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Subject:	**Watermain Hydraulic Assessment for the Proposed Liuna Gardens Development**		

Fengate Liuna Gardens Holdings LP

Watermain Hydraulic Assessment for the Proposed Liuna Gardens Development

C3 WATER INC.

December 16, 2021

VERSION	DATE	DESCRIPTION OF REVISIONS	REVISED BY	REVIEWED BY
1	April 6, 2020	Draft 1	Michelle Scott	Sam Ziemann, P.Eng. Andrew Salomon
2	December 3, 2020	Final	Michelle Scott	Sam Ziemann, P.Eng.
3	October 5, 2021	Additional units added to plan, population increase.	Liam Connolly	Sam Ziemann, P.Eng., Spencer McKay
4	October 8, 2021	Final	Liam Connolly	Sam Ziemann, P.Eng.
5	November 30, 2021	Updated to include Fall 2021 hydrant testing results.	Liam Connolly	Sam Ziemann, P.Eng., Spencer McKay
6	December 16, 2021	Final	Michelle Scott	Sam Ziemann

SIGN OFF

This document, entitled "***Watermain Hydraulic Assessment for the Proposed Liuna Gardens Development***", was prepared by C3 Water Inc. for **Fengate Liuna Gardens Holdings LP.**

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: December 16, 2021

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

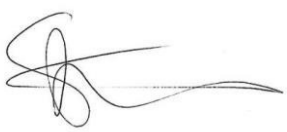


Table of Contents

List of Figures

List of Tables

List of Appendices

1.0 INTRODUCTION

1.1 Background

Fengate Liuna Gardens Holdings LP (the Owner) is intending to undertake the redevelopment of the existing Liuna Gardens Banquet Facility, located at 526 Winona Rd. in Stoney Creek, into a 1000-unit residential development. C3 Water Inc. was retained by the Owner to provide consulting services for 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 Liuna Gardens 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

Figure 1-1 Development Location

1.2 Purpose of Report

This report is intended to provide a hydraulic assessment of the development area and to identify the recommended servicing configuration. A complete water servicing plan from the developer is not yet available at the time of analysis.

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	Maximum
Standard Operating Conditions	275 kPa	690 kPa
Maximum Day Demands + Fire Flows	138 kPa	

2.2 Domestic Demand

An updated development plan was provided to C3W September 1, 2021. Estimated population for the proposed development is based on number of bedrooms for the updated unit count of 1212 units, assuming each bedroom is occupied. The domestic demand is based on an average day demand (ADD) of 360 L/cap/day. Peaking factors of 1.9 and 3 based on the City of Hamilton's WWWMP were used for the maximum day demand (MDD) and peak hour demand (PHD) scenarios, respectively. Table 2-2 summarizes the development demand for each scenario.

Table 2-2 Domestic Demands

Scenario	ADD	MDD	PHD
Demand (L/s)	7.8	14.9	23.5

2.3 Fire Flow Demand

The proposed development is classified as a "Residential Multi (greater than 3 units)" with a target fire flow of 150 L/s, under the City of Hamilton Fire Flow Requirement Design Guidelines Policy (PW19096). The development area 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 Development

Two watermain connections were added to the model for the proposed development; one connected to the existing 200 mm watermain on Winona Road and the other connected to the existing 200mm watermain on East Street. The connections were modelled with various diameters and Hazen-Williams C-factors to determine the required watermain sizing to meet the development requirements. A check valve was added to the proposed pipes to ensure flow reversal does not occur and to prevent water from looping through the development. C-factors were applied to the proposed watermains based on the MECP guidelines as specified 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

The required demand for each scenario was applied to the new junction J-LG01. An elevation of 80.0 m was assigned to the junction. The model setup is shown in Figure 3-1 below.

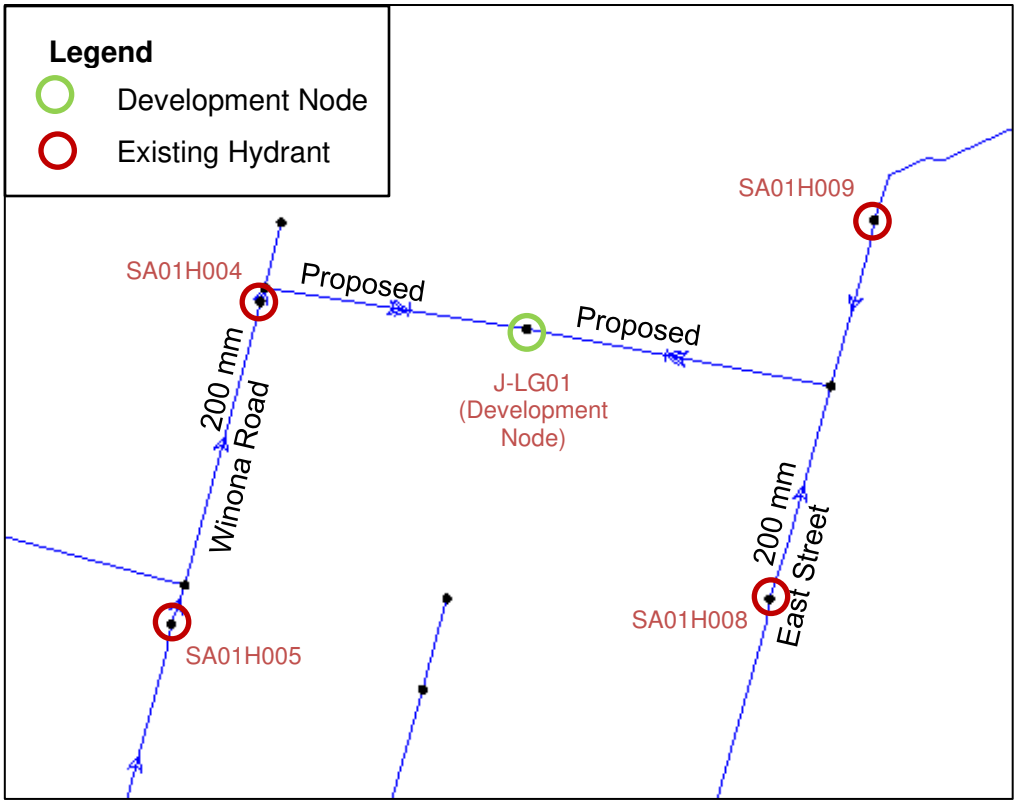


Figure 3-1 Model Layout

3.3 Hydrant Field Test Data

The City's hydraulic water model results were verified using hydrant test data provided by the City to determine if the model results are reflective of field conditions. The model was initially verified using hydrant test data provided by the City dated July 8, 2016. The model results are compared to the 2016 field test results in Figures 3-3 through 3-6 below.

In September 2021, SLA provided updated hydrant field test data dated July 3, 2019. Results of this field test differ significantly from the original 2016 data used for the initial model validation. The 2019 results are more conservative than the 2016 data. At a residual pressure of 138 kPa, each hydrant had a theoretical available flow of at least 100 L/s less flow compared to the 2016 results. Based on the 2019 field tests, none of the hydrants achieved the 150 L/s required to satisfy fire flow requirements for the development.

Because of this discrepancy in hydrant testing between 2016 and 2019, additional testing was completed in October 2021 to confirm currently available flows and pressures in the system. Based on the 2021 tests, theoretical flows at a residual pressure of 138 kPa were 249 L/s on Winona Road and 327 L/s on East Street. Compared to previous tests, the 2021 data more closely matches the 2016 tests than 2019. A summary of the three sets of hydrant field tests is provided in Table 3-3 below. Hydrant locations are shown in Figure 3-1 above. Because of the greater disparity between 2019 and the other tests, the 2019 tests were disregarded for model verification. The model verification and development area C-factors were based on the 2016 field test results as discussed in the following section. The 2021 field tests were later compared to model results to confirm that the model was more conservative than the latest set of field data.

Table 3-3 Theoretical Fire Flows from Field Test Results (L/s)

Hydrant	Test Year		
	2016	2019	2021
SA01H004	198	100	249
SA01H005	286	143	-
SA01H008	247	109	-
SA01H009	219	126	327

3.4 Model Verification

The development area model results were compared to the 2016 hydrant field test results, provided by the City. The model was compared to the 2016 hydrant test results under 2021 ADD conditions. On Winona Road (hydrants SA01H004 & SA01H005), the model was found to have significantly lower flows and pressures than what was recorded in the field testing. The 200mm and 300mm watermains on Winona Road and the 300mm watermain on South Service Road had C-factors of 80 in the model and are noted as being ductile iron (DI) material. To update the model to more closely match the hydrant test results, the C-factors at these locations were increased to 120. It is not expected that a DI watermain would have a C-factor of higher than 120 under most conditions. A review of the other DI pipes in the area of a similar diameter had C-factors between 110 and 141. The updated watermains are summarized in Table 3-4 and Figure 3-2 below.

Table 3-4 Model C-factor Updates

Location	Winona Road	South Service Road	East Street
Diameter (mm)	200&300	300	200
Original C-Factor	80	80	110
New C-Factor	120	120	n/a

