APPENDIX G

WATER SYSTEM MODEL TECHNICAL MEMORANDUM

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010
F: 925.937.9026

October 9, 2019

Mr. Alexander Yuen
Engineer I
City of Daly City
333 - 90th Street
Daly City, California 94015

153172-006

Subject: Hydraulic Analysis for the Jefferson Union High School District (JUHSD) Faculty & Staff Housing Project

Dear Mr. Yuen:

In completion of Phase 006 of the Agreement for Consulting Services dated October 8, 2018, between the City of Daly City (Daly City) and Brown and Caldwell (BC), BC is pleased to submit this letter report for your review and use. This report documents the hydraulic analysis performed to determine the water main sizes required to deliver domestic and fire flow demands to the proposed JUHSD Faculty & Staff Housing Project (Site) in Daly City.

For this assignment, BC expanded the existing hydraulic model of Daly City's potable water system by adding the proposed public water lines (4- to 10-inch diameters) within the Site. BC evaluated potential connection points to Daly City's water system. This report describes the model development, summarizes hydraulic analysis results, and presents BC's recommendations for the diameters and connection points of the distribution pipelines.

BC's scope does not include the following activities and thus they are not part of this analysis:

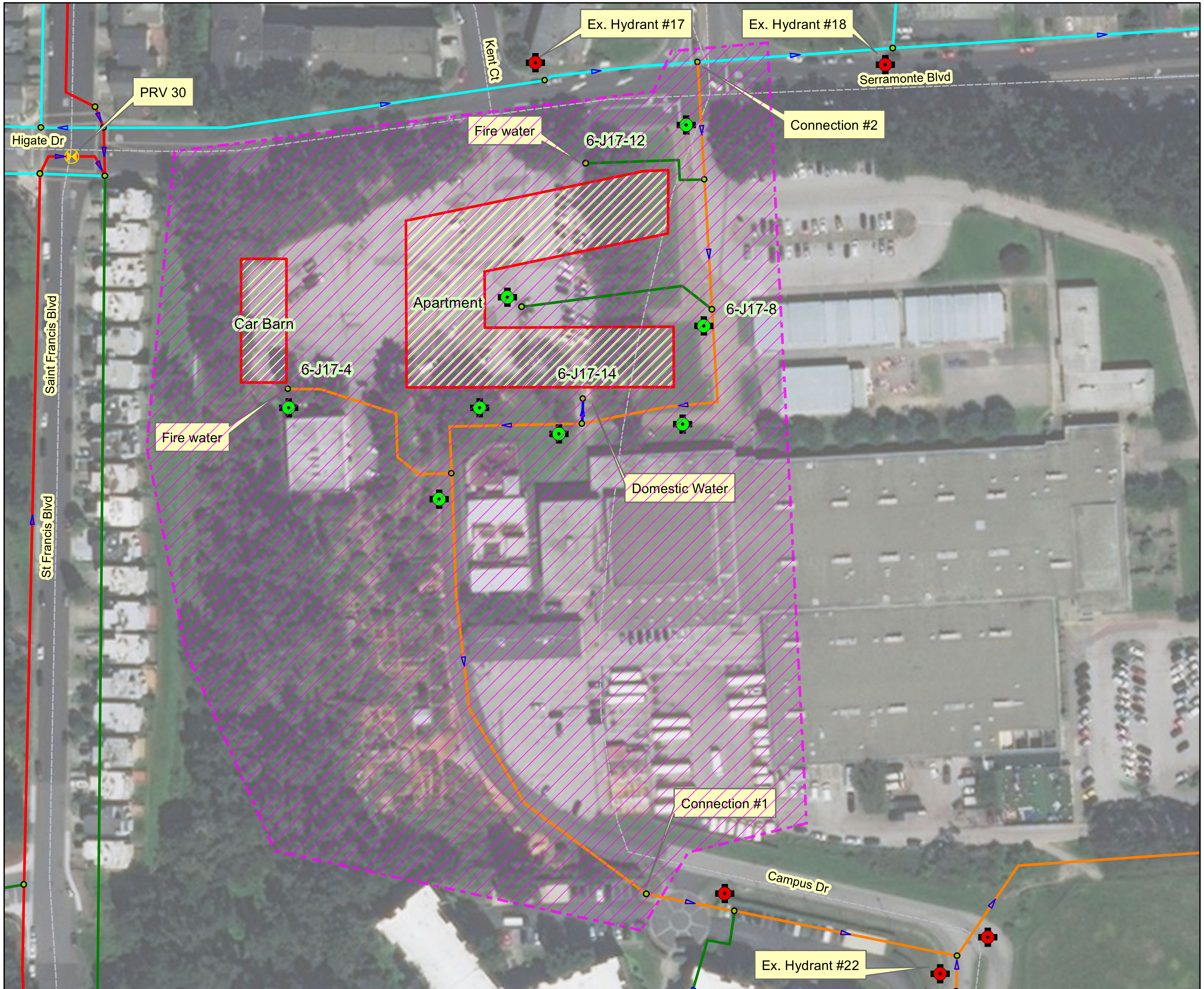
- Surge analysis;
- Water quality analysis and;
- Sizing of the proposed automatic fire-suppression sprinklers system.

