Attachment 25. Hydraulic Analysis

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

T: 925.937.9010
F: 925.937.9026

June 8, 2020

Mr. Roland Yip, PE, QSP/D
Senior Civil Engineer
City of Daly City
333 - 90th Street
Daly City, California 94015

153172-013

Subject: Hydraulic Analysis for the 493 Eastmoor Project

Dear Mr. Yip:

In completion of Phase 013 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 493 Eastmoor Project Site in City.

For this assignment, BC evaluated potential connection points to City's water system and modifications to the City 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
- 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 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 City pipe network (last updated in May 2020), 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.

City of Daly City
Hydraulic Analysis
493 Eastmoor Project

Figure 1
Existing and Proposed Water System

Legend

Junction

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

Pipe (Diameter, In)

- <=4
- 6
- 8
- 10
- >=12

- Pump
- PRV
- Reservoir
- Water Source
- Existing Hydrant
- New Hydrant

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

0 50 100
Feet

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

Brown AND Caldwell

Author: Kevin Kai Path: C:\Users\kkai\Dropbox\Work\Daly City\Model\DalyCity-050220.mxd

The 493 Eastmoor Project Site includes 72 affordable senior residential units (35 studio, 36 one-bedroom, and 1 two-bedroom) with podium-level parking, and 1,196 square feet (ft^2) of street-level retail/office in a new 7-story building. As shown on the drawings by LPMD Architects (provided to BC on March 24, 2020), the overall project encompasses approximately 70,905 ft^2 of gross building area near the northwest corner of Sullivan Avenue and Eastmoor Avenue in Pressure Zone 4.

The basic construction type for the 493 Eastmoor building is Type III-A in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by the California Building Code. The project consists of one new building described in Table 1 and shown on Figure 1.

Table 1. Proposed Facilities

Building	Type	Approx. Area, ft^2	New Lateral, Diameter and Length
493 Eastmoor	Residential	70,905	• Domestic: 2-in, 120-ft • Fire Sprinkler: 8-in, 120-ft • Landscaping: 1-in, 120-ft

ft = foot/feet
in = inch

As determined during the project kick-off meeting on March 24, 2020, the proposed project will connect at one location to the existing City water system:

- Connect to existing 14-inch-diameter cast iron pipe (CIP) in Eastmoor Avenue.

The hydraulic model consists of the following elements and assumptions:

1. The City will require new project hydrants per City Design Standards (Section 6.02.C) and 2019 California Fire Code (CFC); see the minimum number of required hydrants for the proposed building in Table 2.
2. New lateral pipes servicing the proposed building.

BC modeled new water service to the development using one demand node for the proposed building; 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 requires 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 April 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 III-A building construction type for the proposed 493 Eastmoor building.
2. Per the City Municipal Code, the proposed building will have approved National Fire Protection Association (NFPA) 13 automatic sprinklers. The highest ceiling elevations will be approximately 70 feet above pad elevations for the 493 Eastmoor building.

3. Table 2 shows the required fire flow and duration per CFC Appendix B (Table B105.1(2) and B105.2). When the building has an automatic fire protection sprinkler system (Section 903.3.1.1 CFC), the local fire authority can reduce minimum fire-flow by up to 75 percent but not less than 1,000 gpm. However, NCFA does not permit reduction of fire flow by more than 50 percent and not less than 1,500 gpm.
4. Per CFC Appendix C (Table C102.1), the proposed 493 Eastmoor building requires four hydrants based on the full fire-flow before sprinkler related reduction. Existing fire hydrants on public streets can be considered as available to meet the CFC hydrant requirements. NCFA shall specify all new hydrant location.
5. Required hydrant spacing per City Design Standards (Section 6.02.C): 300 feet between hydrants. NCFA shall specify final hydrant spacing.

Demand Allocations

BC allocated the new domestic water and fire sprinkler demands to two model nodes using the unit demand factors by land use as developed in the Water Demands Summary Technical Memorandum (BC, July 13, 2012) and CFC. 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	Approx. Area[a] ft²	No. of Units	Stories	Building Type[b], per CBC	Approx. Building Height, ft.	Land Use Classifications	Unit Water Demands[c,d]	Ave. Day Demands[e], gpm	Required Fireflow[f], gpm	Reduced Fireflow[g], gpm	Flow Duration[h], Hrs.	Min. No. of Hydrants[i]	Ave. Spacing between Hydrants[j], ft.
493 Eastmoor													
Apartment Building	69,709	72	7	III-A	70	High density residential	60 gpcd	14.0	3,750	1,875	2	4	300
Commercial Office	1,196	-	-	III-A	-	Commercial	0.045 gpsfpd	0.1	1,500	1,000	2	1	300
Project Total	70,905		-	-	-	-	-	14.1	3,750	1,875	2	4	300

a. Approximate total building areas of all floor levels within the exterior walls from developer.
b. For mixed construction building, calculations per State Fire Marshal code interpretation "Fire Flow Requirements with Mixed Construction" 11-015.
c. Unit Water Demands and occupants per Unit from Near- and Long-Term Water Resources Planning (BC, 2012). Residential: 3.12 people per unit and:60 gpcd. Commercial: 0.045 gpsfpd
d. gpcd = gallons per capita per day, gpsfpd = gallons per ft² per day, gps = gallons per minute per sprinkler, gpd/rm = gallons per day per room.
e. gpm = gallons per minute. Residential/Hotel demand is averaged over 16 hours and all non-residential demand is averaged over 8-hours per day.
f. Required fire flow per the 2019 CFC, Appendix B. (Table B105.1(1) and B105.1(2)).
g. Reduced fire flow with an approved automatic sprinkler system Per CFC Table B105.1(1). NCFA does not permit reduction of fire flow by more than 50 percent and the reduced fire flow shall not be less than 1,500 gpm.
h. Required fire flow duration are to be based on the reduced fire flow required per CFC Tables.
i. Required minimum number of hydrants are to be based on the full fire flow per the 2019 CFC, Appendix B and C. (Table C102.1).
j. Required hydrant spacing per 1990 City Design Standards (Section 6.02.C). Actual final spacing of hydrants as required by NCFA.