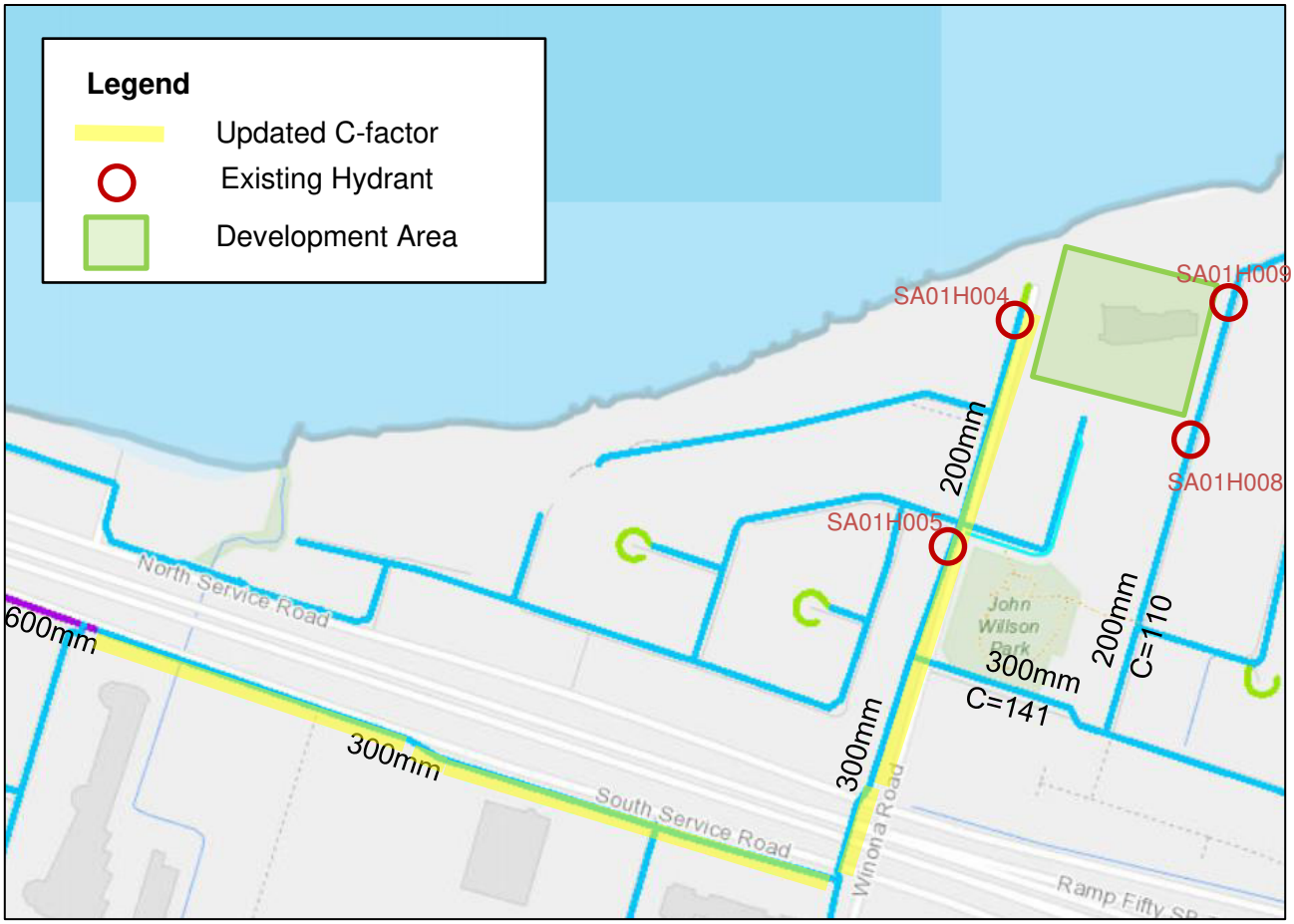


Figure 3-2 Model C-Factor Updates

The model results are compared to the 2016 field test results in Figure 3-3 and Figure 3-5 below for Winona Road, and Figure 3-5 and Figure 3-6 for East Street. It was found that on Winona Road, with the increased C-factors, the model were still conservative compared to the 2016 field testing results. The hydrants on East Street were found to have similar results when comparing the model to the field tests. The model updated C-factors did not significantly impact the results on East Street.