Hydraulic Model Development

BC modeled the proposed project using InfoWater 12.4 by Innovyze, Inc. InfoWater is a commercially available, fully Geographic Information System (GIS) integrated, water distribution modeling and management software application that calculates and tracks various hydraulic constituents, such as flow, velocity and pressure of water through the water system.

The updated model includes the existing Daly City pipe network (last updated on October, 2019), including distribution mains 8 to 16 inches in diameter; note that the model also shows mains with diameters less or equal to 6 inches when those mains are the only local water mains or provide locations for service connections and the proposed pipe network and facilities for the project site. Figure 1 illustrates the existing and proposed water systems of the proposed project.

This page intentionally left blank.



Author: Kevin Kai Path: C:\Users\kkai\Dropbox\Work\Daly City\Model\DalyCity-090319.mxd

City of Daly City
Hydraulic Analysis
JUHSD Project

Figure 1
Existing and Proposed Water System

Legend

Junction
- (All Modeled Facilities)
- (Project Specific Facilities)

Pipe (Diameter, In)
- <=4
- 6
- 8
- 10
- >=12

Valve
- PRVs

Proposed Water System

Existing Hydrant

New Hydrant

* For new hydrants, actual spacing and location as required by North County Fire Authority.

N

0 65 130
Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

DALY CITY CALIFORNIA

Brown AND Caldwell

This page intentionally left blank.

Jefferson Union High School District plans to expand the facilities on the campus at 699 Serramonte Boulevard in Daly City, located between St. Francis Boulevard and Callan Boulevard. Potable water for this development would come from the City's Pressure Zone 6/6B. As shown on the drawings by BKF Engineers and Seidel Architects (provided to BC on March 21, 2019), the project consists of a 4-floor, 122-unit apartment building with a detached 64-stall parking lift structure ("Car Barn").

The basic construction type for the apartment building is V-A. The basic construction type for the Car Barn is II-B. The project consists of two new buildings described in Table 1 and shown on Figure 1:

Table 1. Serramonte Center Expansion – New Facilities

Building	Type	Approx. Area, sq. ft	New Lateral, Diameter and Length
Apartment	High density residential	176,870	4 to 8-in, 180-ft
Car Barn	Parking structure	5,370	10-in, 230-ft

As determined during the project kick-off meeting on August 8, 2019, the proposed project will connect at two locations to the existing Daly City water system:

- Connection 1: 10 inch-diameter ductile iron pipe (DIP) that ends at the northern terminus of Campus Drive.
- Connection 2: 6 inch-diameter asbestos cement pipe (ACP) in Serramonte Boulevard.

