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WATER STUDY FOR THE HOPE APARTMENTS PROJECT IN THE CITY OF CARLSBAD

December 15, 2022

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HOPE APARTMENTS PROJECT
IN THE CITY OF CARLSBAD

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REGISTERED PROFESSIONAL ENGINEER
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EXP. 12/31/2022
CIVIL
STATE OF CALIFORNIA

12-15-22

Prepared by:

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Job No. 1040-003

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December 15, 2022 1040-003

Carlsbad Village II, LLC
C/O Werner Properties
5120 Shoreham Place #160
San Diego, CA 92122

Attention: Patrick Zabrocki, Project Manager

Subject: Water Study for the Hope Apartment Project in the City of Carlsbad

Introduction

The Hope Apartments project is located in the western portion of the City of Carlsbad. The project is located on the southeast corner of the intersection of Grand Avenue and Hope Avenue. A vicinity map for the project is presented on Figure 1.

Project Description

The existing site where the Hope Apartments is proposed encompasses a gross area of approximately 3 acres. The Hope Apartments project involves redevelopment of the project area with 156 residential dwelling units. There is an existing building in the southwest corner of the site that is proposed to remain. It receives water service from a separate existing water meter also proposed to remain.

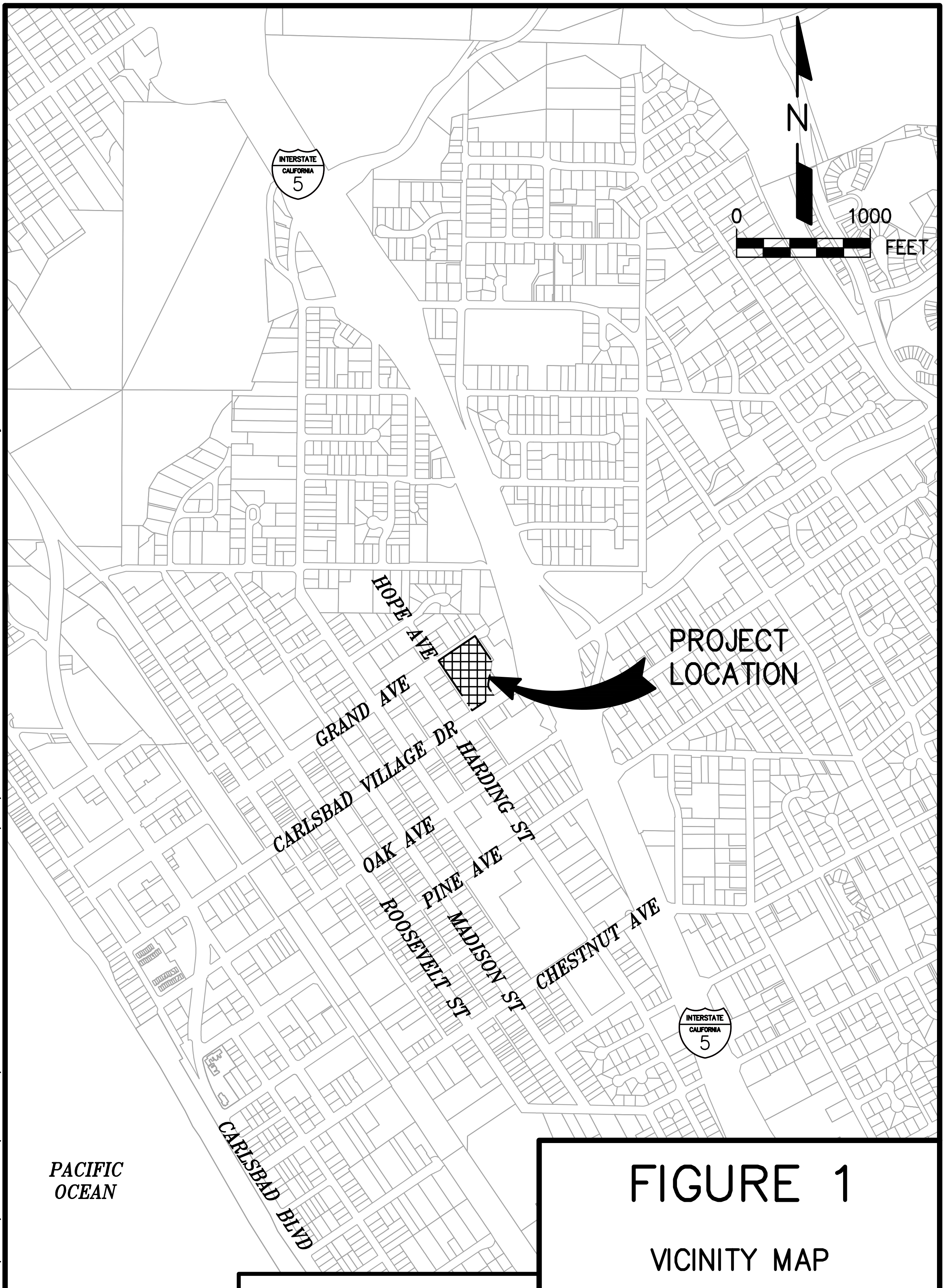

FIGURE 1

VICINITY MAP

HOPE APARTMENTS

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Purpose of Study

The purpose of this study is to analyze the existing and proposed public water system's capacity of serve the project. This report will provide recommendations for any immediate improvements to the existing public water system determined to be necessary to serve the Hope Apartment project. Preliminary water service, meter, and backflow sizing for the private domestic system will also be provided. Preliminary sizing of the onsite private fire system is included in this report, but will need to be confirmed by the fire sprinkler system designer prior to installation.

Water System Design Criteria

The design criteria used in sizing the water distribution system piping for the Hope Apartments project are consistent with the Carlsbad Municipal Water District Potable Water Master Plan prepared by HDR Jacobs and dated June 17, 2019. Appendix A includes an excerpt of the first portion of Chapter 3 which includes the City's potable water design criteria.

These criteria include a minimum static pressure of 60 psi, a desired maximum static pressure of 125 psi, and a maximum static pressure allowed of 150 psi. Under Peak Hour Demand conditions, minimum residual pressure at any location must not be less than 40 psi. Under a Maximum Day Demand with Fire Flow, a minimum residual pressure of 20 psi must be maintained in the water system. Peaking factors used in analyzing demand scenarios were 1.6 for average day to maximum day demands and 2.9 for average day to peak hour demands.

Projected Water Demand

The expected water demand for the Hope Apartments project was estimated using water demand criteria from the Carlsbad Municipal Water District's Potable Water Master Plan. Table 1 below presents the estimated onsite water demand for the project.

TABLE 1 HOPE APARTMENTS AVERAGE WATER DEMAND			
Land Use	**Quantity**	**Demand Factor[1]**	**Average Demand**
Multi-Family Residential	156 DUs	185 gpd/DU	28,860 gpd
TOTAL			**28,860 gpd**

[1] Table 4-2 Design Criteria from CMWD Potable Water Master Plan, June 17, 2019.

Per Table 1, average day demand for the Hope Apartments project is 28,860 gpd or 20.0 gpm. The maximum day demand is 46,176 gpd or 32.0 gpm (ADD x 1.6). The peak hour demand is 83,694 gpd or 58.1 gpm (ADD x 2.9).

Fire Flow Requirements

The fire flow requirement for the Hope Apartments project is based the Carlsbad Fire Department "Fire Department Access & Water Requirements for Commercial and Residential Development Guideline". The fire flow requirement is determined based on Attachment 23 of this document CFC Table B105.1. Hope Apartments is proposed to be a 250,000 square foot building with a construction type of VA. This correlates to a 8,000 gpm fire flow requirement at 20 psi.

However, the building will have a fire sprinkler system, so the City allows the requirement to be reduced by 50% (4,000 gpm). This 4,000 gpm flow must be provided at public fire hydrants. Appendix B provides the relevant pages for calculating the fire flow requirement.

Existing Water System

The existing public water system to which the Hope Apartments project will connect is the 255 Pressure Zone. There are existing 6-inch lines north of the project in Grand Avenue west of the project in Harding Street, and south of the project in Carlsbad Village Drive. The existing water system in the area is shown on Figure 2.

The building finished floor elevation within the Hope Apartments project is 68.5 feet. With service from the 255 Pressure Zone, this results in a maximum static pressure of 81 psi.

Proposed Water System

The Hope Apartments project is proposing to obtain potable water service from the existing 255 Pressure Zone system. This will be accomplished by making two connections to the proposed water line in Grand Avenue fronting the project: one connection will be made for the private domestic water system and one connection will be made for the private fire protection system.

As shown in Figure 3, the existing, public, potable water line in Grand Avenue will need to be upsized to serve the project. The project proposes to upsize the Grand avenue line to an 8-inch line from the intersection with Hope Avenue east to the existing 8-inch line in the easement.

Fire Protection Service. Fire protection service will be provided to the Hope Apartments project site by a minimum 8-inch service connection to the public water line in Grand Avenue, Figure 3 shows the location of this connection and service. This service will be required to have a minimum 8-inch backflow preventer. The Hope Apartments project will have one private, onsite fire hydrant connected via a minimum 8-inch private water line.

The City of Carlsbad has not provided a fire flow requirement for the onsite private hydrant, so the preliminary sizing provided is based on maintaining a minimum pressure of 20 psi during a fire flow event in the public system. The onsite, private fire system sizing will need to be confirmed by the fire sprinkler designer during the preparation of the private fire system plans.

