TECHNICAL MEMORANDUM

To:	**Michelle Mattern, Development Manager**	Company:	**1842 King St. E. Inc.**
From:	**Sam Ziemann, P.Eng.** **c. 519-404-4529**	Our File:	**Job #75-41-211517**
Cc:		Date:	**August 3, 2021**
Subject:	**Hydraulic Assessment of the Proposed 1842 King Street East Development**		

1842 King St. E Inc.

Hydraulic Assessment of the Proposed 1842 King Street East Development

C3 WATER INC.

August 3, 2021

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VERSION	DATE	DESCRIPTION OF REVISIONS	REVISED BY	REVIEWED BY
1	March 9, 2021	Draft 1	Jeffrey Stevens, Michelle Scott	Sam Ziemann, Steve Pongracz (Lanhack)
2	March 19, 2021	Final – Updated Servicing Configuration	Jeffrey Stevens, Michelle Scott	Sam Ziemann, Steve Pongracz (Lanhack)
3	March 22, 2021	Final – Updated Development Description	Michelle Scott	Sam Ziemann, Steve Pongracz (Lanhack), City of Hamilton
4	July 28, 2021	Updated Draft – Addressed City Comments	Jeffrey Stevens, Michelle Scott	Sam Ziemann, Steve Pongracz (Lanhack)
5	August 3, 2021	Final	Jeffrey Stevens, Michelle Scott	Sam Ziemann

SIGN OFF

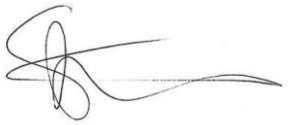
This document, entitled **"Hydraulic Assessment of the Proposed 1842 King Street East Development",** was prepared by C3 Water Inc. for **1842 King St. E. Inc**.

C3W certifies that the information contained in this report is accurate, complete and in accordance to the terms of our engagement. This assessment is based, in part, on information provided by others. Unless specifically noted, C3W has assumed that this information is correct, and has relied on it in the development of conclusions.

The material herein reflects C3 Water's best judgement based upon the information available at the time of preparation. Any use which a third party makes of this report or any reliance on or decisions made based on it, are the responsibilities of such third parties. C3 Water Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based upon this report.

DATE: August 3, 2021

Prepared by: **Sam Ziemann, P.Eng., President**
C. 519-404-4529



1.0 INTRODUCTION

1.1 Background

The proposed 1842 King Street East development is located in Pressure District 4 (PD4) in the City of Hamilton (City). Figure 1-1 illustrates the proposed development area. C3 Water Inc (C3W) has been retained by 1842 King St. E. Inc. to complete a water hydraulic analysis for the proposed development.

Figure 1-1 1842 King Street East Development Area (Approximate)

Water services for the development will be provided by the existing City-owned 200mm watermains on King Street East and Lawrence Road. The development is expected to have a total population of 3,606 and will be comprised of the following:

- Four (4) 12-storey multi-residential buildings
- Four (4) 4-storey stacked townhouses

PD4 is a closed zone supplied by the HD04B and HD08A pumping stations, located at Greenhill Avenue and Dewitt Road, respectively. PD4 does not have floating storage. Therefore, without floating storage, zone pressures and available fire flows are dependent on the pump stations and distribution system capacity. An overview of PD4 is presented in Figure 1-2 below.

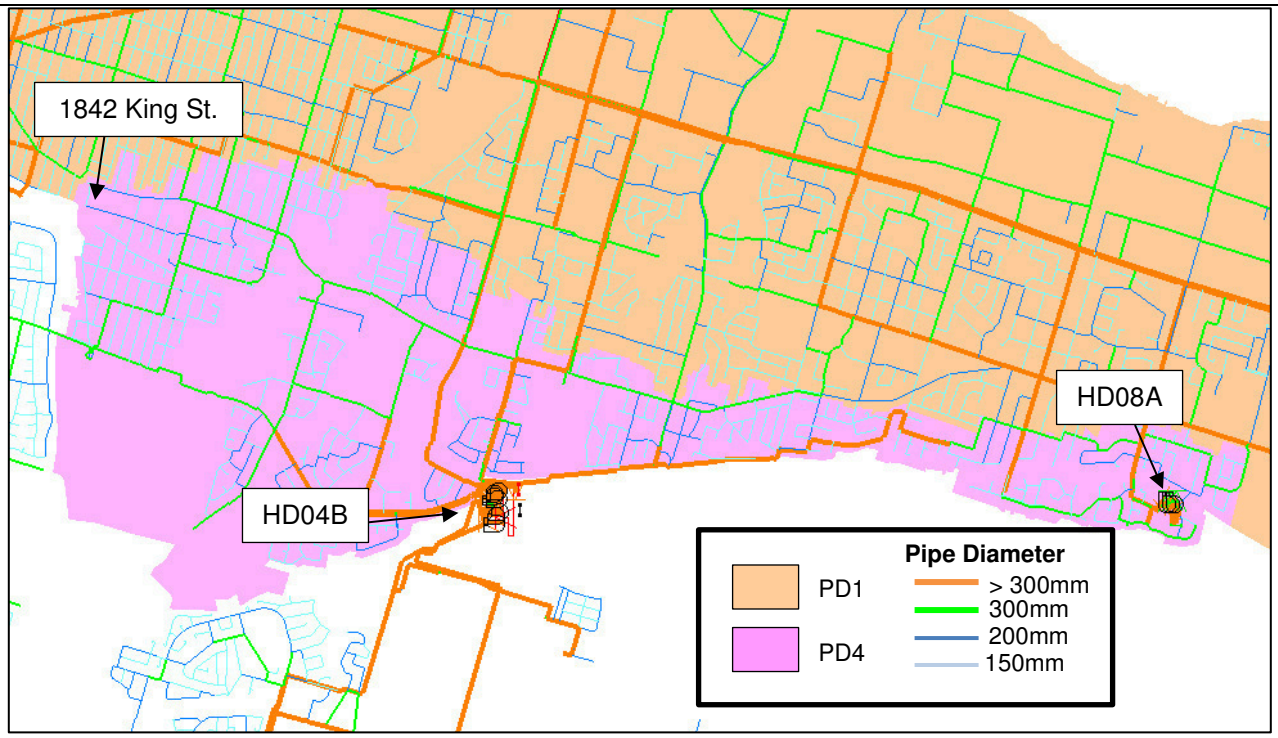


Figure 1-2 PD4 Overview

This report provides the watermain hydraulic assessment conducted by C3W for the proposed development in accordance with the City of Hamilton's Comprehensive Development Guidelines (2018) (Hamilton Guidelines) and the Ministry of Environment, Conservation and Parks (MECP) Design Guidelines for Drinking-Water Systems (2008) (MECP Guidelines). The hydraulic assessment was completed using the City's full pipe model, titled "Hamilton_EPS_200625_include_PD9_10." using Bentley WaterCAD Connect Edition Update 3 10.03.02.75 software.

2.0 CRITERIA

2.1 Pressure Requirements

The MECP Guidelines outline maximum and minimum system pressures for standard operating conditions as well as fire flow conditions. As outlined in the City of Hamilton's Water and Wastewater Masterplan (KMK, 2006), acceptable hydrant and service connection pressures under normal conditions range from 275 kPa to 690 kPa. Standard operating conditions were assessed for the proposed development to ensure that water services maintained acceptable pressure under various demand and fire flow conditions for existing (2021) and future (2031) scenarios. Table 2-1 provides the pressure criteria that were utilized.

Table 2-1: Pressure Requirements

Pressure Requirement	Minimum	Preferred	Maximum
Standard Operating Conditions	275 kPa (40 psi)	350 to 480 kPa (50 to 70 psi)	690 kPa (100 psi)
Maximum Day Demands + Fire Flows	140 kPa (20 psi)		

2.2 Domestic Demand

Domestic demands for the proposed development were calculated by Lanhack Consultants Inc. (Lanhack) based on an expected population of 3,606 with an average day consumption of 360 L/Capita/Day. Detailed water demand calculations can be found in Appendix A. Table 2-2 summarizes the domestic demands for the development.

Table 2-2**:** Domestic Demands for the Development Area

Watermain	Population	Demand (L/s)		
		ADD	MDD	PHD
King Street West	3,606	15.03	28.56	45.09

2.3 Fire Flow Demand

The fire flow requirements for the proposed development are based on the Hamilton Watermain Fire Flow Requirement Design Guidelines Policy (PW19096). The City's residential fire flow requirements are summarized in Table 2-3 below. As the proposed development consists of multi-family dwellings, a target fire flow of 150 L/s was used. The development is required to meet the minimum fire flow at a residual pressure of 140 kPa under MDD conditions, as specified in Table 2-1. The development's 12-storey buildings will be equipped with sprinkler systems.