The hydraulic model consists of the following elements and assumptions:

1. New project will require new hydrants per City Design Standards (Section 6.02.C) and 2016 California Fire Code;
2. New 10-inch-diameter public water main through the school site connecting the existing 10-inch-diameter water main in Campus Drive to the existing 6-inch-diameter water main in Serramonte Boulevard completing a loop of the City's water system.
3. New lateral pipes servicing the proposed buildings will connect to the new 10 inch-diameter public water main in Campus Drive.
4. BC modeled new service to the Car Barn using one fire demand node; however, the City may require separate connections/meters for fire, domestic, and irrigation demand.
5. BC modeled new services to the Apartment using one fire demand node and one domestic demand node; however, the City may require separate connections/meters for fire, domestic, and irrigation demand. The findings of this water study still apply when proposed building require multiple connections.

Required Fire Flow and Hydrant

For these analyses, North County Fire Authority (NCFA) agreed to the following required fire flow and duration after the initial project review in September 2019. The local fire authority may increase fire flow demand at its discretion to address concerns regarding wild land or other issues.

1. To estimate the fire flow requirements, BC used Type IIB building construction type for the proposed Car Barn, Type VA building construction type for the proposed apartment building.
2. The proposed buildings will have approved National Fire Protection Association (NFPA) 13 automatic sprinklers, and highest ceiling elevations will be approximately 48 feet above pad elevations for the apartment.
3. Table 2 shows required and reduced fireflow and duration per California Fire Code 2016 Appendix BB (Table BB105.1) for different building construction types in Table 2. When the building has an automatic fire protection sprinkler system (Section 903.3.1.2 CFC), the local fire authority can reduce minimum fire-flow by up to 75 percent but not less than 1,500 gpm. However, North County Fire Authority does not permit reduction of fire flow more than 50 percent.
4. Required hydrant numbers per California Fire Code 2016 Appendix CC (Table CC105.1): Eight hydrants for the apartment building and two hydrants for the Car Barn. Due to the proximity of the proposed buildings, some of the new hydrants shown in Figure 1 may serve multiple buildings, thus reducing the total number of the required hydrants.
5. Required hydrant spacing per City Design Standards (Section 6.02.C) and 2016 California Fire Code, Table CC105.1: 200 feet for the apartment building and 300 feet for Car Barn.

Demand Allocations

BC allocated the new domestic water and fire demands to several model nodes using the unit demand factors by land use as developed in the Water Demands Summary Technical Memorandum (BC, July 13, 2012) and California Fire Code. Table 2 presents the domestic and fire hydrant water demands used for this analysis. Table 2A presents the sprinkler system demands used for this analysis.

Table 2. Average Day and Fire Flow Demands for the Proposed Project												
Proposed Project	No. of Units	Approx. Area[a] sq. ft.	Building Type[i], per CBC	Approx. Building Height, ft.	Land Use Classifications	Unit Water Demands[b,c]	Ave. Day Demands[d], gpm	Required Fireflow[f], gpm	Reduced Fireflow[g], gpm	Flow Duration, Hrs.	Min. No. of Hydrants[h]	Ave. Spacing between Hydrants[e], ft.
JUHSD Project												
Apartment	122	176,870	VA	48	High density residential	60 gpcd	23.8	7,500	3,750	4	8	200
Car Barn	-	5,370	IIB	25	Parking	-	0.0	2,250	1,500	2	2	300
Project Total	-	-	-	-	-	-	23.8	-	-	-	-	-

a Approximate total building areas of all floor levels within the exterior walls from developer.

b Unit Water Demands and occupants per Unit from Near- and Long-Term Water Resources Planning (BC, 2012). Hotel: 60 gpd per room. Theater/Restaurant/Gym: 0.135 gpsfpd

c gpcd = gallons per capita per day, gpsfpd = gallons per square foot per day, gps = gallons per minute per sprinkler, gpd/rm = gallons per day per room

d gpm = gallons per minute. Residential/Hotel demand is averaged over 16 hours and all non-residential demand is averaged over 8-hours per day.

