plan FOR 200K

ABBOTSFORD

ENGINEERING & REGIONAL UTILITIES

CITY WATER MASTER PLAN

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EXECUTIVE SUMMARY

The City of Abbotsford adopted a new Official Community Plan (OCP) in June 2016. The OCP outlines a path forward for the City to grow to a population of 200,000 by 2041. In order to meet the needs of a growing City, adequate infrastructure capacity must be in place. For this reason, the City has embarked on developing a new Water Distribution Master Plan.

This Water Distribution Master Plan (the Plan) builds on the Abbotsford Mission Water and Sewer Commission (AMWSC) Source and Supply Water Master Plans in order to identify distribution system upgrades that are needed in order to convey source water to the City's existing and future customers. The Plan will assist the City in updating and forecasting capital needs and in updating the Development Cost Charge (DCC) Bylaw.

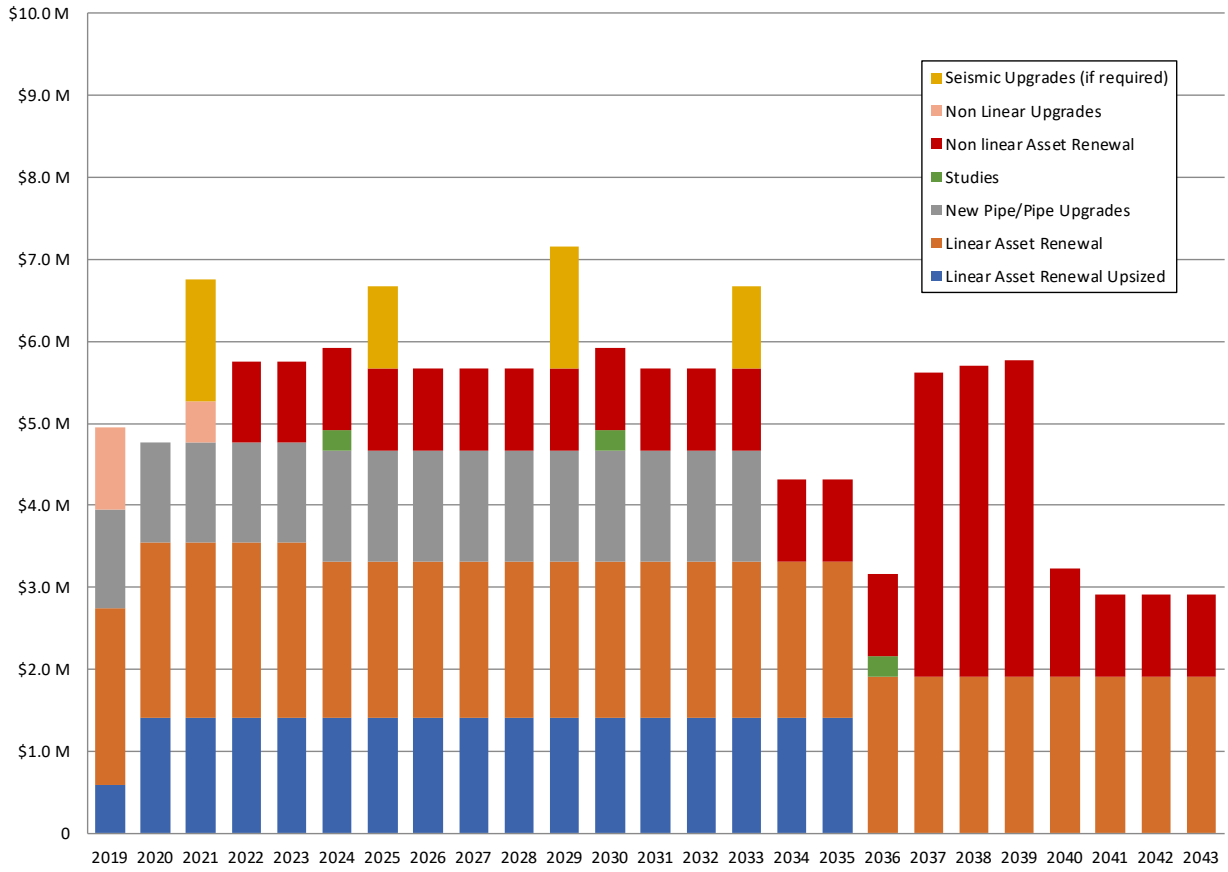
Abbotsford's water demands associated with growth forecasts were developed in order to determine future needs of the City. These water demands were used to update the City's water model. The updated hydraulic analysis identified 194 distinct capital projects, including a total of 97 km of linear assets (pipes). Excluding Special Study Areas A and B, there are 78 km of proposed pipe upgrades at a cost of approximately $93 million (2017 dollars). This translates to an average annual budget of approximately $4 - 5 million. An additional average annual expenditure of approximately $1 – 1.5 million is also required for non linear assets including reservoirs, pump stations, PRVs and advanced metering infrastructure. The total proposed annual average spending of $5 – 6.5 million is in line with the City's historical expenditures.

In addition to the budget recommendations outlined above, the recommendations from this Plan are summarized below. This excludes recommendations specific to Special Study Areas A and B.

- 1.16 ML of capacity to be added by 2021 at McKee reservoir so as to provide sufficient capacity to 2051. This shall be reviewed and confirmed as part of the McKee Area Neighbourhood Study.
- Pump flow test to be conducted to determine the firm capacity of the Old Yale pump station and/or determine why the pump station may not be operating to its firm capacity.
- PRV-MTN-VILLAGE-1 to be upgraded immediately, as it is deficient in the existing scenario. PRV-MTN-VILLAGE-2 becomes deficient in the 2021 scenario and, therefore, should be upgraded by 2021.
- The proposed Saddle PRV to be added as a new recommended feed from the supply system into pressure zone 123 to address fire flow deficiencies in the existing scenario. This is recommended as an immediate improvement.
- The set points for PRV-SANDON-3 and PRV-SANDON-4 to be re-evaluated to draw more flow through PRV-SANDON-3 under high flow conditions.
- If a large wet industry is proposed within the City, a site specific water study to be conducted to determine if infrastructure improvements are required.
- New minimum fire flows to be updated per the Fire Underwriter Survey (see Table 4.6).
- The pressure boundary between pressure zone 123 and 103 to be changed as outlined below (see Figure 4.2).
- Bradner pump station to be upgraded, including the addition of a backup generator.

- The 2006 Lifeline study to be updated in order to: 1) develop seismic construction standards for critical water mains, 2) determine requirement for seismic valves on reservoirs, 3) determine post disaster readiness of pump stations and 4) determine upgrades that are required on existing infrastructure.
- An asset management renewal study to be completed including condition assessments for non-linear facilities

Water Distribution Master Plan Cost Summary



1 INTRODUCTION

1.1 Background

The City of Abbotsford adopted a new Official Community Plan (OCP) in June 2016. The OCP outlines a path forward for the City to grow to a population of 200,000 by 2041. In order to meet the needs of a growing City, adequate infrastructure capacity must be in place. For this reason, the City has embarked on developing new utility master plans.

Water is supplied to the City by the Abbotsford Mission Water & Sewer Commission (AMWSC) from Norrish Creek, Cannell Lake and 19 groundwater wells. The AMWSC is currently in the process of completing a Source Study and Water Master Plan (bound separately) that will provide adequate water to both Abbotsford and Mission in order to meet the objectives outlined in each community's OCP.

1.2 Purpose and Scope

This Water Distribution Master Plan (the Plan) builds on the AMWSC Source and Supply Water Master Plans in order to identify distribution system upgrades that are needed in order to convey source water to the City's existing and future customers. The Plan will assist the City in updating and forecasting capital needs and in updating the Development Cost Charge (DCC) Bylaw.

This plan was collaboratively developed with staff from the City, GeoAdvice Engineering Inc. and Urban Systems Ltd. through the process of a series of technical memos. These memos are contained within Appendix A and summarized in the table below:

Table 1.1: Technical Memo Summary

Technical Memo	Purpose	Report Section Reference
#1 – Calculation and Allocation of Future Water Demands	To provide a rationale for existing and future water demands.	Sections 1.3 and 2.2
#2 – Water Supply and Distribution Model Calibration	To update the calibration of the hydraulic water model.	Section 2.1
#3 – Water Quality Model Validation	To validate the water quality model against recent water sampling results.	Section 2.1
#4 – System Evaluation Criteria	To provide a summary of the system evaluation criteria for the hydraulic analysis.	Section 2.3
#5 – Water Distribution System Capacity Analysis	To evaluate the performance of the distribution system and identify the required upgrades.	Section 2.4

Technical Memo	Purpose	Report Section Reference
#6a – Special Study Area A: Gloucester East Industrial Lands Expansion	To evaluate the unique servicing requirements for Special Study Area A.	Section 2.4
#6b – Special Study Area B: Industrial Reserve Lands	To evaluate the unique servicing requirements for Special Study Area B.	Section 2.4
#7 – Pressure Zone 103 & 123 Boundary Optimization	To evaluate the benefit of adjusting the pressure zone boundary between 103 and 123 zones.	Section 4.3.4

Technical memos were also prepared for the Historic Downtown and City Centre Neighbourhood Plans; however, these memos are bound separately with the neighbourhood plan servicing review report.

1.3 Population Growth

This study considered population growth from 2016 to 2051, where the year 2016 is considered to be the existing base scenario, 2041 is used to reflect the OCP future scenario and the year 2051 is used to reflect the build out conditions for new infrastructure. The years 2021, 2026, 2031, and 2036 are used for determining infrastructure upgrade timing. The complete actual and equivalent population data were provided by the City for the existing and future horizon years from 2016 to 2051. The actual population represents the residential population that is physically connected to the City water system while the equivalent population includes the non-residential employment population. The background to these growth forecasts is outlined in further detail in Technical Memo #1 Calculation and Allocation of Future Water Demands contained in Appendix A.

The population equivalent data was extracted from the data provided by the City. The existing population equivalent is based on existing ICI and agricultural metered water usage converted to population equivalent using the existing residential per capita water usage rate. The future 2051 population equivalent data was extracted per parcel based on population equivalent per hectare densities for each land use type provided by the City, as summarized in **Table 1.2**.

Table 1.2: Population Equivalent Densities

Land Use	Population Equivalent Per Hectare (PE/ha)
Industrial	50
Commercial	90
Commercial (with Car Wash)	250
Institutional	50

To determine the future (2051) population equivalencies, the area of each future serviced parcel was multiplied by the respective population equivalent density. Further special exceptions and assumptions for the future population equivalencies are as follows:

- Negative growth was accounted for if there was a change of land use. If the land use remained unchanged, any negative growth was set to zero.
- Commercial properties were assigned growth only if flagged by the City.
- Institutional properties with a growth population equivalent larger than 500 were adjusted to reflect a population equivalent growth rate of 1.6% per annum.
- Population equivalencies for the Special Study Areas were adjusted based on the servicing reports provided by the City.
- Agricultural population equivalencies were determined based on the current agricultural demands growing by 75% in the next 25 years (i.e. 2.26% per annum), with no agricultural growth between 2041 and 2051.

Table 1.3: Population Forecasts

Year	Actual Serviced Population (Residential)	Population Equivalent (Non-Residential)
2016 (Existing)	132,584	107,815
2021	144,698	125,033
2026	156,812	142,251
2031	168,926	159,469
2036	181,040	176,687
2041	193,154	193,644
2051	217,382	212,042

1.4 Special Study Areas

As part of the populations summarized above, the City requested special cases be allocated to specific points in the model representing future growth. These Unique Development Plans and Special Study Areas include:

- Airport Lands Expansion Plans
- City in the Country (CICP) Industrial Lands Expansion
- UDistrict
- McKee Peak
- Auguston
- Special Study Area A: Gloucester East Industrial Lands Expansion
- Special Study Area B: Industrial Reserve Lands, north of the Airport
- City Centre Neighbourhood Plan
- Historic Downtown Neighbourhood Plan

2 HYDRAULIC ANALYSIS

2.1 Software Platform

The City's water distribution system is currently modelled in Innovyze's InfoWater platform. The model recently had the physical infrastructure and calibration updated in 2016. For this master plan, the model was updated to assign the population growth based on the spatial distribution provided by the City. A detailed summary of the updated water model calibration can be found in Technical Memo #2 Water Supply and Distribution System Model Calibration and Technical Memo #3 Water Quality Model Validation (Appendix A).

All hydraulic capacity analysis was completed using steady-state simulations to conservatively reflect future conditions.

All pipes in the system that are not included in the City's Watermain Renewal Program were "aged" by reducing the Hazen Williams C-factor for each pipe by a value of 5 for every 10 year period in order to model pipe internal deterioration.

2.2 Water Demand Inputs

The water demands associated with the growth forecasts from Section 1.3 have been developed in order to determine the future needs of the City. Detailed background on these calculations can be found in Technical Memo #1 (Appendix A).

The existing serviced average day demand (ADD) and maximum day demand (MDD) data are summarized in **Table 2.1**. The MDD/ADD peaking factor is 1.42.

Table 2.1: Abbotsford 2016 Demand Data

Demand Type	ADD (L/s)	MDD (L/s)
Existing Single Family	166.3	236.3
Existing Multi Family	89.0	126.4
Existing Commercial	40.2	57.2
Existing Industrial	90.8	129.0
Existing Institutional	25.6	36.4
Existing Agricultural	89.2	126.8
Subtotal	**501.2**	**712.1**
Existing Non-Revenue Water	88.4	146.0
Total	**589.6**	**858.1**

Table 2.2 summarizes the existing residential per capita demand rates.

Table 2.2: Abbotsford 2016 Per Capita Demand Rates

Demand Type	ADD (L/cap/day)	MDD (L/cap/day)
Residential	180	256

The future ADD and MDD per capita demand rates are shown in **Table 2.3** and **Table 2.4**, respectively. These values were developed as part of the 2017 AMWSC Water Supply Master Plan.

Table 2.3: Future ADD Per Capita Demand Rates (L/cap/day)

Demand Type	2041	2051
Residential	161	162
ICI	178	185
Agricultural	162	162

Table 2.4: Future MDD Per Capita Demand Rates (L/cap/day)

Demand Type	2041	2051
Residential	229	230
ICI	253	263
Agricultural	230	230

Table 2.5 and **Table 2.6** show the Abbotsford future demand scenarios for the years 2041 and 2051, respectively.

Table 2.5: Abbotsford Future ADD (L/s)

Demand Type	2041	2051
Existing Subtotal	501.2	501.2
Residential Growth	86.3	132.6
ICI Growth	91.1	139.8
Agricultural Growth	67.1	67.1
Non-Revenue Water	75.2	75.2
Total	**821.0**	**915.9**

Table 2.6: Abbotsford Future MDD (L/s)

Demand Type	2041	2051
Existing Subtotal	712.1	712.1
Residential Growth	122.7	188.4
ICI Growth	129.5	198.6
Agricultural Growth	95.4	95.4
Non-Revenue Water	124.1	124.1
Total	**1,183.8**	**1,318.6**

Non-revenue water is assumed to decrease over the next 25 years to 2041, and then from 2041 to 2051 it is assumed to remain constant.

2.3 Analysis Criteria

Based on the City's design specifications and discussions with the City, the following criteria were used for the evaluation of the hydraulic capacity performance of the water distribution system. These are outlined in greater detail in Technical Memo #4 Hydraulic Performance and Design Criteria (Appendix A).

Hydraulic Criteria

Table 2.7 summarizes the key performance and design criteria for analyzing the City water distribution system.

Table 2.7: Performance and Design Criteria

Criteria	Scenario
Maximum Pressure	830 kPa (120.4 psi)
Minimum Pressure	300 kPa (43.5 psi)
Minimum Pressure (MDD+FF)	150 kPa (21.8 psi)

Hydraulic deficiencies within 10% of the above performance and design criteria were not addressed as they are within the model accuracy.

Fire Flow Criteria

Table 2.8 shows the required fire flow for each land use type.

Table 2.8: Fire Flow Requirements (150 kPa minimum)

Land Use Type	Required Fire Flow (L/s)
Single Detached / Duplex Residential	75
Ground Oriented (Townhomes)	150
Midrise (Apartments)	175
Commercial / Mixed Use	200
Institutional	200
Industrial	220

The above required fire flows are based on the 2015 Draft Development Bylaw Revisions.

Fire flow deficiencies within 10% of the above fire flow requirements were not addressed as they are within the model accuracy. Furthermore, if the required fire flow is available upstream (within 100 m) of a deficient node, especially in the case of a dead end, the deficiency was also not addressed.

Based on discussions with the City, pipe improvements were not recommended for deficient fire flow areas located in agricultural areas in the following pressure zones: 68, 70, 90, 103 (South rural area), 123 (South rural area), 140, 155 and 183 m.

Storage Reservoir Capacity Design Criteria

There are three types of storage that need to be considered in the City water distribution system:

- Fire storage (A) – This is the amount of water required to extinguish fires within the service area of a storage reservoir. This storage is based on the worst case fire flow land use scenario.
- Equalization storage (B) – This is the amount of storage required for normal water consumption. MMCD states that this should be 25 % of MDD.
- Emergency storage (C) – The emergency storage requirement is 25 % of A + B.

The required storage reservoir capacity is the sum of the Fire storage (A), Equalization storage (B) and Emergency storage (C).

Pressure Reducing Valve Criteria

Two criteria were used to evaluate pressure reducing valves (PRV):

- The recommended peak velocity through a pressure reducing valve (PRV) is 6 m/s to minimize "wear and tear".
- The upstream hydraulic grade line must be higher than the PRV setting so that it is remaining active.

Pump Station Criteria

Design flows for all pumps were estimated based on the modeled pump curves. The largest non-fire flow pump was subtracted from the total pumping capacity at each pump station as per Abbotsford Bylaws.

Pumping capacity is a key design criterion for water distribution systems. There are two scenarios to consider:

- When pumping to a dead-end pressure zone, the required pumping capacity is the greater of:
    - PHD of the downstream pressure zones
    - MDD plus maximum fire flow demand of the downstream pressure zones
- When pumping to a pressure zone with a storage tank, the required pumping capacity is equal to MDD of the downstream pressure zones.

2.4 System Performance Analysis

Before undertaking the system performance analysis, the water distribution system model was calibrated and the water quality analysis was validated. The details of the model calibration and validation are contained within Technical Memo's #2 and #3 (Appendix A).

This section summarizes the capacity analysis completed with detailed information contained in Technical Memo #5 Water Distribution System Capacity Analysis (Appendix A).

2.4.1 Storage Capacity Analysis

Storage capacity in the City water distribution system reservoirs was analyzed under existing and 2041 conditions.

Table 2.9: Existing Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	1.29	+ 2.05	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	0.96	+ 1.28	No
TNK-CASSIAR	137, 138, & 80	4.61	3.88	+ 0.73	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.52	+ 1.22	No
TNK-EMPRESS	181 & 153	3.80	2.59	+ 1.21	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	3.46	+ 0.11	No
TNK-MCMILLAN	103	9.49	6.18	+ 3.31	No

Table 2.10: 2041 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	2.28	+ 1.06	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	2.23	+ 0.01	No
TNK-CASSIAR	137, 138, & 80	4.61	4.16	+ 0.46	No
TNK-ST-MORITZ					

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.88	+ 0.87	No
TNK-EMPRESS	181 & 153	3.80	2.69	+ 1.11	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	4.35	- 0.78	**Deficient**
TNK-MCMILLAN	103	9.49	7.76	+ 1.73	No

As shown above, the only reservoir to become deficient is the McKee Reservoir. It is recommended that 1.16 ML be added in capacity by 2021 so as to provide sufficient storage capacity to 2051. This shall be reviewed and confirmed as part of the McKee Area Neighbourhood Study.

2.4.2 Pump Station Capacity Analysis

Similar to reservoir storage, the pump station capacities were assessed.

Table 2.11: Existing Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	6.3	8.3	- 2.0	**Deficient**
Buchanan	183B	1.3	1.2	+ 0.1	No
Empress	297, 248, 175A, 262, 217, & 168	88.3	14.2	+ 74.2	No
Eagle Mountain	330	101.9	75.4	+ 26.5	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	85.7	+ 83.9	No
Saddle					
Upper Maclure	175	403.8	240.9	+ 162.9	No
Mountain Village	181, 153, 297, 248, 175A, 262, 217, & 168	50.0	26.6	+ 23.4	No
Old Yale	163	439.6	288.5	+ 151.1	No
Selkirk	237, 290, 304, 208, & 180	181.5	25.3	+ 156.2	No
Westminster	290	85.1	76.3	+ 8.8	No
Westview	304	83.9	76.4	+ 7.5	No

Table 2.12: 2041 Pumping Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	+ 16.7	No
Buchanan	183B	1.3	1.6	- 0.3	**Deficient**
Empress	297, 248, 175A, 262, 217, & 168	88.3	25.8	+ 62.5	No
Eagle Mountain	330	101.9	76.5	+ 25.4	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	129.0	+ 40.6	No
Saddle					
Upper Maclure	175	403.8	240.8	+ 163.0	No
Old Yale	163	439.6	333.4	+ 106.2	No
Selkirk	237, 290, 304, 208, & 180	181.5	58.4	+ 123.2	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	42.0	+ 50.5	No
Westminster	290	85.1	77.6	+ 7.5	No
Westview	304	83.9	81.8	+ 2.1	No

Based on the pump station capacity analysis results, there is one (1) pump station deficiency under existing conditions and one (1) pump station deficiency in the future. Under the existing condition, the Bradner pump station is deficient; however, the City is already committed to replacing the Bradner pump station sometime in the next five (5) years. The future Bradner pump station can meet all future capacity requirements. The Buchanan pump station becomes deficient under the 2026 condition.

Although the Buchanan pump station is indicated as deficient in the future, it is only predicted to be deficient by 0.3 L/s in 2041; as such, the deficiency is not critical and no upgrade to this pump station is recommended at this time. No pump station capacity improvements are recommended as part of this study.

Finally, the City has expressed concern over the ability of the Old Yale pump station to deliver its firm capacity based on the observed flow from the pump station during a fire that occurred on August 9th, 2017. During this fire, the maximum observed flow out of the pump station was 319 L/s. As such, it is recommended that the City conduct a pump flow test to determine the firm capacity of the pump station or why the pump station may not be operating to its firm capacity (i.e. 439 L/s).

2.4.3 PRV Capacity Analysis

Pressure reducing valve stations were assessed for peak velocities. Under peak hour conditions only the Sandon-4 PRV was shown to have a velocity that exceeded 6 m/s. In this station the headloss through the small PRV is not high enough to activate the larger PRV. Under maximum day plus fire flow conditions

only four stations have velocities that exceed 6.0 m/s in existing conditions while three stations are deficient in 2041.

Table 2.13: PRV MDD+FF Deficiencies

Valve ID	Diameter (mm)	From Zone	To Zone	Largest Zone Fire Flow Requirement (L/s)		MDD+FF Velocity (m/s)	
				Existing	2041	Existing	2041
PRV-MTN-VILLAGE-1	150	153	103	220	220	**7.17**	**7.60**
PRV-MTN-VILLAGE-2	150	181	153	175	175	5.27	**6.13**
PRV-SUNDEW-MTN-1	150	181	153	175	175	**6.10**	4.41
PRV-MCKINLEY-2	75	237	180	200	200	**10.52**	**10.26**
PRV-CANTERBURY-1	150	181	153	175	175	**10.04**	N/A*
PRV-CLAY-VILLAGE-1	150	231	70	200	200	**7.32**	**7.39**

*The Canterbury PRV will be decommissioned by 2021.

PRV-MTN-VILLAGE-2, PRV-SUNDEW-MTN-1 and PRV-CANTERBURY-1 all feed pressure zone 153 from pressure zone 181 at different locations. While PRV-MTN-VILLAGE-2 becomes deficient by 2021, PRV-SUNDEW-MTN-1 is deficient in the existing scenario but is not deficient in the future. This is due to land use changes in the future, changing the location of the largest fire flow, and thus reducing the flow required from the Sundew Mountain PRV station in the future.

At the McKinley PRV station, during a 200 L/s fire, flow is passing through both PRVs. Although the setting of the fire PRV may be adjusted to force more flow through the fire PRV, one or both of the PRVs will always be deficient under MDD+FF in the existing and future scenarios. Finally, although the Canterbury PRV is deficient under the existing scenario, it will be decommissioned by 2021.

Table 2.14: Required PRV Capacity Improvements

Valve ID	From Zone	To Zone	Existing Diameter (mm)	Proposed Diameter (mm)
PRV-MTN-VILLAGE-1	153	103	150	200
PRV-MTN-VILLAGE-2	181	153	150	200
PRV-P-BRADNER	163	155	N/A	200
PRV-P-SADDLE-1	231	123	N/A	300

As shown in **Table 2.14**, there are four (4) recommended PRV upgrades. PRV-MTN-VILLAGE-1 is proposed for upgrade immediately, as it is deficient in the existing scenario. PRV-MTN-VILLAGE-2 becomes deficient in the 2021 scenario and, therefore, should be upgraded by 2021.

The proposed Bradner PRV is recommended as part of Special Study Area A by the year 2031. The proposed Saddle PRV is a new recommended feed from the supply system into pressure zone 123 to address fire flow deficiencies in the existing scenario and is recommended as an immediate improvement.

No upgrade is recommended at PRV-SANDON-4. Instead it is recommended that the set points for PRV-SANDON-3 and PRV-SANDON-4 be re-evaluated to draw flow through PRV-SANDON-3 under high flow conditions.

Although the PRV capacity analysis showed PRV-SUNDEW-MTN-1 to be deficient in the existing scenario, no upgrade is recommended for this valve. With future land use changes, the valve is predicted to be sufficiently sized in the future.

The McKinley and Clay Village PRV stations are both deficient under the existing and future MDD+FF scenarios. These deficiencies are caused by the new higher required fire flow for institutional properties (200 L/s). Since the institutional properties requiring higher fire flows are existing properties, as opposed to being related to land use changes proposed by the OCP, it is not recommended that these two (2) PRVs be upgraded.

2.4.4 Pipe Network Capacity Analysis

City Wide Distribution System

The water distribution system capacity was analyzed under two conditions:

1. Peak Hour Demand (PHD) – to confirm areas of low pressure
2. Maximum Day + Fire Flow Demand (MDD+FF) – to confirm areas of inadequate fire flows

The following table summarizes the system performance under existing and 2041 scenarios.

Table 2.15: Summary of Hydraulic Modeling Results

Criteria	Scenario	Existing	2041
# of Low Pressure Deficiencies **Demand Nodes < 44 psi**	PHD	191	451
Average Pressure (psi)	PHD	95 psi	91 psi
# of Fire Flow Deficiencies **Residual Pressure < 22 psi**	MDD + FF	209	332
Average Available Fire Flows (L/s)	MDD + FF	238 L/s	214 L/s

Two categories of upgrades have been identified:

1. "Replacement" – Pipes within the City's Asset Replacement Program that are not required to address hydraulic capacity concerns
2. "Capacity" – Pipes required to address pressure or fire flow deficiencies

Within the City distribution system there are approximately 31 km of upgrades identified to address capacity concerns and the remaining 48 km of upgrades are for asset replacement projects already identified. This excludes upgrades in Special Study Areas A & B. The prioritization of these upgrades is discussed further in Section 3.

Table 2.16: Summary of Recommended Network Capacity Improvements

Improvement Type	Length (m)		
	Replacement	**Capacity**	**Total**
New Pipe Loop	454	3,866	**4,320**
Pipe Upgrade	1,151	11,155	**12,306**
Asset Replacement Program	30,198	12,589	**42,786**
Asset Replacement Program - Upsized	15,958*	3,102	**19,060**
Total	**47,760**	**30,711**	**78,472**

* Replacement pipes have been upsized to comply with minimum diameters specified in the Development Bylaw based on land use.

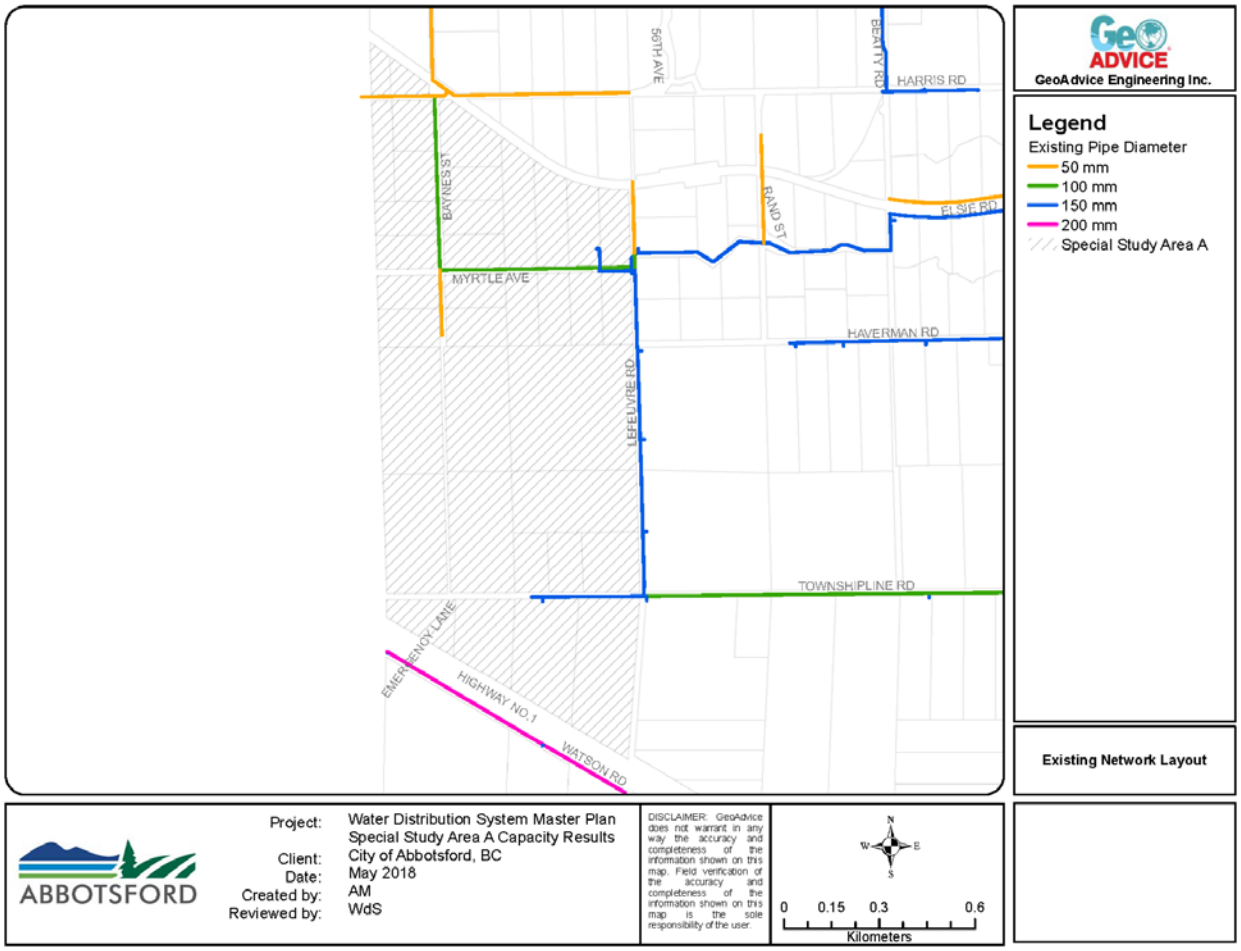
Upgrades have not been recommended to address fire flow deficiencies located at dead ends where the fire flow is available upstream. Also, pipes have not been automatically upgraded based the City bylaw minimum pipe size per land use. At the time of a property's development, the City may require some mains to be upgraded to the City bylaw minimum pipe size based on the proposed development land use, or the City may require further upgrade of these mains based on factors other than capacity (i.e. age, material, condition, adjacent works, etc.). Further details on the pipe capacity analysis are provided in Technical Memo 5 in Appendix A.

2.5 Special Study Areas

2.5.1 Special Study Area A: Gloucester East Industrial Lands Expansion

Special Study Area A is located on the western boundary of the City between Hwy 1, 56th Avenue, and Lefeuvre Road. The existing infrastructure feeding the general area consists of 150 mm diameter water mains on Bradner Road, Township Road, Lefeuvre Road and Myrtle Avenue. Special Study Area A is contained within the City's existing pressure zone 155. **Figure 2.1** illustrates Special Study Area A and the existing network layout.

Figure 2.1: Special Study Area A Existing Network Layout



Residential and ICI growth projections were provided by the City for each parcel in Special Study Area A. The expected 2041 population and population equivalent (PE) data for Special Study Area A are summarized in **Table 2.17**.

Table 2.17: Special Study Area A Population Data

Population Type	2041 Population
Residential	155
ICI	11,326
Total Growth	**11,481**

It should be noted that there is not expected to be any residential population growth in Special Study Area A; all growth is expected to be industrial.

A summary of the modeled Special Study Area A demand scenarios is presented in **Table 2.18.**

Table 2.18: Special Study Area A Demand Data

Scenario	2041 Demand (L/s)
Average Daily Demand (ADD)	25.20
Maximum Daily Demand (MDD)	35.80
Peak Hour Demand (PHD)	53.70

Modeling was carried out for peak hour and maximum day plus fire flow under the existing and 2041 conditions to analyze the network capacity. Proposed improvements were then identified to address the capacity deficiencies within Special Study Area A. The proposed water mains were sized to the minimum diameter which would satisfy the greater of maximum day plus fire and peak hour demand in 2051.

Table 2.19 summarizes the hydraulic modeling results in Special Study Area A under the existing and 2041 scenarios with the existing network. Also included in **Table 2.19** are the hydraulic modeling results under 2041 conditions with the proposed improvements.

Table 2.19: Water Distribution System Summary Results (Special Study Area A)

Criteria	Scenario	Existing	2041 – No Improvements	2041 With Improvements
Low Pressure Deficiencies **Demand Nodes < 44 psi**	PHD	0	32	0
Average Pressure	PHD	103.3 psi	40.1 psi	90.2 psi
Fire Flow Deficiencies **Residual Pressure < 22 psi**	MDD + FF	39	39	8*
Average Available Fire Flow (L/s)	MDD + FF	27 L/s	3 L/s	257 L/s

*Remaining 8 fire flow deficiencies are within 5% of the required fire flow.

The hydraulic results indicate PHD pressures in Special Study Area A can be met under existing conditions but not under the "2041 – No Improvements" scenario.

Special Study Area A is located outside of the Urban Development Boundary; therefore, the City is not currently responsible for providing adequate fire flow to the area. Furthermore, there are very few hydrants in the area; as such, the fire flow analysis was completed with all junctions in the study area

analyzed as fire nodes. The current network is unable to satisfy the required fire flow anywhere in Special Study Area A under existing conditions and the "2041 – No Improvements" scenario.

Water system improvements have been modeled and recommended based on the hydraulic capacity assessment of the City water distribution system under 2041 conditions. Water distribution system improvements were designed to convey the 2051 Special Study Area A flows, as calculated by the model analysis.

Table 2.20 summarizes the system recommendations to service Special Study Area A.

Table 2.20: Summary of Recommended Improvements

Improvement Type	Length (m)
New Pipe Loop	1,092
Pipe Upgrade	3,251
Offsite Improvements	12,569

In order to provide adequate pressures and flows to Special Study Area A, approximately 12.6 km of water mains have been recommended as offsite improvements. With these offsite improvements, there are also a number of new local pipe loops and pipe upgrades that have been recommended to provide adequate fire flows throughout the study area.

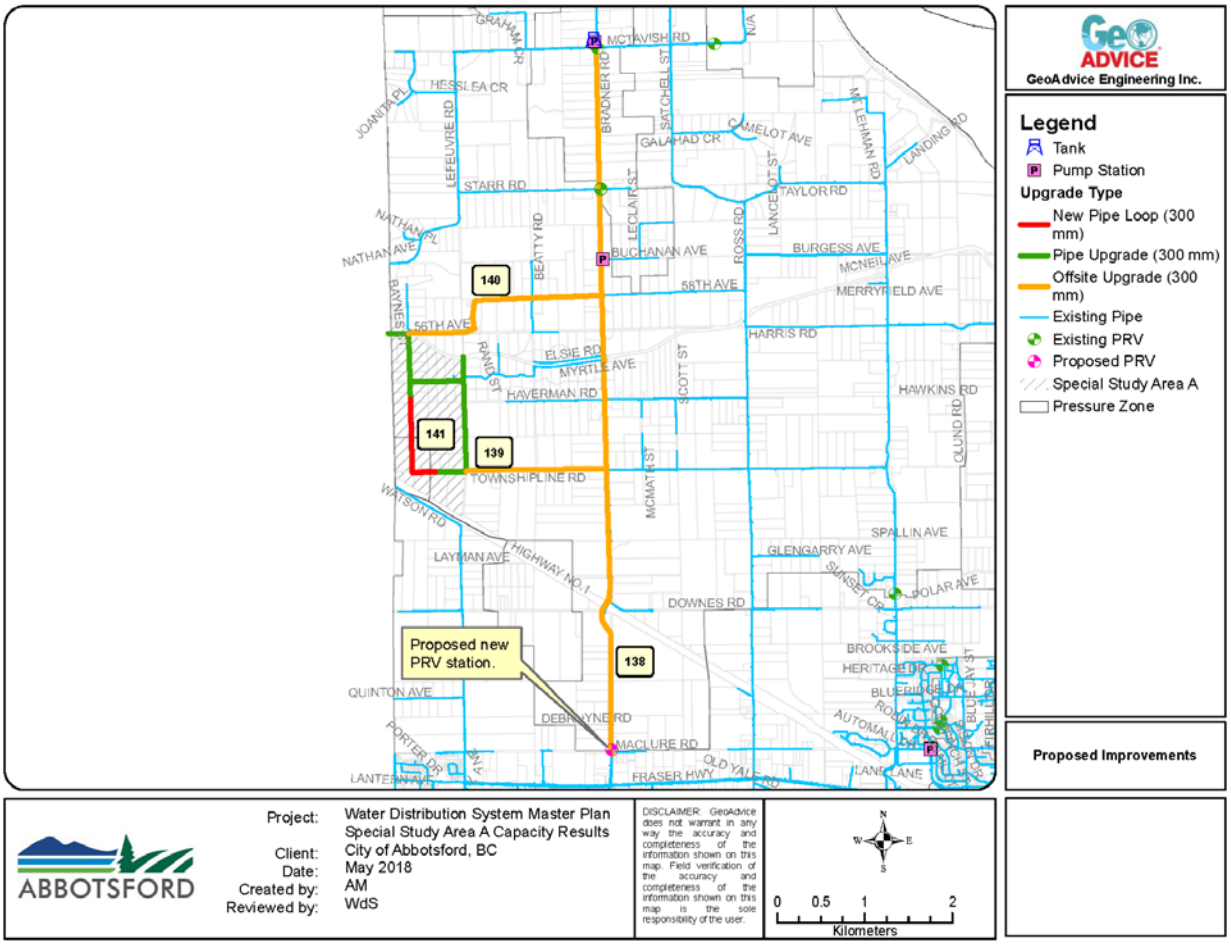
Furthermore, to service Special Study Area A, a new pressure reducing valve (PRV) station is required at Bradner Road and Maclure Road. **Table 2.21** summarizes proposed PRV parameters.

Table 2.21: Recommended Facility Improvements

PRV Station	Valve Type	Diameter (mm)	Pressure Setting (psi)
Bradner Road	Domestic Flow	150	75
	Fire Flow	200	70

Please refer to **Figure 2.2** to review the location of all recommended improvements.

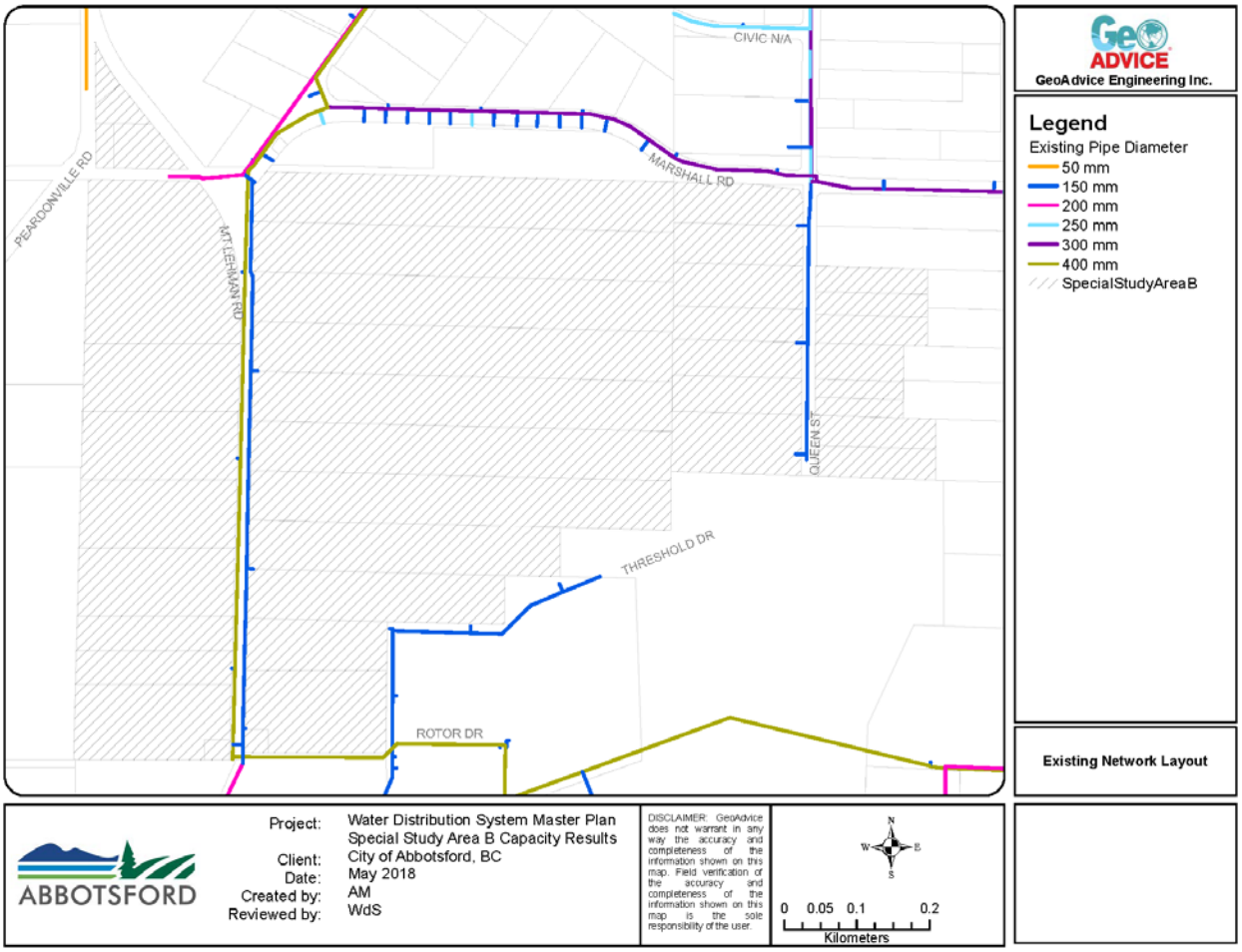
Figure 2.2: Special Study Area A Proposed Improvements



2.5.2 Special Study Area B: Industrial Reserve Lands

Special Study Area B is located to the north of the Abbotsford International Airport. The existing infrastructure feeding the general area consists of 400 mm and 300 mm diameter water mains on Peardonville Road, Queen Street, and Marshall Road. Special Study Area B is contained within the City's existing pressure zone 123. **Figure 2.3** illustrates Special Study Area B and the existing network layout.

Figure 2.3: Special Study Area B Existing Network Layout



Residential and ICI growth projections were provided by the City for each parcel in Special Study Area B. The expected 2041 population and population equivalent (PE) data for Special Study Area B are summarized in **Table 2.22**.

Table 2.22: Special Study Area B Population Data

Population Type	2041 Population
Residential	125
ICI	3,512
Total Growth	**3,637**

It should be noted that there is not expected to be any residential population growth in Special Study Area B; all growth is expected to be industrial.

A summary of the modeled Special Study Area B demand scenarios is presented in **Table 2.23**.

Table 2.23: Special Study Area B Demand Data

Scenario	2041 Demand (L/s)
Average Daily Demand (ADD)	7.96
Maximum Daily Demand (MDD)	11.31
Peak Hour Demand (PHD)	16.95

Modeling was carried out for peak hour and maximum day plus fire flow under the existing and 2041 conditions to analyze the network capacity. Proposed improvements were then identified to address the capacity deficiencies within Special Study Area B. The proposed water mains were sized to the minimum diameter which would satisfy the greater of maximum day plus fire and peak hour demand in 2051.

Table 2.24 summarizes the hydraulic modeling results in Special Study Area B under the existing and 2041 scenarios with the existing network. Also included in **Table 2.24** are the hydraulic modeling results under 2041 conditions with the proposed improvements.

Table 2.24: Water Distribution System Summary Results (Special Study Area B)

Criteria	Scenario	Existing	2041 – No Improvements	2041 With Improvements
Low Pressure Deficiencies **Demand Nodes < 44 psi**	PHD	0	0	0
Average Pressure	PHD	89.4 psi	81.6 psi	81.7 psi
Fire Flow Deficiencies **Residual Pressure < 22 psi**	MDD + FF	10	10	2
Average Available Fire Flow (L/s)	MDD + FF	211 L/s	173 L/s	402 L/s

The hydraulic results indicate PHD pressures in Special Study Area B can be met under existing conditions and 2041 conditions with the existing network.

Furthermore, the network is unable to satisfy the required fire flow at ten (10) fire nodes in Special Study Area B under existing and 2041 conditions. With the system improvements, there are two (2) remaining fire flow deficiencies. To eliminate these deficiencies, hydrants HYD-17C5 and HYD-18C5 must be moved to the parallel 400 mm water main on Mt. Lehman Road.

Water system improvements have been modeled and recommended based on the hydraulic capacity assessment of the City water distribution system under 2041 conditions. Water distribution system improvements were designed to convey the 2051 Special Study Area B flows, as calculated by the model analysis.

Table 2.25 summarizes the system recommendations to service Special Study Area B.

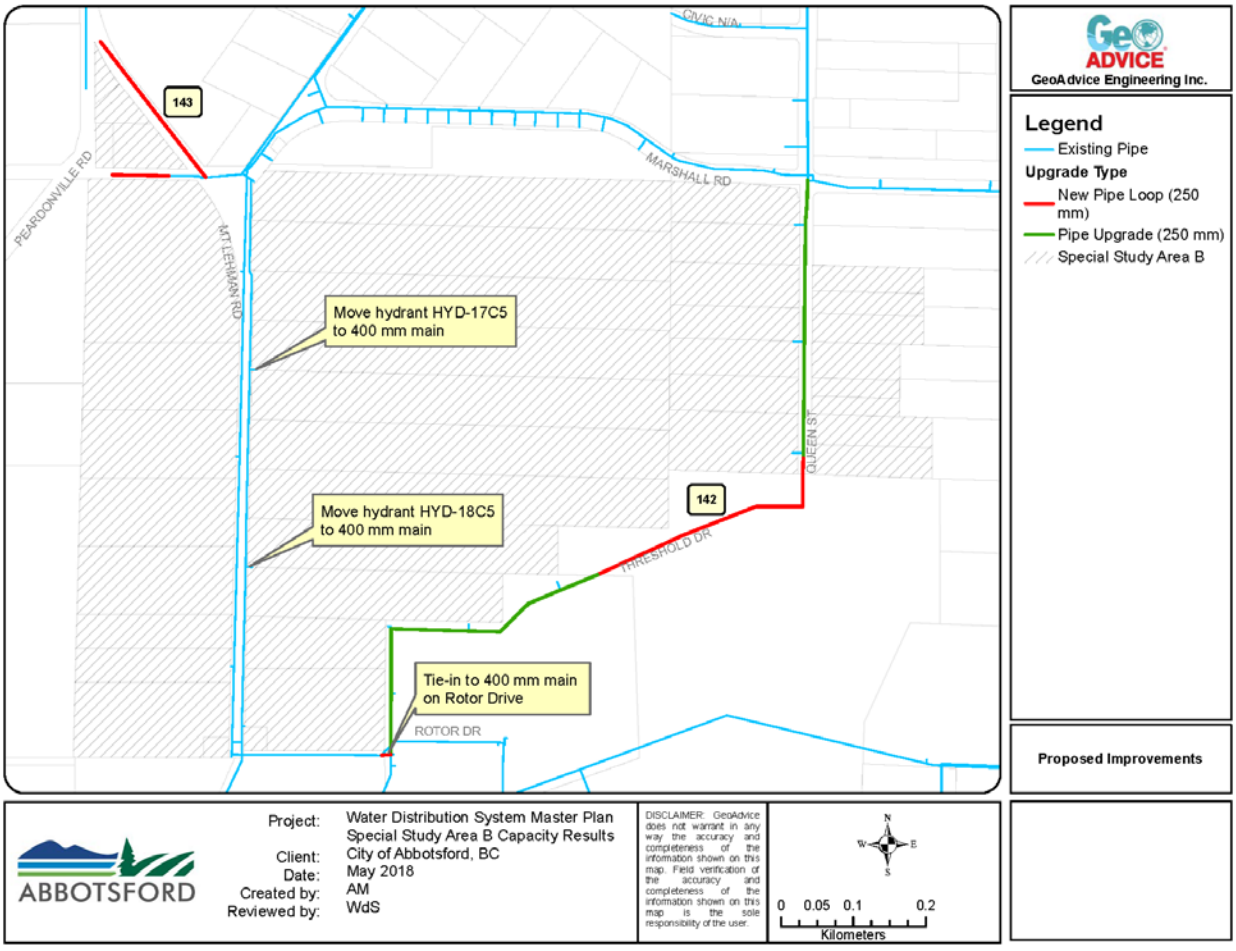
Table 2.25: Summary of Recommended Improvements

Improvement Type	Length (m)
New Pipe Loop	370
Pipe Upgrade	969

New pipe loops and pipe upgrades have been recommended to service the proposed new land use designations and to ensure PHD and fire flows can be satisfied.

