 results in a confirmed target of 231 gpcd.

The demand projections and population projections relationship is illustrated on Figure 3.4. As shown, though population increases steadily, demands experience a large increase between 2015 and 2020 due to the anticipated return to historical rates.

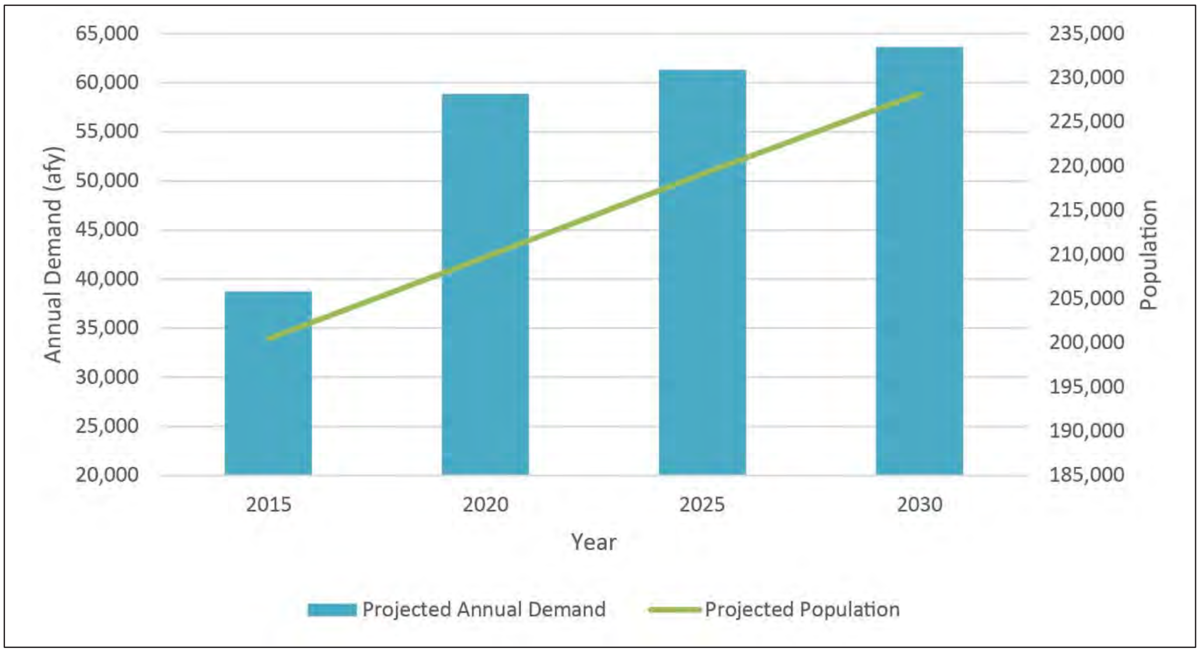


***Figure 3.4 Projected Water Demand***

### 3.3.5 Integration with New Development Demands

The new development demands listed in Table 3.7 were integrated into the long-term demand forecast. The demand projections from Figure 3.4 are illustrated on Figure 3.5, with existing demands (average of years 2012 to 2014), near term demands (year 2020), and long term demands (year 2030) including the demands from the new developments shown separately.

As shown on Figure 3.5, the projected demand consists of the new developments in Table 3.7 and the background increase attributed to continuous population growth (infill and densification). Existing demand accounts for the majority of usage in the future, while currently planned developments contribute approximately 723 afy of additional demand in the near term (by year 2020) and 2,854 afy of additional demand in the long term (by year 2030). The District also accounts the recycled water used for groundwater recharge as conservation in the gpcd calculations. However, this is still considered a demand and is included in the District's demand projections with an estimated 4,500 afy in the near-term and long term.

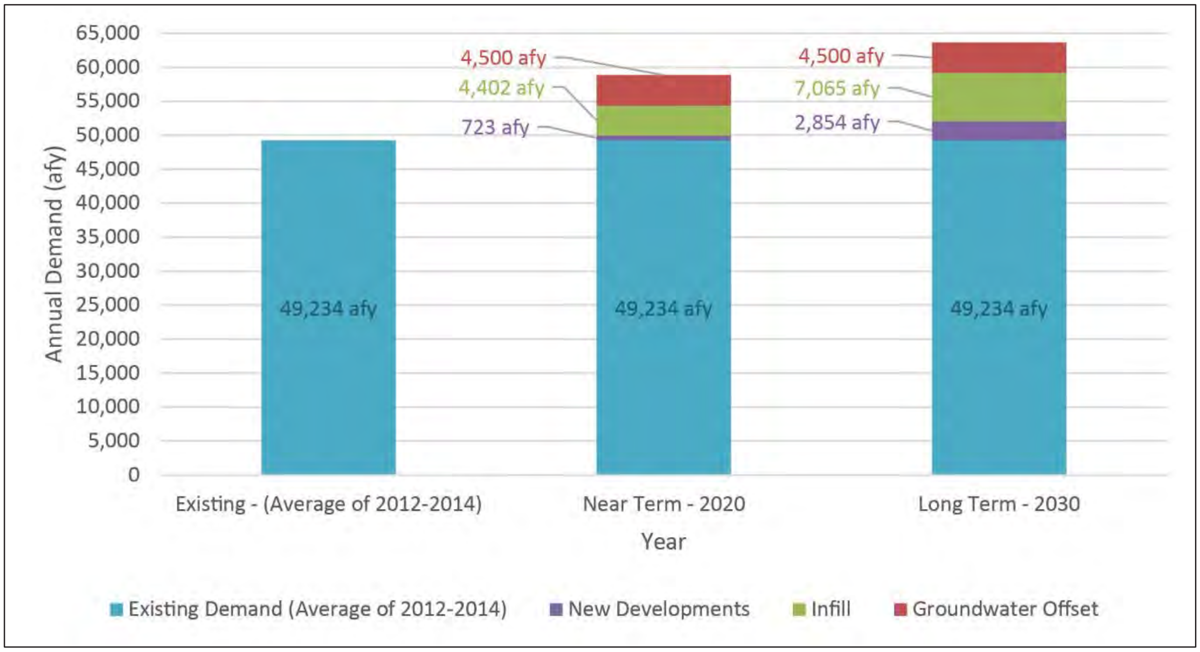


***Figure 3.5 Near- and Long-Term Demands***

### 3.3.6 Water Conservation

Since 2012, California has experienced historic drought conditions resulting in record high temperatures and low precipitation. On January 17, 2014, California's governor proclaimed a State of Emergency asking for a 20 percent water consumption. Following this emergency proclamation, several executive orders have been issued by the governor in response to the continuing drought conditions. Most recently, on April 1, 2015, the governor signed an Executive Order imposing restrictions to achieve a 25 percent reduction in potable urban water usage. In order to reach this reduction, the State Water Board set conservation standards for each water supplier. Based on this reduction, the District currently has a conservation target of 32 percent.

The District has developed mandatory water conservation in several different phases. In response to the most recent Executive Order, the District adopted a resolution increasing its water conservation requirements to Stage 6 on May 12, 2015. As part of Stage 6, landscape watering is restricted to 3 days of the week and only during certain times of the day. Restrictions also only allow fountains and water features that use recirculating water systems. The District strictly enforces the restrictions and issues penalties when appropriate.