e Required hydrant spacing per 1990 Daly City Design Standards (Section 6.02.C). Actual final spacing of hydrants as required by North County Fire Authority.

f Required fire flow Per the 2016 California Fire Code, Appendix BB. (Table BB105.1)

g Reduced fire flow with an approved automatic sprinkler system Per CFC Section BB105. North County Fire Authority does not permit reduction of fire flow by more than 50 percent.

h Required number of hydrants based on the full Fire Flow required per the 2016 California Fire Code, Appendix BB and CC. (Table CC105.1).

i For mixed construction building, calculations per State Fire Marshal code interpretation "Fire Flow Requirements with Mixed Construction" 11-015.

	Table 2A. Sprinkler Demands for the Proposed Project						
Proposed Project	Sprinkler Type	NFPA 13 Occupancy	Sprinkler Area, sq. ft	Density, gpm/sq. ft	Sprinklers Demands[a], gpm	Hose Stream Demands, gpm	Total Sprinklers System Demands, gpm
JUHSD Project							
Apartment	NFPA 13	Light hazard	1,500	0.10	150	100	250
Car Barn	NFPA 13	Extra Hazard Group 2	5,370	0.40	2,148	500	2,648

a Sprinkler demand based on Density/area curves of 2019 NFPA 13, Figure 19.3.3.1.1 (page165) in accordance with the density/area method of 19.3.3.2.

Hydraulic Analysis

BC used Daly City's Water Master Plan (BC, August 1991) hydraulic design criteria for this analysis; they reflect the fire flow requirements under the revised California Fire Code with provisions for automatic fire sprinklers. Table 3 summarizes the distribution system pressure criteria, and Table 4 summarizes the velocity and headloss criteria.

Table 3. Pressure Criteria

Condition	Pressure, (pounds per square inch [psig])	System-wide Demand Multiplier[a]
Minimum pressure at peak-hour[b]	40	3.0
Minimum residual pressure under Fire Flow + Max Day Demand—hydrant pressure per California Waterworks Standard (CCR Title 22, 2008)[c]	20	1.5 + fire flow
Minimum residual pressure under Fire Sprinkler demand + Max Day Demand—sprinkler pressure at highest sprinkler (pressure measured at pad elevation on utility side of water meter)[d]	55	1.5

a Demand multipliers based on the 1991 Master Plan.

b The latest edition of the California Water Works Standards (Section 64602) requires a peak-hour pressure of 40 psig.

c Fire flow demand at the model junction varies, with a minimum residual pressure of at least 20 pounds per square inch gage (psig).

d Fire sprinkler demand for each building is estimated based on 2019 NFPA 13, Figure 19.3.3.1.1.

Table 4. Velocity and Head Loss Criteria

Parameter	Condition	Distribution Pipeline Criteria[a]
Maximum distribution velocity	Maximum day	5 fps
Maximum distribution headloss	Pipeline diameter < 16 inches	10 feet/1,000 feet
	Pipeline diameter ≥ 16 inches	3 feet/1,000 feet

a fps = feet per second.

BC analyzed the hydraulic network model under four scenarios: maximum day demand, peak hour demand, fire sprinkler demand plus maximum day demand, and structure fire flow plus maximum day demand. Table 5 lists the node's demands information, including junction's identifications, pressure zone, elevations, and average day demands.

Table 5. Model Nodes and Domestic Demands				
Junction ID[a]	Description	Pressure Zone	Elevation[b], (ft)	Additional Average Day Demand, (gpm)
6-J17-14	Apartment	6/6B	488	23.8
6-J17-4	Car Barn	6/6B	489	0.0

a See Figure 1 for the location of the demand node.

b See table 2A for fire sprinkler system demand based upon new building area.