Please refer to **Figure 2.4** to review the location of all recommended improvements.

Figure 2.4: Special Study Area B System Improvements



3 RISK ASSESSMENT & CAPITAL PRIORITIZATION

This section summarizes the risk assessment methodology and results, with a focus on linear assets (i.e. pipes). The risk assessment is key to determining the priority of linear asset improvements. Non linear assets, including reservoirs, pump stations and pressure reducing valves, have been prioritized on a case-by-case basis. The City may also apply select risk-prioritization methods for non-linear assets from the AMWSC's Joint Water Master Plan, which can increase consistency among asset-classes and operational procedures. In that way, non-linear facilities may still be assessed on a case-by-case basis as select facilities or types of assets (e.g. PRVs, reservoirs, pump stations) are addressed in years to come.

3.1 Analysis Methodology & Criteria

The methodology for assessing likelihood and consequence of failure for water distribution pipes includes three parts: an assessment of the likelihood and consequence of failure for capacity, an assessment of the likelihood and consequence of failure for condition, and the steps required to link capacity *and* condition in capital prioritization.

LIKELIHOOD OF FAILURE

Capacity

For capacity, the likelihood of asset failure for water pipes is based on the results of the water hydraulic model. **Table 3.1** defines the methodology for assessing the likelihood of failure for capacity.

Table 3.1: Likelihood of Failure for Water Assets - Capacity

PARAMETER	*1*	*2*	*3*	*4*	*5*
Likelihood – Ability to provide desired pressure or flow					
Operating Pressure	Peak Hour Pressure >=40 psi	Peak Hour Pressure >=35 psi to <40 psi	Peak Hour Pressure >=30 psi to <35 psi	Peak Hour Pressure >= 25 psi to <30 psi	Peak Hour Pressure < 25 psi
Fire Flow	Available Fire Flow >= 90% of Required Fire Flow	Available Fire Flow >= 80% to <90% of Required Fire Flow	Available Fire Flow >=70% to <80% of Required Fire Flow	Available Fire Flow >= 60% to <70% of Required Fire Flow	Available Fire Flow < 60% of Required Fire Flow

Condition

For condition, the likelihood of asset failure can be based on multiple factors depending on their relevance and availability, including:

- Asset specific information such as physical pipe testing (e.g. pipe coupon testing), which provides recommended actions or specific estimates of remaining life
- Local service life estimates, as outlined in the City's asset management plan
- Break history

The application of the three factors is translated to a 1 to 5 scale, as defined in **Table 3.2**. A condition rank of 5 indicates that the likelihood of failure is very high and a score of 1 indicates that the probability of failure is very low.

Table 3.2: Likelihood of Failure for Water Assets - Condition

LIKELIHOOD OF FAILURE	SERVICE LIFE		BREAK HISTORY
5	Asset age exceeds its SL* by 25%	***OR***	>= 3 Breaks
4	Asset age exceeds its SL* by 0% - 25%	***OR***	2 Breaks
3	75% of its SL* < Asset Age < 100% of its SL*	***OR***	1 Break
2	50% of its SL* < Asset Age < 75% of its SL*	***OR***	0 Breaks
1	Asset age < 50% of its SL*	***OR***	0 Breaks

* **SL =** Service Life: The number of years that an asset is estimated to be able to fulfill its intended function to the community before it needs to be replaced.

The risk of failure due to age is based on a linear projection of remaining service life, which is consistent with the table above and aligns with Abbotsford's asset management inventory. **Table 3.3** outlines the projected service life per pipe material.

Table 3.3: Material Service Life Estimates

PIPE MATERIAL	ESTIMATED SERVICE LIFE (YEARS)*
AC	50
OTHER (CI, CP/CCP, DI, HDPE, PVC, ST, etc)	75
UNKNOWN	75

* From City of Abbotsford RIVA

CONSEQUENCE OF FAILURE

Capacity

For capacity driven deficiencies, the consequence of failure is a function of the land use type and their associated populations. For example, a water system failure serving a single family residential zone is important but has less overall community impact than an upgrade to a deficiency adjacent a health center. Also, the looped nature of water systems means that deficient nodes are not typically related to the same location as the pipe that needs upgrading: a 200 mm pipe elsewhere in the pressure zone may need upgrading rather than any assets adjacent to the deficient node. **Table 3.4** defines the consequence of failure as it relates to population and land use.

Table 3.4: Consequence of Failure Definitions - Capacity

CONSEQUENCE DEFINITION	DESCRIPTION OF FAILURE	ADJACENT LAND USE DESIGNATION *(proxy for 'failure')*	CONSEQUENCE OF FAILURE
Insignificant	n/a	Agriculture	**1**
Minor	< 10 people impacted or property loss < $0.5M	Single Family Residential / Rural/Suburban Residential	**2**
Moderate	10-50 people impacted or property loss $0.5M - $1.0M	Multi-Family Residential	**3**
Major	50-100 people impacted or property loss $1.0M -$5.0M	Comprehensive Development, Commercial, Industrial	**4**
Severe	>100 people impacted or property loss >$5.0M	Institutional	**5**

Condition

The consequence of failure is based on the actual location of the infrastructure and the financial consequence that might occur if the infrastructure failed. The primary driver for *consequence of failure* relates to whether the pipe is located within a road and the classification of that road. This approach reflects the close link between cost to repair a water main break and the type of affected road. For example, a failure within an arterial road presents greater traffic control and road reconstruction requirements than would a failure within a local road. The City's GIS data identifies the pipe location in relation to road type. A 1 to 5 scale was used to classify the consequence of failure. **Table 3.5** details how each category is defined.

Table 3.5: Consequence of Failure Definitions - Condition

CONSEQUENCE DEFINITION	DESCRIPTION OF FAILURE	ROAD CLASSIFICATION	CONSEQUENCE OF FAILURE
Insignificant	Total cost to restore service and 3rd party liability (< $500)	No Roadway	**1**
Minor	Total cost to restore service and 3rd party liability ($500 - $5,000)	Urban Lane	**2**
Moderate	Total cost to restore service and 3rd party liability ($5,000 - $15,000)	Strata/ Urban Local/ Rural Local	**3**
Major	Total cost to restore service and 3rd party liability ($15,000 - $50,000)	Urban/ Rural Collector / Urban Industrial	**4**
Severe	Total cost to restore service and 3rd party liability (> $50,000)	Urban Arterial / Urban Major Arterial/ Urban Regional Arterial	**5**

MODIFIED CONSEQUENCE SCORE

Due to their larger size or nearby surroundings, some watermains present an increased level of consequence should they fail. For the analysis, pipe size, stream crossings, and pipes in special community areas were treated differently so as to elevate their priority sequencing in capital projects. The areas of modified consequence are:

- Watermains 300 mm and larger present greater failure consequences and a modified score is added to the normal risk rating (Table 3.6 below).
- Watermains that are adjacent to or cross a watercourse or within the natural environment buffer (as mapped by the City) demonstrate a greater consequence on community well-being. Therefore, water assets within these areas were assigned a modified consequence score based on **Table 3.6**).

Table 3.6: Modified Consequence Score

ORIGINAL SCORE		**1**	**2**	**3**	**4**	**5**
MODIFIED SCORE	>=300mm or adjacent to or cross sensitive watercourse, or located within environmental areas	**1**	**3**	**4**	**5**	**5**

Once the likelihood and consequence scores were determined, they were combined to determine the level of risk. **Table 3.7** summarizes how the likelihood and consequence scores are converted to risk scores.

Table 3.7: Risk Score Matrix

Consequence of Failure					
5	**3**	**3**	**4**	**5**	**5**
4	**2**	**3**	**4**	**5**	**5**
3	**2**	**2**	**3**	**4**	**4**
2	**1**	**2**	**2**	**3**	**3**
1	**1**	**1**	**2**	**2**	**3**
	1	2	3	4	5

Likelihood of Failure

3.2 Risk Assessment Results & Capital Prioritization

The risk analysis was conducted for all 97 km of proposed pipe upgrades. These risk scores were then used to help prioritize proposed capital projects, using the following criteria:

- Priority 1 - Upgrades that address both capacity and condition i.e. Priority 1 projects demonstrate both condition and capacity risks >=4. In other words, Priority 1 projects are upgrades that include high risks for both capacity and condition.
- Priority 2 - Upgrades that address either capacity or condition deficiencies i.e. Priority 2 projects demonstrate either a condition or capacity risk >=4. In other words, Priority 2 projects are upgrades that include high risks for either capacity or condition.
- Priority 3 projects consist of capacity risks of 3, 2 or 1 for capacity upgrade defined projects only or condition risks of 3, 2 or 1 that are part of the AC Main Replacement program.

Figures 3.1 and **3.2** illustrate the proposed pipe upgrades by priority. Of the 97 km of proposed pipe upgrades, approximately 3 km are priority 1 projects. As described further in sections below, it is recommended that these upgrades be completed in the short term.

Figure 3.1: Priority of Proposed Pipe Upgrades: Breakdown

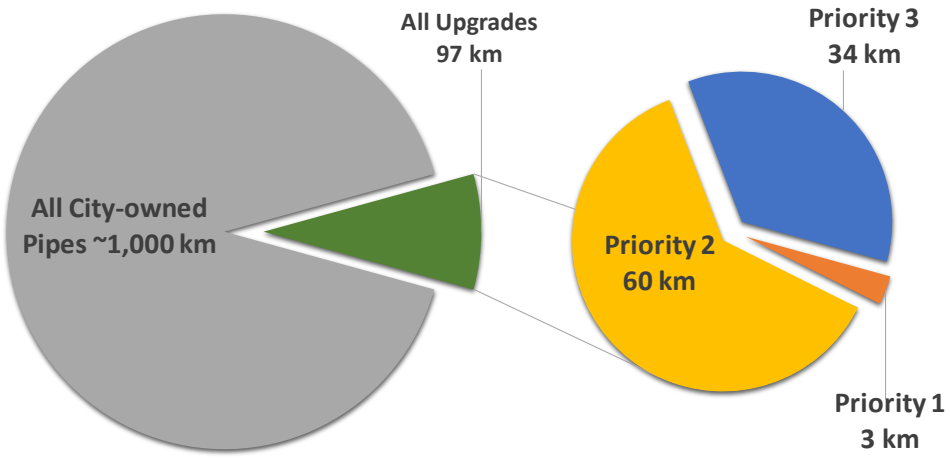
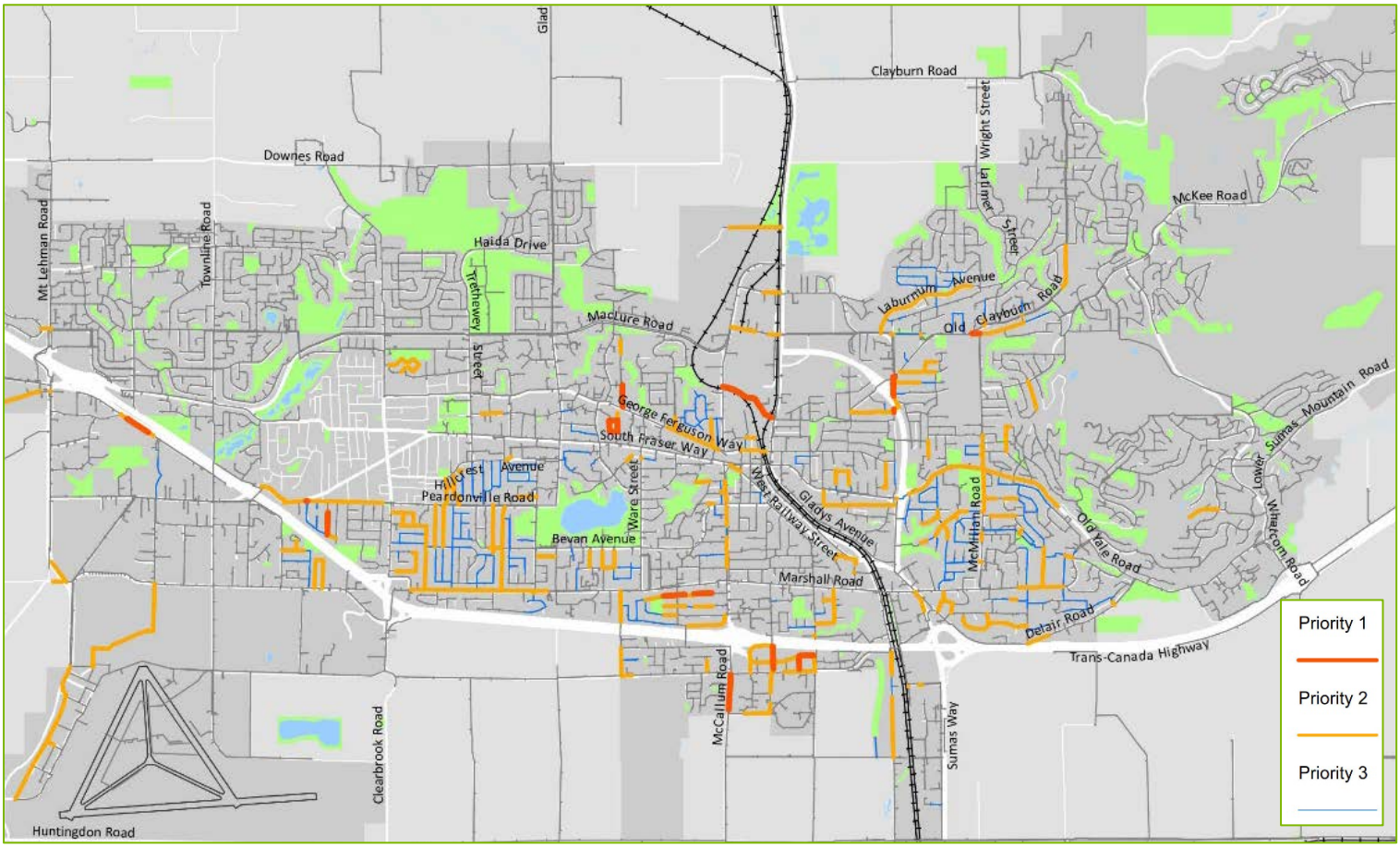


Figure 3.2: Priority of Proposed Pipe Upgrades: Geographic Distribution



4 PROJECTS AND COSTS

4.1 Linear Assets

In total, 194 distinct capital projects were identified including 1,366 different pipe segments. Using GIS, each pipe segment was linked to one of the following road classification types: arterial, collector, local, provincial highway and urban lane. The modified unit rate ($/m) for each pipe segment was then calculated by applying a multiplier (**Table 4.1**) to conventional unit rates (**Table 4.2**).

Table 4.1: Cost Multipliers by Road Classification Type

Road Classification	Multiplier
Provincial Highway	1.3
Arterial	1.2
Collector	1.1
Local	0.9
Strata	0.9
Urban Lane	0.75

Table 4.2: Conventional Unit Rates by Pipe Size

Pipe Size (mm)	Conventional Cost per Lineal Meter ($/m)
	2017 Proposed Pipe Supply & Install
150	$950
200	$1,140
250	$1,210
300	$1,320
350	$1,530
400	$1,550
450	$1,650
500	$2,150
600	$2,230
750	$2,460
Costs include 40% contingency & 10% engineering	

The identified capital projects for linear assets were then categorized as follows:

- Asset Replacement Program
- Asset Replacement Program – Upsized
- New Pipe Loop
- Pipe Upgrades

Table 4.3 summarizes the pipe lengths and estimated capital costs by category and priority. Approximately 75% of the capital costs are associated with the asset replacement program, including pipes that also need to be upsized due to capacity constraints. The 19 km of pipe upgrades in Special Study Areas A & B are not included in **Table 4.3**. Appendix B summarizes capital costs by project.

Table 4.3: Capital Costs by Category for Linear Assets (2018 – 2043)

Category	Length (km)				Capital Cost ($million, 2017 dollars)			
	Priority 1	**Priority 2**	**Priority 3**	**Total**	**Priority 1**	**Priority 2**	**Priority 3**	**Total**
Asset Replacement Program	0	14	29	**43**	$0	$15	$31	**$46**
Asset Replacement Program - Upsized	3	14	2	**19**	$4	$19	$3	**$25**
New Pipe Loop	0	3	1	**4**	$0	$5	$1	**$6**
Pipe Upgrade	0	10	2	**12**	$0	$14	$3	**$17**
Total	**3**	**41**	**34**	**78**	**$4**	**$52**	**$38**	**$93M**

The City plans to continue with their asset renewal program, including the abandonment of approximately 6 km of pipes, while installing new pipes and pipe upgrades. From a budgeting perspective, the City is planning for the average annual budgets outlined in **Table 4.4**.

Table 4.4: Proposed Average Annual Budgets for Linear Assets

Category	Proposed Average Annual Budgets (2017 dollars)
Asset Replacement	$2 million for 25 years
Asset Replacement – Upsized	$1 – 1.5 million for 25 years
New Pipes and Pipe Upgrades	$1.4 million for 15 years

4.2 Non Linear Assets

Non linear assets typically include infrastructure such as storage reservoirs, pump stations, and pressure reducing valves (PRVs). For the purpose of this report, it also includes advanced metering infrastructure (AMI). **Table 4.5** summarizes the City's anticipated budgets/expenditures for these non linear assets.

Table 4.5: Capital Costs by Category for Non Linear Assets (2018 – 2040)

Non Linear Assets	Capital Costs (2017 dollars)
Storage Reservoirs / McKee Area Improvements	8,535,000*
Pump Stations / PRV Upgrades	2,000,000
Average Annual Asset Renewal Budget	**$1 – 1.5 million**

* Project and funding to be confirmed in McKee Area Neighbourhood Plan

Section 2 provides further detail on the required non linear upgrades. The storage requirements are focused in the McKee area and are based, in part, on the previous McKee Peak Study. These costs and funding sources will be confirmed as part of the McKee Area Neighbourhood Plan. The pump station category includes works at the Bradner pump station while the PRV category includes works at PRV-MTN-Village 1/2 and Saddle PRV. The non linear asset renewal budget includes the replacement of current metering infrastructure and the installation/programming of new AMI. Works related to storage, pump stations and PRVs are currently planned to take place between 2018 – 2025 while works related to the AMI are planned between 2037 – 2040. While these upgrades may not occur uniformly over time, the City is planning for an annual asset renewal budget of $1 – 1.5 million for non linear assets.

4.3 Other Issues and Opportunities

The focus of this report has primarily been on infrastructure upgrades and asset renewal. Other complementary areas that require specific discussion include:

- Agricultural water use;
- Dry versus wet industry;
- Fire protection;
- Optimization of existing system;
- Resiliency of the water distribution system;
- Water main flushing; and
- Development reviews.

4.3.1 Agricultural Water Use

The agricultural sector in Abbotsford has successfully used a variety of water management techniques including detention, re-use, re-circulation, ditch irrigation and wells. Current City bylaws dictate that rural properties are to be serviced by a maximum 25 mm diameter service pipe. Existing bylaws also do not allow for open field irrigation. At this time, it is recommended that these current bylaws remain unchanged.

4.3.2 Dry versus Wet Industry

Existing industrial uses in Abbotsford include a mix of wet and dry industries. This mixed use has been allowed for in this Plan. Currently, an agricultural processor can develop in any I2 industrial zone; however, if too many agricultural processers develop in one particular area it could cause issues to the local water system. If a large wet industry is proposed within the City, it is recommended that a site specific water study is conducted to determine if infrastructure improvements are required.

4.3.3 Fire Protection

The City's urban development area is to be designed to meet Fire Underwriter Survey (FUS) minimum fire flows. The fire flows in rural areas, however, will be based on what is available. In other words, the rural water system is not designed to meet FUS flows. In the urban development area, it is recommended that the City adopt new minimum fire flows in relevant bylaws, as shown in **Table 4.6**.

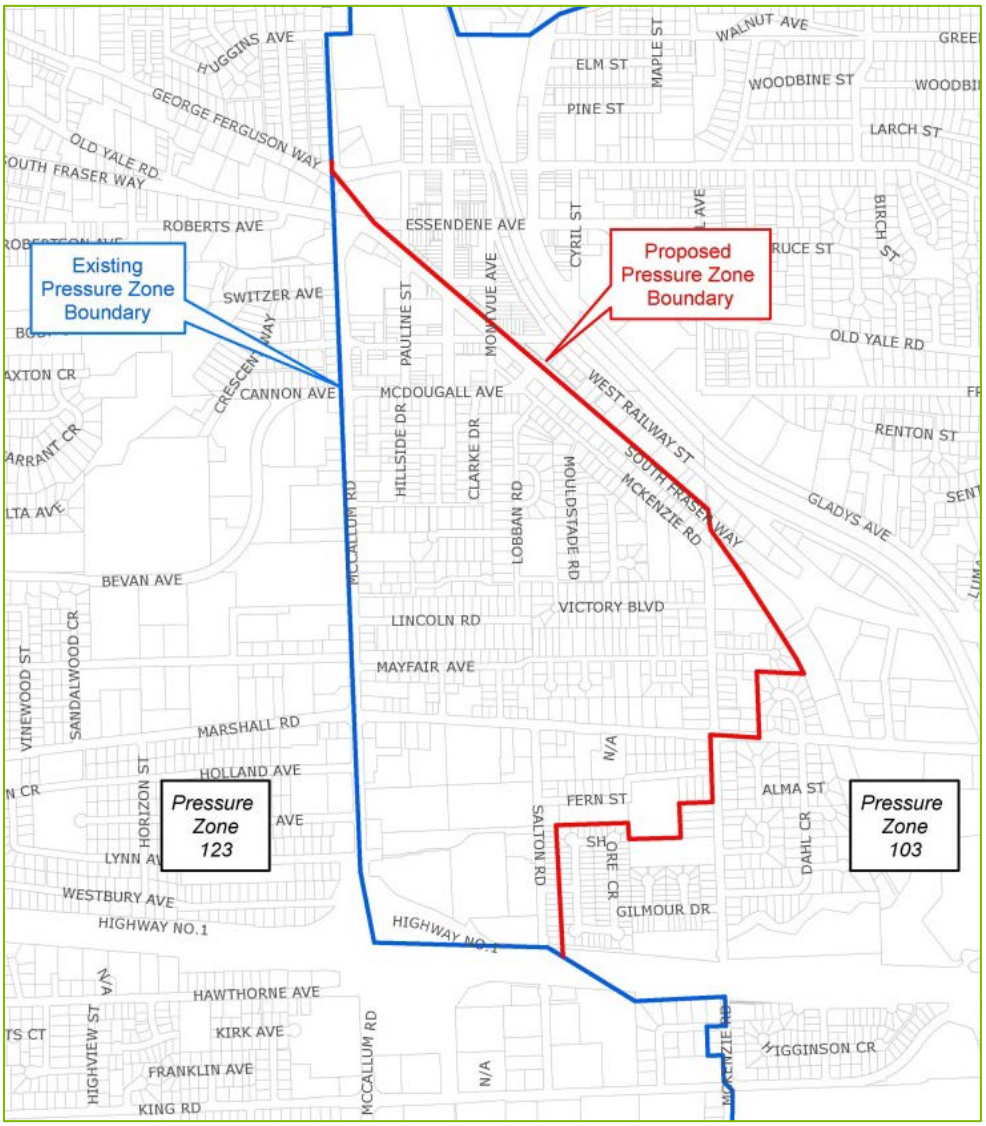
Table 4.6: Existing and Proposed Minimum Fire Flow Requirements

Land Use	Current Bylaw	Proposed
Single Detached/ Duplex Residential	**75 L/s**	**75 L/s**
Ground Oriented (Townhouses)	**120 L/s**	**150 L/s**
Midrise (Apartments)	**167 L/s**	**175 L/s**
Institutional	**167 L/s**	**200 L/s**
Commercial / Mixed Use	**167 L/s**	**200 L/s**
Industrial	**167 L/s**	**220 L/s**

4.3.4 Optimization of Existing System

In order to optimize the existing system, it is recommended that the pressure boundary between pressure zone (PZ) 123 and 103 be changed as illustrated in **Figure 4.1**. The current pressure zones follow the historic boundary between the District of Abbotsford and City of Matsqui along McCallum Road. Currently, there are two undersized water mains one on each side of the road. Instead of replacing both pipes with larger ones, there is an opportunity to realign the pressure zones and replace both pipes with one larger pipe. The effect of this pressure boundary alignment will be an increase of approximately 30 psi for the area. Budget for the pressure boundary optimization is within the asset replacement program.

Figure 4.1: Proposed Pressure Boundary Change Between PZ 123 and 103



4.3.5 Resiliency of Water System

This Plan also considered the resiliency of the water system during severe storm and seismic events. It is recommended that a backup generator is added to the Bradner pump station at a cost of approximately $750,000. It is further recommended that $250,000 be budgeted to update the 2006 Lifeline study in order to: 1) develop seismic construction standards for critical water mains, 2) determine requirement for seismic valves on reservoirs, 3) determine post disaster readiness of pump stations and 4) determine upgrades that are required on existing infrastructure. At this time, approximately $5 million is being earmarked for potential seismic upgrades.

4.3.6 Water Main Flushing

Utilizing the updated model, the City should create a customized unidirectional flushing (UDF) program. UDF consists of isolating pipe sections by closing appropriate valves and opening hydrants in an organized sequential manner. Flushing proceeds from flushed to unflushed pipes, from larger to smaller mains, moving from the source out to the ends of the system. The program should include customized field maps for the City operations crews to follow while carrying out the UDF program.

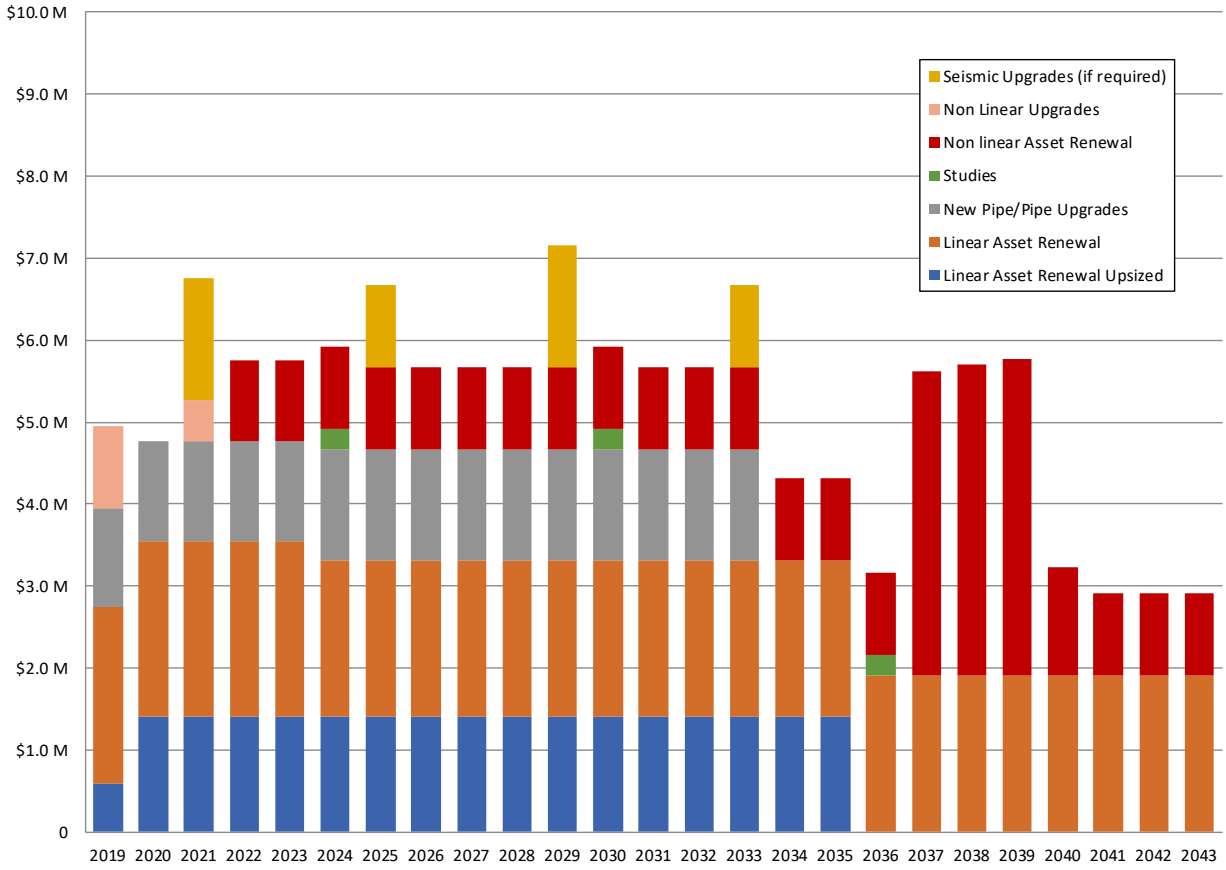
4.3.7 Development Reviews

Utilizing the updated model, the City should create a step-by-step User's Guide for conducting water-servicing analyses for development applications. The User's Guide should be fully customized to the City's development application bylaws and come packaged with City-developed tools to automate the calculation of development demands and fire flow FUS requirements.

4.4 Cost Summary

Figure 4.2 illustrates the overall cost summary for this Plan. McKee Peak Area Improvements and Special Study Areas A & B are excluded from this summary. Proposed annual average spending is in line with the City's historical expenditures. Grant funding will be sought after on major projects.

Figure 4.2: Water Distribution Master Plan Cost Summary



5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Master Plan Summary

The City of Abbotsford adopted a new Official Community Plan (OCP) in June 2016. The OCP outlines a path forward for the City to grow to a population of 200,000 by 2041. In order to meet the needs of a growing City, adequate infrastructure capacity must be in place. For this reason, the City has embarked on developing new utility master plans. This Water Distribution Master Plan identifies distribution system upgrades that are needed in order to convey the source water to the City's existing and future customers.

The water demands associated with growth forecasts from Section 1 were developed in order to determine future needs of the City. These water demands were used to update the City's hydraulic model. The updated hydraulic analysis identified 194 distinct capital projects, including a total of 97 km of linear assets (pipes). Excluding Special Study Areas A and B, there were 78 km of proposed pipe upgrades at a cost of approximately $93 million (2017 dollars). This translates to an average annual budget of approximately $4 - 5 million. An additional average annual expenditure of approximately $1 – 1.5 million is also required for non linear assets including reservoirs, upgraded pump station/PRVs and advanced metering infrastructure. The total proposed annual average spending of $5 – 6.5 million is in line with the City's historical expenditures.

5.2 Summary of Recommendations

In addition to the budget recommendations outlined above, the recommendations from this Plan are summarized below. This excludes recommendations specific to Special Study Areas A and B.

- 1.16 ML of capacity to be added by 2021 at McKee reservoir so as to provide sufficient capacity to 2051. This shall be reviewed and confirmed as part of the McKee Area Neighbourhood Study.
- Pump flow test to be conducted to determine the firm capacity of the Old Yale pump station and/or determine why the pump station may not be operating to its firm capacity.
- PRV-MTN-VILLAGE-1 to be upgraded immediately, as it is deficient in the existing scenario. PRV-MTN-VILLAGE-2 becomes deficient in the 2021 scenario and, therefore, should be upgraded by 2021.
- The proposed Saddle PRV to be added as a new recommended feed from the supply system into pressure zone 123 to address fire flow deficiencies in the existing scenario. This is recommended as an immediate improvement.
- The set points for PRV-SANDON-3 and PRV-SANDON-4 to be re-evaluated to draw more flow through PRV-SANDON-3 under high flow conditions.
- If a large wet industry is proposed within the City, a site specific water study to be conducted to determine if infrastructure improvements are required.
- New minimum fire flows to be updated per the Fire Underwriter Survey (see Table 4.6).

- The pressure boundary between pressure zone 123 and 103 to be changed as outlined above (see Figure 4.2)
- Bradner pump station to be upgraded, including the addition of a backup generator.
- The 2006 Lifeline study to be updated in order to: 1) develop seismic construction standards for critical water mains, 2) determine requirement for seismic valves on reservoirs, 3) determine post disaster readiness of pump stations and 4) determine upgrades that are required on existing infrastructure.
- An asset management renewal study to be completed including condition assessments for non-linear facilities

City of Abbotsford, BC
Calculation and Allocation of Future Water Demands
Technical Memorandum #1

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Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC ("the City") to load the City of Abbotsford water distribution system model with future demands. This document summarizes the methodology and results behind the calculation and spatial allocation of the future demands.

This technical memorandum includes the following:

- Abbotsford existing demand
- Abbotsford future serviced population
- Abbotsford future demand
- Unique development plans and special study areas
- Future demand modeling scenarios

This study considered population growth from 2016 to 2051, where the year 2016 was considered to be the existing base scenario and the year 2051 to be the future scenario. To assess the future water distribution system, the following key scenarios were developed in the model:

- **2041 Scenario**: This scenario is used to forecast any infrastructure capacity issues that the current system is susceptible to have.
- **2051 Scenario:** This scenario is used to size deficient infrastructure such that the future system has adequate capacity to service the future 2051 scenario.

Interim population and demand scenarios were developed at 5-year increments between 2016 and 2041 for determining the timing of system capacity issues and required upgrades.

2.0 Abbotsford Existing Demand

The existing presently serviced average day demand (ADD) and maximum day demand (MDD) data are summarized in **Table 2.1**. The MDD/ADD peaking factor is 1.42.

Table 2.1: Abbotsford 2016 Demand Data

Demand Type	ADD (L/s)	MDD (L/s)
Existing Single Family	166.3	236.3
Existing Multi Family	89.0	126.4
Existing Commercial	40.2	57.2
Existing Industrial	90.8	129.0
Existing Institutional	25.6	36.4
Existing Agriculture	89.2	126.8
Subtotal	**501.2**	**712.1**
Existing Non-Revenue Water	88.4	146.0
Total	**589.6**	**858.1**

Table 2.2 summarizes the existing residential per capita demand rates.

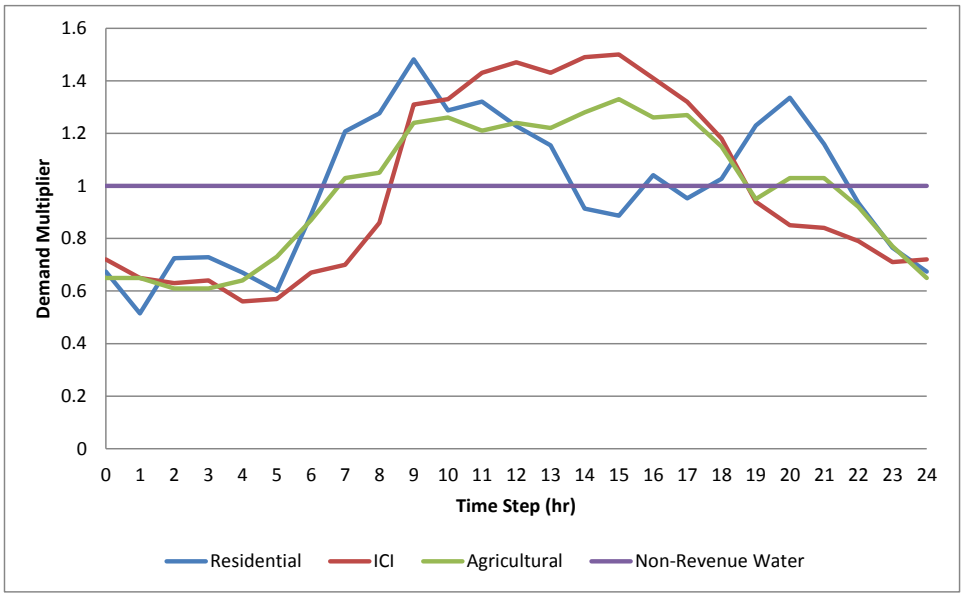
Table 2.2: Abbotsford 2016 Per Capita Demand Rates

Demand Type	ADD (L/cap/day)	MDD (L/cap/day)
Residential	180	256

2.1 Demand Patterns

The existing four (4) demand patterns used in the model are graphically represented in **Figure 2.1.** The demand patterns for commercial, industrial and institutional (ICI) demand types are the same. Similarly, both single-family and multi-family residential demand types used the same pattern. These demand patterns were also assigned to future growth.

Figure 2.1: 2016 MDD Demand Patterns



3.0 Abbotsford Future Serviced Population

This study considered population growth from 2016 to 2051, where the year 2016 was considered to be the existing base scenario and the year 2051 to be the future scenario. The actual and equivalent population data were provided by the City for the existing and future horizon years from 2016 to 2051. The actual population represents the residential population while the equivalent population represents the non-residential employment population.

3.1 Actual Population

The actual population data was provided by the City in the OCPGROWTH_MASTERPLAN_MAR13.shp shapefile and is summarized in **Table 3.1**.

Table 3.1: Actual Serviced Population Summary

Year	Actual Serviced Population
2016 (Existing)	132,584
2041	193,154
2051	217,382

Table 3.1 shows the total actual serviced population data for the existing, 2041 and 2051 scenarios. The total actual population data for 2021 to 2036 are provided in **Appendix A**.

Only growth was allocated from the future population projections. That is to say, all existing demands and their allocation remained constant through all future scenarios. Growth was added onto the existing demands for each growth horizon.

Future residential population was provided at a per parcel level and was allocated to the closest demand junction in the model.

Finally, the water boundary shapefile was used to determine the unserviced areas. For example, the Clearbrook Waterworks District has been excluded. On the other hand, the McKee Peak area was included in the future growth, as it is expected to be serviced in the future.

3.2 Population Equivalent

The population equivalent data was extracted from the OCPGROWTH_MASTERPLAN_ MAR13.shp shapefile provided by the City and is summarized in **Table 3.2**.

Table 3.2: Population Equivalent Summary

Year	Population Equivalent
2016 (Existing)	107,815
2041	193,644
2051	212,042

Table 3.2 shows the total population equivalent data for the existing, 2041 and 2051 scenarios. The total population equivalent data for 2021 to 2036 are provided in **Appendix A**.

The existing population equivalent is based on existing ICI and agricultural metered water usage converted to population equivalent using the existing residential per capita water usage rate.

The future 2051 population equivalent data was extracted per parcel based on population equivalent per hectare densities for each land use type provided by the City as summarized in **Table 3.3**.

Table 3.3: Population Equivalent Densities

Land Use	Population Equivalent Per Hectare (PE/ha)
Industrial	50
Commercial	90
Commercial (with Car Wash)	250
Institutional	50

To determine the future (2051) population equivalencies, the area of each future serviced parcel was multiplied by the respective population equivalent density. Further special exceptions and assumptions for the future population equivalencies are as follows:

- Negative growth was accounted for if there was a change of land use. If the land use remained unchanged, any negative growth was set to zero.
- Commercial properties were assigned growth only if flagged “Y” under the “BUILD_35” field in the OCPGROWTH_MASTERPLAN_ MAR13.shp.
- Institutional properties with a growth population equivalent larger than 500 were adjusted to reflect a population equivalent growth rate of 1.6% per annum.

- Population equivalencies for the Unique Development Plans and Special Study Areas were adjusted based on the servicing reports provided by the City.
- Agricultural population equivalencies were determined based on the current agricultural demands growing by 75% in the next 25 years (i.e. 2.26% per annum), with no agricultural growth between 2041 and 2051.

The future population equivalent was determined for each parcel then converted to demand based on the future per capita water usage rates as summarized in **Table 4.2** and **Table 4.3** in **Section 4.0**. Future ICI and agricultural demands were then allocated to the closest demand junction in the model.

4.0 Abbotsford Future Demand

4.1 Future Domestic Demand Calculations

Abbotsford future population growth for the 2041 and 2051 scenarios is shown in **Table 4.1**.

Table 4.1: Abbotsford Serviced Population Growth

Population Type	2041	2051
Residential (Actual)	+ 60,570	+ 84,798
ICI (Equivalent)	+45,083	+63,481
Agricultural (Actual + Equivalent)	+40,746	+40,746
Total Growth	**+ 146,399**	**+ 189,025**

The future population growth data for 2021 to 2036 are provided in **Appendix B.**

The future ADD and MDD per capita demand rates are shown in **Table 4.2** and **Table 4.3**, respectively. These values were developed as part of the 2017 AMWSC Water Supply Study. For detailed background on these values please refer to the Demand Projections memorandum prepared by Urban Systems (April 2017).

Table 4.2: Future ADD Per Capita Demand Rates

Demand Type	2041	2051
Residential	161 L/cap/day	162 L/cap/day
ICI	178 L/cap/day	185 L/cap/day
Agricultural	162 L/cap/day	162 L/cap/day

Table 4.3: Future MDD Per Capita Demand Rates

Demand Type	2041	2051
Residential MDD	229 L/cap/day	230 L/cap/day
ICI MDD	253 L/cap/day	263 L/cap/day
Agricultural MDD	230 L/cap/day	230 L/cap/day

Table 4.4 and **Table 4.5** show the Abbotsford future demand scenarios for the years 2041 and 2051, respectively.

Table 4.4: Abbotsford Future ADD (L/s)

Demand Type	2041	2051
Existing Subtotal	501.2	501.2
Residential Growth	86.3	132.6
ICI Growth	91.1	139.8
Agricultural Growth	67.1	67.1
Non-Revenue Water	75.2	75.2
Total	**821.0**	**915.9**

Table 4.5: Abbotsford Future MDD (L/s)

Demand Type	2041	2051
Existing Subtotal	712.1	712.1
Residential Growth	122.7	188.4
ICI Growth	129.5	198.6
Agricultural Growth	95.4	95.4
Non-Revenue Water	124.1	124.1
Total	**1,183.8**	**1,318.6**

Non-revenue water is assumed to decrease over the next 25 years to 2041, and then from 2041 to 2051 it is assumed to remain constant.

The future demands for the 2021 to 2036 scenarios are provided in **Appendix C.**

4.2 Future Domestic Demand Spatial Allocation

The following junction nodes were manually excluded from receiving future domestic demand in the model:

- Hydrant nodes
- Nodes connected to pumps, reservoirs, tanks and valves
- Nodes on pipes with a diameter equal to or greater than 450 mm
- Nodes on supply mains belonging to the AMWSC

Future demand data were then allocated to demand nodes. For each demand node, all contributing demands were summed up to represent the total future demand imposed on that node. To determine water demands, the population growth values for each parcel were multiplied by an average day demand rate per capita to produce a liter per day usage. Peaking factors as agreed with the City were then applied to this usage value to generate MDD demands.

4.3 Future Fire Flow Demand Requirements and Spatial Allocation

Table 4.6 summarizes the required fire flows for different land use types.

Table 4.6: Abbotsford Fire Flow Requirements

Land Use	Required Fire Flow (L/s)
Single Family Residential	75
Duplex Residential	75
Three- & Four-plex Residential	150
Apartments & Row Housing	175
Commercial	200
Institutional	200
Industrial	220

The above required fire flows are based on proposed requirements for the City of Abbotsford, BC 2015 Development Bylaw Revisions.

Fire flow demands were assigned spatially to hydrant nodes in the model. Each hydrant node was assigned a required fire flow based on surrounding projected future land uses from the OCP model. Where multiple land use types surround a hydrant node, the largest required fire flow was assigned.

5.0 Unique Development Plans and Special Study Areas

As part of the populations summarized in **Section 3**, the City requested special cases be allocated to specific points in the model representing future growth. These unique development plans and special study areas include:

- Airport Lands Expansion Plans
- City in the Country (CICP) Industrial Lands Expansion
- UDistrict
- McKee Peak
- Auguston
- Special Study Area A: Gloucester East Industrial Lands Expansion
- Special Study Area B: Industrial Reserve Lands, north of the Airport
- City Centre Neighbourhood Plan
- Historic Downtown Neighbourhood Plan

6.0 Future Demand Modeling Scenarios

To assess the future water distribution system, fourteen (14) modeling scenarios were created:

1. 2016 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
2. 2016 Peak Hour Demand (Steady State Simulation)
3. 2021 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
4. 2021 Peak Hour Demand (Steady State Simulation)
5. 2026 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
6. 2026 Peak Hour Demand (Steady State Simulation)
7. 2031 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
8. 2031 Peak Hour Demand (Steady State Simulation)
9. 2036 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
10. 2036 Peak Hour Demand (Steady State Simulation)
11. 2041 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
12. 2041 Peak Hour Demand (Steady State Simulation)
13. 2051 Maximum Day Demand + Fire Flow (Fire Flow Simulation)
14. 2051 Peak Hour Demand (Steady State Simulation)

Proposed water mains will be sized to the minimum diameter satisfying the greater of maximum day plus fire and peak hour demand.

It is recommended that all pressure analysis, fire flow analysis, and sizing be conducted using steady-state simulations. The primary reasons for this recommendation include the following:

- MDD+FF simulations are, by definition, steady-state simulations and fire flow accounts for most sizing requirements.
- There are many uncertainties regarding EPS operational controls under future conditions.

Finally, all pipes in the system that are not included in the City's Watermain Renewal Program were "aged" by reducing the C-factor for each pipe by a value of '5' for every 10-year period to compensate for pipe deterioration and/or internal build-up.

Submission

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Appendix A Future Serviced Population

Table A.1: Future Actual and Population Equivalent

Year	Actual Population	Population Equivalent
2016 (Existing)	132,584	107,815
2021	144,698	125,033
2026	156,812	142,251
2031	168,926	159,469
2036	181,040	176,687
2041	193,154	193,644
2051	217,382	212,042

Appendix B Population Growth

Table B.1: Abbotsford Serviced Actual Population Growth

Population Type	2021	2026	2031	2036	2041	2051
Agriculture	0	0	0	0	0	0
Airport	0	0	0	0	0	0
City Centre	+ 1,705	+ 3,410	+ 5,115	+ 6,820	+ 8,525	+ 11,935
Country	0	0	0	0	0	0
General Industrial	0	0	0	0	0	0
High Impact Industrial	0	0	0	0	0	0
Hospital	0	0	0	0	0	0
Institutional	0	0	0	0	0	0
Institutional Complex	0	0	0	0	0	0
Neighbourhood Centre	+ 260	+ 519	+ 779	+ 1,039	+ 1,299	+ 1,818
Open Space	0	0	0	0	0	0
Regional Commercial	0	0	0	0	0	0
Rural	0	0	0	0	0	0
Secondary Commercial	0	0	0	0	0	0
Suburban	+ 115	+ 230	+ 345	+ 460	+ 575	+ 805
University Village	+ 101	+ 202	+ 303	+ 404	+ 505	+ 708
Urban 1 - Midrise	+ 2,594	+ 5,189	+ 7,783	+ 10,378	+ 12,972	+ 18,161
Urban 2 - Ground	+ 1,110	+ 2,221	+ 3,331	+ 4,442	+ 5,552	+ 7,773
Urban 3 - Infill	+ 1,095	+ 2,190	+ 3,285	+ 4,380	+ 5,475	+ 7,665
Urban 4 - Detached	+ 4,640	+ 9,279	+ 13,919	+ 18,558	+ 23,198	+ 32,477
Urban Centre	+ 405	+ 810	+ 1,215	+ 1,620	+ 2,025	+ 2,836
Urban Large Lot	+ 89	+ 177	+ 266	+ 355	+ 443	+ 621
Total Growth	**+ 12,114**	**+ 24,228**	**+ 36,342**	**+ 48,456**	**+ 60,570**	**+ 84,798**

Table B.2: Abbotsford Serviced Population Equivalent Growth

Population Type	2021	2026	2031	2036	2041	2051
Agriculture	+ 8,149	+ 16,298	+ 24,448	+ 32,597	+ 40,746	+ 40,746
Industrial	+ 6,991	+ 13,981	+ 20,972	+ 27,963	+ 34,693	+ 48,935
Commercial	+ 797	+ 1,594	+ 2,390	+ 3,187	+ 3,984	+ 5,577
Institutional	+ 1,281	+ 2,563	+ 3,844	+ 5,125	+ 6,406	+ 8,969
Total Growth	**+ 17,218**	**+ 34,436**	**+ 51,654**	**+ 68,872**	**+ 85,829**	**+ 104,227**

Table B.3: Abbotsford Total Serviced Actual Population

Population Type	2021	2026	2031	2036	2041	2051
Agriculture	10,453	10,453	10,453	10,453	10,453	10,453
Airport	0	0	0	0	0	0
City Centre	1,799	3,504	5,209	6,914	8,619	12,029
Country	0	0	0	0	0	0
General Industrial	333	333	333	333	333	333
High Impact Industrial	27	27	27	27	27	27
Hospital	73	73	73	73	73	73
Institutional	85	85	85	85	85	85
Institutional Complex	0	0	0	0	0	0
Neighbourhood Centre	311	571	831	1,090	1,350	1,870
Open Space	82	82	82	82	82	82
Regional Commercial	7	7	7	7	7	7
Rural	66	66	66	66	66	66
Secondary Commercial	440	440	440	440	440	440
Suburban	669	784	899	1,014	1,129	1,359
University Village	101	202	303	404	505	708
Urban 1 - Midrise	19,642	22,237	24,831	27,426	30,020	35,209
Urban 2 - Ground	14,481	15,592	16,702	17,812	18,923	21,144
Urban 3 - Infill	21,200	22,295	23,390	24,485	25,580	27,770
Urban 4 - Detached	71,090	75,729	80,369	85,008	89,648	98,927
Urban Centre	1,155	1,560	1,965	2,370	2,775	3,586
Urban Large Lot	2,684	2,773	2,861	2,950	3,039	3,216
Total	**144,698**	**156,812**	**168,926**	**181,040**	**193,154**	**217,382**

Table B.4: Abbotsford Total Serviced Population Equivalent

Population Type	2021	2026	2031	2036	2041	2051
Agriculture	40,818	48,967	57,116	65,266	73,415	73,415
Industrial	50,553	57,544	64,535	71,525	78,255	92,497
Commercial	20,096	20,892	21,689	22,486	23,283	24,876
Institutional	13,566	14,847	16,129	17,410	18,691	21,254
Total	**125,033**	**142,251**	**159,469**	**176,687**	**193,644**	**212,042**

Appendix C Future Demands

Table C.1: Abbotsford Future ADD (L/s)

Demand Type	2021	2026	2031	2036	2041	2051
Existing Subtotal	501.2	501.2	501.2	501.2	501.2	501.2
Residential Growth	17.3	34.5	51.8	69.1	86.3	132.6
ICI Growth	18.2	36.4	54.7	72.9	91.1	139.8
Agricultural Growth	13.4	26.9	40.3	53.7	67.1	67.1
Non-Revenue Water	85.6	82.9	80.2	77.7	75.2	75.2
Total	**635.7**	**681.9**	**728.2**	**774.6**	**821.0**	**915.9**

Table C.2: Abbotsford Future MDD (L/s)

Demand Type	2021	2026	2031	2036	2041	2051
Existing Subtotal	712.1	712.1	712.1	712.1	712.1	712.1
Residential Growth	24.5	49.1	73.6	98.1	122.7	188.4
ICI Growth	25.9	51.8	77.7	103.6	129.5	198.6
Agricultural Growth	19.1	38.2	57.2	76.3	95.4	95.4
Non-Revenue Water	141.3	136.8	132.4	128.2	124.1	124.1
Total	**922.9**	**987.9**	**1,053.1**	**1,118.3**	**1,183.8**	**1,318.6**

City of Abbotsford Water Supply and Distribution System Model Calibration

Technical Memorandum #2

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R0	June 5, 2017	First Draft	Andrea McCrea	Werner de Schaetzen
R1	June 29, 2017	Final Submission	Andrea McCrea	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

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1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban System Ltd. (USL) were retained by the City of Abbotsford, BC ("City") to prepare the master plans for the Abbotsford Mission Water and Sanitary Services ("AMWSS") water supply system and the City's water distribution system. As part of each of the master plans, GeoAdvice completed the calibration of the AMWSS water supply system and City's water distribution system hydraulic model.