In addition to the Stage 6 restrictions, the District is a signatory to the Memorandum of Understanding (MOU) regarding urban water conservation with the California Urban Water Conservation Council (CUWCC). In 2014, the Independent Technical Panel (ITP) reviewed the 14 Best Management Practices (BMP), also known as demand management measures (DMM), and streamlined the requirements to size more general requirements plus an "other" category. The District has agreed to implement these requirements in the water conservation programs. The revised DMM categories include:

1. Water waste prevention ordinances.
2. Metering.
3. Conservation pricing.
4. Public education and outreach.
5. Programs to assess and manage distribution system real loss.
6. Water conservation program coordination and staffing support.
7. Other demand management measures that have a significant impact on water use as measured in gallons per capita per day, including innovative measures.

In addition to the DMMs, the District, in partnership with other companies and organizations, offers several rebate incentive programs for indoor and outdoor use for both residential and commercial customers. On a residential level, MWD provides rebates for high efficiency washing machines, high efficiency toilets, rotating sprinkler nozzles, weather based irrigation controllers, soil moisture sensor systems, and rain barrels. On a business and commercial level, MWD offers rebates for various water saving equipment, such as high efficiency toilets, turf removal, irrigation controllers, on-site retrofit for conversion to recycled water, HVAC equipment.

As the District continues to pursue and improve upon water conservation and implementation of the DMMs, the District’s water demand per person is anticipated to decrease. The actual uptake of these programs by District customers determines how much water is being saved by the current program. This will require that the District be proactive in marketing and educating customers as to the benefits of installing water efficient devices and changing water use habits.

Since conservation targets are mandated by the State, the previously presented demand projections assume conservation goals will be met. Due to the anticipated water conservation effort by the District and mandated ordinances by the State, the projected water demand is not expected to exceed the projected year 2020 per capita demand of 231 gpcd. However, if water conservation practices do not continue, the system demand is expected to increase to historic levels.

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# MODEL DEVELOPMENT

This chapter documents the procedures used to update and calibrate the District's hydraulic model used for this WMP. The purpose of this documentation is to provide an overview of the model update process, including steps taken to calibrate the model. In addition, this chapter details how the projected demands developed in Chapter 3 were allocated in the existing model.

## 5.1 DATA SOURCES

A description of data sources used in the model update and calibration process is provided below:

- **Existing Water Model.** The District provided Carollo with a copy of its recently updated water system hydraulic model. The District's water model was originally constructed in InfoWater® in preparation for the development of this WMP.
- **Water GIS Layers.** GIS layers of the water distribution system were provided by the District. The layers provide the location, unique ID, length, and pipe diameter for all water mains within the District's service area.
- **Water Consumption Data.** Water consumption records and production records from years 2012 to 2014 were provided by the District and were the primary source for existing demand allocation in the hydraulic model.

## 5.2 MODEL UPDATE

A hydraulic computer model of the water distribution system is an important tool for many analyses of a water system. Models are used as a part of water master plans to identify deficiencies in water systems, and to size capital improvements. The widespread use of personal computers and availability of hydraulic modeling software has made network analysis modeling efficient and practical for virtually any water system.

Developing a good hydraulic model begins with entering the best available information into the database and calibrating the model to match existing conditions in the field. Once the model has been calibrated, it becomes an invaluable tool to solve planning and operational problems. It can simulate the existing and future water systems, identify system deficiencies, analyze impacts from increased demands, and determine the appropriateness of proposed improvements for the system.

The District's existing hydraulic model was developed in InfoWater®. InfoWater® consists of multiple products that work together to bring a graphical approach to the analysis and design of water distribution systems. The program includes seamless integration with the

District's GIS data. At the start of this project, it was agreed that the model would be updated by District with the most up to date system network.

### 5.2.1 Pressure Zone Designation

The District's hydraulic model assigned pressure zones based on the spatial location overlay. All facilities were updated to reflect the pressure zone served instead of the physical location.

### 5.2.2 Diurnal Patterns

Typically, hourly Supervisory Control and Data Acquisition (SCADA) for all of the system's supply sources and reservoirs is used to establish a daily diurnal demand pattern by balancing the total inflow into the water distribution system and the change in storage. The resulting hourly demand factors, which are based on data from November 17 through November 25, 2015, are presented on Figure 5.1. As shown on this figure, the District's water demand peaks between 4:00 a.m. and 5:00 a.m. with an hourly peaking factor of nearly 2.0. This peaking factor and diurnal pattern was applied for the model calibration discussed in Section 5.3.

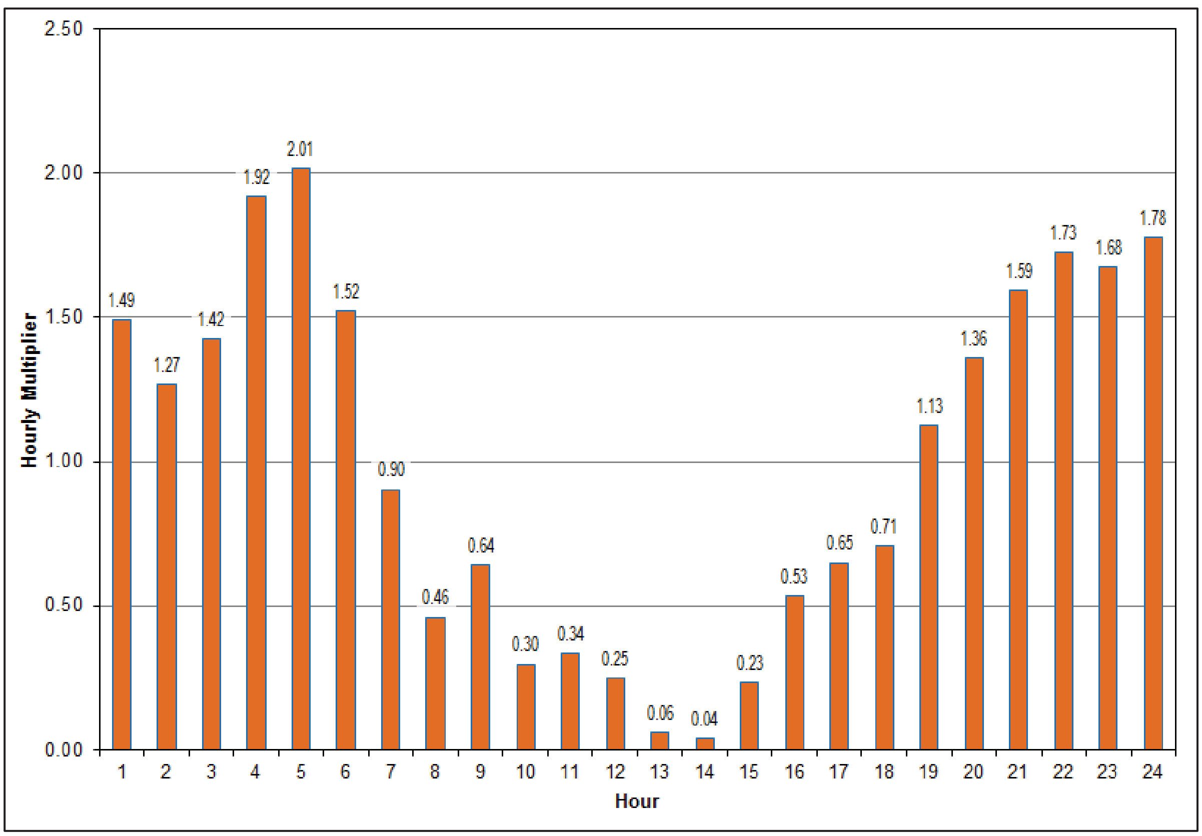


***Figure 5.1 Calibration System-Wide Diurnal Pattern (November 17-25, 2015)***

Based on discussion with District staff, separate diurnal curves were developed for Zones 1, 2 and 3, and 4 due to the differences in land use types. Zone 1 includes a large amount of industrial use. Zone 2 includes a mix of industrial, commercial, and residential land use. Zone 3 includes a mix of commercial and residential land use, while Zone 4 and all of the zones closer to the foothills primarily include residential land use. As a result, three different diurnal curves were developed based on an average of data from November 17, 2015 to November 25, 2015 to represent the different water use patterns.