1. **Scenario 1.** Maximum day demand is the theoretical largest demand that occurs during any single day of the year. The day of maximum demand is usually associated with hot weather during the late summer or early fall. The maximum day demand factor for Daly City is 1.5. BC applied this global multiplier to all demand nodes in the model to simulate maximum day demand conditions.
2. **Scenario 2.** Peak hour is the largest demand that occurs on any one single hour during the day of maximum demand and is larger than maximum day demand. BC multiplied average-day demands globally by 3.0 for peak-hour conditions.
3. **Scenario 3.** Based on the density/area method from the 2019 NFPA 13, BC estimated the fire sprinkler demand to be 250 gpm and 2,648 gpm for the proposed apartment building and parking structure, respectively (see Table 2A). In accordance with City procedure, BC also assumed a minimum residual pressure of 55 psig will be required at pad elevation of the proposed building. The project fire protection engineer will address the actual required pressure and number of sprinkler head for the fire protection system.
4. **Scenario 4.** BC analyzed available fire flow by running the structure fire flow simulation under the maximum day demand scenario in the steady state mode.
5. **Scenario 5.** BC analyzed the Daly City water model using the Average Day Demand (ADD) for the field test day simulation.

Findings, Conclusions and Recommendations

After analyzing the model output for five different model scenarios, BC found that the existing Daly City public water system with the proposed Serramonte private water system expansion shown in Figure 1 would deliver satisfactory pressure and flow to the project. Table 6 summarizes the hydraulic analysis results for Scenario 1-4.

Table 6. Hydraulic Analysis Scenario 1-4 Results								
	Model Assumptions				Analysis Results			
Analysis Scenario[a,b]	Tank Level	System Demands	Fire Flow/ Sprinkler Demands	Min. Pressure	Max. Pressure	Available Sprinkler/ Fire Flow	Max. Velocity	Max. Headloss
1	Full -1 ft	Maximum day	-	-	78 psig	-	<5 fps	<10 ft / 1,000 ft
2	Full -10 ft	Peak hour	-	>40 psig	-	-	-	-
3.1 (Apartment)	Full -1 ft	Maximum day	250 gpm	>55 psig	-	1,700 gpm @ 55 psig	-	-
3.2 (Car Barn)	Full -1 ft	Maximum day	2,648 gpm	>55 psig	-	1,900 gpm @ 55 psig	-	-
4.1 (Apartment)	Full -5 ft	Maximum day	3,750 gpm,	>20 psig	-	-	-	-
4.2 (Car Barn)	Full -5 ft	Maximum day	1,500 gpm	>20 psig	-	-	-	-

a For Scenario 5 detail results, see Table 8.

b For Scenario 4 detail results, see Table 7.

Finding 1. Under maximum day demand conditions, BC found that the modeled system met both the maximum velocity and headloss criteria. The Uniform Plumbing Code (Section 608.2) limits internal pressures in any structure to 80 psig; therefore, structures with pad elevation lower than approximately 470 feet in Pressure Zones 6/6B will require individual pressure-regulating devices.

- All Junctions for the proposed buildings appear to have pad elevation higher than 470 feet, thus new construction will not require individual pressure-regulating devices. The designer of the building plumbing system will address building internal pressure control.

Finding 2. Under peak-hour demand conditions, BC found that all junctions within the proposed project meet the peak-hour minimum required residual pressure of 40 psig.

Finding 3.1. Under maximum day conditions with sprinkler flow demands, the modeled system delivered the estimated sprinkler flow to the proposed Apartment building and met the minimum required residual pressure of 55 psig at pad elevation of the proposed building on the utility side of the water meter. The estimated available sprinkler flow at 55 psig is approximately 1,700 gpm at the Apartment building.

Finding 3.2. Due to the proposed NFPA 13 occupancy classification, “Extra Hazard Group 2”, the Car Barn has a relatively high estimated sprinkler flow of 2,648 gpm. For this reason, under maximum day conditions, the modeled system has insufficient capacity to deliver the estimated sprinkler flow to the proposed Car Barn while meeting the minimum required residual pressure of 55 psig at pad elevation of the proposed building on the utility side of the water meter. The estimated available sprinkler flow at 55 psig is approximately 1,900 gpm at the Car Barn.

