WILSON ENGINEERING
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# MEMORANDUM

TO: LWWSD

FROM: Ben Gibson, PE, and Brian Smith, PE

SUBJECT: Hydraulic Analysis of the Eagleridge Water System

DATE: November 10, 2020

## Introduction

The District's Eagleridge water system was installed in 1989, and currently serves 68 residences from an intertie with the City of Bellingham water system. Historically the City water system alone has not provided adequate pressure at the intertie, requiring the use of the existing Eagleridge booster pumps. However, upgrades to the City system over the past few decades have resulted in higher pressures, and as such, the necessity of these existing pumps has come into question. The purpose of this technical memorandum is to summarize the results of the hydraulic analysis performed to investigate the feasibility of removing the existing Eagleridge booster pumps.

## Executive Summary

A hydraulic model was developed for the Eagleridge water system in order to simulate two scenarios: peak hourly demand, and fire flow with maximum day demand, both without the existing booster pumps. The model showed that for the peak hourly demand scenario, the minimum system pressure would be 34.42 psi, which is greater than the minimum requirement of 30 psi. For the fire flow demand scenario, the maximum available hydrant flow while maintaining the required minimum 20 psi throughout the system ranged from 341 gpm to 359 gpm, which is less than the minimum required 500 gpm.

Therefore, we conclude that the domestic pumps could be decommissioned and remain within regulatory requirements for pressure. Note that the normal system pressures will be about 30 psi lower than they are now and may be perceived as a reduction in "level of services" by a few customers. Since it appears that the fire pumps will remain necessary, when they eventually need to be replaced we recommend that the new pumps have VFD controls and are sized appropriately based on current suction-side pressures and fire flow needs.

## Current Water System Operation

*Overview*

The Eagleridge Water System connects to the City of Bellingham system through a 6 inch service line, feeding into the pump station through a strainer, a meter, and a backflow preventer (two parallel six inch DCVAs). The pump station is located at 1708 North Shore Drive, and consists of a CMU structure containing three pumps for domestic service, two pumps for fire suppression, pump controls, and a diesel generator. The pump station feeds into a looped network consisting of approximately 5,000 lineal feet of mostly 8 inch pipe, serving approximately 68 residences and 6 fire hydrants. The existing system is shown in Figure 1.

*Current System Performance*

The system was modeled in its current configuration (with pumps) to determine the existing system pressures. The model verifies that the current system provides adequate pressure and flow in both the peak hour demand (PHD) and fire flow scenarios. Demands for both scenarios are discussed in the following section. According to the model, the lowest system pressures during the PHD and fire flow scenarios were 68.35 and 64.40 psi, respectively, which are well above the 30 psi and 20 psi minimum requirements. For the PHD scenario, only two of the three domestic pumps were set to run, with both fire pumps off (fire pumps are only set to turn on when system pressure at the pump house drops below 60 psi). Similarly, for the fire flow scenario, only a single fire pump was turned on, with all of the domestic pumps off. In reality the domestic pumps would also be on during a fire event, in addition to the fire pumps, but to be conservative and to more accurately represent a scenario where the domestic pumps are removed with just the fire pumps remaining in service (as discussed later in this memo), the fire flow scenario was run without the domestic pumps.

*Critical Node*

The minimum pressures for both of the scenarios discussed above occurred at node J-NE-19, as shown on Figure 1, which represents the highest elevation node in the Eagleridge water main distribution system at an approximate elevation of 409' and is the critical node for this model (both with and without pumps). This node is located at the approximate location of the meter for the residence at 1777 Donald Avenue, where the residence itself is at an elevation of approximately 421'. This is the highest meter in the system. While 1777 Donald Avenue has the highest elevation *meter*, and is therefore the critical node from a distribution main standpoint, it is not the highest elevation *residence*. The highest elevation residence is 1784 Donald Avenue at an elevation of approximately 440', which is included in the model as node J-

90, and shown in Figure 1 for reference. This is the highest point in the system and represents the worst case scenario in terms of level of service. It is not the critical node in terms of regulatory requirement since the meter for 1784 Donald is actually located much lower, on Eagleridge Way (see node J-88, Figure 1) with an elevation of approximately 375'.


LWWSD EAGLERIDGE

FIGURE 1

EXISTING WATER DISTRIBUTION SYSTEM

WHATCOM COUNTY WASHINGTON

DATE 11-3-2020 | SCALE AS SHOWN | JOB NUMBER 2020-080 | SHEET 1 OF 1

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## Hydraulic Model Inputs

*Infrastructure*

The system model was constructed using original record drawings from Weden Engineering, and is shown in Figure 1 – Existing Water System. The distribution network in the model is "skeletonized" to only include the mains, excluding the individual service lines (except for the worst-case service connection, J-90, as discussed previously). The distribution network consists mainly of 8 inch pipe, with a few short sections of 6 inch, and one section of 4 inch pipe. All piping is cement-lined ductile iron, and is modeled as having a Hazen-Williams roughness coefficient of 120. Pump curves were developed based on cut sheets for the existing pumps, but since the main intent of this analysis is to determine system performance without the pumps, they were only used to model the scenarios with the current configuration discussed previously.