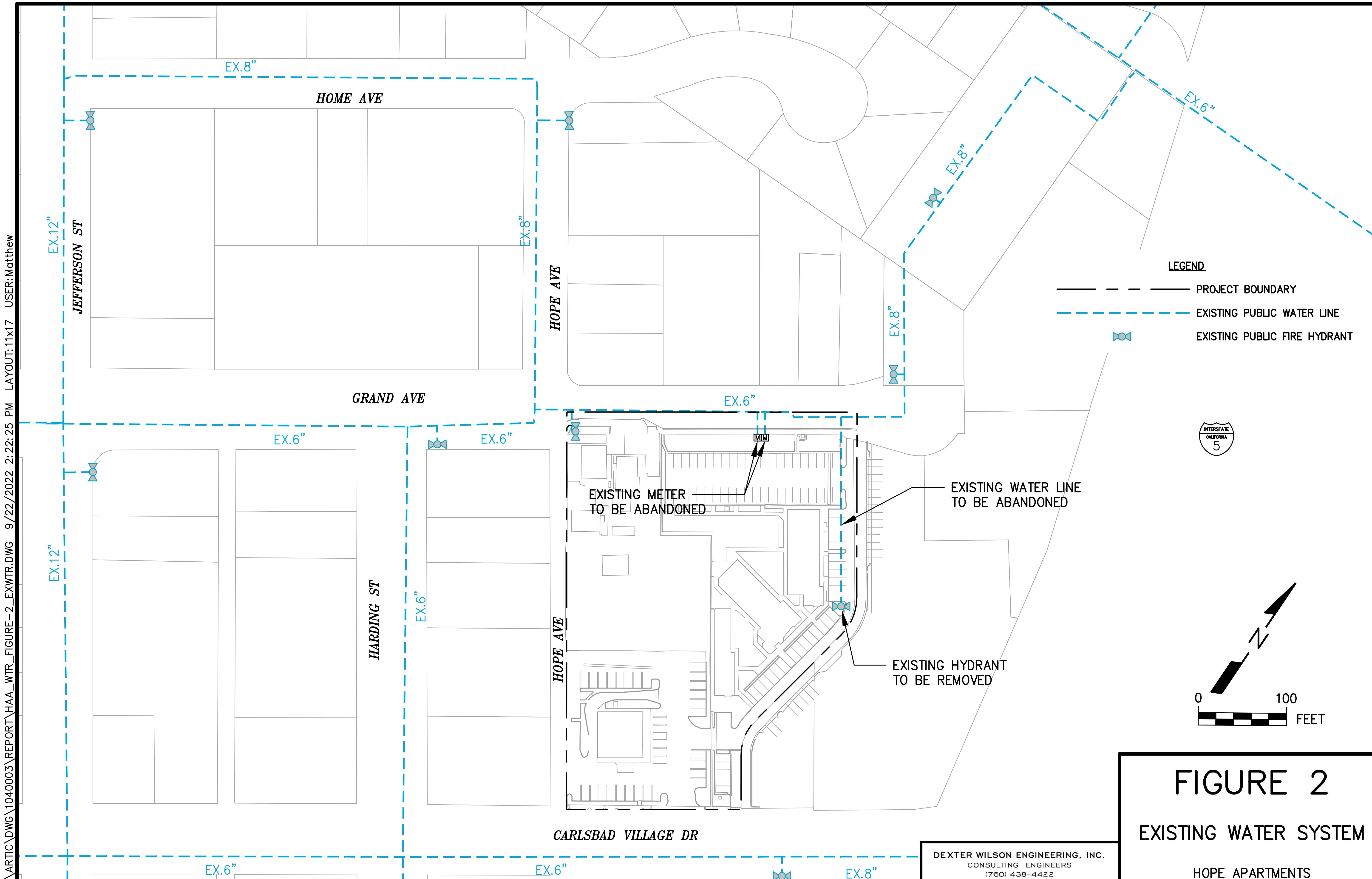

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FIGURE 2

EXISTING WATER SYSTEM

HOPE APARTMENTS

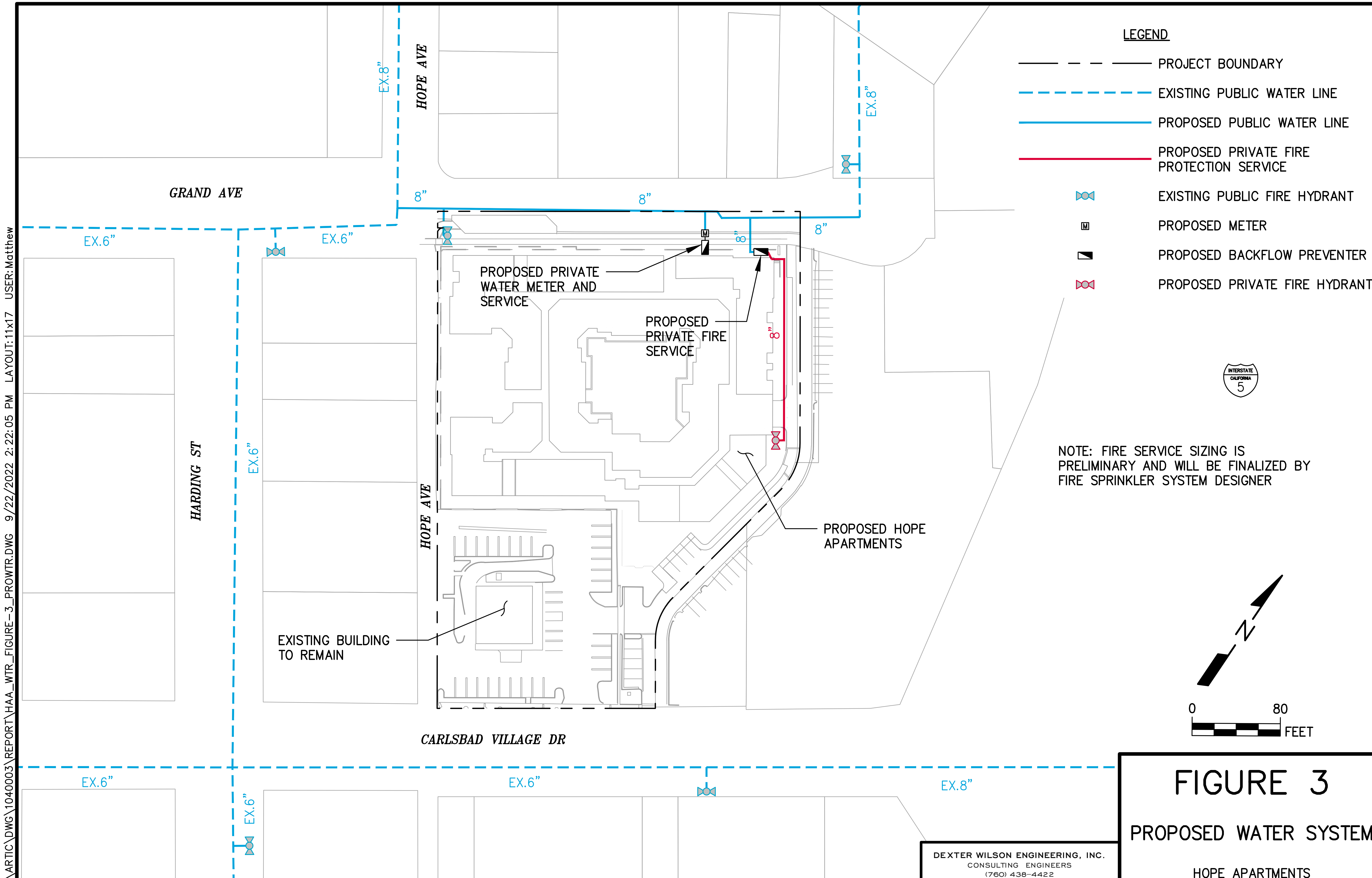

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FIGURE 3

PROPOSED WATER SYSTEM

HOPE APARTMENTS

Domestic Water Service. Domestic water service will be provided to the Hope Apartments site with one domestic water meter connected to existing 255 Pressure Zone piping. Figure 3 shows the proposed location of the domestic service, water meter, and backflow preventer.

A preliminary water fixture unit (WFU) count was performed to estimate the water meter size. By utilizing the 2019 California Plumbing Code, a WFU count can be equated to a peak flow rate in gpm which, in turn, can be used to recommend a water meter size. Note that the water meter sizing provided herein is a preliminary estimate. Once the building plumbing plans are finalized, the WFU count should be confirmed. The private onsite domestic water system will be sized at the time of final plumbing plans.

The peak flow rate in Table 2 differs with the peak hour demand presented earlier in this report as the WFU method is primarily reserved for meter sizing and takes a more conservative approach in calculating peak domestic water demand. A 4-inch lateral with a single 3-inch meter and 3-inch backflow preventer has a maximum continuous capacity of 400 gpm. This will be sufficient to serve the Hope Apartments project. WFU count and meter sizing calculations are available in Appendix C.

TABLE 2
HOPE APARTMENTS PROJECT
PRELIMINARY WFU AND WATER METER SUMMARY

WFUs	Peak Flow Rate	Water Meter Size
2,051	331 gpm	One 3-inch

Hydraulic Analysis

The University of Kentucky KYPIPE program was used to model the existing and proposed water system for the Hope Apartments project. This computer program utilizes the Hazen-Williams equation for determining head-loss in pipes; the Hazen-Williams "C" value used for all pipes is 120. To simulate minor losses through pipe fittings and valves, all pipe lengths included in the hydraulic model were increased by 10 percent.

Available Hydraulic Grade Line Available. The available hydraulic grade line (HGL) was determined using fire hydrant flow test data for a fire hydrant located west of the project at the intersection of Jefferson Street and Home Avenue and a hydrant located south of the project on Carlsbad village Drive. The flow test data is provided in Appendix D for reference.

Using the data provided by the hydrant flow tests, an extrapolation calculation was executed to determine the available pressure and hydraulic grade line at various flow values for the tested fire hydrants. The extrapolation calculation for the fire hydrant is provided at the end of Appendix D.

Computer Model Analysis

Computer modeling of the existing public water system for the Hope Apartments project was performed to confirm that the public system can provide adequate domestic and fire protection service. The public system and water system was analyzed under a maximum day demand plus 4,000 gpm fire flow scenario.

Appendix E provides the results of the computer modeling for the analyzed water system. Exhibit A at the back of this report provides the Node and Pipe Diagram for the computer model.

Analysis of Computer Model Results. The results in Appendix D show that the water system presented in Figure 3 is adequate for domestic service and fire protection. To abide by City of Carlsbad design criteria, velocities must be below 15 fps during maximum day demand plus fire flow. Under maximum day demand plus fire flow, the results of the computer runs show that 4,000 gpm fire flow can be provided to the hydrants with minimum residual pressure of 33 psi and a maximum velocity of 14.1 fps. Under peak hour demand, the results of the computer runs show that minimum residual pressures are 63 psi and maximum pipe velocities are 0.66 fps.

Conclusions and Recommendations

The following recommendations and conclusions are made based on an analysis of the potable water system for the Hope Apartments project.

1. The Hope Apartments project will be served by the City of Carlsbad potable water 255 Pressure Zone system. Figure 2 presents the existing facilities near the project.

2. Water service will include two connections to the existing public water system: one connection will be made for the private domestic water system and one connection will be made for the private fire protection system. Figure 3 presents the locations of these connections and public water system improvements.

3. Maximum static pressures at finished floor elevation within the project will be 81 psi based on the maximum available hydraulic grade line of 255 feet delivered from the potable water 255 Pressure Zone.

4. To serve the Hope Apartments project the existing water line in Grand Avenue must be upsized to 8-inches from the intersection of Hope Avenue to the existing 8-inch easement line east of the project.

5. The proposed public water facilities are capable of delivering max day demand plus 4,000 gpm fire flow to two hydrants near the project. The minimum residual pressure is 33 psi and the maximum velocity is 14.1 fps.

