S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

June 7, 2021

File: 19087

City of Hamilton
71 Main St. West
Hamilton, Ontario
L8P 4Y5

RE: Fire Flow Estimate
225 East Ave North (Phase 3)
City of Hamilton

Fire flow demands for developments are governed by a number of guidelines and criteria, such as the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999), Ontario Building Code (OBC), and various codes and standards published by the National Fire Protection Association (NFPA).

The proposed affordable housing development will be constructed in 3 phases. Phase 1 will consist of constructing a 2-tiered building comprised of a 3-storey wing and a 5-storey wing. Phase 2 will consist of the redevelopment of the existing 3-storey stables building along the west property line. Phase 3 will consist of constructing a 3-storey midrise apartment building. This development will include a parking structure at grade, asphalt and concrete walkways, sidewalks and landscaped areas.

The fire flow for this site was determined to be the greater of the OBC fire flow calculation (OBC section A-3.2.5.7) or the City of Hamilton Target Available Fire Flow. Fire flow calculations were completed on the proposed 2-tiered multi residential building as it was determined to require the most fire flow. The result of the OBC fire flow calculation was a minimum flow rate of 9000 L/min (150 L/sec) (see attached OBC fire flow calculation sheet). This is equal to the City of Hamilton target available fire flow for a Residential Multi (greater than 3 units) which is 150 l/sec. Therefore, the minimum required fire flow for this site is **150 l/sec.**

The following hydrant flow test data for the public fire hydrant in closest proximity to the proposed development has been analysed to determine if the municipal system adjacent to the subject site is adequate to provide the required fire flow, with a minimum pressure of 20 psi. The table below summarizes the hydrant flow data made available by the City of Hamilton:

Hydrant Flow Data	
Hydrant ID	HA10H19
Location	East Avenue North
Static Pressure	64 psi
Residual Pressure During Test Flow	52 psi
Test Flow Rate	470 IGPM (35.6 l/s)
Theoretical Flow @ 20 psi	**948 IGPM (71.8 l/s)**

Based on the above hydrant flow test data, the theoretical maximum available flow rate based on the City of Hamilton fire hydrant flow test is **71.8 l/s**. It has been previously noted that the current fire flow rate from the existing 150mmØ watermain is insufficient to support this development under the City of Hamilton standards. As such, through agreement with the City of Hamilton, it is proposed to upgrade the existing East Ave North 150mmØ watermain to a new 150mmØ watermain from Robert Street to Barton Street coupled with a proposed new 300mmØ watermain along Robert Street from Victoria Avenue North to Emerald Street North. Sufficient fire flow will be available prior to this development's occupancy. For additional information please find attached the hydraulic modelling prepared by C3, dated July 31, 2020 supporting the municipal watermain upgrades.

Prepared by:

S. LLEWELLYN & ASSOCIATES LIMITED

LICENSED PROFESSIONAL ENGINEER
S.V. FRANKOVICH
07/06/2021
PROVINCE OF ONTARIO

S. DeGrow, Dipl. T. S. Frankovich, P.Eng.

OBC FIRE FLOW WATER SUPPLY

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Project: **225 East Ave North**
Project Number: 19087
Date: Jan-20

Type of Development: **Multi-Residential**

Required Fire Water Supply (Q) per OBC: **$Q = K\ V\ S_{tot}$** *(OBC Tables and Figures attached)*

Where:
Q = Minimim supply of water in litres
K = Water suppy coefficient from Table 1
V = total building volume in cubic meters
S_{tot} = total of spatial coefficient values from property line exposures on all sides
$S_{tot} = 1.0 + [S_{side1} + S_{side2} + S_{side3} + \ldots.]$ from Figure 1. Max. 2.0

Water Supply Coefficient (K)

Building Group/Division Classification: **C (Residential Occupancies)**

From Table 1, **K =** **23**

Building Volume (V)

	4-Storey Section	6-Storey Section
Building Footprint Area:	**1037** m^2	**658.6** m^2
Building Height:	**14** m	**21** m

Building Volume (V): ***28348.6*** **m^3** (conservatively assume attic has same footprint)

Spatial Coefficient (S)

See Figure 1 for
Spatial Coefficients

Side	Dist (m)	S_{coeff}
Front	**10**	**0**
Back	**1**	**0.5**
Left	**48.2**	**0**
Right	**6**	**0.4**
	Total	0.9

Therefore, S_{tot} = **1.9**

Required Water Supply

$Q = K\ V\ S_{tot}$ = 1238834 m^3

From Table 2, the minimum required water supply flow rate = ***9000*** ***l/min*** ***or*** 150 l/s

City of Hamilton Target flow for residential medium (3 or less units) = **150** **l/s <-- governs**

OBC Tables and Figures

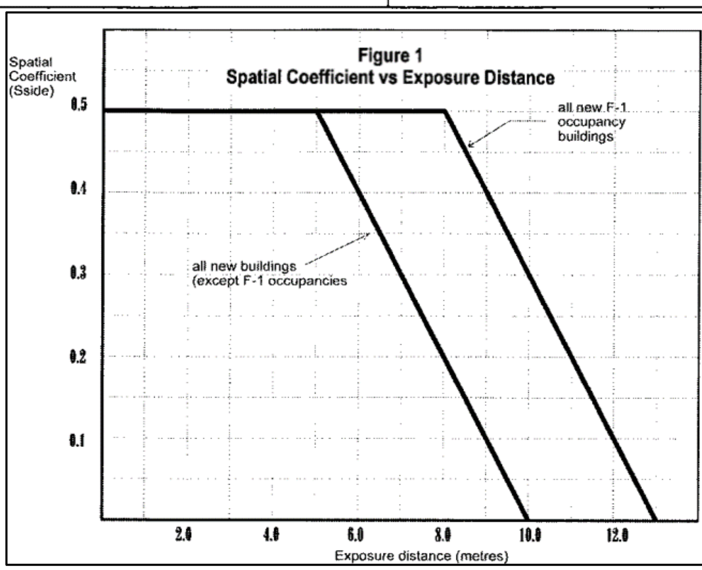
Table 1

Water Supply Coefficient - K

Type of Construction	Classification by Group or Division in Accordance with Table 3.1.2.1. of the Building Code				
	A-2 B-1 B-2 B-3 C D	A-4 F-3	A-1 A-3	E F-2	F-1
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2.	18	22	25	31	41
Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

Table 2

Part 3 Buildings under the Building Code	Required Minimum Water Supply Flow Rate, L/min
One-storey building with building area not exceeding 600 m²	1 800
All other buildings	2 700 (if Q ≤ 108 000 L)(1) 3 600 (if Q > 108 000 L and ≤ 135 000 L)(1) 4 500 (if Q > 135 000 L and ≤ 162 000 L)(1) 5 400 (if Q > 162 000 L and ≤ 190 000 L)(1) 6 300 (if Q > 190 000 L and ≤ 270 000 L)(1) 9 000 (if Q > 270 000 L)(1)



City of Hamilton Target Flows (Policy PW19096)

Table 1: Target Available Fire Flow

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1,800 m³)[1]	100
Industrial	250
Institutional	150
Residential Multi (greater than 3 units)	150
Residential Medium (3 or less units)	125
Residential Single	75
Residential Single (Dead End)	50

Adequate Water Services - Required Fire Flow-RFF and Available Fire Flow-AFF – (PILOT VERSION-01)

Application Number :	(DA-20-001)
Municipal Address :	225 & 247 East Avenue North

Through staff report PW19096 - City of Hamilton Watermain Fire Flow Requirement Design Guidelines Policy on November 27th, 2019 Council adopted the new fire flow policy. This form is intended to guide applicants through the documentation requirements of this change. FUS calculations are no longer required for new submissions. This form is supplemental to related and supporting documentation/calculations.

1 - REQUIRED FIRE FLOW – RFF

1 a) Required Fire Flow-RFF a)

$Q = KVS_{Tot}$

Please provide required fire flow-RFF using the water supply flow rate method (OBC section A-3.2.5.7 ; OFM-TG-03-1999 FIRE PROTECTION WATER SUPPLY GUIDELINE FOR PART 3 IN THE ONTARIO BUILDING CODE - 6.3 Buildings Requiring On-Site Fire Protection Water Supply ; **$Q = KVS_{Tot}$**). This methodology shall be applied to all buildings falling under Part 3 and Part 9 of the Building Code (OBC sections 1.1.2.2 and 1.1.2.4). Detailed calculations shall be submitted as an appended memo.

Enter calculated value here (highest if multiple buildings)

150 Litres / second

Comments :

1 b) Required Fire Flow-RFF b)

Target Table

Please select from **Table 1 : Target Available Fire Flow**

Table 1: Target Available Fire Flow

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1,800 m^3)[1]	100
Industrial	250
Institutional	150
Residential Multi (greater than 3 units)	150
Residential Medium (3 or less units)	125
Residential Single	75
Residential Single (Dead End)	50

[1] 1800m^3 represents a maximum building volume that qualifies as "Small ICI"

Enter applicable value for Target Available Fire Flow (highest value if multiple Land Uses) here:

150 Litres / second

Comments :

1 c) Required Fire Flow-RFF c)

Enter higher of a) or b) from above

Enter value here :

150 Litres / second

Comments :

Adequate Water Services - Required Fire Flow-RFF and Available Fire Flow-AFF – (PILOT VERSION-01)

Application Number :	(DA-20-001)
Municipal Address :	225 & 247 East Ave North

2 - AVAILABLE FIRE FLOW - AFF

2 a) Available Fire Flow-AFF a)

Field Hydrant Test calculated at 20 psi
Please provide available fire flow-AFF as determined through developer hydrant fire flow test or City Hydrant test database.
Enter value here : 71.80 Litres / second
Please check : ☐ Developer hydrant fire flow test, or *(as directed in FC or thereafter)* ☑ City Hydrant test database
Comments :

OR (as directed in FC or thereafter)

2 b) Available Fire Flow-AFF b)

Computer Modelling
Please provide available fire flow-AFF as determined through computer modelling.
☐ Modelling criteria and boundary conditions were approved by Hamilton Water
Enter value here : Litres / second
Comments :

DECLARATION OF ADEQUATE SERVICES

☐ RFF c) is less than or equal to AFF, or

☑ RFF c) is greater than AFF.

Prepared by : Steven DeGrow

Date : February 27, 2020

To:	**George Sweetman**	Company:	**Indwell Community Homes**
From:	**Sam Ziemann, P.Eng.**	Our File:	**75-41-201446**
Cc:	**John Oreskovic, SLA**	Date:	**July 31, 2020**
Subject:	**Watermain Hydraulic Assessment of the 225 East Avenue Development**		

Indwell Community Homes

Hydraulic Assessment for the Proposed 225 East Avenue Development

C3 WATER INC.