Finding 4.1 and 4.2. Under maximum day conditions with structure fire flow demands, the modeled system delivered the required fire hydrant flows and met the minimum required residual pressure of 20 psig for the proposed Apartment and Car Barn. Table 7 lists the available fire flow simulation results.

- Daly City's water system would deliver the total maximum fire demand for the proposed project (3,750 gpm for 240 minutes equals 900,000 gallons) from Reservoir 6 and 6B, Reservoir 5 and 5B Pump Stations, and pressure reducing stations from adjacent pressure zones.
- Since the Pressure Zone 6/6B draws water from several sources, BC assumes based on past master planning that these various water sources will have enough available capacity to supply the required fire flow. Note that Reservoir 6 and 6B holds approximately 1.5 million gallons each and hence has enough storage to supply the required fire flow.

Table 7. Residual Pressure During Fire Flow Demand Simulation

Junction ID	Description	Static Pressure, (psig)	Fire-Flow Demand (gpm)	Residual Pressure, (psig)	Available Flow at Hydrant[a] (gpm)	Available Flow Pressure, (psig)	Notes
6-J17-8	Apartment	74	3,750	24	3,900	20	Provide 8 new hydrants.
6-J17-4	Car Barn	71	1,500	59	3,500	20	Provide 2 new hydrants.

a New project hydrants will be required per California Fire Code and Daly City Design Standards (Section 6.02.C).

Finding 5. As described in the American Water Works Association (AWWA) Manual M-32 Computer Modeling of Water Distribution Systems, fire flow testing is a widely used method for estimating the available fire flow from specific fire hydrants within water distribution systems and for validating water models. Fire flow tests consist of measuring flow from a hydrant (flow hydrant) while measuring the pressure at an adjacent hydrant (residual or pressure hydrant). The flow hydrant causes a pressure drop (AWWA recommends a drop of 10 psig, or more to create sufficient "stress" on the water system to reveal its characteristics) measured at the residual hydrant. Normally, city/agency staff use a supervisory control and data acquisition (SCADA) system to record flow rates from pumps/ pressure reducing valves (PRVs) and reservoir levels at test time to determine water demand and operating parameters. The modeler then simulates the test in the model by setting the pump/PRV operation and reservoir levels to match the field data and imposes a flow hydrant in the model. Finally, the modeler compares the pressure drop at the residual hydrant in the model results to the field data. Table 8 and 8A list the fire hydrant test data versus the model simulation results for this project.

Table 8. Summary of Fire Hydrant Test and Model Results					
	BPS Status	Reservoir Level	Pressure Hydrant[b]		Flow Hydrant[c]
	Reservoir 5 BPS	Reservoir 6	Static (psig)	Residual (psig)	Flow (gpm)
Field measurements[a]	Off	17.1	75	70	999
Model results	Off	17.1	71	66	999
Deviation	-	-	-4	-4	-

a Fire flow test was conducted by Daly City Staff on 6:35, 8/31/2019.
b Pressure Hydrant location: Hydrant 17 on Map C-10.
c Flow Test Hydrant location: Hydrant 18 on Map C-10.

Table 8A. Summary of Fire Hydrant Test and Model Results					
	BPS Status	Reservoir Level	Pressure Hydrant[b]		Flow Hydrant[c]
	Reservoir 5B BPS	Reservoir 6B	Static (psig)	Residual (psig)	Flow (gpm)
Field measurements[a]	Off	23.7	80	75	1,127
Model results	Off	23.7	74	65	1,127
Deviation	-	-	-6	-10	-

a Fire flow test was conducted by Daly City Staff on 1:17, 9/21/2018.
b Pressure Hydrant location: Hydrant 22 on Map C-10.
c Flow Test Hydrant location: Hydrant 23 on Map C-10.