The resulting hourly demand factors are presented on Figure 5.2. As shown on this figure, the District’s Zone 1 water demand peaks at around 10:00 p.m. with an hourly peaking factor of approximately 1.5. The District's Zone 2 water demand peaks at 11:00 p.m. with an hourly peaking factor of approximately 2.0. The District's Zone 3 water demand peaks at around 3:00 a.m. with an hourly peaking factor of nearly 1.8. The District's Zone 4 and the higher zone water demand peaks at around 4:00 a.m. with an hourly peaking factor of approximately 1.7. This peaking factor and diurnal pattern was applied for the model system analysis.

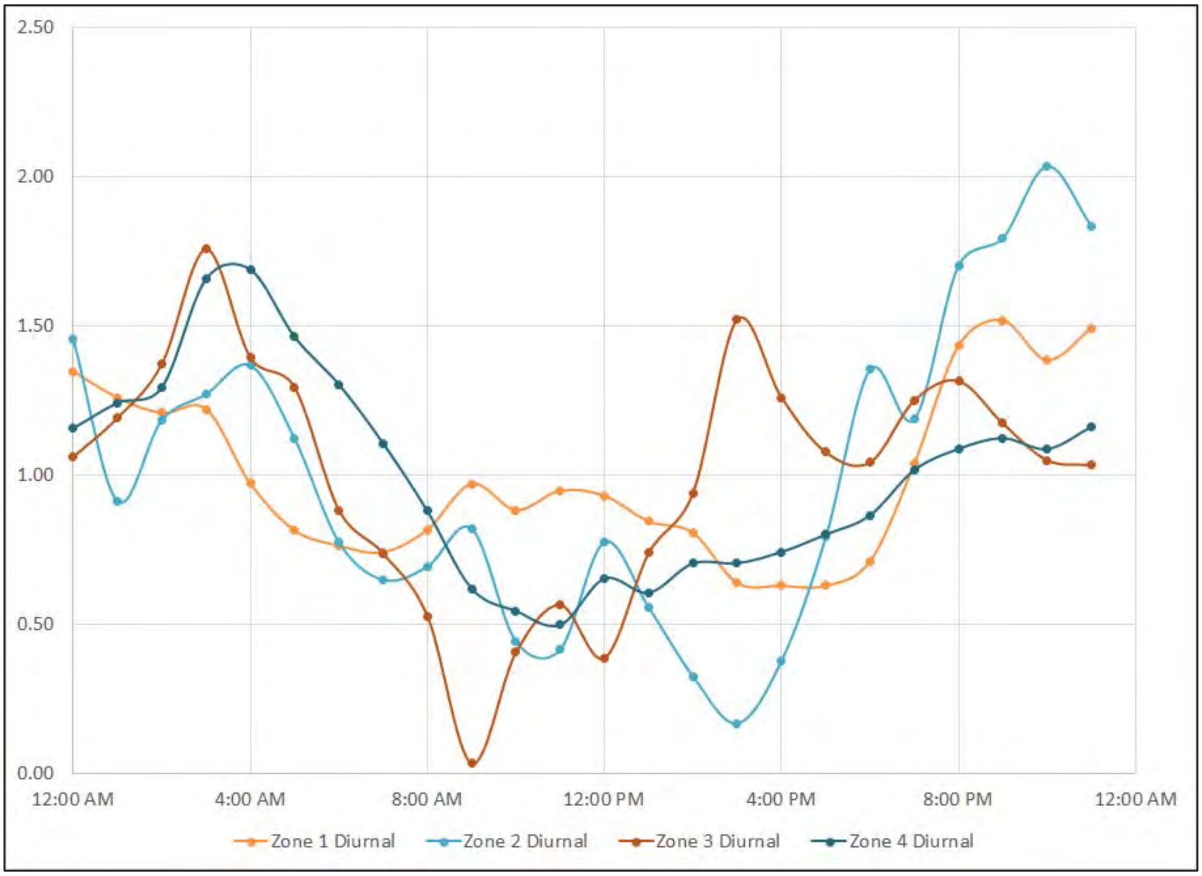


***Figure 5.2 System Analysis Zone Diurnal Pattern***

### 5.2.3 Demand Allocation

The District's water system hydraulic model included an average of consumption for the years 2012 through 2014. These demands were allocated based on billing data using a Thiessen polygon methodology. To account for water loss, the water demands in the hydraulic model were scaled up to better reflect the amount of water that must be delivered. Demands were added to the model to reflect the estimated increase in demand in year 2030 discussed in Chapter 3. The existing demands in Table 4.4 were adjusted to account for water loss and are presented in Table 5.1.

**Table 5.1 Existing Pressure Zone Demands Including Water Loss**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Zone | ADD (mgd)(1) | MDD (mgd)(2) | Percentage (%) |
|---|---|---|---|
| Zone 1 | 4.8 | 7.7 | 10.3% |
| Zone 2 | 14.6 | 23.4 | 31.3% |
| Zone 3 | 11.8 | 18.9 | 25.5% |
| Zone 3A | 0.5 | 0.7 | 1.0% |
| Zone 4 | 7.8 | 12.5 | 17.0% |
| Zone 5 | 3.4 | 5.4 | 6.7% |
| Zone 5C | 0.8 | 1.3 | 1.8% |
| Zone 5D | 0.02 | 0.03 | <0.1% |
| Zone 6 | 2.0 | 3.3 | 4.4% |
| Zone 6A | 0.5 | 0.8 | 1.1% |
| Zone 6C | 0.4 | 0.7 | 0.9% |
| Zone 7 | 0.02 | 0.03 | <0.1% |
| Zone 8 | 0.02 | 0.03 | <0.1% |
| **Total** | **46.7** | **74.7** | **N/A** |

Notes:
(1) ADD based on average of production in years 2012 to 2014.
(2) MDD assumed to be existing ADD multiplied by MDD peaking factor of 1.6.

The hydraulic modeling software has an option of assigning up to ten different demand types for each demand node. The next sections summarize the process used to allocate the existing (average of years 2012 through 2014) and future water demands (year 2030) in the model.

#### 5.2.3.1 Existing Demand Allocation

Several methods can be used for the allocation and estimation of water demands within the system, depending on the type of information that is available. Demands were allocated using the Thiessen polygons method, using the District's water consumption by meter from 2012 to 2014 to allocate the demands to the nearest node in the distribution system hydraulic model. The demands were then linked to the model and assigned as demands under **Demand Type 1**.