6. Peak hour demand was modeled up to the project connection. The minimum residual pressure in this scenario is 64 psi.

7. All new potable water pipelines recommended for the project are to be designed to meet AWWA C900 DR 18 Class 235 for PVC pipe. The water system design must conform to the requirements of the Carlsbad Municipal Water District.

8. An individual pressure regulator must be installed on the 255 Pressure Zone potable water building supply to the apartment building in order to maintain building service pressures below 80 psi in accordance with the California Plumbing Code.

Thank you for the opportunity to assist with the potable water planning for the Hope Apartments project. If you have any questions about the enclosed information and recommendations, please do not hesitate to call.

Dexter Wilson Engineering, Inc.

Kathleen Heitt, P.E.

KH:MS:ah

Attachments

APPENDIX A

CARLSBAD MUNICIPAL WATER DISTRICT
WATER SYSTEM DESIGN CRITERIA

Although the Total Revised Coliform Rule is now in effect, CMWD should closely monitor samples in affected areas to determine if additional assessments are required. Since 2016, the Level 1 and Level 2 assessments for non-compliance would require additional sampling efforts by CMWD.

CMWD should follow the development of state mandated water conservation measures and advocate for credit in achieving potable water use reductions through its recycled water program.

4.2 Design Criteria

As part of the planning process, design criteria from the previous master plan was reviewed with engineering and operations staff to re-confirm the design criteria or update specific criteria based on system operations the past five years.

4.2.1 Potable Water Criteria

Table 4-2 lists the design criteria for the 2019 Master Plan. Unit demands were revised based on current water demand information, as discussed in Section 3.1.

Table 4-2: Water Master Plan Design Criteria

Item	Criteria
Unit Demands	
Single Family Residential	450 gpd/DU
Multi-Family Residential	185 gpd/DU
Non-Residential	1,500 gpd/acre
Peaking Factors	
Minimum Day/Average Day Ratio	0.5
Maximum Day/Average Day Ratio	1.6
Maximum Month/Average Day Ratio	1.4
Peak Hour/Average Day Ratio	2.9
Piping/Pipelines	
Maximum Velocity - Peak Hour	8 fps
Maximum Velocity - Max Day + Fire	15 fps
Maximum Headloss - desired at peak flow	5 ft/1,000 ft
Maximum Headloss - allowable at peak flow	10 ft/1,000 ft
Maximum length of dead-end pipe	150 ft
Maximum No. of hydrants on a dead-end pipe	1
Maximum No. of services off a dead-end pipe	18
Pressure	
Maximum Static - Desired	125 psi
Maximum Static - Allowed	150 psi
Minimum Static	60 psi
Minimum Residual (Peak Hour)	40 psi
Minimum Residual (Max Day + Fire)	20 psi
Maximum desired pressure drop from static	25 psi

Table 4-2: Water Master Plan Design Criteria

Item	Criteria
Typical Fire Flows	
Single Family Residential	1,500 gpm for 2 hours
Multi-Family Residential	3,000 gpm for 2 hours
Non-Residential	4,000 gpm for 4 hours
Storage	
Operating Storage	15% MDD
Fire Storage	Maximum fire flow x duration
Emergency Reserve Storage (in-zone)	100% MDD
Emergency Storage (Planned SDCWA shutdown)	10 x ADD
Water Pressure Regulating Stations	—
Minimum Number of Valves	2
Capacity	Low = Average High = MDD + Fire Flow
Redundancy Required	Yes (by zone)
Other	Pressure Relief Valve required at a minimum of one station per zone.
Pump Station	—
Pumping Period	24 hours
Pumping Capacity	MDD for all zones served
Minimum Number of Pumps	3 (2 duty + 1 standby)
Redundancy	1 unit equal to largest duty pump
Standby Power	Generator

Notes:
fps=feet per second

Maximum velocity criteria are industry standard for new construction but may be exceeded under existing performance conditions if replacement costs are excessive and not critical to level of service. The fire flow velocity requirement of 10 fps in the 2012 Master Plan was determined to be conservative. It was increased to 15 fps to avoid oversizing small water mains creating water quality issues in the distribution system. Fire flow requirements for areas within Carlsbad that are designated as High and Very High Fire Hazard Severity Zones, shown on Figure 4-1, were reviewed, which in some cases may require higher fire flows.

APPENDIX B

PROJECT FIRE FLOW REQUIREMENTS

Kathleen Heitt

From: Randy Metz <Randy.Metz@carlsbadca.gov>
Sent: Tuesday, September 20, 2022 10:40 AM
To: Patrick Zabrocki; Gina Ruiz
Cc: tyler lawson; Kathleen Heitt; Shannon Harker; Austin Wermers
Subject: RE: Hope Apartments - Fire Flow question

Good Morning Patrick.

Based on the information you have provided for a 205,000sf Type V-A construction building with fire sprinklers, the required fire flow for this project will be 4000gpms. The city has locally amended the sprinkler reduction to a 50% maximum, with the original required flow being 8000gpms. We also don't permit the use of private fire hydrants in order to achieve your fire flow so you will need to use 2 public hydrants, which can support this flow for a minimum of 4 hours. Although the code allows for a fire sprinkler reduction in flow, it does not reduce the amount of hours necessary to provide the original flow requirement.

I hope this helps in your planning efforts. If you have any additional questions, feel free to reach out to me.

Regards,

Randy

Randy Metz, EFO, CFO, FM, MIFireE
Division Chief – Fire Marshal
Community Risk Reduction Bureau
City of Carlsbad
Office: 442-339-2661
randy.metz@carlsbadca.gov

From: Patrick Zabrocki <PZabrocki@wermersproperties.com>
Sent: Tuesday, September 20, 2022 10:18 AM
To: Gina Ruiz <Gina.Ruiz@carlsbadca.gov>; Randy Metz <Randy.Metz@carlsbadca.gov>
Cc: tyler lawson <tlawson@plsaengineering.com>; Kathleen Heitt <kathleen@dwilsoneng.com>; Shannon Harker <Shannon.Werneke@carlsbadca.gov>; Austin Wermers <AustinW@wermersproperties.com>
Subject: Hope Apartments - Fire Flow question

Hello Gina,

Thank you for chatting with me real quick yesterday when you were on the phone with Chris Schoeneck. I appreciate your assistance with our question.

The project I mentioned is the Hope Apartments project (CT2022-001/SDP 2022-006 (DEV2022-0030)(PRE 2022-0008)).

We are proposing a 156 unit apartment building consisting of a total of 205,234 sf, at the intersection of Grand and Hope (adjacent to the Lofts).

Carlsbad Fire Department
Fire Prevention Bureau

Fire Department Access & Water Requirements for Commercial and Residential Development Guideline

Approved and Authorized by:
Randall Metz, Fire Marshal
Issued: February 18, 2021

B. Manufacturer’s specification of the material being installed must indicate that the application is consistent with the manufacturer’s recommendations.

C. Material shall only be installed on slopes of no more than one degree (1.75% grade), unless otherwise specified by the manufacturer, and drainage shall be provided as required to provide adequate traction for the fire apparatus. Surfaces shall be crowned or sloped to one side to drain water away from the roadway; surfaces shall not have a “V” or other configuration causing water to accumulate in the fire access roadway. This information shall be detailed on the plan.

D. The design shall include a curb cut that delineates entry onto the engineered fire access surface from a street. A 4” or lower curb cut or a rolled/ramped curb is acceptable. The curb cut must be shown on the plan. The entry to the area shall be clearly marked as a fire lane with either a red curb or sign to prevent the entry from being blocked.

E. A minimum four-inch wide concrete strip around the perimeter of the designated area shall be specified on the plan to clearly delineate the extent of fire department access. If the area is accessible to or intended to be used by anyone other than emergency responders, the concrete curb shall be painted red and stenciled “Fire Lane—No Parking” in white every 30 feet or portion thereof. In areas where painting the curb is not feasible, alternative methods of delineating the extent of the fire access roadway, such as by stamping “Fire Lane—No Parking” into the concrete, posting of signs, or by the use of red reflectors, may be acceptable if approved by Carlsbad plan review staff. Describe the method of identifying the extent of the fire access roadway clearly on the plan.

F. The following sentence shall be placed, verbatim, as a note on the plan: “Final approval is subject to actual field acceptance testing utilizing Carlsbad fire apparatus.”

G. A clause requiring the maintenance of alternative access roadways shall be placed in the CCRs, deed, and/or similar documents.

8. Hydrant and Water Availability Requirements

Applicants must provide documentation that hydrants are provided in the quantity and spacing described in California Fire Code (CFC) Appendix C. This will prove that they are capable of delivering the amount of water required by CFC Appendix B. The quantity and spacing of hydrants are governed by the fire flow required for the structure(s) served. The required fire flow is dependent upon the size of the structure, type of construction, and whether the building is equipped with fire sprinklers. This information must be shown clearly on the plans to assist in the determination of the fire flow requirement.

A. Water Availability – To facilitate the review process and avoid untimely delays in project approval, applicants are strongly encouraged to arrange a hydrant flow test with the water company *prior to submitting plans to the Carlsbad* if the project includes a new structure or increase in the floor area of an existing structure. Water availability information may not be required to be submitted for every project, and plans may be submitted with a hydrant flow test pending, but the applicant should understand that project approval may be delayed if it is determined during review that this information is required. If the project requires evaluation of the available fire flow, it will not be approved without a completed Carlsbad Water Availability form or equivalent data sheets from a water district. Water availability information must be no older than six months.

1) Obtain a Water Availability form from Carlsbad Building Department.

2) Fill out the project and building information in the first section of the Water Availability form. Care should be taken when determining the applicable fire area for the project. As stated above, fire flow is dependent on several factors, so *the largest building or group of structures is not necessarily the most demanding* in terms of fire flow.

3) Determine the required fire flow from CFC Table B105.1, provided in Attachment 23. A **maximum 50%** reduction in fire flow (but not duration) may be taken when the fire-flow calculation area consists only of buildings equipped with an approved automatic fire sprinkler system.

4) Contact the local water company to request a hydrant flow test or fire flow modeling calculation and have a representative of the water company complete and sign the last section on the form. In some cases, the water company may allow or require a qualified third party to perform the flow test for you.

    a) In newly developed areas without water infrastructure, the water department may issue a "will-serve" letter indicating the expected amount of water that will be delivered once the water system is installed and operational.

    b) If multiple hydrants are located within the maximum distance allowed by CFC Table C105.1, the amount of water available from each hydrant may be combined, provided that the hydrants are flowed simultaneously.

    c) It is the applicant's responsibility to ensure that the following information is provided at a minimum on either the water company's test data sheet and/or the Carlsbad Water Availability form:

i. Static pressure and residual pressure in psi and observed flow in gpm; or

ii. Calculated flow in gpm at 20 psi.

d) Scan or photocopy the completed form or data sheets onto your plans or include the original with your plan submittal.