The City's water supply and distribution systems are encompassed within one single hydraulic model. The model includes the entire AMWSS supply system, the City's distribution system, and the District of Mission ("District") distribution system. The following GeoAdvice reports summarize the latest updates of the supply and distribution systems as well as the integration of the District and City models:

- *District of Mission Water Distribution System Modeling and Capacity Analysis (April 2017)*
- *City of Abbotsford Water Model Update (March 2017)*

For the purpose of having fully integrated and consistent results across the water supply and distribution system master plans, both systems were calibrated simultaneously and congruently. The results of the model update and calibration for both projects are included in this technical memorandum.

The water model was calibrated using the InfoWater software program (Innovyze). InfoWater is a water system modeling and management software application. Furthermore, the City's *Water Modeling Standards, Conventions & Guidelines (2010)* were followed in the course of the model update.

This technical memorandum summarizes:

- The steps to update the model; and
- The model calibration methodology and results.

The attached spreadsheet ***2017-019-ABB_2017-021-ABB_TM2_Supply&DistributionSystem ModelCalibration_Appendices_r1_2017-06-29.xlsx*** contains the following report appendices:

Appendix A – SCADA Data Excluded From Model Calibration
Appendix B – Updated Pump Curves
Appendix C – Operational Controls
Appendix D – Pattern Controls
Appendix E – Tabular Model Calibration Results
Appendix F – Graphical Model Calibration Results

2.0 Model Update

The first step was to review the existing InfoWater model (File Name: *ABBY_JAN_2017.IWDB*) and GIS data provided by the City on May 17, 2017. The model and the City's GIS were reviewed before beginning the model calibration process.

2.1 Supply/Distribution Model Update

The City's hydraulic model required minor updates and corrections to bring it in-line with the City's actual water supply and distribution systems. **Table 2.1** below summarizes the updates and assumptions that were made in the model.

Table 2.1: List of Model Updates

Update #	Description of Issue	Resolution
1	Discrepancies present between model pipe data (diameter, material, install year, etc.) and GIS data	Joined all model pipes to their counterpart GIS pipe. Imported available GIS data into model. Updated diameters, materials and installation years as needed.
2	Missing new pipes in model from GIS	Added new pipes based on GIS changes identified by the City.
3	Model controls inconsistent with physical system operation	Updated pump station, altitude valve and PRV controls based on SCADA records.

2.2 Existing Demand Update

The existing demands were scaled to match the demands on the calibration day (August 20, 2016) which represents maximum day demand (MDD). **Table 2.2** summarizes the existing 2016 MDD for the City and the District.

Table 2.2: 2016 Maximum Day Demand

City/District	Demand (L/s)	Demand (MLD)
Abbotsford	920.7	79.6
Mission	282.3	24.4
Total	**1,203.0**	**104.0**

3.0 SCADA Data Review

The next step was to review and analyze the SCADA data provided by the City. SCADA data collected included the following:

- Pump on/off status and flows
- Pump inlet and outlet pressures
- Pump control operating procedures
- Reservoir levels and flows
- PRV flows and pressures
- Control valve settings and operating procedures
- Pressure and flow readings at locations within the AMWSS and City systems

The SCADA data was reviewed for the following:

- Data gaps and inconsistencies
- System maintenance periods
- Unusual circumstances
- Field data anomalies

The model was calibrated using 24-hour SCADA data collected by the City. The calibration day was selected to be August 20, 2016 as it represents the Maximum Day Demand (MDD) in 2016. **Table 3.1** summarizes the City SCADA data that were provided and used to compare against the modeling results. In total, 147 SCADA data files were used to calibrate the water supply and distribution system model as explained in **Table 3.1**.

Table 3.1: Summary of the SCADA Data Used to Calibrate Model

Measurement Type	Number of Calibration Points	Model Calibration Use
Pump Station		
Flow	27	• To compare with pump modeling flow predictions
Pressure	15	• To compare with pump modeling suction and discharge pressure predictions
Reservoir		
Level	14	• To compare with reservoir modeling level predictions
PRV		
Flow	28	• To compare with flow modeling predictions
Pressure	46	• To compare with pressure modeling predictions
Pipe Flow	13	• To compare pipe modeling predictions
Junction Pressure	4	• To compare junction modeling predictions

An additional 45 field data measurements were provided and analyzed but were ultimately disregarded due to the following reasons:

- Field data seem invalid and inconsistent with other measurements provided;
- Duplicate SCADA data; or
- There are still pending and unresolved questions about the field data measurements.

The City confirmed to disregard or ignore the field data. A list of all the disregarded field data measurements is presented in **Appendix A**.

Pump Measurements

In total, 42 pump measurements were used for the model calibration. 27 pump flow measurements were used in the calibration to compare against predicted flow modeling results. Additionally, 15 pressure measurements were used in the calibration for comparison, which include the suction and discharge pressures at most of the pump stations. The pump flow and pressure measurements were further used to validate the pump curves in the model.

Tank Level Measurements

In total, 14 tank measurements were used for the model calibration. Additionally, the initial level of the tanks was updated in the model to match the recorded initial water level (midnight on August 20, 2016). For example, at 12:00 AM of August 20, 2016, the tank level recorded for the St. Moritz Tank was 8.84 m and was thus updated in the model. This approach guaranteed that the same boundary conditions were used at the start of the 24-hour modeling simulation. **Table 3.2** summarizes the initial tank levels.

Table 3.2: Tank Initial Levels (August 20, 2016 @ 12:00 AM)

Tank	Initial Level
TNK-ATKINSON	4.28 m
TNK-BRADNER	5.44 m
TNK-CASSIAR	5.67 m
TNK-EAGLE-MTN	5.56 m
TNK-EMPRESS	5.52 m
TNK-HACKING	1.90 m
TNK-LEDGEVIEW	14.87 m
TNK-MACLURE-A	4.04 m
TNK-MACLURE-B	3.94 m
TNK-MACLURE-C	3.98 m
TNK-MARY-ANN	5.34 m
TNK-MCKEE	3.96 m
TNK-MCMILLAN	6.53 m
TNK-ST-MORITZ	8.84 m

The 24-hour tank level measurements were used in the calibration to compare against predicted tank level modeling results for all tanks.

PRV Measurements

In total, 74 PRV measurements were used for the model calibration. 28 PRV flow measurements and 46 PRV pressure measurements were used in the calibration to compare against predicted modeling results.

Pipe Flow Measurements

In total, 13 flow measurements were used in the calibration to compare against predicted flow modeling results.

Junction Pressure Measurements

In total, 4 junction pressure measurements were used in the calibration to compare against predicted pressure modeling results.

4.0 Model Calibration

When calibrating the model, the goal was to compare the measured values from the SCADA data against the predicted results from the model, to show that the model results are in agreement with the observed field data.

The model was calibrated using the criteria specified in **Table 4.1**.

Table 4.1: Recommended Calibration Accuracy

Parameter	Recommended Accuracy
Flow	± 10 - 20 %
Peak Flow	± 10 %
Peak Timing	± 1 hour
Reservoir Level	± 10 - 20 %
Pressure	± 10 %
Shape	Representative of observed pattern

The 'first cut' at calibration focused on system boundary facilities such as pumping stations, storage facilities, and control valves. Key facility attributes that were reviewed and adjusted as necessary included pump curves, storage geometry, controls and zone configurations.

Pipe Roughness Update

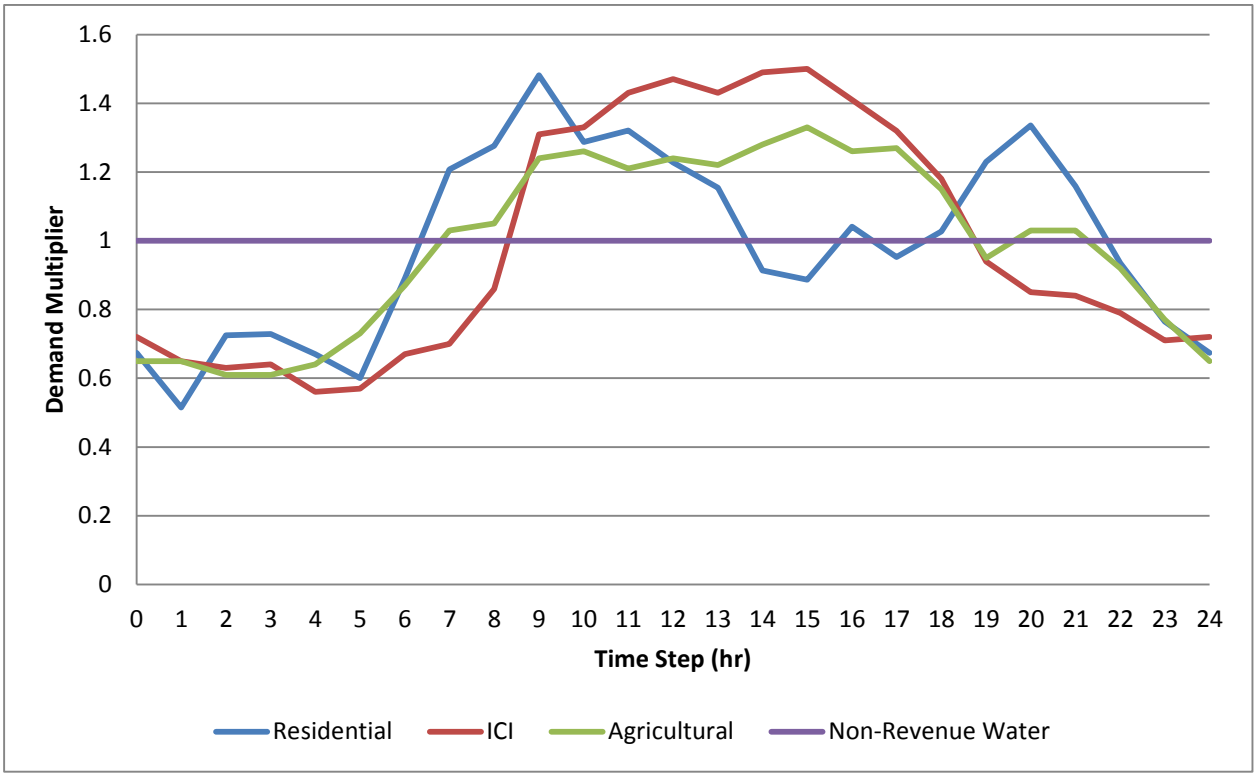
The hydraulic model was set-up to use the Hazen-Williams headloss formula to estimate friction loss through water mains. The pipes were grouped together based on their known physical characteristics, i.e. material, age and diameter. It was assumed that all pipes within a group have the same roughness coefficient. The Hazen-Williams coefficients for each pipe group were updated as part of the 2016 steady state model calibration and, as such, were not further changed as part of this study. Refer to the report *City of Abbotsford Water Model Update (March 2017)* for the calibrated pipe roughness coefficients.

Demand Patterns Update

A demand pattern is a set of multipliers that scale the base demand. The base demand is defined as the average demand at the junction, and the demand pattern is used to characterize the water demand over time. A typical pattern covers a 24-hour cycle to analyze changes during one day.

The model has four (4) key demand patterns. The demand patterns for Commercial, Industrial and Institutional (ICI) demand types are the same. Similarly, both Single-family and Multi-family Residential demand types used the same pattern. All patterns were reviewed and calibrated as necessary based on the observed SCADA flows. Refer to **Figure 4.1** for a graphical representation of each demand pattern used in the model.

Figure 4.1: 2016 MDD Demand Patterns



Furthermore, these patterns were used both for the Abbotsford demands and the District of Mission demands.

Pump Curves Update

All pump curves were reviewed against the available pump flow and pressure SCADA points. Updates were made to curves where the field data showed evidence of impeller deterioration or where it was suspected that the original pump curve was incorrect. The curves for the following pumps were adjusted to calibrate the model:

- Bevan 1, 2, & 4
- Bradner 1
- Industrial C
- McConnell
- Old Yale 5 & 6
- Townline 1 & 2
- Upper Maclure 1
- Westminster 1

The updated pump curves can be found in **Appendix B**.

Operational Controls Update

Operational control schemes were modeled to accurately simulate the hydraulic behavior of the water supply and distribution systems. During an extended period simulation (EPS), controls specify the status of selected pipes, pumps, and valves as a function of time, flow rate, tank water level, or junction pressure.

The calibrated operational controls used in the City model are detailed in **Appendix C**.

Additionally, to calibrate the model, three (3) patterns were created to control the following PRVs:

- PRV-EMPRESS-1
- PRV-SANDON-2
- PRV-SANDON-4

These patterns were created to ensure that observed pressures controlled by these PRVs were mimicked in the model during the calibration scenario. The patterns can be found in **Appendix D**.

4.1 Model Calibration Results

Calibration was completed by comparing field SCADA data and modeling results. A significant amount of effort during calibration was devoted to correcting modeling errors, missing values and SCADA data.

The overall quality of the model accuracy was estimated by comparing the field data measurements against the model predictions. The model calibration results were classified according to categories presented in **Table 4.2**.

Table 4.2: Calibration Agreement Categories

Agreement Status	% Difference
Excellent	± 5%
Good	± 10%
Satisfactory	± 20%
Poor	> 20%

Table 4.3 summarizes the flow calibration results.

Table 4.3: Summary of Flow Calibration Results

Agreement Status	Supply Flow		Distribution Flow	
	Quantity	%	Quantity	%
Excellent	14	52%	29	71%
Good	8	30%	8	20%
Satisfactory	1	4%	3	7%
Poor	4	15%	1	2%
Total	**27**	**100%**	**41**	**100%**

Table 4.4 summarizes the pressure calibration results.

Table 4.4: Summary of Pressure Calibration Results

Agreement Status	Supply Pressure		Distribution Pressure	
	Quantity	%	Quantity	%
Excellent	29	88%	29	91%
Good	3	9%	2	6%
Satisfactory	1	3%	1	3%
Poor	0	0%	0	0%
Total	**33**	**100%**	**32**	**100%**

Table 4.5 summarizes the tank level calibration results.

Table 4.5: Summary of Level Calibration Results

Agreement Status	Supply Level		Distribution Level	
	Quantity	%	Quantity	%
Excellent	2	50%	8	80%
Good	2	50%	1	10%
Satisfactory	0	0%	1	10%
Poor	0	0%	0	0%
Total	**4**	**100%**	**10**	**100%**

Table 4.6 summarizes all of the calibration results.

Table 4.6: Total Summary of Calibration Results

Agreement Status	Supply Total		Distribution Total	
	Quantity	%	Quantity	%
Excellent	45	70%	66	80%
Good	13	20%	11	13%
Satisfactory	2	3%	5	6%
Poor	4	6%	1	1%
Total	**64**	**100%**	**83**	**100%**

The complete tabular calibration results can be found in **Appendix E**, and the complete collection of calibration graphs can be found in **Appendix F**.

As shown in the tables above, there are 5 calibration points with "poor" agreements, all of which are flow calibration points. **Table 4.7** summarizes the "poor" calibration agreements.

Table 4.7: "Poor" Calibration Agreements

SCADA Tag	SCADA Description	Comment
WS.fl_tr7	Maclure Flow	Mass balance calculations performed for the Abbotsford system reveal large discrepancies in the measured flows at these 4 locations. As such, the measured flow data at these locations are suspect and should not be used for model calibration.
WS.flow_400_valve_7	Maclure PSV Flow (400 mm)	
WS.flow_res_out_400_7	Maclure Reservoir Outlet Flow OUT (400 mm)	
WS.flow_res_out_750_7	Maclure Reservoir Outlet Flow OUT (750 mm)	
WW.prv_flow_13	Selkirk PRV Flow	Model over-predicts flow through the Selkirk PRV station. If flow is further restricted, there is insufficient flow to fill the Cassiar storage reservoir. It is suspected that there may be discrepancy in the units provided in the field data.

Mass balance calculations based on the Abbotsford take-off measured flow data revealed large discrepancies in the data at the Maclure control valve station and reservoirs. As such, the field data is suspect and does not provide an accurate representation of the flows at Maclure for model calibration.

Overall, good agreements were achieved between the model results and measured SCADA data. As such, the model can be used as a reliable planning tool for both the AMWSS water supply system and City water distribution system master plans.

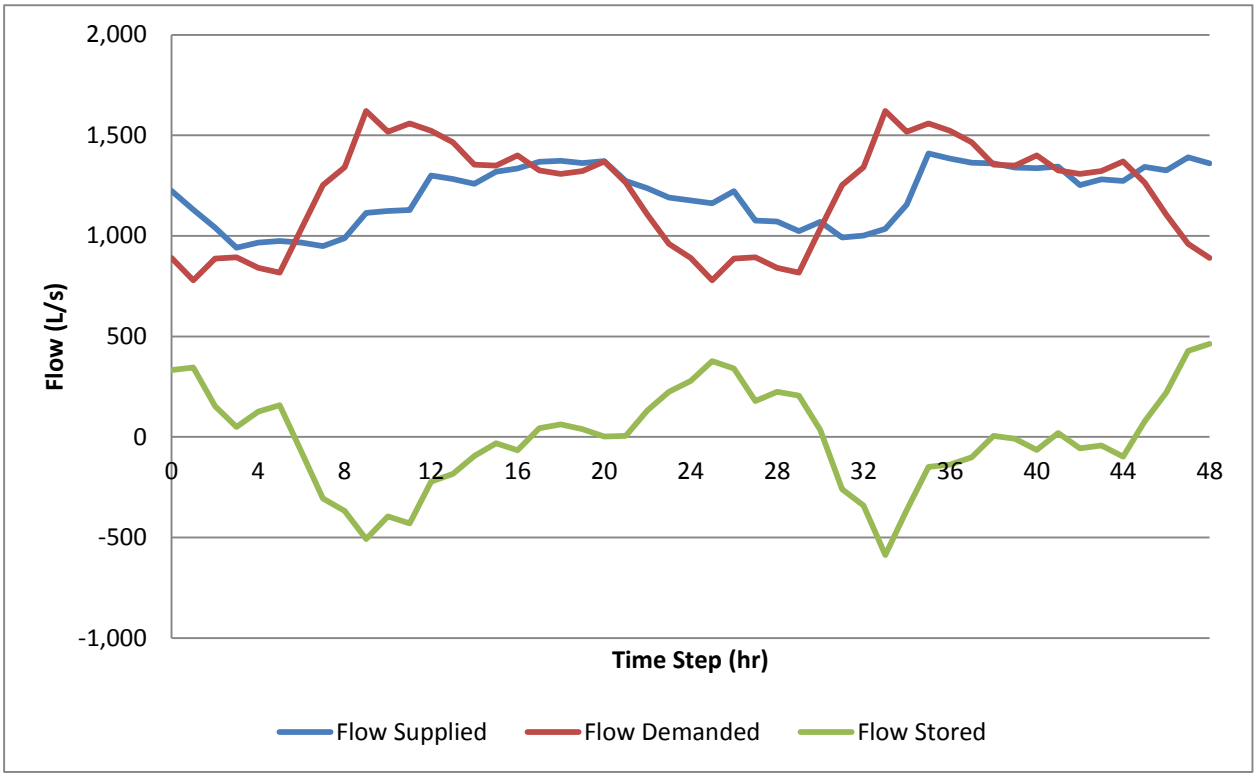
Based upon the findings from the model calibration, it is recommended that the City verify the excluded SCADA points listed in **Appendix A** and review the SCADA points with poor calibration agreements listed in **Table 4.7**.

5.0 EPS Model Validation

With the EPS model calibration complete, the next step was to review the robustness of the model. Key EPS model results, such as total system flows as well as tank cycling, were reviewed over a 2-day period to ensure that the MDD model results were able to converge over a sustained period of the time.

Figure 5.1 shows the total flow supplied by the system, the total flow demanded, and the total flow stored during the 48 hour MDD EPS run.

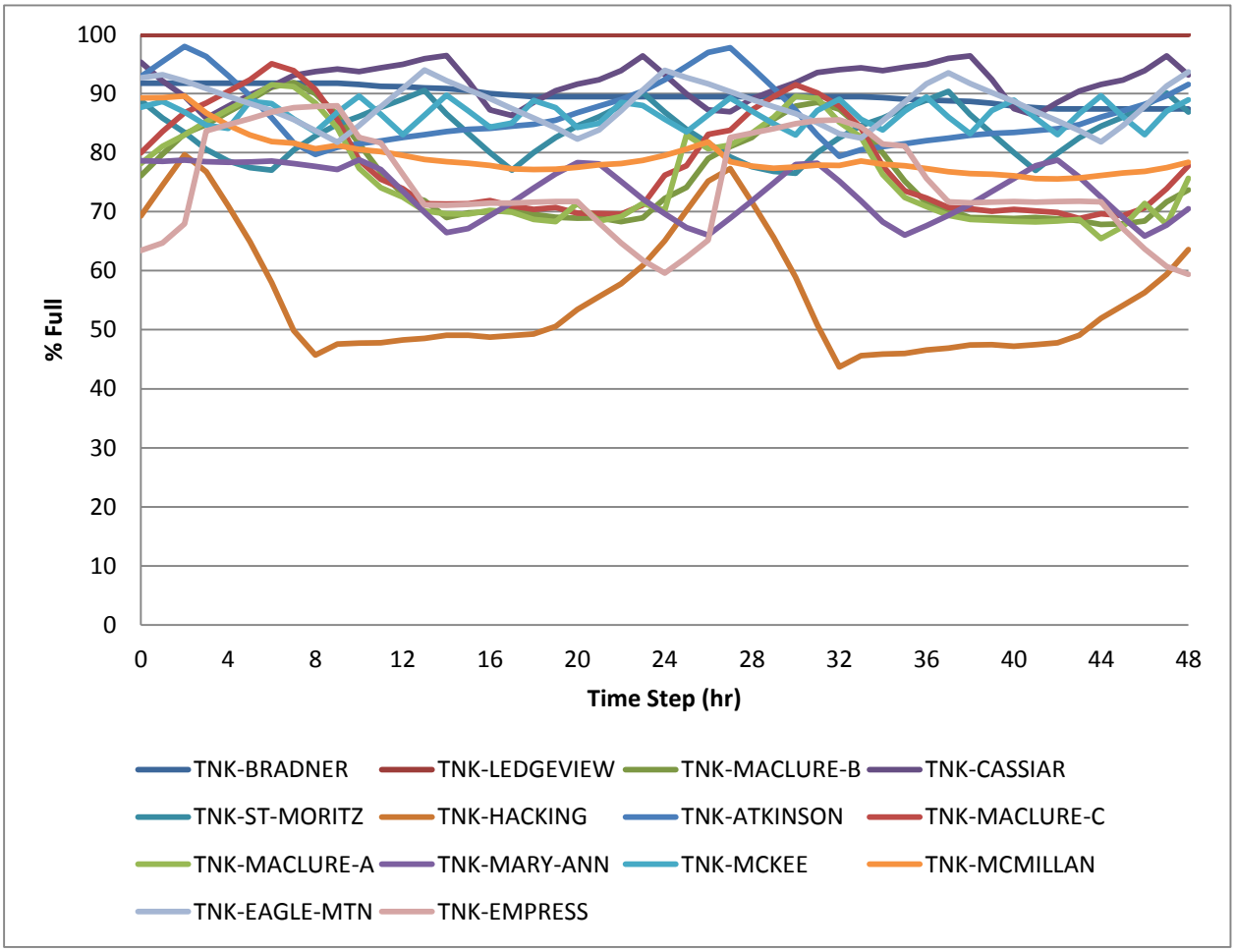
Figure 5.1: System Flow Analysis (2016 MDD EPS)



As shown in **Figure 5.1**, the flow supplied represents the total flow provided by the water sources (i.e. Cannell Lake, Norrish Creek, and the groundwater wells) throughout the 48-hour 2016 MDD EPS run. The flow demanded shows the total flow demanded by all water users throughout the simulation duration. Finally, the flow stored represents the total flow into and out of all storage nodes throughout the 2016 MDD EPS run.

Tank levels were also reviewed to ensure typical level cycling, ensuring that each tank refills over the course of the simulation. **Figure 5.2** shows the levels (% full) of each tank and how each tank cycles over the duration of the 2016 MDD EPS run.

Figure 5.2: Tank Levels (2016 MDD EPS)



As shown in **Figure 5.2**, the tanks are able to cycle over the course of the 48-hour simulation. The Ledgeview tank remains 100% full at all times, which is consistent with the field data. Furthermore, the model predicts that the Hacking tank falls below 50% through the middle of the day, which differs slightly from the field data; however, the model results have an excellent correlation with the Atkinson tank, which is in the same pressure zone as the Hacking tank. It should be noted that the Atkinson tank has a bottom elevation (63.3 m) 2 meters lower than the Hacking tank (65.3 m). Also, the Atkinson tank has a maximum level of 4.60 m; whereas, the Hacking tank has a maximum level of 2.75 m.

Furthermore, the statuses of all control PRV valves feeding from the supply system to the distribution systems were reviewed to ensure adequate pressure was provided by the supply system throughout the simulation duration. Additionally, general system pressures were reviewed and a summary is provided in **Table 5.1** below.

Table 5.1: Summary of System Pressures

System	Average Minimum Pressure	Average Maximum Pressure	Average Pressure
AMWSS Supply	100.3 m	107.7 m	103.0 m
Abbotsford Distribution	65.3 m	68.5 m	67.0 m
Mission Distribution	65.4 m	67.0 m	66.2 m

As shown in the table above, the average minimum, maximum, and average pressures are within the expected ranges for the supply and distribution systems.

Submission

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June 29, 2017

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City of Abbotsford, BC
Water Quality Model Validation

Technical Memorandum #3

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Project ID: 2017-021-ABB

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	August 29, 2017	Final Submission	Andrea McCrea	Werner de Schaetzen

Statement of Qualifications and Limitations
This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC ("City") to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice completed the validation of the City's water distribution system quality model.

The City's water distribution system quality model was originally developed and calibrated in 2015. Please refer to the following GeoAdvice technical memoranda, which summarize the previous water quality model calibration:

- *Technical Memorandum – Water Quality Model Calibration and Analysis (October 23, 2015)*
- *Technical Memorandum – Water Quality System Optimization (March 7, 2016)*

As part of the water distribution system master plan, the City's water quality model was updated and validated for evaluating water quality performance.

The water quality model was validated using InfoWater (Innovyze), a water system modeling and management software application that integrates advanced hydraulic and water quality modeling and functionalities.

This technical memorandum includes the following:

- Review of the water quality field SCADA data and sampling points;
- The water quality model set up; and
- Water quality model validation results.

2.0 Water Quality SCADA Data Review

The first step was to review and analyze the SCADA water quality data for the week of November 20-27, 2016. The SCADA water quality data (File Name: *Chlorine dosing - Nov 2016.xlsx*) was provided by the City on June 16, 2017. The SCADA water quality data included free and total chlorine levels.

Table 2.1 summarizes the total chlorine statistic results for the week of November 20-27, 2016.

Table 2.1: Summary of Total Chlorine (November 20-27, 2016)

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.24	1.60	1.36
Bevan Wells	0.39	0.52	0.45
Farmer Wells	0.22	0.41	0.33
Industrial Wells	0.17	0.19	0.18
Marshall Wells	0.03	0.11	0.06
Townline Wells	0.20	0.64	0.42

Appendix A shows the total chlorine statistic results for each day during the week of November 20-27, 2016.

Table 2.2 summarizes the water flow statistic results for the week of November 20-27, 2016.

Table 2.2: Summary of Water Flow (November 20-27, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	243.95	652.32	551.26	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.87	14.07	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	58.85	35.06	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	14.84	2.17	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	44.75	6.02	Yes
Townline Well 2	0.00	0.00	0.00	Yes

As shown in **Table 2.2** above, the City was only fed by Bell Road, Industrial Wells A&C, Pine Well, and Townline Well 1 during the week of November 20-27, 2016.

Appendix B shows the flow statistic results for each day during the week of November 20-27, 2016.

3.0 Water Quality Sampling Data Review

The City monitors water quality once a week at 29 water sampling locations (East E2 to E15 and West W1 to W16). Total chlorine was measured by the City at 28 sampling points on November 22, 2016 as shown in **Figure 3.1.** Sampling was not conducted at sampling point W10.

The following observations can be made based on the review of **Figure 3.1**:

- Chlorine concentrations for the East (E) sampling points vary between 0.19 mg/L to 1.05 mg/L.
- Chlorine concentrations for the West (W) sampling points vary between 0.17 mg/L to 1.05 mg/L.
- Higher chlorine concentrations were observed for the West (W) sampling points.
- Sampling points with the highest chlorine concentrations were mainly located at the center of the City in Pressure Zone 123.
- Although sampling point E06 is hydraulically located closer to injection sources, it has a lower chlorine concentration than E03.
- Sampling point E13 has a lower chlorine concentration compared to the surrounding sampling points E11, E12, E14, and E15.
- Although sampling point W02 is hydraulically located closer to injection sources, it has a lower chlorine concentration than W03.
- Although sampling point W14 is located closer to injection sources, it has a lower chlorine concentration than W11, W13, and W16.

GeoAdvice Engineering Inc.

Legend

- WQ Injection
- Storage
- Pump Station

Pipe Diameter (mm)

- < 300
- >= 300

Total Chlorine (mg/L)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20

Bell Road Ammonia Station
TNK-MARY-ANN
TNK-BRADNER
TNK-MACLURE-C
TNK-MACLURE-B
TNK-MACLURE-A
TNK-CASSIAR
TNK-EAGLE-MTN
TNK-EMPRESS
TNK-ST-MORITZ
TNK-MCMAHON
TNK-MCKEE
TNK-LEDGEVIEW
TNK-ATKINSON
TNK-HACKING
Bevan Wells
Marshall Wells
Townline Wells
Industrial Wells
Farmer Wells
W11 0.68 mg/L
W12 0.64 mg/L
W13 0.21 mg/L
W14 0.17 mg/L
W15 1.01 mg/L
W01 1.03 mg/L
W02 1.02 mg/L
W03 1.05 mg/L
W04 0.64 mg/L
W05 0.95 mg/L
W06 0.82 mg/L
W07 0.78 mg/L
W08 0.82 mg/L
W09 0.32 mg/L
E01 0.61 mg/L
E02 0.89 mg/L
E03 0.36 mg/L
E04 0.25 mg/L
E05 0.22 mg/L
E06 0.3 mg/L
E07 0.19 mg/L
E08 0.41 mg/L
E09 0.57 mg/L
E10 1.20 mg/L
E11 1.33 mg/L
E12 0.61 mg/L
E13 0.65 mg/L
E14 1 mg/L
E15 1.06 mg/L

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Measured Chlorine at Sampling Points on November 22, 2016

Project: **Water Distribution System Master Plan**
Water Quality Model Validation
Client: **City of Abbotsford, BC**
Date: **August 2017**
Created by: **AM**
Reviewed by: **WdS**

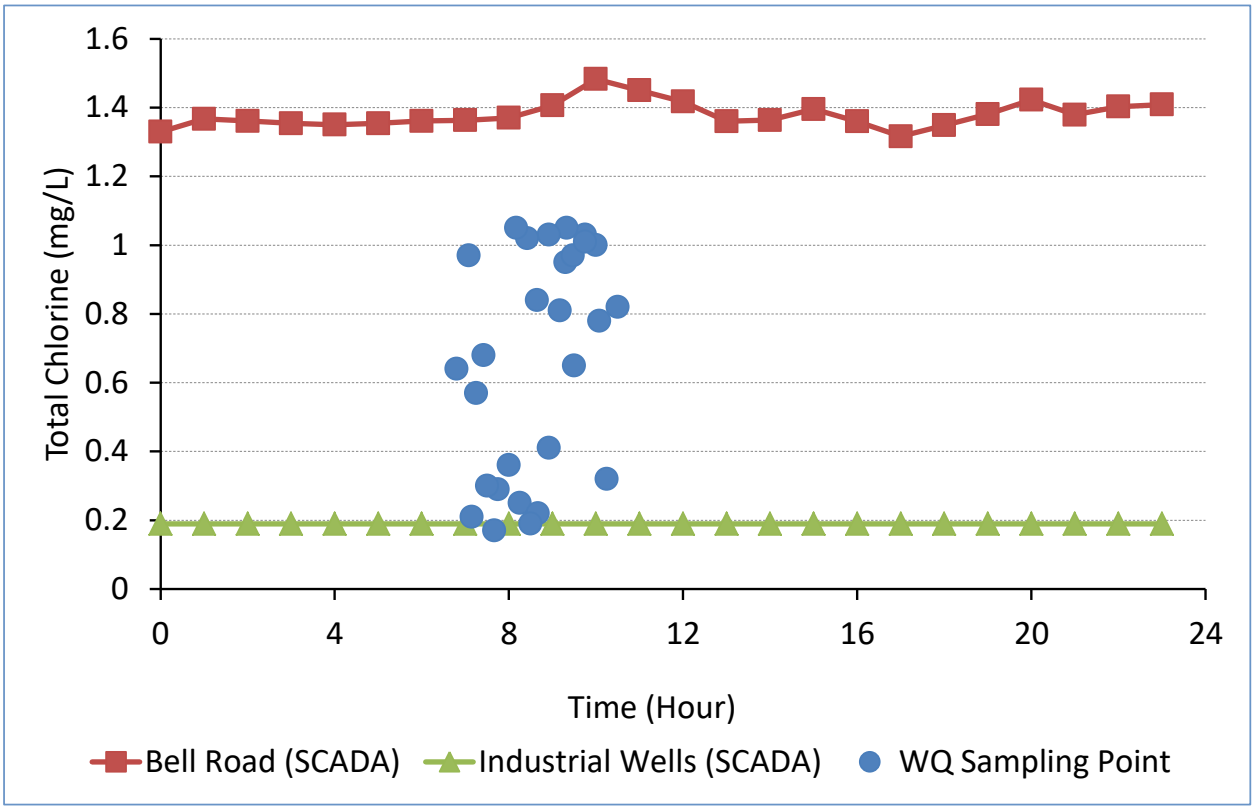
0 1.5 3 6
Kilometers

N W E S

Figure 3.1

Total chlorine measurements taken at the 28 sampling points were also compared with the available SCADA data on November 22, 2016. **Figure 3.2** compares the SCADA data at Bell Road Ammonia Station, and Industrial Wells with the 28 sampling points.

Figure 3.2: **Measured Chlorine on November 22, 2016**



Based on the data summarized in **Figure 3.2**, the following observations can be made:

- All water quality samples were collected between 6:30 am and 11:00 am.
- The average concentration of total chlorine measured at the 28 sampling points is about 0.66 mg/L.
- The average concentrations of total chlorine measured at the Bell Road Ammonia Station and Industrial Wells are 1.38 mg/L and 0.19 mg/L, respectively.
- The total chlorine measured at all sampling points was less than the Bell Road Ammonia Station, as expected.
- The total chlorine concentrations measured at all sampling points are higher than at the Industrial Wells, except for sampling point W14.

The water quality sampling field measurements are summarized in **Appendix C**.

4.0 Water Quality Model Setup

The InfoWater model is able to track the movement and decay of total chlorine through the network over time. The water quality parameters used in the City model for this study are as follows:

- Simulation start time = November 20, 2016
- Simulation end time = November 27, 2016
- Simulation duration = 8 days
- Average day demand (ADD) scenario
- Chemical constituent: Total Chlorine (mg/L)
    - Initial concentration at nodes (junctions and tanks) = 0.5 mg/L
- Bulk decay reaction
    - Bulk reaction coefficient (K_b) = - 0.12/day
- Wall decay reaction
    - Pipe wall reaction coefficients (K_w) are summarized in **Table 4.1**
- Decay rate: First order
- Injection sources at:
    - Bell Road Ammonia Station
    - Bevan Wells
    - Farmer Wells
    - Industrial Wells
    - Marshall Wells
    - Townline Wells
- The City storage reservoirs with their mixing models are summarized in **Table 4.2**

Please refer to the following GeoAdvice technical memorandum, which summarizes the previous detailed water quality calibration and analysis of the City's model:

- *Technical Memorandum – Water Quality Model Calibration and Analysis (October 23, 2015)*

Table 4.1: Pipe Wall Reaction Coefficients K_W (m/day)

Material	West	Central	East
AC	- 0.090	- 0.014	- 0.008
CI	- 0.200	- 0.008	- 0.095
CO	- 0.200	- 0.008	- 0.095
DI	- 0.025	- 0.010	- 0.018
PVC	- 0.032	- 0.002	- 0.004
PE	- 0.032	- 0.002	- 0.004
HDPE	- 0.032	- 0.002	- 0.004
ST	- 0.001	- 0.002	- 0.005
Other	- 0.016	- 0.002	- 0.004

Table 4.2: Storage Reservoir Mixing Model

Storage Reservoir	Mixing Model
Atkinson	Last In First Out
Bradner	Last In First Out
Cassiar	Last In First Out
Eagle Mountain	Last In First Out
Empress	Two-Compartment Mixing
Hacking	Last In First Out
Maclure Cell A	Last In First Out
Maclure Cell B	Last In First Out
Maclure Cell C	First In First Out
McKee	First In First Out
McMillan	Last In First Out
St. Moritz	Last In First Out

5.0 Water Quality Model Validation

The overall quality of the model was estimated by comparing the sampling and SCADA data with the model predictions. Validation was completed by comparing the sampling data against the modeling results. A total of 28 sampling points was used to validate the water quality model. Validation results are summarized in **Table 5.1**.

Table 5.1: Model and Field Agreement Analysis

Model & Field Correlation*	Status	Total	Percentage
Less than 0.1 mg/L	"Good" Agreement	9	32%
Between 0.1 and 0.3 mg/L	"Moderate" Agreement	18	64%
More than 0.3 mg/L	"Poor" Agreement	1	4%
	Total	28	100%

*The model and field correlation categories are based on the parameters used in the 2015 water quality calibration study.

It can be seen that about 96% of the model results have a "Good" or "Moderate" correlation with the field data. Eight (8) of the model predictions are found to be above observed values, while the other twenty (20) are below. The validation results are further summarized in **Appendix D**.

One (1) model validation point was found to be in "Poor" agreement with the field data. This point occurs at sampling point E13. The following observations can be made based on review of the modeling results:

- Sampling point E13 is expected to have a higher chlorine concentration than observed based on its location relative to the sources and based on neighbouring observed chlorine concentrations (i.e. E11, E12, E14, and E15).
- The measured chlorine at sampling point E13 is too low, and it is suspected that there is an anomaly in the field observation.
- Based on the chlorine measurements taken throughout the year, the measured chlorine concentration at sampling point E13 is, on average, higher than the concentration predicted by the model.

6.0 Conclusion

GeoAdvice and USL were retained by the City of Abbotsford to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice completed the validation of the City's water distribution system quality model.

Approximately 96% of the model predicted chlorine results have a "Good" or "Moderate" correlation with the field data. One (1) model predicted chlorine result has a "Poor" agreement with the field data.

Overall, based on the water quality model validation, the City's water distribution system quality model developed in 2015 is still valid and can be used to assess water quality performance for the master plan project.

Submission

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Appendix A SCADA Water Quality Data Review

Summary of Total Chlorine for November 20, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.41	1.60	1.49
Bevan Wells	0.44	0.52	0.47
Farmer Wells	0.22	0.36	0.29
Industrial Wells	0.19	0.19	0.19
Marshall Wells	0.03	0.06	0.04
Townline Wells	0.27	0.32	0.29

Summary of Total Chlorine for November 21, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.29	1.48	1.40
Bevan Wells	0.39	0.52	0.46
Farmer Wells	0.26	0.37	0.32
Industrial Wells	0.19	0.19	0.19
Marshall Wells	0.03	0.05	0.04
Townline Wells	0.20	0.34	0.26

Summary of Total Chlorine for November 22, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.32	1.48	1.38
Bevan Wells	0.42	0.48	0.45
Farmer Wells	0.30	0.38	0.34
Industrial Wells	0.19	0.19	0.19
Marshall Wells	0.03	0.06	0.04
Townline Wells	0.35	0.50	0.43

Summary of Total Chlorine for November 23, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.31	1.43	1.39
Bevan Wells	0.40	0.51	0.45
Farmer Wells	0.32	0.37	0.34
Industrial Wells	0.19	0.19	0.19
Marshall Wells	0.04	0.10	0.06
Townline Wells	0.43	0.50	0.47

Summary of Total Chlorine for November 24, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.29	1.41	1.34
Bevan Wells	0.42	0.49	0.45
Farmer Wells	0.32	0.36	0.34
Industrial Wells	0.19	0.19	0.19
Marshall Wells	0.05	0.11	0.07
Townline Wells	0.47	0.55	0.50

Summary of Total Chlorine for November 25, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.26	1.38	1.31
Bevan Wells	0.39	0.47	0.44
Farmer Wells	0.30	0.38	0.34
Industrial Wells	0.17	0.19	0.18
Marshall Wells	0.05	0.10	0.07
Townline Wells	0.45	0.55	0.49

Summary of Total Chlorine for November 26, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.24	1.40	1.30
Bevan Wells	0.41	0.47	0.44
Farmer Wells	0.31	0.36	0.33
Industrial Wells	0.17	0.17	0.17
Marshall Wells	0.06	0.10	0.08
Townline Wells	0.25	0.47	0.42

Summary of Total Chlorine for November 27, 2016

SCADA Location	Minimum Chlorine (mg/L)	Maximum Chlorine (mg/L)	Average Chlorine (mg/L)
Bell Road Ammonia Station	1.27	1.37	1.31
Bevan Wells	0.40	0.45	0.42
Farmer Wells	0.33	0.41	0.36
Industrial Wells	0.17	0.18	0.17
Marshall Wells	0.03	0.09	0.05
Townline Wells	0.33	0.64	0.46

Appendix B SCADA Flow Data Review

Summary of Water Flow (November 20, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	243.95	641.05	546.59	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.46	13.32	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	58.06	33.27	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	14.76	3.62	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	0.00	0.00	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 21, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	280.85	652.32	561.89	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.45	14.39	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	58.74	35.71	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	14.84	4.26	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	0.00	0.00	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 22, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	492.13	642.97	563.15	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.68	13.35	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	58.85	35.79	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	0.00	0.00	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	0.00	0.00	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 23, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	498.23	637.04	564.33	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.87	15.44	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	58.24	38.13	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	14.38	5.34	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	0.00	0.00	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 24, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	491.80	635.97	565.19	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.61	13.28	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	58.78	35.67	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	14.22	0.59	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	0.00	0.00	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 25, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	491.37	631.57	564.94	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.29	15.20	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	57.84	35.50	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	14.21	3.53	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	0.00	0.00	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 26, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	277.92	629.58	535.79	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.68	13.31	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	57.94	33.21	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	0.00	0.00	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	44.62	18.49	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Summary of Water Flow (November 27, 2016)

SCADA Location	Minimum Flow (L/s)	Maximum Flow (L/s)	Average Flow (L/s)	Water Quality Source?
Bell Road Ammonia Station	307.34	619.64	508.19	Yes
Bevan Well 1	0.00	0.00	0.00	Yes
Bevan Well 2	0.00	0.00	0.00	Yes
Bevan Well 3	0.00	0.00	0.00	Yes
Bevan Well 4	0.00	0.00	0.00	Yes
Farmer Well 1	0.00	0.00	0.00	Yes
Farmer Well 2	0.00	0.00	0.00	Yes
Farmer Well 3	0.00	0.00	0.00	Yes
Industrial Well A	0.00	25.32	14.28	Yes
Industrial Well B	0.00	0.00	0.00	Yes
Industrial Well C	0.00	57.76	33.17	Yes
Marshall Well 1	0.00	0.00	0.00	Yes
Marshall Well 2	0.00	0.00	0.00	Yes
Marshall Well 3	0.00	0.00	0.00	Yes
McConnell Well	0.00	0.00	0.00	No
Pine Well	0.00	0.00	0.00	No
Riverside Well 1	0.00	0.00	0.00	No
Riverside Well 2	0.00	0.00	0.00	No
Townline Well 1	0.00	44.75	29.64	Yes
Townline Well 2	0.00	0.00	0.00	Yes

Appendix C Water Quality Sampling Points

Model ID	Sampling Point	Location	Collection Time (November 22, 2016)	Measured Chlorine	Unit
JCT-27580	E02	Old Yale & Arnold	7:45:00	0.29	mg/L
JCT-19824	E03	Marion & Wellsline	8:00:00	0.36	mg/L
JCT-11346	E04	Campbell & Tolmie	8:15:00	0.25	mg/L
JCT-3738	E05	No.3 & South Parallel	8:40:00	0.22	mg/L
JCT-26090	E06	Cole Rd. across from 1024	7:30:00	0.30	mg/L
JCT-2950	E07	No.1 & Tolmie	8:30:00	0.19	mg/L
JCT-5814	E08	3434 McDermott Rd.	8:55:00	0.41	mg/L
JCT-11784	E09	Lower Sumas Mtn.	7:15:00	0.57	mg/L
JCT-11560	E10	36101 Regal Parkway	7:05:00	0.97	mg/L
JCT-13062	E11	St. Moritz Way	9:10:00	0.81	mg/L
JCT-12916	E12	Beck Rd.	9:45:00	1.03	mg/L
JCT-21412	E13	McMillan Rd.	9:30:00	0.65	mg/L
JCT-34254	E14	Victory & Mouldstade	10:00:00	1.00	mg/L
JCT-21224	E15	2195-2215 Orchard Dr.	9:20:00	1.05	mg/L
JCT-3070	W01	35041 Harris Rd.	8:55:00	1.03	mg/L
JCT-7018	W02	Sandy Hill School	8:25:00	1.02	mg/L
JCT-42032	W03	35944 McKee Rd.	8:10:00	1.05	mg/L
JCT-7074	W04	Bateman Park	8:39:00	0.84	mg/L
JCT-8884	W05	3315 Gladwin Rd.	9:18:00	0.95	mg/L
JCT-15534	W06	32961 SFW (Ventura Lane)	9:28:00	0.97	mg/L
JCT-24502	W07	3211 Joyce Ave.	10:05:00	0.78	mg/L
JCT-33828	W08	Municipal Works Yard	10:30:00	0.82	mg/L
JCT-28370	W09	515 Gladwin Rd.	10:15:00	0.32	mg/L
JCT-4474	W11	5030 Lefeuvre Rd.	7:25:00	0.68	mg/L
JCT-2548	W13	7942 Bradner Rd.	7:09:00	0.21	mg/L
JCT-28606	W14	Dunach School	7:40:00	0.17	mg/L
JCT-16422	W15	3154 Clearbrook Rd.	9:45:00	1.01	mg/L
JCT-19352	W16	27875 Swensson Ave.	6:48:00	0.64	mg/L

Appendix D Water Quality Model Validation Results

Sampling Point	Location	Measured Chlorine (mg/L)	Predicted Chlorine (mg/L)	Difference (mg/L)
E02	Old Yale & Arnold	0.29	0.16	- 0.13
E03	Marion & Wellsline	0.36	0.15	- 0.21
E04	Campbell & Tolmie	0.25	0.12	- 0.13
E05	No.3 & South Parallel	0.22	0.07	- 0.15
E06	Cole Rd. across from 1024	0.30	0.16	- 0.14
E07	No.1 & Tolmie	0.19	0.08	- 0.11
E08	3434 McDermott Rd.	0.41	0.12	- 0.29
E09	Lower Sumas Mtn.	0.57	0.78	+ 0.21
E10	36101 Regal Parkway	0.97	0.91	- 0.06
E11	St. Moritz Way	0.81	1.00	+ 0.19
E12	Beck Rd.	1.03	1.06	+ 0.03
E13	McMillan Rd.	0.65	0.98	**+ 0.33**
E14	Victory & Mouldstade	1.00	0.94	- 0.06
E15	2195-2215 Orchard Dr.	1.05	0.96	- 0.09
W01	35041 Harris Rd.	1.03	0.97	- 0.06
W02	Sandy Hill School	1.02	0.90	- 0.12
W03	35944 McKee Rd.	1.05	0.89	- 0.16
W04	Bateman Park	0.84	0.71	- 0.13
W05	3315 Gladwin Rd.	0.95	0.88	- 0.07
W06	32961 SFW (Ventura Lane)	0.97	0.87	- 0.10
W07	3211 Joyce Ave.	0.78	0.65	- 0.13
W08	Municipal Works Yard	0.82	0.81	- 0.01
W09	515 Gladwin Rd.	0.32	0.58	+ 0.26
W11	5030 Lefeuvre Rd.	0.68	0.46	- 0.22
W13	7942 Bradner Rd.	0.21	0.48	+ 0.27
W14	Dunach School	0.17	0.33	+ 0.16
W15	3154 Clearbrook Rd.	1.01	0.91	- 0.10
W16	27875 Swensson Ave.	0.64	0.67	+ 0.03

City of Abbotsford, BC
Hydraulic Performance and Design Criteria

Technical Memorandum #4

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Document History and Version Control

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R0	October 5, 2017	First Draft	Andrea McCrea	Werner de Schaetzen
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Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC (City) to prepare the City water distribution system master plan. This technical memorandum describes the recommended hydraulic performance and design criteria.