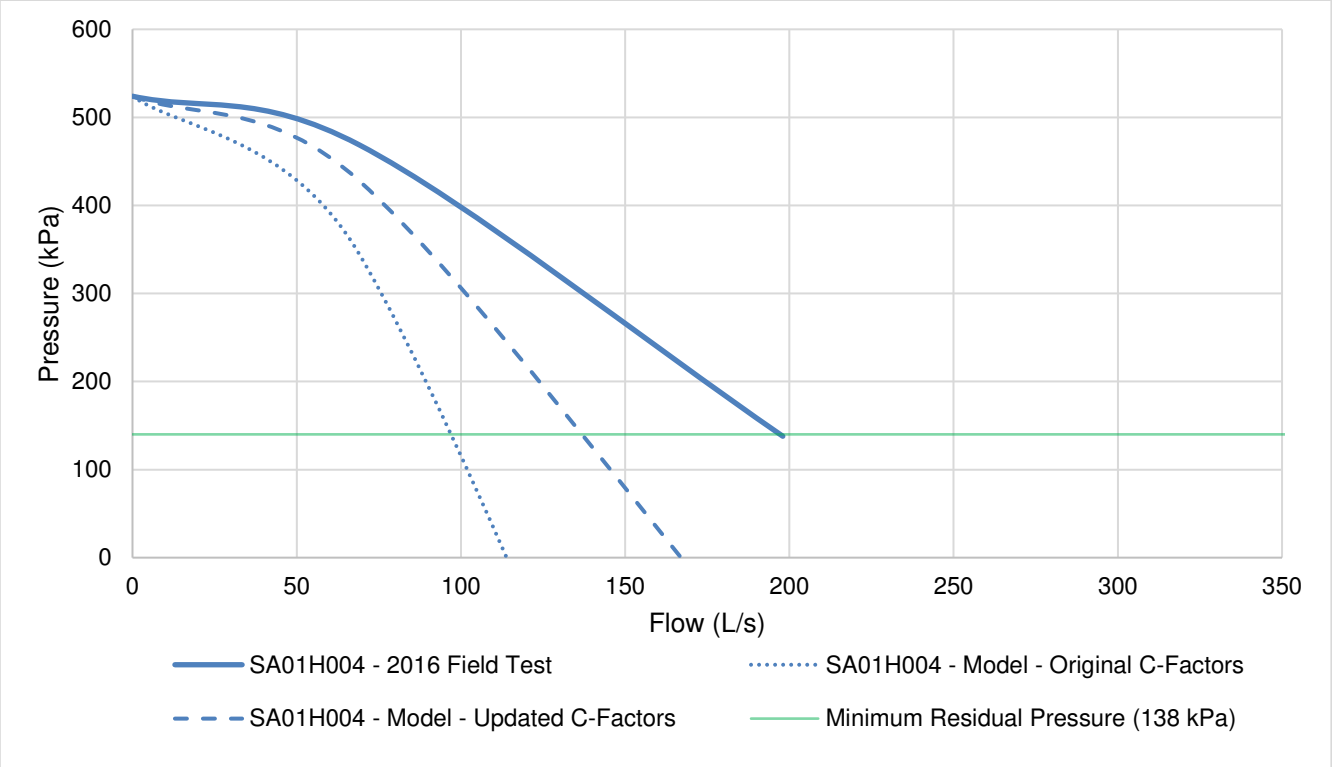


Figure 3-3 Model Verification – Winona Road, Hydrant SA01H004

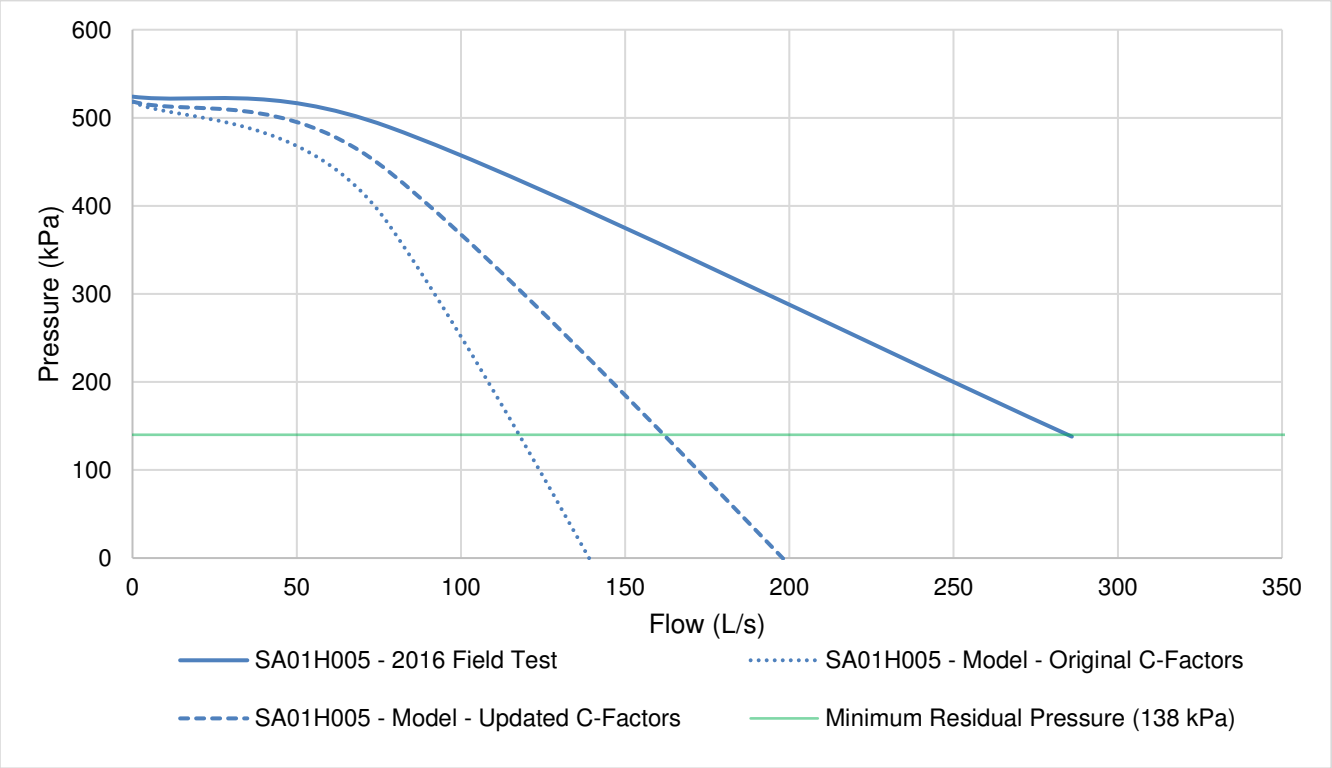


Figure 3-4 Model Verification – Winona Road, Hydrant SA01H005

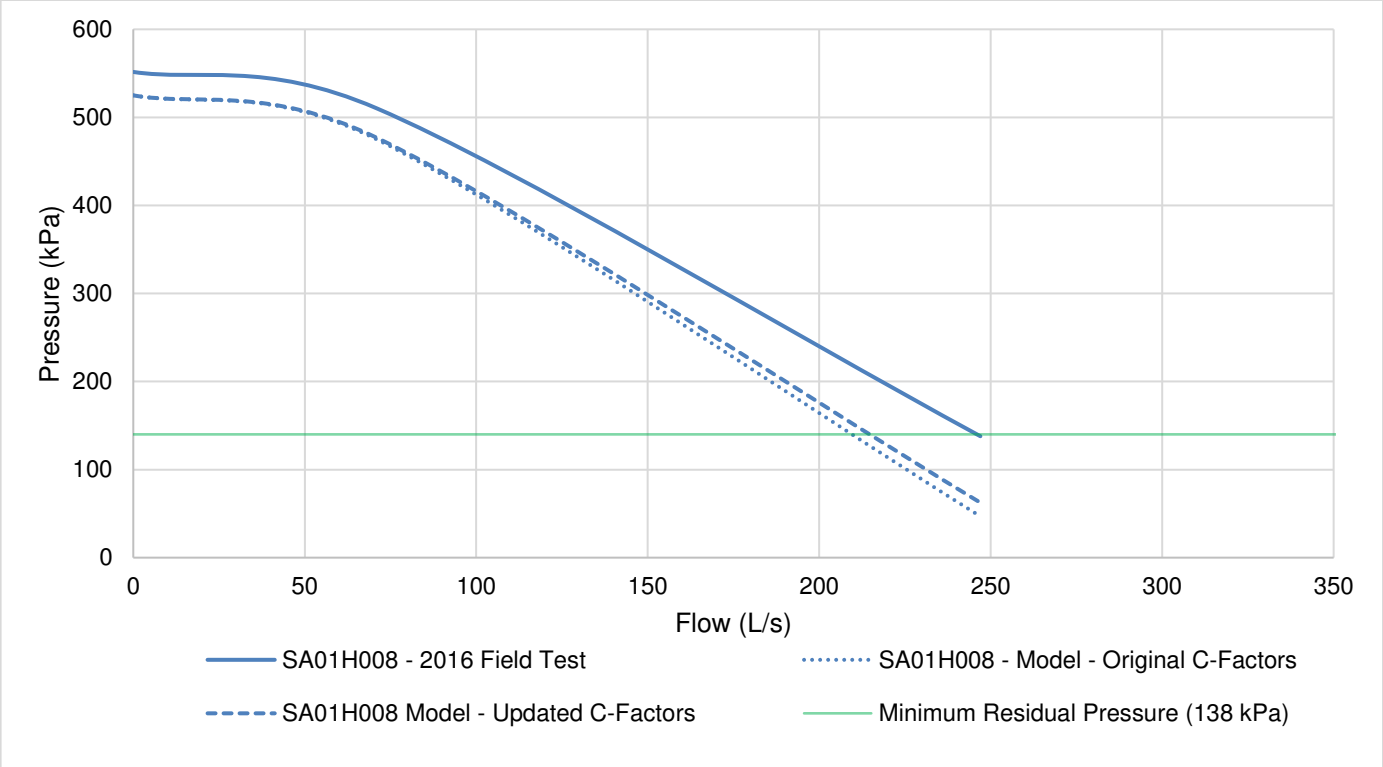


Figure 3-5 Model Verification – East Street, Hydrant SA01H008

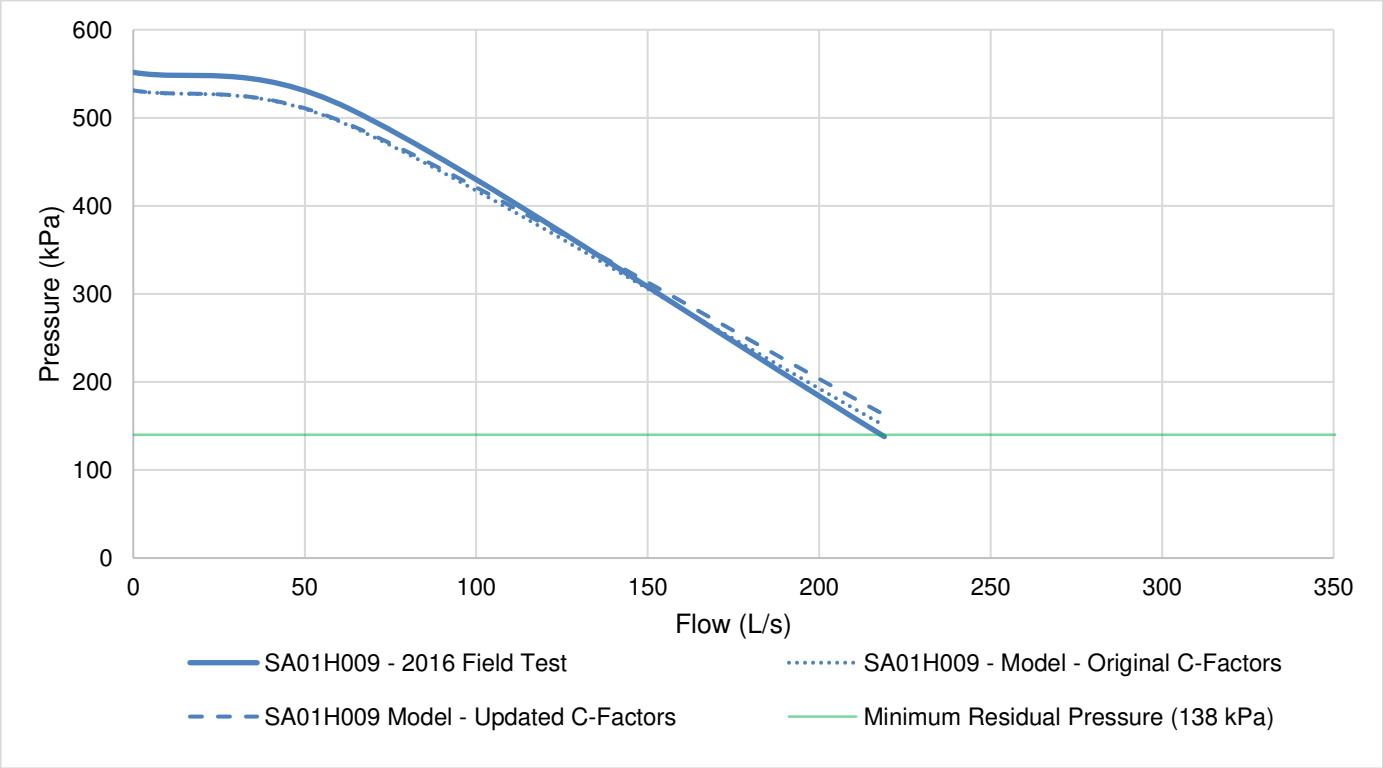


Figure 3-6 Model Verification – East Street, Hydrant SA01H009

3.4.1 Model Verification – 2021 Update

The model results with the updated C-factors were compared to the 2021 field test data. Boundary conditions within the model were set to match the pumping station discharge flow and reservoir levels from SCADA at the time of the hydrant tests. The 2021 hydrant test results and the model test results are presented in Figure 3-7 and Figure 3-8 below. The model had a higher static pressure at each of the hydrant locations compared to what was recorded in the field. This may be attributed to a difference in elevation between the hydrant node in the model and the pressure sensor used for field testing. The available fire flows based on the model results were more conservative than the 2021 tests. Because of this, the current model verification based on the 2016 tests, as presented in the previous section, were considered acceptable and no further adjustments to pipe C-factors were made based on the 2021 field tests.