5) Please ensure that the fire area, building size, construction type, and flow data are complete and accurate. Errors or omissions in this information may result in plans having to be resubmitted or fire flow testing being redone.

B. Fire-Flow Calculation Area – The fire-flow calculation area shall be the total floor area of all floor levels within the exterior walls, and under the horizontal projections of the roof of a building, except as modified in Section B104.3. Portions of buildings which are separated by fire walls without openings, constructed in accordance with the California Building Code are allowed to be considered as separate fire-flow calculation areas. The fire-flow calculation area of buildings constructed of Type IA and Type IB construction shall be the area of the three largest successive floors. CFC Appendix B Section B104.

C. Hydrant Location – Hydrants shall be provided along the length of the fire access roadway in the quantities and up to the maximum distances prescribed in CFC Table C-105.1. See Attachments 24 and 29.

1) Hydrants must be located no more than three feet from the edge of a fire access roadway and cannot be located in areas where they will be visually or operationally obstructed (behind fences or walls, in bushes, behind parking spaces, etc.). Clearance shall be provided to a distance no less than three feet from the perimeter of the hydrant. Where hydrants are located in landscaped areas, a 4x4’ concrete pad shall be required to ensure that vegetation does not encroach on this clear space.

2) The hydrant outlets must face the fire access roadway. Where all of the outlets cannot face the fire access roadway (e.g., the hydrant is located in a landscape peninsula or island in a parking lot; the hydrant has three outlets), the 4” outlet(s) shall take precedence.

3) The hydrant shall be located at least 40 feet from the building(s) it serves. Where it is impractical to locate the hydrant 40 feet from adjacent structures, additional hydrants may be provided or the hydrant may be located closer provided that nearby walls do not contain openings and the hydrant is not

ATTACHMENT 23

CFC TABLE B105.1:
Minimum Required Fire Flow and Flow Duration for Buildings as adopted by the City of Carlsbad

FIRE FLOW CALCULATION AREA (square feet)					FIRE FLOW (gallons/min)		Flow Duration
Type IA and IB	**Type IIA and IIIA**	**Type IV and VA**	**Type IIB and IIIB**	**Type VB**	**unsprinklered commercial/SFR**	***sprinklered commercial/SFR***	
0-22700	0-12700	0-8200	0-5900	0-3600	1500/1000	*1500/1000*	2
22701-30200	12701-17000	8201-10900	5901-7900	3601-4800	1750	*1500/1000*	
30201-38700	17001-21800	10901-12900	7901-9800	4801-6200	2000	*1500/1000*	
38701-48300	21801-24200	12901-17400	9801-12600	6201-7700	2250	*1500/1125*	
48301-59000	24201-33200	17401-21300	12601-15400	7701-9400	2500	*1500/1250*	
59001-70900	33201-39700	21301-25500	15401-18400	9401-11300	2750	*1500/1375*	
70901-83700	39701-47100	25501-30100	18401-21800	11301-13400	3000	*1500*	3
83701-97700	47101-54900	30101-35200	21801-25900	13401-15600	3250	*1625*	
97701-112700	54901-63400	35201-40600	25901-29300	15601-18000	3500	*1750*	
112701-128700	63401-72400	40601-46400	29301-33500	18001-20600	3750	*1875*	
128701-145900	72401-82100	46401-52500	33501-37900	20601-23300	4000	*2000*	4
145901-164200	82101-92400	52501-59100	37901-42700	23301-26300	4250	*2125*	
164201-183400	92401-103100	59101-66000	42701-47700	26301-29300	4500	*2250*	
183401-203700	103101-114600	66001-73300	47701-53000	29301-32600	4750	*2375*	
203701-225200	114601-126700	73301-81100	53001-58600	32601-36000	5000	*2500*	
225201-247700	126701-139400	81101-89200	58601-65400	36001-39600	5250	*2625*	
247701-271200	139401-152600	89201-97700	65401-70600	39601-43400	5500	*2750*	
271201-295900	152601-166500	97701-106500	70601-77000	43401-47400	5750	*2875*	
295901+	166501+	106501-115800	77001-83700	47401-51500	6000	*3000*	
		115801-125500	83701-90600	51501-55700	6250	*3125*	
		125501-135500	90601-97900	55701-60200	6500	*3250*	
		135501-145800	97901-106800	60201-64800	6750	*3375*	
		145801-156700	106801-113200	64801-69600	7000	*3500*	
		156701-167900	113201-121300	69601-74600	7250	*3625*	
		167901-179400	121301-129600	74601-79800	7500	*3750*	
		179401-191400	129601-138300	79801-85100	7750	*3875*	
		191401+	138301+	85101+	8000	*4000*	

Minimum fire flow for a detached, unsprinklered single-family residence/duplex up to 3600 sq.ft. is 1000 gpm.

Construction Types shall be based upon actual construction without applying 1-hour equivalency allowed by CBC Table 601 footnote ‘e’.

Fire flow measured at 20 psi.

APPENDIX C

WATER FIXTURE UNIT COUNT
AND METER SIZING

Project Name Hope Apartments

Job Number 1040-003
Date 5/17/2022

Water Fixture Units

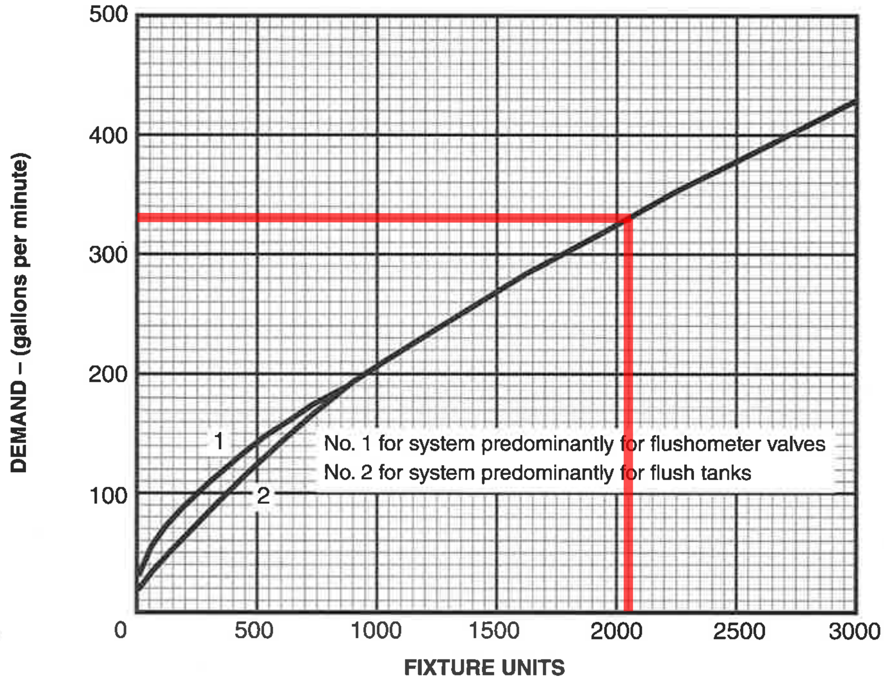
The basis for the Water Fixture Units is "Private" per the 2019 California Plumbing Code.

DESCRIPTION	Studio			1-BR			2-BR		
	QUANTITY	FIXTURE UNITS EACH	TOTAL FIXTURE UNITS	QUANTITY	FIXTURE UNITS EACH	TOTAL FIXTURE UNITS	QUANTITY	FIXTURE UNITS EACH	TOTAL FIXTURE UNITS
CLOTHES WASHER		4	0		4	0		4	0
LAUNDRY SINK		1.5	0		1.5	0		1.5	0
TUB/SHOWER	8	4	32	67	4	268	140	4	560
SHOWER		2	0		2	0		2	0
KITCHEN SINK	8	1.5	12	67	1.5	100.5	70	1.5	105
DISHWASHER		1.5	0		1.5	0		1.5	0
LAVATORY	8	1	8	67	1	67	140	1	140
WATER CLOSET (1.6 GPF)	8	2.5	20	67	2.5	167.5	140	2.5	350
HOSE BIBB		2.5	0		2.5	0		2.5	0
EACH ADDTL HB		1	0		1	0		1	0
OTHER			0			0			0
TOTAL			72			603			1155

DESCRIPTION	3-BR			Leasing/Roof Deck			Rec/Fitness		
	QUANTITY	FIXTURE UNITS EACH	TOTAL FIXTURE UNITS	QUANTITY	FIXTURE UNITS EACH	TOTAL FIXTURE UNITS	QUANTITY	FIXTURE UNITS EACH	TOTAL FIXTURE UNITS
CLOTHES WASHER		4	0		4	0		4	0
LAUNDRY SINK		1.5	0		1.5	0		1.5	0
TUB/SHOWER	22	4	88		4	0		4	0
SHOWER		2	0		2	0		2	0
KITCHEN SINK	11	1.5	16.5		1.5	0	1	1.5	1.5
DISHWASHER		1.5	0		1.5	0		1.5	0
LAVATORY	22	1	22	4	1	4	4	1	4
WATER CLOSET (1.6 GPF)	22	2.5	55	6	2.5	15	6	2.5	15
HOSE BIBB		2.5	0		2.5	0		2.5	0
EACH ADDTL HB		1	0		1	0		1	0
OTHER			0			0			0
TOTAL			181.5			19			20.5

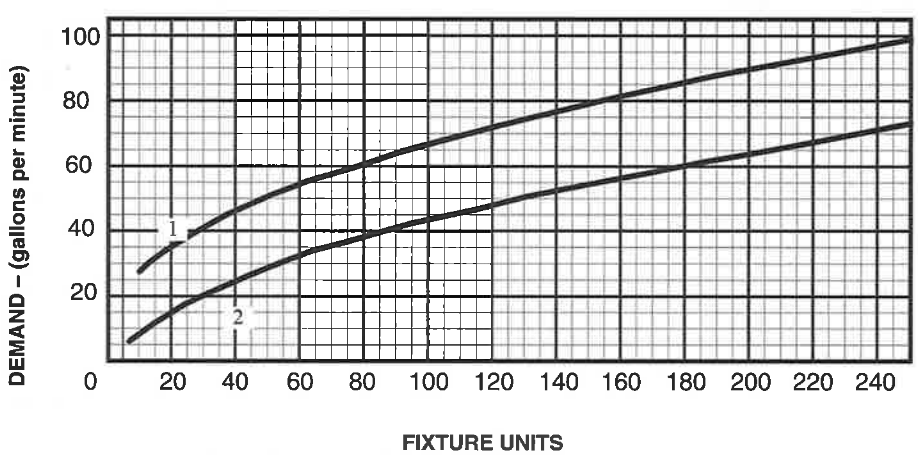
Total WFU 2051

CHART A 103.1(1)
ESTIMATE CURVES FOR DEMAND LOAD



For SI units: 1 gallon per minute = 0.06 L/s

CHART A 103.1(2)
ENLARGED SCALE DEMAND LOAD



For SI units: 1 gallon per minute = 0.06 L/s

APPENDIX D

FIRE HYDRANT FLOW TEST
AND
EXTRAPOLATION CALCULATION

No. 277.D

CARLSBAD FIRE DEPARTMENT
Fire Prevention Division
1635 Faraday Avenue – Carlsbad, CA 92008
760.602.4665

WATER AVAILABILITY FORM

SECTION A: TO BE COMPLETED BY CUSTOMER

PROJECT NAME: Hope Apartments SR#: ______
(Assigned upon plan submittal)

PROJECT ADDRESS: 945/955 Grand Ave (several services) CITY: Carlsbad

PHONE: (760) 438-4422 (matthew@dwilsoneng.com) FAX NUMBER: (760) 438-0173

Largest Building (ft.^{2}): ~142,000 Sprinkled? Yes Construction Type: ______

SECTION B: TO BE COMPLETED BY LOCAL WATER COMPANY. CUSTOMER TO PROVIDE RESULTS TO CFD.