The hydraulic performance and design criteria described in this technical memorandum are primarily based on the City's Engineering Standards and Specifications from the City of Abbotsford Development Bylaw, 2011, Bylaw No. 2070-2011, Schedule "F". Additional hydraulic performance and design criteria have been recommended to supplement the City standards and specifications.

As part of the City water distribution system master plan, the hydraulic performance and design criteria will be used to assess the hydraulic capacity of the City water distribution system. In assessing the system, only City owned infrastructure will be evaluated. Infrastructure owned by the Abbotsford Mission Water & Sewer Commission, BC (AMWSC), the District of Mission (DOM), and the Clearbrook Waterworks District (CWD) will not be evaluated.

2.0 Hydraulic Performance and Design Criteria

Based on the City's current design specifications and discussions with the City of Abbotsford staff, the following criteria are recommended for the evaluation of the hydraulic capacity performance of the water distribution system.

2.1 Hydraulic Criteria

Table 2.1 summarizes the key hydraulic performance and design criteria for analyzing the City water distribution system.

Table 2.1: Hydraulic Performance and Design Criteria

Criteria	Parameter
Maximum Pressure	830 kPa (120.4 psi)
Minimum Pressure	300 kPa (43.5 psi)
Minimum Residual Pressure (MDD+FF)*	150 kPa (21.8 psi)

*The predicted available fire flow, as calculated by the hydraulic model, will represent the flow available in the water main while maintaining the minimum residual pressure at the fire node. In addition, the minimum system pressure constraint of 0 psi will be maintained at all nodes in the City water distribution system.

Hydraulic deficiencies within 10% of the above performance and design criteria will not be addressed as they are within the model accuracy.

2.2 Fire Flow Criteria

Table 2.2 shows the required fire flow for each land use type.

Table 2.2: Fire Flow Requirements (150 kPa minimum)

Land Use Type	Required Fire Flow (L/s)
Agricultural	75 L/s
Single Family Residential	75 L/s
Duplex Residential	75 L/s
Comprehensive Development	75 L/s
Three & Four-plex Residential	150 L/s
Apartments and Row Housing	175 L/s
Commercial	200 L/s
Institutional	200 L/s
Industrial	220 L/s

The above required fire flows are based on the 2015 Draft Development Bylaw Revisions.

Fire flow deficiencies within 10% of the above fire flow requirements will not be addressed as they are within the model accuracy. Furthermore, if the required fire flow is available at an upstream hydrant (within 100 m) of a deficient node, especially in the case of a dead end, the deficiency will also not be addressed.

Furthermore, fire flow conveyance capacity will not be assessed in agricultural areas and areas located outside of the City Urban Development Boundary. These areas include the following pressure zones:

- HGL = 68 m
- HGL = 70 m
- HGL = 90 m
- HGL = 103 m (South rural area)
- HGL = 123 m (South rural area)
- HGL = 140 m
- HGL = 155 m
- HGL = 183 m

2.3 Water Quality Criteria

Table 2.3 summarizes the key water quality performance criteria for analyzing the City water distribution system.

Table 2.3: Water Quality Performance Criteria

Criteria	Parameter
Minimum Total Chlorine Residual	0.2 mg/L

2.4 Storage Reservoir Capacity Design Criteria (MMCD)

There are three types of storage which need to be considered in the City water distribution system:

- Fire storage (A) – This is the amount of water required to extinguish fires within the service area of a storage reservoir. This storage is based on the worst case fire flow land use scenario.
- Equalization storage (B) – This is the amount of storage required for normal water consumption. MMCD states that this should be 25 % of MDD.
- Emergency storage (C) – The emergency storage requirement is 25 % of A + B.

The required storage reservoir capacity is the sum of the Fire storage (A), Equalization storage (B) and Emergency storage (C).

Table 2.4 shows fire storage (A) requirements used in this analysis.

Table 2.4: Fire Flow (FF) Storage Calculations

Landuse	FF (L/s)	FUS* Duration (hour)	FF Volume (ML)
Agricultural	75	1.63	0.44
Single Family Residential	75	1.63	0.44
Duplex Residential	75	1.63	0.44
Comprehensive Development	75	1.63	0.44
Three & Four-plex Residential	150	2.00	1.08
Apartments and Row Housing	175	2.13	1.34
Commercial	200	2.50	1.80
Institutional	200	2.50	1.80
Industrial	220	2.80	2.22

*Fire Underwriter Survey, *Water Supply for Public Fire Protection (1999)*

Pressure zones HGL 70 m and 90 m will be excluded from the storage capacity analysis, as they are directly fed by the AMWSC supply system.

Table 2.5 shows the current storage capacities and corresponding HGL (hydraulic grade line) pressure zone of each City owned tank in the water distribution system.

Table 2.5: Existing Tank Capacities

Storage Reservoir ID	Capacity (ML)	HGL Zone (m)
TNK-ATKINSON	2.33	68
TNK-BRADNER	2.24	155
TNK-CASSIAR	2.25	137
TNK-EAGLE-MTN	3.75	297
TNK-EMPRESS	3.80	181
TNK-HACKING	1.08	68
TNK-MCKEE	3.57	237
TNK-MCMILLAN	9.49	103
TNK-ST-MORITZ	2.73	138

2.5 PRV Capacity Design Criteria

Each City PRV station will be reviewed in terms of peak velocity and operational capacity. To limit the amount of "wear and tear", the recommended peak velocity through a PRV should be less than or equal to 6 m/s. In addition, all the City PRVs in the distribution system must be active, i.e. upstream HGL must be higher than the PRV setting.

Table 2.6 summarizes the City owned control valves. Note the Pressure Zone HGL names are historic and do not necessarily reflect the actual HGL as set by the PRV settings.

Table 2.6: City Control Valves

Valve ID	From Pressure Zone	To Pressure Zone	Diameter (mm)	Elevation (m)	Setting	HGL Setting
ATV-BRADNER-RES-1	155	155	150	149.4	N/A	N/A
PRV-BATEMAN-1	123	63	50	30.1	57 psi	70 m
PRV-BOWMAN-01	68	50	50	6.1	62 psi	50 m
PRV-CANTEBURY-1	181	153	150	103.1	61 psi	146 m
PRV-CLAY-VILLAGE-1	231	90	150	11.4	93 psi	79 m
PRV-CRANBERRY-1	248	185	50	118.0	80 psi	174 m
PRV-DINA-1	153	103	100	55.6	65 psi	101 m
PRV-EAGLEMTN-1	297	248	250	212.9	45 psi	245 m
PRV-EAGLEMTN-2	297	248	100	213.7	49 psi	248 m
PRV-EMPRESS-A	297	248	150	171.1	104 psi	245 m
PRV-EMPRESS-B	297	262	150	172.2	123 psi	259 m
PRV-EMPRESS-A-2	297	248	75	171.6	109 psi	248 m
PRV-EMPRESS-B-2	297	262	75	172.7	127 psi	262 m
PRV-FADDEN-1*	68	68	100	10.0	87 psi	71 m
PRV-FARMER-01	123	103	250	19.2	0	N/A
PRV-HARRIS-3	231	70	200	4.5	94 psi	68 m
PRV-HWY11-1	123	70	250	6.0	95 psi	72 m
PRV-LOCARNO-1	297	217	50	179.8	54 psi	218 m
PRV-LOCARNO-2	297	217	150	179.3	54 psi	217 m
PRV-LUCERN-1	217	168	200	149.9	53 psi	187 m
PRV-LUCERNE-DAIRY	123	123	150	60.0	0	N/A
PRV-MCKINLEY-1	237	180	200	115.0	106 psi	189 m
PRV-MCKINLEY-2	237	183	200	115.0	88 psi	177 m
PRV-MCKINLEY-2-75	237	183	75	115.7	95 psi	183 m

Valve ID	From Pressure Zone	To Pressure Zone	Diameter (mm)	Elevation (m)	Setting	HGL Setting
PRV-MCTAVISH-1	155	140	150	82.0	61 psi	125 m
PRV-MILLAR-1	137	123	150	35.8	64 psi	81 m
PRV-MTN-VILLAGE-1	153	103	150	54.1	59 psi	96 m
PRV-MTN-VILLAGE-2	181	153	150	51.0	145 psi	153 m
PRV-MTN-VILLAGE-3	181	103	150	52.7	53 psi	90 m
PRV-SUNSPRING-1	137	102	75	49.0	75 psi	102 m
PRV-SUNSPRING-2	137	102	200	49.0	70 psi	98 m
PRV-SANDON-1	231	103	100	52.9	69 psi	107 m
PRV-SANDON-2	231	103	300	52.2	75 psi	100 m
PRV-SANDON-3	231	138	300	52.2	121 psi	125 m
PRV-SANDON-4	231	138	100	52.9	99 psi	139 m
PRV-SANDYHILL-1	237	183	200	116.3	91 psi	180 m
PRV-SANDYHILL-2	237	183	75	116.3	90 psi	179 m
PRV-SUNDEW-MTN-1	181	153	150	101.1	74 psi	153 m
PRV-WESTVIEW-1**	304	304	250	209.8	134 psi	304 m
PRV-WHATCOM-1*	68	68	25	8.0	85 psi	68 m
PRV-WRIGHT-1	123	63	50	13.7	70 psi	63 m
PRV-YALE-CT-1	138	103	150	61.6	50 psi	96 m
TCV-ANGUS-01	103	68	200	5.0	0	N/A
TCV-HARRIS	70	70	150	4.0	50	N/A
TCV-LUCERN-114	217	217	200	183.7	0	N/A
TCV-MTLEHMAN-01	155	155	200	71.0	0	N/A
TCV-VYE-POTTER	103	103	200	8.0	0	N/A

*Valve normally hydraulically closed.
**Pressure relief valve in pump station.

Only City owned PRVs will be reviewed. No AMWSC owned PRVs will be reviewed.

2.6 Pump Station Capacity Analysis

Design flows for all pumps were estimated based on the modeled pump curves. The largest non-fire flow pump was subtracted from the total pumping capacity at each pump station as per Abbotsford Bylaws.

Pumping capacity is a key design criterion for water distribution systems. There are two scenarios to consider:

- When pumping to a dead-end pressure zone, the required pumping capacity is the greater of:
  - PHD of the downstream pressure zones
  - MDD plus maximum fire flow demand of the downstream pressure zones
- When pumping to a pressure zone with a storage tank, the required pumping capacity is equal to MDD of the downstream pressure zones.

Table 2.7 summarizes the City owned pump stations. The fire pumps are indicated in red.

Table 2.7: City Pump Stations

Pump ID	From Pressure Zone	To Pressure Zone	Design Flow (L/s)	Firm Capacity (L/s)
PMP-BRADNER-1	155	194	6.31	6.31
PMP-BRADNER-2	155	194	6.31	
PMP-BUCHANAN-1	155	189	1.26	1.26
PMP-BUCHANAN-2	155	189	1.26	
PMP-EMPRESS-1	181	297	44.16	88.32
PMP-EMPRESS-2	181	297	44.16	
PMP-EMPRESS-3	181	297	44.16	
PMP-EAGLE-MTN-01	297	330	23.02	101.87
PMP-EAGLE-MTN-02	297	330	23.02	
PMP-EAGLE-MTN-03	297	330	78.85	
PMP-GLEN-MTN-1	103	138	37.80	37.80
PMP-GLEN-MTN-2	103	138	37.80	
PMP-MACLURE-1N	123	181A	201.89	403.78
PMP-MACLURE-2N	123	181A	201.89	
PMP-MACLURE-3N	123	181A	201.89	
PMP-MTN-VILLAGE-1	103	181	25.00	59.09
PMP-MTN-VILLAGE-2	103	181	25.00	
PMP-MTN-VILLAGE-3	103	181	34.09	
PMP-OLDYALE-1	123	182	37.80	515.20
PMP-OLDYALE-2	123	182	37.80	
PMP-OLDYALE-4	123	182	219.80	
PMP-OLDYALE-5	123	182	219.80	
PMP-OLDYALE-6	123	182	219.80	

Pump ID	From Pressure Zone	To Pressure Zone	Design Flow (L/s)	Firm Capacity (L/s)
PMP-SADDLE-1	123	137	46.99	93.98
PMP-SADDLE-2	123	137	46.99	
PMP-SADDLE-3	123	137	46.99	
PMP-SELKIRK-1	137	237	56.77	181.54
PMP-SELKIRK-2	137	237	58.54	
PMP-SELKIRK-3	137	237	66.23	
PMP-SELKIRK-4	137	237	66.23	
PMP-WESTMINSTER-1	237	290	9.33	85.10
PMP-WESTMINSTER-2	237	290	9.33	
PMP-WESTMINSTER-3	237	290	75.77	
PMP-WESTVIEW-1	237	304	9.33	83.88
PMP-WESTVIEW-2	237	304	8.11	
PMP-WESTVIEW-3	237	304	75.77	

Only City owned pump stations will be reviewed. No AMWSC owned pump stations (i.e. groundwater well pumps) will be reviewed.

2.7 Additional Modeling Assumptions

The following City of Abbotsford infrastructure will be included "by default" in the future modeling scenarios:

- Planned pressure zone 123/103 boundary changes
  - Planned changes documented in file "PZone_123.pdf" provided by the City on June 23, 2017
  - Changes to take effect in the 2021 horizon scenario
- New Vicarro Pump Station
  - To pump from pressure zone 231 m to 266 m
  - Changes to take effect in the 2021 horizon scenario
- Mt Village Pump Station will be replaced with a PRV station
  - To be implemented when Vicarro Pump Station is commissioned
  - Changes to take effect in the 2021 horizon scenario

2.8 Analysis Scenarios

Table 2.8 summarizes the scenarios that will be used to identify any water main, PRV station, pump station, and storage reservoir capacity issues.

Table 2.8: Analysis Scenarios

Horizon Year	Demand Scenario	Simulation Type	Purpose
2016	ADD	Water Quality Simulation	Identify hydraulic, fire flow, and water quality deficiencies
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	
2021	ADD	Water Quality Simulation	Identify hydraulic, fire flow, and water quality deficiencies
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	
2026	ADD	Water Quality Simulation	Identify hydraulic, fire flow, and water quality deficiencies
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	
2031	ADD	Water Quality Simulation	Identify hydraulic, fire flow, and water quality deficiencies
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	
2036	ADD	Water Quality Simulation	Identify hydraulic, fire flow, and water quality deficiencies
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	
2041	ADD	Water Quality Simulation	Identify hydraulic, fire flow, and water quality deficiencies
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	
2051	ADD	Water Quality Simulation	Identify and size system improvements
	MDD	Fire Flow Simulation	
	MDD	Extended Period Hydraulic Simulation	
	PHD	Steady State Hydraulic Simulation	

2.9 New Pipe Characteristics

Table 2.9 summarizes the characteristics of new pipes.

Table 2.9: Design Criteria

Criteria	Scenario
Minimum Pipe Diameter	
≤ 45 units/ha	200 mm
> 45 units/ha	250 mm
Congregate Apartment and Institutional	250 mm
Commercial	250 mm
Industrial	250 mm
Roughness Coefficient (≤ 250 mm)	135
Roughness Coefficient (> 250 mm)	140
Material	Ductile Iron or PVC
Maximum Velocity: PHD	1.5 m/s
Maximum Velocity: MDD+FF	3.0 m/s
Wall Reaction Rate	0 m/day

2.10 Likelihood of Failure Criteria

Table 2.10 summarizes the key criteria for analyzing likelihood of failure for water distribution system water mains.

Table 2.10: Likelihood of Failure Criteria

Parameter	1	2	3	4	5
Pressure	Peak Hour Pressure ≥ 40 psi	Peak Hour Pressure ≥ 30 psi to < 40 psi	Peak Hour Pressure ≥ 20 psi to < 30 psi	Peak Hour Pressure ≥ 10 psi to < 20 psi	Peak Hour Pressure < 10 psi
Fire Flow	Available Fire Flow ≥ 90% of Required Fire Flow	Available Fire Flow ≥ 80% to < 90% of Required Fire Flow	Available Fire Flow ≥ 70% to < 80% of Required Fire Flow	Available Fire Flow ≥ 60% to < 70% of Required Fire Flow	Available Fire Flow < 60% of Required Fire Flow

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City of Abbotsford, BC
Water Distribution System Capacity Analysis

Technical Memorandum #5

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Document History and Version Control

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Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC ("City") to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice analyzed the capacity of the City water distribution system under existing and future conditions using the City's hydraulic model. This technical memorandum includes the following:

- Summary of future system operational assumptions;
- Existing and future storage capacity analyses;
- Existing and future pumping capacity analyses;
- Existing and future pressure reducing valve (PRV) capacity analyses;
- Existing and future network capacity analyses; and
- Summary of recommended system improvements.

1.1 Background Studies

Please refer to following technical memoranda as part of the water distribution system master plan:

- *Technical Memorandum #1 – Calculation and Allocation of Future Water Demands (October 26, 2017)*
- *Technical Memorandum #2 – Water Supply and Distribution System Model Calibration (June 5, 2017)*
- *Technical Memorandum #3 – Water Quality Model Validation (August 29, 2017)*
- *Technical Memorandum #4 – Hydraulic Performance and Design Criteria (October 13, 2017)*
- *Technical Memorandum – Water Distribution System Analysis Pressure Zone 103 & 123 Boundary Optimization (April 13, 2018)*
- *Technical Memorandum #6a – Water Distribution System Impact Assessment Special Study Area A: Gloucester East Industrial Lands Expansion (April 16, 2018)*
- *Technical Memorandum #6b – Water Distribution System Impact Assessment Special Study Area B: Industrial Reserve Lands (April 16, 2018)*
- *Technical Memorandum – Water Distribution System Analysis City Center Neighbourhood Plan (April 13, 2018)*
- *Technical Memorandum – Water Distribution System Analysis Historic Downtown Neighbourhood Plan (April 13, 2018)*

2.0 System Capacity Analysis Assumptions

In analyzing the City's water distribution system, a number of assumptions were made regarding the system facilities and how the system was analyzed. These assumptions are summarized as follows:

Storage

- The Atkinson and Hacking storage reservoirs share the same service area; as such, their capacities were combined in assessing the required storage for their shared service area.
    - The functional capacity of the Atkinson reservoir was reduced based on the elevation difference between the Atkinson and Hacking storage reservoirs.
- The Cassiar and St. Moritz storage reservoirs share the same service area (connected at one location); as such, their capacities were combined in assessing the required storage for their shared service area.
    - The functional capacity of the St. Moritz reservoir was reduced based on the elevation difference between the Cassiar and St. Moritz storage reservoirs.
- The areas serviced by the Atkinson, Hacking, and Bradner storage reservoirs are outside of the City's Urban Development Boundary; as such, no fire storage was included in the required storage capacities for these storage reservoirs.

Pumping

- The areas serviced by the Bradner and Buchanan pump stations are located outside of the City's Urban Development Boundary; as such, no fire flow capacity was included in the required pumping capacities for these pump stations.
- The replacement of the Bradner pump station is a project to which the City is committed in the next five (5) years; as such, the future pump station capacity analysis for the Bradner pump station is based on the capacity of the proposed pump station.
- The Glen Mountain and Saddle pump stations share the same service area (connected at one location); as such, their capacities were combined in assessing the required pumping for their shared service area.
- The decommissioning of the Mountain Village pump station is a project to which the City is committed in the next five (5) years; as such, the Mountain Village pump station capacity was not analyzed under future conditions.
    - When the Mountain Village pump station is decommissioned the Wells Gray pump station will become active. The Wells Gray pump station will serve the same purpose as the Mountain Village pump station in the future, acting in high flow conditions to boost pressure to fill the Empress storage reservoir. As such, the Wells Gray pump station was not analyzed under existing conditions, only future conditions.

PRV

- The installation of two (2) new PRV stations on Marshall Road at Canterbury Avenue and Timberlane Drive is a project to which the City is committed in the next five (5) years; as such, these proposed PRV stations were analyzed under future conditions.
    - The proposed PRV at Marshall Road and Canterbury Avenue (PRV-MARSHALL) will feed pressure zone 153.
        - Upon installation of the Marshall Road PRV at Canterbury Avenue, the existing PRV on Boley Street at Canterbury Avenue (PRV-CANTERBURY) will be decommissioned; as such the Canterbury PRV station was only analyzed under the existing condition.
    - The proposed PRV at Marshall Road and Timberlane Drive (PRV-TIMBERLANE) will feed pressure zone 138.

Pipe Network

- There are a number of pipe network upgrade and/or replacement projects to which the City is committed in the next five (5) years. These projects were included and analyzed in the future scenarios and are as follows:
    - Pipes listed under the City's Asset Replacement Program for the years 2017 and 2018.
        - Although the City has many more projects scheduled as part of the Asset Replacement Program further into the future, these projects slated for future replacement were not included in the base future scenarios; as the timing of their replacement is not definite.
        - When recommending system improvements to eliminate system deficiencies, pipes listed in the Asset Replacement Program were first implemented.
        - Each pipe in the Asset Replacement Program was reviewed to validate the proposed replacement size and to determine whether the replacement is or will be necessary to address system capacity issues.
        - This methodology enables the City to identify projects in the Asset Replacement Program that may be deferred based on hydraulic capacity.
    - Other projects that the City is committed to within the next five (5) years that were included in the base future scenarios include the following:
        - Marshall Road extension, connecting existing water mains on Marshall Road from 35758 Marshall Road to Timberlane Drive (approximately 775 m of new 300 mm diameter water main).
        - Canterbury Avenue extension, connecting existing water main on Canterbury Avenue from 35674 Canterbury Avenue to the future water main on Marshall Road (approximately 200 m of 200 mm diameter water main).

    - Mt. Lehman Road water main replacement, from 3407 Mt. Lehman Road to Cardinal Avenue (approximately 425 m of 300 mm diameter water main).
    - Jackson Street and Hawthorne Avenue water main replacement, along Jackson Street from 33115 Capri Court to Hawthorne Avenue (approximately 90 m of 300 mm diameter water main) and along Hawthorne Avenue from Jackson Street to 33285 Hawthorne Avenue (approximately 400 m of 300 mm diameter water main).
- When analyzing pressure deficiencies in the water distribution system, upgrades were not recommended for deficiencies within 10% of the required minimum pressure (i.e. > 40 psi).
- When analyzing fire flow deficiencies in the water distribution system, upgrades were not recommended for deficiencies within 10% of the required minimum residual pressure (i.e. > 20 psi).
- When analyzing fire flow deficiencies in the water distribution system, upgrades were not recommended for deficiencies located on dead ends where:
    - For required fire flows 100 L/s or less, the fire flow was available at an upstream fire node within 100 m (provided that no boundaries, natural or otherwise, prevented the use of the upstream fire node(s)).
    - For required fire flows more than 100 L/s the fire flow was available at an upstream fire node within 200 m (provided that no boundaries, natural or otherwise, prevented the use of the upstream fire node(s)).
- The recommended future pressure zone boundary between zones 103 and 123 was not implemented in the base existing and future scenarios. The optimized pressure zone boundary was only included as a recommended system improvement. Other system improvements were recommended assuming the optimized pressure zone boundary will be implemented.

3.0 Storage Capacity Analysis

Storage capacity in the City water distribution system was analyzed by comparing the existing capacities of each City owned storage reservoir against the existing and future required capacities.

The required storage reservoir capacities were calculated based on the Master Municipal Construction Documents (MMCD) Design Guide Manual, as described in *Technical Memorandum #4 – Hydraulic Performance and Design Criteria (October 13, 2017)*. The required storage reservoir capacities were calculated for the existing condition through to the 2041 condition at each 5-year horizon.

The storage reservoir capacity analysis results for the existing and 2041 conditions are summarized in **Table 3.1** and **Table 3.2**. The storage reservoir capacity analysis results for all horizon year conditions can be found in **Appendix A**.

Table 3.1: Existing Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	1.29	+ 2.05	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	0.96	+ 1.28	No
TNK-CASSIAR	137, 138, & 80	4.61	3.88	+ 0.73	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.52	+ 1.22	No
TNK-EMPRESS	181 & 153	3.80	2.59	+ 1.21	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	3.46	+ 0.11	No
TNK-MCMILLAN	103	9.49	6.18	+ 3.31	No

Table 3.2: 2041 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	2.28	+ 1.06	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	2.23	+ 0.01	No
TNK-CASSIAR	137, 138, & 80	4.61	4.16	+ 0.46	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.88	+ 0.87	No
TNK-EMPRESS	181 & 153	3.80	2.69	+ 1.11	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	4.35	- 0.78	Deficient
TNK-MCMILLAN	103	9.49	7.76	+ 1.73	No

Based on the storage reservoir capacity analysis results, there are no storage reservoir deficiencies under existing conditions, and there is one (1) storage reservoir that becomes deficient in the future. The McKee reservoir becomes deficient under the 2021 condition.

The Maclure storage reservoir was reviewed as part of the Abbotsford Mission Water and Sewer Commission (AMWSC) Supply Master Plan and was found to have sufficient capacity under existing and future conditions.

3.1 Recommended Storage Capacity Improvement Project

The storage capacity analysis indicates that there will be insufficient storage available at the McKee storage reservoir by the year 2021. The additional capacity required at the McKee storage reservoir was calculated based on the 2051 storage capacity requirement. **Table 3.3** summarizes the required storage capacity improvements.

Table 3.3: Required Storage Capacity Improvements

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	2051 Capacity Required (ML)	Additional Required Capacity (ML)
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	4.73	+ 1.16

As shown in **Table 3.3**, it is recommended that an additional storage capacity of 1.16 ML be added at the McKee storage reservoir by 2021. The recommended additional storage capacity is based on the 2051 storage requirement.

It should be noted that the required storage capacity at the McKee storage reservoir may be dependent on the servicing strategies determined as part of the McKee Neighbourhood Plan project. Therefore, the storage requirements of the McKee reservoir should be re-evaluated in context with the McKee Neighbourhood Plan storage servicing.

4.0 Pump Station Capacity Analysis

Pumping capacity in the City water distribution system was analyzed by comparing the existing capacities of each City owned pump station against the existing and future required capacities.

The methodology for calculating the required pump station capacities is summarized in *Technical Memorandum #4 – Hydraulic Performance and Design Criteria (October 13, 2017)*. The required pump station capacities were calculated for the existing condition through to the 2041 condition at each 5-year horizon.

The pump station capacity analysis results for the existing and 2041 conditions are summarized in **Table 4.1** and **Table 4.2**. The pump station capacity analysis results for all horizon year conditions can be found in **Appendix B**.

Table 4.1: Existing Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	6.3	8.3	- 2.0	Deficient
Buchanan	183B	1.3	1.2	+ 0.1	No
Empress	297, 248, 175A, 262, 217, & 168	88.3	14.2	+ 74.2	No
Eagle Mountain	330	101.9	75.4	+ 26.5	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	85.7	+ 83.9	No
Saddle					
Upper Maclure	175	403.8	240.9	+ 162.9	No
Mountain Village	181, 153, 297, 248, 175A, 262, 217, & 168	50.0	26.6	+ 23.4	No
Old Yale	163	439.6	288.5	+ 151.1	No
Selkirk	237, 290, 304, 208, & 180	181.5	25.3	+ 156.2	No
Westminster	290	85.1	76.3	+ 8.8	No
Westview	304	83.9	76.4	+ 7.5	No

Table 4.2: 2041 Pumping Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	+ 16.7	No
Buchanan	183B	1.3	1.6	- 0.3	Deficient
Empress	297, 248, 175A, 262, 217, & 168	88.3	25.8	+ 62.5	No
Eagle Mountain	330	101.9	76.5	+ 25.4	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	129.0	+ 40.6	No
Saddle					
Upper Maclure	175	403.8	240.8	+ 163.0	No
Old Yale	163	439.6	333.4	+ 106.2	No
Selkirk	237, 290, 304, 208, & 180	181.5	58.4	+ 123.2	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	42.0	+ 50.5	No
Westminster	290	85.1	77.6	+ 7.5	No
Westview	304	83.9	81.8	+ 2.1	No

Based on the pump station capacity analysis results, there is one (1) pump station deficiency under existing conditions and one (1) pump station deficiency in the future. Under the existing condition, the Bradner pump station is deficient; however, the City is already committed to replacing the Bradner pump station sometime in the next five (5) years. The future Bradner pump station can meet all future capacity requirements. The Buchanan pump station becomes deficient under the 2026 condition.

Although the Buchanan pump station is indicated deficient in the future, it is only predicted to be deficient by 0.3 L/s in 2041; as such, the deficiency is not critical and no upgrade to this pump station is recommended at this time. No pump station capacity improvements are recommended as part of this study.

Finally, the City has expressed concern over the ability of the Old Yale pump station to deliver its firm capacity based on the observed flow from the pump station during a fire that occurred on August 9th, 2017. During this fire, the maximum observed flow out of the pump station was 319 L/s. As such, it is recommended that the City conduct a pump flow test to determine the firm capacity of the pump station or why the pump station may not be operating to its firm capacity.

5.0 PRV Capacity Analysis

PRV stations were reviewed for peak velocities under existing and future PHD and MDD+FF conditions. The recommended peak velocity through a PRV should be less than or equal to 6 m/s.

PRV velocities under PHD conditions were analyzed using the City's hydraulic model. The deficient PRV stations under PHD conditions are summarized in **Table 5.1**, with velocity results presented for the existing and 2041 conditions. The complete PRV PHD velocity results can be found in **Appendix C**.

Table 5.1: PRV PHD Deficiencies

Valve ID	Diameter (mm)	From Zone	To Zone	PHD Velocity (m/s)	
				Existing	2041
PRV-SANDON-4	100	231	138	7.60	7.14

Although the velocity through PRV-SANDON-4 is high, the model predicts that the pressure does not drop low enough under PHD conditions to activate PRV-SANDON-3 (the larger valve in the station).

PRV velocities under MDD+FF conditions were also analyzed using the following methodology:

- First, the velocity through each PRV was calculated assuming the entire downstream pressure zone demand plus the zone's largest fire flow demand is flowing through the PRV. This is a very conservative approach for pressure zones with multiple feeds.
- If a PRV was found to be velocity deficient, then a manual run was conducted in the model under MDD conditions with the largest fire flow in close proximity to the PRV.

The deficient PRVs under MDD+FF conditions are summarized in **Table 5.2**, with velocity results presented for the existing and 2041 conditions. The complete PRV MDD+FF velocity results can be found in **Appendix C**.

Table 5.2: PRV MDD+FF Deficiencies

Valve ID	Diameter (mm)	From Zone	To Zone	Largest Zone Fire Flow Requirement (L/s)		MDD+FF Velocity (m/s)	
				Existing	2041	Existing	2041
PRV-MTN-VILLAGE-1	150	153	103	220	220	7.17	7.60
PRV-MTN-VILLAGE-2	150	181	153	175	175	5.27	6.13
PRV-SUNDEW-MTN-1	150	181	153	175	175	6.10	4.41
PRV-MCKINLEY-2	75	237	180	200	200	10.52	10.26
PRV-CANTERBURY-1	150	181	153	175	175	10.04	N/A*
PRV-CLAY-VILLAGE-1	150	231	70	200	200	7.32	7.39

*The Canterbury PRV will be decommissioned by 2021.

PRV-MTN-VILLAGE-2, PRV-SUNDEW-MTN-1 and PRV-CANTERBURY-1 all feed pressure zone 153 from pressure zone 181 at different locations. While PRV-MTN-VILLAGE-2 becomes deficient by 2021, PRV-SUNDEW-MTN-1 is deficient in the existing scenario but is not deficient in the future. This is due to land use changes in the future, changing the location of the largest fire flow, and thus reducing the flow required from the Sundew Mountain PRV station in the future.

The McKinley and Clay Village PRV stations are both deficient under the existing and future MDD+FF scenarios. These deficiencies are caused by the new higher required fire flow for institutional properties (200 L/s). Since the institutional properties requiring the higher fire flows are existing properties and not land use changes proposed by the OCP, it is not recommended that these two (2) PRVs be upgraded.

Finally, although the Canterbury PRV is deficient under the existing scenario, it will be decommissioned by 2021.

5.1 Recommended PRV Capacity Improvement Projects

The PRV capacity analysis indicates that there are six (6) deficient PRVs in the existing scenario and five (5) in the future (2041) scenario. The required sizes for the recommended PRV upgrades were determined based on the 2051 system demands. **Table 5.3** summarizes the required PRV capacity improvements.

Table 5.3: Required PRV Capacity Improvements

Valve ID	From Zone	To Zone	Existing Diameter (mm)	Proposed Diameter (mm)
PRV-MTN-VILLAGE-1	153	103	150	200
PRV-MTN-VILLAGE-2	181	153	150	200
PRV-P-BRADNER	163	155	N/A	200
PRV-P-SADDLE-1	231	123	N/A	300

As shown in **Table 5.3**, there are two (2) recommended PRV upgrades. PRV-MTN-VILLAGE-1 is proposed for upgrade immediately, as it deficient in the existing scenario. PRV-MTN-VILLAGE-2 becomes deficient in the 2021 scenario and, therefore, should be upgraded by 2021.

The proposed Bradner PRV is recommended as part of Special Study Area A by the year 2031. The proposed Saddle PRV is a new recommended feed from the supply system into pressure zone 123 to address fire flow deficiencies in the existing scenario and is recommended as an immediate upgrade.

No upgrade is recommended at PRV-SANDON-4. Instead it is recommended that the set points for PRV-SANDON-3 and PRV-SANDON-4 be re-evaluated to draw flow through PRV-SANDON-3 under high flow conditions.

Although the PRV capacity analysis showed PRV-SUNDEW-MTN-1 to be deficient in the existing scenario, no upgrade is recommended for this valve. With future land use changes, the valve is predicted to be sufficiently sized in the future.

6.0 Network Capacity Analysis

The network capacity was analyzed by reviewing system pressures and fire flows. High system pressures were identified under average day demand (ADD), and low system pressures were identified under peak hour demand (PHD). The network's capacity to deliver fire flow was analyzed by reviewing residual pressures under maximum day demand plus fire flow (MDD+FF).

The existing and future network capacity modeling results are summarized in **Table 6.1**. The fire flow analysis was only conducted on fire flow nodes (nodes near fire hydrants).

Table 6.1: Summary of Hydraulic Modeling Results

Criteria	Scenario	Existing	2041
# of High Pressure Deficiencies Demand Nodes > 150 psi	ADD	500	415
Average Pressure (psi)	ADD	98 psi	97 psi
# of Low Pressure Deficiencies Demand Nodes < 44 psi	PHD	191	451
Average Pressure (psi)	PHD	95 psi	91 psi
# of Fire Flow Deficiencies Residual Pressure < 22 psi	MDD + FF	209	332
Average Available Fire Flows (L/s)	MDD + FF	238 L/s	214 L/s

Hydraulic results indicate that about 2.1% of the demand nodes (500 deficiencies) experience high pressures under ADD in the existing scenario, and 1.8% (415 deficiencies) experience high pressures under ADD in the future scenario. Since pressure decreases with growth and the additional demand in the system, high pressure deficiencies were not addressed.

Hydraulic results indicate that about 0.8% of the demand nodes (191 deficiencies) experience low pressures under PHD in the existing scenario, and 1.9% (451 deficiencies) experience low pressures under PHD in the future scenario. The existing and 2041 PHD pressure modeling results are illustrated in **Figure 6.1** and **Figure 6.2**, respectively.

Fire flow results indicate that about 6.3% of the fire nodes (209 deficiencies) are unable to satisfy the required fire flow in the existing scenario. In the 2041 scenario, about 10.0% of the fire nodes (332 deficiencies) are unable to satisfy the required fire flow. The existing and 2041 residual pressure modeling results are illustrated in **Figure 6.3** and **Figure 6.4**, respectively.

GeoAdvice Engineering Inc.

Legend

Pressure

- < 40 psi
- 40 psi - 44 psi
- > 44 psi
- Tank
- Pump Station
- Pipe
- Well
- PRV
- Pressure Zone

Existing PHD Pressure Results

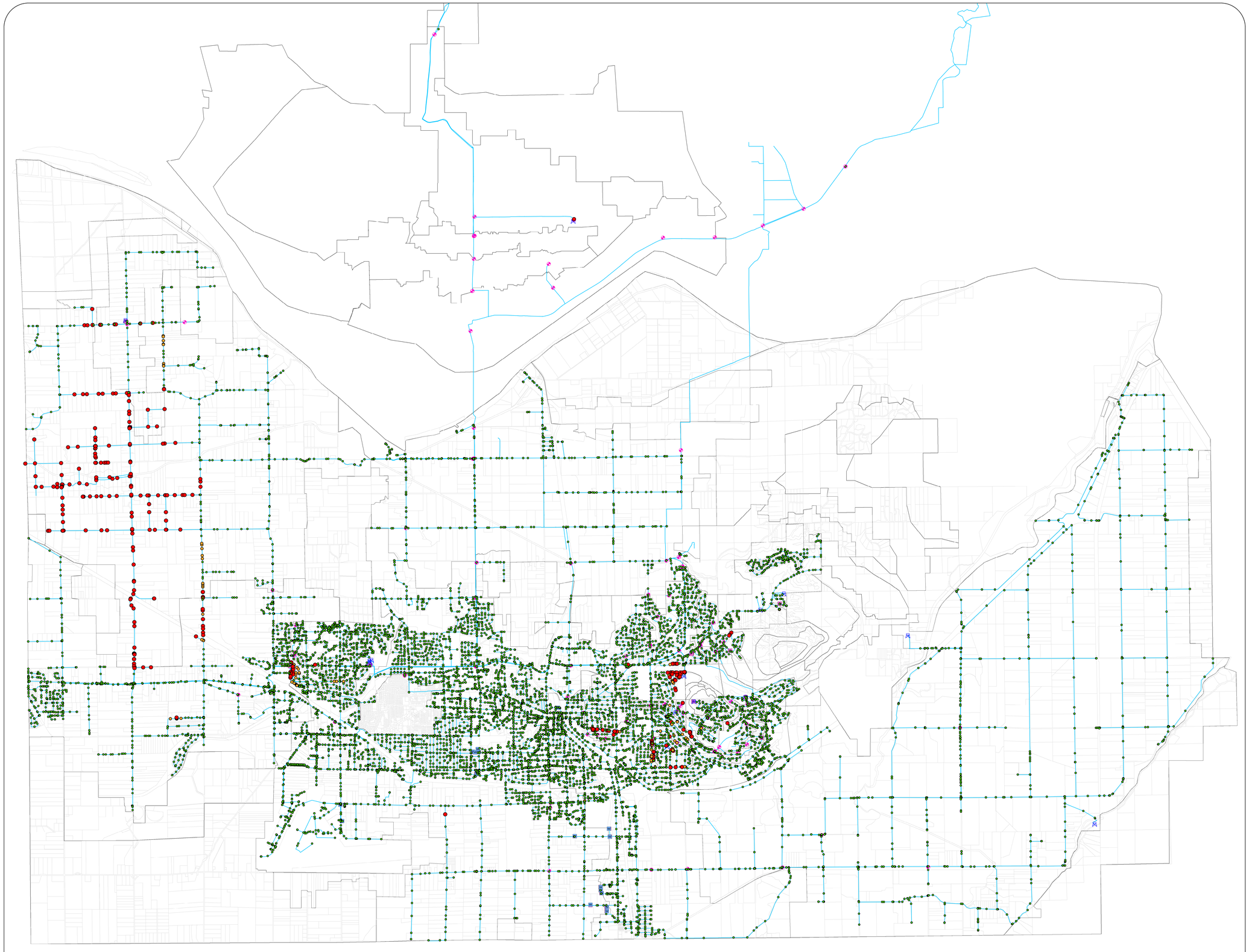
ABBOTSFORD

Project: **Water Distribution System Master Plan**
Network Capacity Results
Client: **City of Abbotsford, BC**
Date: **May 2018**
Created by: **AM**
Reviewed by: **WdS**

0 1.5 3 6
Kilometers

N
W E
S

Figure 6.1



GeoAdvice Engineering Inc.

Legend

Pressure

- < 40 psi
- 40 psi - 44 psi
- > 44 psi
- Tank
- Pump Station
- Pipe
- Well
- PRV
- Pressure Zone

2041 PHD
Pressure Results

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Project: **Water Distribution System Master Plan**
Network Capacity Results
Client: **City of Abbotsford, BC**
Date: **May 2018**
Created by: **AM**
Reviewed by: **WdS**

0 1.5 3 6
Kilometers

N
W E
S

Figure 6.2

GeoAdvice Engineering Inc.

Legend

Residual Pressure

- < 20 psi
- 20 psi - 22 psi
- > 22 psi
- Tank
- Pump Station
- Pipe
- Well
- PRV
- Pressure Zone

Existing MDD+FF Results

ABBOTSFORD

Project: **Water Distribution System Master Plan**
Network Capacity Results
Client: **City of Abbotsford, BC**
Date: **May 2018**
Created by: **AM**
Reviewed by: **WdS**

0 1.5 3 6
Kilometers

N W E S

Figure 6.3

GeoAdvice Engineering Inc.

Legend

Residual Pressure

- < 20 psi
- 20 psi - 22 psi
- > 22 psi
- Tank
- Pump Station
- Pipe
- Well
- PRV
- Pressure Zone

2041 MDD+FF Results

ABBOTSFORD

Project: **Water Distribution System Master Plan**
Network Capacity Results
Client: **City of Abbotsford, BC**
Date: **May 2018**
Created by: **AM**
Reviewed by: **WdS**

0 1.5 3 6
Kilometers

N W E S

Figure 6.4

6.1 Recommended Network Capacity Improvement Projects

Network capacity improvements have been modeled and recommended based on the hydraulic capacity assessment of the City water distribution system under 2041 conditions. Network capacity improvements were designed to convey flows under 2051 conditions in the City water distribution system.

As agreed with the City, to identify upgrades, the City's Asset Replacement Program was first implemented in the model throughout the entire water distribution system. Pipes in the Asset Replacement Program were also reviewed to determine whether any further upsizing was necessary. Additional pipe upgrades and loops were then identified to eliminate the remaining deficiencies.

Table 6.2 summarizes the network capacity upgrade recommendations. The length of network capacity improvements has been broken down as follows:

- "Replacement" – Pipes in the Asset Replacement Program not required to address hydraulic capacity
- "Capacity" – Pipes required to address pressure and fire flow deficiencies

Table 6.2: Summary of Recommended Network Capacity Improvements

Improvement Type	Length (m)		
	Replacement	Capacity	Total
New Pipe Loop	770	15,841	**16,611**
Pipe Upgrade	1,151	16,900	**18,051**
Asset Replacement Program	30,198	12,589	**42,787**
Asset Replacement Program - Upsized	15,958	3,102	**19,060**
Total	**48,077**	**48,432**	**96,951**

As shown in **Table 6.2**, the majority of the recommended upgrades, approximately 48.9 km, are required to address pressure and/or fire flow deficiencies in the water distribution system.

Approximately 48.1 km of recommended upgrades are solely part of the City's Asset replacement program and are not required to address specific network capacity issues; however, these improvements contribute to strengthening the network and providing redundancy.

Upgrades have not been recommended to address fire flow deficiencies located at dead ends where the fire flow is available upstream. Also, pipes have not been automatically upgraded based the City bylaw minimum pipe size per land use. At the time of a property's development, the City may require some mains to be upgraded to the City bylaw minimum pipe size based on the proposed development land use, or the City may require further upgrade of these mains based on factors other than capacity (i.e. age, material, condition, adjacent works, etc.).

The recommended network capacity improvements were grouped into projects. The project ID does not indicate any order or priority for the projects.

The recommended pipe improvements are summarized in **Appendix D** and shown in **Figure 6.5**.

In consultation with the City, approximately 7.8 km of pipe to be abandoned were also identified and are summarized in **Appendix D.**

Special Study Area A

Special Study Area B

GeoAdvice Engineering Inc.

Legend

Upgrade Type

- Asset Replacement Program
- Asset Replacement Program - Upsized
- New Pipe Loop
- Pipe Upgrade
- Existing Pipe
- Tank
- Pump Station
- Well
- PRV
- Pressure Zone

Recommended System Improvements

ABBOTSFORD

Project: **Water Distribution System Master Plan**
Network Capacity Results
Client: **City of Abbotsford, BC**
Date: **May 2018**
Created by: **AM**
Reviewed by: **WdS**

0 1.5 3 6
Kilometers

N W E S

Figure 6.5

7.0 Conclusion

GeoAdvice and USL were retained by the City of Abbotsford to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice analyzed the hydraulic and fire flow capacity of the City's water distribution system.

The following system improvements have been recommended:

- **+ 1.16 ML of storage required at the McKee storage reservoir**
- **No pump improvements**
- **2 PRV upgrades**
- **2 New PRV stations**
- **1 PRV set point change at the Sandon PRV station (to pressure zone 138)**
- **1 pressure zone boundary adjustment between pressure zones 103 and 123**
- **16.6 km of new pipes/loops**
- **18.1 km of pipe upgrades**
- **42.8 km of asset replacement program pipes**
- **19.1 km of asset replacement program pipes with upsizing required**

The recommended network capacity improvements were grouped into projects; however, the project ID does not indicate any order or priority for the projects. Timing, ranking, and costing of the recommended system improvements were not completed as part of this technical memorandum but will be provided as part of the final master plan report.