Table 2-3: Hamilton Residential Fire Flow Requirements

Development Type	Target Fire Flow (L/s)
Residential Multi (> 3 Units)	**150**
Residential Medium (≤ 3 Units)	125
Residential Single	75
Residential Single (Dead End)	50

3.0 HYDRAULIC WATER MODEL

3.1 Boundary Conditions

The proposed development was modelled under the following demand scenarios under both existing (2021) and future (2031) conditions:

- ADD
- Maximum Day Demand (MDD)
- MDD plus Fire Flow
- Peak Hour Demand (PHD)

Table 3-1 summarizes the initial boundary conditions set up in the model, as specified by the City.

Table 3-1: Model Boundary Conditions

Element	Initial Status
HD04B-PMP-1	Off
HD04B-PMP-2	Off
HD04B-PMP-3	Off
HD04B-PMP-4	Off
HD08A-PMP-1	**On**
HD08A-PMP-2	Off
HD08A-PMP-3	Off

3.2 Model Verification

Hydrant flow tests provided by Jackson Waterworks from June 12, 2020 were used to verify the City's hydraulic water model results at hydrants HB25H019 on King Street East and HB28H027 on Lawrence Road, shown in Figure 3-1 below.

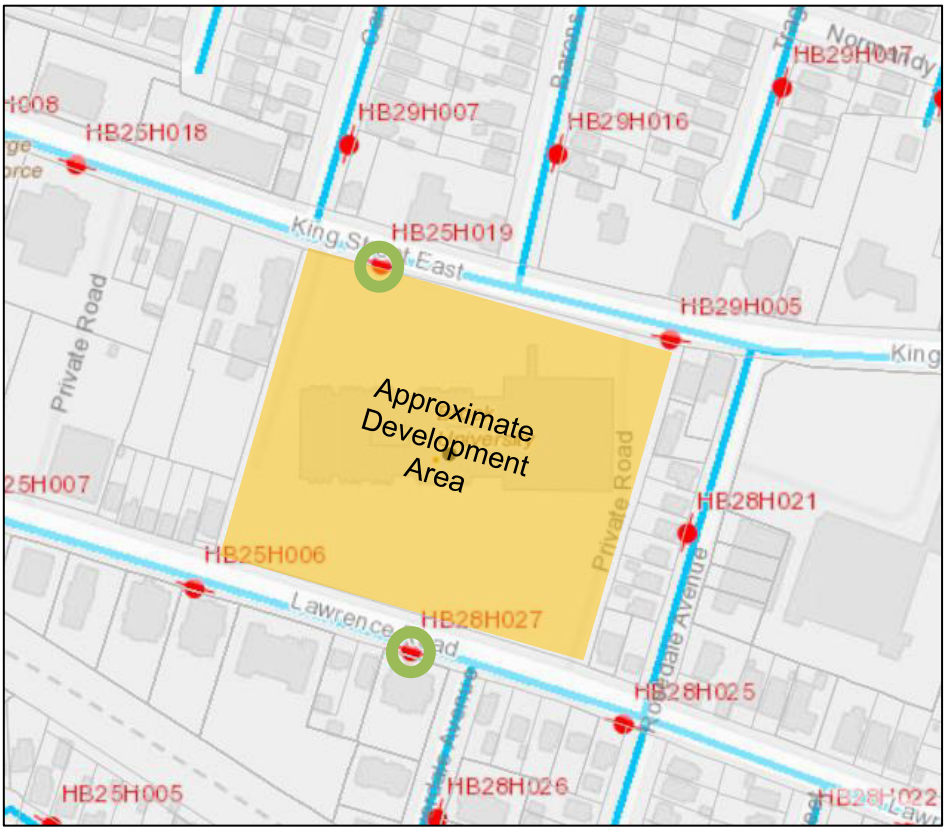


Figure 3-1: Hydrants used for Model Validation

The model was run under steady state (SS) 2021 ADD conditions, with HD08A-PMP-1 and HD08A-PMP-2 running. The results were compared to the field tests, shown in Figure 3-2 and Figure 3-3 below. The model closely matched the field results at Lawrence Road.

At the King Street hydrant, the model showed significantly less fire flow than was recorded in the field test. At the test flow of 142 L/s, the model pressure dropped by 310 kPa compared to only 69 kPa recorded in the field test. As a sensitivity exercise, the C-factors on the King Street watermain were increased from 80 to 140 from Kenilworth Avenue to east of Glencarry Avenue. A C-factor of 140 is considered very high (low roughness) for ductile iron pipe and would only be used for a PVC watermain. With a C-factor of 140, there was still considerably less fire flow available in the model than was recorded in the field test.

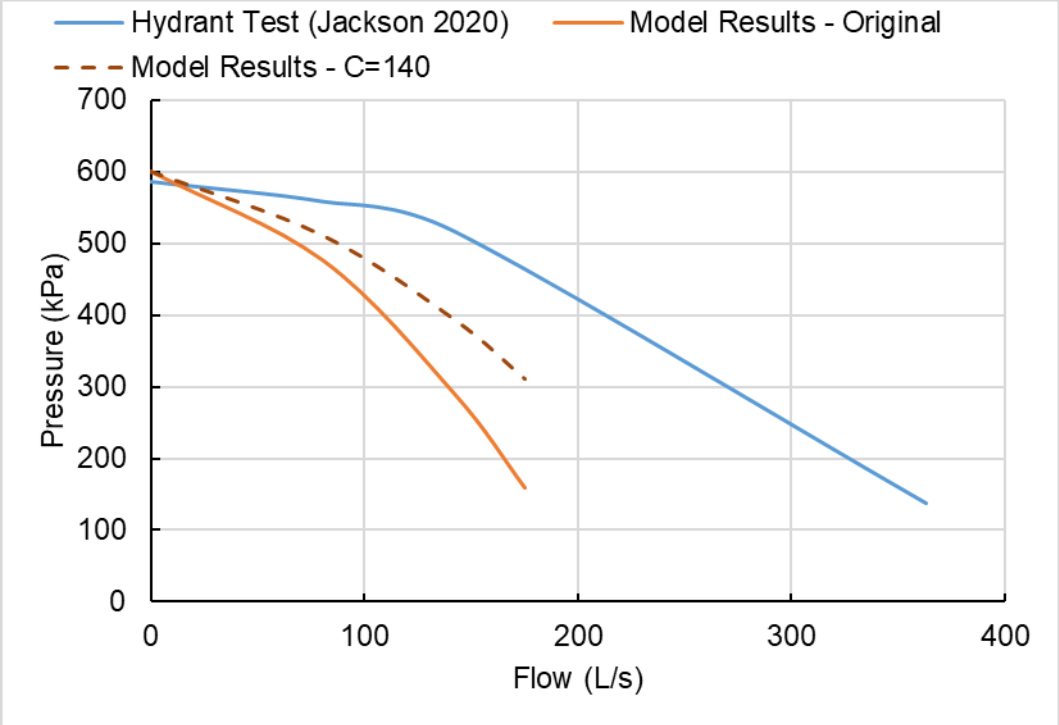


Figure 3-2. Model Verification – King Street (HB25H019)

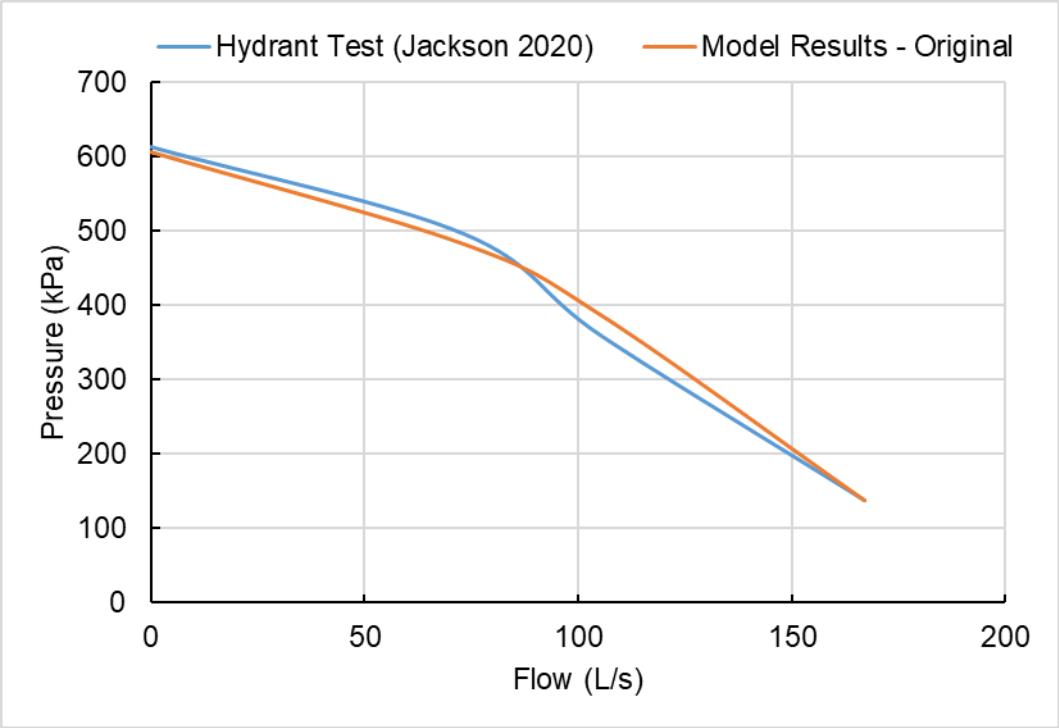


Figure 3-3 Model Verification – Lawrence Road (HB28027)