*Field Data*

The system information that is needed to develop an accurate hydraulic model is fairly standard for most basic components such as pipe, bends, valves, etc. For other components such as pumps and meters, whose properties are make and model specific, the manufacturer will usually provide cut sheets with the necessary information. This was true for the Eagleridge pumps and DCVA, but information for the existing meter and strainer was not available.

A site visit was performed on August 4, 2020 with LWWSD staff, wherein a flow/pressure test was carried out to measure system pressures. A data logger was installed at two locations within the system to record pressures during known flow events, with the intent being to determine the actual headlosses within the system – specifically, for the portion between the City network and the pump station. Doing so results in a more accurate hydraulic model.

The first location where pressure was recorded was just upstream of the pumphouse, in the DCVA vault (immediately downstream of the DCVAs). A fire hydrant was opened at the intersection of Eagleridge Way and Aquila Court, and set to a flow of 220 gpm. Prior to opening the hydrant, the average recorded pressure at the DCVA was observed to be 75.6 psi. After opening the hydrant, the average recorded pressure at the DCVA was found to be 68.3 psi, which shows a pressure loss through the City system (City main, meter, DCVA) of 7.3 psi at a flow of 220 gpm.

The hydrant was then opened to a flow of approximately 393 gpm, which resulted in an average pressure at the DCVA of 58 psi, indicating a pressure loss across the City system (City main, meter, DCVA) of 17.6 psi at a flow of 393 gpm. Using these two pressure loss data points (7.3 psi at 220 gpm, and 17.6 psi at 393 gpm), along with the other known headlosses, the minor headloss coefficient, K, for the water meter and strainer was calibrated in the model to reflect the observed headloss.

### *Demands*

The demands used in the hydraulic model are based on the 2017 LWWSD Water System Plan Update (2017 WSP), which states that the Eagleridge community's expected build-out is 71 ERUs, with an average daily demand (ADD) of 250 gpd/ERU, a maximum daily demand (MDD) of 800 gpd/ERU, and a fire flow requirement of 500 gpm. Therefore, a system MDD of 39.44 gpm was used for the fire flow scenario (in addition to the 500 gpm fire demand), and a demand of 130.5 gpm was used for the PHD scenario.

### *City of Bellingham System Pressure*

Based on input from the City of Bellingham Utility Operations Engineer, Jim Bergner, pressure at the City intertie during a fire flow scenario of 539 gpm (accounting for the 500 gpm fire flow in addition to the 39 gpm MDD flow) will be 59 psi, with a static pressure of 78 psi. Similarly, pressure at the intertie during the 130.5 gpm peak hourly demand will be 73 psi, again with a static pressure of 78 psi. These pressures are with reservoir levels that are the lowest observed reservoir levels. Exact levels with equalizing storage and fire suppression storage depleted were not quantified by the City, but it is expected that the lowest observed reservoir levels that are represented are at least approximately close to those conditions.

It should be noted that according to the City, portions of their hydraulic model have not been updated since 2004. As the attached correspondence shows, a workaround was used to generate the requested pressures. This method seems to have yielded fairly accurate results, considering that the calculated static pressure is within 3% of the static pressure observed in the field: 78 psi according to model, and 75.6 psi average observed downstream of the strainer, meter, and backflow assemblies.

## Hydraulic Model Results

The hydraulic model was run for two scenarios: peak hourly demand and fire flow with maximum daily demand. For both models, in order to simulate the removal of the existing pumps, the model pumps were deactivated and flow was routed through an 8 inch bypass line as shown in Figure 2.