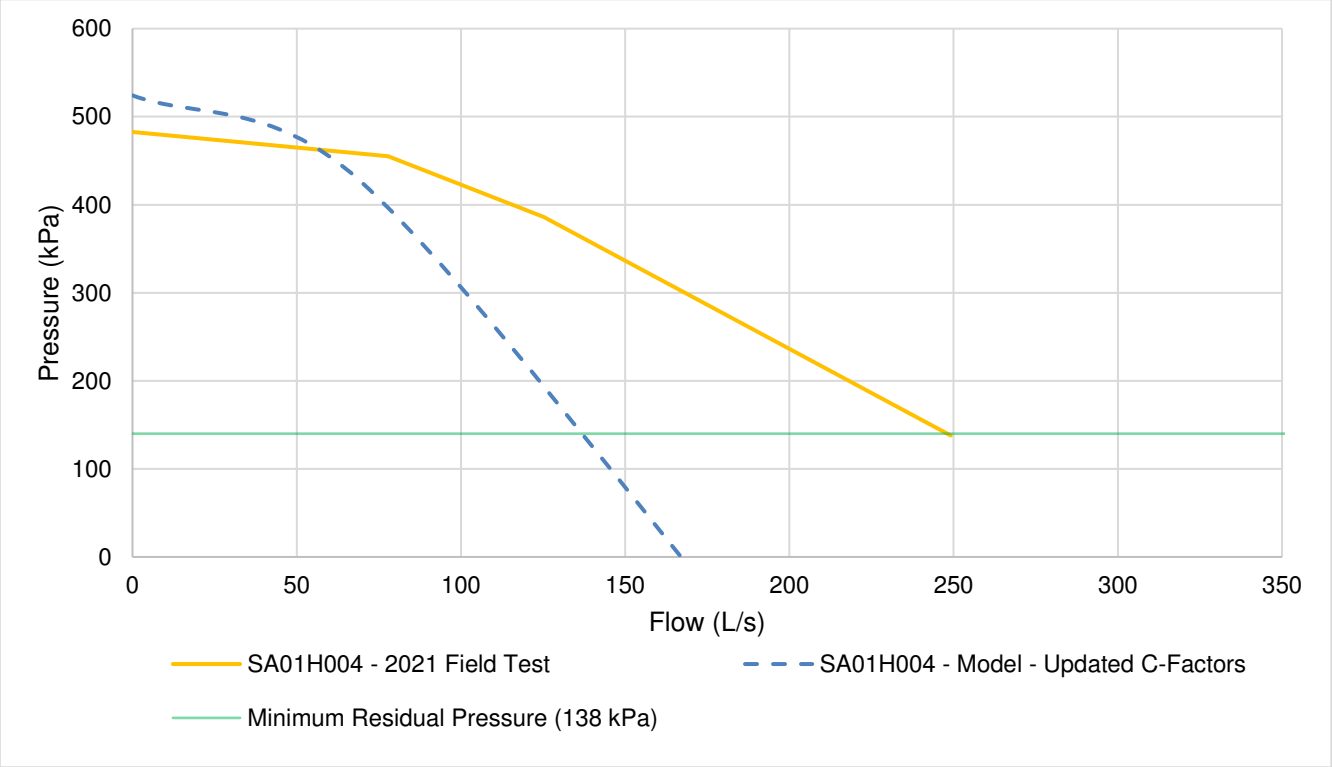


Figure 3-7 Model Verification Update – Winona Road, Hydrant SA01H004

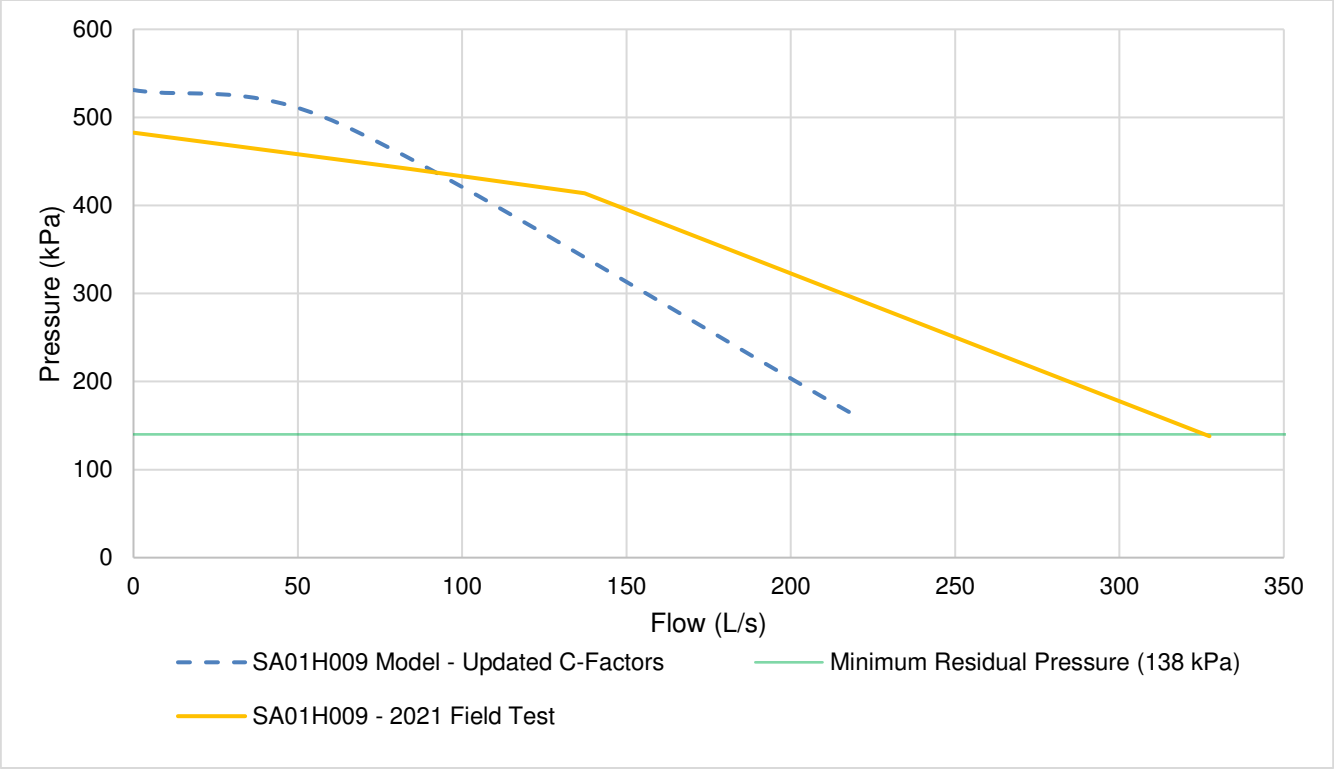


Figure 3-8 Model Verification Update – East Street, Hydrant SA01H009

4.0 ANALYSIS

4.1 Available Fire Flow

The model and results will be updated based on the new flow testing results to be completed in October 2021 and therefore the following results should be considered preliminary.

The model was used to determine the available fire flow at the existing hydrants in the development area under MDD conditions at a residual pressure of 140 kPa. Results are presented in Table 4-1 below. Hydrants SA01H008 and SA01H009 on East Street met the fire flow requirement of 150 L/s under all MDD scenarios. Hydrant SA01H004 on Winona Road did not meet the fire flow requirement of 150 L/s. Given that the model is showing conservative results compared to the field test results, it is recommended that additional field testing is completed on Winona Road to confirm the available flows at this location.

Table 4-1 Fire Flow Results (L/s) at Existing Hydrants

Hydrant	Location	2021		2031		Meets FF Criteria?
		50%	75%	50%	75%	
SA01H004	Winona Road	125	138	131	137	No
SA01H008	East Street	207	207	196	204	Yes
SA01H009		210	210	199	207	Yes

The model was run to determine the residual pressure at hydrant SA01H004 on Winona Road and SA01H009 on East Street, if these hydrants were run simultaneously. The results are summarized in Table

4-2 below. It can be seen that when Hydrant SA01H004 was run at a flow of 110 L/s and hydrant SA01H009 is operated at 160 L/s, for a combined fire flow of 270 L/s, the residual pressure at both hydrants was maintained above 140 kPa under all scenarios.

Table 4-2 Residual Pressure (kPa) – Combined Hydrant Tests

Hydrant	Scenario	2021		2031	
	Flow at Hydrant (L/s)	50%	75%	50%	75%
SA01H004	110	154	179	145	170
SA01H009	160	165	190	156	181
Combined Flow	**270**				

Additionally, the model was used to determine the available fire flow within the development under MDD conditions at a residual pressure of 140 kPa under a variety of service connection configurations. One configuration assessed was to service the development from both the existing 200mm watermain on Winona Road and the 200mm watermain on East Street. An alternative configuration was assessed with the development only connected to the Winona Road watermain.

The available fire flows were evaluated at Junction J-LG01 with development watermains modelled with a diameter of 150mm and a C-factor of 100 as specified in Table 3-2 in Section 3.2. The fire flow results under 2021 and 2031 MDD conditions with the two servicing configurations are summarized in Table 4-3 below. The proposed development does not meet the fire flow requirement of 150 L/s when connected to both Winona Road and East St. when the PD1 tanks was 50% full or under any conditions when connected only to Winona Road.

It should be noted, however, that the service connections are expected to likely be PVC material. PVC watermains typically have a C-factor of at least 140. As this fire flow analysis was run with service connection C-factors of 100, as per the MECP guidelines, the model results are conservative. It is expected that the development would be able to meet the required fire flow of 150 L/s if the development is serviced from both Winona Road and East Street with 150mm diameter PVC pipes.

Table 4-3 Fire Flow Results (L/s) within the Development (J-LG01) – 150mm Connection

Year	2021		2031		Meets FF Criteria?
Tank Levels	**50%**	**75%**	**50%**	**75%**	
Winona and East Connection	144	151	142	149	No
Winona Connection Only	66	69	65	68	No

The available fire flows were additionally modelled under the scenarios described above, with the service connections modelled as 200mm with a C-factor of 110. The results are summarized in Table 4-4 below. The proposed development was able to meet the fire flow requirement of 150 L/s under all scenarios when the development was serviced from both Winona Road and East Street. The development did not meet the fire flow requirements when connected only to Winona Road.

Table 4-4 Fire Flow Results (L/s) within the Development (J-LG01) – 200mm Connection

Year	2021		2031		Meets FF Criteria?
Tank Levels	50%	75%	50%	75%	
Winona and East Connection	221	231	218	227	Yes
Winona Connection Only	99	104	98	103	No

As such, it is recommended that the development is serviced by both Winona Road and East Street. Complete model results can be found in Appendix A.

4.2 System Pressures

The pressure results for the development junction J-LG01 are presented in Table 4-5. Pressure results are expected to range +/- 2 kPa depending on the service connection sizes. Under each of the scenarios, the development pressure was above the minimum preferred operating pressure of 350 kPa. Under ADD conditions, when the PD1 tanks are 75% full, the development pressure exceeded the preferred operating pressure of 480 kPa but did not exceed the maximum standard operating pressure of 690 kPa.

Table 4-5 Pressure Results (kPa)

Scenario	2021		2031	
PD 1 Tank Levels	50%	75%	50%	75%
ADD	467	493	466	492
MDD	460	484	455	480
PHD	443	468	434	458

4.3 Transient Pressures

The MECP Guidelines recommend 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 733 kPa (493 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 existing Winona Road and East Street watermains and the two new watermains within the proposed development. 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. The development node (J-LG01) was modelled as the hydrant node 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 flushing capacity of the existing Winona Road watermain was evaluated from Winona Road to a proposed future hydrant within the proposed development, represented by node J-LG01. The flushing capacity of the existing East Street watermain was evaluated from East Street to the proposed hydrant located within the development. The modelled flushing configurations for Winona Road and East Street are shown in Figure 4-1, Figure 4-2 and Figure 4-3.

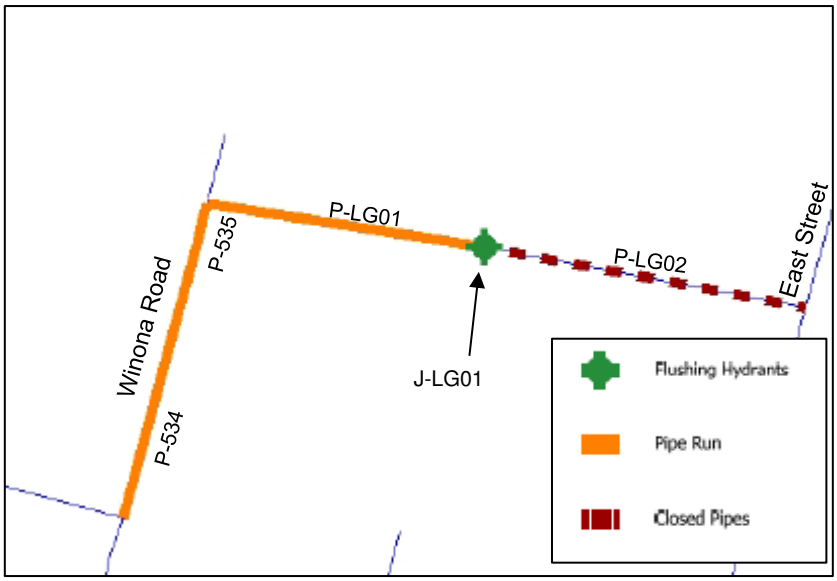


Figure 4-1 Winona Road Watermain Flushing Configuration

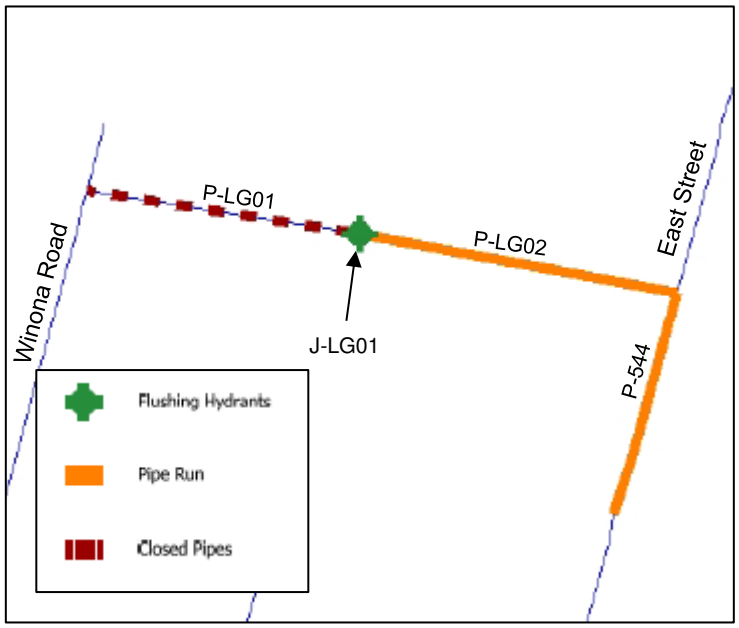


Figure 4-2 East Street Watermain Flushing Configuration (a)