Hydrant testing was also completed at King Street hydrant HB25H019 by the City on August 12, 2018. The model results with the original C-factor of 80 are compared to the City's hydrant test in Figure 3-4 below. The model was run under the 2021 ADD SS scenario with no PD4 pumps running. At the test flow of 68 L/s, the model had a pressure drop of 152 kPa compared to 159 kPa recorded in the field. The model results are significantly closer to the hydrant test completed by the City in 2018 compared to the test completed by Jackson Waterworks in 2020.

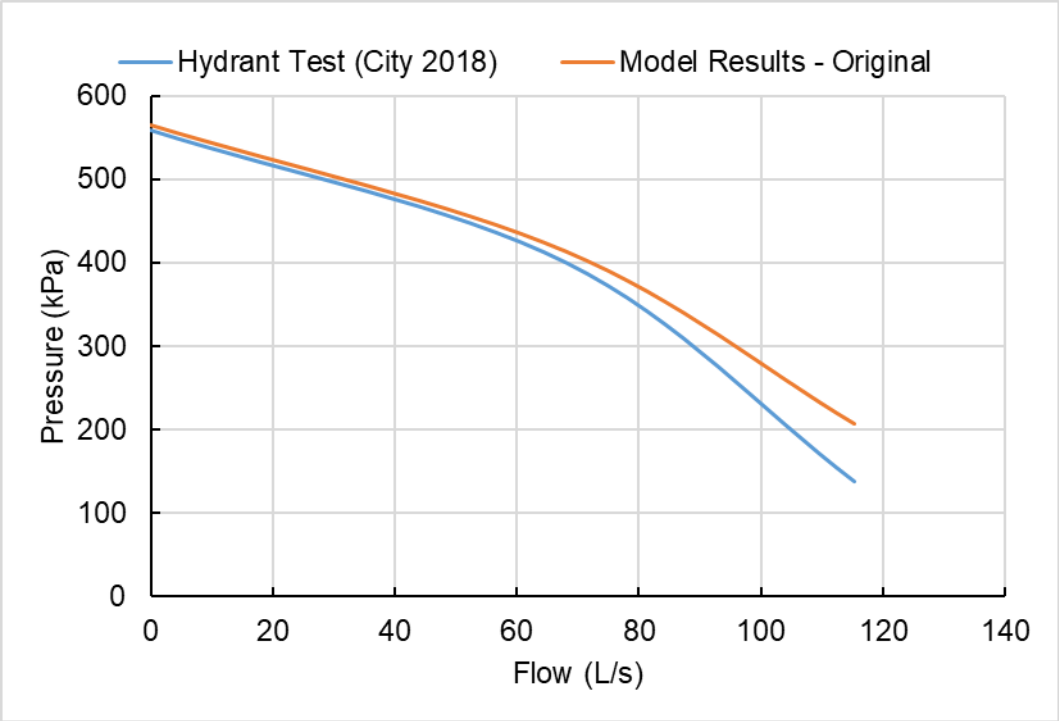


Figure 3-4 Model Verification – King Street (HB25H019) – City Field Test

Based on the findings of the model verification, the 200mm watermains on King Street and Lawrence Road were modelled with a C-factor of 80, unchanged from the original model. The hydrant test results recorded by Jackson Waterworks in 2020 at the King Street hydrant HB25H019 do not appear to be feasible given the location and size of the watermains currently included in the model.

3.3 Development

Figure 3-5 illustrates the proposed 1842 King Street East development servicing configuration. Backflow prevention devices were added to the model at both connections to the municipal watermains. The development's domestic demands were evenly distributed between the two servicing connections at the end of the 150mm pipes.

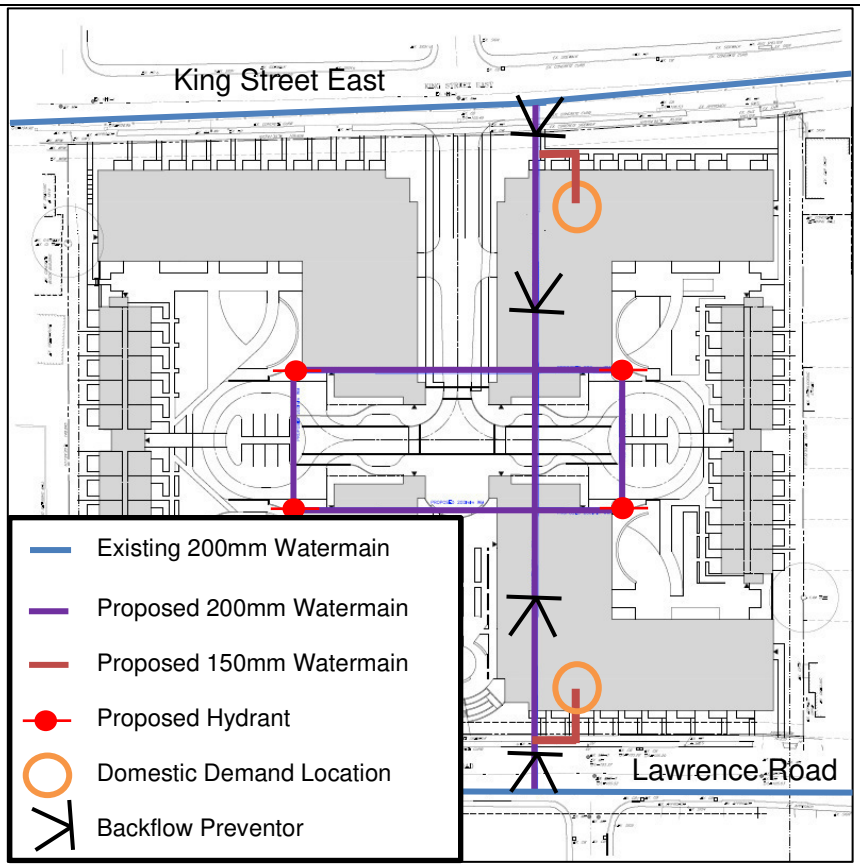


Figure 3-5 Servicing Layout (Not to Scale)

4.0 ANALYSIS

4.1 Available Fire Flow

The model was used to determine the available fire flow at ten junctions, including the four proposed hydrants within the development, the four municipal hydrants in the surrounding area, and at the service connections from Lawrence Road and King Street East. The model was run under MDD conditions to a residual pressure of 140 kPa. The locations of all fire flow nodes can be seen in Figure *4-1* below. The fire flow results predicted by the model are representative of the amount of water available in a watermain and not the extent of flow available from a hydrant. Several hydrants may need to be operated to provide the desired fire flows.