Finally, the water consumption based demands allocated into the model were scaled up to match the average of 2012 to 2014 Average Day Demand (ADD) calculated from the District's production records to adjust for unaccounted for water. As mentioned in Chapter 3, the average of the 2012 through 2014 demands were approximately 49,234 afy (or 44 mgd) and the supply was 52,325 afy (or 46.7 mgd), which is a difference of approximately 6 percent.

#### 5.2.3.2 Future Demand Allocation

As discussed in Chapter 3, two sources were used for future (or build out) demands: known near-term developments (see Table 3.7 in Chapter 3) and population growth projected by the District shown in Table 2.5. The District also provided a GIS shapefile containing the locations of the vacant parcels within the water service area.

Water demands for the two major developments, Empire Lakes and San Bernardino County area development, were calculated by pressure zone and assigned to the nearest major model junction close to the development (within the appropriate pressure zones).

With the exception of the two major developments, future demands were only available by land use classification. Existing demands and demands for the two major developments were subtracted from the projected demands shown in Table 3.8 to determine the remainder of the projected demand growth. These future demands were distributed over the vacant parcels in respective land use categories in order to distribute the buildout demands.

## 5.3 MODEL CALIBRATION

This section summarizes overall methodology employed to calibrate the District's water system hydraulic model and provides a detailed description of each of the major components of the model calibration process.

### 5.3.1 Model Calibration Data Collection

To coordinate the data requirements for model calibration and field-testing, a model calibration plan was prepared which described what SCADA and field data needs were required to calibrate the updated hydraulic model. The calibration plan included site maps for specific test locations, pressure logger locations, and included a list of the SCADA data needs, durations, time intervals, and units. This section summarizes the data collection process that was conducted per the calibration plan.

### 5.3.2 SCADA Data Gathering

Field-testing and data gathering for model calibration took place from November 17, 2015 through November 25, 2015. Carollo coordinated with District staff to obtain 5-minute data for available SCADA points within the water distribution system, including reservoir levels and pumping station on/off times. This data was used to generate the diurnal patterns described in Section 5.2.2 and for the Extended Period Simulation (EPS) model calibration. Table 5.2 identifies the SCADA data sources that were available for model calibration.

**Table 5.2 EPS Calibration Data Gathering Parameters**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Facility Name | Measurement | Unit | Interval(1) | Source |
|---|---|---|---|---|
| **<u>Reservoirs</u>** | | | | |
| Reservoir 1 | level | ft | 5 min | SCADA |
| Reservoir 1B-1 | level | ft | 5 min | SCADA |
| Reservoir 1C | level | ft | 5 min | SCADA |
| Reservoir 2 | level | ft | 5 min | SCADA |
| Reservoir 2A | level | ft | 5 min | SCADA |
| Reservoir 2C | level | ft | 5 min | SCADA |
| Reservoir 3-1 | level | ft | 5 min | SCADA |
| Reservoir 3-2 | level | ft | 5 min | SCADA |
| Reservoir 3-3 | level | ft | 5 min | SCADA |
| Reservoir 3A | level | ft | 5 min | SCADA |
| Reservoir 3C | level | ft | 5 min | SCADA |
| Reservoir 3C2 | level | ft | 5 min | SCADA |
| Reservoir 4 | level | ft | 5 min | SCADA |
| Reservoir 4B | level | ft | 5 min | SCADA |
| Reservoir 4C | level | ft | 5 min | SCADA |
| Reservoir 4D | level | ft | 5 min | SCADA |
| Reservoir 5 | level | ft | 5 min | SCADA |

**Table 5.2 EPS Calibration Data Gathering Parameters**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Facility Name | Measurement | Unit | Interval(1) | Source |
|---|---|---|---|---|
| Reservoir 5A | level | ft | 5 min | SCADA |
| Reservoir 5B | level | ft | 5 min | SCADA |
| Reservoir 5C | level | ft | 5 min | SCADA |
| Reservoir 5D | level | ft | 5 min | SCADA |
| Reservoir 6 | level | ft | 5 min | SCADA |
| Reservoir 6B | level | ft | 5 min | SCADA |
| Reservoir 6C | level | ft | 5 min | SCADA |
| Reservoir 7B | level | ft | 5 min | SCADA |
| Reservoir 8B-1 | level | ft | 5 min | SCADA |
| **Pumping Stations** | | | | |
| PS 1 | on/off times | N/A | 5 | SCADA |
| PS 1A | on/off times | N/A | 5 | SCADA |
| PS 2 | on/off times | N/A | 5 | SCADA |
| PS 2A | on/off times | N/A | 5 | SCADA |
| PS 3 | on/off times | N/A | 5 | SCADA |
| PS 3C2 | on/off times | N/A | 5 | SCADA |
| PS IZ-3 | on/off times | N/A | 5 | SCADA |
| PS 3A | on/off times | N/A | 5 | SCADA |
| PS 4 | on/off times | N/A | 5 | SCADA |
| PS 4B | on/off times | N/A | 5 | SCADA |
| PS 4C | on/off times | N/A | 5 | SCADA |
| PS 5 | on/off times | N/A | 5 | SCADA |
| PS 5A | on/off times | N/A | 5 | SCADA |
| PS 5B | on/off times | N/A | 5 | SCADA |
| PS 6 | on/off times | N/A | 5 | SCADA |
| PS 6B | on/off times | N/A | 5 | SCADA |
| PS 7B | on/off times | N/A | 5 | SCADA |
| PS 8B | on/off times | N/A | 5 | SCADA |
| **Wells** | | | | |
| Well 1 | on/off times | N/A | 5 | SCADA |
| Well 3 | on/off times | N/A | 5 | SCADA |
| Well 4 | on/off times | N/A | 5 | SCADA |

**Table 5.2 EPS Calibration Data Gathering Parameters**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Facility Name | Measurement | Unit | Interval$^{(1)}$ | Source |
|---|---|---|---|---|
| Well 5 | on/off times | N/A | 5 | SCADA |
| Well 8 | on/off times | N/A | 5 | SCADA |
| Well 10 | on/off times | N/A | 5 | SCADA |
| Well 12 | on/off times | N/A | 5 | SCADA |
| Well 13 | on/off times | N/A | 5 | SCADA |
| Well 15 | on/off times | N/A | 5 | SCADA |
| Well 16 | on/off times | N/A | 5 | SCADA |
| Well 17 | on/off times | N/A | 5 | SCADA |
| Well 19 | on/off times | N/A | 5 | SCADA |
| Well 20 | on/off times | N/A | 5 | SCADA |
| Well 21 | on/off times | N/A | 5 | SCADA |
| Well 22 | on/off times | N/A | 5 | SCADA |
| Well 23 | on/off times | N/A | 5 | SCADA |
| Well 24 | on/off times | N/A | 5 | SCADA |
| Well 26 | on/off times | N/A | 5 | SCADA |
| Well 30 | on/off times | N/A | 5 | SCADA |
| Well 31 | on/off times | N/A | 5 | SCADA |
| Well 33 | on/off times | N/A | 5 | SCADA |
| Well 34 | on/off times | N/A | 5 | SCADA |
| Well 38 | on/off times | N/A | 5 | SCADA |
| Well 39 | on/off times | N/A | 5 | SCADA |
| Well 40 | on/off times | N/A | 5 | SCADA |
| Well 41 | on/off times | N/A | 5 | SCADA |
| Well 42 | on/off times | N/A | 5 | SCADA |
| Well 43 | on/off times | N/A | 5 | SCADA |
| Well 46 | on/off times | N/A | 5 | SCADA |

Notes:
(1) Reservoir levels, though reported every 5 minutes, only update when there is a significant change in water levels (more than 3-4 inches).
(2) SCADA information not available for PRVs.