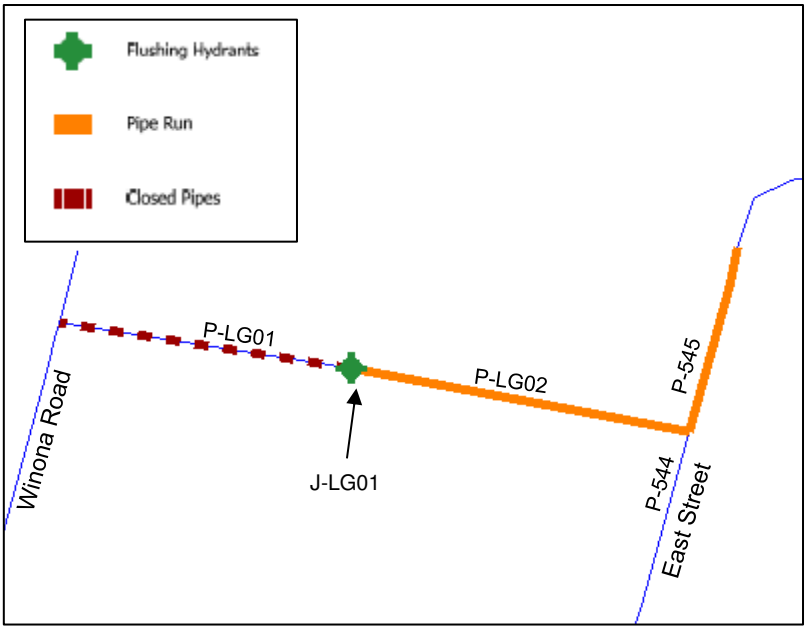


Figure 4-3 East Street Watermain Flushing Configuration (b)

The model results indicate that the required flushing velocity could be achieved for both Winona Road and East Street watermains. The results are summarized in Table 4-6 and Table 4-7 below for 150mm and 200mm service connections, respectively. Full results can be found in Appendix B.

Table 4-6 Flushing Results (150mm Service Connections)

Event	Pipe	Length (m)	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
Winona	P-534	104.4	200	2.0	TRUE
	P-535	5.2	200	2.0	TRUE
	P-LG01	94.5	**150**	3.5	TRUE
East	P-544	78.8	200	1.0	TRUE
	P-545	61	200	1.0	TRUE
	P-LG02	110	**150**	3.6	TRUE

Table 4-7 Flushing Results (200mm Service Connections)

Event	Pipe	Length (m)	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
Winona	P-534	104.4	200	2.2	TRUE
	P-535	5.2	200	2.2	TRUE
	P-LG01	94.5	**200**	2.2	TRUE
East	P-544	78.8	200	1.1	TRUE
	P-545	61	200	1.2	TRUE
	P-LG02	110	**200**	2.3	TRUE

5.0 CONCLUSIONS

Based on the model validated under 2016 field testing conditions, the watermain hydraulic assessment of the proposed Liuna Gardens development demonstrated that:

1. The service pressures under existing conditions (2021), and future (2031) conditions are expected to range between 434 kPa and 493 kPa which are within the standards established by the MECP and City of Hamilton Guidelines;
2. The existing hydrants SA01H008 and SA01H009 on East Street are able to meet the fire flow requirement of 150 L/s at a residual pressure of 140 kPa when each hydrant is run individually.
3. When hydrant SA01H004 on Winona Road and SA01H009 on East Street are run simultaneously, they can achieve a combined fire flow of at least 270 L/s while maintaining both hydrants above 140 kPa.
4. The proposed development was able to meet the fire flow requirement of 150 L/s at a residual pressure of 140 kPa when the development is connected to the existing 200mm watermains on both Liuna Road and East Street with a 200mm development watermain.
5. The proposed watermains can withstand transient pressure plus maximum operating pressure assuming they conform to city specifications of 150 DR18 PVC pipe;
6. All proposed watermains can achieve a minimum flushing velocity of 0.8 m/s based on the outlined unidirectional flow procedure

APPENDIX A

Fire Flow Results

Pipe = 150 C= 100

2021 - 50% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**201.7128372**	149.9999931	201.7128372	140	140.0178931	182.6619895	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**198.8547712**	149.9999931	198.8547712	140	140.0149342	182.6689462	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**164.5670821**	149.9999931	164.5670821	140	139.9983643	135.1107861	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**132.5541057**	149.9999931	132.5541057	140	139.9981933	140.228791	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**79.53842435**	149.9999931	79.53842435	140	140.0021122	141.2115169	SA01S005	TRUE
J-LG01	1	3	FALSE	150	**144.2116215**	164.8999999	159.111613	140	139.9974701	182.8007689	HB15T003	TRUE

2021 - 75% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**209.8879004**	149.9999931	209.8879004	140	140.0248761	205.6921763	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**207.0604399**	149.9999931	207.0604399	140	140.0211939	205.6994355	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**171.4545107**	149.9999931	171.4545107	140	139.9995479	135.1119697	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**137.989166**	149.9999931	137.989166	140	139.9978909	140.2284885	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**82.7362625**	149.9999931	82.7362625	140	140.0017046	141.2111092	SA01S005	TRUE
J-LG01	1	2	TRUE	150	**150.7648231**	164.8999999	165.6648145	140	140.0420904	205.8428439	HB15T003	TRUE

Pipe = 200 C= 110

2021 - 50% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**201.7129296**	149.9999931	201.7129296	140	140.0176564	182.6619895	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**198.8548482**	149.9999931	198.8548482	140	140.0146843	182.6689462	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**164.5670667**	149.9999931	164.5670667	140	139.9985616	135.1109834	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**132.5540903**	149.9999931	132.5540903	140	139.9982591	140.2288567	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**79.53838584**	149.9999931	79.53838584	140	140.0022043	141.211609	SA01S005	TRUE
J-LG01	1	3	TRUE	150	**220.9918521**	164.8999999	235.8918436	140	140.0198131	182.6146338	HB15T003	TRUE

2021 - 75% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**209.8880083**	149.9999931	209.8880083	140	140.0245605	205.6921763	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**207.0605015**	149.9999931	207.0605015	140	140.0209178	205.6994355	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**171.4545107**	149.9999931	171.4545107	140	139.9994821	135.1119039	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**137.9891814**	149.9999931	137.9891814	140	139.997812	140.2283964	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**82.7362779**	149.9999931	82.7362779	140	140.0017177	141.2111224	SA01S005	TRUE
J-LG01	1	3	TRUE	150	**230.7692153**	164.8999999	245.6692222	140	140.026875	205.6381269	HB15T003	TRUE

Pipe = 150 C= 100

2031 - 50% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**198.9771779**	149.9999931	198.9771779	140	140.0237057	181.2642404	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**196.1257197**	149.9999931	196.1257197	140	140.0199578	181.2720651	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**162.5379837**	149.9999931	162.5379837	140	139.9984432	135.110865	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**131.0617669**	149.9999931	131.0617669	140	139.998864	140.2294617	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**78.76766423**	149.9999931	78.76766423	140	140.0051632	141.2145547	SA01S005	TRUE
J-LG01	1	3	FALSE	150	**142.3109523**	164.8999999	157.2109592	140	139.997641	181.4184456	HB15T003	TRUE

2031 - 75% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**207.1797352**	149.9999931	207.1797352	140	140.0327008	204.3157577	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**204.3599454**	149.9999931	204.3599454	140	140.0279665	204.3237928	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**169.4486091**	149.9999931	169.4486091	140	139.9997714	135.1121932	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**136.5131542**	149.9999931	136.5131542	140	139.9982328	140.2288304	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**81.97375832**	149.9999931	81.97375832	140	140.0044399	141.2138446	SA01S005	TRUE
J-LG01	1	16	FALSE	150	**148.8776314**	164.8999999	163.7776229	140	140.0589364	204.4809437	HB15T003	FALSE

Pipe = 200 C= 110

2031 - 50% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**198.9772395**	149.9999931	198.9772395	140	140.0236005	181.2642404	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**196.1257659**	149.9999931	196.1257659	140	140.0198657	181.2720651	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**162.5380299**	149.9999931	162.5380299	140	139.9983117	135.1107335	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**131.0617361**	149.9999931	131.0617361	140	139.9989561	140.2295406	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**78.76764882**	149.9999931	78.76764882	140	140.0053079	141.2146994	SA01S005	TRUE
J-LG01	1	3	TRUE	150	**217.6658004**	164.8999999	232.5658073	140	140.0285583	181.2125581	HB15T003	TRUE

2031 - 75% - Connect to Winona and East

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?
SA01H009	1	3	TRUE	150	**207.1798431**	149.9999931	207.1798431	140	140.0324115	204.3157577	HB15T003	TRUE
SA01H008	1	3	TRUE	150	**204.3600224**	149.9999931	204.3600224	140	140.0278087	204.3237928	HB15T003	TRUE
SA01H005	1	3	TRUE	150	**169.4485783**	149.9999931	169.4485783	140	140.0000081	135.1124299	SA01S001	TRUE
SA01H004	1	3	FALSE	150	**136.5131542**	149.9999931	136.5131542	140	139.9981407	140.2287252	SA01R001	TRUE
SA01H062	1	3	FALSE	150	**81.97375062**	149.9999931	81.97375062	140	140.0045057	141.2139103	SA01S005	TRUE
J-LG01	1	3	TRUE	150	**227.474031**	164.8999999	242.3740379	140	140.0380663	204.2574474	HB15T003	TRUE

APPENDIX B

Flushing Results

Flushing Results

150mm Service Connections

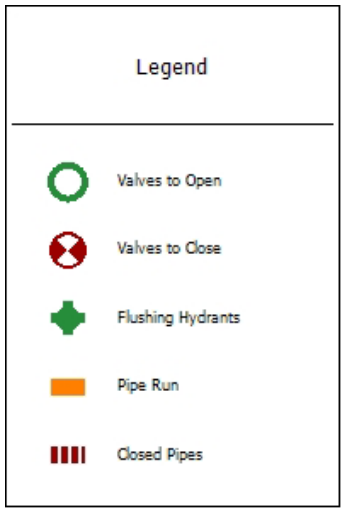
ID	Label	Length (m)	Diameter (mm)	Flushing Event	Velocity (Maximum Flushing) (m/s)	Satisfies Flushing Target Velocity?	Shear Stress (Maximum Flushing) (kg/m²)	Satisfies Flushing Target Shear Stress?	Satisfies Flushing Target?
32646	P-534	104.4	200	Winona	1.977011009	TRUE	1.11	TRUE	TRUE
32647	P-535	5.2	200	Winona	1.977011009	TRUE	1.11	TRUE	TRUE
32678	P-544	78.8	200	East	0.991746876	TRUE	0.41	TRUE	TRUE
32679	P-545	61	200	East	1.032551508	TRUE	0.45	TRUE	TRUE
32681	P-LG01	94.5	150	Winona	3.514686625	TRUE	4.74	TRUE	TRUE
32682	P-LG02	110	150	East	3.598752714	TRUE	4.95	TRUE	TRUE