July 31, 2020

VERSION	DATE	DESCRIPTION OF REVISIONS	REVISED BY	REVIEWED BY
1	May 19, 2020	Draft	Michelle Scott	Sam Ziemann, John Oreskovic (SLA)
2	May 29, 2020	Final	Michelle Scott	Sam Ziemann, John Oreskovic (SLA), Sarah Primmer (GMBP)
3	July 28, 2020	Draft 2 – Includes Existing Watermains Scenario	Michelle Scott	Sam Ziemann, John Oreskovic (SLA)
4	July 31, 2020	Final	Michelle Scott	Sam Ziemann

SIGN OFF

This document, entitled "***Hydraulic Assessment for the Proposed 225 East Avenue Development***", was prepared by C3 Water Inc. for **Indwell Community Homes**

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.

C3 Water Inc.

LICENSED PROFESSIONAL ENGINEER
S.C. ZIEMANN
100058053
PROVINCE OF ONTARIO

July 31, 2020

Sam Ziemann, P.Eng.
Vice-President
519 772-9620 X295
sam.ziemann@c3water.com

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1.0 INTRODUCTION

1.1 Background

Indwell Community Homes is intending to undertake the development of a multi-unit residential building at 225 East Avenue in the City of Hamilton. The proposed development will replace the existing industrial building at this location. C3 Water Inc. was retained by Indwell to provide consulting services for the hydraulic assessment for the proposed development in accordance with the City of Hamilton's Comprehensive Development Guidelines (2018) (Hamilton Guidelines), the Ministry of Environment, Conservation and Parks (MECP) Design Guidelines for Drinking-Water Systems (2008) (MECP Guidelines) and the City of Hamilton Water and Wastewater Master Plan (KMK, 2006).

The proposed development is located in Pressure District 1 (PD1) of the City of Hamilton's Water distribution system. Figure 1-1 below provides an overview of the proposed development area. The development will be serviced by the 150mm watermain on East Avenue. A new 300mm watermain is being installed on Robert Street from the 150mm on Emerald Street to the 600mm on Victoria Avenue. It is expected that the watermain will be installed prior to the development of the proposed residential building.

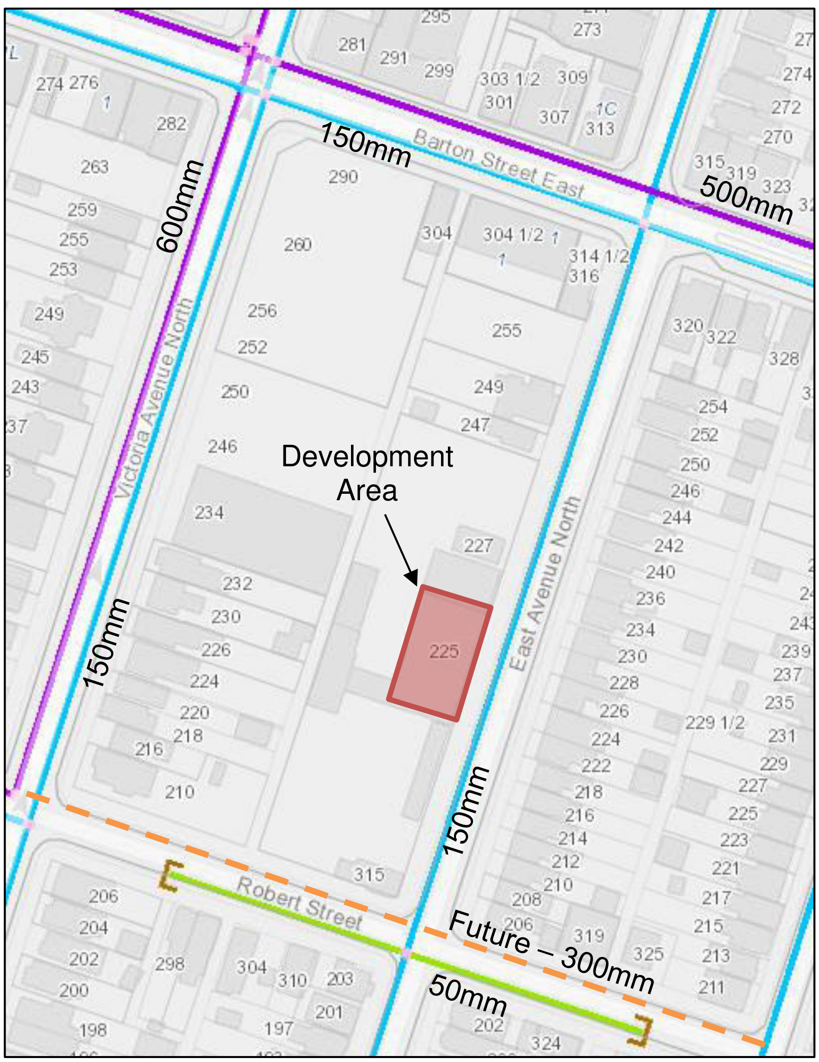


Figure 1-1 Development Location

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 (WWWMP), 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 conditions and fire flow conditions for existing (2021) and future (2031) conditions. 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

The peak hour domestic demand (PHD) for the proposed development was provided by S. Llewellyn & Associates (SLA) using the Fixture Unit Method. The demand calculations can be found in Appendix A. Peaking factors of 1.9 and 3 based on the City of Hamilton's WWWMP for the maximum day demand (MDD) and peak hour demand (PHD) scenarios, respectively were used to calculate the Average Day Demand (ADD). Table 2.2 summarizes the development demand for each scenario.

Table 2.2 Domestic Demands

Scenario	ADD	MDD	PHD
Demand (L/s)	3.7	7.1	11.1

2.3 Fire Flow Demand

The fire flow requirements for the proposed development are based on the Ontario Building Code (OBC) Fire Flow Water Supply Requirements and Hamilton Watermain Fire Flow Requirement Design Guidelines Policy (PW19096). The Hamilton residential fire flow requirements are summarized in Table 2.3 below. The OBC Fire Flow requirements are provided in Appendix B.

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

Based on the Hamilton on OBC guidelines, the proposed development is required to meet a minimum fire flow of 150 L/s at a residual pressure of 140 kPa under MDD conditions, as specified in Table 2.1.

3.0 HYDRAULIC WATER MODEL

The hydraulic assessment was completed using the City's full pipe model titled "Hamilton_Working=20171221". The analysis was carried out using Bentley WaterCAD V8i Version 08.11.06.58.

3.1 Boundary Conditions

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

- ADD
- MDD
- MDD plus Fire Flow
- PHD

The model was run with the PD1 tanks at both 50% full and 75% full, as shown in Table 3.1 below. Under all scenarios, the treatment plant pumps (HWHLP-PMP-1 to HWHLP-PMP-6) were set to an initial status of off (reservoir only conditions).

Table 3.1 PD1 Tank Levels (m)

Tank	50%	75%
HDR01	129	131.2
HDR1B	128	130.7
HDR1C	129	131.2

3.2 Calibration

The development area was calibrated using hydrant field test results, provided by the City. The hydrant testing was completed on July 18, 2018. The model was compared to the hydrant test results under 2021 ADD conditions with the PD1 tank levels set to 75%. Existing hydrants HA10H019 and HA10H018 on East Avenue were used for model calibration.

The 150mm watermain on East Avenue is noted in the model as being ductile iron material and was originally modelled with a C-factor of 80. The pressure in the model was found to be higher than the field-testing results at high flows indicating that there is additional headloss in the water system that should be reflected in the model. Therefore, the C-factors on the model pipes were reduced to represent the field test results more accurately. C-factors were modified on East Ave. from Wilson St. to Barton St. to 45 and on East Ave. from Barton St. to Birge Street as well as Victoria Ave. from Cannon Street to Barton Street to 50. The updated C-factors and hydrant locations are shown in Figure 3-1 below. The calibration results are summarized in Figure 3-2 and Figure 3-3 below for hydrant HA10H019 and HA10H018, respectively