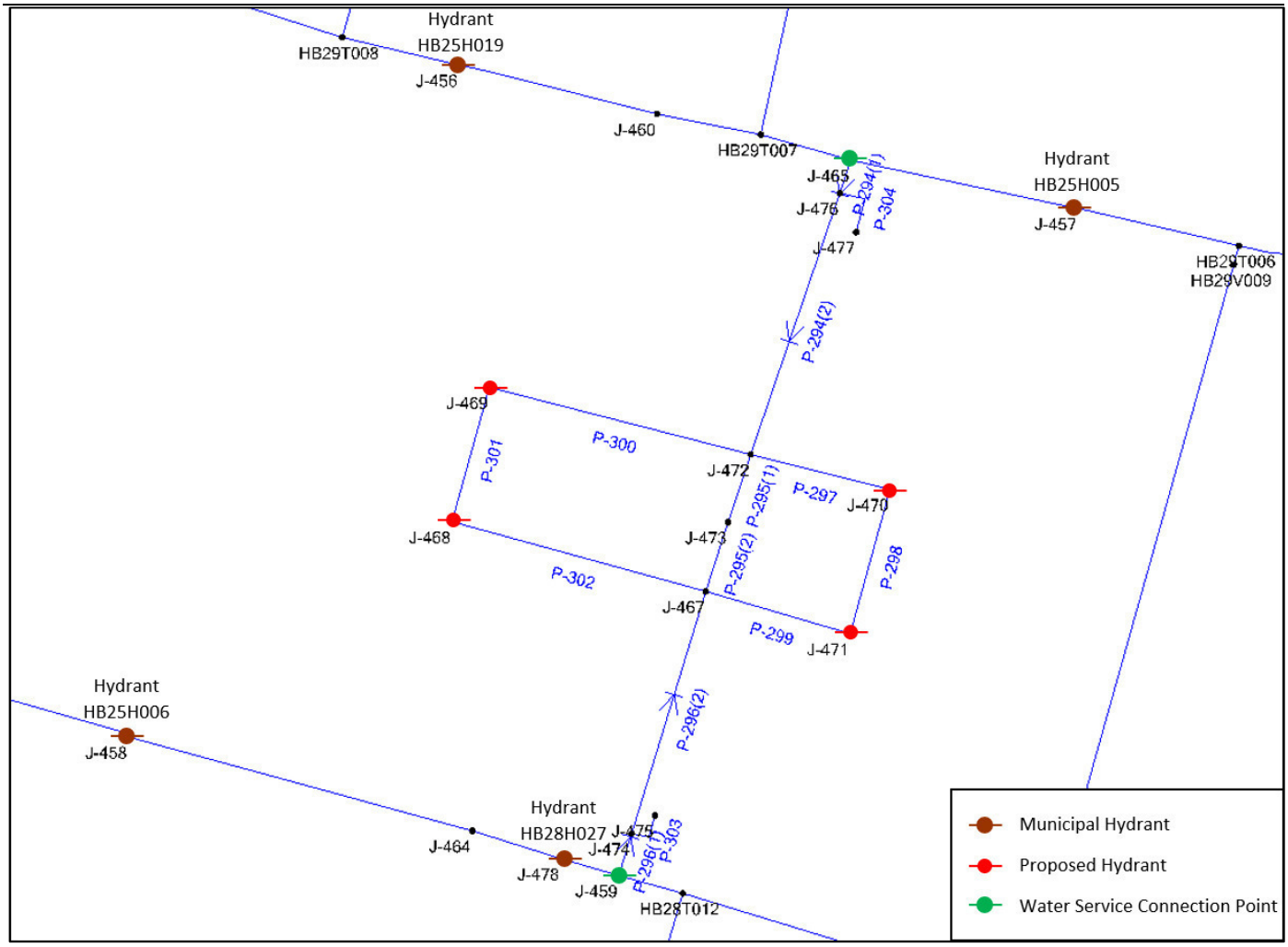


Figure 4-1 Fire Flow Nodes

The following pumps were operated for the fire flow analysis:

- HD08A-PMP-1
- HD08A-PMP-2
- HD04B-PMP-1
- HD04B-PMP-2

Based on input from the City, the above pumps are the maximum supply that can be provided to PD4 during a fire flow event.

The fire flow results at the hydrant locations within the proposed development are summarized in Table 4-1 below. The fire flow requirement of 150 L/s was met at all the proposed hydrants within the development area.

Table 4-1: Available Fire Flow Results (L/s) – Within Development

Hydrant	2021	2031	Meets FF Criteria?
Proposed Private Hydrant (NW Corner)	**156**	**156**	**TRUE**
Proposed Private Hydrant (SW Corner)	**156**	**156**	**TRUE**
Proposed Private Hydrant (SE Corner)	**160**	**160**	**TRUE**
Proposed Private Hydrant (NE Corner)	**160**	**160**	**TRUE**

Table 4-2 summarizes the available fire flows at the nodes on Lawrence Road and King Street East, including the existing hydrants and proposed service connections. Hydrant locations are shown above in Figure 4-1. With all available pumps operating, of the six nodes tested, the fire flow requirement was met at hydrant HB29H005 on King Street only.

Table 4-2: Available Fire Flow Results (L/s) on Lawrence Road and King Street East

Hydrant	2021	2031	Meets FF Criteria?
King HB25H019	132	132	FALSE
King HB29H005	**153**	**153**	**TRUE**
Lawrence HB25H006	128	128	FALSE
Lawrence HB28H027	143	143	FALSE
King Connection Point	139	138	FALSE
Lawrence Connection Point	142	142	FALSE

4.2 System Pressures

The pressure within the development area was assessed under various existing and future scenarios with HD08A-PMP-1 running. The results are presented in Table 4-3 below. The pressures ranged between 414 – 586 kPa. This falls within the standard operating range of 275 – 690 kPa, but above the preferred operating range of 350 – 480 kPa specified in Table 2-1.

Table 4-3: Pressure Results (kPa) with HD08A-PMP-1 running

Scenario	Min	Max
2021		
ADD	565	586
MDD	517	538
PHD	421	448
2031		
ADD	565	586
MDD	517	538
PHD	414	441

4.3 Transient Pressures

The MECP Guidelines recommends that all watermains be designed to withstand maximum operating pressure plus the surge pressure that would be created by stopping of a water column moving at 0.6 m/s.

It was assumed that the new pipe will consist of AWWA C900-compliant PVC pipe with a pressure rating of 1034 kPa (150psi) (150 DR18), as outlined in the City of Hamilton's Specification for the Installation of Watermains (April 2014). This class of pipe is expected to experience a surge pressure of 240 kPa (34.8 psi) for a 0.6 m/s instantaneous flow velocity change (JM Eagle. 2017). The maximum operating pressure plus transient pressure was therefore calculated to be approximately 826 kPa (586 kPa + 240 kPa) and is within the rated 1034 kPa range of the pipe. Pipe restraints and thrust blocks should be utilized and designed for a minimum pressure of 1034 kPa.

4.4 System Flushing

The hydraulic model was used to evaluate the flushing capacity of the proposed watermains within the development with HD08A-PMP-1 turned on. The ADD 2021 scenario was used to represent existing conditions for construction flushing requirements. Flushing demands were modelled to replace domestic demands while the area is under development. Results were based on a minimum velocity of 0.8 m/s as required by the MECP Guidelines. Various nodes were modelled as hydrant nodes, each with an emitter coefficient of 11.2 L/s/m0.5 (150 gpm/psi). This value is recommended by the American Water Works Association (AWWA) to represent a single 60mm (2.5”) outlet and considers all lateral valve and bends within the hydrant.

The modeled flushing configurations for the development area are shown in Figure 4-2 and 4-3 below.