### *Peak Hourly Demand*

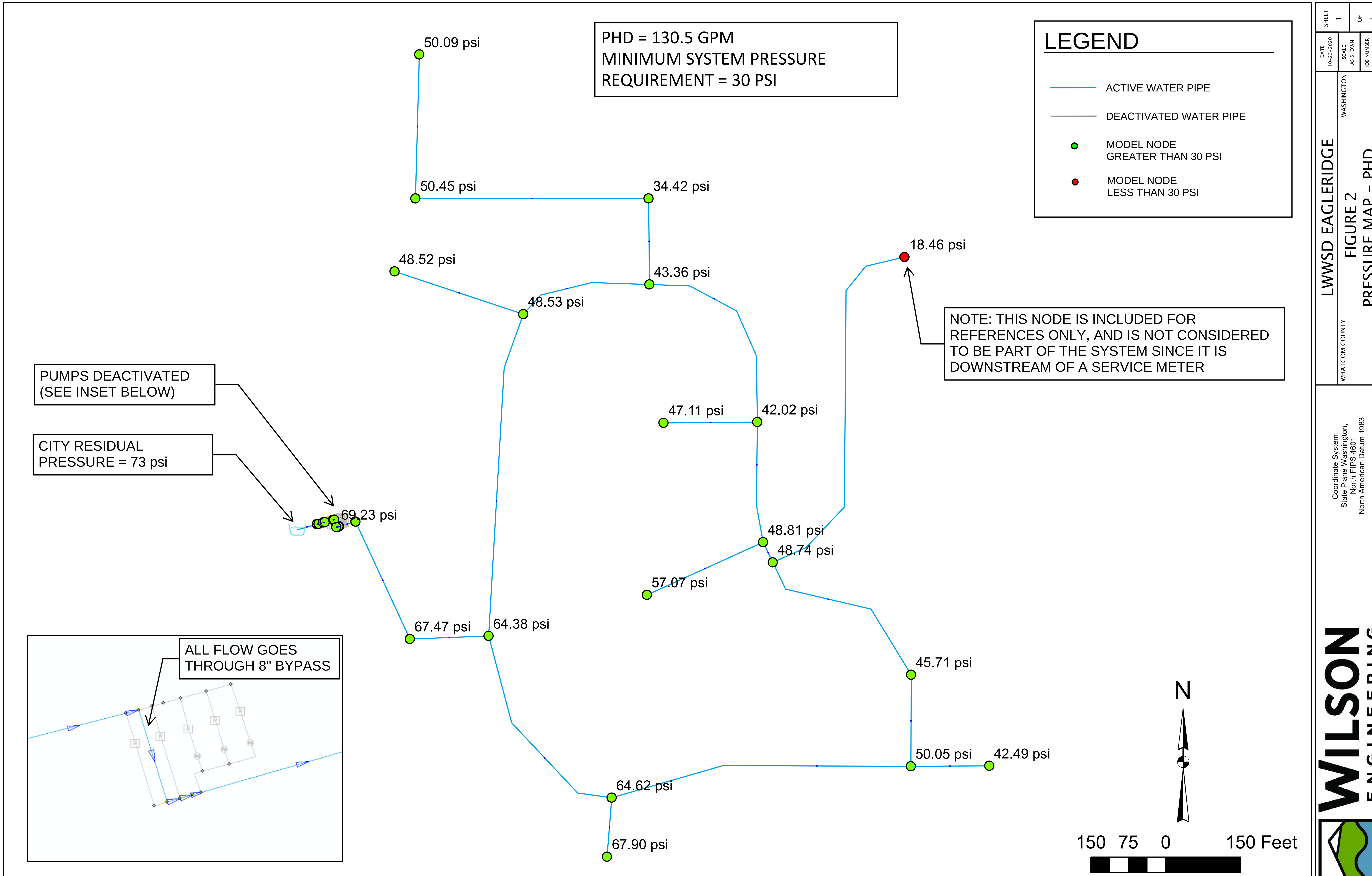
The District has adopted the Design Standards set forth in WAC 246-290-230. Paragraph 5 states that "New public water systems or additions to existing systems shall be designed with the capacity to deliver the design PHD quantity of water at 30 psi (210 kPa) under PHD flow conditions measured at all existing and proposed service water meters or along property lines adjacent to mains if no meter exists, and under the condition where all equalizing storage has been depleted."

As Figure 2 shows, the lowest *system* pressure occurs at node J-NE-19 (the critical node for this model), with 34.42 psi, which is greater than the minimum required pressure. Based on these results, it appears that removing the domestic pumps is acceptable from a PHD minimum pressure standpoint. A summary of the PHD system pressures is shown in Table 1 below for both the scenario with domestic pumps (current configuration) and without the domestic pumps.

Table 1: PHD System Pressures With and Without Domestic Pumps

| Node | PHD Pressure with Pumps (psi) | PHD Pressure without Pumps (psi) | | Node | PHD Pressure with Pumps (psi) | PHD Pressure without Pumps (psi) |
|---|---|---|---|---|---|---|
| J-NE-3 | 100.00 | 69.23 | | J-NE-14 | 75.94 | 42.02 |
| J-NE-4 | 101.39 | 67.47 | | J-NE-15 | 81.04 | 47.11 |
| J-NE-6 | 98.31 | 64.38 | | J-NE-16 | 82.45 | 48.53 |
| J-NE-7 | 98.55 | 64.62 | | J-NE-17 | 82.45 | 48.52 |
| J-NE-8 | 101.82 | 67.90 | | J-NE-18 | 77.29 | 43.36 |
| J-NE-9 | 89.97 | 50.05 | | J-NE-19 | 68.35 | 34.42 |
| J-NE-10 | 76.42 | 42.49 | | J-NE-20 | 84.38 | 50.45 |
| J-NE-11 | 79.64 | 45.71 | | J-NE-21 | 84.02 | 50.09 |
| J-NE-12 | 82.74 | 48.81 | | J-88 | 82.67 | 48.74 |
| J-NE-13 | 91.00 | 57.07 | | J-90 | 52.39 | 18.46* |

*Note: Node J-90 is downstream of a service meter, and not subject to the 30 psi minimum.