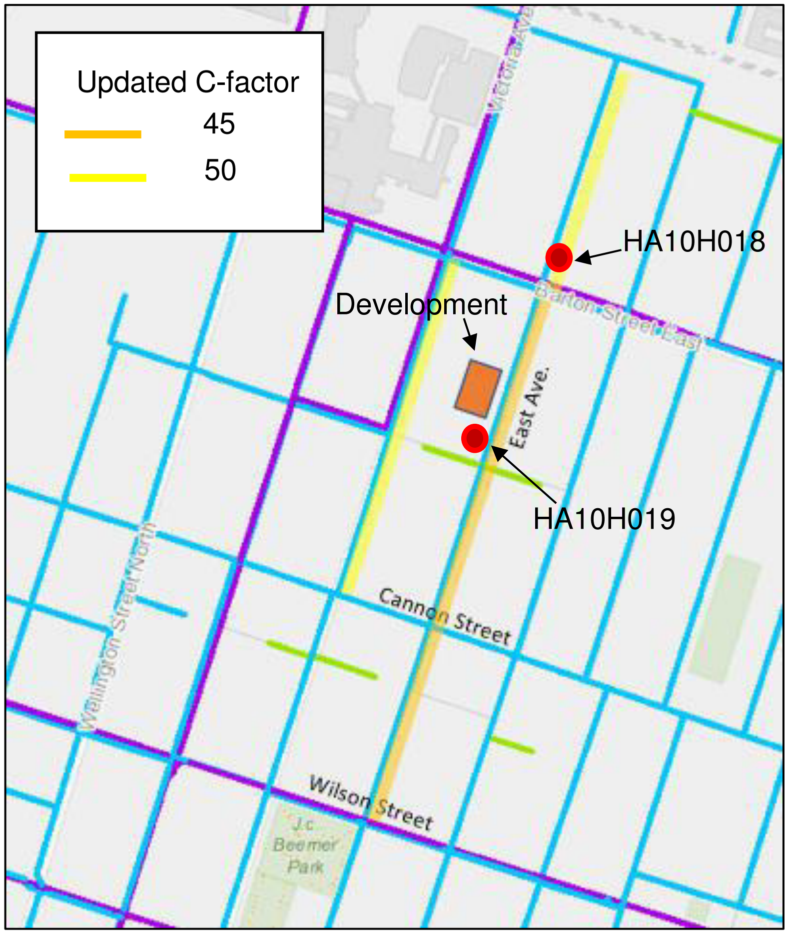


Figure 3-1 Updated C-factors

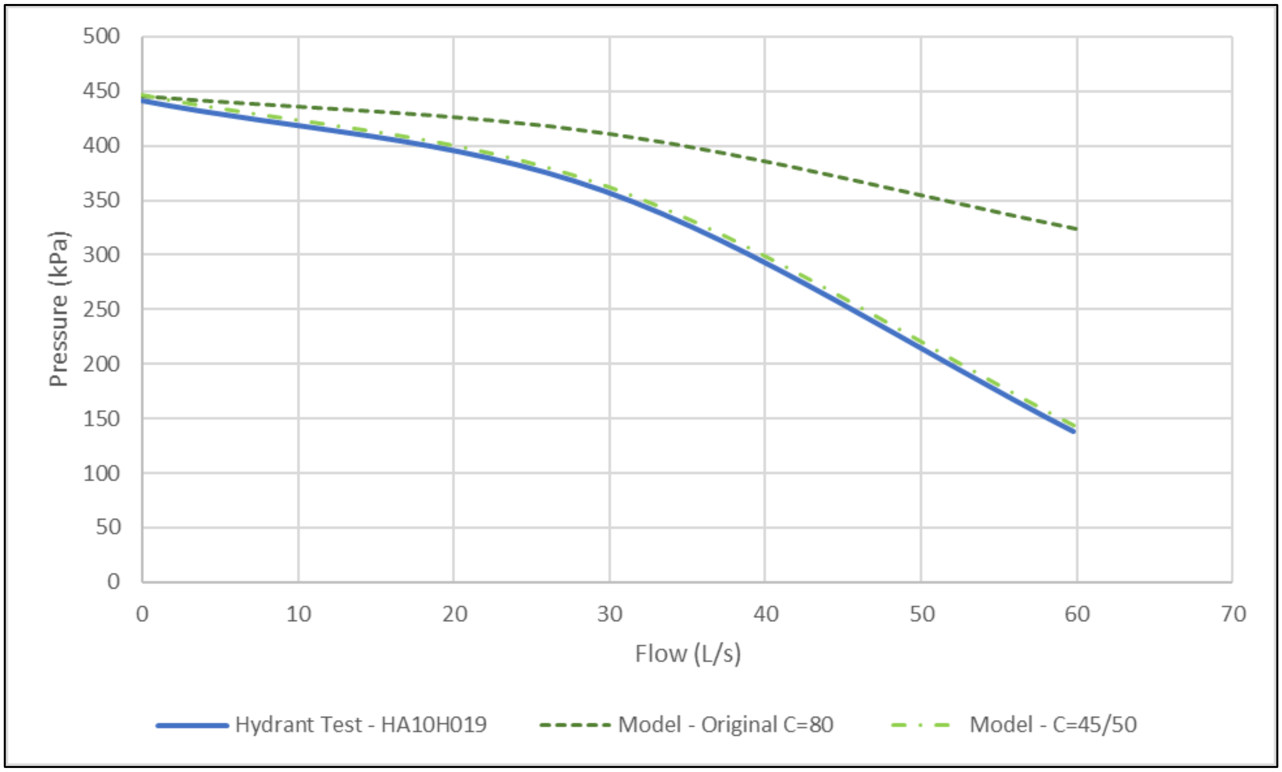


Figure 3-2 Calibration Results – Hydrant HA10H019

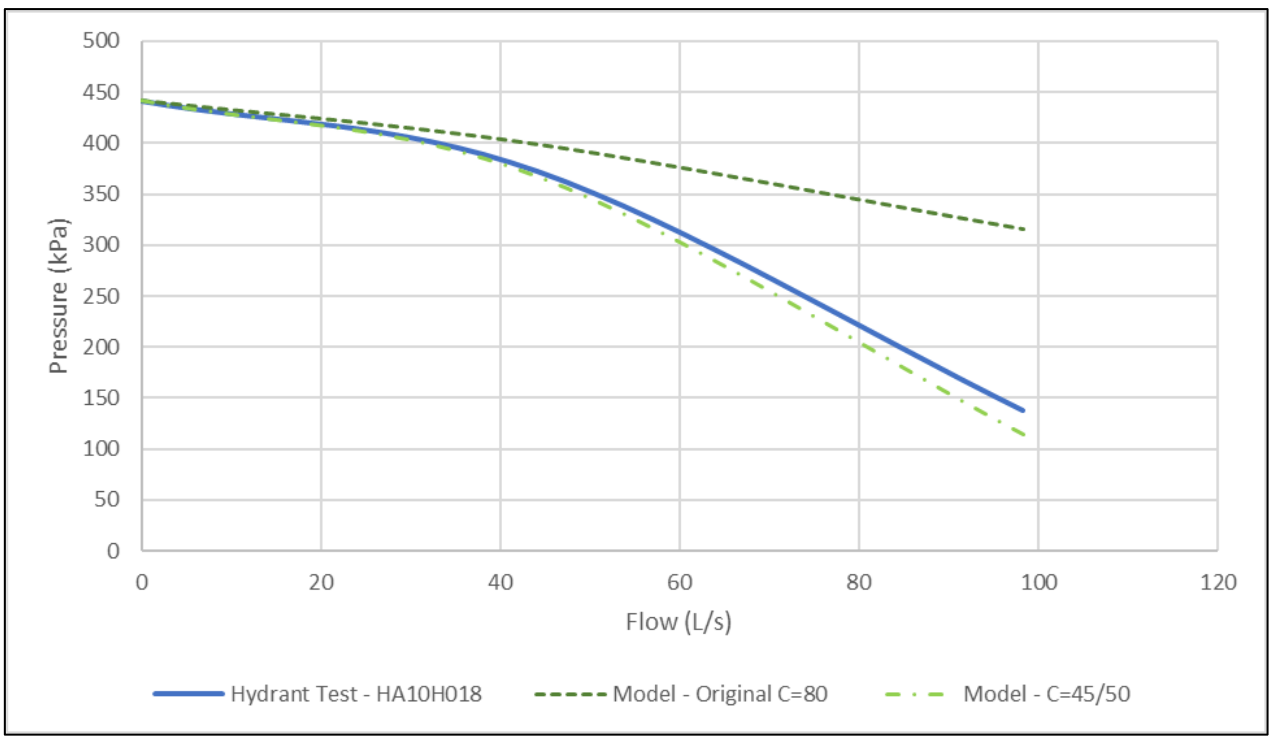


Figure 3-3 Calibration Results – Hydrant HA10H018

3.3 Model Set-up

Two junctions were added to the model, J-EA-1 to represent the development service connection and J-EA-2 to represent the proposed development hydrant as shown in Figure 3-4. Domestic demands were applied to J-EA-1. The proposed 300mm watermain on Robert Street was added to the model with a C-factor of 120 as per the MECP guidelines for modelling C-factors of new watermains in Table 3.2 below.

Table 3.2 MECP Guidelines for C-Factors

Pipe Diameter (mm)	C-Factor
150	100
200-250	110
300-600	120
> 600	130

Due to the low C-factors on East Avenue, preliminary fire flow results indicated that the fire flow requirement of 150 L/s cannot be met at the development or at the proposed hydrant location with the existing 150mm watermain on East Avenue. As such, three (3) watermain scenarios were modelled:

1. Existing watermains on East Avenue.
2. Partial replacement of the 150mm watermain on East Avenue from the 300mm watermain on Robert Street to the proposed hydrant J-EA-2.
3. Full replacement of the 150mm watermain on East Avenue from the 300mm watermain on Robert Street to the 150mm watermain on Barton Street.

The C-factors were assigned based on the MECP guidelines in Table 3.2 and are summarized in Table 3.3 and Figure 3-4 below.

Table 3.3 Development Watermain Information

			C-factor		
Pipe ID	Stretch of WM	Length (m)	Existing WMs	Partial Replacement	Full Replacement
P-566	300mm on Robert to existing hydrant HA10H019	10	45	100	100
P-563	HA10H019 to New Hydrant (J-EA-2)	35	45	100	100
P-562	New Hydrant (J-EA-2) to 225 East (J-EA-1)	30	45	100	100
P-552	225 East (J-EA-1) to 150 on Barton	121	45	45	100

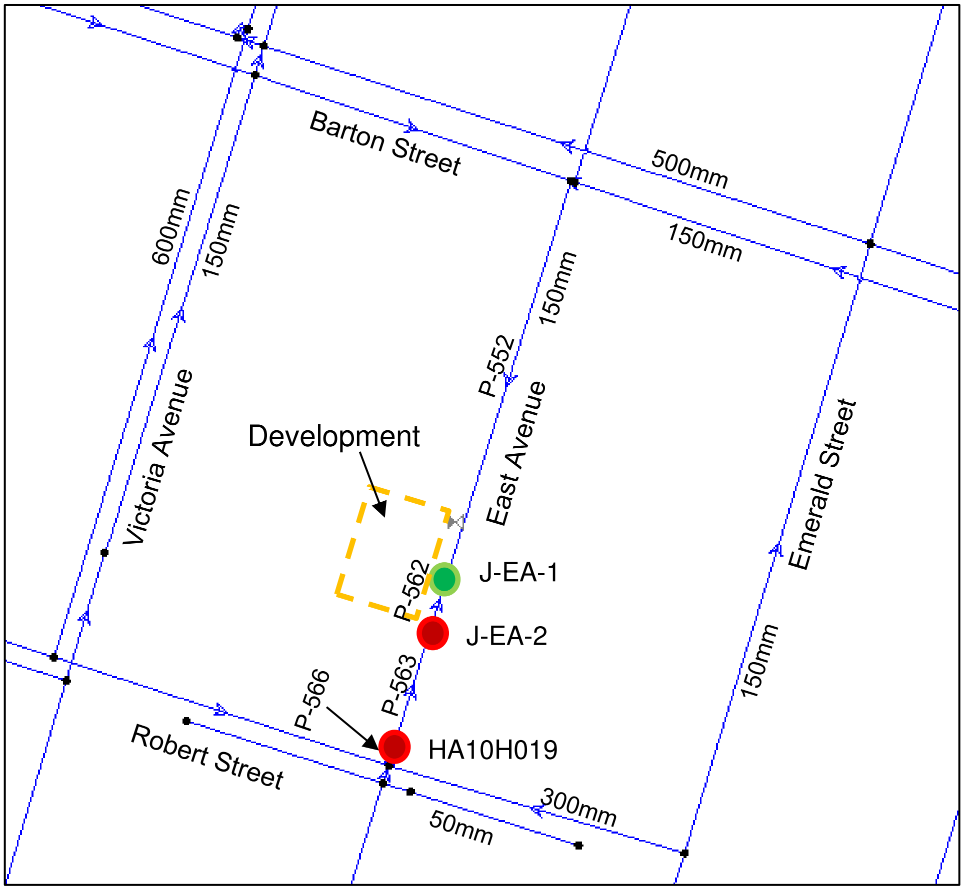


Figure 3-4 Model – Development Area (Not to Scale)

4.0 ANALYSIS

4.1 System Pressures

The pressure results for the development junction J-EA-1 are presented in Table 4.1, Table 4.2 and Table 4.3 below for the existing watermains, partial replacement and full replacement scenarios, respectively. Under each of the scenarios, the development pressure is within the preferred operating range of 350-480 kPa. The development pressure was found to range from 385-450 kPa.