Water Purveyor: City of Carlsbad

Location of test (reference map required): Grand Ave at Hope Ave

TEST INFORMATION IS VALID FOR 6 MONTHS FROM DATE PERFORMED

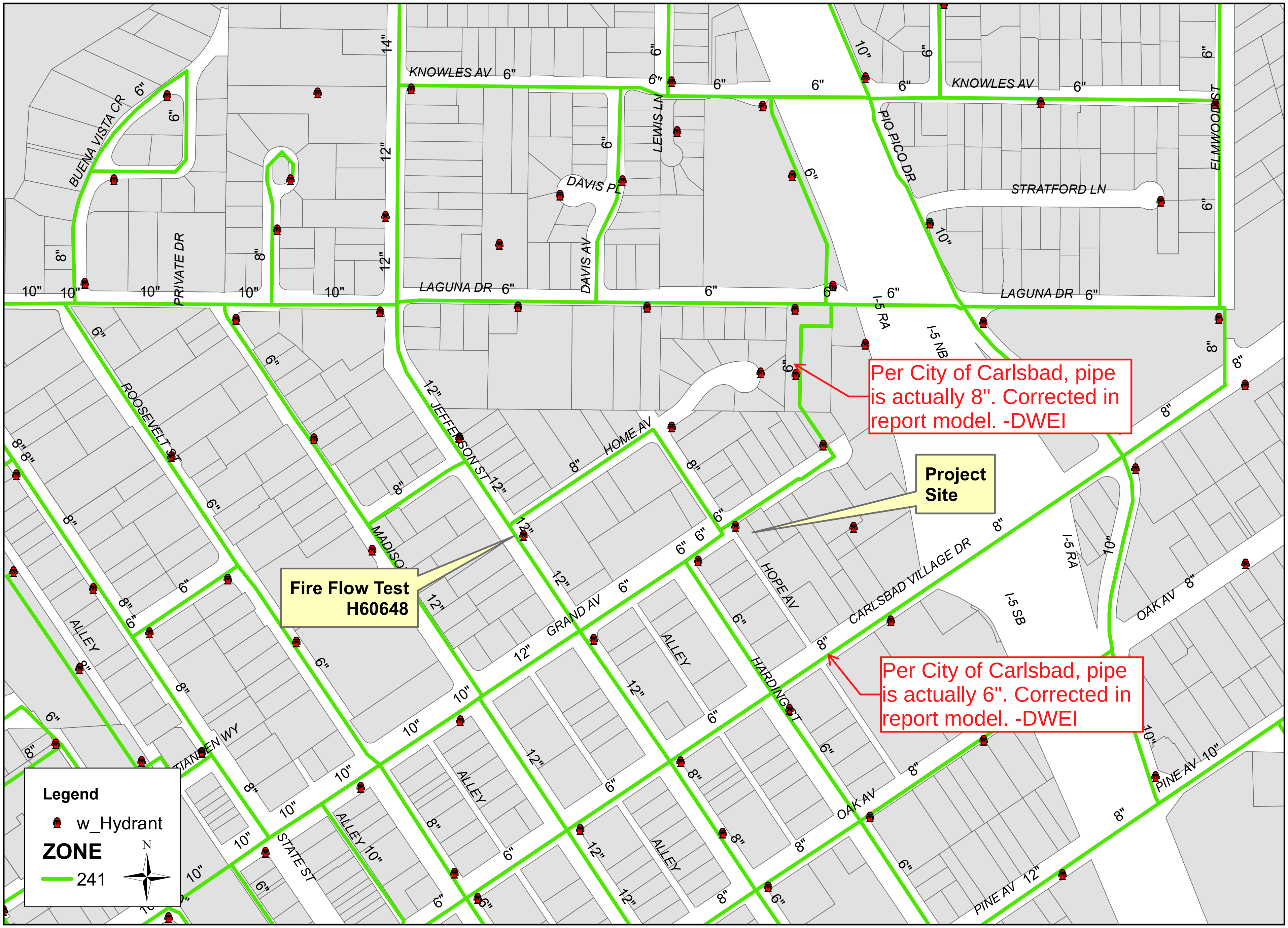
Flow Test Results	
Static pressure: **76** **PSI**	Hydrant Number (if applicable): H60648
Elevation of test: 65 Feet	Main Size: 12 INCH
Pressure Zone: 241 Feet	Date/Time of Test: ______
Pitot Tube Reading: ______ PSI	Corresponding Flow: ______ GPM
Total Flow: **6,475** **GPM**	**Residual Pressure** **20** **PSI**
At peak demand, this water system is capable of providing a fire flow discharge at 20 psi in the vicinity of the fire of 6,475 gpm.	

Note: If the water availability information was obtained in a manner other than a flow test (i.e. computer modeling), fill out the information above as applicable and check here: x

Name: Jennifer R. Mael, P.E. Eng. Lic. No. (if applicable): C69606

Signature: Jen R Mael

Title/Org: Project Manager Date: 07/28/2022



#277.D Hope Apartments - Fire Flow Analysis

Fire Hydrant Flow Test Date 5/17/2022

Input Flow Test Results

Static Pressure	76	PSI
Residual Pressure	20	PSI
Hydrant Flow	6475	GPM

Actual Hydrant Elevation		Feet	HGL		Feet
Estimated Hydrant Elevation	65	Feet	HGL	240.4	Feet

Equation $\Delta H = k\, Q^{1.85}$

k = 1.14982E-05

Extrapolated Calculations

	Q, gpm	Residual Pressure		Available HGL	
ADD	20	76.0	psi	240.4	ft
MDD	32	76.0	psi	240.4	ft
PHD	58	76.0	psi	240.4	ft
	330	75.8	psi	239.9	ft
	1300	73.1	psi	233.8	ft
	1500	72.3	psi	231.8	ft
	1700	71.3	psi	229.5	ft
	1900	70.2	psi	227.0	ft
	2000	69.6	psi	225.7	ft
	2100	69.0	psi	224.3	ft
	2332	67.5	psi	220.9	ft
	2474	66.6	psi	218.6	ft
MDD+FIRE	2650	65.3	psi	215.7	ft
	3000	62.5	psi	209.3	ft
	3042	62.2	psi	208.5	ft
	3300	59.9	psi	203.3	ft
	3500	58.1	psi	199.0	ft
	3700	56.1	psi	194.5	ft
	3900	54.1	psi	189.8	ft
	4032	52.7	psi	186.6	ft
	4100	52.0	psi	184.9	ft
	4300	49.7	psi	179.8	ft
	4500	47.4	psi	174.5	ft
	5000	41.3	psi	160.3	ft
	5760	30.9	psi	136.3	ft
	5750	31.0	psi	136.7	ft

Residual Pressure, psi		Available Flow, gpm
0	psi	7,637
10	psi	7,076
20	psi	6,475
30	psi	5,822
40	psi	5,099
50	psi	4,277
60	psi	3,290
70	psi	1,936
80	psi	Residual Pressure Exceeds Static Pressure
90	psi	Residual Pressure Exceeds Static Pressure
100	psi	Residual Pressure Exceeds Static Pressure
110	psi	Residual Pressure Exceeds Static Pressure
120	psi	Residual Pressure Exceeds Static Pressure
130	psi	Residual Pressure Exceeds Static Pressure
140	psi	Residual Pressure Exceeds Static Pressure
150	psi	Residual Pressure Exceeds Static Pressure
160	psi	Residual Pressure Exceeds Static Pressure
170	psi	Residual Pressure Exceeds Static Pressure
180	psi	Residual Pressure Exceeds Static Pressure
190	psi	Residual Pressure Exceeds Static Pressure

No. 277.B

CARLSBAD FIRE DEPARTMENT
Fire Prevention Division
1635 Faraday Avenue – Carlsbad, CA 92008
760.602.4665

WATER AVAILABILITY FORM

SECTION A: TO BE COMPLETED BY CUSTOMER

PROJECT NAME: Hope Apartments SR#: ______ (Assigned upon plan submittal)

PROJECT ADDRESS: 945/955 Grand Ave (several services) CITY: Carlsbad

PHONE: (760) 438-4422 (matthew@dwilsoneng.com) FAX NUMBER: (760) 438-0173

Largest Building (ft.^{2}): ~142,000 Sprinkled? Yes Construction Type: ______

SECTION B: TO BE COMPLETED BY LOCAL WATER COMPANY. CUSTOMER TO PROVIDE RESULTS TO CFD.