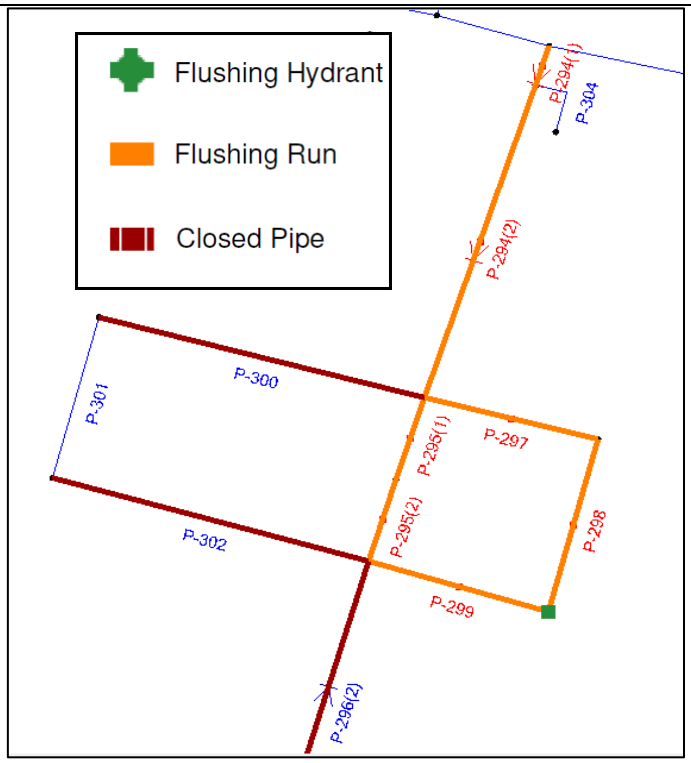


Figure 4-2 Flushing Configuration 1

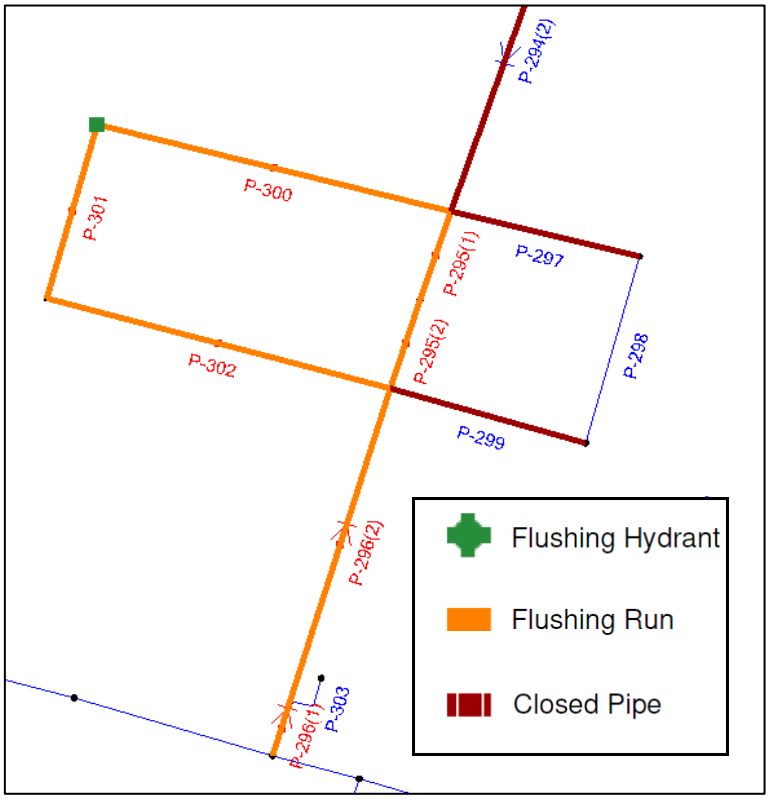


Figure 4-3 Flushing Configuration 2

The model results indicate that the required flushing velocity can be achieved within the development area. The results are summarized in Table 4-4 below. Full results can be found in Appendix C.

Table 4-4: Flushing Results with HD08A-PMP-1 running – ADD 2021

Event	Pipe	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
Event 1	P-297	200	1.14	TRUE
	P-298	200	1.14	TRUE
	P-299	200	1.14	TRUE
	P-295(1)	200	1.14	TRUE
	P-295(2)	200	1.14	TRUE
	P-294(1)	200	2.53	TRUE
	P-294(2)	200	2.29	TRUE
Event 2	P-300	200	1.14	TRUE
	P-301	200	1.14	TRUE
	P-302	200	1.14	TRUE
	P-295(1)	200	1.14	TRUE
	P-295(2)	200	1.14	TRUE
	P-296(1)	200	2.53	TRUE
	P-296(2)	200	2.29	TRUE

5.0 CONCLUSIONS

The watermain hydraulic assessment of the proposed 1842 King Street East development demonstrated that:

1. The service pressures at the proposed King Street East connection under existing (2021), and future (2031) conditions are expected to range between 414 kPa and 586 kPa which are within the operating standards established by the MECP and City of Hamilton Guidelines.
2. The required fire flow of 150 L/s under maximum day demand conditions was achieved at all proposed hydrants within the development. Of the four existing hydrants surrounding the development area and the two service connections, the fire flow requirement was met at hydrant HB29H005 on King Street only.
3. The development watermains can withstand transient pressure plus maximum operating pressure assuming they conform to City specifications of 150 DR18 PVC pipe.
4. All watermains in the development area were able to achieve a minimum flushing velocity of 0.8 m/s based on the outlined unidirectional flow procedure, when HD08A-PMP-1 was running.

APPENDIX A

Domestic Demand Calculations

Table 3.1: Sanitary Discharge Flow Rate

Type of Unit	Number of Bedrooms per Unit (1)	Average Daily Flow per Capita (L/d) (2)	Total Number of Units (3)	Design Population (4)	Total Peak Flow (5)(6) (L/s)	Including Infiltration Allowance (7) (L/s)
1-Bedroom Unit	1.0	360	1175	2350	58.17	**59.78**
2-Bedroom Unit	2.0	360	230	920		
3-Bedroom Unit	3.0	360	56	336		

(1) Number of bedrooms based on site plan and floor plans prepared by Graziani and Corazza Architects Inc.

(2) Average Domestic Sewage Flow Rate from City of Hamilton Development Guideline Chapter E.1.4
Daily Flow = 360 L/day/capita

*(3) Refer to site plan prepared by Graziani and Corazza Architects Inc. – **Appendix C***

(4) Design population based on two (2) persons per sleeping room within a dwelling unit or suite.
Refer to OBC Section 3.1.17.1.(1).(b)

(5) Total Avg. Flow = [(Avg. Daily Flow per Capita) x (Total Design Population)]
= [360 L/d/person x (2350 persons + 920 persons+ 336 persons)] / 24 / 60 / 60
= 15.03 L/s

(6) Total peak flow determined from City of Hamilton Development Guideline Chapter E.1.5 (Babbitt Formula)
$M = 5 / P^{0.2} = 5 / (3606/1000)^{0.2} = 3.87$

(7) Infiltration Allowance determined from the City of Hamilton development Guideline Chapter E.1.6.
Infiltration Allowance of 0.6 L/s/ha was used for the site
= 0.6 L/s x 2.68 ha = 1.61 L/s

Total Sanitary Discharge Peak Flow Rate = 59.78 L/s

Table 4.1: Estimated Domestic Water Supply Demands

Expected (1) Population	Average Day (2) Demand (L/s)	Maximum Day (3) Demand (L/s)	Peak Hour (4) Demand (L/s)	Fire Flow (5) (L/s)	Max. Day + Fire Flow (L/s)
3606	15.03	**28.56**	45.09	150.00	**178.56**

(1) Design population based on two (2) persons per sleeping room within a dwelling unit or suite.
Refer to OBC Section 3.1.17.1.(1).(b)

(2) Average Consumption Rate for Residential Area = 360 L/cap/day
= (360 L/d x 3606 persons) / 24 / 60 / 60
= 15.03 L/s

*(3) *Maximum Day Factor of 1.9 x Average Day Demand*

*(4) *Peak Hour Factor of 3.0 x Average Day Demand*

*(5) Fire Flow of (150.00 L/s) calculation based on greater of OBC and the City of Hamilton Watermain Fire Flow Requirement Design Guidelines - **Appendix B***

**Demand Factors from: City of Hamilton Water and Wastewater Masterplan, Class Environmental Assessment Report (November 2006)*

Maximum Daily Demand + Fire Flow = 178.56 L/s

APPENDIX B

Fire Flow Results

Fire Flow Results

2021 - 4 Pumps Running

Label	Notes	Zone	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (psi)	Pressure (Calculated Residual) (psi)	Pressure (Zone Lower Limit) (psi)	Pressure (Calculated Zone Lower Limit) (psi)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (psi)	Pressure (Calculated System Lower Limit) (psi)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
J-456	HB25H019	4	3	FALSE	150	132	150	132	20	20	20	21	HB29T008	(N/A)	-2,634	DL06T014	TRUE
J-457	HB29H005	4	5	TRUE	150	153	150	153	20	21	20	20	J-477	(N/A)	-2,634	DL06T014	TRUE
J-458	HB25H006	4	4	FALSE	150	128	150	128	20	20	20	22	HB25R001	(N/A)	-2,634	DL06T014	TRUE
J-459	Lawrence Connection	4	5	FALSE	150	142	150	142	20	23	20	20	J-475	(N/A)	-2,634	DL06T014	TRUE
J-465	King Connection	4	5	FALSE	150	139	150	139	20	23	20	20	J-477	(N/A)	-2,634	DL06T014	TRUE
J-468	Proposed	4	3	TRUE	150	156	150	156	20	20	20	22	J-469	(N/A)	-2,634	DL06T014	TRUE
J-469	Proposed	4	3	TRUE	150	156	150	156	20	20	20	22	J-468	(N/A)	-2,634	DL06T014	TRUE
J-470	Proposed	4	3	TRUE	150	160	150	160	20	20	20	21	J-471	(N/A)	-2,634	DL06T014	TRUE
J-471	Proposed	4	3	TRUE	150	160	150	160	20	20	20	21	J-470	(N/A)	-2,634	DL06T014	TRUE
J-478	HB28H027	4	5	FALSE	150	143	150	143	20	21	20	20	J-475	(N/A)	-2,634	DL06T014	TRUE