### 5.3.3 Temporary Pressure Logger Installation

In addition to the data obtained from the District's SCADA system, Carollo also provided sixteen temporary pressure loggers to District staff and the District provided two temporary pressure loggers that were attached to hydrants within the District's distribution system. The data obtained from the temporary pressure loggers consisted of 5-minute pressure data for the duration of the EPS data gathering period. The hydrant locations where the temporary pressure loggers were installed are shown on Figure 5.3

**Table 5.3 Pressure Loggers**
**Water System Master Plan**
**Cucamonga Valley Water District**

| Site | Logger No. | Pressure Zone | Intersection |
|---|---|---|---|
| 1 | C4 | 8 | Snowdrop Street and Robinhood Road |
| 2 | C5 | 7 | London Avenue, north of Spector Court |
| 3 | C7 | 6 | Vicara Drive between Sapphire Street and Jasper Street |
| 4 | C8(1) | 6A | Deer Canyon Drive between Cobblestone Lane and Broken Arrow Road |
| 5 | C9 | 5 | Mustang Road and Buckthorn Avenue |
| 6 | C10 | 4 | Liberty Street and London Avenue |
| 7 | C12(1) | 4 | Keenland Drive and Penrose Place |
| 8 | C13 | 5C | Altura Drive and Cervantes Place |
| 9 | C16 | 6C | Crimson Place between Bisque Drive and Maroon Drive |
| 10 | C17 | 5D | Woodley Ridge Drive and Golden Ridge Place |
| 11 | C14(1) | 3 | Avalon Street between Emerald Street and Opal Street |
| 12 | C20 | 3 | Trinity Place and Colusa Street |
| 13 | C21 | 3 | Victoria Windrows Loop between Snapdragon Street and Sugar Gum Street |
| 14 | C22 | 3A | Valle Vista Drive between Club Drive and Camino Sur |
| 15 | C18 | 2 | Effen Street and Cambridge Avenue |
| 16 | C23 | 2 | Jasper Street and Salina Street |
| 17 | C24 | 2 | Claret Court between Chablis Place and La Tour Court |
| 18 | C26 | 1 | Lucas Ranch Road between 6th Street and 5th Street |

Note:
(1) Some pressure loggers experienced technical difficulties during the calibration data gathering period, resulting in lower pressures than expected or no data gathered.

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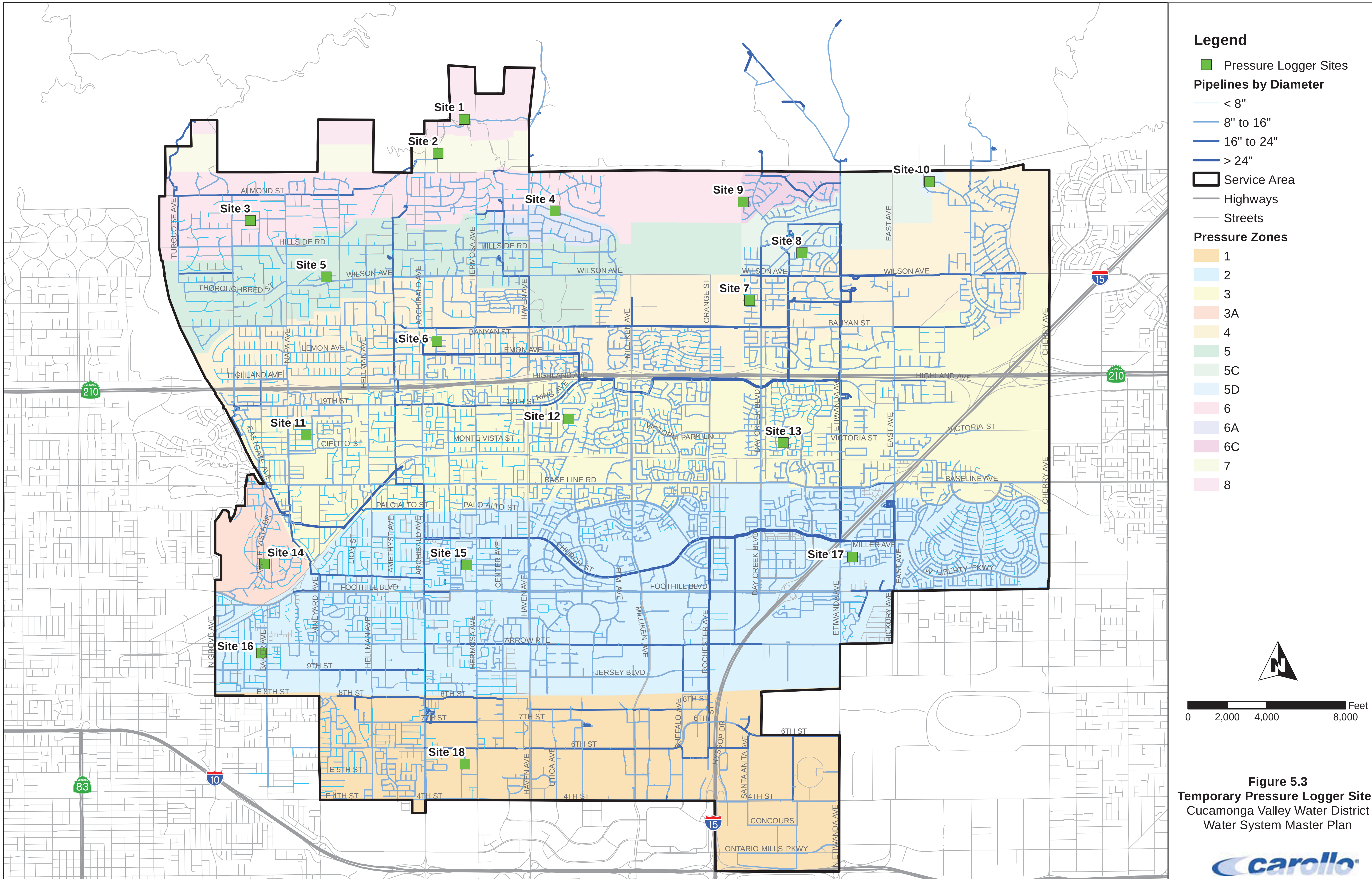


**Figure 5.3**
**Temporary Pressure Logger Sites**
Cucamonga Valley Water District
Water System Master Plan

## 5.4 MODEL CALIBRATION METHODOLOGY AND RESULTS

The purpose of a water system hydraulic model is to estimate, or predict, how the water distribution system will respond under a given set of conditions. One way to test the accuracy of the hydraulic model is to create a set of known conditions in the water system and then compare the results observed in the field against the results of the hydraulic model simulation using the same conditions.

The calibration process for the District's water distribution system hydraulic model consisted of two parts: (1) a macro calibration and (2) an EPS calibration. This section summarizes the results of this calibration process.