Table 4.1 Pressure Results (kPa) – Existing Watermains

Scenario	2021		2031	
PD 1 Tank Levels	**50%**	**75%**	**50%**	**75%**
ADD	424	449	423	449
MDD	414	438	409	433
PHD	392	416	385	408

Table 4.2 Pressure Results (kPa) – Partial Replacement

Scenario	2021		2031	
PD 1 Tank Levels	50%	75%	50%	75%
ADD	425	450	424	449
MDD	415	440	411	435
PHD	396	420	389	412

Table 4.3 Pressure Results (kPa) – Full Replacement

Scenario	2021		2031	
PD 1 Tank Levels	50%	75%	50%	75%
ADD	425	450	424	449
MDD	416	440	411	435
PHD	397	421	389	413

4.2 Available Fire Flow

The model was used to determine the available fire flow at the existing hydrant HA10H019, the proposed development hydrant J-EA-2 and the development service connection J-EA-1 under MDD conditions at a residual pressure of 140 kPa. Results are presented in Table 4.4, Table 4.5 and

Table 4.6 for the existing watermains, partial replacement and full replacement scenarios, respectively. Under the partial and full replacement scenarios, the fire flow requirement of 150 L/s is met at the proposed hydrant J-EA-2. Under the existing watermains and partial replacement scenarios, the fire flow requirement is not met at the development service connection, J-EA-1. Full fire flow results can be found in Appendix C.

Table 4.4 Available Fire Flow (L/s) – Existing Watermains

Year	2021		2031	
Tank Levels	50%	75%	50%	75%
HA10H019	166	174	164	172
J-EA-1	78	82	77	81
J-EA-2	91	95	90	94

Table 4.5 Available Fire Flow (L/s) – Partial Replacement

Year	2021		2031	
Tank Levels	50%	75%	50%	75%
HA10H019	316	331	311	327
J-EA-1	137	143	135	142
J-EA-2	169	177	167	175

Table 4.6 Available Fire Flow (L/s) – Full Replacement

Year	2021		2031	
Tank Levels	**50%**	**75%**	**50%**	**75%**
HA10H019	335	351	330	346
J-EA-1	161	169	159	167
J-EA-2	190	200	188	197

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 690 kPa (450 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 development area. The ADD 2021 scenario with the PD1 tanks at 50% was used to represent existing conditions for construction flushing requirements. Results were based on a minimum velocity of 0.8 m/s as required by the MECP Guidelines. The hydrant nodes HA10H019 and J-EA-2 were modelled with an emitter coefficient of 11.2 $L/s/m^{0.5}$ (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 modelled flushing configurations for the development area are show in Figure 4-1, Figure 4-2 and Figure 4-3 below.

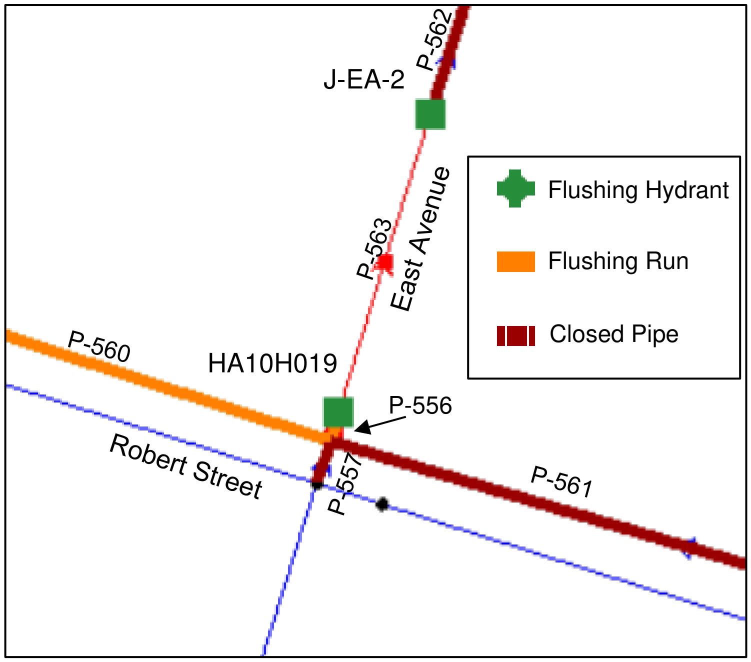


Figure 4-1 Flushing Configuration 1

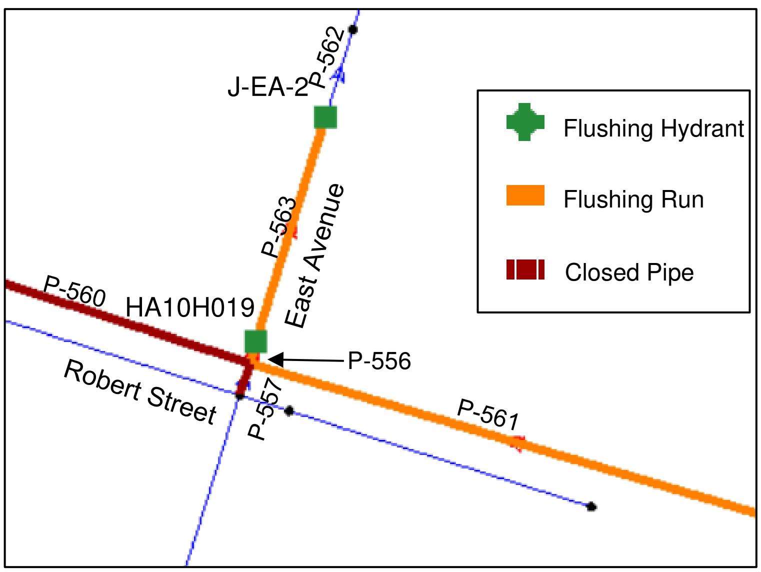


Figure 4-2 Flushing Configuration 2

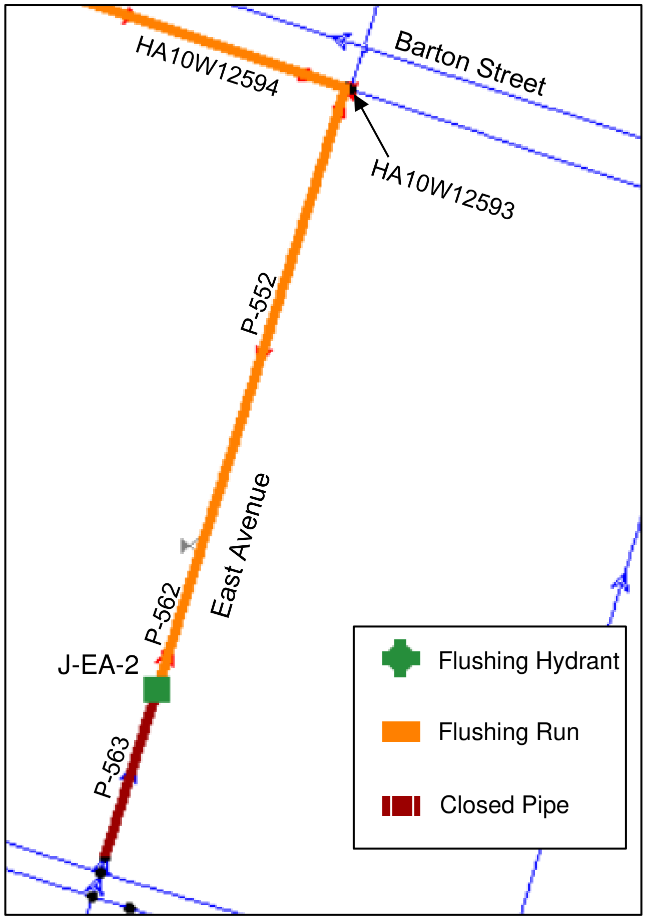


Figure 4-3 Flushing Configuration 3

The model results indicate that the required flushing velocity can be achieved in the development area. The results are summarized in Table 4.7, Table 4.8 and Table 4.9 below for the existing watermains, partial replacement and full replacement scenarios, respectively. Full results can be found in Appendix D.

Table 4.7 Flushing Results – Existing Watermains

Street	Pipe	Length (m)	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
Barton St.	HA10W12593	1.3	150	1.2	TRUE
Barton St.	HA10W12594	105.4	150	0.8	TRUE
East Ave.	P-552	121	150	2.0	TRUE
East Ave.	P-556	10	150	6.0	TRUE
Robert St.	P-560	111.3	300	1.5	TRUE
Robert St.	P-561	97.5	300	1.0	TRUE
East Ave.	P-562	30	150	1.8	TRUE
East Ave.	P-563	35	150	2.6	TRUE

Table 4.8 Flushing Results – Partial Replacement

Street	Pipe	Length (m)	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
Barton St.	HA10W12593	1.3	150	1.3	TRUE
Barton St.	HA10W12594	105.4	150	0.9	TRUE
East Ave.	P-552	121	150	2.1	TRUE
East Ave.	P-556	10	150	7.5	TRUE
Robert St.	P-560	111.3	300	1.9	TRUE
Robert St.	P-561	97.5	300	1.1	TRUE
East Ave.	P-562	30	150	1.9	TRUE
East Ave.	P-563	35	150	3.6	TRUE

Table 4.9 Flushing Results – Full Replacement

Street	Pipe	Length (m)	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
Barton St.	HA10W12593	1.3	150	1.7	TRUE
Barton St.	HA10W12594	105.4	150	1.2	TRUE
East Ave.	P-552	121	150	3.0	TRUE
East Ave.	P-556	10	150	7.4	TRUE
Robert St.	P-560	111.3	300	1.9	TRUE
Robert St.	P-561	97.5	300	1.0	TRUE
East Ave.	P-562	30	150	2.8	TRUE
East Ave.	P-563	35	150	3.6	TRUE

5.0 CONCLUSIONS

The watermain hydraulic assessment of the proposed East Avenue development demonstrated that:

1. The service pressures under existing conditions (2021), and future (2031) conditions are expected to range between 385 kPa and 450 kPa which are within the preferred standards established by the MECP and City of Hamilton Guidelines;
2. The proposed development was able to meet the fire flow requirement of 150 L/s at a residual pressure of 140 kPa at the proposed hydrant J-EA02 when the 150mm watermain is either partially replaced of fully replaced with a new 150mm watermain;
3. The proposed watermains can withstand transient pressure plus maximum operating pressure assuming they conform to city specifications of 150 DR18 PVC pipe;
4. All proposed watermains can achieve a minimum flushing velocity of 0.8 m/s based on the outlined unidirectional flow procedure.