PHD = 130.5 GPM
MINIMUM SYSTEM PRESSURE
REQUIREMENT = 30 PSI
LEGEND
ACTIVE WATER PIPE
DEACTIVATED WATER PIPE
MODEL NODE
GREATER THAN 30 PSI
MODEL NODE
LESS THAN 30 PSI
50.09 psi
50.45 psi
34.42 psi
48.52 psi
43.36 psi
48.53 psi
18.46 psi
NOTE: THIS NODE IS INCLUDED FOR REFERENCES ONLY, AND IS NOT CONSIDERED TO BE PART OF THE SYSTEM SINCE IT IS DOWNSTREAM OF A SERVICE METER
PUMPS DEACTIVATED
(SEE INSET BELOW)
CITY RESIDUAL
PRESSURE = 73 psi
47.11 psi
42.02 psi
69.23 psi
48.81 psi
48.74 psi
57.07 psi
67.47 psi
64.38 psi
45.71 psi
ALL FLOW GOES
THROUGH 8" BYPASS
50.05 psi
42.49 psi
64.62 psi
67.90 psi
N
150 75 0 150 Feet
SHEET 1 OF 1
DATE 10-23-2020
SCALE AS SHOWN
JOB NUMBER 2020-080
LWWSD EAGLERIDGE
WHATCOM COUNTY
WASHINGTON
FIGURE 2
PRESSURE MAP – PHD
Coordinate System:
State Plane Washington,
North FIPS 4601
North American Datum 1983
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*Fire Flow and Maximum Daily Demand*

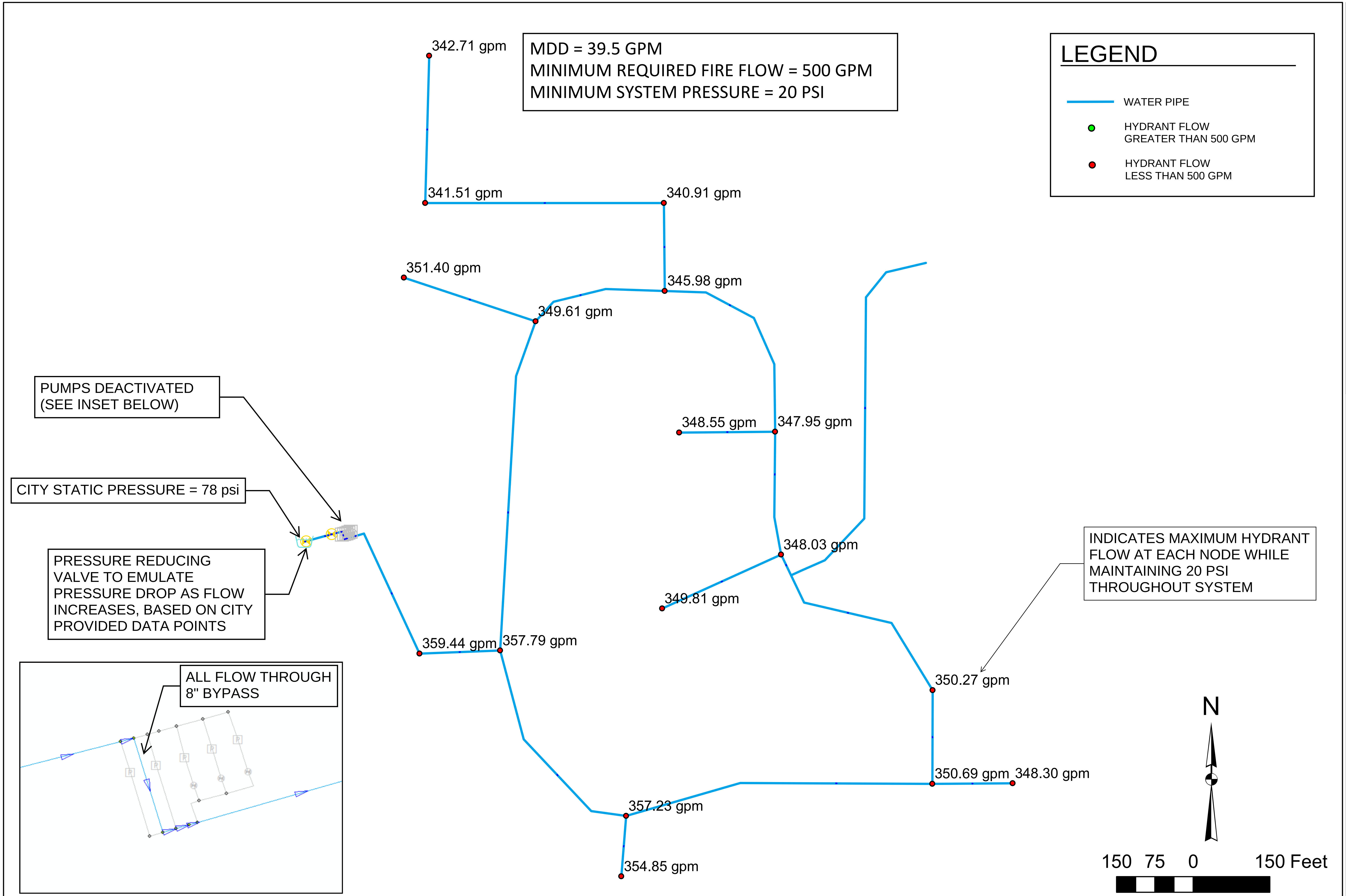
Paragraph 6 of WAC 246-290-230 states that “If fire flow is to be provided, the distribution system shall also provide maximum day demand (MDD) plus the required fire flow at a pressure of at least 20 psi (140 kPa) at all points throughout the distribution system, and under the condition where the designed volume of fire suppression and equalizing storage has been depleted.”