### 5.4.1 Macro Calibration

Initially, the model was run under existing demand conditions, and converted to an EPS model. Necessary adjustments were made to produce reasonable system pressures and velocities, and to confirm that the reservoirs were cycling. Such adjustments include modifications of pipeline connectivity, operational controls, ground elevations, and facility characteristics.

The macro calibration process involves several steps to verify that the model produces reasonable results:

- **Transmission Main Connectivity.** Using the connectivity features of the modeling software, the connectivity of the transmission mains within the distribution system was verified. Problems found using the connectivity locators were reviewed to determine whether adjustments were needed to the connectivity of the model. Output reports of pipe flow characteristics, such as headloss (feet per thousand feet [ft/kft]) and velocity (feet per second [fps]) were also used to locate problem areas where additional adjustments may be necessary.
- **System Pressures.** The macro calibration compared the model output to the typical pressures observed within the distribution system in pounds per square inch (psi). This process was used to locate major errors in model creation, elevations, or connectivity, as well as changes that reflect how operational controls of the system should be implemented in the model.
- **Facility Characteristics/Operational Controls.** Hydraulic model results were compared to data provided by the District to verify that facility attributes entered into the model, such as the physical characteristics of the tanks and pumps, produced results comparable to what the system experiences. Carollo worked extensively with District operations staff to understand the operational characteristics of each facility so that they were simulated appropriately in the model. Initial statuses and on/off controls were input into the model for each well and pump. Groundwater levels were adjusted in the model based on historical field data. Imported and surface water supplies were modified to simulate field conditions.

### 5.4.2 Extended Period Simulation Calibration

The extended period calibration is intended to calibrate the EPS capabilities of the hydraulic model by closely matching the model pressures and flows to field conditions over a 24-hour period of similar demand and system boundary conditions. Pressure data, reservoir level data, and source water and pump flows were recorded to create diurnal patterns and obtain EPS calibration data. The primary varied parameters for this calibration were operational controls and pipeline roughness coefficients, although other parameters were also adjusted as calibration results were generated. Carollo worked closely with District operations staff to model each facility with appropriate controls.

From the 2-week calibration data gathering period, Tuesday, November 24, 2015, was selected to be used for the 24-hour EPS calibration day. Tuesday was chosen because it had the most complete set of data and was not days within the Thanksgiving holiday.

The estimated daily demand (based on production records) for this day was about 30,955 gpm. This is approximately 26-percent higher than the average annual consumption in 2012 to 2014 of 23,000 gpm. For the EPS calibration, the ADD was scaled down by a factor of 0.74 to match this estimated demand condition during the calibration day.

The EPS calibration compared model simulated reservoir levels to the field measured data. In addition, model simulated pressures at the pressure logger locations were compared to the actual field pressures recorded during the calibration day.

The following modifications were made to the model during calibration:

- Modification of PRV initial status or pressure setpoint to meet collected field data.
- Modification of initial statuses and control strategies for pumps. In general, controls for pumps were based on the level in the reservoir. Some of the pumps had rule-based controls created, where the pumps can be turned off by both a suction and discharge pressure.
- Modifying directions of pipelines at PRVs, in some cases, the incorrect pipe direction was preventing flow through PRVs. Also, control strategies were added at selected PRVs to match field controls.
- Moving demands off transmission pipelines to distribution pipelines.
- Opening pipelines that were causing disconnected nodes, and closing pipelines at zone boundaries that were allowing flow between zones.
- Correct zone designations for pipelines in the model; adding zone designations to model junctions.

The EPS model results for each reservoir and calibration point listed in Table 5.2 and Table 5.3 are presented in Appendix B. To maintain legibility of this report chapter, a few sample of the EPS calibration are shown on Figure 5.4 through Figure 5.5. A comparison of model results to observed field conditions for Reservoir 2C is presented on Figure 5.4. A comparison of model results to the pressure logger C16 site is presented on Figure 5.5.