200mm Service Connections

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?
32646	P-534	104.4	200	Winona	2.198959379	TRUE	1.35	TRUE	TRUE
32647	P-535	5.2	200	Winona	2.198959379	TRUE	1.35	TRUE	TRUE
32678	P-544	78.8	200	East2	1.131280437	TRUE	0.52	TRUE	TRUE
32679	P-545	61	200	East	1.177928244	TRUE	0.58	TRUE	TRUE
32681	P-LG01	94.5	200	Winona	2.198959379	TRUE	1.59	TRUE	TRUE
32682	P-LG02	110	200	East2	2.309208754	TRUE	1.74	TRUE	TRUE

Flushing Field Report

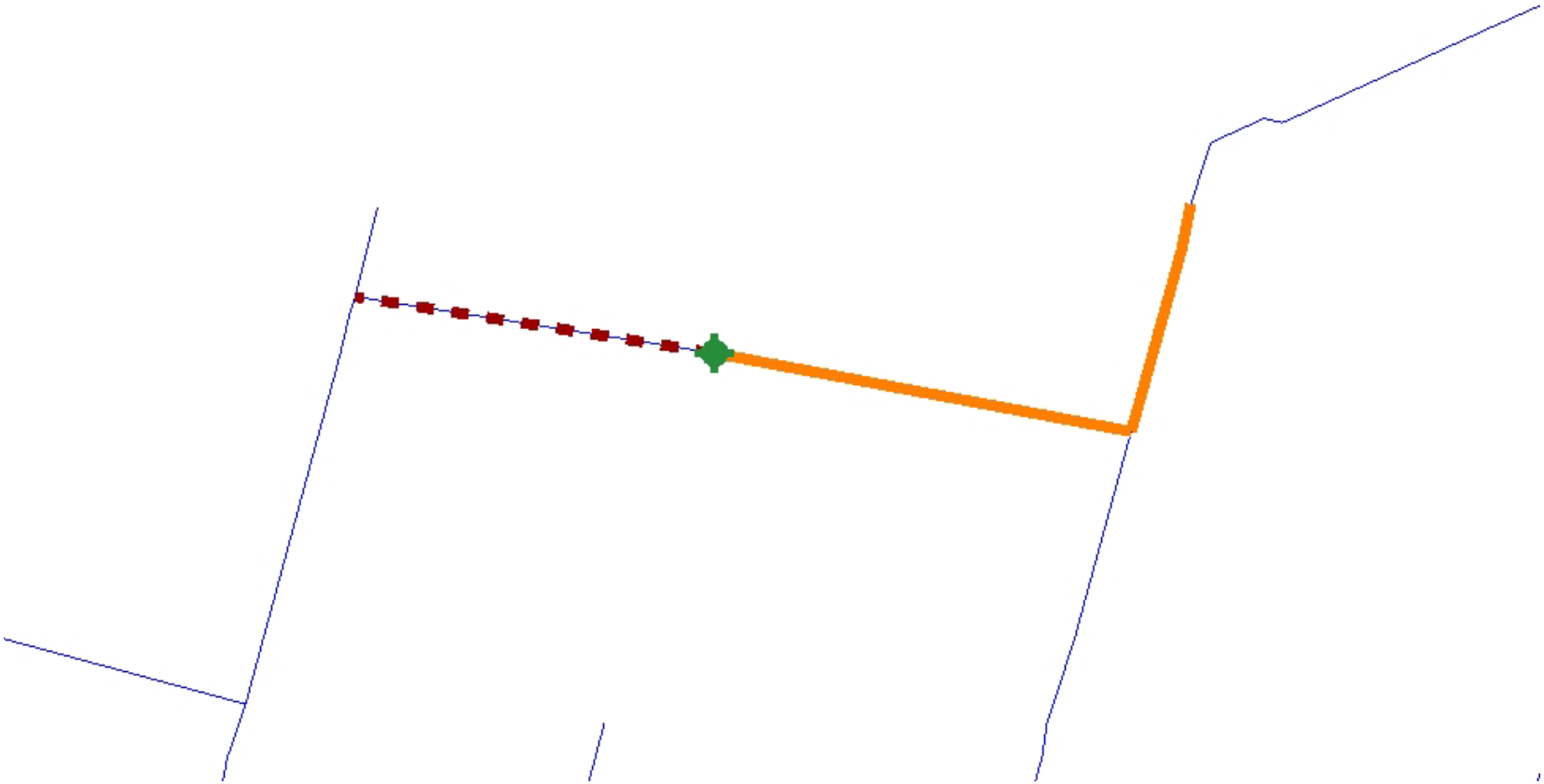
Study: Flushing Study



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East

Primary View



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-LG01				294.7112638085	61.87169822136

Valve	Operation	Notes
P-LG01	Closed ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	1.5	1.5
Volume (ML)	0.0	0.0

Start Time _____

End Time _____

Operator _____

Date

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

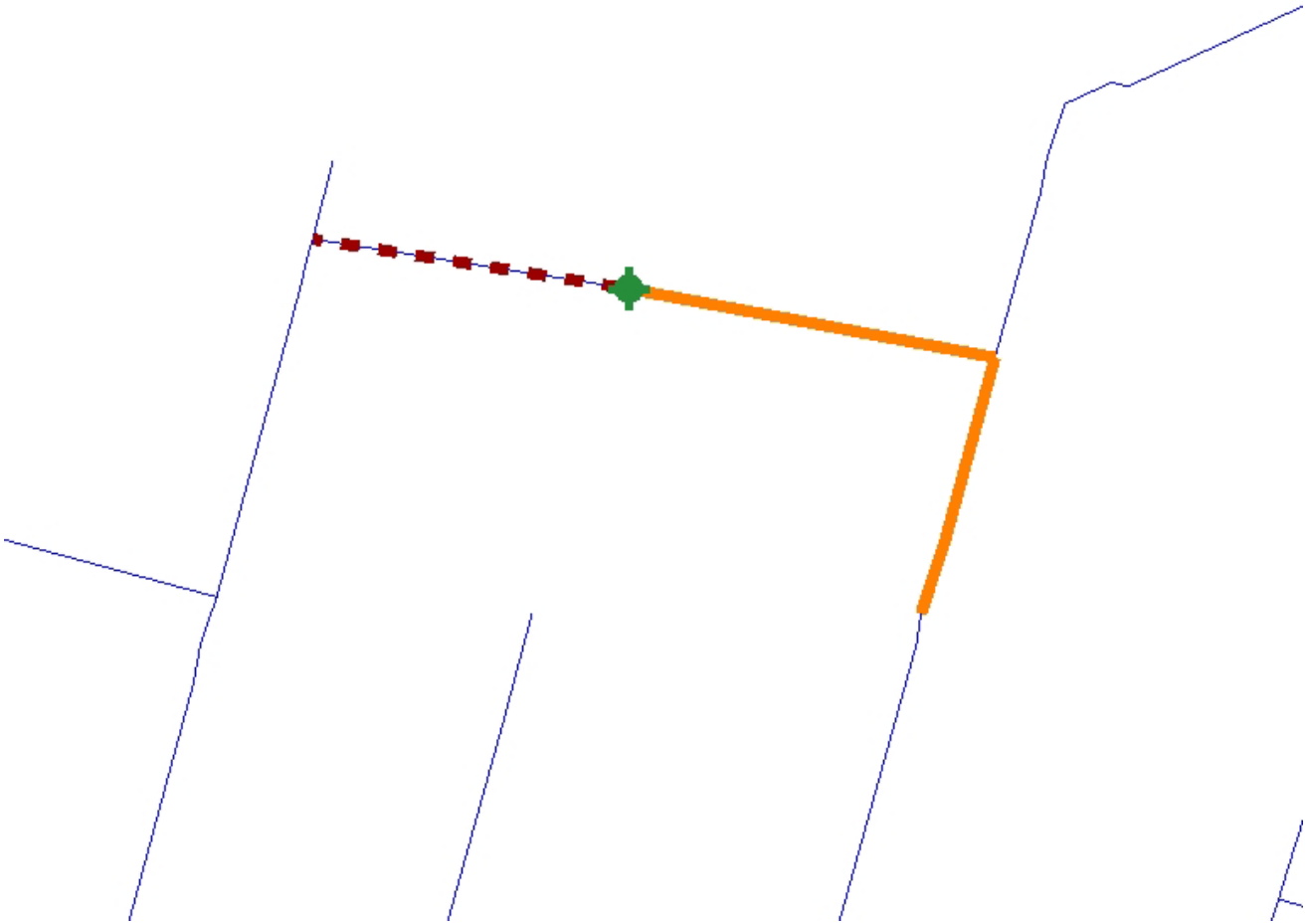
Pipe Run to be Cleaned
P-545, P-LG02

Notes _____

Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East2

Primary View



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East2

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-LG01				294.7112638085	61.87169822136

Valve	Operation	Notes
P-LG01	Closed (prior) ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	1.9	1.9
Volume (ML)	0.0	0.0