APPENDIX A

Demand Calculations

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

January 27, 2020

File: 18054

City of Hamilton
71 Main St. West
Hamilton, Ontario
L8P 4Y5

RE: Water Usage Assessment
225 East Ave North
City of Hamilton

The proposed affordable housing development will be constructed in 2 phases. Phase 1 will consist of construction a 2-tiered building comprised of a 3-storey wing and a 5-storey wing. This development will include a parking structure at grade, asphalt and concrete walkways, sidewalk and landscaped areas. Phase 2 is currently undetermined.

The following is an estimate of the water usage for the proposed development. Water usage for the site was calculated based on the "Fixture Unit Method" as per Table 7.6.3.2.A. forming part of sentences 7.6.3.1(1) to (3) and 7.6.3.4.(2), (3) and (5) of the 2012 Ontario Building Code. See Table 4.1 for fixture unit (FU) calculations.

Table 4.1 – Fixture Unit Calculations

Component	No. of Fixtures	FU/ Fixture	Total FU
Lavatory (8.3L/min or less per head) (Private)	95	0.7	66.5
Water Closet (6 LPF or less with flush tank) (Private)	95	2.2	209.0
Sink, Kitchen, (Commercial)	4	4	16.0
Sink, Kitchen, (Domestic) (8.3L/min or less)	95	1.4	133.0
Dishwasher, (Domestic)	95	1.4	133.0
Clothes Washer, 3.5kg (Public)	10	3	30.0
Lavatory (8.3L/min or less per head) (Public)	10	2	20.0
Water Closet (6 LPF or less with flush tank) (Public)	10	2.2	22.0
Shower Head, 9.5L/min or less per head (Private)	95	1.4	133.0
		Total FU:	**762.5**

3228 South Service Road, Suite 105, East Wing Burlington, Ontario L7N 3H8
Tel. (905) 631-6978 Fax (905) 631-8927

Total peak water usage for the site was derived below from the fixture unit count as per Table 7.4.10.5 of the Ontario Building Code.

Total Fixture Unit Count = 762.5 FU
Water Usage: 147 IGPM (11.14 l/s)

We trust that the information provided addresses the City of Hamilton requirements.

Prepared by:

S.LLEWELLYN & ASSOCIATES LIMITED

LICENSED PROFESSIONAL ENGINEER
S.V. FRANKOVICH
PROVINCE OF ONTARIO

S. DeGrow, Dipl. T.

S. Frankovich, P.Eng.

3228 South Service Road, Suite 105, East Wing Burlington, Ontario L7N 3H8
Tel. (905) 631-6978 Fax (905) 631-8927

APPENDIX B

OBC Fire Flow Requirements

OBC FIRE FLOW WATER SUPPLY

S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Project: **225 East Avenue - Indwell Development**
Project Number: 19087
Date: July 2020

Type of Development: **Residential - Multi-storey Building**

Required Fire Water Supply (Q) per OBC: **$Q = K\ V\ S_{tot}$** *(OBC Tables and Figures attached)*

Where:
Q = Minimim supply of water in litres
K = Water suppy coefficient from Table 1
V = total building volume in cubic meters
S_{tot} = total of spatial coefficient values from property line exposures on all sides
$S_{tot} = 1.0 + [S_{side1} + S_{side2} + S_{side3} + \ldots]$ from Figure 1. Max. 2.0

Water Supply Coefficient (K)

Building Group/Division Classification: **C (residential)**

From Table 1, **K =** **18**

Building Volume (V)

Building Volume (V): ***26600*** **m^3** +

Spatial Coefficient (S)

See Figure 1 for Spatial Coefficients

Side	Dist (m)	S_{coeff}
Front	**7.5**	**0.25**
Back	**1**	**0.5**
Left	**48**	**0**
Right	**6.5**	**0.35**
	Total	1.1

Therefore, S_{tot} = **2.1**

Required Water Supply

$Q = K\ V\ S_{tot}$ = 1005480 litres

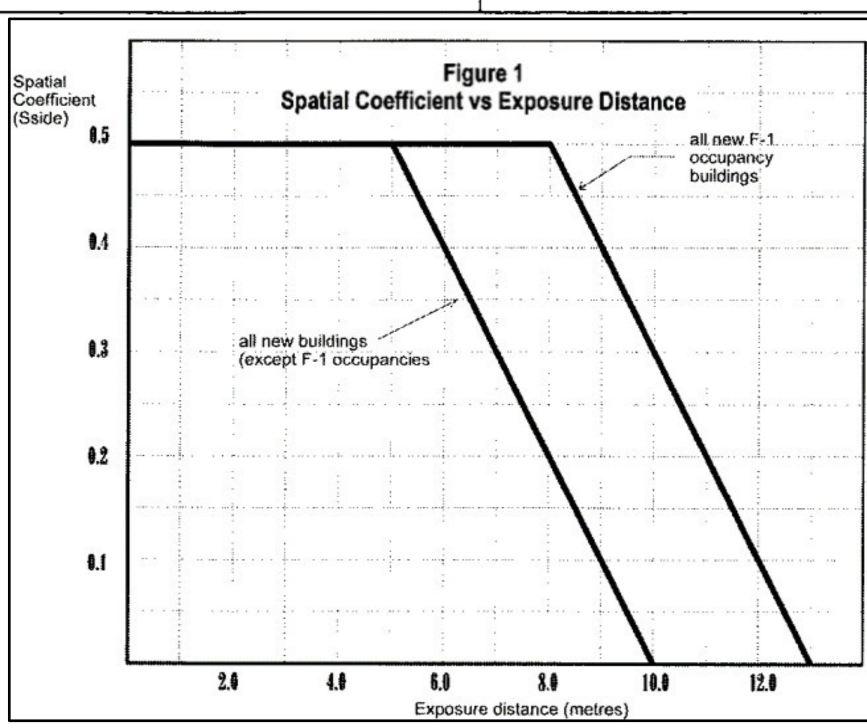
From Table 2, the minimum required water supply flow rate = ***9000 l/min*** ***or*** 150 l/s

City of Hamilton Target flow for residential multi (greater than 3 units) = **150 l/s <-- governs**

OBC Tables and Figures

Table 1					
Water Supply Coefficient - K					
Type of Construction	Classification by Group or Division in Accordance with Table 3.1.2.1. of the Building Code				
	A-2 B-1 B-2 B-3 C D	A-4 F-3	A-1 A-3	E F-2	F-1
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2., including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2.	18	22	25	31	41
Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

Table 2	
Part 3 Buildings under the Building Code	Required Minimum Water Supply Flow Rate, L/min
One-storey building with building area not exceeding 600 m²	1 800
All other buildings	2 700 (if Q ≤ 108 000 L)(1) 3 600 (if Q > 108 000 L and ≤ 135 000 L)(1) 4 500 (if Q > 135 000 L and ≤ 162 000 L)(1) 5 400 (if Q > 162 000 L and ≤ 190 000 L)(1) 6 300 (if Q > 190 000 L and ≤ 270 000 L)(1) 9 000 (if Q > 270 000 L)(1)



City of Hamilton Target Flows (Policy PW19096)

Table 1: Target Available Fire Flow

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1,800 m^3)[1]	100
Industrial	250
Institutional	150
Residential Multi (greater than 3 units)	150
Residential Medium (3 or less units)	125
Residential Single	75
Residential Single (Dead End)	50

Adequate Water Services - Required Fire Flow-RFF and Available Fire Flow-AFF – (PILOT VERSION-01)

Application Number :	(DA-20-001)
Municipal Address :	225-247 East Avenue North

Through staff report PW19096 - City of Hamilton Watermain Fire Flow Requirement Design Guidelines Policy on November 27th, 2019 Council adopted the new fire flow policy. This form is intended to guide applicants through the documentation requirements of this change. FUS calculations are no longer required for new submissions. This form is supplemental to related and supporting documentation/calculations.

1 - REQUIRED FIRE FLOW – RFF

1 a) Required Fire Flow-RFF a)

$Q = KVS_{Tot}$

Please provide required fire flow-RFF using the water supply flow rate method (OBC section A-3.2.5.7 ; OFM-TG-03-1999 FIRE PROTECTION WATER SUPPLY GUIDELINE FOR PART 3 IN THE ONTARIO BUILDING CODE - 6.3 Buildings Requiring On-Site Fire Protection Water Supply ; **$Q = KVS_{Tot}$**). This methodology shall be applied to all buildings falling under Part 3 and Part 9 of the Building Code (OBC sections 1.1.2.2 and 1.1.2.4). Detailed calculations shall be submitted as an appended memo.

Enter calculated value here (highest if multiple buildings)

150 Litres / second

Comments :

1 b) Required Fire Flow-RFF b)

Target Table

Please select from **Table 1 : Target Available Fire Flow**

Table 1: Target Available Fire Flow

Land Use	Target AFF (L/s)
Commercial	150
Small ICI (<1,800 m^3)[1]	100
Industrial	250
Institutional	150
Residential Multi (greater than 3 units)	150
Residential Medium (3 or less units)	125
Residential Single	75
Residential Single (Dead End)	50

[1] 1800m^3 represents a maximum building volume that qualifies as “Small ICI”

Enter applicable value for Target Available Fire Flow (highest value if multiple Land Uses) here:

150 Litres / second

Comments :

1 c) Required Fire Flow-RFF c)

Enter higher of a) or b) from above

Enter value here :

150 Litres / second

Comments :

Adequate Water Services - Required Fire Flow-RFF and Available Fire Flow-AFF – (PILOT VERSION-01)

Application Number :	(DA-20-001)
Municipal Address :	225-247 East Avenue North

2 - AVAILABLE FIRE FLOW - AFF

2 a) Available Fire Flow-AFF a)

Field Hydrant Test calculated at 20 psi

Please provide available fire flow-AFF as determined through developer hydrant fire flow test or City Hydrant test database.

Enter value here :

_______ Litres / second

Please check :

☐ Developer hydrant fire flow test, or *(as directed in FC or thereafter)*

☐ City Hydrant test database

Comments :

OR (as directed in FC or thereafter)

2 b) Available Fire Flow-AFF b)

Computer Modelling

Please provide available fire flow-AFF as determined through computer modelling.

☑ Modelling criteria and boundary conditions were approved by Hamilton Water

Enter value here :

167 Litres / second

Comments :

Fire flow modeled at proposed hydrant J-EA-2 under partial replacement conditions TWL set at 50%.

DECLARATION OF ADEQUATE SERVICES

☑ RFF c) is less than or equal to AFF, or

☐ RFF c) is greater than AFF.