The hydraulic model allows for the analysis of fire flow scenarios in a number of ways. Figure 4 shows the maximum available hydrant flow at each node while maintaining a minimum pressure of 20 psi throughout the system. As Figure 4 shows, this maximum flow varies from 340.91 to 359.44 gpm, below the minimum required 500 gpm. Therefore, it appears that removing the fire suppression pumps is not acceptable.

*Existing Fire Pumps*

The existing two fire pumps are not very well suited to the current needs of the system and should be replaced when they reach the end of their useful life, at the latest. Since the existing fire pumps were installed when the fire flow requirement was 750 gpm (versus 500 gpm, now), and because the City water pressure has increased since this pumping system was designed and installed, it would appear that the existing fire pumps are significantly oversized. This is verified by the hydraulic model, which shows, with a single fire pump running, the available hydrant flow ranges from 1,112 gpm to 1,199 gpm while maintaining 20 psi throughout the system – over double the required flow.

Furthermore, the existing fire pumps are simple on-off controlled pumps. These are inefficient compared to modern variable frequency drive (VFD) controls, and since they do not have bladder tanks or precise controls to achieve a target discharge pressure, they tend to cause pressure spikes and dips. Figure 3 below shows a plot of the pressure recorded by a data logger at the hydrant. The pressure spike shown at approximately 9:40am on the plot represents one of the fire pumps turning on, where peak pressure exceeds 120 psi, which exceeds the DOH’s recommendation for maximum working pressure of 80 psi. Not only is the pressure excessive, but it could (and does, as shown) increase and decrease quickly, causing




SHEET 1 OF 1
DATE 11-5-2020
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JOB NUMBER 2020-080

LWWSD EAGLERIDGE
WHATCOM COUNTY
WASHINGTON

# FIGURE 4
## AVAILABLE HYDRANT FLOW (20-PSI)

Coordinate System:
State Plane Washington,
North FIPS 4601
North American Datum 1983

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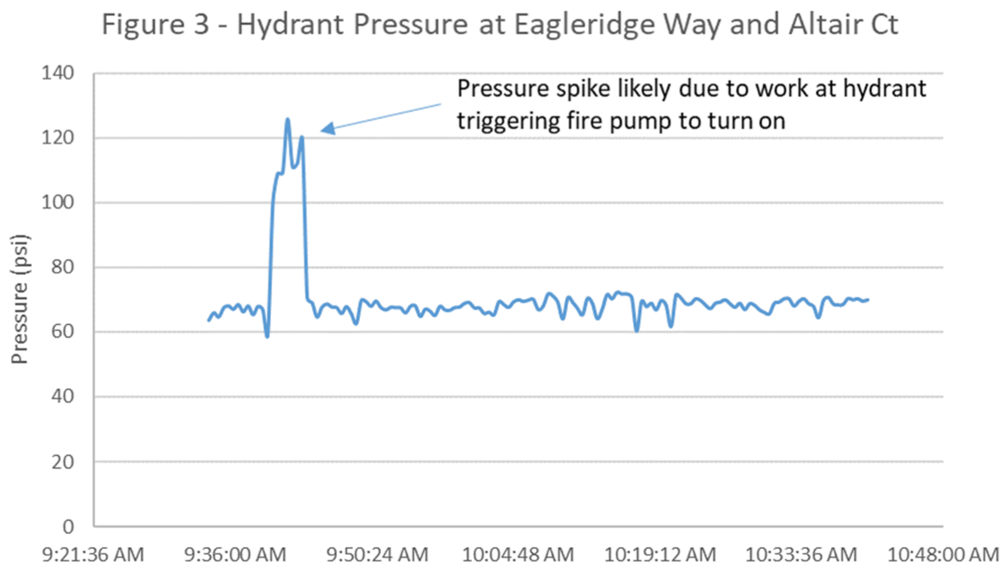
water hammer and potentially damaging the distribution system, services, or plumbing, causing leaks and water loss.