Start Time _____

End Time _____

Operator _____

Date

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

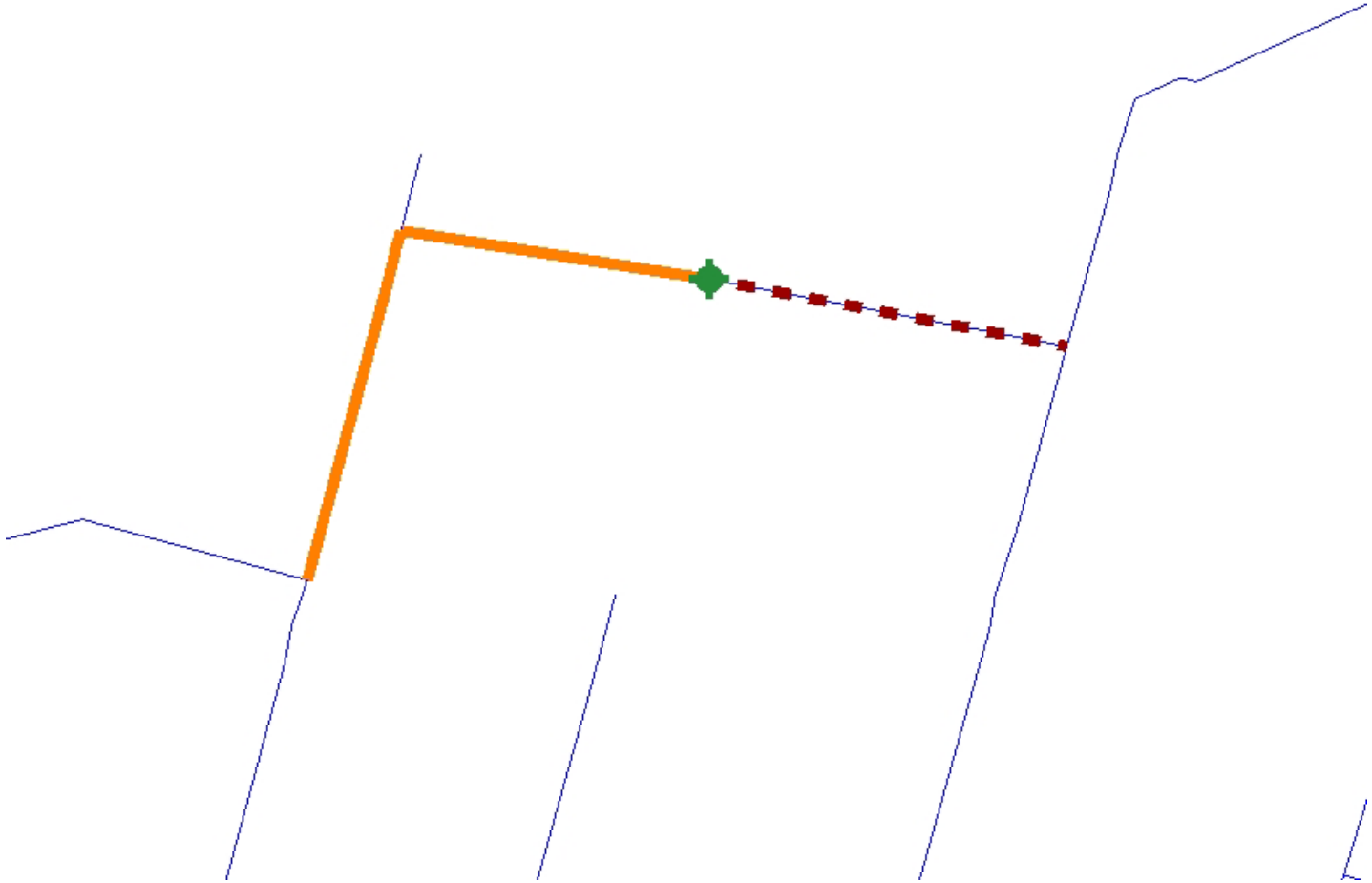
Pipe Run to be Cleaned
P-544, P-LG02

Notes _____

Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: Winona

Primary View



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: Winona

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-LG01				281.2248730182	60.43945371215

Valve	Operation	Notes
P-LG01	Reopen ☐	
P-LG02	Closed ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	1.4	1.4
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-LG01, P-535, P-534

Notes _____

Flushing Field Report

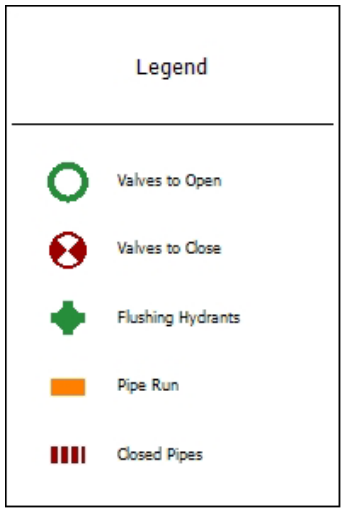
Study: Flushing Study; Area: Liuna 2; Event: Winona

Final Actions

Valve	Operation	Notes
P-LG02	Reopen ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing Field Report

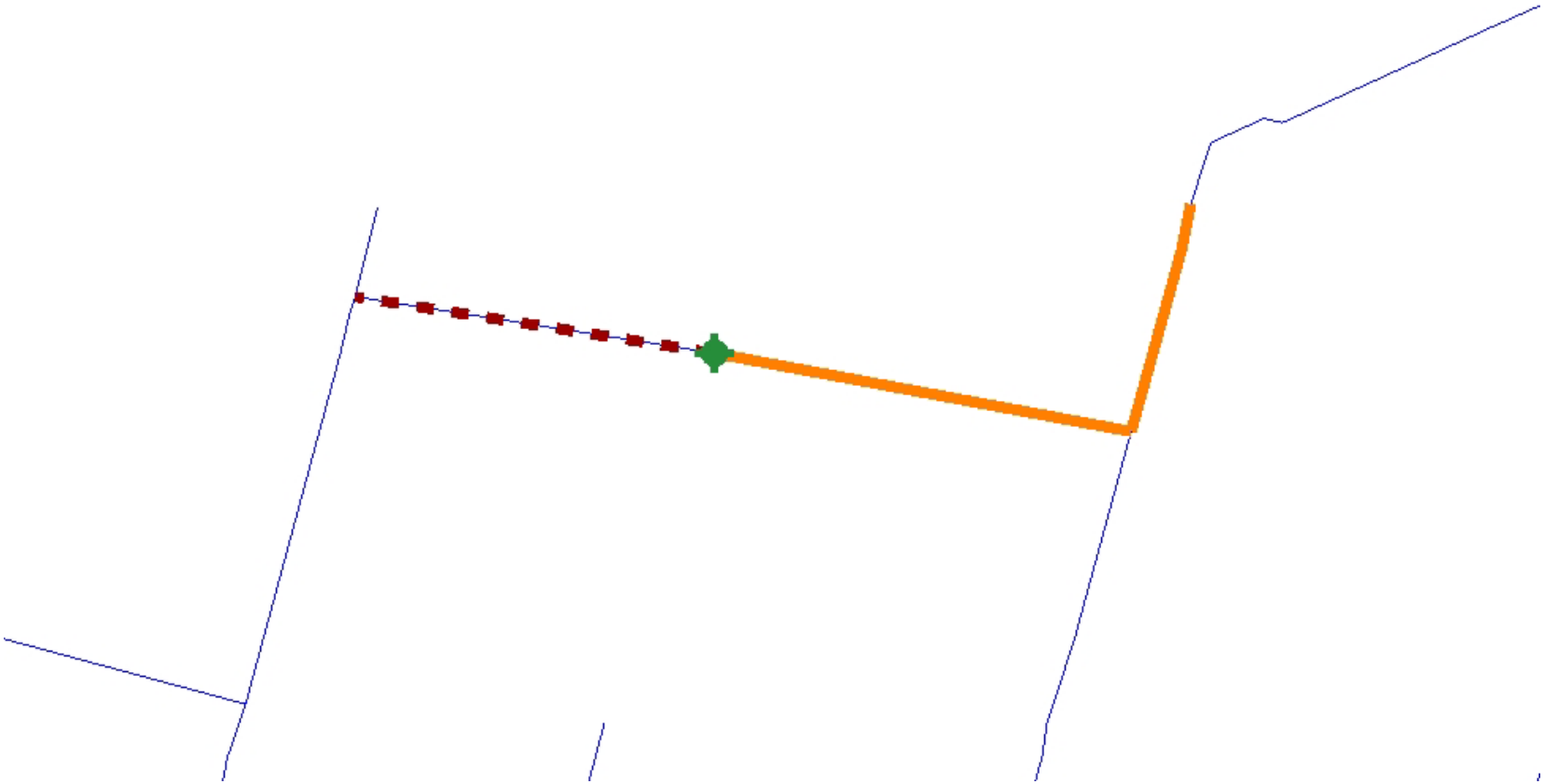
Study: Flushing Study



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East

Primary View



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-LG01				384.0286224728	70.62776578058

Valve	Operation	Notes
P-LG01	Closed ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	1.7	1.7
Volume (ML)	0.0	0.0

Start Time

End Time

Operator

Date

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

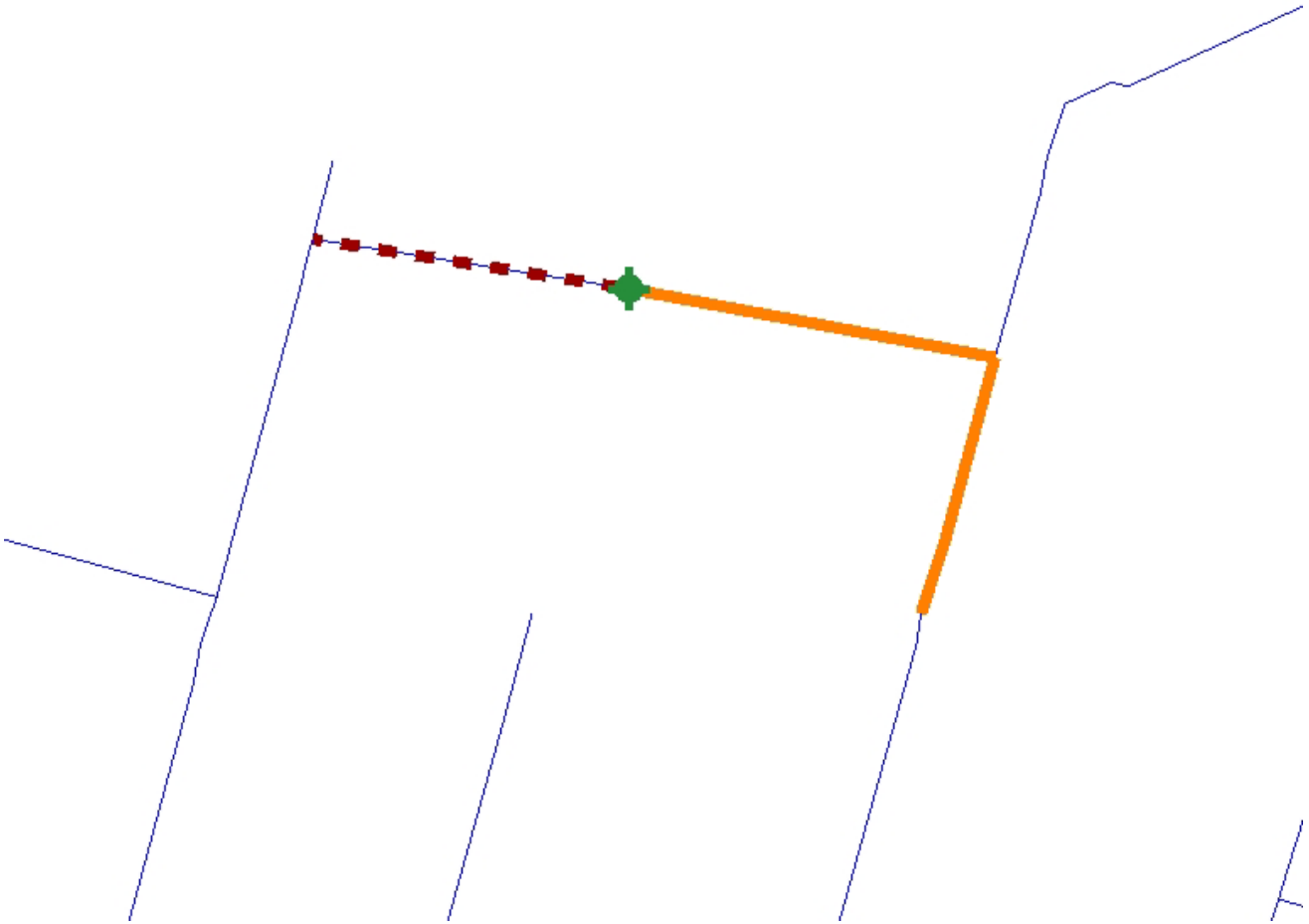
Pipe Run to be Cleaned
P-545, P-LG02

Notes

Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East2

Primary View



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: East2

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-LG01				384.0286224728	70.62776578058