2031 - 4 Pumps Running

Label	Notes	Zone	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (psi)	Pressure (Calculated Residual) (psi)	Pressure (Zone Lower Limit) (psi)	Pressure (Calculated Zone Lower Limit) (psi)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (psi)	Pressure (Calculated System Lower Limit) (psi)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
J-456	HB25H019	4	3	FALSE	150	132	150	132	20	20	20	21	HB29T008	(N/A)	-1	SA03RS09	TRUE
J-457	HB29H005	4	5	TRUE	150	153	150	153	20	21	20	20	J-477	(N/A)	-1	SA03RS09	TRUE
J-458	HB25H006	4	4	FALSE	150	128	150	128	20	20	20	22	HB25R001	(N/A)	-1	SA03RS09	TRUE
J-459	Lawrence Connection	4	5	FALSE	150	142	150	142	20	23	20	20	J-475	(N/A)	-1	SA03RS09	TRUE
J-465	King Connection	4	5	FALSE	150	138	150	138	20	23	20	20	J-477	(N/A)	-1	SA03RS09	TRUE
J-468	Proposed	4	3	TRUE	150	156	150	156	20	20	20	22	J-469	(N/A)	-1	SA03RS09	TRUE
J-469	Proposed	4	3	TRUE	150	156	150	156	20	20	20	22	J-468	(N/A)	-1	SA03RS09	TRUE
J-470	Proposed	4	3	TRUE	150	160	150	160	20	20	20	21	J-471	(N/A)	-1	SA03RS09	TRUE
J-471	Proposed	4	3	TRUE	150	160	150	160	20	20	20	21	J-470	(N/A)	-1	SA03RS09	TRUE
J-478	HB28H027	4	5	FALSE	150	143	150	143	20	21	20	20	J-475	(N/A)	-1	SA03RS09	TRUE

APPENDIX C

Flushing Results

Event 1

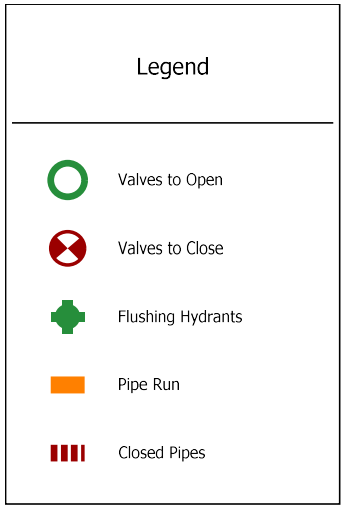
ID	Label	Length (m)	Diameter (mm)	Flushing Event	Velocity (Maximum Flushing) (m/s)	Satisfies Flushing Target Velocity?	Shear Stress (Maximum Flushing) (kg/m²)	Satisfies Flushing Target Shear Stress?	Satisfies Flushing Target?
33540	P-297	20	200	Event - 1	1.14	TRUE	0.47	TRUE	TRUE
33541	P-298	34	200	Event - 1	1.14	TRUE	0.47	TRUE	TRUE
33542	P-299	20	200	Event - 1	1.14	TRUE	0.47	TRUE	TRUE
33543	P-300	62	200	Event - 1	0	FALSE	0	TRUE	FALSE
33544	P-301	34	200	Event - 1	0	FALSE	0	TRUE	FALSE
33545	P-302	62	200	Event - 1	0	FALSE	0	TRUE	FALSE
33549	P-295(1)	17	200	Event - 1	1.14	TRUE	0.47	TRUE	TRUE
33550	P-295(2)	17	200	Event - 1	1.14	TRUE	0.47	TRUE	TRUE
33552	P-296(1)	11	200	Event - 1	0.24	FALSE	0.03	TRUE	FALSE
33553	P-296(2)	61	200	Event - 1	0	FALSE	0	TRUE	FALSE
33557	P-294(1)	8	200	Event - 1	2.53	TRUE	2.05	TRUE	TRUE
33558	P-294(2)	60	200	Event - 1	2.29	TRUE	1.71	TRUE	TRUE

Event 2

ID	Label	Length (m)	Diameter (mm)	Flushing Event	Velocity (Maximum Flushing) (m/s)	Satisfies Flushing Target Velocity?	Shear Stress (Maximum Flushing) (kg/m²)	Satisfies Flushing Target Shear Stress?	Satisfies Flushing Target?
33540	P-297	20	200	Event - 2	0	FALSE	0	TRUE	FALSE
33541	P-298	34	200	Event - 2	0	FALSE	0	TRUE	FALSE
33542	P-299	20	200	Event - 2	0	FALSE	0	TRUE	FALSE
33543	P-300	62	200	Event - 2	1.14	TRUE	0.47	TRUE	TRUE
33544	P-301	34	200	Event - 2	1.14	TRUE	0.47	TRUE	TRUE
33545	P-302	62	200	Event - 2	1.14	TRUE	0.47	TRUE	TRUE
33549	P-295(1)	17	200	Event - 2	1.14	TRUE	0.47	TRUE	TRUE
33550	P-295(2)	17	200	Event - 2	1.14	TRUE	0.47	TRUE	TRUE
33552	P-296(1)	11	200	Event - 2	2.53	TRUE	2.05	TRUE	TRUE
33553	P-296(2)	61	200	Event - 2	2.29	TRUE	1.71	TRUE	TRUE
33557	P-294(1)	8	200	Event - 2	0.24	FALSE	0.03	TRUE	FALSE
33558	P-294(2)	60	200	Event - 2	0	FALSE	0	TRUE	FALSE

Flushing Field Report

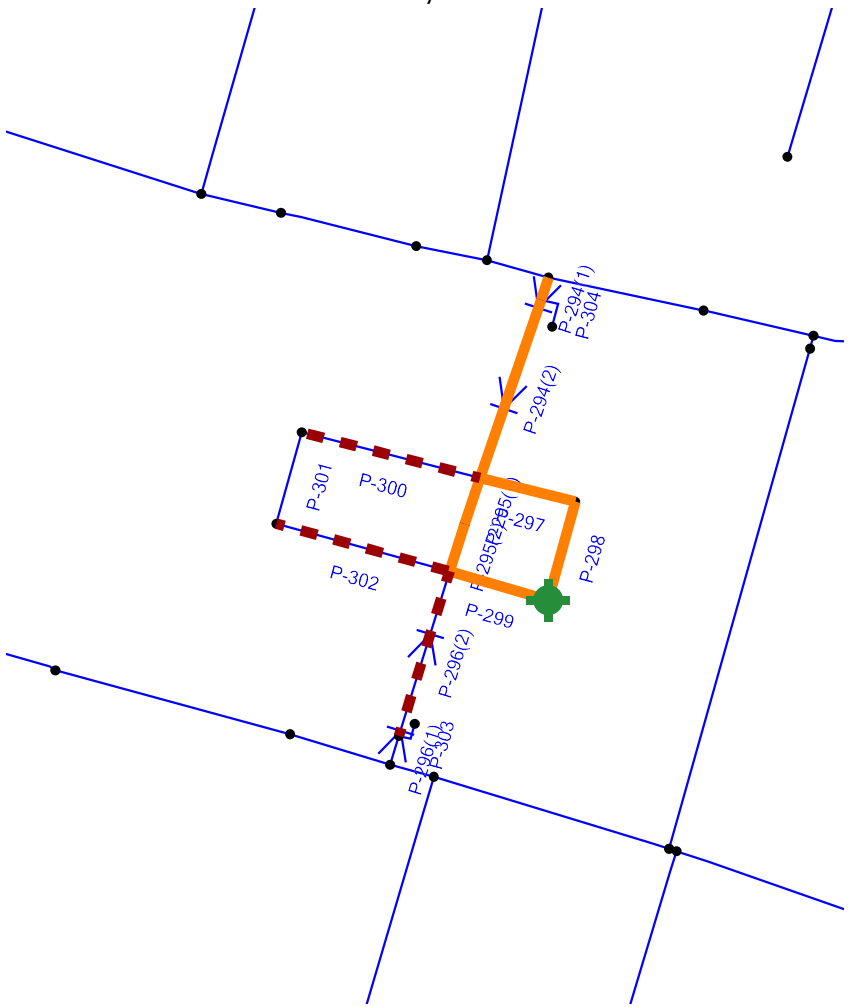
Study: Flushing Study



Flushing Field Report

Study: Flushing Study; Area: Area - 2; Event: Event - 1

Primary View



Flushing Field Report

Study: Flushing Study; Area: Area - 2; Event: Event - 1

Fire Hydrant	Notes	Pressure (psi) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (psi)	Predicted Flow (L/s)
J-471				58	72

Valve	Operation	Notes
P-296(2)	Close ☐	
P-302	Close ☐	
P-300	Close ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Pipe Run to be Cleaned
P-299, P-295(1), P-294(2), P-295(2), P-298, P-297, P-294(1)