Water Purveyor: City of Carlsbad

Location of test (reference map required): Carlsbad Village Drive east of Hope Ave

TEST INFORMATION IS VALID FOR 6 MONTHS FROM DATE PERFORMED

Flow Test Results	
Static pressure: **76** **PSI**	Hydrant Number (if applicable): H60912
Elevation of test: 65 Feet	Main Size: 8 INCH
Pressure Zone: 241 Feet	Date/Time of Test: ______
Pitot Tube Reading: ______ PSI	Corresponding Flow: ______ GPM
Total Flow: **1,500** **GPM**	**Residual Pressure** **48** **PSI**

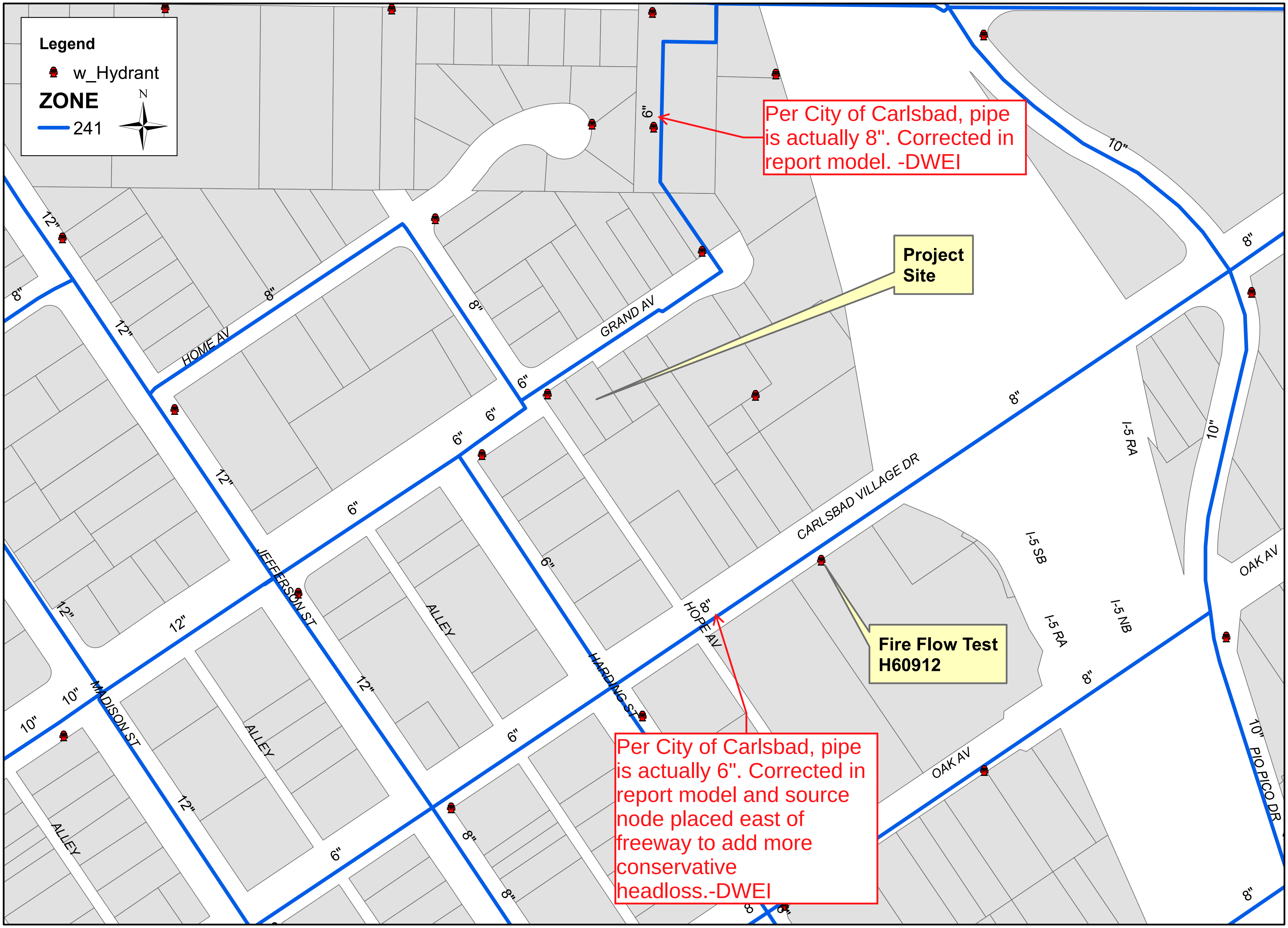
At peak demand, this water system is capable of providing a fire flow discharge at 20 psi in the vicinity of the fire of 4,375 gpm. The maximum fire flow requested is 1,500 gpm as shown above.

Note: If the water availability information was obtained in a manner other than a flow test (i.e. computer modeling), fill out the information above as applicable and check here: x

Name: Jennifer R. Mael, P.E. Eng. Lic. No. (if applicable): C69606

Signature: Jennifer R. Mael

Title/Org: Project Manager Date: 06/28/2022



#277.B Hope Apartments - Fire Flow Analysis

Fire Hydrant Flow Test Date 5/17/2022

Input Flow Test Results

Static Pressure	76 PSI		
Residual Pressure	48 PSI		
Hydrant Flow	1500 GPM		
Actual Hydrant Elevation	Feet	HGL	Feet
Estimated Hydrant Elevation	65 Feet	HGL	240.4 Feet

Equation $\Delta H = k\,Q^{1.85}$

k = 8.60251E-05

Extrapolated Calculations

	Q, gpm	Residual Pressure	Available HGL
ADD	20	76.0 psi	240.4 ft
MDD	32	76.0 psi	240.4 ft
PHD	58	75.9 psi	240.3 ft
	330	74.3 psi	236.5 ft
	989.61	63.0 psi	210.5 ft
MDD+FIRE	1382	51.9 psi	184.9 ft
	1700	40.7 psi	158.9 ft
	1900	32.6 psi	140.3 ft
	2100	23.8 psi	120.0 ft
	2300	14.3 psi	97.9 ft
	2500	4.0 psi	74.1 ft
	2600	-1.5 psi	61.6 ft
	2700	-7.1 psi	48.7 ft
	3000	-24.9 psi	7.4 ft
	3100	-31.3 psi	-7.1 ft
	3300	-44.4 psi	-37.5 ft
	3500	-58.3 psi	-69.4 ft
	3700	-72.8 psi	-103.0 ft
	3900	-88.0 psi	-138.1 ft
	4032	-98.4 psi	-162.2 ft
	4100	-103.9 psi	-174.8 ft
	4300	-120.5 psi	-213.1 ft
	4500	-137.7 psi	-252.8 ft
	5000	-183.7 psi	-359.0 ft
	5760	-261.4 psi	-538.4 ft
	5750	-260.3 psi	-535.9 ft

THE DIFFERENCE BETWEEN THE STATIC PRESSURE AND RESIDUAL PRESSURE IS 28 PSI FOR A RELATIVELY LOW FIRE HYDRANT FLOW OF 1500 GPM. SINCE THERE IS A SIGNIFICANT DIFFERENCE BETWEEN THE STATIC AND RESIDUAL PRESSURE, IT WOULD MAKE SENSE THAT THE HGL IS NEGATIVE AT A HIGHER FLOW. THIS EXTRAPOLATION IS ALSO CONSERVATIVE SINCE IT DOESN'T TAKE INTO ACCOUNT THE COMPLEX LOOPING OF THE ACTUAL SYSTEM.

Residual Pressure, psi	Available Flow, gpm
0 psi	2,573
10 psi	2,384
20 psi	2,182
30 psi	1,962
40 psi	1,718
50 psi	1,441
60 psi	1,108
70 psi	652
80 psi	Residual Pressure Exceeds Static Pressure
90 psi	Residual Pressure Exceeds Static Pressure
100 psi	Residual Pressure Exceeds Static Pressure
110 psi	Residual Pressure Exceeds Static Pressure
120 psi	Residual Pressure Exceeds Static Pressure
130 psi	Residual Pressure Exceeds Static Pressure
140 psi	Residual Pressure Exceeds Static Pressure
150 psi	Residual Pressure Exceeds Static Pressure
160 psi	Residual Pressure Exceeds Static Pressure
170 psi	Residual Pressure Exceeds Static Pressure
180 psi	Residual Pressure Exceeds Static Pressure
190 psi	Residual Pressure Exceeds Static Pressure

APPENDIX E

COMPUTER MODELING RESULTS
WATER SYSTEM ANALYSIS

NODE AND PIPE DIAGRAM REFERENCE:

Exhibit A at the back of the report.

CONDITIONS MODELED:

1. Peak Hour Demand

2. Max Day Demand plus 4,000 gpm Fire Flow split between Nodes 4 and 102

3. Max Day Demand plus 4,000 gpm Fire Flow split between Nodes 4, 16, and 102

4. Max Day Demand plus 4,000 gpm Fire Flow split between Nodes 16, 24, and 104

```
* * * * * * * * * * * *  K Y P I P E  * * * * * * * * * * * *
*                                                            *
*  Pipe Network Modeling Software                            *
*                                                            *
*  CopyRighted by KYPIPE LLC (www.kypipe.com)                *
*  Version: 10.009  10/01/2019                               *
*  Company:  Dexter        Serial #:  592169                 *
*  Interface:  Classic                                       *
*  Licensed for Pipe2018                                     *
*                                                            *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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Date & Time: Mon Nov 28 08:29:35 2022

Master File : \\ARTIC\Eng\1040003\KY Pipe\1040-003_hopeapartments2.KYP\1040-003_hopeapartments2.P2K

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***********************************************
 S U M M A R Y   O F   O R I G I N A L   D A T A
***********************************************
```

U N I T S   S P E C I F I E D

FLOWRATE .... = gallons/minute
HEAD (HGL) .... = feet
PRESSURE .... = psig

P I P E L I N E   D A T A

P I P E N A M E	NODE NAMES #1	#2	LENGTH (ft)	DIAMETER (in)	ROUGHNESS COEFF.	MINOR LOSS COEFF.
1	0	2	1005.00	8.00	120.0000	0.00
2	2	4	50.00	8.00	120.0000	0.00
3	4	6	265.00	8.00	120.0000	0.00
5	6	8	50.00	8.00	120.0000	0.00
7	8	I-BFP	70.00	8.00	120.0000	0.00
9	O-BFP	HYD	130.00	8.00	120.0000	0.00
11	0	12	870.00	12.00	120.0000	0.00
13	12	14	1490.00	6.00	120.0000	0.00
15	14	16	610.00	8.00	120.0000	0.00
17	18	16	55.00	8.00	120.0000	0.00
19	8	18	115.00	8.00	120.0000	0.00
21	0	22	430.00	12.00	120.0000	0.00
23	22	24	430.00	6.00	120.0000	0.00
25	24	2	174.00	6.00	120.0000	0.00
101	100	102	920.00	8.00	120.0000	0.00
103	104	102	425.00	6.00	120.0000	0.00
105	24	104	540.00	6.00	120.0000	0.00

P U M P/L O S S   E L E M E N T   D A T A

THERE IS A DEVICE AT NODE 100 DESCRIBED BY THE FOLLOWING DATA: (ID= 2)

HEAD (ft)	FLOWRATE (gpm)	EFFICIENCY (%)
175.38	0.00	75.00
110.77	1500.00	75.00
-57.88	3000.00	75.00

THERE IS A DEVICE AT NODE 0 DESCRIBED BY THE FOLLOWING DATA: (ID= 3)

HEAD (ft)	FLOWRATE (gpm)	EFFICIENCY (%)
175.38	0.00	75.00
46.15	6475.00	75.00
-291.14	12950.00	75.00

THERE IS A DEVICE AT NODE BFP DESCRIBED BY THE FOLLOWING DATA: (ID= 1)