Prepared by : Steven DeGrow

Date : July 31, 2020

APPENDIX C

Fire Flow Results

MDD 2021 Original Watermains 50%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	3	TRUE	150	166.173433	149.999993	166.173433	140	140.0006262	172.6387319	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	77.5781229	157.059996	84.6381254	140	139.9985747	182.6143313	HB15T003	TRUE
J-EA-2	1	4	FALSE	150	90.807518	149.999993	90.807518	140	139.9973254	172.0058673	J-EA-1	TRUE

MDD 2021 Original Watermains 75%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	3	TRUE	150	174.228985	149.999993	174.228985	140	140.0045057	175.9603766	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	81.5000427	157.059996	88.5600376	140	139.9985484	205.6620743	HB15T003	TRUE
J-EA-2	1	3	FALSE	150	95.2891862	149.999993	95.2891862	140	140.1340138	175.5154751	J-EA-1	TRUE

MDD 2021 Partial Replacement 50%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	316.092638	149.999993	316.092638	140	139.9976279	150.6477402	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	136.700684	157.059996	143.760687	140	139.9974832	182.235065	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	168.664849	149.999993	168.664849	140	140.0038613	148.8030512	J-EA-1	TRUE

MDD 2021 Partial Replacement 75%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	331.32279	149.999993	331.32279	140	139.997641	151.5872923	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	143.372873	157.059996	150.43286	140	139.9974832	205.2604255	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	176.842161	149.999993	176.842161	140	140.010384	149.6767578	J-EA-1	TRUE

MDD 2021 Full Replacement 50%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	311.422423	149.999993	311.422423	140	139.9976542	150.3760992	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	135.038267	157.059996	142.098269	140	139.997641	180.7984687	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	166.54666	149.999993	166.54666	140	140.0030065	148.5879451	J-EA-1	TRUE

MDD 2021 Full Replacement 75%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	326.82672	149.999993	326.82672	140	139.9976279	151.3127977	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	141.783203	157.059996	148.843191	140	139.9975227	203.849723	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	174.813201	149.999993	174.813201	140	140.0095555	149.4604681	J-EA-1	TRUE

MDD 2031 Original Watermains 50%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	3	TRUE	150	164.090779	149.999993	164.090779	140	140.0001922	171.8198637	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	76.67459	157.059996	83.7345848	140	139.9993769	181.2143861	HB15T003	TRUE
J-EA-2	1	4	FALSE	150	89.7481618	149.999993	89.7481618	140	139.9972991	171.2407593	J-EA-1	TRUE

MDD 2031 Original Watermains 75%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	3	TRUE	150	172.235082	149.999993	172.235082	140	140.0042032	175.138234	J-EA-2	TRUE
J-EA-1	1	3	FALSE	150	80.6360567	157.059996	87.6960515	140	139.9991402	204.2872338	HB15T003	TRUE
J-EA-2	1	3	FALSE	150	94.2747602	149.999993	94.2747602	140	140.1449552	174.7582706	J-EA-1	TRUE

MDD 2031 Partial Replacement 50%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	334.879931	149.999993	334.879931	140	139.9974964	166.1326043	J-EA-2	TRUE
J-EA-1	1	3	TRUE	150	160.982955	157.059996	168.042942	140	139.9975621	182.0749683	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	190.436512	149.999993	190.436512	140	140.0195238	164.8050142	J-EA-1	TRUE

MDD 2031 Partial Replacement 75%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	350.965067	149.999993	350.965067	140	139.997641	168.5327791	J-EA-2	TRUE
J-EA-1	1	3	TRUE	150	168.785623	157.059996	175.845625	140	139.9977068	205.0920044	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	199.611684	149.999993	199.611684	140	140.0300838	167.1890531	J-EA-1	TRUE

MDD 2031 Full Replacement 50%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	329.863429	149.999993	329.863429	140	139.9976147	165.4241363	J-EA-2	TRUE
J-EA-1	1	3	TRUE	150	158.98933	157.059996	166.049332	140	139.9974964	180.6239589	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	188.006554	149.999993	188.006554	140	140.0193265	164.2026198	J-EA-1	TRUE

MDD 2031 Full Replacement 75%

Label	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) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Is Fire Flow Run Balanced?
HA10H019	1	4	TRUE	150	346.135832	149.999993	346.135832	140	139.9976805	167.8204185	J-EA-2	TRUE
J-EA-1	1	3	TRUE	150	166.876451	157.059996	173.936454	140	139.9976805	203.6646531	HB15T003	TRUE
J-EA-2	1	3	TRUE	150	197.280581	149.999993	197.280581	140	140.030452	166.5856461	J-EA-1	TRUE

APPENDIX D

Flushing Results

ADD 2021 - 50%

Existing Watermains

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?
24048	HA10W12593	1.3	150	Event - 3	1.193805327	TRUE	2.81	TRUE	TRUE
27183	HA10W12594	105.4	150	Event - 3	0.848400975	TRUE	1.86	TRUE	TRUE
32735	P-552	121	150	Event - 3	2.042206302	TRUE	7.63	TRUE	TRUE
32743	P-556	10	150	Event - 1	5.965128909	TRUE	55.35	TRUE	TRUE
32748	P-560	111.3	300	Event - 1	1.491282227	TRUE	0.62	TRUE	TRUE
32749	P-561	97.5	300	Event - 2	1.017410789	TRUE	0.3	TRUE	TRUE
32752	P-562	30	150	Event - 3	1.832263158	TRUE	6.22	TRUE	TRUE
32753	P-563	35	150	Event - 1	2.608773027	TRUE	11.96	TRUE	TRUE

Partial Replacement

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?
24048	HA10W12593	1.3	150	Event - 3	1.251445123	TRUE	3.07	TRUE	TRUE
27183	HA10W12594	105.4	150	Event - 3	0.889370422	TRUE	2.03	TRUE	TRUE
32735	P-552	121	150	Event - 3	2.140815545	TRUE	8.32	TRUE	TRUE
32743	P-556	10	150	Event - 1	7.483450765	TRUE	19.2	TRUE	TRUE
32748	P-560	111.3	300	Event - 1	1.870862691	TRUE	0.94	TRUE	TRUE
32749	P-561	97.5	300	Event - 2	1.129301997	TRUE	0.37	TRUE	TRUE
32752	P-562	30	150	Event - 3	1.9308724	TRUE	1.65	TRUE	TRUE
32753	P-563	35	150	Event - 1	3.614198574	TRUE	5.26	TRUE	TRUE

Full Replacement

ID	Label	Length (m)	Diameter (mm)	Flushing Event	Velocity (Maximum	Satisfies Flushing Target Velocity?	Shear Stress (Maximum	Satisfies Flushing Target Shear	Satisfies Flushing
24048	HA10W12593	1.3	150	Event - 3	1.73175752	TRUE	5.6	TRUE	TRUE
27183	HA10W12594	105.4	150	Event - 3	1.230752491	TRUE	3.71	TRUE	TRUE
32735	P-552	121	150	Event - 3	2.962510156	TRUE	3.5	TRUE	TRUE
32743	P-556	10	150	Event - 1	7.426885613	TRUE	18.93	TRUE	TRUE
32748	P-560	111.3	300	Event - 1	1.856721258	TRUE	0.92	TRUE	TRUE
32749	P-561	97.5	300	Event - 2	1.033162735	TRUE	0.31	TRUE	TRUE
32752	P-562	30	150	Event - 3	2.752567157	TRUE	3.2	TRUE	TRUE
32753	P-563	35	150	Event - 1	3.586837744	TRUE	5.19	TRUE	TRUE

Flushing Field Report

Study: Flushing Study

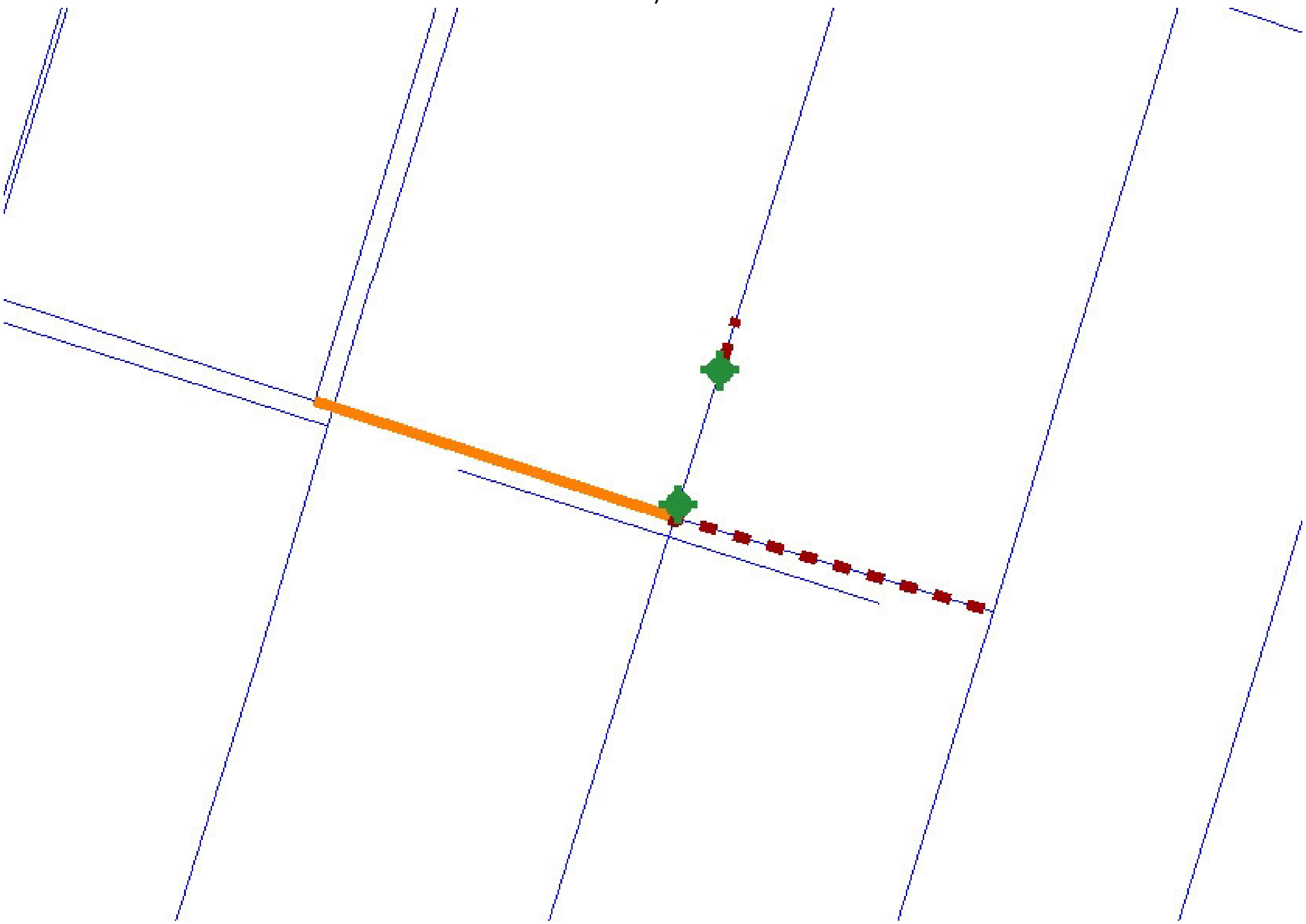
Legend

- Valves to Open
- Valves to Close
- Flushing Hydrants
- Pipe Run
- Closed Pipes

Flushing Field Report

Study: Flushing Study; Area: East Ave; Event: Event - 1

Primary View



Flushing Field Report

Study: Flushing Study; Area: East Ave; Event: Event - 1

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-EA-2				309.3008936159	63.38467307599
HA10H019				354.5117053341	67.85923670530