As part of model validation procedure, BC inserted SCADA system reservoir level and Booster Pump Station (BPS) data (Reservoir 5B BPS is off), recorded during hydrant testing into the Daly City water model and analyzed the model assuming the Average Day Demand (ADD) for the test day. We compared the field-measured static pressure and residual pressure to the static pressure and residual pressure predicted by the model.

Fire Hydrant Flow Test Findings

The first hydrant test (Table 8) was conducted at the north end of the proposed project along Serramonte Blvd. The water system at this test location is well looped with watermain diameters ranging from 6 to 12. The system has enough hydraulic capacity and the model predicts that pressure at the hydrant would drop 5 psig.

1. Both the model static and residual pressure results agreed with field measurements to within -4 psig. Within the water industry standards for a distribution system, typically a model is sufficiently validated when the static and residual pressure predicted by the model at the specific locations are within 5 psig of the field measured static and residual pressures. The following are a few possible reasons for the lower static pressure predicted by the water model:
    a. The actual C-value of the pipe segments near the test hydrants may be higher than the C-value used in the model.
    b. The actual demand during the hydrant test may be lower than the ADD used in the model.

The second hydrant test (Table 8A) was conducted at the south end of the proposed project along Campus Drive. The water system at this test location is also well looped with watermain diameters ranging from 10 to 12. The system has enough hydraulic capacity and the model predicts that pressure at the hydrant would drop 9 psig.

1. The model static pressure result agreed with field measurements to within -6 psig, however the model residual result deviated from the field measurement by -10 psig which is higher than the water industry standards. Within the water industry standards for a distribution system, typically a model is sufficiently validated when the static and residual pressure predicted by the model at the specific locations are within 5 psig of the field measured static and residual pressures. The following are a few possible reasons for the higher static pressure predicted by the water model:
    a. The actual C-value of the pipe segments near the test hydrants may be higher than the C-value used in the model.
    b. The actual demand during the hydrant test may be lower than the ADD used in the model.
    c. The actual observed flow during the hydrant test may be lower than the hydrant flow used in the model.
    d. Since the flow test hydrant location is close to the PRV 30 (Zone 7 to Zone 6/6B), the PRV pressure setting would have a major influence on the hydrant test results. Unfortunately, we have neither flow nor pressure measurements from the PRV during the test. For future similar hydrant tests, we recommend that the City staff record the pressure and flow data when performing hydrant testing near a PRV.

Summary

For the proposed JUHSD Faculty & Staff Housing Project, the model conforms to the fire hydrant flow requirements while the existing Daly City public water system with the proposed public water system expansion shown in Figure 1 would meet the velocity and headloss criteria. Improvements as described in this letter and summarized below would produce a water system that meets all City criteria except the sprinkler flow requirement for the Car Barn. The modeled system has insufficient capacity to deliver the estimated sprinkler flow of 2,648 gpm to the proposed Car Barn at 55 psig residual pressure. The estimated available sprinkler flow at 55 psig is approximately 1,900 gpm at the Car Barn.

1. The proposed water system is shown in Table 9. The proposed project will connect at two locations to the existing Daly City water system:
    – Connection 1: 10 inch-diameter ductile iron pipe (DIP) that ends at the northern terminus of Campus Drive.
    – Connection 2: 6 inch-diameter asbestos cement pipe (ACP) in Serramonte Boulevard

Table 9. Summary of Proposed Water System	
Proposed Water System	**Estimated Quantity**
4-in Pipe	30 ft
8-in Pipe	360 ft
10-in Pipe	1,500 ft
Hydrants	10

1. The proposed project will require minimum of 10 new fire hydrants per the 2016 California Fire Code and City Design Standards (Section 6.02.C). The project fire protection engineer will address the actual number, spacing, and location of the fire hydrant system.

BC appreciates the opportunity to assist Daly City with this project. Please call us with any questions.

Very truly yours,

Brown and Caldwell

Kevin Kai, P.E., Project Manager
California License C 60024

KK/BF:dek
cc: William Faisst, Brown and Caldwell