Submission

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Reviewed and Approved by:

Werner de Schaetzen, Ph.D., P.Eng.
Project Manager

Appendix A Storage Capacity Analysis Results

Table A.1: Existing Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	1.29	+ 2.05	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	0.96	+ 1.28	No
TNK-CASSIAR	137, 138, & 80	4.61	3.88	+ 0.73	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.52	+ 1.22	No
TNK-EMPRESS	181 & 153	3.80	2.59	+ 1.21	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	3.46	+ 0.11	No
TNK-MCMILLAN	103	9.49	6.18	+ 3.31	No

Table A.2: 2021 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	1.49	+ 1.85	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	1.22	+ 1.02	No
TNK-CASSIAR	137, 138, & 80	4.61	3.93	+ 0.68	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.60	+ 1.15	No
TNK-EMPRESS	181 & 153	3.80	2.61	+ 1.18	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	3.63	- 0.07	Deficient
TNK-MCMILLAN	103	9.49	6.45	+ 3.04	No

Table A.3: 2026 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	1.69	+ 1.65	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	1.47	+ 0.77	No
TNK-CASSIAR	137, 138, & 80	4.61	3.99	+ 0.62	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.67	+ 1.08	No
TNK-EMPRESS	181 & 153	3.80	2.63	+ 1.17	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	3.81	- 0.24	Deficient
TNK-MCMILLAN	103	9.49	6.78	+ 2.71	No

Table A.4: 2031 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	1.88	+ 1.46	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	1.72	+ 0.52	No
TNK-CASSIAR	137, 138, & 80	4.61	4.04	+ 0.57	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.74	+ 1.01	No
TNK-EMPRESS	181 & 153	3.80	2.65	+ 1.15	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	3.99	- 0.42	Deficient
TNK-MCMILLAN	103	9.49	7.09	+ 2.40	No

Table A.5: 2036 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	2.08	+ 1.26	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	1.98	+ 0.26	No
TNK-CASSIAR	137, 138, & 80	4.61	4.10	+ 0.52	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.81	+ 0.94	No
TNK-EMPRESS	181 & 153	3.80	2.67	+ 1.13	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	4.17	- 0.60	Deficient
TNK-MCMILLAN	103	9.49	7.42	+ 2.07	No

Table A.6: 2041 Storage Reservoir Capacity Analysis Results

Storage Reservoir	Service Area Pressure Zone	Storage Reservoir Capacity (ML)	Capacity Required (ML)	Excess (ML)	Deficient?
TNK-ATKINSON	68	3.34	2.28	+ 1.06	No
TNK-HACKING					
TNK-BRADNER	155, 183, 140, & 183B	2.24	2.23	+ 0.01	No
TNK-CASSIAR	137, 138, & 80	4.61	4.16	+ 0.46	No
TNK-ST-MORITZ					
TNK-EAGLE-MTN	297, 248, 262, 217, 168, 175A, & 330	3.75	2.88	+ 0.87	No
TNK-EMPRESS	181 & 153	3.80	2.69	+ 1.11	No
TNK-MCKEE	237, 290, 304, 208, 189, 180	3.57	4.35	- 0.78	Deficient
TNK-MCMILLAN	103	9.49	7.76	+ 1.73	No

Appendix B Pumping Capacity Analysis Results

Table B.1: Existing Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	6.3	8.3	- 2.0	Deficient
Buchanan	183B	1.3	1.2	+ 0.1	No
Empress	297, 248, 175A, 262, 217, & 168	88.3	14.2	+ 74.2	No
Eagle Mountain	330	101.9	75.4	+ 26.5	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	85.7	+ 83.9	No
Saddle					
Upper Maclure	175	403.8	240.9	+ 162.9	No
Mountain Village	181, 153, 297, 248, 175A, 262, 217, & 168	50.0	26.6	+ 23.4	No
Old Yale	163	439.6	288.5	+ 151.1	No
Selkirk	237, 290, 304, 208, & 180	181.5	25.3	+ 156.2	No
Westminster	290	85.1	76.3	+ 8.8	No
Westview	304	83.9	76.4	+ 7.5	No

Table B.2: 2021 Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	16.7	No
Buchanan	183B	1.3	1.2	0.0	No
Empress	297, 248, 175A, 262, 217, & 168	88.3	16.6	71.7	No
Eagle Mountain	330	101.9	75.6	26.2	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	94.3	75.3	No
Saddle					
Upper Maclure	175	403.8	241.0	162.8	No
Old Yale	163	439.6	304.3	135.3	No
Selkirk	237, 290, 304, 208, & 180	181.5	31.9	149.6	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	30.1	62.4	No
Westminster	290	85.1	76.6	8.5	No
Westview	304	83.9	77.4	6.4	No

Table B.3: 2026 Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	16.7	No
Buchanan	183B	1.3	1.3	-0.1	Deficient
Empress	297, 248, 175A, 262, 217, & 168	88.3	18.9	69.4	No
Eagle Mountain	330	101.9	75.8	26.0	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	103.0	66.6	No
Saddle					
Upper Maclure	175	403.8	241.0	162.7	No
Old Yale	163	439.6	311.7	127.9	No
Selkirk	237, 290, 304, 208, & 180	181.5	38.5	143.0	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	33.0	59.5	No
Westminster	290	85.1	76.9	8.2	No
Westview	304	83.9	78.5	5.3	No

Table B.4: 2031 Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	16.7	No
Buchanan	183B	1.3	1.4	-0.1	Deficient
Empress	297, 248, 175A, 262, 217, & 168	88.3	21.2	67.1	No
Eagle Mountain	330	101.9	76.1	25.8	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	111.3	58.2	No
Saddle					
Upper Maclure	175	403.8	240.8	163.0	No
Old Yale	163	439.6	318.6	121.0	No
Selkirk	237, 290, 304, 208, & 180	181.5	45.1	136.5	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	36.0	56.6	No
Westminster	290	85.1	77.1	8.0	No
Westview	304	83.9	79.6	4.3	No

Table B.5: 2036 Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	16.7	No
Buchanan	183B	1.3	1.5	-0.2	Deficient
Empress	297, 248, 175A, 262, 217, & 168	88.3	23.5	64.8	No
Eagle Mountain	330	101.9	76.3	25.6	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	120.1	49.5	No
Saddle					
Upper Maclure	175	403.8	240.8	163.0	No
Old Yale	163	439.6	326.0	113.6	No
Selkirk	237, 290, 304, 208, & 180	181.5	51.7	129.8	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	38.9	53.6	No
Westminster	290	85.1	77.4	7.7	No
Westview	304	83.9	80.7	3.2	No

Table B.6: 2041 Pump Station Capacity Analysis Results

Pump Station	Service Area Pressure Zone	Firm Capacity (L/s)	Capacity Required (L/s)	Excess (L/s)	Deficient?
Bradner	183	25.0	8.3	+ 16.7	No
Buchanan	183B	1.3	1.6	- 0.3	Deficient
Empress	297, 248, 175A, 262, 217, & 168	88.3	25.8	+ 62.5	No
Eagle Mountain	330	101.9	76.5	+ 25.4	No
Glen Mountain	138, 137, 80, 237, 290, 304, 208, & 180	169.6	129.0	+ 40.6	No
Saddle					
Upper Maclure	175	403.8	240.8	+ 163.0	No
Old Yale	163	439.6	333.4	+ 106.2	No
Selkirk	237, 290, 304, 208, & 180	181.5	58.4	+ 123.2	No
Wells Gray	181, 153, 297, 248, 175A, 262, 217, & 168	92.5	42.0	+ 50.5	No
Westminster	290	85.1	77.6	+ 7.5	No
Westview	304	83.9	81.8	+ 2.1	No

Appendix C PRV Capacity Analysis Results

Refer to the attached spreadsheet: **2017-021-ABB_PRVCapacityAnalysis_r1_2018-04-26.xlsx**

Appendix D Recommended Network Capacity Improvements

Refer to the attached spreadsheet: **2017-021-ABB_MasterPlanPipeUpgrades_r3_2018-05-09.xlsx**

City of Abbotsford, BC
Water Distribution System Impact Assessment
Special Study Area A:
Gloucester East Industrial Lands Expansion

Technical Memorandum

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R0	January 5, 2018	First Draft	Andrea McCrea	Werner de Schaetzen
R1	April 16, 2018	Final Submission	Andrea McCrea	Werner de Schaetzen

Statement of Qualifications and Limitations

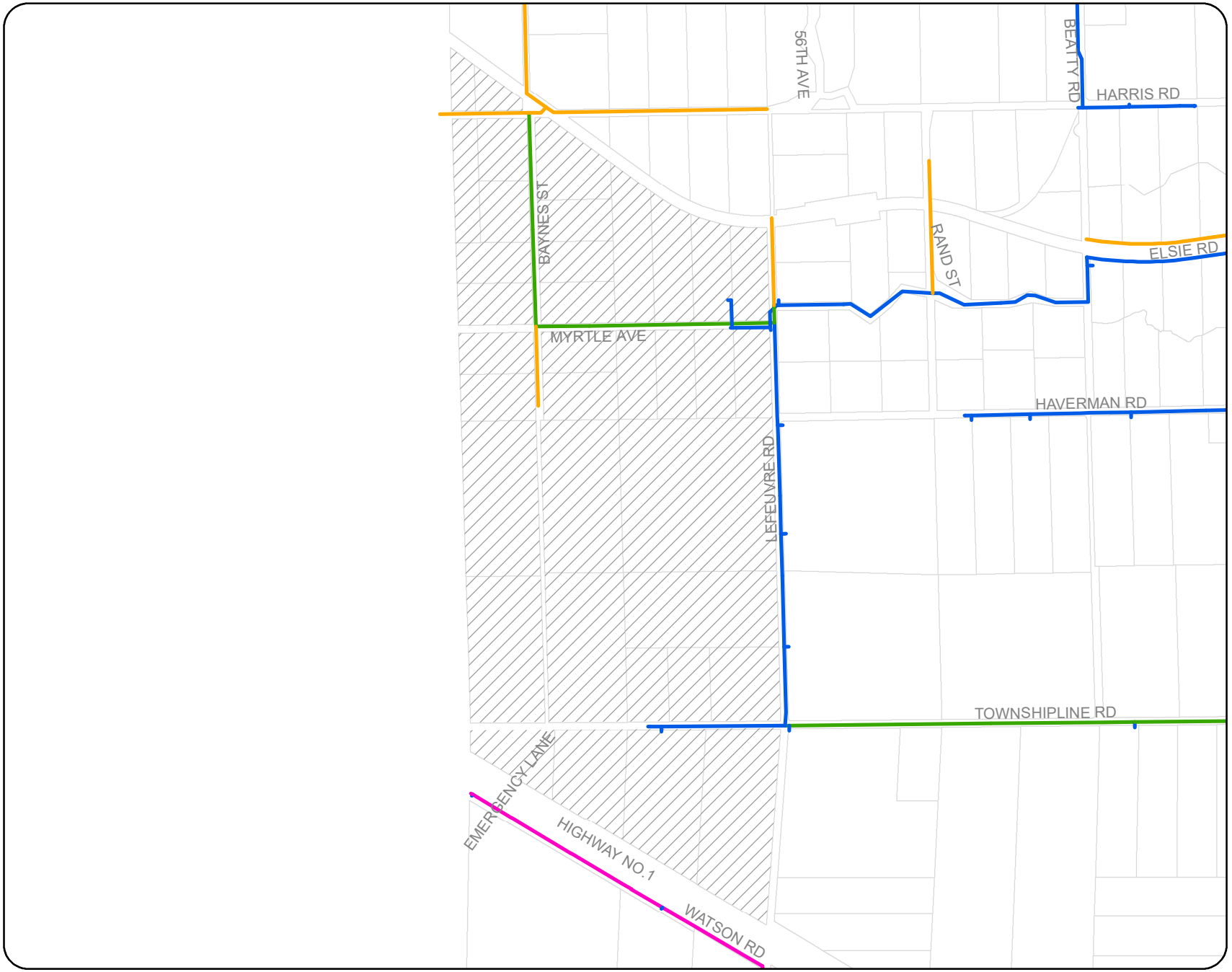
This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC ("City") to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice conducted a hydraulic servicing assessment of the Gloucester East Industrial Lands Expansion (Special Study Area A).

Special Study Area A is located on the western boundary of the City between Hwy 1, 56th Avenue, and Lefeuvre Road. The existing infrastructure feeding the general area consists of 150 mm diameter water mains on Bradner Road, Township Road, Lefeuvre Road and Myrtle Avenue. Special Study Area A is contained within the City's existing pressure zone 155. **Figure 1.1** illustrates the study area and the existing network layout.

The City's hydraulic model was analyzed using the software program InfoWater (Innovyze Software). InfoWater is a water system modeling and management software that integrates advanced hydraulic modeling and GIS functionalities.



GeoAdvice Engineering Inc.

Legend

Existing Pipe Diameter

- 50 mm
- 100 mm
- 150 mm
- 200 mm
- Special Study Area A

Existing Network Layout

ABBOTSFORD

Project:	Water Distribution System Master Plan Special Study Area A Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

N W E S

0 0.15 0.3 0.6

Kilometers

Figure 1.1

1.1 Assumptions and Limitations

In order to complete this study, it was necessary to make several assumptions, as identified below. In consultation with the City, it was agreed that the following system criteria and constraints be used to complete this study:

- The system modeling is consistent with the Water Distribution System Master Plan study being conducted concurrently by GeoAdvice and USL.
- The Special Study Area A water distribution network was analyzed under existing and future (2041) population demand projections.
- For proposed pipes and recommended improvements, the network was sized to meet 2051 population demand projections.
- All scenarios were analyzed under the assumption that the supply system is capable of delivering the required head and flow.
- The results presented in this memo are based on the analysis of steady state simulations. The predicted available fire flows, as calculated by the hydraulic model, represent the flow available in the water main while maintaining a residual pressure of 22 psi at the hydrant. No extended period simulations were completed in this analysis to assess the water quality and the impact on the pumping, PRV and storage capacities.
- The proposed water main network was laid out by GeoAdvice and reviewed by the City. Modeled node elevations were assigned according to road center lines or elevation contours.

2.0 Water Demand Analysis

Residential and ICI growth projections were provided by the City for each parcel in Special Study Area A. The expected 2041 population and population equivalent (PE) data for Special Study Area A are summarized in **Table 2.1**.

Table 2.1: Special Study Area A Population Data

Population Type	2041 Population
Residential	155
ICI	11,326
Total Growth	**11,481**

It should be noted that there is not expected to be any residential population growth in Special Study Area A; all growth is expected to be industrial.

A summary of the modeled Special Study Area A demand scenarios is presented in **Table 2.2**.

Table 2.2: Special Study Area A Demand Data

Scenario	2041 Demand (L/s)
Average Daily Demand (ADD)	25.20
Maximum Daily Demand (MDD)	35.80
Peak Hour Demand (PHD)	53.70

3.0 Water Main Capacity Analysis

Modeling was carried out for peak hour and maximum day plus fire flow under the existing and 2041 conditions to analyze the network capacity. Proposed improvements were then identified to address the capacity deficiencies within Special Study Area A. The proposed water mains were sized to the minimum diameter which would satisfy the greater of maximum day plus fire and peak hour demand in 2051. Refer to **Section 4.0** for the proposed layout and system improvement recommendations.

Table 3.1 summarizes the hydraulic modeling results in Special Study Area A under the existing and 2041 scenarios with the existing network. Also included in **Table 3.1** are the hydraulic modeling results under 2041 conditions with the proposed improvements.

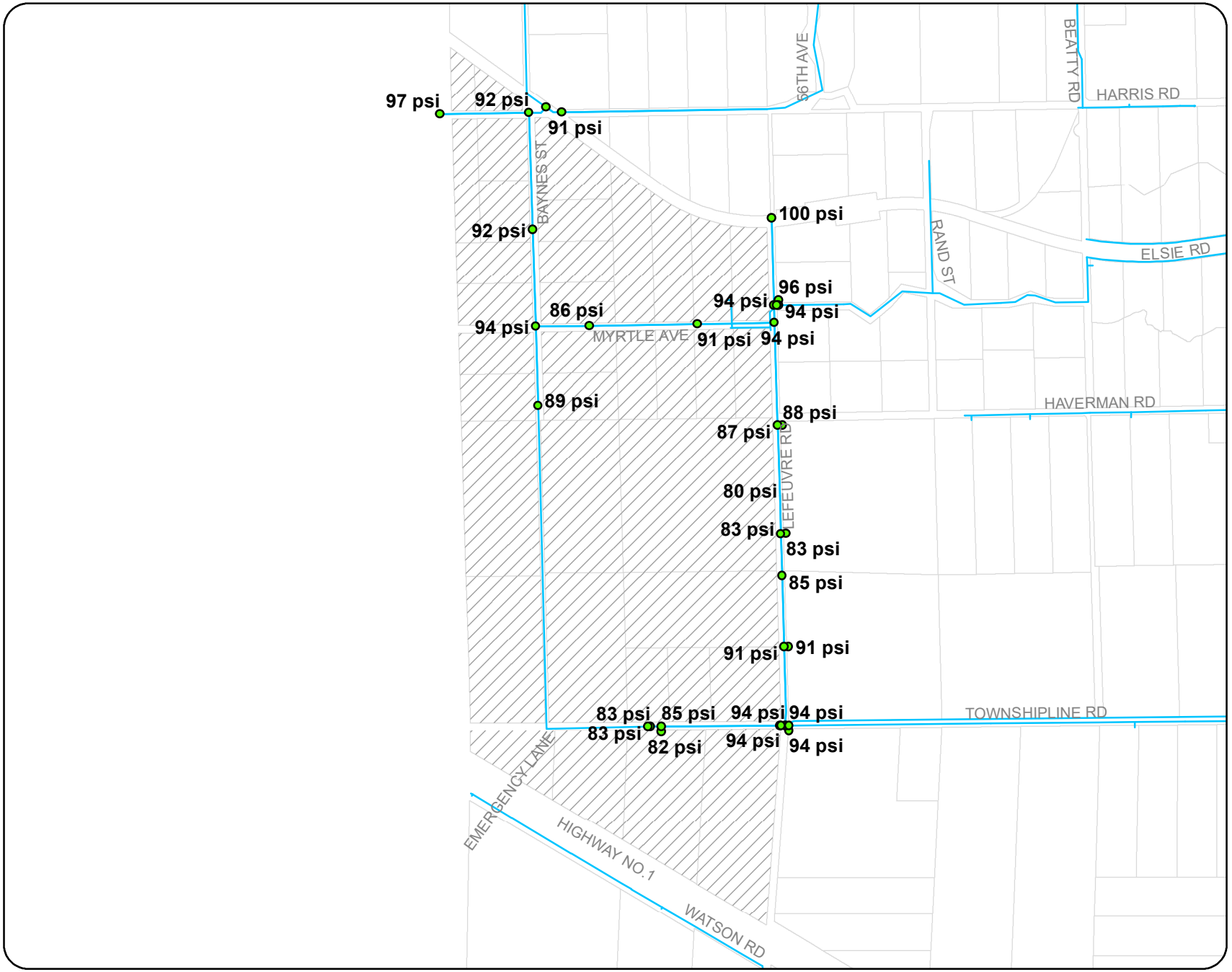
Table 3.1: Water Distribution System Summary Results (Special Study Area A)

Criteria	Scenario	Existing	2041	2041 With Improvements
High Pressure Deficiencies Demand Nodes > 830 kPa (120 psi)	ADD	1	0	0
Average Pressure	ADD	113.1 psi	72.2 psi	100.0 psi
Low Pressure Deficiencies Demand Nodes < 300 kPa (43.5 psi)	PHD	0	32	0
Average Pressure	PHD	103.3 psi	-40.1 psi	90.2 psi
Fire Flow Deficiencies Residual Pressure < 150 kPa (21.8 psi)	MDD + FF	39	39	8*
Average Available Fire Flow (L/s) @ 150 kPa (21.8 psi)	MDD + FF	27 L/s	3 L/s	257 L/s

*Remaining 8 fire flow deficiencies are within 5% of the required fire flow.

The hydraulic results indicate PHD pressures in Special Study Area A can be met under existing conditions but not under 2041 conditions. Pressure modeling results under 2041 PHD conditions with the proposed system improvements are shown in **Figure 3.1**.

Special Study Area A is located outside of the Urban Development Boundary; therefore, the City is not currently responsible for providing adequate fire flow to the area. Furthermore, there are very few hydrants in the area; as such, the fire flow analysis was completed with all junctions in the study area analyzed as fire nodes. The current network is unable to satisfy the required fire flow anywhere in Special Study Area A under existing and 2041 conditions. Fire flow results under 2041 conditions with the proposed system improvements are shown in **Figure 3.2**.



GeoAdvice Engineering Inc.

Legend

Pressure

- < 40 psi
- 40 psi - 44 psi
- > 44 psi
- Pipe
- Special Study Area A

2041 PHD Pressure Results With Proposed Improvements

Project:	Water Distribution System Master Plan Special Study Area A Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

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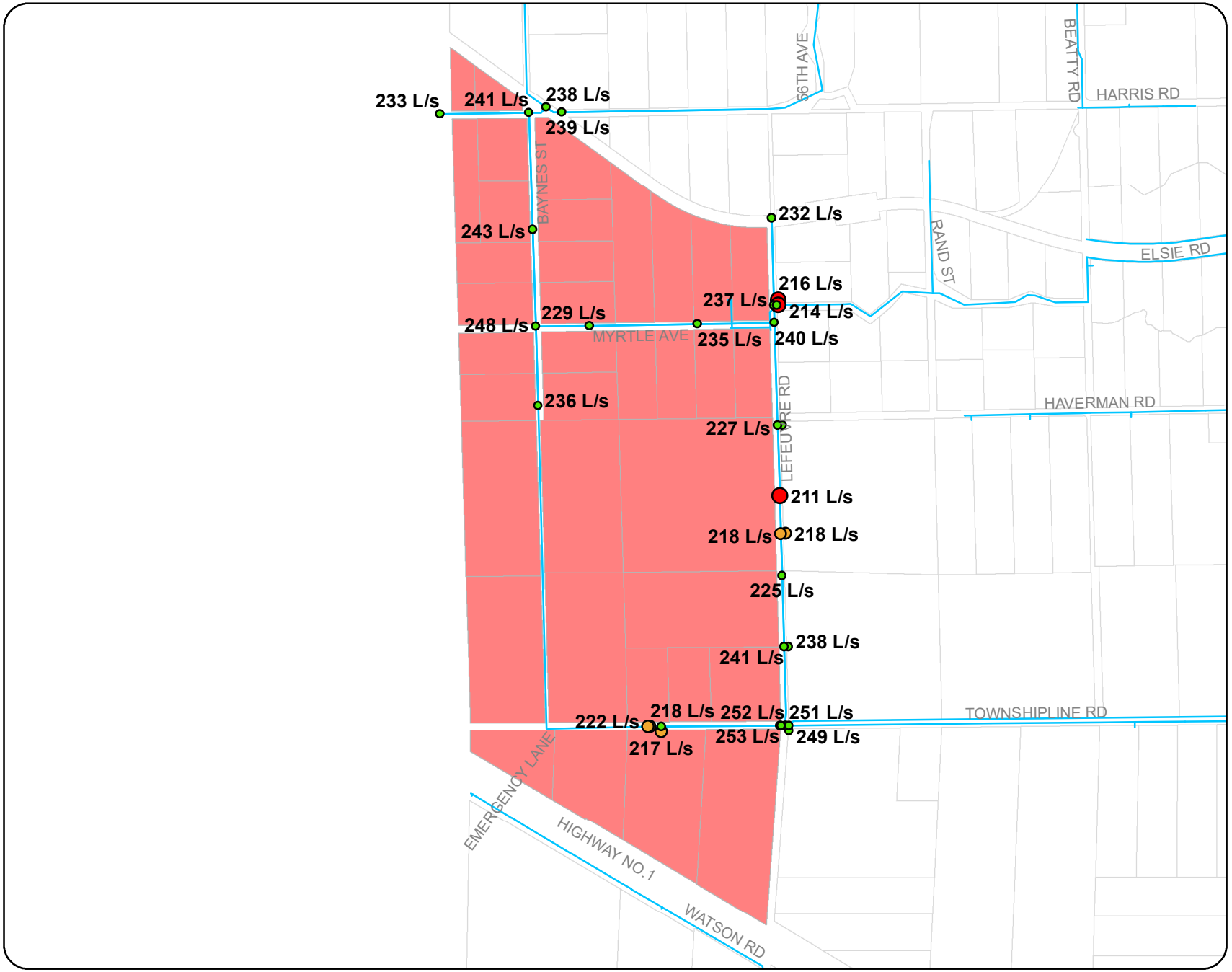
N W E S

0 0.15 0.3 0.6

Kilometers

Figure 3.1



GeoAdvice Engineering Inc.

Legend

Residual Pressure

- < 20 psi
- 20 psi - 22 psi
- > 22 psi
- Pipe

OCP Land Use

- Industrial (Required Fire Flow = 220 L/s)

The available flow annotated on the figure represents the total available flow in the main at 22 psi.

2041 MDD+FF Results With Proposed Improvements

Project:	Water Distribution System Master Plan Special Study Area A Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

N W E S

0 0.15 0.3 0.6

Kilometers

Figure 3.2

4.0 Summary of System Recommendations

Water system improvements have been modeled and recommended based on the hydraulic capacity assessment of the City water distribution system under 2041 conditions. Water distribution system improvements were designed to convey the 2051 Special Study Area A flows, as calculated by the model analysis.

Table 4.1 summarizes the system recommendations to service Special Study Area A.

Table 4.1: Summary of Recommended Improvements

Improvement Type	Length (m)
New Pipe Loop	1,092
Pipe Upgrade	3,251
Offsite Improvements	12,569

In order to provide adequate pressures and flows to the study area, approximately 12.6 km of water mains have been recommended as offsite improvements. With these offsite improvements, there are also a number of new local pipe loops and pipe upgrades that have been recommended required to provide adequate fire flows throughout the study area.

Table 4.2 summarizes in detail the recommended system improvements.

Table 4.2: Recommended Pipe Improvements

Project ID*	Location	Upgrade Type	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
141	Baynes Street to Township Road	New Pipe Loop	N/A	300	1,092
141	Township Road	Pipe Upgrade	150	300	352
141	Lefeuvre Road	Pipe Upgrade	50	300	224
141	Lefeuvre Road	Pipe Upgrade	100	300	45
141	Lefeuvre Road	Pipe Upgrade	150	300	1,035
141	Myrtle Avenue	Pipe Upgrade	100	300	614
141	Baynes Street	Pipe Upgrade	50	300	203
141	Baynes Street	Pipe Upgrade	100	300	549
141	56th Avenue	Pipe Upgrade	50	300	229
138	Bradner Road	Offsite Improvement	N/A	200	21

Project ID*	Location	Upgrade Type	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
138	Bradner Road	Offsite Improvement	150	300	8,236
140	58th Avenue	Offsite Improvement	100	300	1,433
140	58th Avenue	Offsite Improvement	150	300	14
140	56th Avenue	Offsite Improvement	50	300	622
140	56th Avenue	Offsite Improvement	N/A	300	622
139	Township Road	Offsite Improvement	100	300	1,621

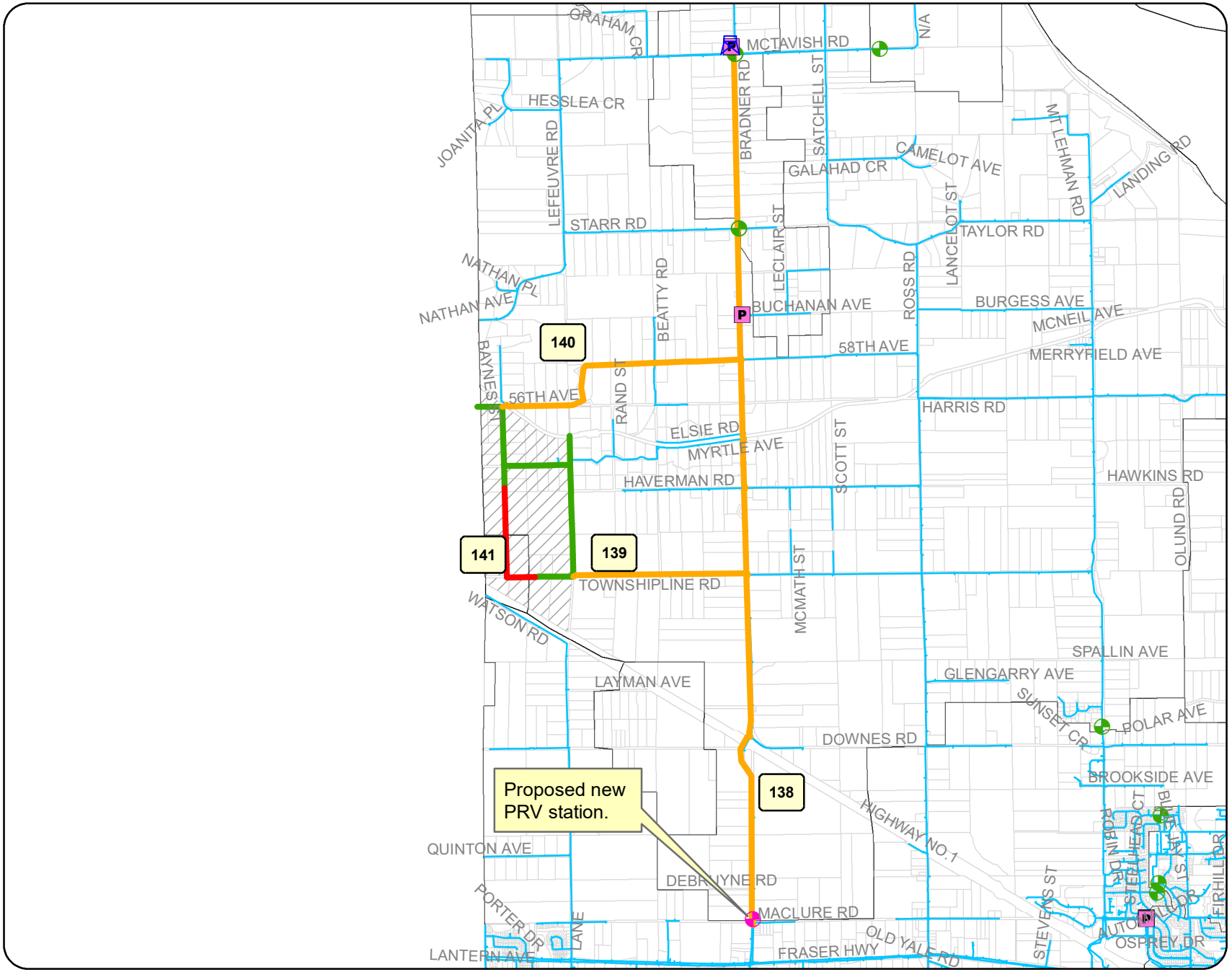
*The project IDs are consistent with those used in the City of Abbotsford water distribution system master plan. The ID does not indicate any order or priority for the projects.

Furthermore, to service Special Study Area A, a new pressure reducing valve (PRV) station is required at Bradner Road and Maclure Road. **Table 4.3** summarizes proposed PRV parameters.

Table 4.3: Recommended Facility Improvements

PRV Station	Valve Type	Diameter (mm)	Pressure Setting (psi)
Bradner Road	Domestic Flow	150	75
	Fire Flow	200	70

Please refer to **Figure 4.1** to review the location of all recommended improvements.



GeoAdvice Engineering Inc.

Legend

- Tank
- Pump Station

Upgrade Type

- New Pipe Loop (300 mm)
- Pipe Upgrade (300 mm)
- Offsite Upgrade (300 mm)
- Existing Pipe
- Existing PRV
- Proposed PRV
- Special Study Area A
- Pressure Zone

Proposed Improvements

Project:	Water Distribution System Master Plan Special Study Area A Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

N W E S

0 0.5 1 2

Kilometers

Figure 4.1

Submission

Prepared by:

Andrea McCrea, E.I.T.
Hydraulic Modeler / Project Engineer

Reviewed and Approved by:

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA W. de SCHAETZEN #30059

April 16, 2018

Werner de Schaetzen, Ph.D., P.Eng.
Project Manager

City of Abbotsford, BC
Water Distribution System Impact Assessment
Special Study Area B: Industrial Reserve Lands

Technical Memorandum

Prepared for:
City of Abbotsford, BC
32315 South Fraser Way
Abbotsford, BC V2T 1W7

And

Urban Systems Ltd.
550-1090 Homer Street
Vancouver, BC V6B 2W9

Prepared by:
GeoAdvice Engineering Inc.
Unit 203, 2502 St. Johns Street
Port Moody, BC V3H 2B4

Submission Date: April 16, 2018

Contact: Mr. Werner de Schaetzen, Ph.D., P.Eng.
Project ID: 2017-021-ABB

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	January 5, 2018	First Draft	Andrea McCrea	Werner de Schaetzen
R1	April 16, 2018	Final Submission	Andrea McCrea	Werner de Schaetzen

Statement of Qualifications and Limitations

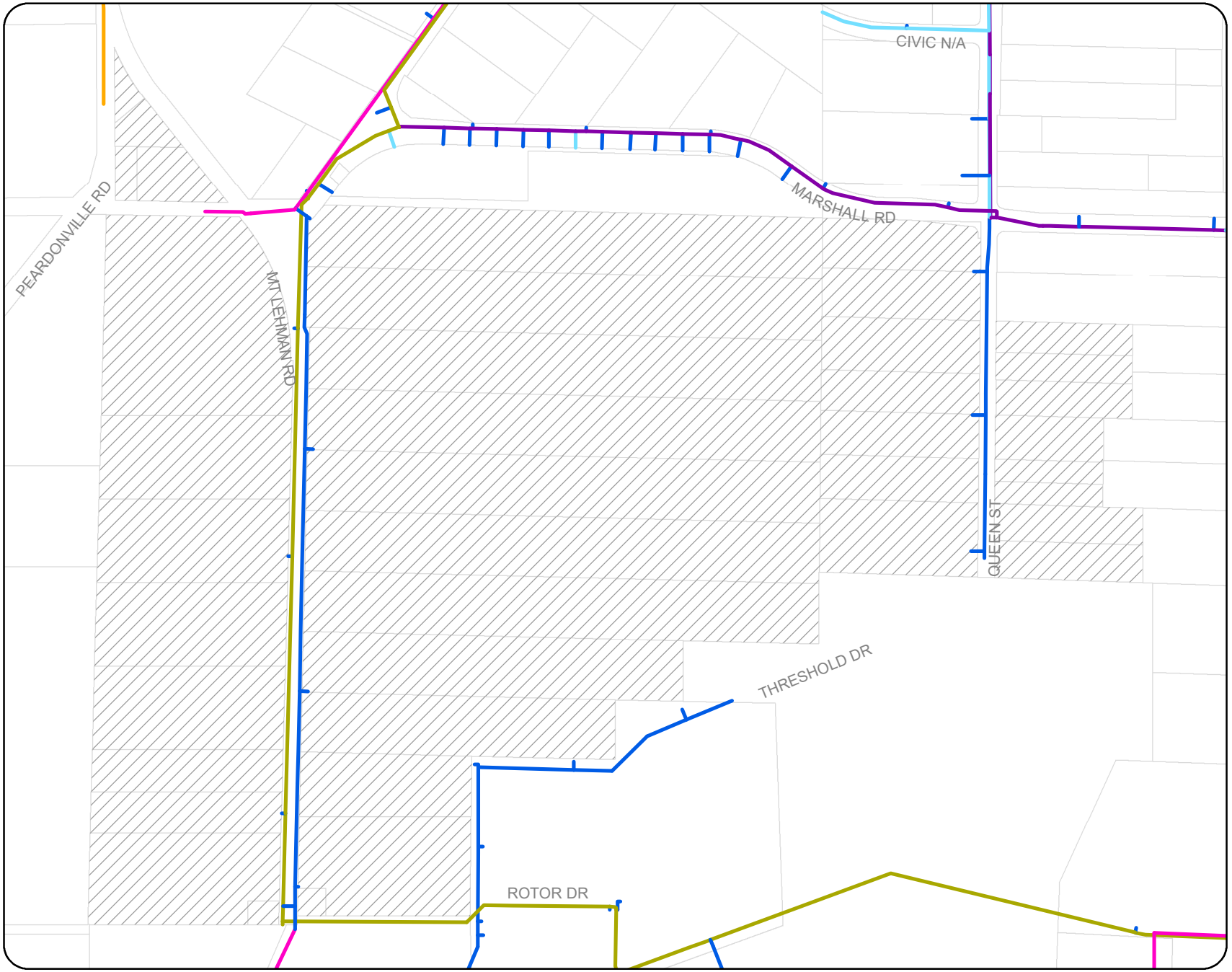
This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC ("City") to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice conducted a hydraulic servicing assessment of the Industrial Reserve Lands (Special Study Area B).

Special Study Area B is located to the north of the Abbotsford International Airport. The existing infrastructure feeding the general area consists of 400 mm and 300 mm diameter water mains on Peardonville Road, Queen Street, and Marshall Road. Special Study Area B is contained within the City's existing pressure zone 123. **Figure 1.1** illustrates the study area and the existing network layout.

The City's hydraulic model was analyzed using the software program InfoWater (Innovyze Software). InfoWater is a water system modeling and management software that integrates advanced hydraulic modeling and GIS functionalities.



GeoAdvice Engineering Inc.

Legend

Existing Pipe Diameter

- 50 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 400 mm
- SpecialStudyAreaB

Existing Network Layout

ABBOTSFORD

Project:	Water Distribution System Master Plan Special Study Area B Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

N
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S

0 0.05 0.1 0.2
Kilometers

Figure 1.1

1.1 Assumptions and Limitations

In order to complete this study, it was necessary to make several assumptions, as identified below. In consultation with the City, it was agreed that the following system criteria and constraints be used to complete this study:

- The system modeling is consistent with the Water Distribution System Master Plan study being conducted concurrently by GeoAdvice and USL.
- The Special Study Area B water distribution network was analyzed under existing and future (2041) population demand projections.
- For proposed pipes and recommended improvements, the network was sized to meet 2051 population demand projections.
- All scenarios were analyzed under the assumption that the supply system is capable of delivering the required head and flow.
- The results presented in this memo are based on the analysis of steady state simulations. The predicted available fire flows, as calculated by the hydraulic model, represent the flow available in the water main while maintaining a residual pressure of 22 psi at the hydrant. No extended period simulations were completed in this analysis to assess the water quality and the impact on the pumping, PRV and storage capacities.
- The proposed water main network was laid out by GeoAdvice and reviewed by the City. Modeled node elevations were assigned according to road center lines or elevation contours.

2.0 Water Demand Analysis

Residential and ICI growth projections were provided by the City for each parcel in Special Study Area B. The expected 2041 population and population equivalent (PE) data for Special Study Area B are summarized in **Table 2.1**.

Table 2.1: Special Study Area B Population Data

Population Type	2041 Population
Residential	125
ICI	3,512
Total Growth	**3,637**

It should be noted that there is not expected to be any residential population growth in Special Study Area B; all growth is expected to be industrial.

A summary of the modeled Special Study Area B demand scenarios is presented in **Table 2.2**.

Table 2.2: Special Study Area B Demand Data

Scenario	2041 Demand (L/s)
Average Daily Demand (ADD)	7.96
Maximum Daily Demand (MDD)	11.31
Peak Hour Demand (PHD)	16.95

3.0 Water Main Capacity Analysis

Modeling was carried out for peak hour and maximum day plus fire flow under the existing and 2041 conditions to analyze the network capacity. Proposed improvements were then identified to address the capacity deficiencies within Special Study Area B. The proposed water mains were sized to the minimum diameter which would satisfy the greater of maximum day plus fire and peak hour demand in 2051. Refer to **Section 4.0** for the proposed layout and system improvement recommendations.

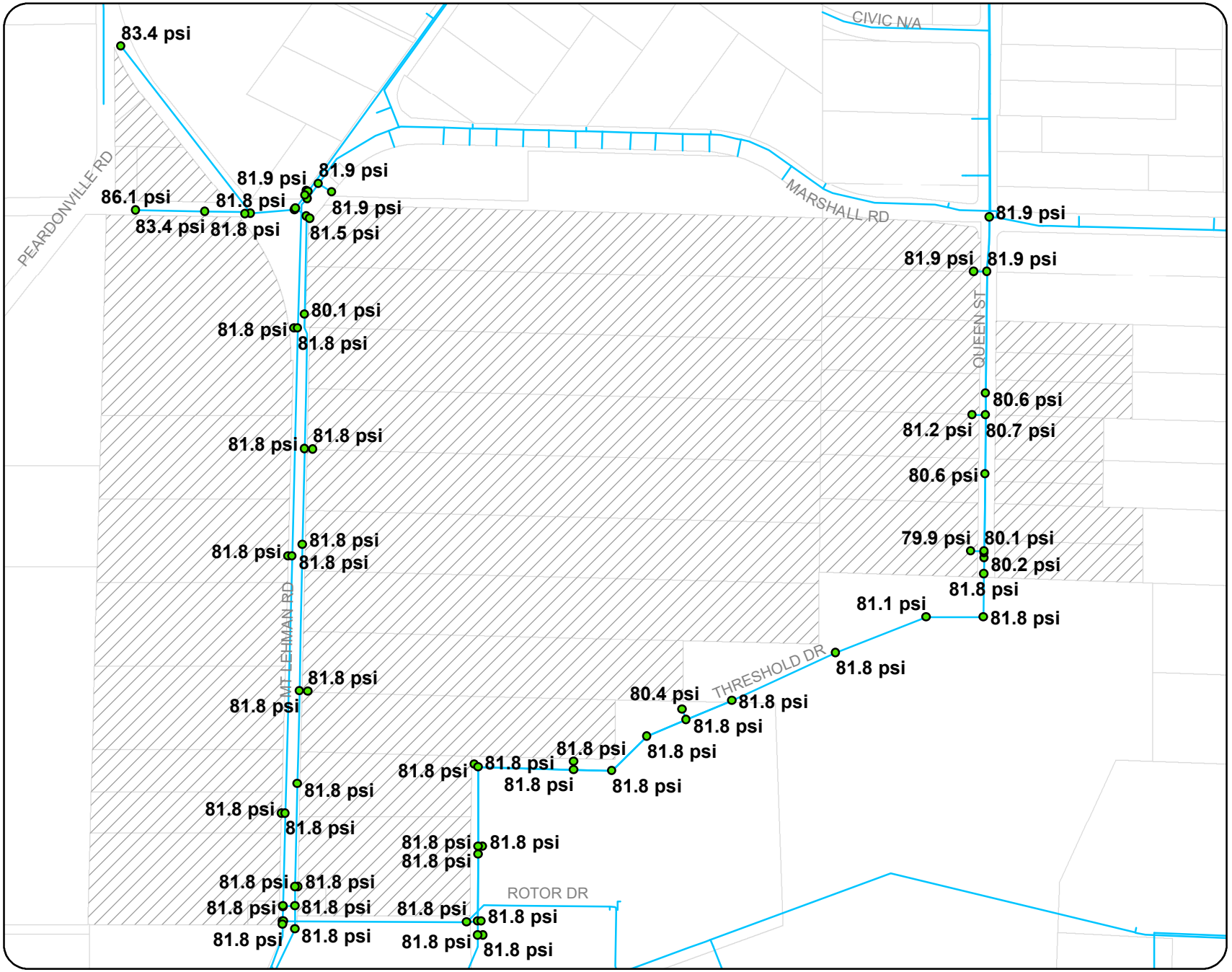
Table 3.1 summarizes the hydraulic modeling results in Special Study Area B under the existing and 2041 scenarios with the existing network. Also included in **Table 3.1** are the hydraulic modeling results under 2041 conditions with the proposed improvements.

Table 3.1: Water Distribution System Summary Results (Special Study Area B)

Criteria	Scenario	Existing	2041	2041 With Improvements
High Pressure Deficiencies Demand Nodes > 830 kPa (120 psi)	ADD	0	0	0
Average Pressure	ADD	92.8 psi	89.9 psi	89.6 psi
Low Pressure Deficiencies Demand Nodes < 300 kPa (43.5 psi)	PHD	0	0	0
Average Pressure	PHD	89.4 psi	81.6 psi	81.7 psi
Fire Flow Deficiencies Residual Pressure < 150 kPa (21.8 psi)	MDD + FF	10	10	2
Average Available Fire Flow (L/s) @ 150 kPa (21.8 psi)	MDD + FF	211 L/s	173 L/s	402 L/s

The hydraulic results indicate PHD pressures in Special Study Area B can be met under existing conditions and 2041 conditions with the existing network. Pressure modeling results under 2041 PHD conditions with the proposed system improvements are shown in **Figure 3.1**.

Furthermore, the network is unable to satisfy the required fire flow at ten (10) fire nodes in Special Study Area B under existing and 2041 conditions. With the system improvements, there are two (2) remaining fire flow deficiencies. To eliminate these deficiencies, hydrants HYD-17C5 and HYD-18C5 must be moved to the parallel 400 mm water main on Mt. Lehman Road. Fire flow results under 2041 conditions with the proposed system improvements are shown in **Figure 3.2**.



GeoAdvice Engineering Inc.

Legend

Pressure

- < 40 psi
- 40 psi - 44 psi
- > 44 psi
- Pipe
- Special Study Area B

2041 PHD Pressure Results With Proposed Improvements

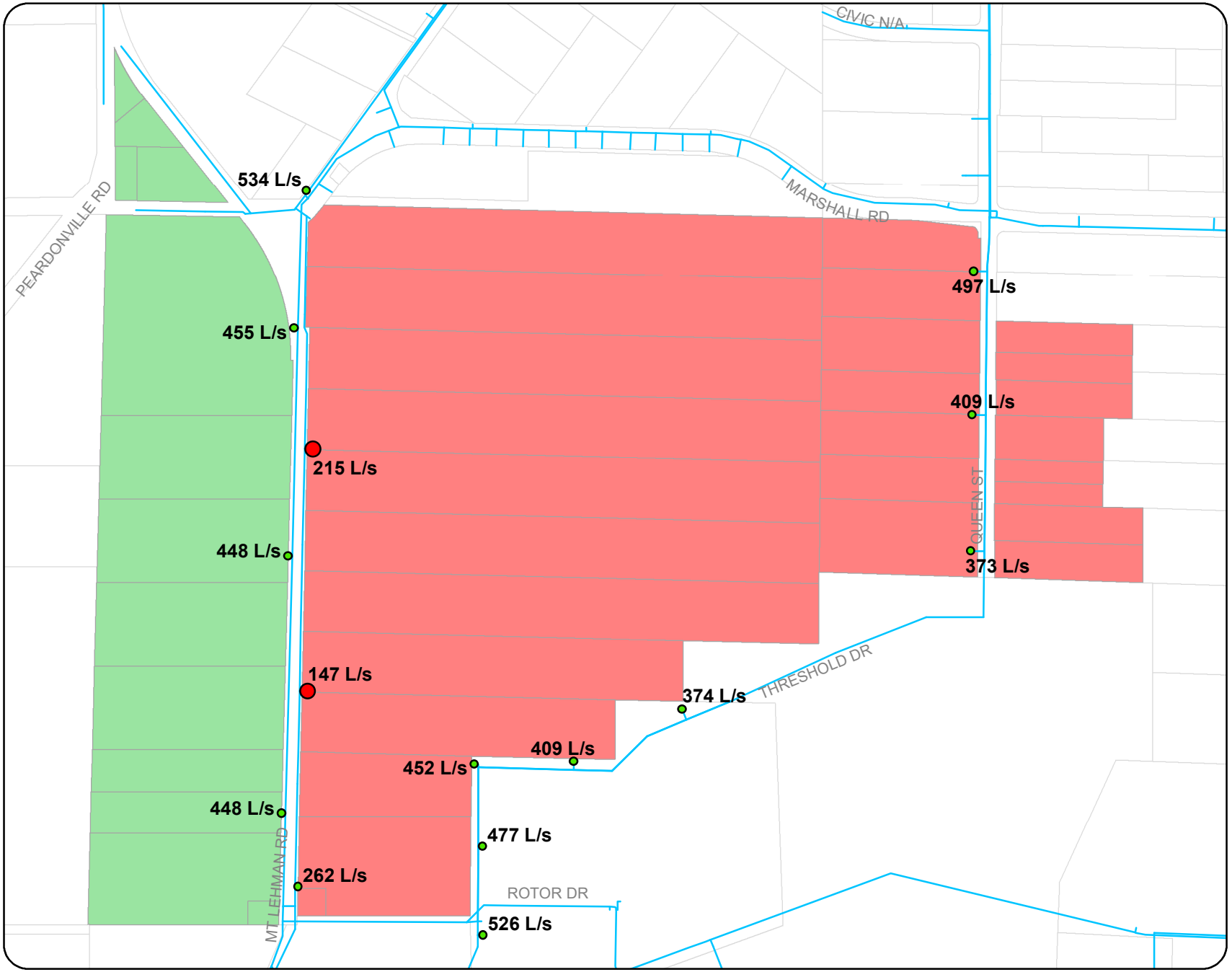
Project:	Water Distribution System Master Plan Special Study Area B Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

N W E S

0 0.05 0.1 0.2

Kilometers

Figure 3.1



GeoAdvice Engineering Inc.

Legend

Residual Pressure

- < 20 psi
- 20 psi - 22 psi
- > 22 psi
- Pipe

OCP Land Use

- Agricultural (Required Fire Flow = 75 L/s)
- Industrial (Required Fire Flow = 220 L/s)

The available flow annotated on the figure represents the total available flow in the main at 22 psi.

2041 MDD+FF Results With Proposed Improvements

ABBOTSFORD

Project:	Water Distribution System Master Plan Special Study Area B Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

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N W E S

0 0.05 0.1 0.2

Kilometers

Figure 3.2

4.0 Summary of System Recommendations

Water system improvements have been modeled and recommended based on the hydraulic capacity assessment of the City water distribution system under 2041 conditions. Water distribution system improvements were designed to convey the 2051 Special Study Area B flows, as calculated by the model analysis.

Table 4.1 summarizes the system recommendations to service Special Study Area B.

Table 4.1: Summary of Recommended Improvements

Improvement Type	Length (m)
New Pipe Loop	370
Pipe Upgrade	969

New pipe loops and pipe upgrades have been recommended to service the proposed new land use designations and to ensure PHD and fire flows can be satisfied.

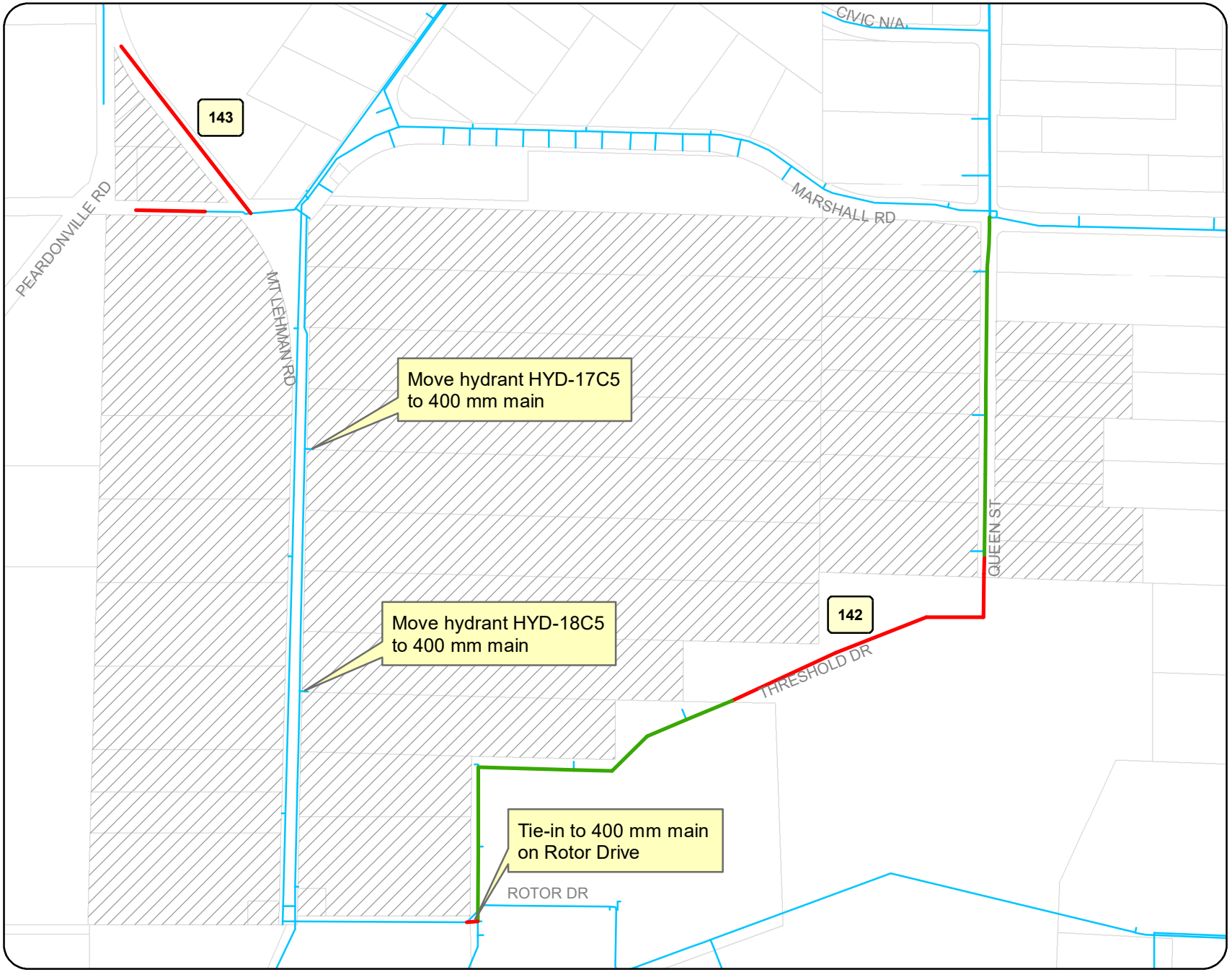
Table 4.2 summarizes in detail the recommended system improvements.