Table 2A. Sprinkler Demands for the Proposed Project

Proposed Project	Sprinkler Type	NFPA 13 Occupancy	Sprinkler Area, ft²	Density, gpm/ft²	Sprinklers Demands[a], gpm	Hose Stream Demands, gpm	Total Sprinklers System Demands, gpm
493 Eastmoor							
Apartment Building	NFPA 13	Light	3,000	0.1	300	100	400
Commercial/Office	NFPA 13	Ordinary 2	1,500	0.2	300	250	550
Project Total					300	250	550

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

Hydraulic Analysis

BC used City's Water Master Plan (BC, August 1991) hydraulic design criteria for this analysis; they reflect the fire flow requirements under the revised CFC 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 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.*

psig = pound(s) per square inch gauge

Table 4. Velocity and Head Loss Criteria

Parameter	Condition	Distribution Pipeline Criteria
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

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 (ADD).

Table 5. Model Nodes and Domestic Demands

Junction ID[a]	Description[b]	Pressure Zone	Elevation (ft)	Additional Demand, (gpm)
5-J178	493 Eastmoor Sprinkler	5	245	550
5-J180	493 Eastmoor Domestic	5	245	14.1

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

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

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 City is 1.5. BC applied this global multiplier to all demand nodes in the model to simulate maximum day demand conditions.

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.

Scenario 3. Based on the density/area method from the 2019 NFPA 13, BC estimated the fire sprinkler demand to be 550 gpm for the proposed 493 Eastmoor building (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.

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.

Scenario 5. BC analyzed the City water model using the 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 City public water system shown in Figure 1 would deliver satisfactory pressure and flow to the project building. Table 6 summarize the hydraulic analysis results for Scenario 1-5.

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	-	-	130 psig	-	<5 fps	<10 ft/1,000 ft
2	Full -10 ft	Peak hour	-	>40 psig	-	-	-	-
3	Full -1 ft	Maximum day	550 gpm (Sprinkler)	>55 psig	-	-	-	-
4	Full -5 ft	Maximum day	1,875 gpm (Hydrant)	>20 psig	-	-	-	-

a. For Scenario 4 detail results, see Table 7.

b. For Scenario 5 detail results, see Table 8.

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 360 feet in Pressure Zones 5 will require individual pressure-regulating devices:

- Junction 5-J180 appears to have pad elevation lower than 360 feet. 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. Under maximum day conditions with sprinkler flow demands, the modeled system delivered the estimated sprinkler flow to the proposed 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.

Finding 4. 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 building. Table 7 lists the available fire flow simulation results:

- City's water system would deliver the total maximum fire demand for the Project (1,875 gpm for 120-minute equals 225,000 gallons) from Reservoir 5, 5B, and pressure reducing stations from adjacent pressure zones.
- Since Zone 5 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.

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
3-J176	493 Eastmoor Fire Hydrant	128	1,875	113	7,000	20	Provided at Ex. and New Hydrants.

a. New project hydrant will be required per CFC and 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 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 4 BPS	Reservoir 5	Static (psig)	Residual (psig)	Flow (gpm)
Field measurements[a]	Off	13.3'	114	112	1,433
Model results	Off	13.3'	118	114	1,433
Deviation	-	-	-4	-2	-

a. Fire flow test was conducted by City Staff on 01:15,4/11/2017.
b. Pressure Hydrant location: Hydrant 5 on Map D-07.
c. Flow Test Hydrant location: Hydrant 4 on Map D-07.

As part of model validation procedure, BC inserted SCADA system reservoir level (Reservoir 5 at 13.3-ft) and Booster Pump Station (BPS) data (Reservoir 4 BPS is off), recorded during hydrant testing into the City water model and analyzed the model assuming the 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 water system at this test location is well looped with watermain diameters ranging from 6 to14-inch-diameter. The system has enough hydraulic capacity and the model predicts that pressure at the hydrant would drop 4 psig.

The model static pressure result deviated from the field measurement by -4 psig and the model residual result deviated from the field measurement by -2 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 pressures.

Summary

For the proposed 493 Eastmoor Project Site, the model conforms to the fire hydrant flow requirements while the existing City public water system 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.

The proposed water system is summarized in Table 9. The project will connect at one location to the existing City water system:

- Connect to existing 14-inch-diameter CIP in Eastmoor Avenue.

Table 9. Summary of Proposed Water System	
Proposed Water System	Estimated Quantity
New Pipelines	• Domestic: 2-in, 120-ft • Fire Sprinkler: 8-in, 120-ft • Landscaping: 1-in, 120-ft
New Hydrants	3

The project will require minimum of three new fire hydrant for the 493 Eastmoor building per the CFC 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 City with this project. Please call us with any questions.

Very truly yours,

Brown and Caldwell

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

06/08/2020

KK:ddt

cc: William K. Faisst, Brown and Caldwell