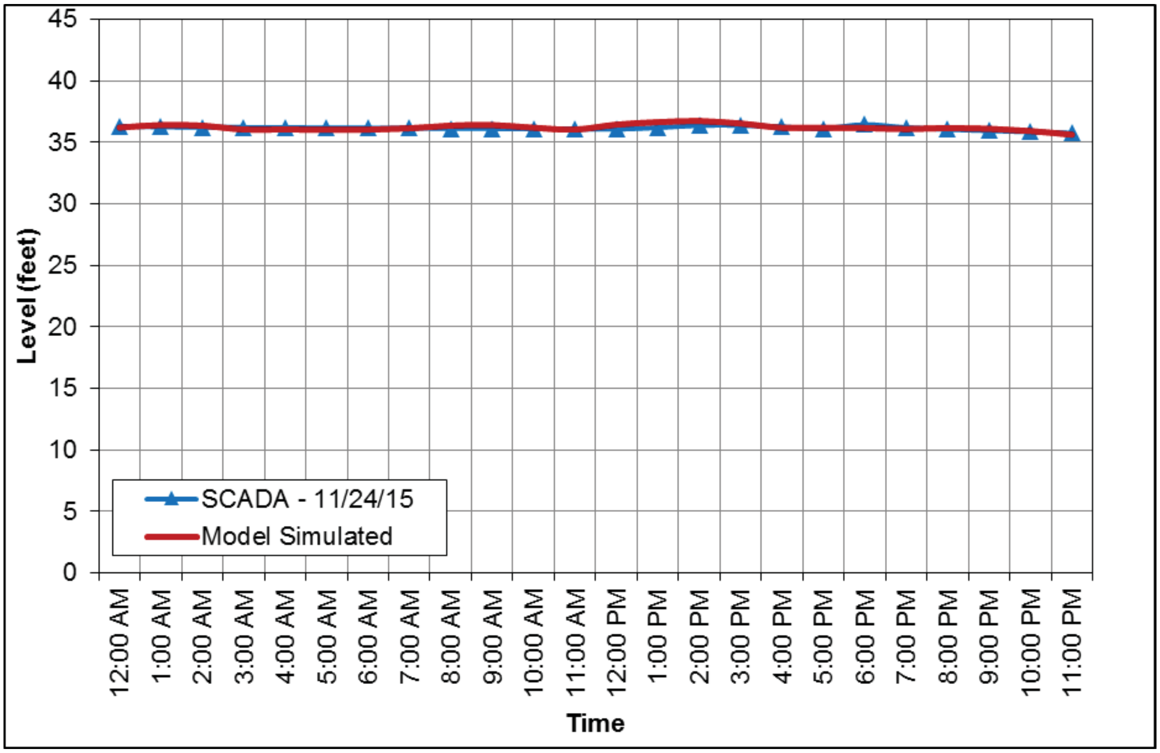


***Figure 5.4 EPS Calibration Results – Reservoir 2C Level***

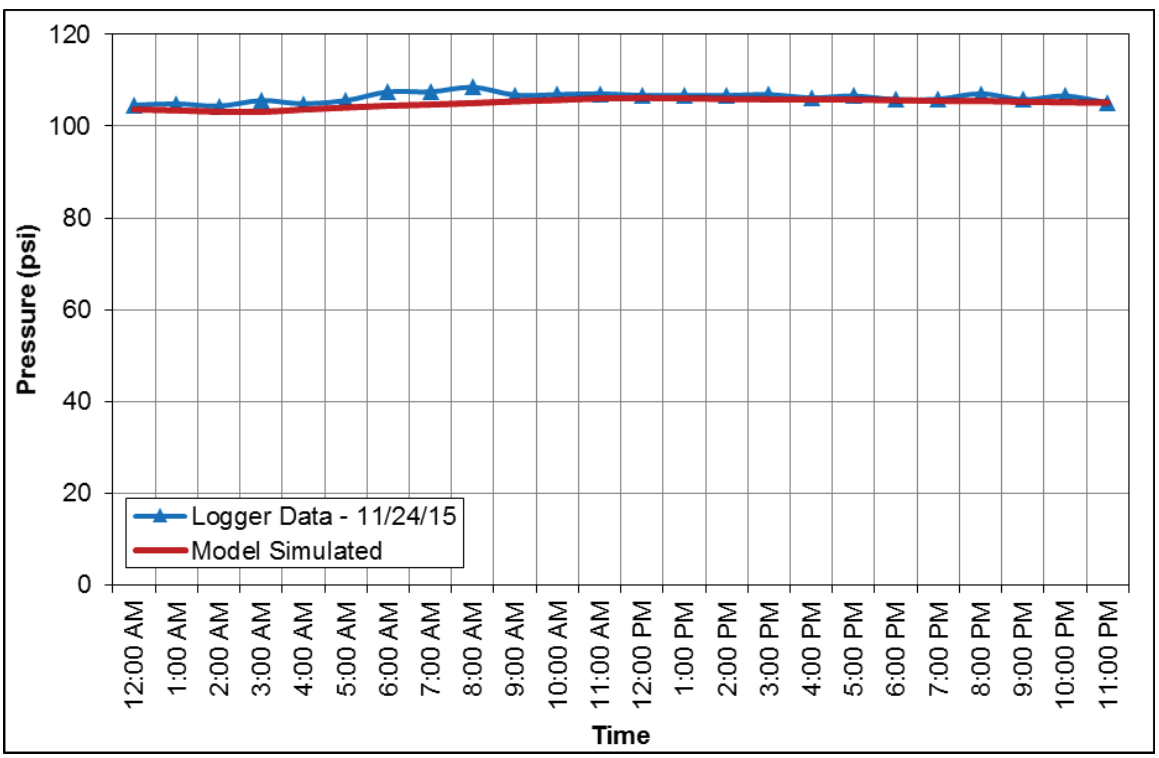


***Figure 5.5 EPS Calibration Results – Pressure Logger C16***

### 5.4.3 Calibration Result Summary

Overall, it can be concluded that the trends seen in the field data are well predicted by the model, with some minor differences. The calibration results indicate the model predicts conditions very similar to those observed in the field. Based on the results of the calibration, it can be concluded that the model is sufficiently calibrated to conduct hydraulic analysis for the preparation of this WMP. The model provides an accurate representation of the District's distribution system and system operations to a level suitable for the distribution system analysis described in Chapters 7 and 8, as well as the District's future modeling endeavors.

The model calibration comparison plots of all SCADA and pressure logger points used for the model calibration are included in Appendix B.

# EVALUATION CRITERIA

This chapter presents the planning criteria and methodologies for the analysis used to evaluate the existing potable water system and the associated facilities to identify existing system deficiencies and size future improvements and expansions. The planning criteria are used in the existing and future water system analyses (Chapter 7 and 8, respectively) and to define capital improvement projects in Chapter 9.

## 6.1 POTABLE WATER SYSTEM EVALUATION CRITERIA

The District's water system is evaluated under a range of normal and emergency operating conditions and demand scenarios. The normal operating conditions are:

- Average Day Demand (ADD).
- Peak Hour Demand (PHD).
- Maximum Day Demand (MDD).
- MDD plus Fire Flow (MDD+FF).

Distribution system evaluation criteria are required to determine the performance of the District's water system under the range of operating conditions as discussed above and to identify system deficiencies and improvement projects. Under each operating condition, the capacities and performance of the water system are compared to the evaluation criteria to determine which pipelines or water facilities need to be upgraded or replaced. The evaluation criteria for the potable water system consist of the following categories:

- System Pressure.
- Pipeline Velocity.
- Storage Volume.
- Pumping Station (PS) Capacity.
- Pressure Reducing Valve (PRV) Capacity.

The evaluation criteria used for the evaluation of the District's potable water system are summarized in Table 6.1. Detailed descriptions for each evaluation criteria are provided following the table.

**Table 6.1 Water System Evaluation Criteria
Water System Master Plan
Cucamonga Valley Water District**

| Description[1] | Value | Units |
|---|---|---|
| **Maximum Pressure** | | |
| Without Individual Pressure Regulator at Meter | 80 | psi |
| With Individual Pressure Regulator at Meter | 150 | psi |
| **Minimum Pressure** | | |
| Peak Hour Demand (PHD) | 40 | psi |
| Maximum Day Demand (MDD) + Fire Flow | 20 | psi |
| **Pipeline Criteria** | | |
| Maximum Velocity with ADD | 5 | fps |
| Maximum Velocity with PHD | 8 | fps |
| Maximum Velocity with MDD + Fire Flow | 10 | fps |
| Hazen-Williams C-Factor | | |
| Pipelines Greater Than 50 Years in Age | 110 | N/A |
| Pipelines Between 20 to 50 Years in Age | 120 | N/A |
| Pipelines Less Than 20 Years in Age | 130 | N/A |
| Minimum Size for Pipeline Replacement | 8 | inches |
| **Fire Flow Requirements** | | |
| Very Low and Low Density Residential - Non-Hillside Zones | 1,000 | gpm for 2 hrs. |
| Very Low and Low Density Residential - Hillside Zones | 1,250 | gpm for 2 hrs. |
| Medium Density Residential | 1,500 | gpm for 2 hrs. |
| High and Very High Density Residential | 2,500 | gpm for 3 hrs. |
| Commercial | 3,500 | gpm for 4 hrs. |
| Industrial | 3,500 | gpm for 4 hrs. |
| Public/Institutional | 4,000 | gpm for 4 hrs. |
| Schools | 4,000 | gpm for 4 hrs. |
| Agriculture, Parks, Irrigation | 1,000 | gpm for 2 hrs. |
| **Storage Volume** | | |
| Operational | 30% of MDD | MG |
| Fire Fighting Storage | Max FF in Zone | MG |
| Emergency - Lower Zones | 100% ADD | MG |
| Emergency - Upper Zones | 100% MDD | MG |
| **Pumping Station Capacity** | | |
| Normal Conditions - Zones with Gravity Storage | Meet MDD with largest unit o.o.s. | gpm |
| Normal Conditions - Zones Without Gravity Storage | Meet MDD +FF with largest unit o.o.s. | gpm |
| Emergency Condition - Power Outage | Meet MDD with backup power only | gpm |
| Emergency Condition - Earthquake | Meet ADD with largest unit o.o.s. | gpm |

Notes:
(1) Upper Zones include Zones 4, 5, 5C, 5D, 6, 6A, 6C, 7, and 8.
(2) Lower Zones include Zones 1, 2, 3, and 3A.