Table 4.2: Recommended Pipe Improvements

Project ID*	Location	Upgrade Type	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
143	Marshall Road	New Pipe Loop	N/A	250	78
143	Mt Lehman Road	New Pipe Loop	N/A	250	239
142	Threshold Drive	New Pipe Loop	N/A	250	303
142	Queen Street	New Pipe Loop	N/A	250	67
142	Threshold Drive	Pipe Upgrade	150	250	484
142	Queen Street	Pipe Upgrade	150	250	384

*The project IDs are consistent with those used in the City of Abbotsford water distribution system master plan. The ID does not indicate any order or priority for the projects.

Please refer to **Figure 4.1** to review the location of all recommended improvements.



GeoAdvice Engineering Inc.

Legend

- Existing Pipe

Upgrade Type

- New Pipe Loop (250 mm)
- Pipe Upgrade (250 mm)
- Special Study Area B

Proposed Improvements

ABBOTSFORD

Project:	Water Distribution System Master Plan Special Study Area B Capacity Results
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

N W E S

0 0.05 0.1 0.2

Kilometers

Figure 4.1

Submission

Prepared by:

Andrea McCrea, E.I.T.
Hydraulic Modeler / Project Engineer

Reviewed and Approved by:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. de SCHAETZEN
30059

April 16, 2018

Werner de Schaetzen, Ph.D., P.Eng.
Project Manager

City of Abbotsford, BC
Water Distribution System Analysis
Pressure Zone 103 & 123 Boundary Optimization

Technical Memorandum

Prepared for:
City of Abbotsford, BC
32315 South Fraser Way
Abbotsford, BC V2T 1W7

And

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Submission Date: April 13, 2018

Contact: Mr. Werner de Schaetzen, Ph.D., P.Eng.
Project ID: 2017-021-ABB

OQM | Organizational Quality Management Program

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	February 7, 2018	First Draft	Andrea McCrea	Werner de Schaetzen
R1	February 28, 2018	Second Draft	Andrea McCrea	Werner de Schaetzen
R2	April 13, 2018	Final Submission	Andrea McCrea	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

1.0 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) and Urban Systems Ltd. (USL) were retained by the City of Abbotsford, BC ("City") to prepare the City water distribution system master plan. As part of the master plan, GeoAdvice conducted the optimization of the boundary between pressure zones 103 and 123.

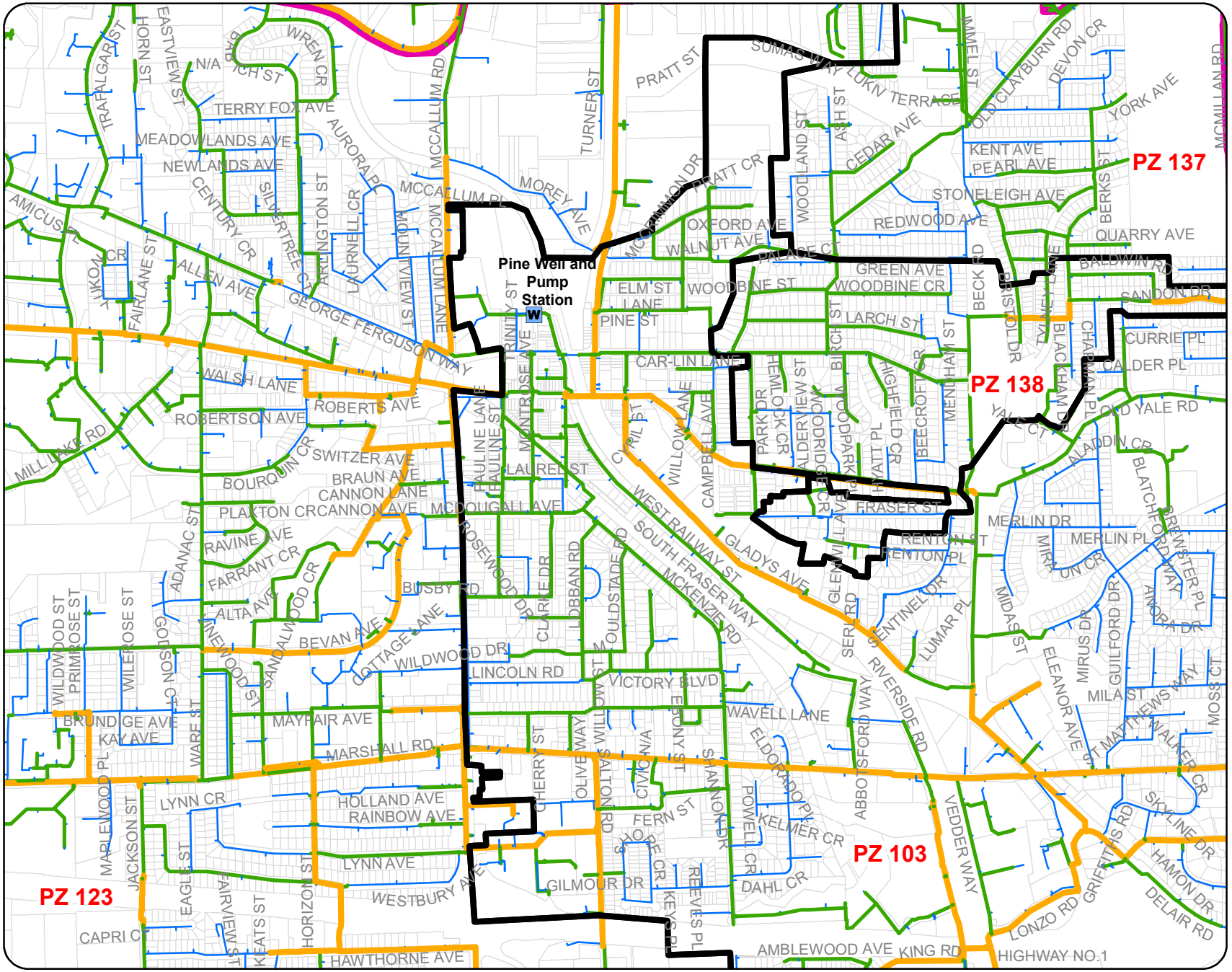
The City is planning to change the pressure zone boundary alignment between pressure zones 103 and 123 in the City's water distribution system. The primary objective of this pressure zone boundary change is to eliminate the twin water mains along McCallum Road between South Fraser Way and Marshall Road, where one pipe is in pressure zone 103 and the other is in pressure zone 123. To determine a new optimized pressure zone boundary configuration, three (3) proposed pressure zone boundary configurations were investigated.

Pressure zone 103 is fed primarily from the Abbotsford Mission Water and Sewer Commission (AMWSC) supply system through the Sandon pressure reducing valve (PRV) station. The McMillan reservoir provides storage for pressure zone 103. There are a number of secondary PRV feeds to pressure zone 103 through the Dina, Farmer, Mountain Village, and Yale Ct. PRV stations. Pressure zone 103 is also fed from the Industrial, Pine and Riverside groundwater wells; however, for the purposes of this analysis, it was assumed that no water was supplied from the groundwater wells.

Pressure zone 123 is fed primarily from the Abbotsford Mission Water and Sewer Commission (AMWSC) supply system from the Maclure reservoirs. There is one secondary PRV feed to pressure zone 123 through the Downs PRV station. Pressure zone 123 is also fed from the Bevan, Farmer, Marshall, McConnell and Townline groundwater wells; however, for the purposes of this analysis, it was assumed that no water was supplied from the groundwater wells.

Figure 1.1 illustrates the study area and the existing pressure zone boundary.

The City's hydraulic model was analyzed using the software program InfoWater (Innovyze Software). InfoWater is a water system modeling and management software that integrates advanced hydraulic modeling and GIS functionalities.



GeoAdvice Engineering Inc.

Legend

Existing Pipe Diameter

- ≤ 150 mm
- 200 mm - 250 mm
- 300 mm - 400 mm
- ≥ 450 mm

W Well

Existing Pressure Zone Boundary

Existing Pressure Zone Boundary

ABBOTSFORD

Project:	Water Distribution System Master Plan Pressure Zone 103 & 123 Boundary Optimization
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

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N W E S

0 0.175 0.35 0.7

Kilometers

Figure 1.1

2.0 Proposed Pressure Zone Boundary Configurations

This study reviewed the pressure zone boundary between pressure zones 103 and 123. The section of pressure zone boundary under review extends from Gladys Avenue and Morey Avenue to McKenzie Road and King Crescent. The primary objective of this pressure zone boundary change is to eliminate the twin water mains along McCallum Road between South Fraser Way and Marshall Road, where one pipe is in pressure zone 103 and the other is in pressure zone 123.

In order to determine an optimized pressure zone boundary between pressure zone 103 and 123, three (3) different pressure zone configurations were investigated and analyzed. For all options investigated, the eastern water main on McCallum Road was assumed to be abandoned, with all services transferred over to the western water main.

The impact of each pressure zone boundary configuration was analyzed by reviewing the hydraulic and fire flow model simulation results for each proposed configuration against the existing pressure zone configuration. The modeling results were reviewed for the area changing pressure zones plus a buffer area of approximately 500 m to the east and west of the pressure zone boundary.

Figure 2.1 illustrates the study area and the three (3) proposed pressure zone boundary configurations.

Option 1

Option 2

Option 3

PZ 123

PZ 103

GeoAdvice Engineering Inc.

Legend

- Pipe
- Pipe to be Abandoned
- Well
- Pressure Zone Boundary
- Proposed Pressure Zone Boundary

Proposed Pressure Zone Boundary Configurations

Project: **Water Distribution System Master Plan**
Pressure Zone 103 & 123 Boundary Optimization
Client: **City of Abbotsford, BC**
Date: **April 2018**
Created by: **AM**
Reviewed by: **WdS**

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0 0.25 0.5 1
Kilometers

N W E S

Figure 2.1

Document Path: W:\2017-021-ABB\08\Reporting Maps\PZ 103 & 123 Boundary Analysis Maps\2017-021-ABB_Fig21_ProposedPressureZoneBoundaries_r1_2018-04-13.mxd

3.0 Hydraulic Performance Criteria

Based on the City's current design specifications and discussions with the City of Abbotsford staff, the following criteria in **Table 3.1** were used to evaluate the hydraulic capacity performance of the water distribution system in the study area for each pressure zone boundary configuration.

Table 3.1: Hydraulic Performance Criteria

Criteria	Parameter
Maximum Pressure (ADD)	830 kPa (120.4 psi)
Minimum Pressure (PHD)	300 kPa (43.5 psi)
Minimum Residual Pressure (MDD+FF)	150 kPa (21.8 psi)

4.0 Pressure Zone Capacity Analysis

Modeling was carried out for peak hour and maximum day plus fire flow under 2041 conditions to analyze the impact of the proposed pressure zone boundary configurations on the network capacity.

Table 4.1 summarizes the hydraulic modeling results in the study area under the 2041 scenario for each pressure zone boundary configuration.

Table 4.1: 2041 Water Distribution System Summary Results (Study Area)

Criteria	Scenario	Pressure Zone Boundary Configuration			
		Existing*	Option 1	Option 2	Option 3
High Pressure Junctions Demand Nodes > 830 kPa (120 psi)	ADD	64	206	61	114
Average Pressure Pressure Zone 103 Pressure Zone 123	ADD	 78.8 psi 104.1 psi	 82.2 psi 105.5 psi	 86.5 psi 102.6 psi	 85.7 psi 103.8 psi
Low Pressure Deficiencies Demand Nodes < 300 kPa (43.5 psi)	PHD	13	10	11	11
Average Pressure Pressure Zone 103 Pressure Zone 123	PHD	 70.1 psi 95.4 psi	 76.4 psi 95.0 psi	 80.0 psi 92.7 psi	 79.9 psi 93.5 psi
Fire Flow Deficiencies Residual Pressure < 150 kPa (21.8 psi)	MDD + FF	63	57	50	53
Average Available Fire Flow (L/s) @ 150 kPa (21.8 psi)	MDD + FF	230 L/s	251 L/s	249 L/s	254 L/s

*The existing scenario was run with both parallel water mains on McCallum Road. For Options 1, 2 and 3, the eastern main along McCallum Road was assumed to be abandoned.

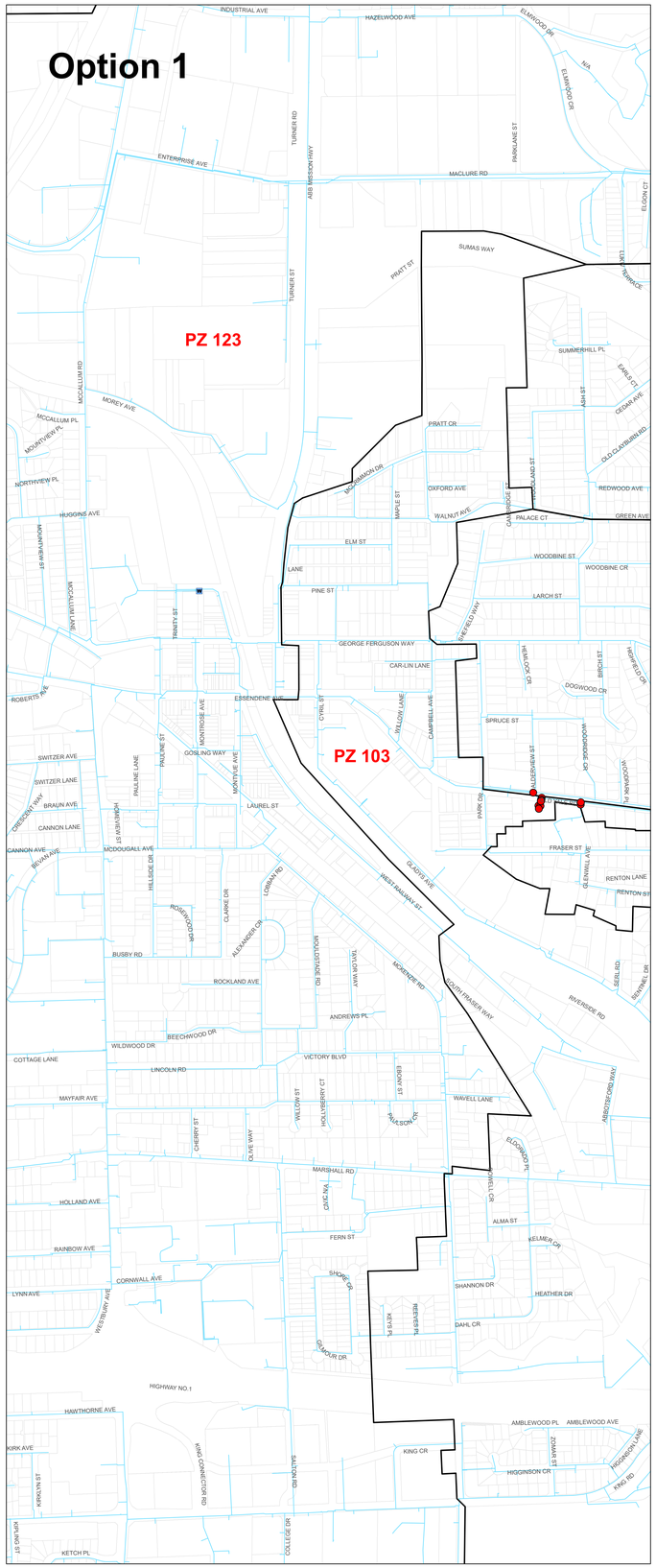
As shown in **Table 4.1**, there are 64 junctions with high pressures in the study area under the existing pressure zone boundary configuration. Option 2 yields the smallest number of junctions with high pressures, increasing the average pressure in pressure zone 103 and decreasing the average pressure in pressure zone 123 within the study area.

Under peak hour demand (PHD), all options yield less low pressure deficiencies than under the existing pressure zone boundary configuration. Option 1 eliminates three (3) low pressure deficiencies, while Options 2 and 3 eliminate two (2) low pressure deficiencies in the study area. Within the study area, Option 2 yields the largest increase in average pressure in pressure zone 103, and all options decrease the average pressure in pressure zone 123. The low pressure deficiencies for each pressure zone configuration option under 2041 PHD conditions are shown in **Figure 4.1**.

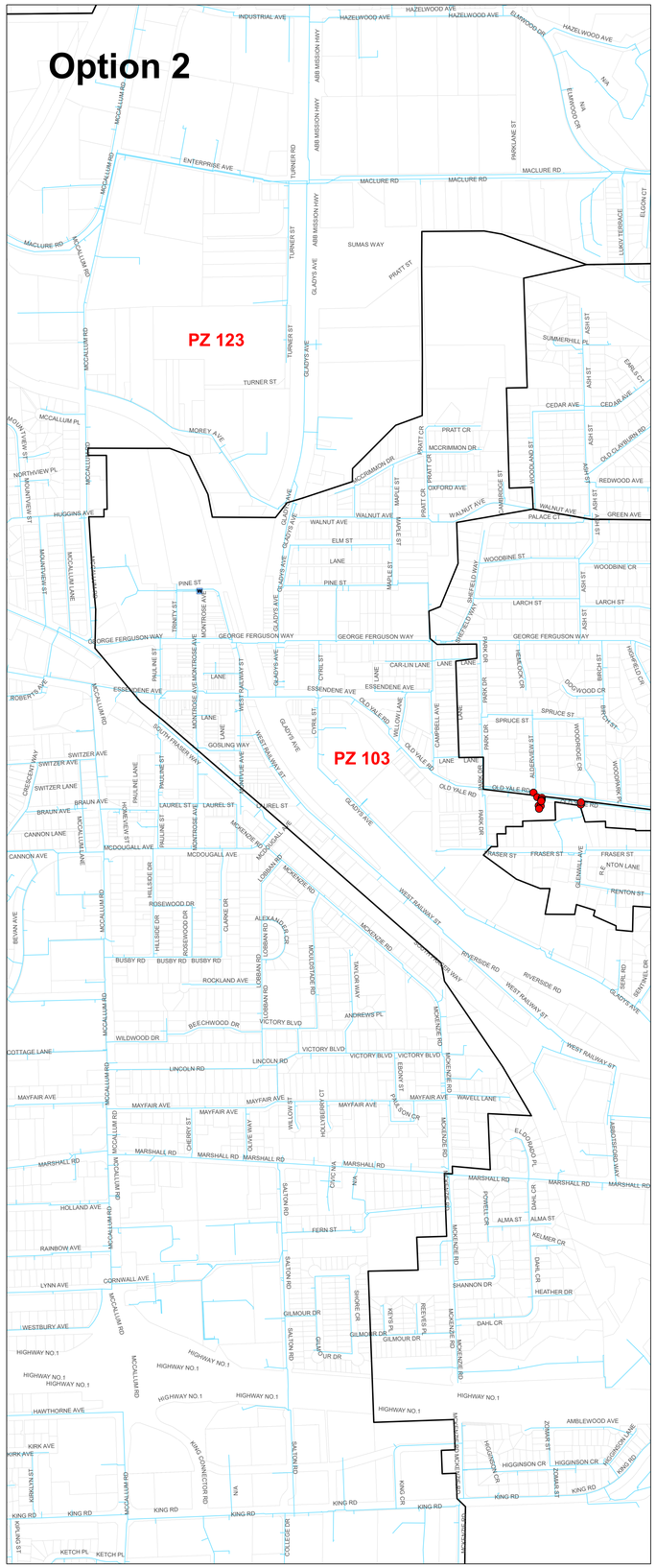
Under maximum day demand plus fire flow (MDD+FF), all options yield less fire flow deficiencies than under the existing pressure zone boundary configuration. Option 1 eliminates six (6) fire flow deficiencies, Option 2 eliminates thirteen (13) fire flow deficiencies, and Option 3 eliminates ten (10) fire flow deficiencies in the study area. All options increase the average available fire flow within the study area, with Option 3 yielding the largest increase in average available fire flow. The fire flow deficiencies for each pressure zone configuration option under 2041 MDD+FF conditions are shown in **Figure 4.2**.

Overall, Option 2 provides the best compromise between minimizing high pressures, low pressures, and fire flow deficiencies within the study area. It is recommended that the City proceed with pressure zone configuration Option 2.

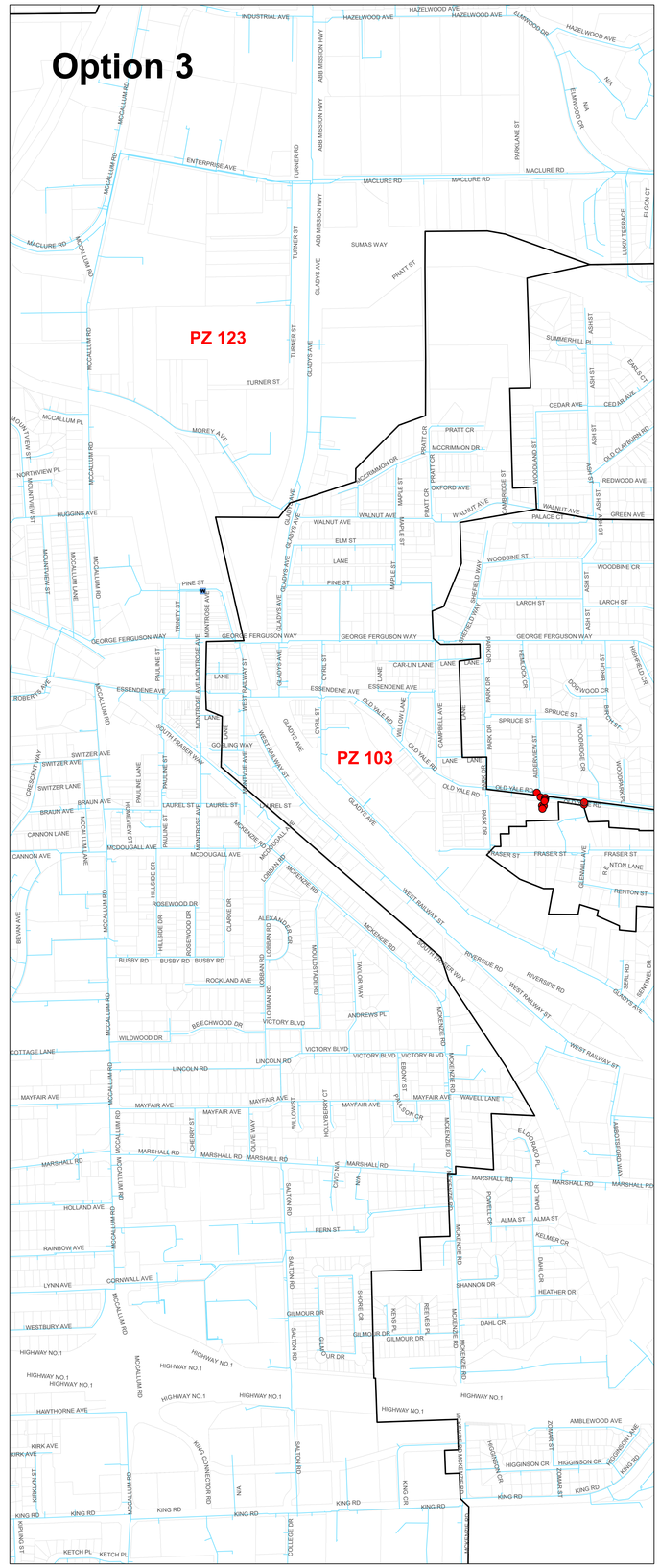
Option 1



Option 2



Option 3



GeoAdvice Engineering Inc.

Legend

- Pressure Deficiency (< 44 psi)
- Well
- Pipe
- Future Pressure Zone Boundary

2041 PHD Pressure Modeling Results

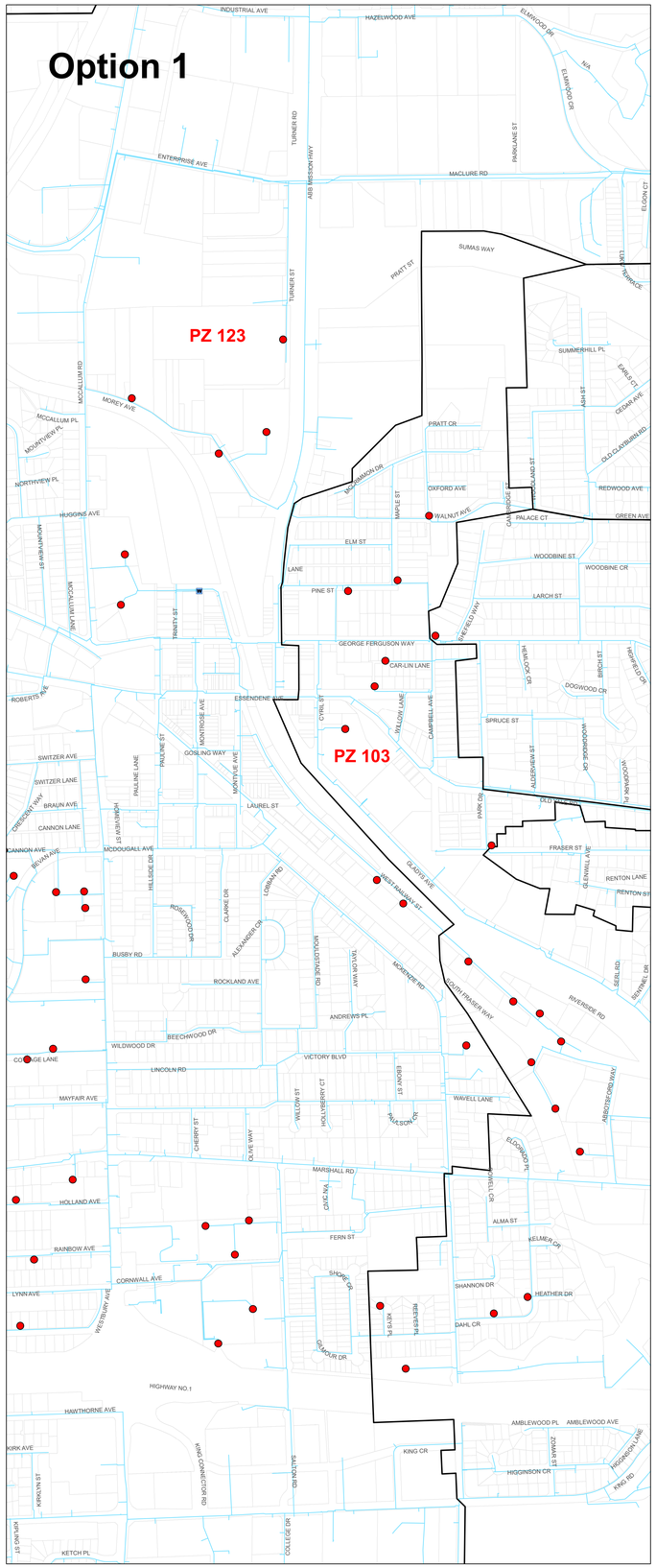
Project: **Water Distribution System Master Plan**
Pressure Zone 103 & 123 Boundary Optimization
Client: **City of Abbotsford, BC**
Date: **April 2018**
Created by: **AM**
Reviewed by: **WdS**

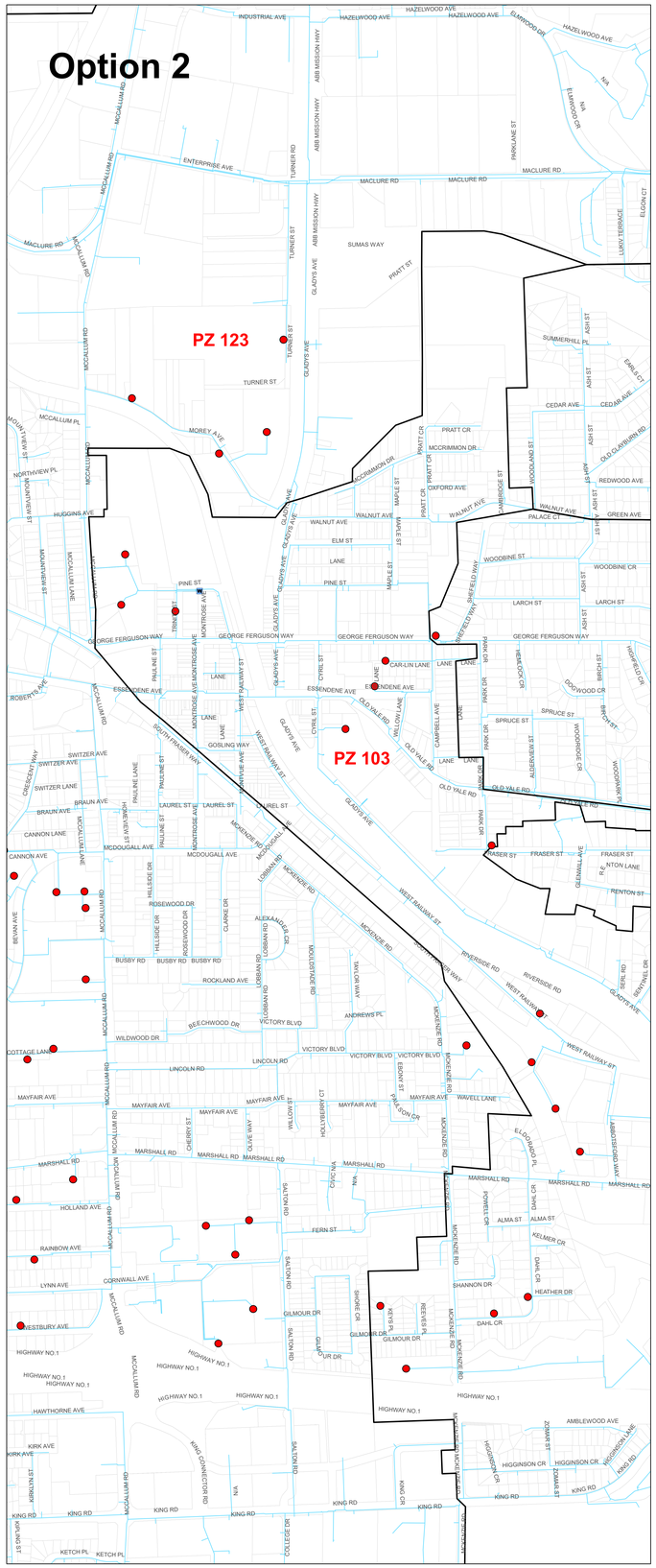
0 0.25 0.5 1
Kilometers

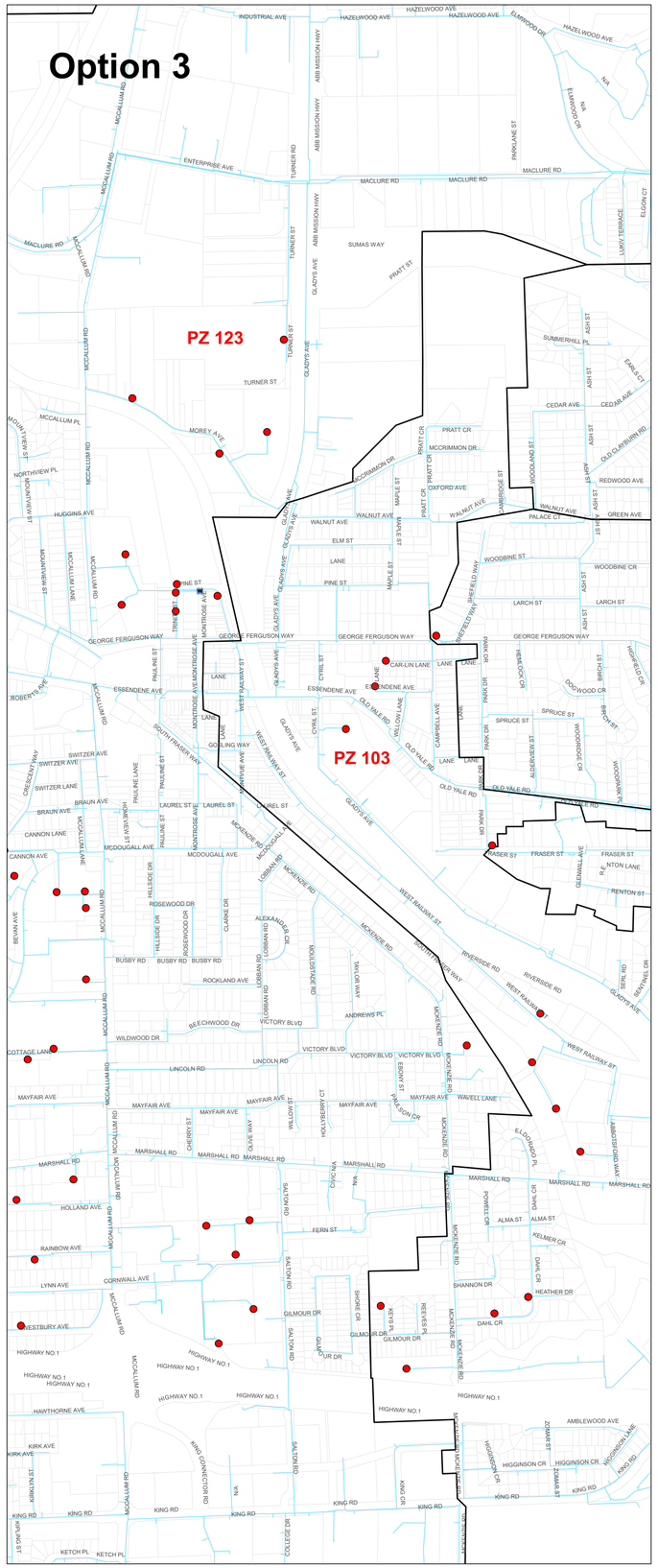
N W E S

Figure 4.1

Document Path: W:\2017-021-ABB\08\Reporting Maps\PZ 103 & 123 Boundary Analysis Maps\2017-021-ABB_Fig41_2041PHDPressureResults_r1_2018-04-13.mxd







GeoAdvice Engineering Inc.

Legend

- Fire Flow Deficiency (> 22 psi)
- Well
- Pipe
- Future Pressure Zone Boundary

2041 MDD+FF Residual Pressure Modeling Results

Project: **Water Distribution System Master Plan**
Pressure Zone 103 & 123 Boundary Optimization
Client: **City of Abbotsford, BC**
Date: **April 2018**
Created by: **AM**
Reviewed by: **WdS**

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0 0.25 0.5 1
Kilometers

N W E S

Figure 4.2

Document Path: W:\2017-021-ABB\08\Reporting Maps\PZ 103 & 123 Boundary Analysis Maps\2017-021-ABB_Fig42_2041MDD+FFResults_r1_2018-04-13.mxd

5.0 McCallum Road Water Main Recommendations

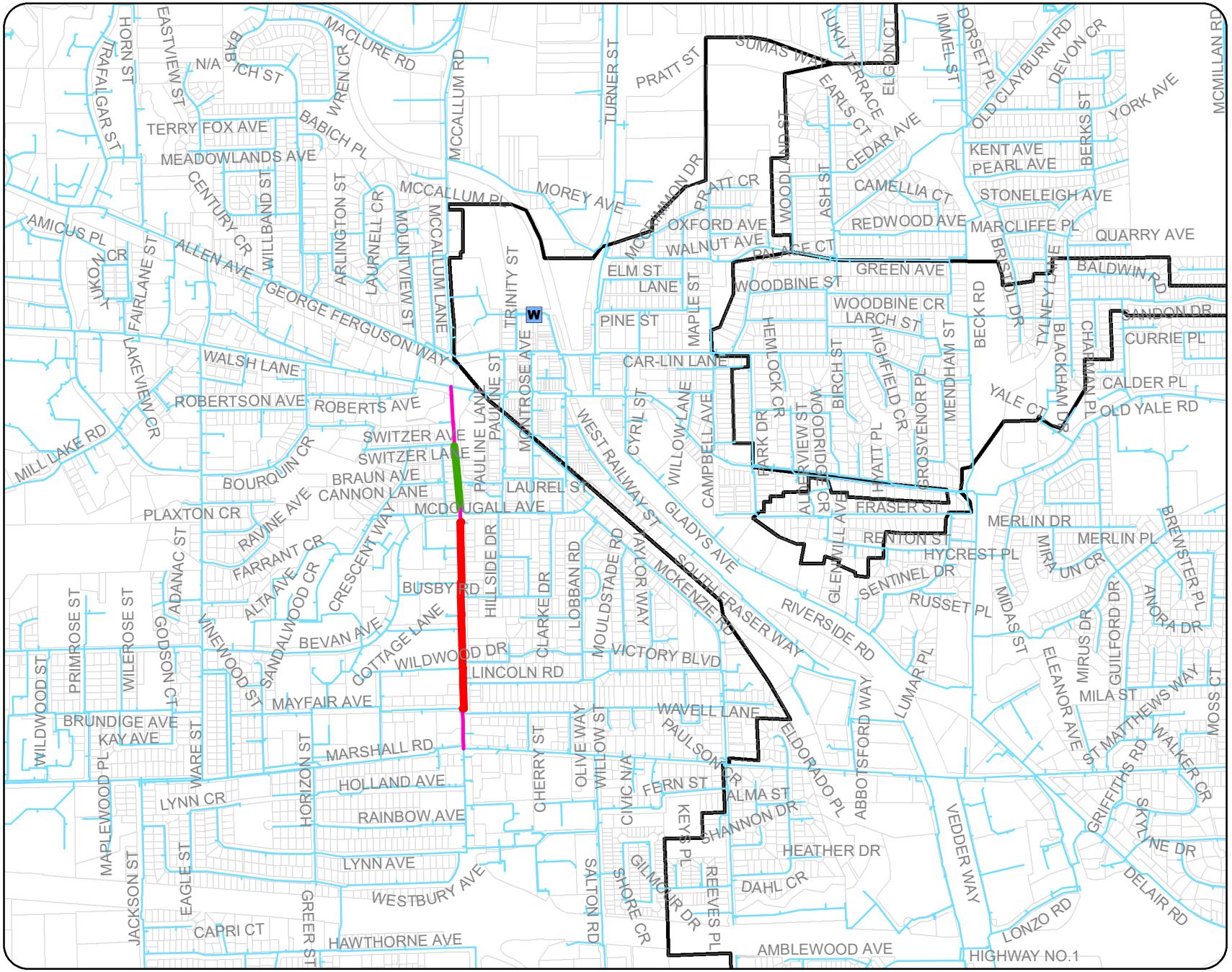
The primary objective of this pressure zone boundary change is to eliminate the twin water mains along McCallum Road between South Fraser Way and Marshall Road, where one pipe is in pressure zone 103 and the other is in pressure zone 123.

To eliminate the twin water mains along McCallum Road, all services were transferred over to the western water main and the eastern water main was assumed to be abandoned. The remaining western water main was then sized to meet 2051 flows and pressures under the recommended pressure zone configuration, Option 2. To size this water main, it was also assumed that the City's Asset Replacement Program is in place.

It was found that the required diameter for the water main along McCallum Road is 300 mm. Approximately 790 m of water main requires upgrades. Some of the pipes along McCallum Road are already 300 mm in diameter. As such, not all of the pipes along McCallum Road are recommended for upgrade based on capacity. The City may require further pipe replacements along McCallum Road based other factors, including age, material, condition, adjacent works, etc.

The recommended pipe upgrades on McCallum Road are recommended in the City water distribution system master plan as part of upgrade projects 121 and 122.

The recommended pipe upgrades on McCallum Road are summarized in **Appendix A** and shown in **Figure 5.1**.



GeoAdvice Engineering Inc.

Legend

- New 300 mm Pipe on McCallum Road
- 300 mm McCallum Road Upgrade
- Existing 300 mm Pipe on McCallum Road
- Pipe
- W Well
- Pressure Zone Boundary Configuration Option 2

McCallum Road Pipe Upgrades

ABBOTSFORD

Project:	Water Distribution System Master Plan Pressure Zone 103 & 123 Boundary Optimization
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

N W E S

0 0.175 0.35 0.7
Kilometers

Figure 5.1

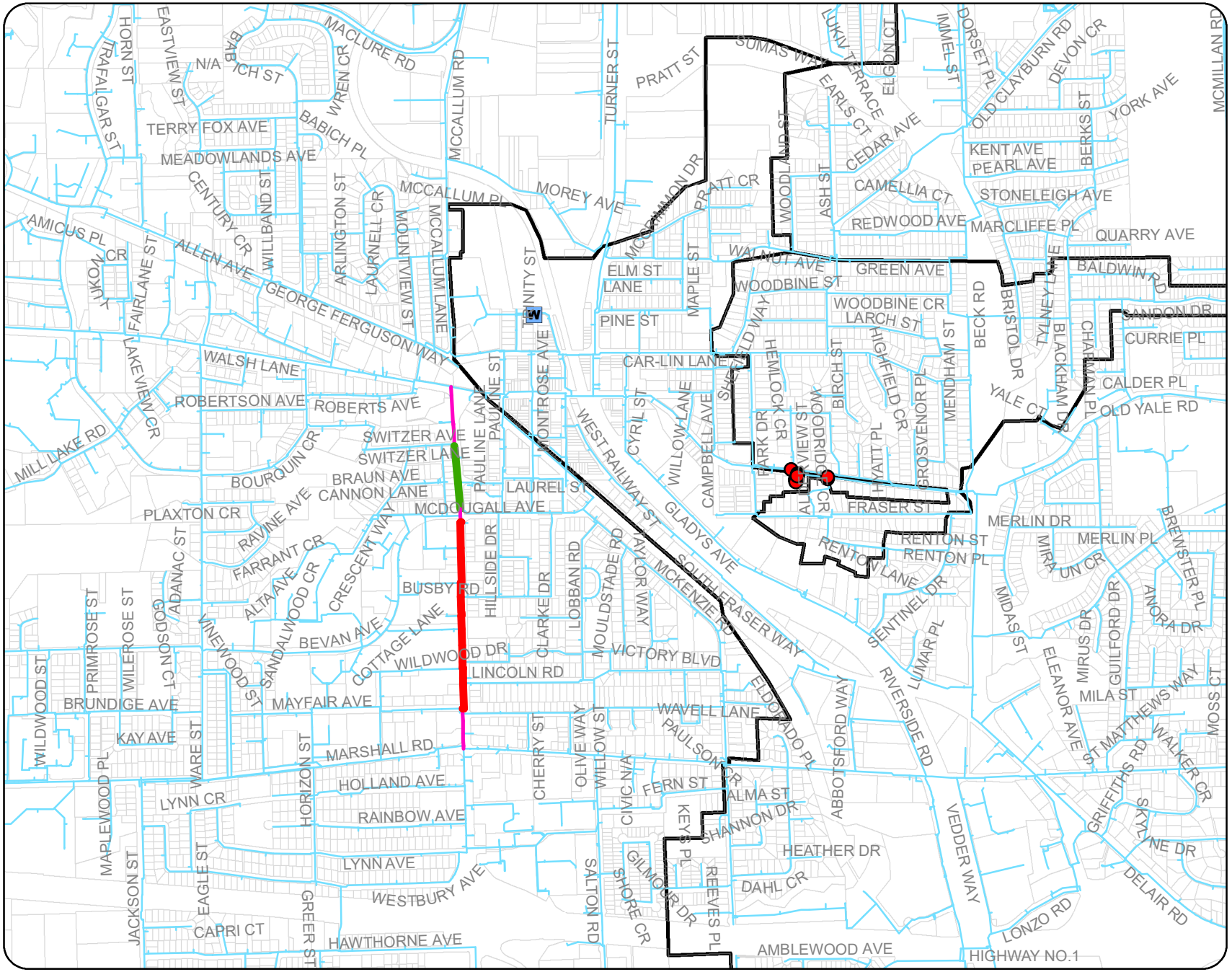
Table 5.1 summarizes the hydraulic modeling results in the study area under the 2041 scenario with the recommended pipe upgrades on McCallum Road and with pressure zone configuration Option 2.

Table 5.1: 2041 Water Distribution System Summary Results (Option 2 + McCallum Upgrades)

Criteria	Scenario	2041 With McCallum Road Pipe Upgrades and Pressure Zone Configuration Option 2
High Pressure Junctions Demand Nodes > 830 kPa (120 psi)	ADD	64
Average Pressure Pressure Zone 103 Pressure Zone 123	ADD	 87.0 psi 103.1 psi
Low Pressure Deficiencies Demand Nodes < 300 kPa (43.5 psi)	PHD	10
Average Pressure Pressure Zone 103 Pressure Zone 123	PHD	 82.1 psi 94.0 psi
Fire Flow Deficiencies Residual Pressure < 150 kPa (21.8 psi)	MDD + FF	23
Average Available Fire Flow (L/s) @ 150 kPa (21.8 psi)	MDD + FF	301 L/s

As shown in **Table 5.1**, the upgrades along McCallum Road provide marginal increases in pressure in the study area. Moreover, the pipe upgrades along McCallum Road have the greatest effect on the available fire flow, eliminating an additional twenty-seven (27) fire flow deficiencies and increasing the average available fire flow by an additional 52 L/s in the study area.

Pressure modeling results and fire flow modeling results under 2041 conditions with the recommended pipe upgrades on McCallum Road and pressure zone boundary configuration Option 2 are shown in **Figure 5.2** and **Figure 5.3**, respectively.



GeoAdvice Engineering Inc.

Legend

- Pressure Deficiency (< 44 psi)
- New 300 mm Pipe on McCallum Road
- 300 mm McCallum Road Upgrade
- Existing 300 mm Pipe on McCallum Road
- Pipe
- W Well
- Pressure Zone Boundary Configuration Option 2

2041 PHD Pressure Results Pressure Zone Configuration 2 With McCallum Road Pipe Upgrades

ABBOTSFORD

Project:	Water Distribution System Master Plan Pressure Zone 103 & 123 Boundary Optimization
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

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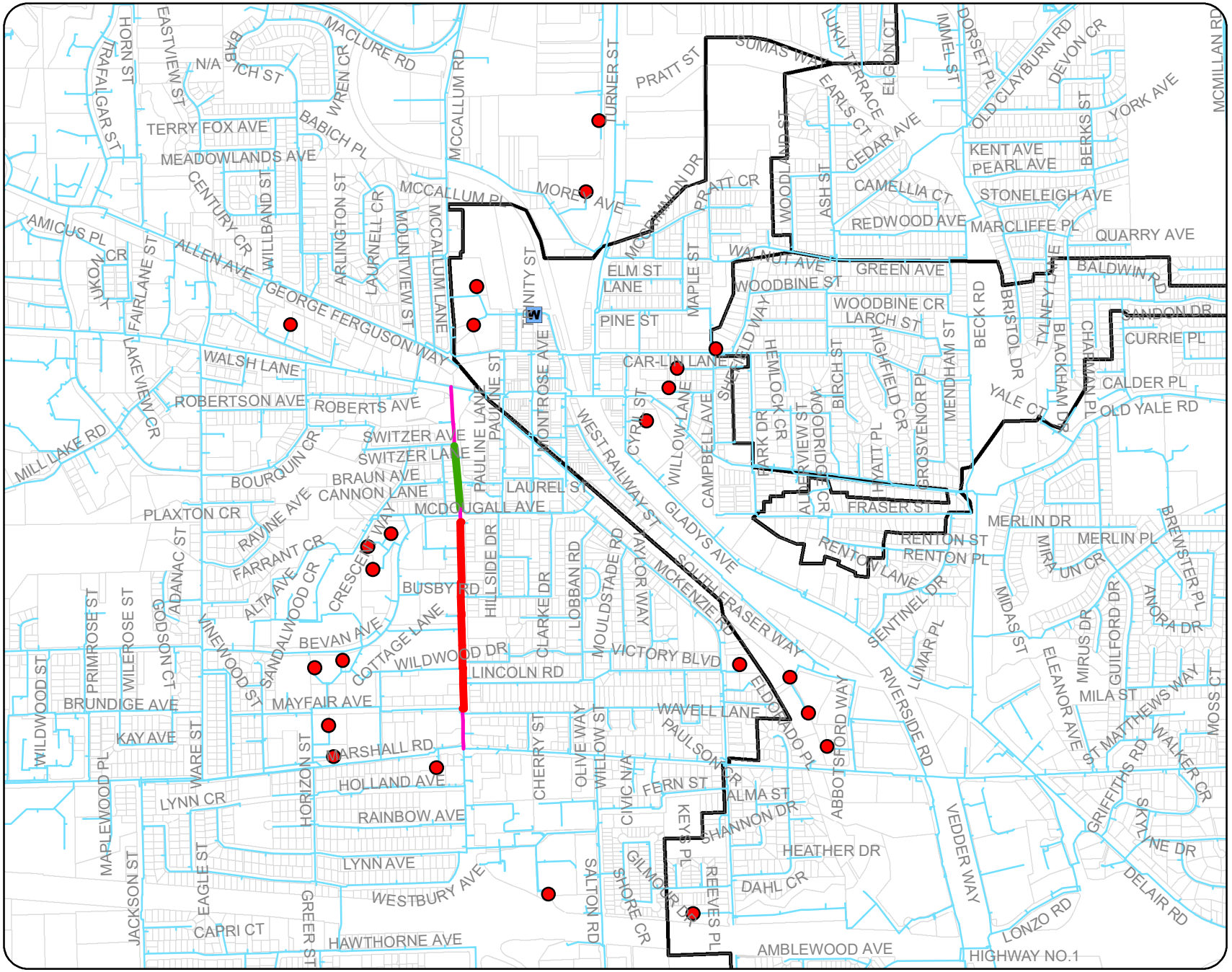
N W E S

0 0.175 0.35 0.7
Kilometers

Figure 5.2



GeoAdvice Engineering Inc.