Since it appears that the fire pumps will remain necessary, we recommend replacing them with appropriately sized pumps (based on current suction-side pressures and fire flow needs) with VFD controls.

**Attachments**

- Correspondence with City of Bellingham
  - Node J1 Pressure at fire flow (539 gpm), with explanation of model workaround
  - Node J1 Pressure at PHD (130.5 gpm)

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Brian Smith <bsmith@wilsonengineering.com>

# LWWSD water intertie at Eagleridge

**Bergner, Jim P.** <jbergner@cob.org> Wed, Oct 14, 2020 at 1:43 PM
To: Brian Smith <bsmith@wilsonengineering.com>
Cc: Melanie Mankamyer <mmankamyer@wilsonengineering.com>, Ben Gibson <bgibson@wilsonengineering.com>

Hi Brian,

Here's what you can expect to see at J1 with a demand of 539gpm.

**Regards,**


***Jim Bergner***

*Utility Operations Engineer*

*Public Works - Engineering*

*104 W. Magnolia St., Suite 109, Bellingham, WA 98225*

*P: 360.778.7731*

jbergner@cob.org




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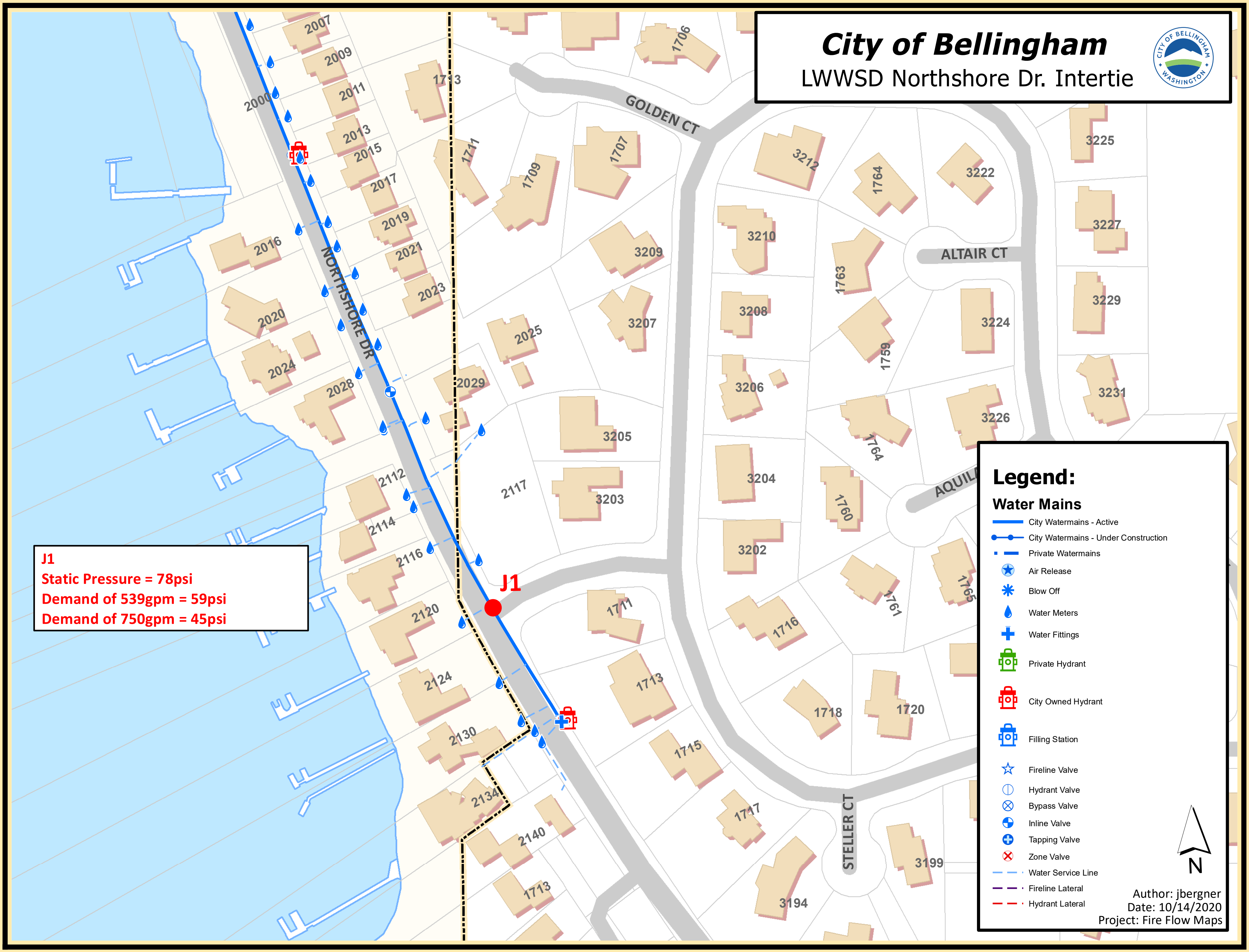
**From:** Brian Smith <bsmith@wilsonengineering.com>
**Sent:** Tuesday, October 13, 2020 4:22 PM
**To:** Bergner, Jim P. <jbergner@cob.org>
**Cc:** Melanie Mankamyer <mmankamyer@wilsonengineering.com>; Ben Gibson <bgibson@wilsonengineering.com>
**Subject:** Re: LWWSD water intertie at Eagleridge