HEAD (ft)	FLOWRATE (gpm)	EFFICIENCY (%)
-22.62	500.00	75.00 (Default)
-22.85	1000.00	75.00 (Default)
-23.08	1500.00	75.00 (Default)
-23.31	2000.00	75.00 (Default)

N O D E D A T A

NODE NAME	NODE TITLE	EXTERNAL DEMAND (gpm)	JUNCTION ELEVATION (ft)	EXTERNAL GRADE (ft)
2		0.00	62.00	
4		0.00	65.00	
6		58.00	65.00	
8		0.00	66.00	
12		0.00	56.00	
14		0.00	63.00	
16		0.00	72.00	
18		0.00	71.00	
22		0.00	61.00	
24		0.00	60.00	
100		----	65.00	65.00
102		0.00	72.00	
104		0.00	62.00	
0		----	62.00	62.00
O-BFP		0.00	68.00	
HYD		0.00	70.00	
I-BFP		0.00	68.00	

O U T P U T O P T I O N D A T A

OUTPUT SELECTION: ALL RESULTS ARE INCLUDED IN THE TABULATED OUTPUT

MAXIMUM AND MINIMUM PRESSURES = 5
MAXIMUM AND MINIMUM VELOCITIES = 5
MAXIMUM AND MINIMUM HEAD LOSS/1000 = 5

S Y S T E M C O N F I G U R A T I O N

NUMBER OF PIPES ....(P) = 17
NUMBER OF END NODES ....(J) = 14
NUMBER OF PRIMARY LOOPS ....(L) = 2
NUMBER OF SUPPLY NODES ....(F) = 2
NUMBER OF SUPPLY ZONES ....(Z) = 1

Case: 1 = PEAK HOUR DEMAND

P I P E L I N E R E S U L T S

PIPE NAME	NODE NUMBERS #1	#2	FLOWRATE gpm	HEAD LOSS ft	MINOR LOSS ft	LINE VELO. ft/s	HL+ML/1000 ft/f	HL/1000 ft/f
1	0	2	10.75	0.00	0.00	0.07	0.00	0.00
2	2	4	48.06	0.00	0.00	0.31	0.08	0.08
3	4	6	48.06	0.02	0.00	0.31	0.08	0.08
5	6	8	-9.94	0.00	0.00	0.06	0.00	0.00
7	8	I-BFP	0.00	0.00	0.00	0.00	0.00	0.00
9	O-BFP	HYD	0.00	0.00	0.00	0.00	0.00	0.00
11	0	12	9.94	0.00	0.00	0.03	0.00	0.00
13	12	14	9.94	0.03	0.00	0.11	0.02	0.02
15	14	16	9.94	0.00	0.00	0.06	0.00	0.00
17	18	16	-9.94	0.00	0.00	0.06	0.00	0.00
19	8	18	-9.94	0.00	0.00	0.06	0.00	0.00
21	0	22	-20.69	0.00	0.00	0.06	0.00	0.00
23	22	24	-20.69	0.03	0.00	0.23	0.07	0.07
25	24	2	37.31	0.03	0.00	0.42	0.19	0.19
101	100	102	58.00	0.10	0.00	0.37	0.11	0.11

103	104	102	-58.00	0.19	0.00	0.66	0.44	0.44
105	24	104	-58.00	0.24	0.00	0.66	0.44	0.44

P U M P/L O S S   E L E M E N T   R E S U L T S

NAME	FLOWRATE gpm	INLET HEAD ft	OUTLET HEAD ft	PUMP HEAD ft	EFFIC-ENCY %	USEFUL POWER Hp	INCREMTL COST $	TOTAL COST $	#PUMPS PARALLEL	#PUMPS SERIES	NPSH Avail. ft
100	58.00	0.00	175.23	175.2	75.00	3.	0.1	0.1	**	**	33.2
Device "0" is closed											
0	0.00	0.00	177.67	0.0	75.00	0.	0.0	0.0	**	**	33.2
Warning P2K107:Device			BFP is operating out of range.								
BFP	0.00	171.65	149.26	-22.4	75.00	0.	0.0	0.0	**	**	204.8

N O D E   R E S U L T S

NODE NAME	NODE TITLE	EXTERNAL DEMAND gpm	HYDRAULIC GRADE ft	NODE ELEVATION ft	PRESSURE HEAD ft	NODE PRESSURE psi
2		0.00	239.67	62.00	177.67	76.99
4		0.00	239.67	65.00	174.67	75.69
6		58.00	239.64	65.00	174.64	75.68
8		0.00	239.65	66.00	173.65	75.25
12		0.00	239.67	56.00	183.67	79.59
14		0.00	239.65	63.00	176.65	76.55
16		0.00	239.65	72.00	167.65	72.65
18		0.00	239.65	71.00	168.65	73.08
22		0.00	239.67	61.00	178.67	77.43
24		0.00	239.70	60.00	179.70	77.87
100		----	240.23	65.00	175.23	75.93
102		0.00	240.13	72.00	168.13	72.86
104		0.00	239.94	62.00	177.94	77.11
0		----	239.67	62.00	177.67	76.99
O-BFP		0.00	217.26	68.00	149.26	64.68
HYD		0.00	217.26	70.00	147.26	63.81
I-BFP		0.00	239.65	68.00	171.65	74.38

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES psi	JUNCTION NUMBER	MINIMUM PRESSURES psi
12	79.59	HYD	63.81
24	77.87	O-BFP	64.68
22	77.43	16	72.65
104	77.11	102	72.86
0	76.99	18	73.08

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
103	0.66	11	0.03
105	0.66	21	0.06
25	0.42	5	0.06
101	0.37	15	0.06
2	0.31	17	0.06

H L + M L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL+ML/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL+ML/1000 (ft/ft)
105	0.44	11	0.00

103	0.44	21	0.00
25	0.19	5	0.00
101	0.11	15	0.00
3	0.08	17	0.00

H L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL/1000 (ft/ft)
105	0.44	11	0.00
103	0.44	21	0.00
25	0.19	5	0.00
101	0.11	15	0.00
3	0.08	17	0.00

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM SUPPLY NODES
(-) OUTFLOWS FROM THE SYSTEM INTO SUPPLY NODES

NODE NAME	FLOWRATE gpm	NODE TITLE
100	58.00	

NET SYSTEM INFLOW = 58.00
NET SYSTEM OUTFLOW = 0.00
NET SYSTEM DEMAND = 58.00

Case: 2 = MAX DAY DEMAND + 4,000 GPM FIRE FLOW SPLIT NODES 4 AND 102

P I P E L I N E   R E S U L T S

P I P E N A M E	NODE NUMBERS #1	#2	FLOWRATE gpm	HEAD LOSS ft	MINOR LOSS ft	LINE VELO. ft/s	HL+ML/ 1000 ft/f	HL/ 1000 ft/f
1	0	2	1276.30	33.46	0.00	8.15	33.29	33.29
2	2	4	1575.10	2.46	0.00	10.05	49.15	49.15
3	4	6	-424.90	1.15	0.00	2.71	4.34	4.34
5	6	8	-456.90	0.25	0.00	2.92	4.97	4.97
7	8	I-BFP	0.00	0.00	0.00	0.00	0.00	0.00
9	O-BFP	HYD	0.00	0.00	0.00	0.00	0.00	0.00
11	0	12	456.90	0.60	0.00	1.30	0.69	0.69
13	12	14	456.90	30.04	0.00	5.18	20.16	20.16
15	14	16	456.90	3.03	0.00	2.92	4.97	4.97
17	18	16	-456.90	0.27	0.00	2.92	4.97	4.97
19	8	18	-456.90	0.57	0.00	2.92	4.97	4.97
21	0	22	906.02	1.05	0.00	2.57	2.45	2.45
23	22	24	906.02	30.80	0.00	10.28	71.64	71.64
25	24	2	298.80	1.60	0.00	3.39	9.18	9.18
101	100	102	1392.78	36.00	0.00	8.89	39.13	39.13
103	104	102	607.22	14.51	0.00	6.89	34.14	34.14
105	24	104	607.22	18.44	0.00	6.89	34.14	34.14

P U M P/L O S S   E L E M E N T   R E S U L T S

NAME	FLOWRATE gpm	INLET HEAD ft	OUTLET HEAD ft	PUMP HEAD ft	EFFIC-ENCY %	USEFUL POWER Hp	INCREMTL COST $	TOTAL COST $	#PUMPS PARALLEL	#PUMPS SERIES	NPSH Avail. ft	
100	1392.78	0.00	119.06	119.1	75.00	42.	0.1	0.3	**	**	33.2	1.0000
0	2639.22	0.00	150.86	150.9	75.00	101.	5.0	5.0	**	**	33.2	1.0000

Warning P2K107:Device BFP is operating out of range.

BFP	0.00	110.35	87.97	-22.4	75.00	0.	0.0	0.0	**	**	143.6	1.0000

N O D E   R E S U L T S

NODE NAME	NODE TITLE	EXTERNAL DEMAND gpm	HYDRAULIC GRADE ft	NODE ELEVATION ft	PRESSURE HEAD ft	NODE PRESSURE psi
2		0.00	179.41	62.00	117.41	50.88
4		2000.00	176.95	65.00	111.95	48.51
6		32.00(0.55)	178.10	65.00	113.10	49.01
8		0.00	178.35	66.00	112.35	48.69
12		0.00	212.26	56.00	156.26	67.71
14		0.00	182.22	63.00	119.22	51.66
16		0.00	179.19	72.00	107.19	46.45
18		0.00	178.92	71.00	107.92	46.77
22		0.00	211.81	61.00	150.81	65.35
24		0.00	181.01	60.00	121.01	52.44
100		----	184.06	65.00	119.06	51.59
102		2000.00	148.06	72.00	76.06	32.96
104		0.00	162.57	62.00	100.57	43.58
0		----	212.86	62.00	150.86	65.37
O-BFP		0.00	155.97	68.00	87.97	38.12
HYD		0.00	155.97	70.00	85.97	37.25
I-BFP		0.00	178.35	68.00	110.35	47.82

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES psi	JUNCTION NUMBER	MINIMUM PRESSURES psi
12	67.71	102	32.96
0	65.37	HYD	37.25
22	65.35	O-BFP	38.12
24	52.44	104	43.58
14	51.66	16	46.45

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
23	10.28	11	1.30
2	10.05	21	2.57
101	8.89	3	2.71
1	8.15	5	2.92
103	6.89	15	2.92

H L + M L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL+ML/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL+ML/1000 (ft/ft)
23	71.64	11	0.69
2	49.15	21	2.45
101	39.13	3	4.34
103	34.14	17	4.97
105	34.14	15	4.97

H L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL/1000 (ft/ft)
23	71.64	11	0.69
2	49.15	21	2.45
101	39.13	3	4.34