Legend

- Fire Flow Deficiency (< 22 psi)
- New 300 mm Pipe on McCallum Road
- 300 mm McCallum Road Upgrade
- Existing 300 mm Pipe on McCallum Road
- Pipe
- Well
- Pressure Zone Boundary Configuration Option 2

2041 MDD+FF
Residual Pressure Results
Pressure Zone Configuration 2
With McCallum Road Pipe Upgrades

Project:	Water Distribution System Master Plan Pressure Zone 103 & 123 Boundary Optimization
Client:	City of Abbotsford, BC
Date:	April 2018
Created by:	AM
Reviewed by:	WdS

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N W E S

0 0.175 0.35 0.7
Kilometers

Figure 5.3

6.0 Pressure Zone Boundary Adjustment of Option 2

Overall, Option 2 provides the best compromise between minimizing high pressures, low pressures, and fire flow deficiencies within the study area. It is recommended that the City proceed with pressure zone configuration Option 2.

However, the City has expressed a desire to alter the proposed boundary slightly to keep the properties on Shore Crescent within Pressure Zone 103. The City has indicated that the service pipes in the Shore Crescent area are in poor condition; therefore, increasing the pressure in this area may cause service breaks.

Figure 6.1 illustrates the desired pressure zone boundary alignment near Shore Crescent (proposed boundary change is shown in green below).

Figure 6.1: Pressure Zone Boundary Alignment Near Shore Crescent

The modeling results presented in the previous sections of this memo have not been updated based on the altered pressure zone boundary alignment as shown in green in **Figure 6.1**; however, no hydraulic issues are expected with this alignment.

Submission

Prepared by:

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Hydraulic Modeler / Project Engineer

Reviewed and Approved by:

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA W. de SCHAETZEN # 30059

April 13, 2018

Werner de Schaetzen, Ph.D., P.Eng.
Project Manager

OQM | Organizational Quality Management Program

GeoADVICE

Appendix A McCallum Road Pipe Upgrades

Pipe ID	Location	Upgrade Type	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
PPE-438C8	McCallum Road: McDougall Ave. to Busby Rd.	Asset Replacement Program - Upsized	100	300	107.0
PPE-498C8	McCallum Road: McDougall Ave. to Busby Rd.	Asset Replacement Program - Upsized	100	300	79.3
PPE-1356C8	McCallum Road: McDougall Ave. to Busby Rd.	Asset Replacement Program - Upsized	100	300	2.1
PPE-1357C8	McCallum Road: McDougall Ave. to Busby Rd.	Asset Replacement Program - Upsized	150	300	0.6
PPE-369C8	McCallum Road: Wildwood Dr. to Lincoln Rd.	Asset Replacement Program - Upsized	150	300	1.8
PPE-488C8	McCallum Road: Busby Rd. to Wildwood Dr.	Asset Replacement Program - Upsized	150	300	50.7
PPE-682C8	McCallum Road: Busby Rd. to Wildwood Dr.	Asset Replacement Program - Upsized	150	300	41.6
PPE-978C8	McCallum Road: Lincoln Rd. to Mayfair Ave.	Asset Replacement Program - Upsized	150	300	3.8
PPE-662C8	McCallum Road: Wildwood Dr. to Lincoln Rd.	Asset Replacement Program - Upsized	150	300	30.4

Pipe ID	Location	Upgrade Type	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
PPE-662C8_1	McCallum Road: Wildwood Dr. to Lincoln Rd.	Asset Replacement Program - Upsized	150	300	15.8
PPE-662C8_2	McCallum Road: Lincoln Rd. to Mayfair Ave.	Asset Replacement Program - Upsized	150	300	79.1
PPE-681C8	McCallum Road: Busby Rd. to Wildwood Dr.	Asset Replacement Program - Upsized	150	300	2.0
PPE-387C8	McCallum Road: Busby Rd. to Wildwood Dr.	Asset Replacement Program - Upsized	150	300	52.5
PPE-387C8_1	McCallum Road: Wildwood Dr. to Lincoln Rd.	Asset Replacement Program - Upsized	150	300	18.2
PPE-370C8	McCallum Road: Wildwood Dr. to Lincoln Rd.	Asset Replacement Program - Upsized	150	300	0.9
PPE-389C8	McCallum Road: Busby Rd. to Wildwood Dr.	Asset Replacement Program - Upsized	200	300	57.5
PPE-389C8_1	McCallum Road: McDougall Ave. to Busby Rd.	Asset Replacement Program - Upsized	200	300	43.0
PPE-375C8	McCallum Road: McDougall Ave. to Marshall Rd.	Asset Replacement Program - Upsized	200	300	2.0
PPE-375C8_1	McCallum Road: McDougall Ave. to Marshall Rd.	Asset Replacement Program - Upsized	200	300	3.4

Pipe ID	Location	Upgrade Type	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
PPE-HDNP-05	McCallum Road: Switzer Ave. to McDougall Ave.	New Pipe Loop	N/A	300	81.5
PPE-HDNP-06	McCallum Road: Switzer Ave. to McDougall Ave.	New Pipe Loop	N/A	300	77.5
PPE-HDNP-07	McCallum Road: Switzer Ave. to McDougall Ave.	New Pipe Loop	N/A	300	37.7

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
1	PPE-25B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	6.5	1	2016	Collector	$1,320	1.1	$1,452	$9,435
1	PPE-26B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	7.9	1	2016	Collector	$1,320	1.1	$1,452	$11,507
1	PPE-207B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	17.6	1	2016	Collector	$1,320	1.1	$1,452	$25,554
1	PPE-27B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	22.6	1	2016	Collector	$1,320	1.1	$1,452	$32,748
1	PPE-96B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	31.1	1	2016	Collector	$1,320	1.1	$1,452	$45,117
1	PPE-75B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	67.6	1	2016	Collector	$1,320	1.1	$1,452	$98,155
1	PPE-24B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	74.7	1	2016	Collector	$1,320	1.1	$1,452	$108,430
1	PPE-76B8	McCallum Rd	UDistrict	Asset Replacement Program - Upsized		200	300	104.3	1	2016	Collector	$1,320	1.1	$1,452	$151,455
1	PPE-23B8	McCallum Rd	UDistrict	Pipe Upgrade	Continuity with ARP	200	300	2.6	2	2016	Collector	$1,320	1.1	$1,452	$3,769
1	PPE-28B8	McCallum Rd	UDistrict	Pipe Upgrade	Continuity with ARP	200	300	10.1	2	2016	Collector	$1,320	1.1	$1,452	$14,677
2	PPE-565C9	SALTON RD	UDistrict	Asset Replacement Program - Upsized	Fire Flow	200	300	3.5	1	2016	Local	$1,320	0.9	$1,188	$4,157
2	PPE-689C9	SALTON RD	UDistrict	Asset Replacement Program - Upsized	Fire Flow	200	300	15.7	1	2016	Local	$1,320	0.9	$1,188	$18,654
2	PPE-693C9	SALTON RD	UDistrict	Asset Replacement Program - Upsized	Fire Flow	200	300	62.3	1	2016	Local	$1,320	0.9	$1,188	$74,010
2	PPE-406C9	SALTON RD	UDistrict	Asset Replacement Program - Upsized	Fire Flow	200	300	129.0	1	2016	Local	$1,320	0.9	$1,188	$153,193
2	PPE-UD-01	KING CONNECTOR RD	UDistrict	New Pipe Loop	Fire Flow	N/A	250	120.9	2	2016	Collector	$1,210	1.1	$1,331	$160,963
2	PPE-UD-02	PROPOSED UDISTRICT ROADWAY	UDistrict	New Pipe Loop	Fire Flow	N/A	250	71.6	2	2016	Arterial	$1,210	1.2	$1,452	$103,949
2	PPE-UD-03	PROPOSED UDISTRICT ROADWAY	UDistrict	New Pipe Loop	Fire Flow	N/A	250	102.6	2	2016	Arterial	$1,210	1.2	$1,452	$149,010
2	PPE-UD-09	KING CONNECTOR RD	UDistrict	New Pipe Loop	Fire Flow	N/A	250	209.2	2	2016	Arterial	$1,210	1.2	$1,452	$303,790
2	PPE-1353C9	@1653 SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	48.8	2	2016	Arterial	$1,210	1.2	$1,452	$70,802
2	PPE-1402C9	SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	250	300	6.8	2	2016	Collector	$1,320	1.1	$1,452	$9,853
2	PPE-520C9	SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	200	300	29.2	2	2016	Collector	$1,320	1.1	$1,452	$42,398
2	PPE-234192	SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	1.5	2	2016	Provincial Highway	$1,210	1.3	$1,573	$2,393
2	PPE-228927	SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	150	250	10.0	2	2016	Provincial Highway	$1,210	1.3	$1,573	$15,717
2	PPE-414C9	SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	150	250	33.5	2	2016	Provincial Highway	$1,210	1.3	$1,573	$52,655
2	PPE-415C9	Salton Rd	UDistrict	Pipe Upgrade	Fire Flow	150	250	68.4	2	2016	Provincial Highway	$1,210	1.3	$1,573	$107,557
2	PPE-228929	SALTON RD	UDistrict	Pipe Upgrade	Fire Flow	200	300	7.2	2	2016	Provincial Highway	$1,320	1.3	$1,716	$12,424
3	PPE-14C9	KING CR	UDistrict	Asset Replacement Program - Upsized	Fire Flow	100	200	123.2	1	2016	Local	$1,140	0.9	$1,026	$126,382
3	PPE-37C9	KING CR	UDistrict	Asset Replacement Program - Upsized	Fire Flow	100	200	133.0	1	2016	Local	$1,140	0.9	$1,026	$136,424
3	PPE-UD-06	PROPOSED UDISTRICT ROADWAY	UDistrict	New Pipe Loop	Fire Flow	N/A	200	149.3	2	2016	Local	$1,140	0.9	$1,026	$153,225
3	PPE-UD-04	PROPOSED UDISTRICT ROADWAY	UDistrict	New Pipe Loop	Fire Flow	N/A	200	95.8	2	2016	Arterial	$1,140	1.2	$1,368	$131,079
3	PPE-UD-05	PROPOSED UDISTRICT ROADWAY	UDistrict	New Pipe Loop	Fire Flow	N/A	200	164.0	2	2016	Arterial	$1,140	1.2	$1,368	$224,419
3	PPE-13C9	KING CR	UDistrict	Pipe Upgrade	Fire Flow	150	200	26.0	2	2016	Collector	$1,140	1.1	$1,254	$32,604
4	PPE-1629C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	1.0	2	2016	Collector	$1,210	1.1	$1,331	$1,271
4	PPE-1558C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	1.0	2	2016	Collector	$1,210	1.1	$1,331	$1,331
4	PPE-17C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	1.1	2	2016	Collector	$1,210	1.1	$1,331	$1,402
4	PPE-1023C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	2.0	2	2016	Collector	$1,210	1.1	$1,331	$2,685
4	PPE-6C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	2.4	2	2016	Collector	$1,210	1.1	$1,331	$3,257
4	PPE-18C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	3.0	2	2016	Collector	$1,210	1.1	$1,331	$3,994
4	PPE-16C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	6.7	2	2016	Collector	$1,210	1.1	$1,331	$8,867
4	PPE-1356C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	14.4	2	2016	Collector	$1,210	1.1	$1,331	$19,190
4	PPE-9C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	18.0	2	2016	Collector	$1,210	1.1	$1,331	$23,958
4	PPE-1561C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	22.9	2	2016	Collector	$1,210	1.1	$1,331	$30,477
4	PPE-7C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	55.0	2	2016	Collector	$1,210	1.1	$1,331	$73,205
4	PPE-8C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	72.6	2	2016	Collector	$1,210	1.1	$1,331	$96,605
4	PPE-10C9	KING RD	UDistrict	Pipe Upgrade	Fire Flow	200	250	102.0	2	2016	Collector	$1,210	1.1	$1,331	$135,761
5	PPE-495B9	COLLEGE DR	UDistrict	Pipe Upgrade	Fire Flow	150	250	8.2	2	2016	Local	$1,210	0.9	$1,089	$8,965
5	PPE-620B9	COLLEGE DR	UDistrict	Pipe Upgrade	Fire Flow	150	250	43.8	2	2016	Local	$1,210	0.9	$1,089	$47,679
5	PPE-185B9	COLLEGE DR	UDistrict	Pipe Upgrade	Fire Flow	150	250	46.5	2	2016	Local	$1,210	0.9	$1,089	$50,640
5	PPE-106B9	COLLEGE DR	UDistrict	Pipe Upgrade	Fire Flow	150	250	97.1	2	2016	Local	$1,210	0.9	$1,089	$105,790
6	PPE-UD-08	KING CONNECTOR RD	UDistrict	New Pipe Loop	Fire Flow	N/A	200	92.2	2	2016	Local	$1,140	0.9	$1,026	$94,598
6	PPE-UD-07	KING CONNECTOR RD	UDistrict	New Pipe Loop	Fire Flow	N/A	200	244.7	2	2016	Local	$1,140	0.9	$1,026	$251,050
7	PPE-570C8	KIRKLYN ST	UDistrict	Asset Replacement Program - Upsized		100	200	98.4	2	N/A	Local	$1,140	0.9	$1,026	$100,929
7	PPE-572C8	KIRKLYN ST	UDistrict	Asset Replacement Program - Upsized	Continuity with ARP	100	200	13.9	3	N/A	Collector	$1,140	1.1	$1,254	$17,370
8	PPE-80C8	EDGEWOOD AVE		Asset Replacement Program	Fire Flow	150	200	9.4	3	2036	Local	$1,140	0.9	$1,026	$9,637
8	PPE-10C8	EDGEWOOD AVE		Asset Replacement Program	Fire Flow	150	200	29.9	3	2036	Local	$1,140	0.9	$1,026	$30,655
8	PPE-59C8	EDGEWOOD AVE		Asset Replacement Program	Fire Flow	150	200	125.5	3	2036	Local	$1,140	0.9	$1,026	$128,793
8	PPE-44C8	JACKSON ST		Asset Replacement Program - Upsized	Fire Flow	200	250	116.1	2	2036	Local	$1,210	0.9	$1,089	$126,388
8	PPE-43C8	JACKSON ST		Asset Replacement Program - Upsized	Fire Flow	200	250	139.4	2	2036	Local	$1,210	0.9	$1,089	$151,761
8	PPE-84C8	KING RD		Asset Replacement Program - Upsized	Fire Flow	200	250	4.5	2	2036	Collector	$1,210	1.1	$1,331	$5,982
8	PPE-83C8	KING RD		Asset Replacement Program - Upsized	Fire Flow	200	250	4.5	2	2036	Collector	$1,210	1.1	$1,331	$5,990
8	PPE-42C8	JACKSON ST		Asset Replacement Program - Upsized	Fire Flow	200	250	9.3	2	2036	Collector	$1,210	1.1	$1,331	$12,362
8	PPE-1C8	KING RD		Pipe Upgrade	Fire Flow	150	250	7.6	2	2036	Collector	$1,210	1.1	$1,331	$10,142
8	PPE-9C8	KING RD		Pipe Upgrade	Fire Flow	150	250	89.2	2	2036	Collector	$1,210	1.1	$1,331	$118,731
9	PPE-816D5	SOUTH FRASER WAY		Asset Replacement Program - Upsized		150	300	9.4	1	2016	Collector	$1,320	1.1	$1,452	$13,611
9	PPE-380D5	SOUTH FRASER WAY		Asset Replacement Program - Upsized		150	300	74.1	1	2016	Collector	$1,320	1.1	$1,452	$107,579
9	PPE-294D5	SOUTH FRASER WAY		Asset Replacement Program - Upsized		150	300	152.7	1	2016	Collector	$1,320	1.1	$1,452	$221,651
9	PPE-272D5_3	SOUTH FRASER WAY		Asset Replacement Program - Upsized		150	300	62.6	2	2016	Collector	$1,320	1.1	$1,452	$90,966
9	PPE-865D5	SOUTH FRASER WAY		Pipe Upgrade	Continuity with ARP	150	300	1.0	2	2016	Collector	$1,320	1.1	$1,452	$1,490
9	PPE-251847	SOUTH FRASER WAY		Pipe Upgrade	Continuity with ARP	150	300	2.5	2	2016	Collector	$1,320	1.1	$1,452	$3,559
9	PPE-252002	MATSQUI PL		Pipe Upgrade	Continuity with ARP	150	300	3.7	2	2016	Collector	$1,320	1.1	$1,452	$5,330
9	PPE-745D5	SOUTH FRASER WAY		Pipe Upgrade	Continuity with ARP	150	300	72.1	2	2016	Collector	$1,320	1.1	$1,452	$104,721
10	PPE-DEACON-01	DEACON ST		New Pipe Loop	Fire Flow	N/A	200	18.4	3	2026	Collector	$1,140	1.1	$1,254	$23,061
10	PPE-QUEEN-04	DEACON ST		New Pipe Loop	Fire Flow	N/A	300	172.0	3	2026	Arterial	$1,320	1.2	$1,584	$272,510
10	PPE-QUEEN-02	DEACON ST		New Pipe Loop	Fire Flow	N/A	300	215.6	3	2026	Arterial	$1,320	1.2	$1,584	$341,567
11	PPE-2D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	9.0	2	2026	Arterial	$1,140	1.2	$1,368	$12,315
11	PPE-122D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	10.0	2	2026	Arterial	$1,140	1.2	$1,368	$13,669
11	PPE-126D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	19.7	2	2026	Arterial	$1,140	1.2	$1,368	$26,944
11	PPE-106D7	@3046 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	19.9	2	2026	Arterial	$1,140	1.2	$1,368	$27,236
11	PPE-107D7	@3046 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	20.0	2	2026	Arterial	$1,140	1.2	$1,368	$27,349
11	PPE-124D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	37.1	2	2026	Arterial	$1,140	1.2	$1,368	$50,814

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
11	PPE-125D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	38.2	2	2026	Arterial	$1,140	1.2	$1,368	$52,290
11	PPE-120D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	48.7	2	2026	Arterial	$1,140	1.2	$1,368	$66,642
11	PPE-113D7	@3046 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	56.7	2	2026	Arterial	$1,140	1.2	$1,368	$77,507
11	PPE-121D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	66.3	2	2026	Arterial	$1,140	1.2	$1,368	$90,635
11	PPE-112D7	@3046 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	69.6	2	2026	Arterial	$1,140	1.2	$1,368	$95,232
11	PPE-123D7	@3044 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	77.9	2	2026	Arterial	$1,140	1.2	$1,368	$106,517
11	PPE-105D7	@3046 CLEARBROOK RD		Pipe Upgrade	Fire Flow	150	200	116.1	2	2026	Arterial	$1,140	1.2	$1,368	$158,792
12	PPE-339C6	SOUTHDALE CR		Asset Replacement Program		150	200	10.3	2	2016	Local	$1,140	0.9	$1,026	$10,536
12	PPE-338C6	SOUTHDALE CR		Asset Replacement Program		150	200	83.4	2	2016	Local	$1,140	0.9	$1,026	$85,517
12	PPE-324C6	SOUTHDALE CR		Asset Replacement Program		150	200	23.7	3	2016	Local	$1,140	0.9	$1,026	$24,304
12	PPE-326C6	IMPERIAL ST		Asset Replacement Program		150	200	29.7	3	2016	Local	$1,140	0.9	$1,026	$30,470
12	PPE-328C6	IMPERIAL PL		Asset Replacement Program		100	200	75.5	3	2016	Local	$1,140	0.9	$1,026	$77,509
12	PPE-327C6	IMPERIAL ST		Asset Replacement Program		150	200	91.3	3	2016	Local	$1,140	0.9	$1,026	$93,684
12	PPE-323C6	SOUTHDALE CR		Asset Replacement Program		150	200	115.9	3	2016	Local	$1,140	0.9	$1,026	$118,914
12	PPE-325C6	SOUTHDALE CR		Asset Replacement Program		150	200	121.9	3	2016	Local	$1,140	0.9	$1,026	$125,111
12	PPE-322C6	SOUTHDALE CR		Asset Replacement Program		150	200	162.4	3	2016	Local	$1,140	0.9	$1,026	$166,650
12	PPE-356C6	WESTERLY ST		Asset Replacement Program - Upsized	Fire Flow	100	200	58.0	1	2016	Local	$1,140	0.9	$1,026	$59,485
12	PPE-330C6	WESTERLY ST		Asset Replacement Program - Upsized	Fire Flow	100	200	146.3	1	2016	Local	$1,140	0.9	$1,026	$150,054
12	PPE-357C6	WESTERLY ST		Asset Replacement Program - Upsized	Continuity with ARP	100	200	4.3	2	2016	Local	$1,140	0.9	$1,026	$4,368
13	PPE-576C7	DORMICK AVE		Asset Replacement Program		100	200	1.6	2	N/A	Local	$1,140	0.9	$1,026	$1,617
13	PPE-379C7	DORMICK AVE		Asset Replacement Program		150	200	2.7	2	N/A	Local	$1,140	0.9	$1,026	$2,814
13	PPE-382C7	DORMICK AVE		Asset Replacement Program		100	200	8.2	2	N/A	Local	$1,140	0.9	$1,026	$8,456
13	PPE-374C7	DORMICK AVE		Asset Replacement Program		100	200	23.1	2	N/A	Local	$1,140	0.9	$1,026	$23,659
13	PPE-376C7	DORMICK AVE		Asset Replacement Program		100	200	42.2	2	N/A	Local	$1,140	0.9	$1,026	$43,246
13	PPE-370C7	FIR AVE		Asset Replacement Program		100	200	47.7	2	N/A	Local	$1,140	0.9	$1,026	$48,953
13	PPE-371C7	FIR AVE		Asset Replacement Program		100	200	50.2	2	N/A	Local	$1,140	0.9	$1,026	$51,521
13	PPE-397C7	DORMICK AVE		Asset Replacement Program		100	200	53.5	2	N/A	Local	$1,140	0.9	$1,026	$54,900
13	PPE-377C7	DORMICK AVE		Asset Replacement Program		100	200	55.8	2	N/A	Local	$1,140	0.9	$1,026	$57,224
13	PPE-396C7	DORMICK AVE		Asset Replacement Program		100	200	59.3	2	N/A	Local	$1,140	0.9	$1,026	$60,811
13	PPE-395C7	FIR AVE		Asset Replacement Program		100	200	104.4	2	N/A	Local	$1,140	0.9	$1,026	$107,144
13	PPE-369C7	FIR ST		Asset Replacement Program		100	200	116.9	2	N/A	Local	$1,140	0.9	$1,026	$119,934
13	PPE-373C7	HEMLOCK ST		Asset Replacement Program		100	200	117.6	2	N/A	Local	$1,140	0.9	$1,026	$120,682
14	PPE-308D6	PEARDONVILLE RD		Asset Replacement Program - Upsized	Fire Flow	150	400	10.2	2	2021	Arterial	$1,550	1.2	$1,860	$19,009
14	PPE-425D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	1.3	2	2021	Arterial	$1,320	1.2	$1,584	$2,059
14	PPE-428D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	4.3	2	2021	Arterial	$1,320	1.2	$1,584	$6,743
14	PPE-310D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	17.8	2	2021	Arterial	$1,320	1.2	$1,584	$28,184
14	PPE-370D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	36.2	2	2021	Arterial	$1,320	1.2	$1,584	$57,298
14	PPE-316D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	42.9	2	2021	Arterial	$1,320	1.2	$1,584	$67,977
14	PPE-315D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	43.0	2	2021	Arterial	$1,320	1.2	$1,584	$68,041
14	PPE-318D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	65.0	2	2021	Arterial	$1,320	1.2	$1,584	$102,974
14	PPE-312D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	77.3	2	2021	Arterial	$1,320	1.2	$1,584	$122,508
14	PPE-322D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	87.4	2	2021	Arterial	$1,320	1.2	$1,584	$138,464
14	PPE-320D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	98.9	2	2021	Arterial	$1,320	1.2	$1,584	$156,686
14	PPE-311D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	99.7	2	2021	Arterial	$1,320	1.2	$1,584	$157,990
14	PPE-319D6	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	150	300	143.2	2	2021	Arterial	$1,320	1.2	$1,584	$226,770
14	PPE-239316	PEARDONVILLE RD		Pipe Upgrade	Fire Flow	200	400	1.0	2	2021	Arterial	$1,550	1.2	$1,860	$1,875
14	PPE-228184	LIVINGSTONE AVE		Pipe Upgrade	Fire Flow	200	400	4.5	2	2021	Arterial	$1,550	1.2	$1,860	$8,381
14	PPE-239314	LIVINGSTONE AVE		Pipe Upgrade	Fire Flow	200	400	8.6	2	2021	Arterial	$1,550	1.2	$1,860	$15,972
14	PPE-269D6	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	200	400	26.8	2	2021	Arterial	$1,550	1.2	$1,860	$49,870
14	PPE-307D6	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	200	400	66.6	2	2021	Arterial	$1,550	1.2	$1,860	$123,846
14	PPE-270D6	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	200	400	98.2	2	2021	Arterial	$1,550	1.2	$1,860	$182,741
14	PPE-271D6	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	200	400	113.5	2	2021	Arterial	$1,550	1.2	$1,860	$211,117
14	PPE-274D6	LIVINGSTONE AVE		Pipe Upgrade	Fire Flow	200	400	171.8	2	2021	Arterial	$1,550	1.2	$1,860	$319,461
15	PPE-385C7	MEADOWS ST		Asset Replacement Program	Fire Flow	200	200	28.3	2	2016	Local	$1,140	0.9	$1,026	$29,051
15	PPE-386C7	MEADOWS ST		Asset Replacement Program	Fire Flow	150	200	76.1	2	2016	Local	$1,140	0.9	$1,026	$78,034
15	PPE-387C7	MEADOWS ST		Asset Replacement Program	Fire Flow	150	200	89.5	2	2016	Local	$1,140	0.9	$1,026	$91,828
15	PPE-238C7	MEADOWS ST		Asset Replacement Program	Fire Flow	100	200	154.0	2	2016	Local	$1,140	0.9	$1,026	$158,026
15	PPE-196C7	MEADOWS ST		Asset Replacement Program	Fire Flow	100	200	246.3	2	2016	Local	$1,140	0.9	$1,026	$252,679
15	PPE-588C7	MEADOWS ST		Asset Replacement Program	Fire Flow	150	200	2.7	2	2016	Arterial	$1,140	1.2	$1,368	$3,665
15	PPE-195C7	MEADOWS ST		Asset Replacement Program	Fire Flow	150	200	6.1	2	2016	Arterial	$1,140	1.2	$1,368	$8,308
16	PPE-392C7	MELMAR AVE		Asset Replacement Program	Fire Flow	200	200	10.9	3	2016	Local	$1,140	0.9	$1,026	$11,225
16	PPE-391C7	MELMAR AVE		Asset Replacement Program	Fire Flow	200	200	66.8	3	2016	Local	$1,140	0.9	$1,026	$68,498
16	PPE-389C7	DEBREEN CR		Asset Replacement Program	Fire Flow	100	200	112.4	3	2016	Local	$1,140	0.9	$1,026	$115,316
16	PPE-388C7	DEBREEN CR		Asset Replacement Program	Fire Flow	100	200	228.4	3	2016	Local	$1,140	0.9	$1,026	$234,326
16	PPE-393C7	MELMAR AVE		Asset Replacement Program	Fire Flow	200	200	241.6	3	2016	Local	$1,140	0.9	$1,026	$247,839
17	PPE-191C7	SHERWOOD CR		Asset Replacement Program	Fire Flow	100	200	12.9	2	2016	Local	$1,140	0.9	$1,026	$13,257
17	PPE-189C7	SHERWOOD CR		Asset Replacement Program	Fire Flow	100	200	35.6	2	2016	Local	$1,140	0.9	$1,026	$36,489
17	PPE-190C7	SHERWOOD CR		Asset Replacement Program	Fire Flow	100	200	164.4	2	2016	Local	$1,140	0.9	$1,026	$168,627
17	PPE-502C7	SHERWOOD CR		Asset Replacement Program	Fire Flow	100	200	190.3	2	2016	Local	$1,140	0.9	$1,026	$195,292
18	PPE-249525	SHERWOOD CR		Asset Replacement Program	Continuity with ARP	150	200	11.6	3	N/A	Local	$1,140	0.9	$1,026	$11,924
18	PPE-4C7	CHATEAU PL		Asset Replacement Program		150	200	42.1	3	N/A	Local	$1,140	0.9	$1,026	$43,242
19	PPE-189C6	LOMBARD AVE		Asset Replacement Program	Fire Flow	200	200	28.3	3	2026	Local	$1,140	0.9	$1,026	$29,051
19	PPE-191C6	LOMBARD AVE		Asset Replacement Program	Fire Flow	200	200	118.0	3	2026	Local	$1,140	0.9	$1,026	$121,101
19	PPE-190C6	LOMBARD AVE		Asset Replacement Program	Fire Flow	200	200	121.9	3	2026	Local	$1,140	0.9	$1,026	$125,043
20	PPE-250C7	DOLPHIN CR		Asset Replacement Program		200	200	10.6	3	N/A	Local	$1,140	0.9	$1,026	$10,846
20	PPE-245C7	DOLPHIN CR		Asset Replacement Program		200	200	11.6	3	N/A	Local	$1,140	0.9	$1,026	$11,926
20	PPE-248C7	DOLPHIN CR		Asset Replacement Program		200	200	14.5	3	N/A	Local	$1,140	0.9	$1,026	$14,865
20	PPE-247C7	DOLPHIN CR		Asset Replacement Program		200	200	66.5	3	N/A	Local	$1,140	0.9	$1,026	$68,220
20	PPE-242C7	DOLPHIN CR		Asset Replacement Program		200	200	67.6	3	N/A	Local	$1,140	0.9	$1,026	$69,380
20	PPE-246C7	DOLPHIN CR		Asset Replacement Program		200	200	68.8	3	N/A	Local	$1,140	0.9	$1,026	$70,617

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
20	PPE-244C7	DOLPHIN CR		Asset Replacement Program		200	200	88.6	3	N/A	Local	$1,140	0.9	$1,026	$90,925
20	PPE-243C7	DOLPHIN CR		Asset Replacement Program		200	200	100.4	3	N/A	Local	$1,140	0.9	$1,026	$103,039
21	PPE-470C7	LYNDEN ST		Asset Replacement Program	Fire Flow	100	200	184.4	2	2016	Local	$1,140	0.9	$1,026	$189,201
21	PPE-367C7	BAKERVIEW ST		Asset Replacement Program	Fire Flow	100	200	212.1	2	2016	Local	$1,140	0.9	$1,026	$217,601
21	PPE-202C7	BAKERVIEW ST		Asset Replacement Program	Fire Flow	150	200	64.0	3	2016	Local	$1,140	0.9	$1,026	$65,638
21	PPE-201C7	BAKERVIEW ST		Asset Replacement Program	Fire Flow	150	200	77.5	3	2016	Local	$1,140	0.9	$1,026	$79,466
21	PPE-203C7	BAKERVIEW ST		Asset Replacement Program	Fire Flow	150	200	85.3	3	2016	Local	$1,140	0.9	$1,026	$87,518
21	PPE-239C7	BAKERVIEW ST		Asset Replacement Program	Fire Flow	150	200	101.8	3	2016	Local	$1,140	0.9	$1,026	$104,429
22	PPE-363C7	LYNDEN ST		Asset Replacement Program	Fire Flow	100	200	188.6	2	2016	Local	$1,140	0.9	$1,026	$193,548
22	PPE-368C7	LYNDEN ST		Asset Replacement Program	Fire Flow	100	200	206.6	2	2016	Local	$1,140	0.9	$1,026	$211,945
22	PPE-210C7	LYNDEN ST		Asset Replacement Program	Fire Flow	150	200	75.7	3	2016	Local	$1,140	0.9	$1,026	$77,712
22	PPE-275C7	LYNDEN ST		Asset Replacement Program	Fire Flow	150	200	89.3	3	2016	Local	$1,140	0.9	$1,026	$91,605
22	PPE-209C7	LYNDEN ST		Asset Replacement Program	Fire Flow	150	200	162.9	3	2016	Local	$1,140	0.9	$1,026	$167,110
22	PPE-368C7_2	LYNDEN ST		Asset Replacement Program	Fire Flow	100	200	13.0	3	2016	Arterial	$1,140	1.2	$1,368	$17,723
23	PPE-206C7	EMERALD AVE		Asset Replacement Program		150	200	67.2	3	N/A	Local	$1,140	0.9	$1,026	$68,977
23	PPE-207C7	EMERALD AVE		Asset Replacement Program		150	200	87.9	3	N/A	Local	$1,140	0.9	$1,026	$90,162
24	PPE-214C7	BEAVER ST		Asset Replacement Program		200	200	7.0	3	N/A	Local	$1,140	0.9	$1,026	$7,146
24	PPE-449C7	BEAVER ST		Asset Replacement Program		200	200	9.7	3	N/A	Local	$1,140	0.9	$1,026	$10,001
24	PPE-237C7	BEAVER ST		Asset Replacement Program		200	200	14.0	3	N/A	Local	$1,140	0.9	$1,026	$14,379
24	PPE-359C7_2	BEAVER ST		Asset Replacement Program		200	200	57.7	3	N/A	Local	$1,140	0.9	$1,026	$59,215
24	PPE-213C7	BEAVER ST		Asset Replacement Program		200	200	61.9	3	N/A	Local	$1,140	0.9	$1,026	$63,501
24	PPE-362C7	BEAVER ST		Asset Replacement Program		200	200	81.5	3	N/A	Local	$1,140	0.9	$1,026	$83,621
24	PPE-356C7	BEAVER ST		Asset Replacement Program		200	200	111.8	3	N/A	Local	$1,140	0.9	$1,026	$114,729
24	PPE-355C7	BEAVER ST		Asset Replacement Program		200	200	129.8	3	N/A	Local	$1,140	0.9	$1,026	$133,166
24	PPE-224C7	BEAVER ST		Asset Replacement Program		200	200	154.4	3	N/A	Local	$1,140	0.9	$1,026	$158,403
24	PPE-222C7	BEAVER ST		Asset Replacement Program		200	200	158.1	3	N/A	Local	$1,140	0.9	$1,026	$162,218
25	PPE-353C7	SEAL WAY		Asset Replacement Program		150	200	3.4	3	N/A	Local	$1,140	0.9	$1,026	$3,447
25	PPE-349C7	OTTER ST		Asset Replacement Program		150	200	3.7	3	N/A	Local	$1,140	0.9	$1,026	$3,753
25	PPE-341C7	ALPINE AVE		Asset Replacement Program		150	200	5.8	3	N/A	Local	$1,140	0.9	$1,026	$5,979
25	PPE-343C7	ALPINE AVE		Asset Replacement Program		150	200	8.3	3	N/A	Local	$1,140	0.9	$1,026	$8,506
25	PPE-340C7	ALPINE AVE		Asset Replacement Program		150	200	26.1	3	N/A	Local	$1,140	0.9	$1,026	$26,804
25	PPE-342C7	ALPINE AVE		Asset Replacement Program		150	200	67.9	3	N/A	Local	$1,140	0.9	$1,026	$69,644
25	PPE-352C7	SEAL WAY		Asset Replacement Program		100	200	73.5	3	N/A	Local	$1,140	0.9	$1,026	$75,375
25	PPE-354C7	SEAL WAY		Asset Replacement Program		150	200	73.7	3	N/A	Local	$1,140	0.9	$1,026	$75,606
25	PPE-348C7	GROUSE CT		Asset Replacement Program		100	200	75.0	3	N/A	Local	$1,140	0.9	$1,026	$76,925
25	PPE-339C7	ALPINE AVE		Asset Replacement Program		150	200	77.1	3	N/A	Local	$1,140	0.9	$1,026	$79,085
25	PPE-344C7	RAINIER ST		Asset Replacement Program		100	200	87.8	3	N/A	Local	$1,140	0.9	$1,026	$90,104
25	PPE-350C7	OTTER ST		Asset Replacement Program		150	200	90.0	3	N/A	Local	$1,140	0.9	$1,026	$92,324
25	PPE-347C7	OTTER ST		Asset Replacement Program		150	200	148.0	3	N/A	Local	$1,140	0.9	$1,026	$151,820
26	PPE-318C7	CASCADE ST		Asset Replacement Program	Fire Flow	100	200	189.6	2	2016	Local	$1,140	0.9	$1,026	$194,481
26	PPE-317C7	CASCADE ST		Asset Replacement Program	Fire Flow	100	200	208.8	2	2016	Local	$1,140	0.9	$1,026	$214,226
26	PPE-268C7	CASCADE ST		Asset Replacement Program	Fire Flow	100	200	6.8	2	2016	Collector	$1,140	1.1	$1,254	$8,577
26	PPE-243091	BEVAN CR		Asset Replacement Program		200	200	11.0	2	2016	Collector	$1,140	1.1	$1,254	$13,815
26	PPE-269C7	BEVAN CR		Asset Replacement Program		200	200	20.2	2	2016	Collector	$1,140	1.1	$1,254	$25,322
26	PPE-271C7	BEVAN CR		Asset Replacement Program		200	200	34.3	2	2016	Collector	$1,140	1.1	$1,254	$42,971
26	PPE-270C7	BEVAN CR		Asset Replacement Program		200	200	40.0	2	2016	Collector	$1,140	1.1	$1,254	$50,194
27	PPE-689C7	MAJESTIC CR		Asset Replacement Program	Continuity with ARP	150	200	1.4	3	N/A	Local	$1,140	0.9	$1,026	$1,427
27	PPE-265C7	MAJESTIC CR		Asset Replacement Program		200	200	4.5	3	N/A	Local	$1,140	0.9	$1,026	$4,610
27	PPE-261C7	MAJESTIC CR		Asset Replacement Program		150	200	15.2	3	N/A	Local	$1,140	0.9	$1,026	$15,551
27	PPE-219C7	EMERALD AVE		Asset Replacement Program		200	200	20.5	3	N/A	Local	$1,140	0.9	$1,026	$21,034
27	PPE-267C7	R/W N OF MAJESTIC CR		Asset Replacement Program		200	200	20.9	3	N/A	Local	$1,140	0.9	$1,026	$21,476
27	PPE-220C7	EMERALD AVE		Asset Replacement Program		200	200	24.4	3	N/A	Local	$1,140	0.9	$1,026	$25,076
27	PPE-668C7	MAJESTIC CR		Asset Replacement Program		150	200	24.4	3	N/A	Local	$1,140	0.9	$1,026	$25,081
27	PPE-260C7	MAJESTIC CR		Asset Replacement Program		150	200	26.6	3	N/A	Local	$1,140	0.9	$1,026	$27,259
27	PPE-277C7	MAJESTIC CR		Asset Replacement Program		150	200	38.1	3	N/A	Local	$1,140	0.9	$1,026	$39,111
27	PPE-478C7	MAJESTIC CR		Asset Replacement Program		150	200	44.5	3	N/A	Local	$1,140	0.9	$1,026	$45,643
27	PPE-254C7	R/W E OF DOLPHIN CR		Asset Replacement Program		200	200	46.4	3	N/A	Local	$1,140	0.9	$1,026	$47,648
27	PPE-453C7	MAJESTIC CR		Asset Replacement Program		150	200	68.9	3	N/A	Local	$1,140	0.9	$1,026	$70,720
27	PPE-281C7	MAJESTIC CR		Asset Replacement Program		150	200	73.2	3	N/A	Local	$1,140	0.9	$1,026	$75,071
27	PPE-264C7	MAJESTIC CR		Asset Replacement Program		200	200	73.5	3	N/A	Local	$1,140	0.9	$1,026	$75,396
27	PPE-262C7	MAJESTIC CR		Asset Replacement Program		150	200	75.4	3	N/A	Local	$1,140	0.9	$1,026	$77,320
27	PPE-278C7	MAJESTIC CR		Asset Replacement Program		150	200	81.6	3	N/A	Local	$1,140	0.9	$1,026	$83,692
27	PPE-479C7	MAJESTIC CR		Asset Replacement Program		150	200	84.3	3	N/A	Local	$1,140	0.9	$1,026	$86,448
27	PPE-258C7	MAJESTIC CR		Asset Replacement Program		150	200	101.5	3	N/A	Local	$1,140	0.9	$1,026	$104,177
27	PPE-276C7	MAJESTIC CR		Asset Replacement Program		150	200	145.6	3	N/A	Local	$1,140	0.9	$1,026	$149,407
27	PPE-266C7	R/W N OF MAJESTIC CR		Asset Replacement Program		200	200	50.1	2	N/A	Collector	$1,140	1.1	$1,254	$62,793
27	PPE-253C7	R/W E OF DOLPHIN CR		Asset Replacement Program		200	200	35.9	3	N/A	Arterial	$1,140	1.2	$1,368	$49,163
28	PPE-302C7	BROADWAY ST		Asset Replacement Program		300	300	16.3	2	N/A	Local	$1,320	0.9	$1,188	$19,342
28	PPE-289C7	BROADWAY ST		Asset Replacement Program		300	300	60.9	2	N/A	Local	$1,320	0.9	$1,188	$72,386
28	PPE-303C7	BROADWAY ST		Asset Replacement Program		300	300	100.1	2	N/A	Local	$1,320	0.9	$1,188	$118,927
28	PPE-311C7	BROADWAY ST		Asset Replacement Program		300	300	113.7	2	N/A	Local	$1,320	0.9	$1,188	$135,123
28	PPE-312C7	BROADWAY ST		Asset Replacement Program		300	300	139.7	2	N/A	Local	$1,320	0.9	$1,188	$165,962
28	PPE-287C7	BROADWAY ST		Asset Replacement Program		300	300	145.1	2	N/A	Local	$1,320	0.9	$1,188	$172,437
28	PPE-288C7	BROADWAY ST		Asset Replacement Program		300	300	170.8	2	N/A	Local	$1,320	0.9	$1,188	$202,946
28	PPE-613C7	BROADWAY ST		Asset Replacement Program		300	300	1.0	2	N/A	Arterial	$1,320	1.2	$1,584	$1,584
29	PPE-310C7	RIDGEWAY ST		Asset Replacement Program		150	200	63.1	3	N/A	Local	$1,140	0.9	$1,026	$64,763
29	PPE-305C7	RIDGEWAY ST		Asset Replacement Program		150	200	68.6	3	N/A	Local	$1,140	0.9	$1,026	$70,341
29	PPE-307C7	RIDGEWAY ST		Asset Replacement Program		150	200	74.9	3	N/A	Local	$1,140	0.9	$1,026	$76,875
29	PPE-308C7	RIDGEWAY ST		Asset Replacement Program		150	200	127.8	3	N/A	Local	$1,140	0.9	$1,026	$131,091
29	PPE-243108	RIDGEWAY ST		Asset Replacement Program	Continuity with ARP	150	200	4.8	3	N/A	Collector	$1,140	1.1	$1,254	$6,002

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
30	PPE-45C7	RIDGEWAY ST		Asset Replacement Program		150	200	15.5	3	N/A	Local	$1,140	0.9	$1,026	$15,916
30	PPE-51C7	KENDALE PL		Asset Replacement Program		150	200	16.2	3	N/A	Local	$1,140	0.9	$1,026	$16,571
30	PPE-50C7	KENDALE PL		Asset Replacement Program		150	200	28.6	3	N/A	Local	$1,140	0.9	$1,026	$29,357
30	PPE-47C7	RIDGEWAY ST		Asset Replacement Program		150	200	29.1	3	N/A	Local	$1,140	0.9	$1,026	$29,827
30	PPE-53C7	KENDALE PL		Asset Replacement Program		150	200	34.4	3	N/A	Local	$1,140	0.9	$1,026	$35,324
30	PPE-49C7	LONSDALE CR		Asset Replacement Program		150	200	45.1	3	N/A	Local	$1,140	0.9	$1,026	$46,238
30	PPE-297C7	RIDGEWAY ST		Asset Replacement Program		150	200	58.3	3	N/A	Local	$1,140	0.9	$1,026	$59,834
30	PPE-70C7	LONSDALE CR		Asset Replacement Program		150	200	68.0	3	N/A	Local	$1,140	0.9	$1,026	$69,760
30	PPE-69C7	LONSDALE CR		Asset Replacement Program		150	200	73.0	3	N/A	Local	$1,140	0.9	$1,026	$74,938
30	PPE-46C7	RIDGEWAY ST		Asset Replacement Program		150	200	78.0	3	N/A	Local	$1,140	0.9	$1,026	$80,028
30	PPE-42C7	LONSDALE CR		Asset Replacement Program		150	200	109.7	3	N/A	Local	$1,140	0.9	$1,026	$112,568
30	PPE-243086	RIDGEWAY ST		Asset Replacement Program	Continuity with ARP	150	200	7.9	3	N/A	Collector	$1,140	1.1	$1,254	$9,928
31	PPE-17C7	HACIENDA PL		Asset Replacement Program		150	200	41.1	3	N/A	Local	$1,140	0.9	$1,026	$42,212
31	PPE-18C7	HACIENDA PL		Asset Replacement Program		150	200	107.7	3	N/A	Local	$1,140	0.9	$1,026	$110,490
32	PPE-28C7	BOULT AVE		Asset Replacement Program		100	200	4.0	2	N/A	Local	$1,140	0.9	$1,026	$4,080
32	PPE-26C7	BOULT AVE		Asset Replacement Program		100	200	159.3	2	N/A	Local	$1,140	0.9	$1,026	$163,490
33	PPE-649C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	0.4	2	N/A	Arterial	$1,550	1.2	$1,860	$724
33	PPE-611C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	1.0	2	N/A	Arterial	$1,550	1.2	$1,860	$1,860
33	PPE-612C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	1.0	2	N/A	Arterial	$1,550	1.2	$1,860	$1,860
33	PPE-162C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	1.7	2	N/A	Arterial	$1,550	1.2	$1,860	$3,086
33	PPE-172C7	MARSHALL RD : TO MARSHALL RD DIVERSION		Asset Replacement Program - Upsized	Continuity with ARP	300	400	4.5	2	N/A	Arterial	$1,550	1.2	$1,860	$8,355
33	PPE-257C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	6.0	2	N/A	Arterial	$1,550	1.2	$1,860	$11,147
33	PPE-138C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	17.0	2	N/A	Arterial	$1,550	1.2	$1,860	$31,696
33	PPE-137C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	25.1	2	N/A	Arterial	$1,550	1.2	$1,860	$46,641
33	PPE-139C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	36.9	2	N/A	Arterial	$1,550	1.2	$1,860	$68,602
33	PPE-136C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	38.3	2	N/A	Arterial	$1,550	1.2	$1,860	$71,255
33	PPE-533C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	57.9	2	N/A	Arterial	$1,550	1.2	$1,860	$107,780
33	PPE-690C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	61.1	2	N/A	Arterial	$1,550	1.2	$1,860	$113,631
33	PPE-199C7	HACIENDA PL		Asset Replacement Program - Upsized	Continuity with ARP	300	400	62.8	2	N/A	Arterial	$1,550	1.2	$1,860	$116,841
33	PPE-131C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	65.3	2	N/A	Arterial	$1,550	1.2	$1,860	$121,532
33	PPE-200C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	69.0	2	N/A	Arterial	$1,550	1.2	$1,860	$128,305
33	PPE-177C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	69.7	2	N/A	Arterial	$1,550	1.2	$1,860	$129,581
33	PPE-256C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	72.2	2	N/A	Arterial	$1,550	1.2	$1,860	$134,355
33	PPE-141C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	92.5	2	N/A	Arterial	$1,550	1.2	$1,860	$172,030
33	PPE-212C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	103.9	2	N/A	Arterial	$1,550	1.2	$1,860	$193,341
33	PPE-140C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	114.0	2	N/A	Arterial	$1,550	1.2	$1,860	$212,046
33	PPE-130C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	117.9	2	N/A	Arterial	$1,550	1.2	$1,860	$219,320
33	PPE-146C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	129.7	2	N/A	Arterial	$1,550	1.2	$1,860	$241,168
33	PPE-135C7	MARSHALL RD		Asset Replacement Program - Upsized	Continuity with ARP	300	400	148.0	2	N/A	Arterial	$1,550	1.2	$1,860	$275,325
34	PPE-196C6	OAKRIDGE CR		Asset Replacement Program	Fire Flow	150	200	22.9	3	2021	Local	$1,140	0.9	$1,026	$23,538
34	PPE-150C6	OAKRIDGE CR		Asset Replacement Program	Fire Flow	200	200	63.3	3	2021	Local	$1,140	0.9	$1,026	$64,922
34	PPE-194C6	OAKRIDGE CR		Asset Replacement Program	Fire Flow	200	200	69.7	3	2021	Local	$1,140	0.9	$1,026	$71,547
34	PPE-195C6	OAKRIDGE CR		Asset Replacement Program	Fire Flow	200	200	96.2	3	2021	Local	$1,140	0.9	$1,026	$98,702
34	PPE-199C6	OAKRIDGE CR		Asset Replacement Program	Fire Flow	150	200	135.3	3	2021	Local	$1,140	0.9	$1,026	$138,807
34	PPE-205C6	OAKRIDGE CR		Pipe Upgrade	Fire Flow	150	200	1.5	2	2021	Local	$1,140	0.9	$1,026	$1,550
34	PPE-201C6	OAKRIDGE CR		Pipe Upgrade	Fire Flow	150	200	6.8	2	2021	Local	$1,140	0.9	$1,026	$6,933
34	PPE-200C6	OAKRIDGE CR		Pipe Upgrade	Fire Flow	150	200	26.8	2	2021	Local	$1,140	0.9	$1,026	$27,464
34	PPE-211C6	R/W S OF CRYSTAL CT		Pipe Upgrade	Fire Flow	150	200	37.3	2	2021	Local	$1,140	0.9	$1,026	$38,289
34	PPE-212C6	R/W N OF OAKRIDGE CR		Pipe Upgrade	Fire Flow	150	200	53.8	2	2021	Local	$1,140	0.9	$1,026	$55,176
34	PPE-206C6	OAKRIDGE CR		Pipe Upgrade	Fire Flow	150	200	75.2	2	2021	Local	$1,140	0.9	$1,026	$77,196
34	PPE-202C6	OAKRIDGE CR		Pipe Upgrade	Fire Flow	150	200	99.9	2	2021	Local	$1,140	0.9	$1,026	$102,480
35	PPE-83C7	PANDORA AVE		Asset Replacement Program		150	200	3.3	3	N/A	Local	$1,140	0.9	$1,026	$3,410
35	PPE-76C7	AVALON CR		Asset Replacement Program		150	200	20.7	3	N/A	Local	$1,140	0.9	$1,026	$21,212
35	PPE-80C7	PANDORA AVE		Asset Replacement Program		150	200	42.8	3	N/A	Local	$1,140	0.9	$1,026	$43,923
35	PPE-84C7	PANDORA AVE		Asset Replacement Program		150	200	57.8	3	N/A	Local	$1,140	0.9	$1,026	$59,338
35	PPE-79C7	AVALON CR		Asset Replacement Program		150	200	59.3	3	N/A	Local	$1,140	0.9	$1,026	$60,804
35	PPE-74C7	EMERSON ST		Asset Replacement Program		150	200	73.1	3	N/A	Local	$1,140	0.9	$1,026	$75,050
35	PPE-81C7	PANDORA AVE		Asset Replacement Program		150	200	106.4	3	N/A	Local	$1,140	0.9	$1,026	$109,134
35	PPE-78C7	AVALON CR		Asset Replacement Program		150	200	121.9	3	N/A	Local	$1,140	0.9	$1,026	$125,106
35	PPE-75C7	EMERSON ST		Asset Replacement Program		150	200	21.9	2	N/A	Arterial	$1,140	1.2	$1,368	$29,941
36	PPE-258C8_2	MARSHALL RD		Asset Replacement Program - Upsized		200	250	14.1	3	N/A	Arterial	$1,210	1.2	$1,452	$20,543
36	PPE-191C8	MARSHALL RD		Asset Replacement Program - Upsized		150	250	20.6	3	N/A	Arterial	$1,210	1.2	$1,452	$29,945
36	PPE-258C8	MARSHALL RD		Asset Replacement Program - Upsized		150	250	84.6	3	N/A	Arterial	$1,210	1.2	$1,452	$122,883
36	PPE-182C8	MARSHALL RD		Asset Replacement Program - Upsized		150	250	100.0	3	N/A	Arterial	$1,210	1.2	$1,452	$145,200
37	PPE-232C8	BEVAN WAY		Asset Replacement Program		150	200	48.8	3	N/A	Local	$1,140	0.9	$1,026	$50,103
37	PPE-635C8	BEVAN WAY		Asset Replacement Program		150	200	52.9	3	N/A	Local	$1,140	0.9	$1,026	$54,227
37	PPE-231C8	BEVAN WAY		Asset Replacement Program		150	200	6.0	3	N/A	Arterial	$1,140	1.2	$1,368	$8,208
37	PPE-642C8	BEVAN WAY		Asset Replacement Program	Continuity with ARP	150	200	17.5	3	N/A	Arterial	$1,140	1.2	$1,368	$23,874
38	PPE-621C8	WILDWOOD ST		Asset Replacement Program		100	200	158.2	2	N/A	Local	$1,140	0.9	$1,026	$162,288
38	PPE-624C8	BEVAN AVE		Asset Replacement Program	Continuity with ARP	100	200	10.8	3	N/A	Local	$1,140	0.9	$1,026	$11,107
38	PPE-623C8	BEVAN AVE		Asset Replacement Program	Continuity with ARP	150	200	24.0	3	N/A	Arterial	$1,140	1.2	$1,368	$32,820
39	PPE-608C8	PRIMROSE ST		Asset Replacement Program		100	200	159.6	2	N/A	Local	$1,140	0.9	$1,026	$163,702
39	PPE-613C8	PRIMROSE ST		Asset Replacement Program	Continuity with ARP	100	200	8.0	3	N/A	Local	$1,140	0.9	$1,026	$8,257
39	PPE-612C8	PRIMROSE ST		Asset Replacement Program	Continuity with ARP	150	200	25.0	3	N/A	Arterial	$1,140	1.2	$1,368	$34,188
40	PPE-1596C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	100	200	2.5	2	2016	Local	$1,140	0.9	$1,026	$2,566
40	PPE-270C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	100	200	5.9	2	2016	Local	$1,140	0.9	$1,026	$6,058
40	PPE-271C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	100	200	6.0	2	2016	Local	$1,140	0.9	$1,026	$6,156
40	PPE-266C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	100	200	93.0	2	2016	Local	$1,140	0.9	$1,026	$95,420
40	PPE-276C8	STEVENSON ST		Asset Replacement Program		150	200	8.5	3	2016	Local	$1,140	0.9	$1,026	$8,744
40	PPE-284C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	150	200	10.5	3	2016	Local	$1,140	0.9	$1,026	$10,750