Hi Jim,

Circling back with you on this. We did some field data collection last month, and have refined our analysis within the Eagleridge system. Now the key piece of the analysis depends on what the City-side pressure is.


City of Bellingham
LWWSD Northshore Dr. Intertie
J1
Static Pressure = 78psi
Demand of 539gpm = 59psi
Demand of 750gpm = 45psi
NORTHSHORE DR
GOLDEN CT
ALTAIR CT
STELLER CT
Legend:
Water Mains
City Watermains - Active
City Watermains - Under Construction
Private Watermains
Air Release
Blow Off
Water Meters
Water Fittings
Private Hydrant
City Owned Hydrant
Filling Station
Fireline Valve
Hydrant Valve
Bypass Valve
Inline Valve
Tapping Valve
Zone Valve
Water Service Line
Fireline Lateral
Hydrant Lateral
N
Author: jbergner
Date: 10/14/2020
Project: Fire Flow Maps

One thing we discovered as we were digging in is that the Eagleride fire flow standard is actually 500 gpm, not the 750 gpm we previously discussed. Could you re-check your scenario (where you got 45 psi at 750 gpm), and tell us pressure at J1 under 539 gpm (500 gpm fire flow plus 39 gpm MDD)?

Thanks,

Brian Smith, P.E.
**Wilson Engineering, LLC**

805 Dupont Street, Suite 7
Bellingham, WA 98225
Ph: (360) 733-6100 x216
**www.wilsonengineering.com**

***Civil Engineering and Surveying Services Since 1967***

On Wed, Aug 12, 2020 at 10:27 AM Bergner, Jim P. <jbergner@cob.org> wrote:

> Hi Brian,
>
> I'm still having issues with the MDD scenario in the model that I was trying to use. It got me thinking that maybe the scenario I was trying to use wasn't the best one to use. This particular scenario was created in 2004 with the development of our model. All the other MDD scenarios were also created in 2004. Well that was 16 years ago and as you are probably aware the system has changed a lot since then. Not only have we removed and added new reservoirs, but now all City water customers are now metered. This will all be addressed next year when we start the process to update our Water System Plan and model.
>
> So with that said here is what I ended up doing. I reached out to the Water Treatment Plant manager and got the lowest water levels for the 2 Dakin reservoirs that provide water to this zone. I took those levels and the levels that are used in the ADD scenario that were used for your fire flow request at J1. I calculated out the difference to come up with a pressure of 45psi when flowing 750gpm.
>
> I also ran a fire flow within that zone at Northshore and Academy to see what you should have available at J1. You are left with a pressure of 64psi but with only 450gpm.
>
> Let me know if you have any question or if you need any additional information.
>
> **Regards,**

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Ben Gibson <bgibson@wilsonengineering.com>

# RE: LWWSD water intertie at Eagleridge

**Bergner, Jim P.** <jbergner@cob.org> Thu, Oct 22, 2020 at 3:18 PM
To: Brian Smith <bsmith@wilsonengineering.com>
Cc: Melanie Mankamyer <mmankamyer@wilsonengineering.com>, Ben Gibson <bgibson@wilsonengineering.com>

Hi Brian,

Here's what you are looking at in the way of pressure with a demand at 130.5gpm at J1. I set the reservoir levels to 11.00 for Dakin 1 and 9.71 for Dakin 2. Those reservoirs typically don' go below 13' & 10'.