Valve	Operation		Notes
P-561	Closed	☐	
P-563	Open	☐	
P-562	Closed	☐	
P-557	Closed	☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	

Flushing	Minimum	Recommended
Time (min)	1.0	1.0
Volume (ML)	0.0	0.0

Start Time ______________________

End Time ______________________

Operator ______________________

Date

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

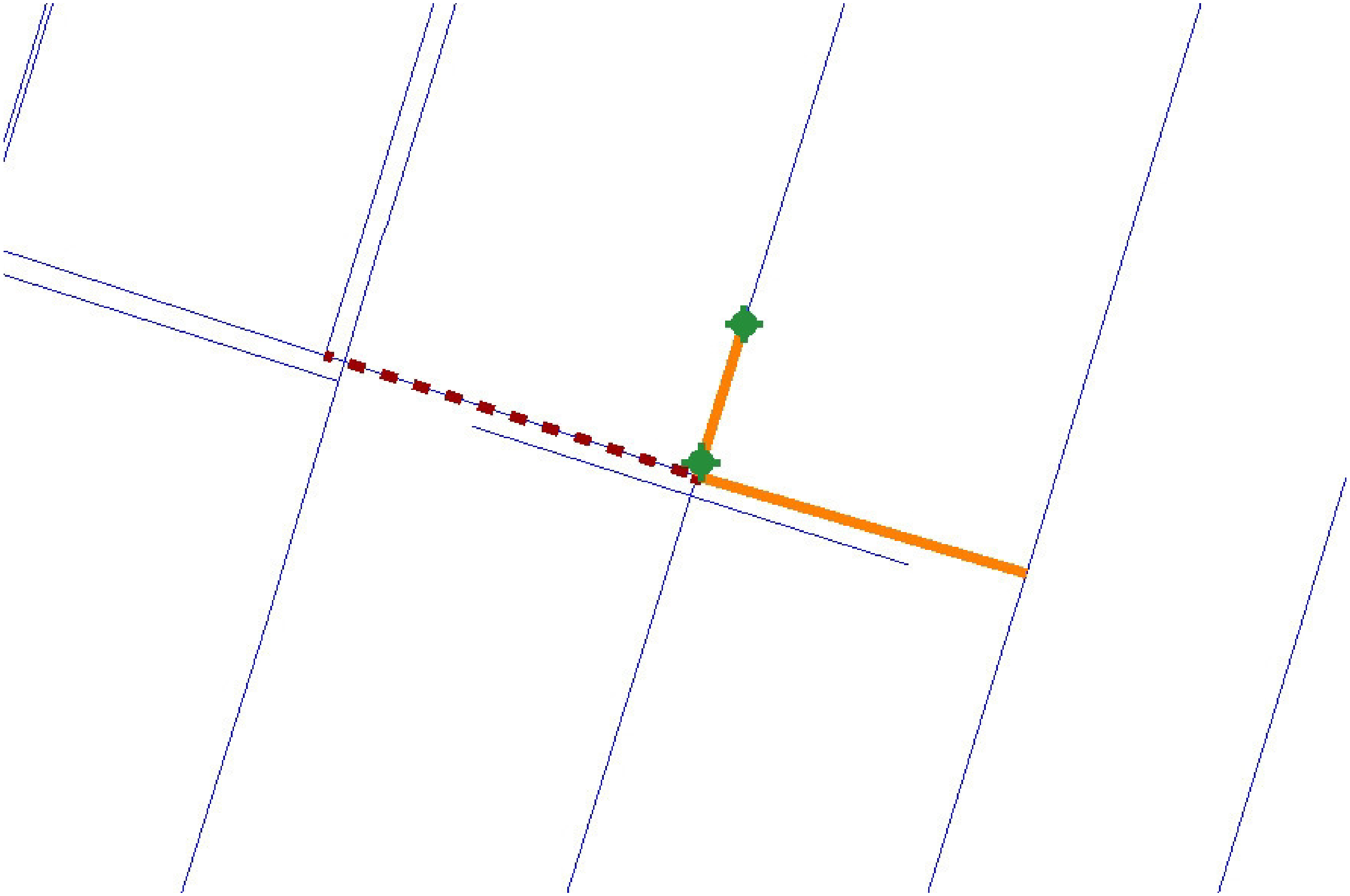
Pipe Run to be Cleaned
P-556, P-560

Notes ____

Flushing Field Report

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

Primary View



Flushing Field Report

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

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-EA-2				246.2454945785	56.55589089153
HA10H019				247.7528547870	56.72872275861

Valve	Operation		Notes
P-561	Reopen	☐	
P-562	Reopen	☐	
P-557	Closed (prior)	☐	
P-560	Closed	☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	

Flushing	Minimum	Recommended
Time (min)	2.2	2.2
Volume (ML)	0.0	0.0

Start Time ____________________

End Time ____________________

Operator ____________________

Date

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

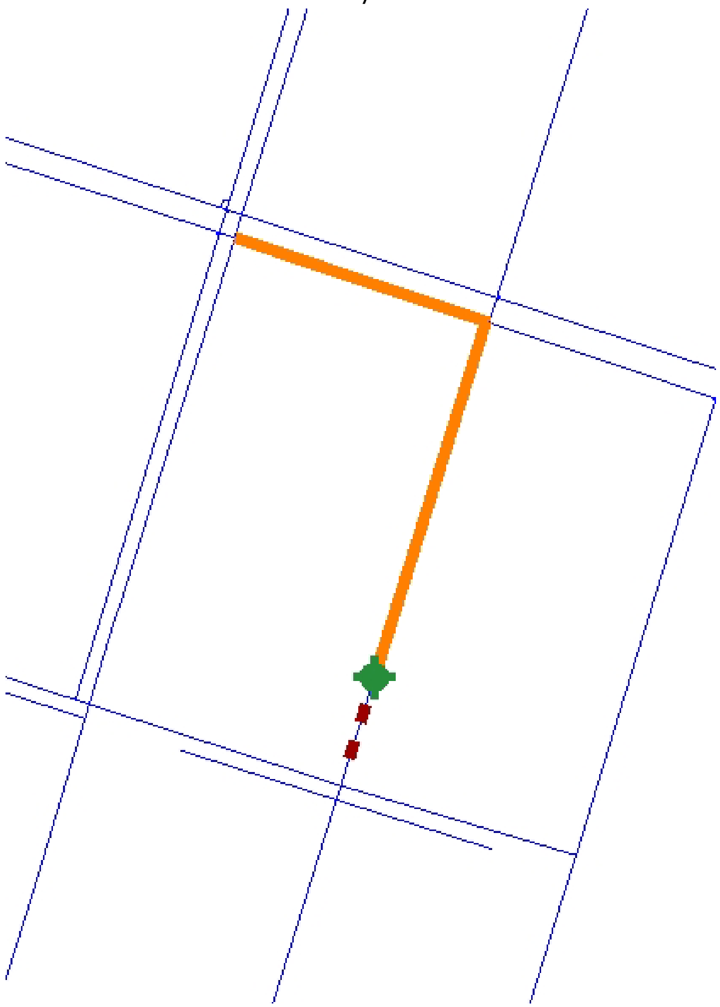
Pipe Run to be Cleaned
P-561, P-556, P-563

Notes ____________________

Flushing Field Report

Study: Flushing Study; Area: East Ave; Event: Event - 3

Primary View



Flushing Field Report

Study: Flushing Study; Area: East Ave; Event: Event - 3

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-EA-2				182.1519393675	48.64189878836

Valve	Operation	Notes
P-557	Reopen ☐	
P-560	Reopen ☐	
P-563	Closed ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	2.3	2.3
Volume (ML)	0.0	0.0

Start Time ______________________

End Time ______________________

Operator ______________________

Date

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

Pipe Run to be Cleaned
HA10W12593, HA10W12594, P-552, P-562

Notes ______________________

Flushing Field Report

Study: Flushing Study; Area: East Ave; Event: Event - 3

Final Actions

Valve	Operation	Notes
P-563	Reopen ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

APPENDIX E

Model Information

Junction Results

AD 2021 Existing Watermains 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	127.84139	421.8785
32734	J-EA-1	84.4	1	<Collection: 1 item>	3.71	127.76654	424.4222
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	127.80108	423.7817

AD 2021 Existing Watermains 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	130.389	446.8116
32734	J-EA-1	84.4	1	<Collection: 1 item>	3.71	130.31469	449.3606
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	130.34898	448.7177

AD 2021 Partial Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	127.84832	421.9463
32734	J-EA-1	84.4	1	<Collection: 1 item>	3.71	127.81986	424.9441
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	127.83303	424.0944

AD 2021 Partial Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	130.3959	446.8792
32734	J-EA-1	84.4	1	<Collection: 1 item>	3.71	130.3678	449.8804
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	130.38081	449.0292

AD 2021 Full Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	127.84955	421.9584
32734	J-EA-1	84.4	1	<Collection: 1 item>	3.71	127.82788	425.0226
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	127.83791	424.1421

AD 2021 Full Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	130.39716	446.8915
32734	J-EA-1	84.4	1	<Collection: 1 item>	3.71	130.37597	449.9603
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	130.38577	449.0777

AD 2031 Existing Watermains 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	127.74364	420.9219
32734	J-EA-1	84.4	1	<Collection: 2 items>	3.71	127.66903	423.4679
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	127.70347	422.8264

AD 2031 Existing Watermains 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	130.3816	446.7392
32734	J-EA-1	84.4	1	<Collection: 2 items>	3.71	130.30671	449.2825
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	130.34127	448.6422

AD 2031 Partial Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	127.75062	420.9902
32734	J-EA-1	84.4	1	<Collection: 2 items>	3.71	127.72219	423.9882
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	127.73535	423.1383

AD 2031 Partial Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	130.27703	445.7159
32734	J-EA-1	84.4	1	<Collection: 2 items>	3.71	130.24899	448.7177
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	130.26197	447.8661

AD 2031 Full Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	127.75181	421.0019
32734	J-EA-1	84.4	1	<Collection: 2 items>	3.71	127.73031	424.0676
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	127.74027	423.1865

AD 2031 Full Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	130.27823	445.7276
32734	J-EA-1	84.4	1	<Collection: 2 items>	3.71	130.25728	448.7988
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	130.26698	447.9151