103	34.14	17	4.97
105	34.14	15	4.97

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM SUPPLY NODES
(-) OUTFLOWS FROM THE SYSTEM INTO SUPPLY NODES

NODE NAME	FLOWRATE gpm	NODE TITLE
100	1392.78	
0	2639.22	

NET SYSTEM INFLOW = 4032.00
NET SYSTEM OUTFLOW = 0.00
NET SYSTEM DEMAND = 4032.00

Case: 3 = MAX DAY DEMAND + 4,000 GPM FIRE FLOW SPLIT NODES 4, 16, AND 102

P I P E L I N E   R E S U L T S

PIPE NAME	NODE NUMBERS #1	#2	FLOWRATE gpm	HEAD LOSS ft	MINOR LOSS ft	LINE VELO. ft/s	HL+ML/ 1000 ft/f	HL/ 1000 ft/f
1	0	2	1421.19	40.83	0.00	9.07	40.62	40.62
2	2	4	2212.02	4.61	0.00	14.12	92.18	92.18
3	4	6	712.02	2.99	0.00	4.54	11.29	11.29
5	6	8	680.02	0.52	0.00	4.34	10.37	10.37
7	8	I-BFP	0.00	0.00	0.00	0.00	0.00	0.00
9	O-BFP	HYD	0.00	0.00	0.00	0.00	0.00	0.00
11	0	12	569.98	0.90	0.00	1.62	1.04	1.04
13	12	14	569.98	45.24	0.00	6.47	30.37	30.37
15	14	16	569.98	4.56	0.00	3.64	7.48	7.48
17	18	16	680.02	0.57	0.00	4.34	10.37	10.37
19	8	18	680.02	1.19	0.00	4.34	10.37	10.37
21	0	22	894.90	1.03	0.00	2.54	2.39	2.39
23	22	24	894.90	30.11	0.00	10.15	70.02	70.02
25	24	2	790.83	9.69	0.00	8.97	55.69	55.69
101	100	102	1145.93	25.09	0.00	7.31	27.27	27.27
103	104	102	104.07	0.55	0.00	1.18	1.30	1.30
105	24	104	104.07	0.70	0.00	1.18	1.30	1.30

P U M P/L O S S   E L E M E N T   R E S U L T S

NAME	FLOWRATE gpm	INLET HEAD ft	OUTLET HEAD ft	PUMP HEAD ft	EFFIC-ENCY %	USEFUL POWER Hp	INCREMTL COST $	TOTAL COST $	#PUMPS PARALLEL	#PUMPS SERIES	NPSH Avail. ft
100	1145.93	0.00	136.14	136.1	75.00	39.	2.1	2.3	**	**	33.2
0	2886.07	0.00	146.45	146.4	75.00	107.	5.0	10.0	**	**	33.2
Warning P2K107:Device BFP is operating out of range.											
BFP	0.00	91.50	69.12	-22.4	75.00	0.	0.0	0.0	**	**	124.7

N O D E   R E S U L T S

NODE NAME	NODE TITLE	EXTERNAL DEMAND gpm	HYDRAULIC GRADE ft	NODE ELEVATION ft	PRESSURE HEAD ft	NODE PRESSURE psi
2		0.00	167.62	62.00	105.62	45.77
4		1500.00	163.01	65.00	98.01	42.47
6		32.00(0.55)	160.02	65.00	95.02	41.18
8		0.00	159.50	66.00	93.50	40.52
12		0.00	207.55	56.00	151.55	65.67
14		0.00	162.30	63.00	99.30	43.03
16		1250.00	157.74	72.00	85.74	37.15
18		0.00	158.31	71.00	87.31	37.83

22	0.00	207.42	61.00	146.42	63.45
24	0.00	177.31	60.00	117.31	50.83
100	----	201.14	65.00	136.14	58.99
102	1250.00	176.05	72.00	104.05	45.09
104	0.00	176.61	62.00	114.61	49.66
0	----	208.45	62.00	146.45	63.46
O-BFP	0.00	137.12	68.00	69.12	29.95
HYD	0.00	137.12	70.00	67.12	29.08
I-BFP	0.00	159.50	68.00	91.50	39.65

M A X I M U M   A N D   M I N I M U M   V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES psi	JUNCTION NUMBER	MINIMUM PRESSURES psi
12	65.67	HYD	29.08
0	63.46	O-BFP	29.95
22	63.45	16	37.15
100	58.99	18	37.83
24	50.83	I-BFP	39.65

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
2	14.12	105	1.18
23	10.15	103	1.18
1	9.07	11	1.62
25	8.97	21	2.54
101	7.31	15	3.64

H L + M L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL+ML/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL+ML/1000 (ft/ft)
2	92.18	11	1.04
23	70.02	105	1.30
25	55.69	103	1.30
1	40.62	21	2.39
13	30.37	15	7.48

H L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL/1000 (ft/ft)
2	92.18	11	1.04
23	70.02	105	1.30
25	55.69	103	1.30
1	40.62	21	2.39
13	30.37	15	7.48

S U M M A R Y   O F   I N F L O W S   A N D   O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM SUPPLY NODES
(-) OUTFLOWS FROM THE SYSTEM INTO SUPPLY NODES

NODE NAME	FLOWRATE gpm	NODE TITLE
100	1145.93	

```
     0            2886.07

 NET SYSTEM INFLOW  =   4032.00
 NET SYSTEM OUTFLOW =      0.00
 NET SYSTEM DEMAND  =   4032.00
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Case: 3 = MAX DAY DEMAND + 4,000 GPM FIRE FLOW SPLIT NODES 16, 24, AND 104

P I P E L I N E R E S U L T S

PIPE NAME	NODE NUMBERS #1	#2	FLOWRATE gpm	HEAD LOSS ft	MINOR LOSS ft	LINE VELO. ft/s	HL+ML/ 1000 ft/f	HL/ 1000 ft/f
1	0	2	1406.32	40.04	0.00	8.98	39.84	39.84
2	2	4	763.85	0.64	0.00	4.88	12.86	12.86
3	4	6	763.85	3.41	0.00	4.88	12.86	12.86
5	6	8	705.85	0.56	0.00	4.50	11.11	11.11
7	8	I-BFP	0.00	0.00	0.00	0.00	0.00	0.00
9	O-BFP	HYD	0.00	0.00	0.00	0.00	0.00	0.00
11	0	12	544.15	0.83	0.00	1.54	0.95	0.95
13	12	14	544.15	41.52	0.00	6.17	27.87	27.87
15	14	16	544.15	4.19	0.00	3.47	6.86	6.86
17	18	16	705.85	0.61	0.00	4.50	11.11	11.11
19	8	18	705.85	1.28	0.00	4.50	11.11	11.11
21	0	22	1113.01	1.54	0.00	3.16	3.59	3.59
23	22	24	1113.01	45.09	0.00	12.63	104.87	104.87
25	24	2	-642.48	6.60	0.00	7.29	37.90	37.90
101	100	102	994.51	19.29	0.00	6.35	20.97	20.97
103	104	102	-994.51	36.18	0.00	11.28	85.13	85.13
105	24	104	255.49	3.71	0.00	2.90	6.87	6.87

P U M P/L O S S E L E M E N T R E S U L T S

NAME	FLOWRATE gpm	INLET HEAD ft	OUTLET HEAD ft	PUMP HEAD ft	EFFIC- ENCY %	USEFUL POWER Hp	INCREMTL COST $	TOTAL COST $	#PUMPS PARALLEL	#PUMPS SERIES	NPSH Avail. ft
100	994.51	0.00	145.20	145.2	75.00	36.	2.0	4.3	**	**	33.2
0	3063.49	0.00	143.07	143.1	75.00	111.	5.3	15.3	**	**	33.2
Warning P2K107:Device			BFP is operating out of range.								
BFP	0.00	92.42	70.04	-22.4	75.00	0.	0.0	0.0	**	**	125.6

N O D E R E S U L T S

NODE NAME	NODE TITLE	EXTERNAL DEMAND gpm	HYDRAULIC GRADE ft	NODE ELEVATION ft	PRESSURE HEAD ft	NODE PRESSURE psi
2		0.00	165.03	62.00	103.03	44.65
4		0.00	164.39	65.00	99.39	43.07
6		58.00	160.98	65.00	95.98	41.59
8		0.00	160.42	66.00	94.42	40.92
12		0.00	204.24	56.00	148.24	64.24
14		0.00	162.72	63.00	99.72	43.21
16		1250.00	158.53	72.00	86.53	37.50
18		0.00	159.14	71.00	88.14	38.19
22		0.00	203.53	61.00	142.53	61.76
24		1500.00	158.43	60.00	98.43	42.65
100		----	210.20	65.00	145.20	62.92
102		0.00	190.91	72.00	118.91	51.53
104		1250.00	154.72	62.00	92.72	40.18
0		----	205.07	62.00	143.07	62.00
O-BFP		0.00	138.04	68.00	70.04	30.35
HYD		0.00	138.04	70.00	68.04	29.48
I-BFP		0.00	160.42	68.00	92.42	40.05

M A X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

JUNCTION	MAXIMUM	JUNCTION	MINIMUM

NUMBER	PRESSURES psi	NUMBER	PRESSURES psi
12	64.24	HYD	29.48
100	62.92	O-BFP	30.35
0	62.00	16	37.50
22	61.76	18	38.19
102	51.53	I-BFP	40.05

V E L O C I T I E S

PIPE NUMBER	MAXIMUM VELOCITY (ft/s)	PIPE NUMBER	MINIMUM VELOCITY (ft/s)
23	12.63	11	1.54
103	11.28	105	2.90
1	8.98	21	3.16
25	7.29	15	3.47
101	6.35	5	4.50

H L + M L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL+ML/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL+ML/1000 (ft/ft)
23	104.87	11	0.95
103	85.13	21	3.59
1	39.84	15	6.86
25	37.90	105	6.87
13	27.87	5	11.11

H L / 1 0 0 0

PIPE NUMBER	MAXIMUM HL/1000 (ft/ft)	PIPE NUMBER	MINIMUM HL/1000 (ft/ft)
23	104.87	11	0.95
103	85.13	21	3.59
1	39.84	15	6.86
25	37.90	105	6.87
13	27.87	5	11.11

S U M M A R Y O F I N F L O W S A N D O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM SUPPLY NODES
(-) OUTFLOWS FROM THE SYSTEM INTO SUPPLY NODES

NODE NAME	FLOWRATE gpm	NODE TITLE
100	994.51	
0	3063.49	

NET SYSTEM INFLOW = 4058.00
NET SYSTEM OUTFLOW = 0.00
NET SYSTEM DEMAND = 4058.00

***** HYDRAULIC ANALYSIS COMPLETED *****

EXHIBIT A

NODE AND PIPE DIAGRAM

EXHIBIT A

NODE AND PIPE DIAGRAM

HOPE APARTMENTS

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