**Regards,**

***Jim Bergner***

*Utility Operations Engineer*

*Public Works - Engineering*

*104 W. Magnolia St., Suite 109, Bellingham, WA 98225*

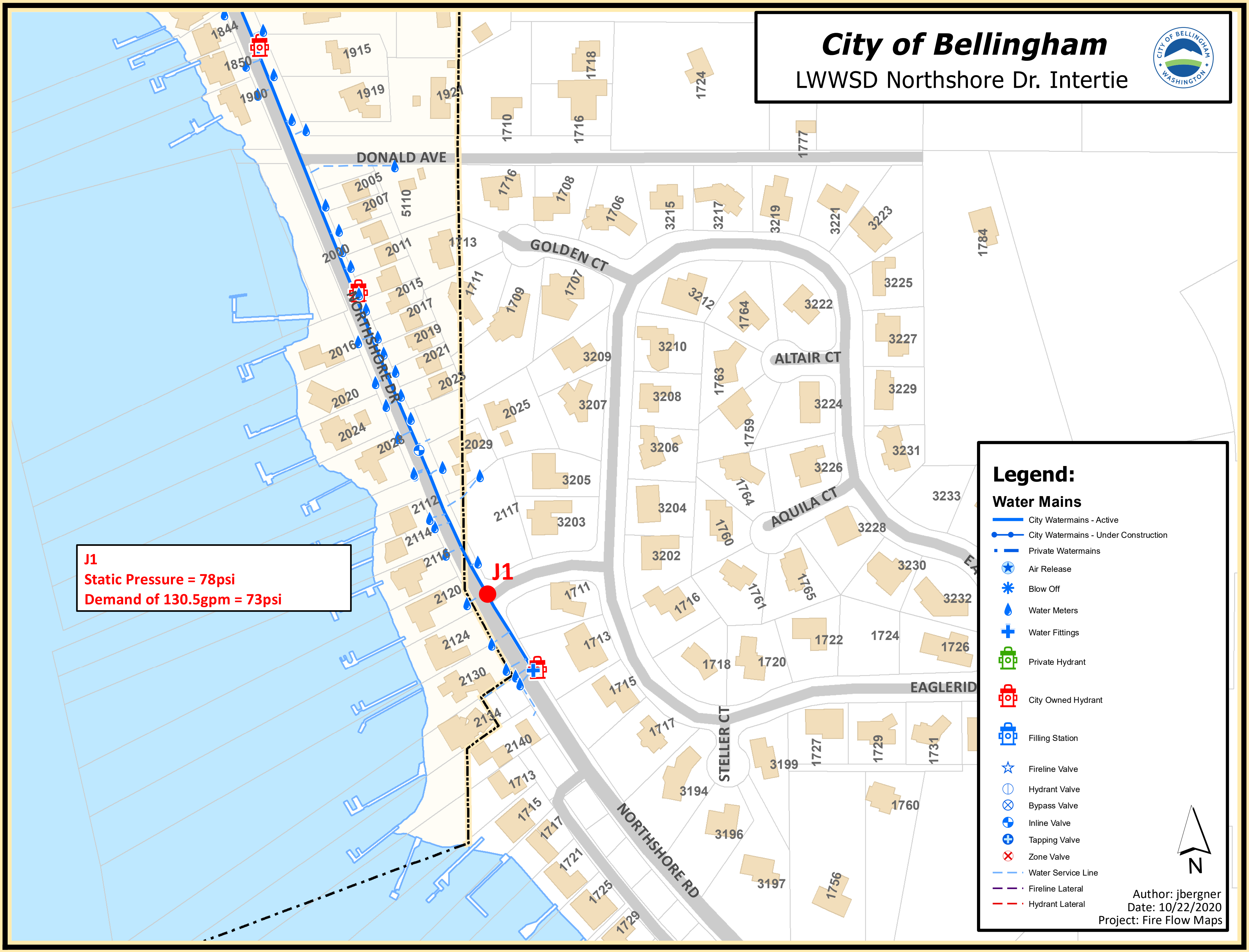
*P: 360.778.7731*

jbergner@cob.org



**From:** Brian Smith <bsmith@wilsonengineering.com>
**Sent:** Wednesday, October 21, 2020 3:11 PM
**To:** Bergner, Jim P. <jbergner@cob.org>
**Cc:** Melanie Mankamyer <mmankamyer@wilsonengineering.com>; Ben Gibson <bgibson@wilsonengineering.com>
**Subject:** Re: LWWSD water intertie at Eagleridge

Hi Jim,



City of Bellingham
LWWSD Northshore Dr. Intertie
CITY OF BELLINGHAM WASHINGTON
J1
Static Pressure = 78psi
Demand of 130.5gpm = 73psi
DONALD AVE
GOLDEN CT
NORTHSHORE DR
ALTAIR CT
AQUILA CT
STELLER CT
NORTHSHORE RD
Legend:
Water Mains
City Watermains - Active
City Watermains - Under Construction
Private Watermains
Air Release
Blow Off
Water Meters
Water Fittings
Private Hydrant
City Owned Hydrant
Filling Station
Fireline Valve
Hydrant Valve
Bypass Valve
Inline Valve
Tapping Valve
Zone Valve
Water Service Line
Fireline Lateral
Hydrant Lateral
N
Author: jbergner
Date: 10/22/2020
Project: Fire Flow Maps