### 6.1.1 Potable Water System Pressures

Minimum system pressures are evaluated under both PHD and MDD plus fire flows conditions. Maximum system pressures are evaluated under ADD. The minimum pressure criterion for PHD demand conditions is 40 pounds per square inch (psi), while the minimum pressure criterion under MDD with fire flow conditions is 20 psi. The pressure analysis is limited to demand nodes, because only locations with service conditions need to meet such pressure requirements. Lower pressures are only acceptable for junctions at water system facilities and on transmission mains. However, no pressure shall be less than 5 psi to avoid potential water quality issues.

Maximum system pressures are evaluated under the ADD conditions. The maximum pressure criterion for normal ADD conditions is 80 psi for service connections without individual pressure-reducing valves. In areas where the maximum pressure exceeds 80 psi, individual pressure-reducing valves are required on service connections; however, the system pressure shall generally not exceed 150 psi.

### 6.1.2 Potable Water Pipeline Velocities

Pipeline velocities are evaluated using three different maximum velocity criteria for selected flow conditions under both existing and future demand scenarios. For transmission and distribution pipelines, a maximum velocity of 5 feet per second (fps) and 8 fps was used for ADD and PHD conditions, respectively. Fire hydrant laterals are excluded from these criteria, as higher velocities are acceptable. Under fire conditions, velocities of up to 10 fps were allowed. Ideally, all transmission and distribution pipelines should have maximum velocities less than 8 fps in order to minimize head loss; however, higher velocities in existing pipelines is not, by itself, sufficient justification for pipeline replacement.

### 6.1.3 Potable Water Storage Capacity

The total storage required for a water system is evaluated in three components.

- Storage for operational use.
- Storage for firefighting.
- Storage for emergencies.

These three components are determined for each pressure zone to evaluate the ability of the water system to meet the storage criteria on both a zone-by-zone basis, as well as a system-wide basis. These three storage requirements are discussed in more detail below.

#### 6.1.3.1 Operational Storage

Operational storage is defined as the quantity of water that is supplied to meet daily fluctuations in demand beyond the quantity of water that is produced on a daily basis. It is necessary to coordinate the production rates of water sources and the available storage Capacity in a water system to provide a continuous flow of treated water supply to the system. Water systems are often designed to supply the average flow on the day of maximum demand. Water storage is then used to supply water for peak hour flows that may occur throughout the day. This operational storage is continuously replenished throughout the day to maintain water quality.

American Water Works Association (AWWA) recommends an operational supply volume ranging from one-quarter to one-third of the demand experienced during one maximum day. It is recommended that pressure zones in the District's water system have operational storage of 30 percent of the MDD supplied by that reservoir.

#### 6.1.3.2 Fire Flow Storage

The governing fire department provides the District with the fire flow rate and duration to determine if fire storage is required for a pressure zone. The values provided in Table 6.1 are simply provided as a reference and are based on typical values for water utilities. Fire flow storage is determined based on the single greatest fire flow requirement (flow and duration) within each pressure zone.

#### 6.1.3.3 Emergency Storage

Storage is also required to meet system demands during emergencies. Emergencies cover a wide range of rare but probable events, such as water contamination, failure at a water treatment plant, power outages, transmission pipeline ruptures, several simultaneous fires, and earthquakes. The volume of water that is needed during an emergency is usually based on the estimated amount of time expected to elapse before the disruptions caused by the emergency are corrected. The occurrence and magnitude of emergencies is difficult to predict. Due to the proximity to the foothills, the District's recommended emergency storage for the upper zones, which includes Zones 4, 5, 5C, 5D, 6, 6A, 7, and 8 is set to 100 percent of MDD per pressure zone. The District's recommended emergency storage for the lower zones, which includes Zones 1, 2, 3, and 3A, is set to 100 percent ADD.

### 6.1.4 Potable Water Pumping Station Capacity

Typically, a pumping station consists of multiple pump units, including one spare pump to provide reliability in case of a breakdown or repair. In addition, critical pumping stations may be equipped with emergency power supplies in case of failure of the primary power source.

For the purpose of this Master Plan, the capacity and design criteria were modified to reflect system conditions typically evaluated as part of a master plan. These criteria are the sizing of pumping stations under normal demand conditions using MDD and MDD plus maximum fire flow for zones with and without gravity storage, respectively. Each station shall have sufficient capacity to meet the required MDD and the maximum zone fire flow with the largest unit out of service (o.o.s.) or based on the available backup power.

In addition, pumping stations shall be sized to maintain a reasonable level of service during emergency conditions. Pumping stations shall be able to meet MDD during a power outage using backup power supplies only. MDD is selected as the governing demand condition as rolling blackouts most likely occur during summer time when energy demand in Southern California peaks due to extensive use of air conditioning systems. ADD is selected as the governing demand condition for an earthquake scenario as reduced water deliveries would be acceptable during catastrophic conditions.

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# CHAPTER 5

## Design Criteria and Performance Evaluation Criteria

This chapter establishes the required District design criteria and performance evaluation criteria for sewer main hydraulic capacity, minimum pipe diameters, and minimum and maximum sewer velocities for sewer mains and siphons.

### Hydraulic Capacity

Different hydraulic capacity criteria have been established for existing sewer mains and new sewer mains. This separate approach enables the District to benefit from empirical monitoring of actual sewer capacity demand in the existing sewer mains, thus ensuring that sewer main replacements are sized and scheduled optimally and so securing the maximum economic benefit. New sewer mains are designed necessarily with projected and estimated data, and so the diminished certainty of future capacity demand warrants different design criteria.

### Sewer Velocity

Sewer velocity is an important design criterion and is a factor in sewer main sizing, sewer maintenance, and mechanical pipe protection. A minimum velocity of 2 feet/second is desirable to maintain self-scouring characteristics for gravity sewer mains. A minimum velocity of 3 feet/second is desirable to maintain self-scouring characteristics for inverted siphons. A maximum velocity of 10 feet/second is desirable to protect sewer pipes from abrasive damage.

### Sewer Main Diameter

Sewer main design shall be based on three key factors:

(1) the required hydraulic capacity,
(2) the required minimum and maximum velocities, and
(3) the District's ability to video monitor and maintain the sewer.

The District currently owns some 6-inch public sewer main and has the equipment to video inspect and clean 6-inch mains. These mains have standard dimension manholes that provide full access for District equipment. Mains smaller than 6-inch diameter, and mains with clean-outs installed in lieu of standard dimension manholes, shall not be allowed.

Below are the design and performance evaluation criteria for new and existing public sewer mains. Hydraulic capacity is quantified as a ratio of the depth of wastewater to the diameter of the sewer main, abbreviated as "d/D." These criteria are in accord with generally accepted engineering practices.

| Criteria Summary | | |
|---|---|---|
| **Design and Performance Evaluation Criteria** | **Existing Sewer Main** | **New Sewer Main** |
| Maximum d/D ratio for pipe less than or equal to 12 inches | 0.75 | 0.50 |
| Maximum d/D ratio for pipe greater than or equal to 15 inches | 0.75 | 0.75 |
| Minimum Pipe Diameter | N/A | 6 inch diam. |
| Gravity sewer main, minimum peak velocity | 2 ft./sec. | 2 ft./sec. |
| Siphon, minimum peak velocity | 3 ft./sec. | 3 ft./sec. |
| Gravity sewer main, maximum velocity | 10 ft./sec. | 10 ft./sec. |