MD 2021 Existing Watermains 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	126.91569	412.8188
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	126.67243	413.7143
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	126.7847	413.8345

MD 2021 Existing Watermains 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	129.38169	436.9533
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	129.1389	437.8534
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	129.25096	437.9714

MD 2021 Partial Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	126.93855	413.0426
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	126.84653	415.4182
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	126.88914	414.8566

MD 2021 Partial Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	129.40444	437.1759
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	129.3127	439.5543
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	129.35518	438.9915

MD 2021 Full Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	126.94265	413.0827
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	126.87383	415.6854
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	126.9057	415.0187

MD 2021 Full Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	129.40859	437.2165
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	129.34019	439.8233
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	129.37186	439.1547

MD 2031 Existing Watermains 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	126.41688	407.9371
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	126.17512	408.8472
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	126.2867	408.9607

MD 2031 Existing Watermains 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	128.88629	432.1048
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	128.64491	433.0187
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	128.75632	433.1304

MD 2031 Partial Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	126.43975	408.1609
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	126.34866	410.5457
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	126.39084	409.9799

MD 2031 Partial Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	128.90915	432.3285
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	128.81828	434.7155
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	128.86036	434.1487

MD 2031 Full Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	126.44385	408.2011
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	126.37644	410.8176
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	126.40766	410.1445

MD 2031 Full Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 1 item>	0	128.91327	432.3689
32734	J-EA-1	84.4	1	<Collection: 2 items>	7.06	128.84617	434.9885
32751	J-EA-2	84.5	1	<Collection: 1 item>	0	128.87724	434.3139

PH 2021 Existing Watermains 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	125.04939	394.5536
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	124.48462	392.3025
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	124.74528	393.875

PH 2021 Existing Watermains 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	127.48788	418.4188
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	126.9235	416.1715
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	127.18399	417.7422

PH 2021 Partial Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	125.10232	395.0716
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	124.88854	396.2556
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	124.98755	396.2461

PH 2021 Partial Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	127.54079	418.9366
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	127.32726	420.1231
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	127.42617	420.1124

PH 2021 Full Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	125.11203	395.1667
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	124.95283	396.8849
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	125.02656	396.6279

PH 2021 Full Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	127.55054	419.032
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	127.39175	420.7542
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	127.46529	420.4953

PH 2031 Existing Watermains 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	124.25633	386.7921
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	123.69219	384.5472
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	123.95256	386.1168

PH 2031 Existing Watermains 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	126.6855	410.5661
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	126.12183	408.3257
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	126.38199	409.8932

PH 2031 Partial Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	124.30959	387.3134
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	124.09633	388.5024
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	124.19511	388.4905

PH 2031 Partial Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	126.73874	411.087
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	126.52576	412.2789
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	126.6244	412.2657

PH 2031 Full Replacement 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	124.31913	387.4067
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	124.16066	389.132
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	124.23405	388.8717

PH 2031 Full Replacement 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32719	HA10H019	84.73477	1	<Collection: 0 items>	0	126.74829	411.1805
32734	J-EA-1	84.4	1	<Collection: 1 item>	11.14	126.59023	412.9098
32751	J-EA-2	84.5	1	<Collection: 0 items>	0	126.66343	412.6477

Pipe Results

AD 2021 Existing Watermains 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.50013	0.08489	0.56	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-2.20987	0.125053	1.15	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-2.20987	0.125053	1.15	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-2.20987	0.125053	1.15	TRUE	35

AD 2021 Existing Watermains 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.508889	0.085386	0.57	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-2.20111	0.124557	1.14	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-2.20111	0.124557	1.14	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-2.20111	0.124557	1.14	TRUE	35

AD 2021 Partial Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	0.854955	0.048381	0.2	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.85505	0.161563	0.42	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.85505	0.161563	0.44	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.85505	0.161563	0.44	TRUE	35

AD 2021 Partial Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	0.873946	0.049455	0.21	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.83605	0.160488	0.42	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.83605	0.160488	0.43	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.83605	0.160488	0.43	TRUE	35

AD 2021 Full Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	1.24412	0.070403	0.09	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.46588	0.13954	0.32	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.46588	0.13954	0.33	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.46588	0.13954	0.33	TRUE	35

AD 2021 Full Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	1.273555	0.072068	0.1	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.43645	0.137875	0.31	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.43645	0.137875	0.33	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.43645	0.137875	0.33	TRUE	35

AD 2031 Existing Watermains 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.503812	0.085098	0.57	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-2.20619	0.124845	1.15	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-2.20619	0.124845	1.15	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-2.20619	0.124845	1.15	TRUE	35

AD 2031 Existing Watermains 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.499709	0.084866	0.56	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-2.21029	0.125077	1.15	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-2.21029	0.125077	1.15	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-2.21029	0.125077	1.15	TRUE	35

AD 2031 Partial Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	0.855659	0.04842	0.2	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.85434	0.161523	0.42	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.85434	0.161523	0.44	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.85434	0.161523	0.44	TRUE	35

AD 2031 Partial Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	0.877103	0.049634	0.21	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.8329	0.160309	0.42	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.8329	0.160309	0.43	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.8329	0.160309	0.43	TRUE	35

AD 2031 Full Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	1.254484	0.070989	0.09	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.45552	0.138954	0.32	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.45552	0.138954	0.33	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.45552	0.138954	0.33	TRUE	35

AD 2031 Full Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	1.288027	0.072887	0.1	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-2.42197	0.137056	0.31	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-2.42197	0.137056	0.32	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-2.42197	0.137056	0.32	TRUE	35

MD 2021 Existing Watermains 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.884254	0.163215	1.89	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-4.17575	0.236299	3.74	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-4.17575	0.236299	3.74	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-4.17575	0.236299	3.74	TRUE	35

MD 2021 Existing Watermains 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.888564	0.163459	1.9	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-4.17144	0.236055	3.73	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-4.17144	0.236055	3.74	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-4.17144	0.236055	3.74	TRUE	35

MD 2021 Partial Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.68955	0.095609	0.7	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-5.37045	0.303905	1.36	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-5.37045	0.303905	1.42	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-5.37045	0.303905	1.41	TRUE	35

MD 2021 Partial Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.698392	0.096109	0.71	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-5.36161	0.303405	1.36	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-5.36161	0.303405	1.42	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-5.36161	0.303405	1.41	TRUE	35

MD 2021 Full Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	2.466693	0.139586	0.32	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-4.59331	0.259928	1.02	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-4.59331	0.259928	1.06	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-4.59331	0.259928	1.06	TRUE	35

MD 2021 Full Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	2.481844	0.140444	0.33	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-4.57816	0.259071	1.01	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-4.57816	0.259071	1.06	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-4.57816	0.259071	1.05	TRUE	35

MD 2031 Existing Watermains 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.89806	0.163997	1.91	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-4.16194	0.235518	3.72	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-4.16194	0.235518	3.72	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-4.16194	0.235518	3.72	TRUE	35

MD 2031 Existing Watermains 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.901616	0.164198	1.91	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-4.15838	0.235316	3.71	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-4.15838	0.235316	3.71	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-4.15838	0.235316	3.71	TRUE	35

MD 2031 Partial Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.718525	0.097249	0.72	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-5.34147	0.302266	1.35	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-5.34147	0.302266	1.41	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-5.34147	0.302266	1.4	TRUE	35

MD 2031 Partial Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	1.725643	0.097651	0.73	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-5.33436	0.301863	1.34	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-5.33436	0.301863	1.4	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-5.33436	0.301863	1.39	TRUE	35

MD 2031 Full Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	2.517525	0.142463	0.34	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-4.54248	0.257052	1	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-4.54248	0.257052	1.04	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-4.54248	0.257052	1.03	TRUE	35

MD 2031 Full Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	2.529281	0.143128	0.34	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-4.53072	0.256386	0.99	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-4.53072	0.256386	1.04	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-4.53072	0.256386	1.03	TRUE	35

PH 2021 Existing Watermains 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	4.559511	0.258016	4.42	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-6.58049	0.372379	8.69	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-6.58049	0.372379	8.69	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-6.58049	0.372379	8.69	TRUE	35

PH 2021 Existing Watermains 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	4.561919	0.258152	4.42	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-6.57808	0.372243	8.68	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-6.57808	0.372243	8.68	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-6.57808	0.372243	8.68	TRUE	35

PH 2021 Partial Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.686372	0.152018	1.66	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-8.45363	0.478377	3.15	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-8.45363	0.478377	3.3	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-8.45363	0.478377	3.28	TRUE	35

PH 2021 Partial Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.691734	0.152321	1.66	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-8.44827	0.478074	3.14	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-8.44827	0.478074	3.3	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-8.44827	0.478074	3.28	TRUE	35

PH 2021 Full Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	3.926561	0.222198	0.77	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-7.21344	0.408197	2.35	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-7.21344	0.408197	2.46	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-7.21344	0.408197	2.44	TRUE	35

PH 2021 Full Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	3.936648	0.222769	0.77	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-7.20335	0.407626	2.34	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-7.20335	0.407626	2.45	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-7.20335	0.407626	2.44	TRUE	35

PH 2031 Existing Watermains 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	4.563483	0.25824	4.42	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-6.57652	0.372155	8.68	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-6.57652	0.372155	8.68	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-6.57652	0.372155	8.68	TRUE	35

PH 2031 Existing Watermains 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	4.566445	0.258408	4.43	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	45	FALSE	0.39	-6.57356	0.371987	8.67	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	45	FALSE	0	-6.57356	0.371987	8.67	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	45	FALSE	0	-6.57356	0.371987	8.67	TRUE	35

PH 2031 Partial Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.65594	0.150295	1.62	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-8.48406	0.4801	3.17	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-8.48406	0.4801	3.17	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-8.48406	0.4801	3.17	TRUE	35

PH 2031 Partial Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	45	FALSE	0.39	2.662075	0.150643	1.63	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-8.47792	0.479752	3.17	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-8.47792	0.479752	3.17	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-8.47792	0.479752	3.17	TRUE	35

PH 2031 Full Replacement 50%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	3.944495	0.223213	0.78	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-7.1955	0.407182	2.34	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-7.1955	0.407182	2.45	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-7.1955	0.407182	2.43	TRUE	35

PH 2031 Full Replacement 75%

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/km)	Has User Defined Length?	Length (User Defined) (m)
32735	P-552	132.4	HA10T016	J-EA-1	150	Ductile Iron	100	FALSE	0.39	3.95431	0.223768	0.78	TRUE	121
32743	P-556	4	HA10H019	J-572	150	Ductile Iron	100	FALSE	0.39	-7.18569	0.406627	2.33	TRUE	10
32752	P-562	16.1	J-EA-1	J-EA-2	150	Ductile Iron	100	FALSE	0	-7.18569	0.406627	2.44	TRUE	30
32753	P-563	41.2	J-EA-2	HA10H019	150	Ductile Iron	100	FALSE	0	-7.18569	0.406627	2.42	TRUE	35