Flushing	Minimum	Recommended
Time (min)	2.1	2.1
Volume (ML)	0.0	0.0

Start Time _____

End Time _____

Operator _____

Date

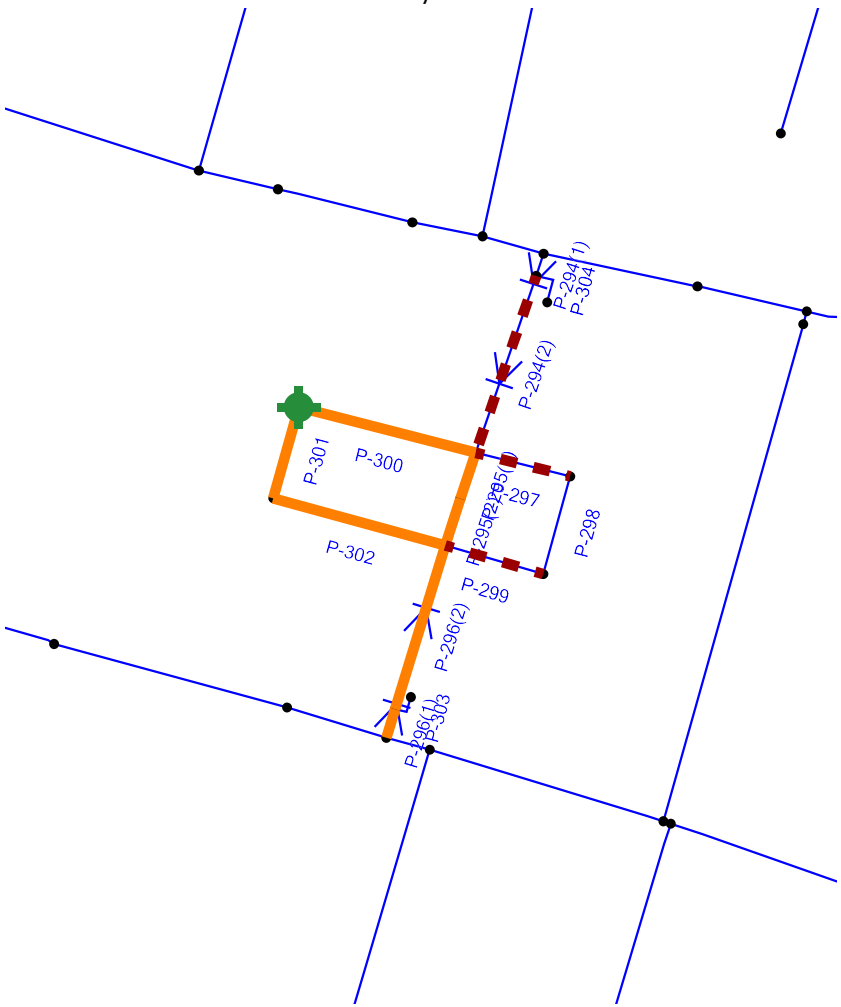
Water Quality	Initial	Final
Clear	☐	☐
Colored	☐	☐
Chlorine Residual		
Turbidity		

Notes _____

Flushing Field Report

Study: Flushing Study; Area: Area - 2; Event: Event - 2

Primary View



Flushing Field Report

Study: Flushing Study; Area: Area - 2; Event: Event - 2

Fire Hydrant	Notes	Pressure (psi) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (psi)	Predicted Flow (L/s)
J-469				58	72

Valve	Operation	Notes
P-296(2)	Reopen ☐	
P-302	Reopen ☐	
P-300	Reopen ☐	
P-297	Close ☐	
P-299	Close ☐	
P-294(2)	Close ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Pipe Run to be Cleaned
P-301, P-300, P-295(1), P-295(2), P-302, P-296(2), P-296(1)

Flushing	Minimum	Recommended
Time (min)	3.3	3.3
Volume (ML)	0.0	0.0

Start Time _____

End Time _____

Operator _____

Date

Water Quality	Initial	Final
Clear	☐	☐
Colored	☐	☐
Chlorine Residual		
Turbidity		

Notes _____

Flushing Field Report

Study: Flushing Study; Area: Area - 2; Event: Event - 2

Final Actions

Valve	Operation	Notes
P-297	Reopen ☐	
P-299	Reopen ☐	
P-294(2)	Reopen ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

APPENDIX D

Model Results

Nodes

ADD 2021 HD08A-PMP-1 running

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (psi)
33458	J-459	105.77	4	<Collection: 0 items>	0	165.58	85
33526	J-465	106.36	4	<Collection: 0 items>	0	165.58	84
33530	J-467	106	4	<Collection: 0 items>	0	165.58	85
33531	J-468	108	4	<Collection: 0 items>	0	165.58	82
33532	J-469	108	4	<Collection: 0 items>	0	165.58	82
33534	J-470	108	4	<Collection: 0 items>	0	165.58	82
33535	J-471	108	4	<Collection: 0 items>	0	165.58	82
33536	J-472	106	4	<Collection: 0 items>	0	165.58	85
33551	J-474	108	4	<Collection: 0 items>	0	165.58	82
33554	J-475	108	4	<Collection: 1 item>	8	165.53	82
33556	J-476	108	4	<Collection: 0 items>	0	165.58	82
33559	J-477	108	4	<Collection: 1 item>	8	165.54	82

MDD 2021 HD08A-PMP-1 running

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (psi)
33458	J-459	105.77	4	<Collection: 1 item>	0	160.96	78
33526	J-465	106.36	4	<Collection: 0 items>	0	160.93	77
33530	J-467	106	4	<Collection: 0 items>	0	160.94	78
33531	J-468	108	4	<Collection: 0 items>	0	160.94	75
33532	J-469	108	4	<Collection: 0 items>	0	160.94	75
33534	J-470	108	4	<Collection: 0 items>	0	160.94	75
33535	J-471	108	4	<Collection: 0 items>	0	160.94	75
33536	J-472	106	4	<Collection: 0 items>	0	160.94	78
33551	J-474	108	4	<Collection: 0 items>	0	160.94	75
33554	J-475	108	4	<Collection: 1 item>	14	160.77	75
33556	J-476	108	4	<Collection: 0 items>	0	160.91	75
33559	J-477	108	4	<Collection: 1 item>	14	160.8	75

PHD 2021 HD08A-PMP-1 running

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (psi)
33458	J-459	105.77	4	<Collection: 0 items>	0	151.45	65
33526	J-465	106.36	4	<Collection: 0 items>	0	151.34	64
33530	J-467	106	4	<Collection: 0 items>	0	151.41	64
33531	J-468	108	4	<Collection: 0 items>	0	151.41	62
33532	J-469	108	4	<Collection: 0 items>	0	151.41	62
33534	J-470	108	4	<Collection: 0 items>	0	151.41	62
33535	J-471	108	4	<Collection: 0 items>	0	151.41	62
33536	J-472	106	4	<Collection: 0 items>	0	151.41	64
33551	J-474	108	4	<Collection: 0 items>	0	151.41	62
33554	J-475	108	4	<Collection: 1 item>	23	151.02	61
33556	J-476	108	4	<Collection: 0 items>	0	151.31	61
33559	J-477	108	4	<Collection: 1 item>	23	151.04	61

ADD 2031 HD08A-PMP-1 running

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (psi)
33458	J-459	105.77	4	<Collection: 0 items>	0	165.56	85
33526	J-465	106.36	4	<Collection: 0 items>	0	165.56	84
33530	J-467	106	4	<Collection: 0 items>	0	165.55	85
33531	J-468	108	4	<Collection: 0 items>	0	165.55	82
33532	J-469	108	4	<Collection: 0 items>	0	165.55	82
33534	J-470	108	4	<Collection: 0 items>	0	165.55	82
33535	J-471	108	4	<Collection: 0 items>	0	165.55	82
33536	J-472	106	4	<Collection: 0 items>	0	165.55	85
33551	J-474	108	4	<Collection: 0 items>	0	165.55	82
33554	J-475	108	4	<Collection: 1 item>	8	165.5	82
33556	J-476	108	4	<Collection: 0 items>	0	165.55	82
33559	J-477	108	4	<Collection: 1 item>	8	165.5	82

MDD 2031 HD08A-PMP-1 running

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (psi)
33458	J-459	105.77	4	<Collection: 0 items>	0	160.77	78
33526	J-465	106.36	4	<Collection: 0 items>	0	160.73	77
33530	J-467	106	4	<Collection: 0 items>	0	160.75	78
33531	J-468	108	4	<Collection: 0 items>	0	160.75	75
33532	J-469	108	4	<Collection: 0 items>	0	160.75	75
33534	J-470	108	4	<Collection: 0 items>	0	160.75	75
33535	J-471	108	4	<Collection: 0 items>	0	160.75	75
33536	J-472	106	4	<Collection: 0 items>	0	160.75	78
33551	J-474	108	4	<Collection: 0 items>	0	160.75	75
33554	J-475	108	4	<Collection: 1 item>	14	160.58	75
33556	J-476	108	4	<Collection: 0 items>	0	160.72	75
33559	J-477	108	4	<Collection: 1 item>	14	160.55	75