Valve	Operation	Notes
P-LG01	Closed (prior) ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	2.0	2.0
Volume (ML)	0.0	0.0

Start Time

End Time

Operator

Date

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

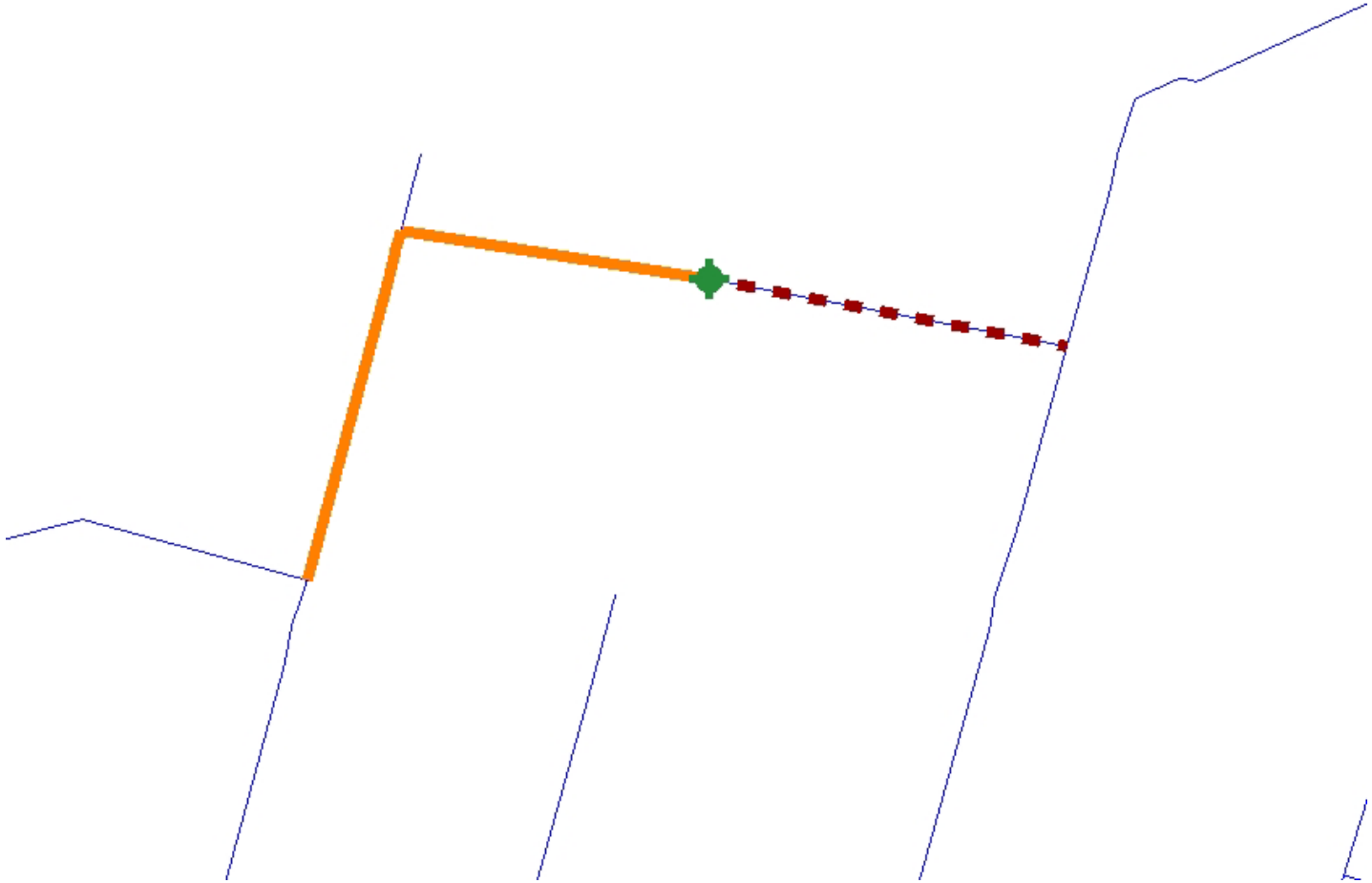
Pipe Run to be Cleaned
P-544, P-LG02

Notes

Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: Winona

Primary View



Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: Winona

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
J-LG01				348.1296151714	67.24564757292

Valve	Operation	Notes
P-LG01	Reopen ☐	
P-LG02	Closed ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	1.6	1.6
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-LG01, P-535, P-534

Notes _____

Flushing Field Report

Study: Flushing Study; Area: Liuna 2; Event: Winona

Final Actions

Valve	Operation	Notes
P-LG02	Reopen ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

APPENDIX C

Model Information

ADD 2021 - Tanks 50% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	127.7086141	466.9175479

ADD 2021 - Tanks 75% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	130.3251521	492.5252336

ADD 2021 - Tanks 50% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	127.7711591	467.5296869

ADD 2021 - Tanks 75% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	130.3876971	493.1373727

ADD 2031 - Tanks 50% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	127.6202753	466.0529679

ADD 2031 - Tanks 75% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	130.2355575	491.6483971

ADD 2031 - Tanks 50% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	127.6901687	466.737015

ADD 2031 - Tanks 75% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	7.80	130.2979909	492.2594315

MDD 2021 - Tanks 50% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	126.7755362	457.7856451

MDD 2021 - Tanks 75% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	129.3118372	482.6080759

MDD 2021 - Tanks 50% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	126.9829654	459.8157459

MDD 2021 - Tanks 75% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	129.5192478	484.6379662

MDD 2031 - Tanks 50% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	126.3101971	453.2314505

MDD 2031 - Tanks 75% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	128.8347221	477.9386285

MDD 2031 - Tanks 50% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	126.5172078	455.2573956

MDD 2031 - Tanks 75% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	14.90	129.0417327	479.9645736

PHD 2021 - Tanks 50% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	124.8191068	438.6383489

PHD 2021 - Tanks 75% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	127.3206378	463.1204657

PHD 2021 - Tanks 50% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	125.3014308	443.3587948

PHD 2021 - Tanks 75% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	127.8029525	467.8408326

PHD 2031 - Tanks 50% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	123.8224048	428.8837602

PHD 2031 - Tanks 75% - 150mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	126.3129133	453.2580149

PHD 2031 - Tanks 50% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	124.3038173	433.5952636

PHD 2031 - Tanks 75% - 200mm Service Connection

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
32680	J-LG01	80	1	<Collection: 1 item>	23.50	126.7943164	457.9694394

ADD 2021 - Tanks 50% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	3.793874256	0.214689366	0.71	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	4.006125704	0.226700334	0.79	FALSE

ADD 2021 - Tanks 75% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	3.794772678	0.214740199	0.71	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	4.005227283	0.226649483	0.79	FALSE

ADD 2021 - Tanks 50% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	3.433858889	0.109303121	0.12	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	4.366140831	0.138978581	0.19	FALSE

ADD 2021 - Tanks 75% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	3.436006387	0.109371485	0.12	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	4.363993573	0.138910235	0.19	FALSE

ADD 2031 - Tanks 50% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	3.807945991	0.215485666	0.72	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	3.992053969	0.225904034	0.78	FALSE

ADD 2031 - Tanks 75% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	3.808923833	0.215540986	0.72	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	3.991076127	0.225848696	0.78	FALSE

ADD 2031 - Tanks 50% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	3.467615744	0.110377638	0.12	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	4.332383975	0.137904055	0.19	FALSE

ADD 2031 - Tanks 75% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	3.469879487	0.11044969	0.12	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	4.330120714	0.13783203	0.19	FALSE

MDD 2021 - Tanks 50% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	7.245644769	0.410019594	2.37	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	7.654354898	0.43314787	2.62	FALSE

MDD 2021 - Tanks 75% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	7.246511181	0.410068647	2.37	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	7.653488968	0.433098854	2.62	FALSE

MDD 2021 - Tanks 50% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	6.558449605	0.20876193	0.41	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	8.341551026	0.265519803	0.63	FALSE

MDD 2021 - Tanks 75% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	6.560491931	0.208826933	0.41	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	8.339507256	0.265454781	0.63	FALSE

MDD 2031 - Tanks 50% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	7.276743184	0.411779407	2.39	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	7.623256965	0.431388094	2.6	FALSE

MDD 2031 - Tanks 75% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	7.277487817	0.411821556	2.39	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	7.622513295	0.431346018	2.6	FALSE

MDD 2031 - Tanks 50% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	6.631631095	0.211091385	0.41	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	8.268369054	0.263190348	0.62	FALSE

MDD 2031 - Tanks 75% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	6.633357662	0.211146341	0.41	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	8.266642969	0.263135428	0.62	FALSE

PHD 2021 - Tanks 50% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	11.42842298	0.646716411	5.5	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	12.07157697	0.6831115	6.09	FALSE

PHD 2021 - Tanks 75% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	11.42901695	0.646750057	5.5	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	12.070983	0.683077854	6.09	FALSE

PHD 2021 - Tanks 50% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	10.3488688	0.32941474	0.95	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	13.15113019	0.418613474	1.47	FALSE

PHD 2021 - Tanks 75% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	10.3502618	0.329459068	0.95	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	13.14973815	0.418569181	1.47	FALSE

PHD 2031 - Tanks 50% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	11.47540176	0.649374824	5.55	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	12.02459819	0.680453014	6.05	FALSE

PHD 2031 - Tanks 75% - 150mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	150	PVC	100	TRUE	0	11.47590428	0.649403311	5.55	FALSE
32682	P-LG02	110	J-566	J-LG01	150	PVC	100	TRUE	0	12.02409471	0.6804246	6.05	FALSE

PHD 2031 - Tanks 50% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	10.45917749	0.332925935	0.96	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	13.04082246	0.415102278	1.45	FALSE

PHD 2031 - Tanks 75% - 200mm Service Connection

ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (L	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)	Has User Defined Length?
32681	P-LG01	94.4	SA01R001	J-LG01	200	PVC	110	TRUE	0	10.46035004	0.332963288	0.96	FALSE
32682	P-LG02	110	J-566	J-LG01	200	PVC	110	TRUE	0	13.03964992	0.415064926	1.45	FALSE