PHD 2031 HD08A-PMP-1 running

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (psi)
33458	J-459	105.77	4	<Collection: 0 items>	0	150.95	64
33526	J-465	106.36	4	<Collection: 0 items>	0	150.84	63
33530	J-467	106	4	<Collection: 0 items>	0	150.91	64
33531	J-468	108	4	<Collection: 0 items>	0	150.91	61
33532	J-469	108	4	<Collection: 0 items>	0	150.91	61
33534	J-470	108	4	<Collection: 0 items>	0	150.91	61
33535	J-471	108	4	<Collection: 0 items>	0	150.91	61
33536	J-472	106	4	<Collection: 0 items>	0	150.91	64
33551	J-474	108	4	<Collection: 0 items>	0	150.91	61
33554	J-475	108	4	<Collection: 1 item>	23	150.52	60
33556	J-476	108	4	<Collection: 0 items>	0	150.81	61
33559	J-477	108	4	<Collection: 1 item>	23	150.42	60

Pipes

ADD 2021 HD08A-PMP-1 running

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (m)	Is Active?
33555	P-303	9	J-474	J-475	150	Ductile Iro	100	FALSE	0	8	0.43	0.003	TRUE	20	TRUE
33540	P-297	33	J-472	J-470	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33541	P-298	35	J-470	J-471	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33542	P-299	35	J-471	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33543	P-300	63	J-472	J-469	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33544	P-301	32	J-469	J-468	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33545	P-302	61	J-468	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33549	P-295(1)	17	J-472	J-473	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33550	P-295(2)	17	J-473	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33552	P-296(1)	10	J-459	J-474	200	Ductile Iro	110	TRUE	0	8	0.24	0.001	TRUE	11	TRUE
33553	P-296(2)	59	J-474	J-467	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	61	TRUE
33557	P-294(1)	8	J-465	J-476	200	Ductile Iro	110	TRUE	0	8	0.24	0.001	TRUE	8	TRUE
33558	P-294(2)	64	J-476	J-472	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	60	TRUE
33560	P-304	14	J-476	J-477	150	Ductile Iro	120	FALSE	0	8	0.43	0.002	TRUE	20	TRUE

MDD 2021 HD08A-PMP-1 running

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (m)	Is Active?
33555	P-303	9	J-474	J-475	150	Ductile Iro	100	FALSE	0	14	0.81	0.008	TRUE	20	TRUE
33540	P-297	33	J-472	J-470	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33541	P-298	35	J-470	J-471	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33542	P-299	35	J-471	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33543	P-300	63	J-472	J-469	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33544	P-301	32	J-469	J-468	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33545	P-302	61	J-468	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33549	P-295(1)	17	J-472	J-473	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33550	P-295(2)	17	J-473	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33552	P-296(1)	10	J-459	J-474	200	Ductile Iro	110	TRUE	0	14	0.45	0.002	TRUE	11	TRUE
33553	P-296(2)	59	J-474	J-467	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	61	TRUE
33557	P-294(1)	8	J-465	J-476	200	Ductile Iro	110	TRUE	0	14	0.45	0.002	TRUE	8	TRUE
33558	P-294(2)	64	J-476	J-472	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	60	TRUE
33560	P-304	14	J-476	J-477	150	Ductile Iro	120	FALSE	0	14	0.81	0.006	TRUE	20	TRUE

PHD 2021 HD08A-PMP-1 running

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (m)	Is Active?
33555	P-303	9	J-474	J-475	150	Ductile Iro	100	FALSE	0	23	1.28	0.019	TRUE	20	TRUE
33540	P-297	33	J-472	J-470	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33541	P-298	35	J-470	J-471	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33542	P-299	35	J-471	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33543	P-300	63	J-472	J-469	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33544	P-301	32	J-469	J-468	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33545	P-302	61	J-468	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33549	P-295(1)	17	J-472	J-473	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33550	P-295(2)	17	J-473	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33552	P-296(1)	10	J-459	J-474	200	Ductile Iro	110	TRUE	0	23	0.72	0.004	TRUE	11	TRUE
33553	P-296(2)	59	J-474	J-467	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	61	TRUE
33557	P-294(1)	8	J-465	J-476	200	Ductile Iro	110	TRUE	0	23	0.72	0.004	TRUE	8	TRUE
33558	P-294(2)	64	J-476	J-472	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	60	TRUE
33560	P-304	14	J-476	J-477	150	Ductile Iro	120	FALSE	0	23	1.28	0.014	TRUE	20	TRUE

ADD 2031 HD08A-PMP-1 running

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (m)	Is Active?
33555	P-303	9	J-474	J-475	150	Ductile Iro	100	FALSE	0	8	0.43	0.003	TRUE	20	TRUE
33560	P-304	14	J-476	J-477	150	Ductile Iro	100	FALSE	0	8	0.43	0.003	TRUE	20	TRUE
33540	P-297	33	J-472	J-470	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE

33541	P-298	35	J-470	J-471	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33542	P-299	35	J-471	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33543	P-300	63	J-472	J-469	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33544	P-301	32	J-469	J-468	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33545	P-302	61	J-468	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33549	P-295(1)	17	J-472	J-473	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33550	P-295(2)	17	J-473	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33552	P-296(1)	10	J-459	J-474	200	Ductile Iro	110	TRUE	0	8	0.24	0.001	TRUE	11	TRUE
33553	P-296(2)	59	J-474	J-467	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	61	TRUE
33557	P-294(1)	8	J-465	J-476	200	Ductile Iro	110	TRUE	0	8	0.24	0.001	TRUE	8	TRUE
33558	P-294(2)	64	J-476	J-472	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	60	TRUE

MDD 2031 HD08A-PMP-1 running

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (m)	Is Active?
33555	P-303	9	J-474	J-475	150	Ductile Iro	100	FALSE	0	14	0.81	0.008	TRUE	20	TRUE
33560	P-304	14	J-476	J-477	150	Ductile Iro	100	FALSE	0	14	0.81	0.008	TRUE	20	TRUE
33540	P-297	33	J-472	J-470	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33541	P-298	35	J-470	J-471	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33542	P-299	35	J-471	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33543	P-300	63	J-472	J-469	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33544	P-301	32	J-469	J-468	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33545	P-302	61	J-468	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33549	P-295(1)	17	J-472	J-473	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33550	P-295(2)	17	J-473	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33552	P-296(1)	10	J-459	J-474	200	Ductile Iro	110	TRUE	0	14	0.45	0.002	TRUE	11	TRUE
33553	P-296(2)	59	J-474	J-467	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	61	TRUE
33557	P-294(1)	8	J-465	J-476	200	Ductile Iro	110	TRUE	0	14	0.45	0.002	TRUE	8	TRUE
33558	P-294(2)	64	J-476	J-472	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	60	TRUE

PHD 2031 HD08A-PMP-1 running

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/m)	Has User Defined Length?	Length (User Defined) (m)	Is Active?
33555	P-303	9	J-474	J-475	150	Ductile Iro	100	FALSE	0	23	1.28	0.019	TRUE	20	TRUE
33560	P-304	14	J-476	J-477	150	Ductile Iro	100	FALSE	0	23	1.28	0.019	TRUE	20	TRUE
33540	P-297	33	J-472	J-470	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33541	P-298	35	J-470	J-471	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33542	P-299	35	J-471	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	20	TRUE
33543	P-300	63	J-472	J-469	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33544	P-301	32	J-469	J-468	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	34	TRUE
33545	P-302	61	J-468	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	62	TRUE
33549	P-295(1)	17	J-472	J-473	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33550	P-295(2)	17	J-473	J-467	200	Ductile Iro	110	FALSE	0	0	0	0	TRUE	17	TRUE
33552	P-296(1)	10	J-459	J-474	200	Ductile Iro	110	TRUE	0	23	0.72	0.004	TRUE	11	TRUE
33553	P-296(2)	59	J-474	J-467	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	61	TRUE
33557	P-294(1)	8	J-465	J-476	200	Ductile Iro	110	TRUE	0	23	0.72	0.004	TRUE	8	TRUE
33558	P-294(2)	64	J-476	J-472	200	Ductile Iro	110	TRUE	0	0	0	0	TRUE	60	TRUE