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
40	PPE-273C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	150	200	41.9	3	2016	Local	$1,140	0.9	$1,026	$43,003
40	PPE-538C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	150	200	83.1	3	2016	Local	$1,140	0.9	$1,026	$85,250
40	PPE-280C8	WILEROSE ST		Asset Replacement Program	Fire Flow	150	200	106.9	3	2016	Local	$1,140	0.9	$1,026	$109,684
40	PPE-272C8	BRUNDIGE AVE		Asset Replacement Program	Fire Flow	150	200	111.2	3	2016	Local	$1,140	0.9	$1,026	$114,079
41	PPE-593C8	WILEROSE ST		Asset Replacement Program		100	200	162.7	2	N/A	Local	$1,140	0.9	$1,026	$166,918
41	PPE-599C8	WILEROSE ST		Asset Replacement Program	Continuity with ARP	100	200	13.0	3	N/A	Local	$1,140	0.9	$1,026	$13,322
41	PPE-598C8	WILEROSE ST		Asset Replacement Program	Continuity with ARP	150	200	22.0	3	N/A	Arterial	$1,140	1.2	$1,368	$30,085
42	PPE-275C8	STEVENSON ST		Asset Replacement Program		150	200	6.0	3	N/A	Local	$1,140	0.9	$1,026	$6,156
42	PPE-282C8	KAY AVE		Asset Replacement Program		150	200	18.5	3	N/A	Local	$1,140	0.9	$1,026	$18,977
42	PPE-277C8	STEVENSON ST		Asset Replacement Program		100	200	36.1	3	N/A	Local	$1,140	0.9	$1,026	$37,040
42	PPE-281C8	WILEROSE ST		Asset Replacement Program		150	200	39.3	3	N/A	Local	$1,140	0.9	$1,026	$40,277
42	PPE-319C8	KAY AVE		Asset Replacement Program		150	200	51.7	3	N/A	Local	$1,140	0.9	$1,026	$53,074
42	PPE-318C8	KAY AVE		Asset Replacement Program		150	200	55.8	3	N/A	Local	$1,140	0.9	$1,026	$57,271
42	PPE-279C8	STEVENSON ST		Asset Replacement Program		150	200	97.4	3	N/A	Local	$1,140	0.9	$1,026	$99,942
43	PPE-129C8	JACKSON ST		Asset Replacement Program - Upsized	Continuity with ARP	200	300	137.5	2	N/A	Local	$1,320	0.9	$1,188	$163,297
43	PPE-208C8	JACKSON ST		Asset Replacement Program - Upsized	Continuity with ARP	200	300	154.8	2	N/A	Local	$1,320	0.9	$1,188	$183,893
44	PPE-894C8	RAINBOW AVE		Asset Replacement Program		100	200	114.3	2	N/A	Local	$1,140	0.9	$1,026	$117,236
44	PPE-908C8	LYNN AVE		Asset Replacement Program		100	200	114.5	2	N/A	Local	$1,140	0.9	$1,026	$117,515
44	PPE-906C8	LYNN AVE		Asset Replacement Program	Continuity with ARP	100	200	3.5	3	N/A	Local	$1,140	0.9	$1,026	$3,559
44	PPE-893C8	RAINBOW AVE		Asset Replacement Program	Continuity with ARP	100	200	4.5	3	N/A	Local	$1,140	0.9	$1,026	$4,611
44	PPE-87C8	WESTBURY AVE		Asset Replacement Program		200	200	5.5	3	N/A	Local	$1,140	0.9	$1,026	$5,624
44	PPE-153C8	EAGLE ST		Asset Replacement Program		150	200	8.2	3	N/A	Local	$1,140	0.9	$1,026	$8,417
44	PPE-151C8	EAGLE ST		Asset Replacement Program		150	200	14.2	3	N/A	Local	$1,140	0.9	$1,026	$14,546
44	PPE-552C8	LYNN CR		Asset Replacement Program		150	200	17.9	3	N/A	Local	$1,140	0.9	$1,026	$18,363
44	PPE-551C8	LYNN CR		Asset Replacement Program		150	200	22.5	3	N/A	Local	$1,140	0.9	$1,026	$23,048
44	PPE-92C8	LYNN AVE		Asset Replacement Program		150	200	23.0	3	N/A	Local	$1,140	0.9	$1,026	$23,595
44	PPE-156C8	LYNN CR		Asset Replacement Program		150	200	42.7	3	N/A	Local	$1,140	0.9	$1,026	$43,781
44	PPE-90C8	WESTBURY AVE		Asset Replacement Program		200	200	46.7	3	N/A	Local	$1,140	0.9	$1,026	$47,897
44	PPE-96C8	WESTBURY AVE		Asset Replacement Program		200	200	100.1	3	N/A	Local	$1,140	0.9	$1,026	$102,710
44	PPE-112C8	LYNN AVE		Asset Replacement Program		150	200	102.2	3	N/A	Local	$1,140	0.9	$1,026	$104,890
44	PPE-95C8	WESTBURY AVE		Asset Replacement Program		200	200	111.4	3	N/A	Local	$1,140	0.9	$1,026	$114,274
44	PPE-922C8	WESTBURY AVE		Asset Replacement Program		200	200	113.6	3	N/A	Local	$1,140	0.9	$1,026	$116,538
44	PPE-101C8	WESTBURY AVE		Asset Replacement Program		200	200	125.6	3	N/A	Local	$1,140	0.9	$1,026	$128,829
44	PPE-100C8	WESTBURY AVE		Asset Replacement Program		200	200	156.6	3	N/A	Local	$1,140	0.9	$1,026	$160,643
44	PPE-113C8	LYNN AVE		Asset Replacement Program		150	200	161.0	3	N/A	Local	$1,140	0.9	$1,026	$165,164
44	PPE-152C8	EAGLE ST		Asset Replacement Program		150	200	167.3	3	N/A	Local	$1,140	0.9	$1,026	$171,669
45	PPE-1686C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	100	200	44.2	2	2021	Local	$1,140	0.9	$1,026	$45,370
45	PPE-896C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	100	200	57.5	2	2021	Local	$1,140	0.9	$1,026	$58,981
45	PPE-136C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	100	200	129.9	2	2021	Local	$1,140	0.9	$1,026	$133,317
45	PPE-121C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	150	200	3.1	3	2021	Local	$1,140	0.9	$1,026	$3,217
45	PPE-895C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	100	200	4.8	3	2021	Local	$1,140	0.9	$1,026	$4,920
45	PPE-120C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	150	200	21.6	3	2021	Local	$1,140	0.9	$1,026	$22,115
45	PPE-122C8	RAINBOW AVE		Asset Replacement Program	Fire Flow	150	200	63.3	3	2021	Local	$1,140	0.9	$1,026	$64,988
46	PPE-882C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	100	250	54.8	1	2021	Local	$1,210	0.9	$1,089	$59,659
46	PPE-1702C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	100	250	76.3	1	2021	Local	$1,210	0.9	$1,089	$83,066
46	PPE-140C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	100	250	88.6	1	2021	Local	$1,210	0.9	$1,089	$96,522
46	PPE-884C8	HOLLAND AVE		Asset Replacement Program - Upsized		100	250	109.2	1	2021	Local	$1,210	0.9	$1,089	$118,869
46	PPE-224908	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	1.0	2	2021	Local	$1,210	0.9	$1,089	$1,102
46	PPE-1700C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	100	250	9.5	2	2021	Local	$1,210	0.9	$1,089	$10,326
46	PPE-881C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	100	250	9.7	2	2021	Local	$1,210	0.9	$1,089	$10,571
46	PPE-883C8	HOLLAND AVE		Asset Replacement Program - Upsized	Continuity with ARP	100	250	10.3	2	2021	Local	$1,210	0.9	$1,089	$11,179
46	PPE-880C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	200	250	10.4	2	2021	Local	$1,210	0.9	$1,089	$11,278
46	PPE-879C8	HOLLAND AVE		Asset Replacement Program - Upsized	Continuity with ARP	200	250	12.7	2	2021	Local	$1,210	0.9	$1,089	$13,866
46	PPE-116C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	18.7	2	2021	Local	$1,210	0.9	$1,089	$20,363
46	PPE-115C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	20.4	2	2021	Local	$1,210	0.9	$1,089	$22,223
46	PPE-117C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	29.4	2	2021	Local	$1,210	0.9	$1,089	$32,016
46	PPE-118C8	HOLLAND AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	30.5	2	2021	Local	$1,210	0.9	$1,089	$33,209
46	PPE-HOLLAND-01	HOLLAND AVE		New Pipe Loop	Continuity with ARP	N/A	250	103.9	2	2021	Arterial	$1,210	1.2	$1,452	$150,803
46	PPE-110C8	HOLLAND AVE		Pipe Upgrade	Continuity with ARP	150	250	2.0	2	2021	Local	$1,210	0.9	$1,089	$2,168
46	PPE-114C8	HOLLAND AVE		Pipe Upgrade	Continuity with ARP	150	250	70.8	2	2021	Local	$1,210	0.9	$1,089	$77,065
47	PPE-728C8	WESTBURY AVE		Asset Replacement Program	Fire Flow	150	200	152.9	2	2021	Local	$1,140	0.9	$1,026	$156,863
47	PPE-197C8	WESTBURY AVE		Asset Replacement Program	Fire Flow	150	200	261.0	2	2021	Local	$1,140	0.9	$1,026	$267,752
48	PPE-364C8	COTTAGE LANE		Pipe Upgrade	Fire Flow	150	200	3.7	3	2016	Local	$1,140	0.9	$1,026	$3,753
48	PPE-363C8	COTTAGE LANE		Pipe Upgrade	Fire Flow	150	200	59.7	3	2016	Local	$1,140	0.9	$1,026	$61,258
48	PPE-355C8	COTTAGE LANE		Pipe Upgrade	Fire Flow	150	200	67.9	3	2016	Local	$1,140	0.9	$1,026	$69,681
48	PPE-368C8	COTTAGE LANE		Pipe Upgrade	Fire Flow	150	200	32.3	3	2016	Arterial	$1,140	1.2	$1,368	$44,159
48	PPE-367C8	COTTAGE LANE		Pipe Upgrade	Fire Flow	150	200	96.2	3	2016	Arterial	$1,140	1.2	$1,368	$131,577
49	PPE-240452	FERN ST		Asset Replacement Program - Upsized	Fire Flow	200	250	6.5	3	2016	Local	$1,210	0.9	$1,089	$7,088
49	PPE-200C9	FERN ST		Asset Replacement Program - Upsized	Fire Flow	200	250	38.4	3	2016	Local	$1,210	0.9	$1,089	$41,794
50	PPE-1024D8	SWITZER AVE		Asset Replacement Program		300	300	136.2	2	N/A	Local	$1,320	0.9	$1,188	$161,746
51	PPE-160D8	ALLIANCE ST		Asset Replacement Program - Upsized		150	250	3.0	3	N/A	Local	$1,210	0.9	$1,089	$3,263
51	PPE-158D8	ALLIANCE ST		Asset Replacement Program - Upsized		150	250	9.8	3	N/A	Local	$1,210	0.9	$1,089	$10,625
51	PPE-157D8	WALSH AVE		Asset Replacement Program - Upsized		150	250	125.9	3	N/A	Local	$1,210	0.9	$1,089	$137,119
51	PPE-109D8	WALSH AVE		Asset Replacement Program - Upsized		150	250	5.3	2	N/A	Collector	$1,210	1.1	$1,331	$7,053
52	PPE-374D8	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	150	300	10.8	2	2016	Arterial	$1,320	1.2	$1,584	$17,031
52	PPE-377D8	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	150	300	14.2	2	2016	Arterial	$1,320	1.2	$1,584	$22,545
52	PPE-375D8	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	150	300	50.0	2	2016	Arterial	$1,320	1.2	$1,584	$79,189
52	PPE-388D8	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	150	300	79.9	2	2016	Arterial	$1,320	1.2	$1,584	$126,634
52	PPE-376D8	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	150	300	149.7	2	2016	Arterial	$1,320	1.2	$1,584	$237,076
52	PPE-235709	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	150	300	0.3	3	2016	Arterial	$1,320	1.2	$1,584	$510

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
52	PPE-235669	GEORGE FERGUSON WAY		Asset Replacement Program - Upsized	Fire Flow	200	300	5.0	3	2016	Arterial	$1,320	1.2	$1,584	$7,996
53	PPE-730D8	BABICH ST		Asset Replacement Program		100	200	5.6	2	N/A	Local	$1,140	0.9	$1,026	$5,796
53	PPE-731D8	BABICH ST		Asset Replacement Program		100	200	120.3	2	N/A	Local	$1,140	0.9	$1,026	$123,383
54	PPE-916D8	LAURNELL CR		Asset Replacement Program		150	200	7.7	3	2036	Local	$1,140	0.9	$1,026	$7,916
54	PPE-352D8	HUGGINS AVE		Asset Replacement Program		150	200	9.7	3	2036	Local	$1,140	0.9	$1,026	$9,952
54	PPE-345D8	MOUNTVIEW ST		Asset Replacement Program		150	200	11.1	3	2036	Local	$1,140	0.9	$1,026	$11,436
54	PPE-358D8	ARLINGTON ST		Asset Replacement Program		150	200	16.7	3	2036	Local	$1,140	0.9	$1,026	$17,174
54	PPE-351D8	HUGGINS AVE		Asset Replacement Program		150	200	24.9	3	2036	Local	$1,140	0.9	$1,026	$25,580
54	PPE-339D8	LAURNELL CR		Asset Replacement Program		150	200	27.6	3	2036	Local	$1,140	0.9	$1,026	$28,311
54	PPE-354D8	HUGGINS AVE		Asset Replacement Program		150	200	32.5	3	2036	Local	$1,140	0.9	$1,026	$33,299
54	PPE-364D8	LAURNELL CR		Asset Replacement Program		150	200	34.2	3	2036	Local	$1,140	0.9	$1,026	$35,128
54	PPE-329D8	HUGGINS AVE		Asset Replacement Program		150	200	40.1	3	2036	Local	$1,140	0.9	$1,026	$41,101
54	PPE-357D8	ARLINGTON ST		Asset Replacement Program		150	200	44.2	3	2036	Local	$1,140	0.9	$1,026	$45,388
54	PPE-347D8	MOUNTVIEW ST		Asset Replacement Program		150	200	48.7	3	2036	Local	$1,140	0.9	$1,026	$49,957
54	PPE-359D8	ARLINGTON ST		Asset Replacement Program		150	200	53.3	3	2036	Local	$1,140	0.9	$1,026	$54,688
54	PPE-344D8	MOUNTVIEW ST		Asset Replacement Program		150	200	57.3	3	2036	Local	$1,140	0.9	$1,026	$58,761
54	PPE-367D8	AURORA PL		Asset Replacement Program		100	200	62.7	3	2036	Local	$1,140	0.9	$1,026	$64,294
54	PPE-353D8	HUGGINS AVE		Asset Replacement Program		150	200	63.9	3	2036	Local	$1,140	0.9	$1,026	$65,607
54	PPE-363D8	CONWAY PL		Asset Replacement Program		100	200	67.8	3	2036	Local	$1,140	0.9	$1,026	$69,530
54	PPE-346D8	MOUNTVIEW ST		Asset Replacement Program		150	200	76.5	3	2036	Local	$1,140	0.9	$1,026	$78,439
54	PPE-341D8	LAURNELL CR		Asset Replacement Program		150	200	83.9	3	2036	Local	$1,140	0.9	$1,026	$86,126
54	PPE-365D8	LAURNELL CR		Asset Replacement Program		150	200	88.3	3	2036	Local	$1,140	0.9	$1,026	$90,586
54	PPE-350D8	AVONDALE AVE		Asset Replacement Program		150	200	99.3	3	2036	Local	$1,140	0.9	$1,026	$101,907
54	PPE-361D8	HUGGINS AVE		Asset Replacement Program		150	200	109.9	3	2036	Local	$1,140	0.9	$1,026	$112,807
54	PPE-362D8	LAURNELL CR		Asset Replacement Program		150	200	127.5	3	2036	Local	$1,140	0.9	$1,026	$130,799
54	PPE-369D8	SILVERTREE CT		Pipe Upgrade	Continuity with ARP	150	200	43.9	3	2036	Local	$1,140	0.9	$1,026	$45,077
55	PPE-620D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	10.4	1	2016	Collector	$1,210	1.1	$1,331	$13,784
55	PPE-933D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	21.4	1	2016	Collector	$1,210	1.1	$1,331	$28,511
55	PPE-614D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	30.6	1	2016	Collector	$1,210	1.1	$1,331	$40,706
55	PPE-859D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	53.7	1	2016	Collector	$1,210	1.1	$1,331	$71,445
55	PPE-623D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	112.5	1	2016	Collector	$1,210	1.1	$1,331	$149,702
55	PPE-619D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	147.4	1	2016	Collector	$1,210	1.1	$1,331	$196,180
55	PPE-622D9	MOREY AVE		Asset Replacement Program - Upsized	Fire Flow	150	250	198.3	1	2016	Collector	$1,210	1.1	$1,331	$263,888
55	PPE-939D9	MOREY AVE		Asset Replacement Program - Upsized	Continuity with ARP	150	250	4.5	2	2016	Collector	$1,210	1.1	$1,331	$5,990
56	PPE-1098D9	ABB MISSION HWY		Asset Replacement Program	Continuity with ARP	200	250	1.7	3	N/A	Provincial Highway	$1,210	1.3	$1,573	$2,734
56	PPE-318E9	ENTERPRISE AVE		Asset Replacement Program		200	250	1.1	2	N/A	Collector	$1,210	1.1	$1,331	$1,402
56	PPE-267E9	MACLURE RD		Asset Replacement Program		200	250	1.3	2	N/A	Collector	$1,210	1.1	$1,331	$1,672
56	PPE-263E9	ENTERPRISE AVE		Asset Replacement Program		200	250	12.4	2	N/A	Collector	$1,210	1.1	$1,331	$16,488
56	PPE-130E9	ENTERPRISE AVE		Asset Replacement Program		200	250	31.5	2	N/A	Collector	$1,210	1.1	$1,331	$41,869
56	PPE-4E9	MACLURE RD		Asset Replacement Program		200	250	43.8	2	N/A	Collector	$1,210	1.1	$1,331	$58,262
56	PPE-3E9	MACLURE RD		Asset Replacement Program		200	250	46.4	2	N/A	Collector	$1,210	1.1	$1,331	$61,818
56	PPE-44E9	ENTERPRISE AVE		Asset Replacement Program		200	250	49.9	2	N/A	Collector	$1,210	1.1	$1,331	$66,437
56	PPE-240E9	ENTERPRISE AVE		Asset Replacement Program		200	250	56.6	2	N/A	Collector	$1,210	1.1	$1,331	$75,273
56	PPE-129E9	ENTERPRISE AVE		Asset Replacement Program		200	250	71.4	2	N/A	Collector	$1,210	1.1	$1,331	$95,024
56	PPE-1266D9	TURNER ST		Asset Replacement Program	Continuity with ARP	200	250	2.1	3	N/A	Collector	$1,210	1.1	$1,331	$2,739
56	PPE-241E9	ENTERPRISE AVE		Asset Replacement Program	Continuity with ARP	200	250	3.8	3	N/A	Collector	$1,210	1.1	$1,331	$5,056
56	PPE-246E9	ENTERPRISE AVE		Asset Replacement Program	Continuity with ARP	200	250	4.7	3	N/A	Collector	$1,210	1.1	$1,331	$6,270
56	PPE-262E9	ENTERPRISE AVE		Asset Replacement Program	Continuity with ARP	200	250	5.4	3	N/A	Collector	$1,210	1.1	$1,331	$7,190
56	PPE-34E9	MCCALLUM RD		Asset Replacement Program		200	250	1.7	2	N/A	Arterial	$1,210	1.2	$1,452	$2,493
56	PPE-138E9	ENTERPRISE AVE		Asset Replacement Program		200	250	20.5	2	N/A	Arterial	$1,210	1.2	$1,452	$29,706
57	PPE-376E9	HAZELWOOD AVE		Asset Replacement Program	Continuity with ARP	200	250	1.9	3	N/A	Provincial Highway	$1,210	1.3	$1,573	$3,009
57	PPE-372E9	HAZELWOOD AVE		Asset Replacement Program	Continuity with ARP	200	250	2.0	3	N/A	Provincial Highway	$1,210	1.3	$1,573	$3,144
57	PPE-218E9	INDUSTRIAL AVE		Asset Replacement Program		200	250	11.0	2	N/A	Collector	$1,210	1.1	$1,331	$14,640
57	PPE-217E9	INDUSTRIAL AVE		Asset Replacement Program		200	250	14.3	2	N/A	Collector	$1,210	1.1	$1,331	$19,072
57	PPE-15E9	INDUSTRIAL AVE		Asset Replacement Program		200	250	45.1	2	N/A	Collector	$1,210	1.1	$1,331	$60,081
57	PPE-234E9	INDUSTRIAL AVE		Asset Replacement Program		200	250	92.7	2	N/A	Collector	$1,210	1.1	$1,331	$123,380
57	PPE-519E9	INDUSTRIAL AVE		Asset Replacement Program	Continuity with ARP	200	250	8.7	3	N/A	Collector	$1,210	1.1	$1,331	$11,633
57	PPE-520E9	INDUSTRIAL AVE		Asset Replacement Program	Continuity with ARP	200	250	16.7	3	N/A	Collector	$1,210	1.1	$1,331	$22,272
58	PPE-148C6	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	7.1	2	2016	Collector	$1,210	1.1	$1,331	$9,501
58	PPE-142C6	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	60.9	2	2016	Collector	$1,210	1.1	$1,331	$81,114
58	PPE-459C6	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	94.6	2	2016	Collector	$1,210	1.1	$1,331	$125,851
58	PPE-145C6	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	123.6	2	2016	Collector	$1,210	1.1	$1,331	$164,566
58	PPE-371C6	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	292.3	2	2016	Collector	$1,210	1.1	$1,331	$389,063
58	PPE-235465	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	14.2	2	2016	Arterial	$1,210	1.2	$1,452	$20,633
58	PPE-235447	PARAMOUNT CR		Pipe Upgrade	Fire Flow	200	250	17.6	2	2016	Arterial	$1,210	1.2	$1,452	$25,596
59	PPE-26E9	VALLEY RD		Pipe Upgrade	Fire Flow	200	250	229.2	2	2016	Local	$1,210	0.9	$1,089	$249,637
59	PPE-29E9	VALLEY RD		Pipe Upgrade	Fire Flow	200	250	259.2	2	2016	Local	$1,210	0.9	$1,089	$282,223
59	PPE-419E9	VALLEY RD		Pipe Upgrade	Fire Flow	200	250	2.9	2	2016	Provincial Highway	$1,210	1.3	$1,573	$4,579
59	PPE-400E9	VALLEY RD		Pipe Upgrade	Fire Flow	200	250	3.0	2	2016	Provincial Highway	$1,210	1.3	$1,573	$4,719
60	PPE-413E10	LABURNUM AVE		Asset Replacement Program	Fire Flow	150	200	4.1	2	2016	Collector	$1,140	1.1	$1,254	$5,098
60	PPE-430E10	LABURNUM AVE		Asset Replacement Program	Fire Flow	150	200	11.3	2	2016	Collector	$1,140	1.1	$1,254	$14,131
60	PPE-126E9	LABURNUM AVE		Asset Replacement Program	Fire Flow	200	200	15.0	2	2016	Collector	$1,140	1.1	$1,254	$18,828
60	PPE-428E10	LABURNUM AVE		Asset Replacement Program	Fire Flow	150	200	61.1	2	2016	Collector	$1,140	1.1	$1,254	$76,644
60	PPE-410E10	LABURNUM AVE		Asset Replacement Program	Fire Flow	150	200	96.4	2	2016	Collector	$1,140	1.1	$1,254	$120,833
60	PPE-158E9	LABURNUM AVE		Asset Replacement Program	Fire Flow	150	200	110.6	2	2016	Collector	$1,140	1.1	$1,254	$138,746
60	PPE-149E9	LABURNUM AVE		Asset Replacement Program	Fire Flow	200	200	132.2	2	2016	Collector	$1,140	1.1	$1,254	$165,834
60	PPE-447E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	2.1	2	2016	Collector	$1,140	1.1	$1,254	$2,588
60	PPE-441E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	15.0	2	2016	Collector	$1,140	1.1	$1,254	$18,752
60	PPE-490E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	29.2	2	2016	Collector	$1,140	1.1	$1,254	$36,664
60	PPE-440E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	50.0	2	2016	Collector	$1,140	1.1	$1,254	$62,740

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
60	PPE-446E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	72.7	2	2016	Collector	$1,140	1.1	$1,254	$91,147
60	PPE-437E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	76.0	2	2016	Collector	$1,140	1.1	$1,254	$95,304
60	PPE-442E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	90.4	2	2016	Collector	$1,140	1.1	$1,254	$113,319
60	PPE-486E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	141.9	2	2016	Collector	$1,140	1.1	$1,254	$177,956
60	PPE-478E10	LABURNUM AVE		Pipe Upgrade	Fire Flow	150	200	158.0	2	2016	Collector	$1,140	1.1	$1,254	$198,087
61	PPE-124E9	IMMEL ST		Asset Replacement Program	Fire Flow	200	200	16.0	3	2026	Local	$1,140	0.9	$1,026	$16,429
61	PPE-125E9	IMMEL ST		Asset Replacement Program	Fire Flow	200	200	70.2	3	2026	Local	$1,140	0.9	$1,026	$71,979
61	PPE-785E10	IMMEL ST		Asset Replacement Program	Fire Flow	200	200	70.9	3	2026	Local	$1,140	0.9	$1,026	$72,765
62	PPE-482E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	2.5	3	2026	Local	$1,140	0.9	$1,026	$2,614
62	PPE-415E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	10.6	3	2026	Local	$1,140	0.9	$1,026	$10,888
62	PPE-1070E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	26.0	3	2026	Local	$1,140	0.9	$1,026	$26,664
62	PPE-399E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	27.2	3	2026	Local	$1,140	0.9	$1,026	$27,901
62	PPE-435E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	61.9	3	2026	Local	$1,140	0.9	$1,026	$63,465
62	PPE-385E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	63.4	3	2026	Local	$1,140	0.9	$1,026	$65,027
62	PPE-471E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	89.8	3	2026	Local	$1,140	0.9	$1,026	$92,170
62	PPE-439E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	10.4	2	2026	Collector	$1,140	1.1	$1,254	$12,994
63	PPE-377E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	6.0	3	2016	Local	$1,140	0.9	$1,026	$6,108
63	PPE-340E10	SUSSEX ST		Asset Replacement Program	Fire Flow	150	200	7.0	3	2016	Local	$1,140	0.9	$1,026	$7,154
63	PPE-337E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	18.6	3	2016	Local	$1,140	0.9	$1,026	$19,079
63	PPE-417E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	19.3	3	2016	Local	$1,140	0.9	$1,026	$19,764
63	PPE-333E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	42.4	3	2016	Local	$1,140	0.9	$1,026	$43,484
63	PPE-335E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	52.4	3	2016	Local	$1,140	0.9	$1,026	$53,724
63	PPE-334E10	MIERAU ST		Asset Replacement Program	Fire Flow	200	200	72.4	3	2016	Local	$1,140	0.9	$1,026	$74,235
63	PPE-369E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	76.1	3	2016	Local	$1,140	0.9	$1,026	$78,108
63	PPE-378E10	TUDOR CT		Asset Replacement Program	Fire Flow	150	200	81.7	3	2016	Local	$1,140	0.9	$1,026	$83,810
63	PPE-408E10	SUSSEX ST		Asset Replacement Program	Fire Flow	150	200	125.4	3	2016	Local	$1,140	0.9	$1,026	$128,668
63	PPE-418E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	164.3	3	2016	Local	$1,140	0.9	$1,026	$168,566
64	PPE-243679	PICTON ST		Asset Replacement Program	Fire Flow	150	200	7.2	3	2016	Local	$1,140	0.9	$1,026	$7,436
64	PPE-405E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	12.2	3	2016	Local	$1,140	0.9	$1,026	$12,552
64	PPE-353E10	ETON CR		Asset Replacement Program	Fire Flow	150	200	18.6	3	2016	Local	$1,140	0.9	$1,026	$19,055
64	PPE-402E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	20.3	3	2016	Local	$1,140	0.9	$1,026	$20,878
64	PPE-323E10	DONLYN AVE		Asset Replacement Program	Fire Flow	150	200	23.7	3	2016	Local	$1,140	0.9	$1,026	$24,299
64	PPE-383E10	ETON CR		Asset Replacement Program	Fire Flow	150	200	28.0	3	2016	Local	$1,140	0.9	$1,026	$28,714
64	PPE-391E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	35.9	3	2016	Local	$1,140	0.9	$1,026	$36,792
64	PPE-403E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	37.9	3	2016	Local	$1,140	0.9	$1,026	$38,925
64	PPE-308E10	DONLYN AVE		Asset Replacement Program	Fire Flow	150	200	38.7	3	2016	Local	$1,140	0.9	$1,026	$39,721
64	PPE-305E10	DONLYN AVE		Asset Replacement Program	Fire Flow	150	200	41.1	3	2016	Local	$1,140	0.9	$1,026	$42,156
64	PPE-382E10	PICTON ST		Asset Replacement Program	Fire Flow	150	200	42.9	3	2016	Local	$1,140	0.9	$1,026	$44,060
64	PPE-306E10	DONLYN AVE		Asset Replacement Program	Fire Flow	150	200	45.4	3	2016	Local	$1,140	0.9	$1,026	$46,577
64	PPE-396E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	60.3	3	2016	Local	$1,140	0.9	$1,026	$61,890
64	PPE-400E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	69.5	3	2016	Local	$1,140	0.9	$1,026	$71,346
64	PPE-354E10	PICTON ST		Asset Replacement Program	Fire Flow	150	200	71.0	3	2016	Local	$1,140	0.9	$1,026	$72,845
64	PPE-1046E10	DONLYN AVE		Asset Replacement Program	Fire Flow	150	200	87.6	3	2016	Local	$1,140	0.9	$1,026	$89,833
64	PPE-407E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	93.9	3	2016	Local	$1,140	0.9	$1,026	$96,386
64	PPE-404E10	ASCOTT AVE		Asset Replacement Program	Fire Flow	150	200	99.0	3	2016	Local	$1,140	0.9	$1,026	$101,590
64	PPE-310E10	DONLYN AVE		Asset Replacement Program	Fire Flow	150	200	123.2	3	2016	Local	$1,140	0.9	$1,026	$126,357
64	PPE-351E10	ETON CR		Asset Replacement Program	Fire Flow	150	200	134.4	3	2016	Local	$1,140	0.9	$1,026	$137,867
64	PPE-363E10	ETON CR		Asset Replacement Program	Fire Flow	150	200	148.4	3	2016	Local	$1,140	0.9	$1,026	$152,272
65	PPE-AIRPORT-12	Airport		New Pipe Loop	Fire Flow	N/A	250	5.3	2	2021	Collector	$1,210	1.1	$1,331	$7,096
65	PPE-AIRPORT-16	Airport		New Pipe Loop	Fire Flow	N/A	250	7.3	2	2021	Collector	$1,210	1.1	$1,331	$9,708
65	PPE-AIRPORT-07	Airport		New Pipe Loop	Fire Flow	N/A	250	7.3	2	2021	Collector	$1,210	1.1	$1,331	$9,771
65	PPE-AIRPORT-19	Airport		New Pipe Loop	Fire Flow	N/A	250	9.7	2	2021	Collector	$1,210	1.1	$1,331	$12,949
65	PPE-AIRPORT-13	Airport		New Pipe Loop	Fire Flow	N/A	250	16.6	2	2021	Collector	$1,210	1.1	$1,331	$22,032
65	PPE-AIRPORT-15	Airport		New Pipe Loop	Fire Flow	N/A	250	29.2	2	2021	Collector	$1,210	1.1	$1,331	$38,815
65	PPE-AIRPORT-06	Airport		New Pipe Loop	Fire Flow	N/A	250	30.7	2	2021	Collector	$1,210	1.1	$1,331	$40,859
65	PPE-AIRPORT-30	Airport		New Pipe Loop	Fire Flow	N/A	250	30.9	2	2021	Collector	$1,210	1.1	$1,331	$41,192
65	PPE-AIRPORT-11	Airport		New Pipe Loop	Fire Flow	N/A	250	36.2	2	2021	Collector	$1,210	1.1	$1,331	$48,145
65	PPE-AIRPORT-10	Airport		New Pipe Loop	Fire Flow	N/A	250	43.7	2	2021	Collector	$1,210	1.1	$1,331	$58,134
65	PPE-AIRPORT-09	Airport		New Pipe Loop	Fire Flow	N/A	250	49.3	2	2021	Collector	$1,210	1.1	$1,331	$65,658
65	PPE-AIRPORT-14	Airport		New Pipe Loop	Fire Flow	N/A	250	60.0	2	2021	Collector	$1,210	1.1	$1,331	$79,867
65	PPE-AIRPORT-20	Airport		New Pipe Loop	Fire Flow	N/A	250	77.7	2	2021	Collector	$1,210	1.1	$1,331	$103,413
65	PPE-AIRPORT-08	Airport		New Pipe Loop	Fire Flow	N/A	250	79.4	2	2021	Collector	$1,210	1.1	$1,331	$105,708
65	PPE-AIRPORT-21	Airport		New Pipe Loop	Fire Flow	N/A	250	114.5	2	2021	Collector	$1,210	1.1	$1,331	$152,345
65	PPE-AIRPORT-17	Airport		New Pipe Loop	Fire Flow	N/A	250	131.5	2	2021	Collector	$1,210	1.1	$1,331	$175,077
65	PPE-AIRPORT-18	Airport		New Pipe Loop	Fire Flow	N/A	250	150.0	2	2021	Collector	$1,210	1.1	$1,331	$199,610
65	PPE-AIRPORT-31	Airport		New Pipe Loop	Fire Flow	N/A	250	265.7	2	2021	Collector	$1,210	1.1	$1,331	$353,647
65	PPE-AIRPORT-32	Airport		New Pipe Loop	Fire Flow	N/A	250	360.6	2	2021	Collector	$1,210	1.1	$1,331	$480,000
66	PPE-HORN-01	HORN ST		New Pipe Loop	Fire Flow	N/A	200	120.3	2	2021	Local	$1,140	0.9	$1,026	$123,421
67	PPE-375E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	21.5	2	2016	Collector	$1,210	1.1	$1,331	$28,617
67	PPE-356E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	27.9	2	2016	Collector	$1,210	1.1	$1,331	$37,130
67	PPE-248E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	46.3	2	2016	Collector	$1,210	1.1	$1,331	$61,581
67	PPE-411E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	59.6	2	2016	Collector	$1,210	1.1	$1,331	$79,324
67	PPE-278E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	74.9	2	2016	Collector	$1,210	1.1	$1,331	$99,716
67	PPE-297E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	77.9	2	2016	Collector	$1,210	1.1	$1,331	$103,700
67	PPE-343E10	OLD CLAYBURN RD		Pipe Upgrade	Fire Flow	150	250	95.9	2	2016	Collector	$1,210	1.1	$1,331	$127,590
68	PPE-503E10	OLD CLAYBURN RD		Asset Replacement Program - Upsized		200	250	3.6	2	N/A	Collector	$1,210	1.1	$1,331	$4,734
68	PPE-712E10	R/W N OF OLD CLAYBURN RD		Asset Replacement Program - Upsized		150	250	15.8	3	N/A	Arterial	$1,210	1.2	$1,452	$22,987
68	PPE-792E10	R/W N OF OLD CLAYBURN RD		Asset Replacement Program - Upsized		150	250	112.4	3	N/A	Arterial	$1,210	1.2	$1,452	$163,215
69	PPE-535E10	HIGH DR		Asset Replacement Program		200	200	7.2	3	2016	Local	$1,140	0.9	$1,026	$7,436
69	PPE-510E10	HIGH DR		Asset Replacement Program		200	200	93.9	3	2016	Local	$1,140	0.9	$1,026	$96,315

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
69	PPE-533E10	HIGH DR		Asset Replacement Program		200	200	156.0	3	2016	Local	$1,140	0.9	$1,026	$160,044
69	PPE-583E10	HIGH DR		Asset Replacement Program - Upsized		150	250	64.6	1	2016	Local	$1,210	0.9	$1,089	$70,366
69	PPE-1373E10	HIGH DR		Asset Replacement Program - Upsized		150	250	13.1	1	2016	Collector	$1,210	1.1	$1,331	$17,403
69	PPE-1372E10	HIGH DR		Asset Replacement Program - Upsized	Continuity with ARP	150	250	0.5	2	2016	Collector	$1,210	1.1	$1,331	$666
69	PPE-1370E10	HIGH DR		Asset Replacement Program - Upsized	Continuity with ARP	200	250	3.1	2	2016	Collector	$1,210	1.1	$1,331	$4,126
69	PPE-1381D10	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	150	250	3.8	2	2016	Collector	$1,210	1.1	$1,331	$5,074
69	PPE-548E10	HIGH DR		Pipe Upgrade	Continuity with ARP	150	200	25.0	2	2016	Local	$1,140	0.9	$1,026	$25,641
69	PPE-584E10	HIGH DR		Pipe Upgrade	Continuity with ARP	150	200	112.0	2	2016	Local	$1,140	0.9	$1,026	$114,938
69	PPE-566E10	HIGH DR		Pipe Upgrade	Continuity with ARP	150	200	121.4	2	2016	Local	$1,140	0.9	$1,026	$124,580
69	PPE-545E10	HIGH DR		Pipe Upgrade	Continuity with ARP	150	200	174.0	2	2016	Local	$1,140	0.9	$1,026	$178,493
70	PPE-542E10	MARVERN WAY		Asset Replacement Program	Fire Flow	100	200	36.3	2	2016	Local	$1,140	0.9	$1,026	$37,198
70	PPE-523E10	ARDEN DR		Asset Replacement Program	Fire Flow	100	200	12.7	3	2016	Local	$1,140	0.9	$1,026	$13,071
70	PPE-468E10	MARVERN WAY		Asset Replacement Program	Continuity with ARP	100	200	22.2	3	2016	Local	$1,140	0.9	$1,026	$22,778
70	PPE-522E10	MARVERN WAY		Asset Replacement Program	Continuity with ARP	100	200	161.8	3	2016	Local	$1,140	0.9	$1,026	$166,051
70	PPE-MAVERN-01	MARVERN WAY		New Pipe Loop	Fire Flow	N/A	200	50.3	2	2016	Collector	$1,140	1.1	$1,254	$63,077
71	PPE-497E10	BEVERLEY CR		Asset Replacement Program	Fire Flow	100	200	45.2	3	2016	Local	$1,140	0.9	$1,026	$46,366
71	PPE-496E10	BEVERLEY CR		Asset Replacement Program	Fire Flow	100	200	54.6	3	2016	Local	$1,140	0.9	$1,026	$56,005
71	PPE-576E10	BEVERLEY CR		Asset Replacement Program	Fire Flow	100	200	174.7	3	2016	Local	$1,140	0.9	$1,026	$179,271
71	PPE-574E10	CHESTNUT ST		Asset Replacement Program	Fire Flow	100	200	175.1	3	2016	Local	$1,140	0.9	$1,026	$179,648
71	PPE-1359E10	OLD CLAYBURN RD		Asset Replacement Program	Fire Flow	100	200	5.9	3	2016	Collector	$1,140	1.1	$1,254	$7,337
71	PPE-1327E10	OLD CLAYBURN RD		Asset Replacement Program	Fire Flow	100	200	10.6	3	2016	Collector	$1,140	1.1	$1,254	$13,233
72	PPE-1218E10	IMMEL ST		Asset Replacement Program		300	300	1.0	2	N/A	Local	$1,320	0.9	$1,188	$1,188
72	PPE-156E9	MACLURE RD		Asset Replacement Program		250	300	6.0	2	N/A	Local	$1,320	0.9	$1,188	$7,128
72	PPE-157E9	MACLURE RD		Asset Replacement Program		250	300	18.0	2	N/A	Local	$1,320	0.9	$1,188	$21,384
72	PPE-155E9	MACLURE RD		Asset Replacement Program		250	300	12.5	3	N/A	Arterial	$1,320	1.2	$1,584	$19,870
72	PPE-617E10	IMMEL ST		Asset Replacement Program		300	300	256.3	3	N/A	Arterial	$1,320	1.2	$1,584	$405,959
73	PPE-53D10	DORSET PL		Asset Replacement Program		100	200	69.1	3	N/A	Local	$1,140	0.9	$1,026	$70,947
73	PPE-1706D10	OLD CLAYBURN RD		Asset Replacement Program	Continuity with ARP	150	200	2.5	3	N/A	Collector	$1,140	1.1	$1,254	$3,135
73	PPE-1754D10	OLD CLAYBURN RD		Asset Replacement Program	Continuity with ARP	100	200	3.3	3	N/A	Collector	$1,140	1.1	$1,254	$4,133
73	PPE-1703D10	OLD CLAYBURN RD		Asset Replacement Program	Continuity with ARP	100	200	3.9	3	N/A	Collector	$1,140	1.1	$1,254	$4,928
73	PPE-1708D10	OLD CLAYBURN RD		Asset Replacement Program	Continuity with ARP	150	200	15.4	3	N/A	Collector	$1,140	1.1	$1,254	$19,273
74	PPE-41D10	YORK AVE		Asset Replacement Program	Fire Flow	100	200	3.4	2	2021	Local	$1,140	0.9	$1,026	$3,442
74	PPE-40D10	YORK AVE		Asset Replacement Program	Fire Flow	100	200	98.0	2	2021	Local	$1,140	0.9	$1,026	$100,584
74	PPE-29D10	YORK AVE		Asset Replacement Program	Fire Flow	100	200	99.6	2	2021	Local	$1,140	0.9	$1,026	$102,217
74	PPE-28D10	YORK AVE		Asset Replacement Program	Fire Flow	100	200	138.2	2	2021	Local	$1,140	0.9	$1,026	$141,831
74	PPE-46D10	DEVON CR		Asset Replacement Program	Fire Flow	100	200	188.5	2	2021	Local	$1,140	0.9	$1,026	$193,397
74	PPE-1732D10	YORK AVE		Asset Replacement Program	Continuity with ARP	100	200	3.6	3	2021	Collector	$1,140	1.1	$1,254	$4,567
75	PPE-552D9	IMMEL ST		Asset Replacement Program - Upsized		150	250	17.9	1	2021	Provincial Highway	$1,210	1.3	$1,573	$28,198
75	PPE-517D9	IMMEL ST		Asset Replacement Program - Upsized		150	250	25.9	1	2021	Local	$1,210	0.9	$1,089	$28,246
75	PPE-775D9	IMMEL ST		Asset Replacement Program - Upsized		150	250	43.5	1	2021	Local	$1,210	0.9	$1,089	$47,424
75	PPE-774D9	IMMEL ST		Asset Replacement Program - Upsized		150	250	63.9	1	2021	Local	$1,210	0.9	$1,089	$69,614
75	PPE-37D10	OLD CLAYBURN RD		Asset Replacement Program - Upsized		150	250	1.3	1	2021	Collector	$1,210	1.1	$1,331	$1,730
75	PPE-1923D9	IMMEL ST		Asset Replacement Program - Upsized	Continuity with ARP	200	250	3.0	1	2021	Collector	$1,210	1.1	$1,331	$3,993
75	PPE-1921D9	IMMEL ST		Asset Replacement Program - Upsized		200	250	4.9	1	2021	Collector	$1,210	1.1	$1,331	$6,497
75	PPE-550D9	IMMEL ST		Asset Replacement Program - Upsized		200	250	13.6	1	2021	Collector	$1,210	1.1	$1,331	$18,060
75	PPE-551D9	IMMEL ST		Asset Replacement Program - Upsized		150	250	49.9	1	2021	Collector	$1,210	1.1	$1,331	$66,393
75	PPE-1723D10	OLD CLAYBURN RD		Asset Replacement Program - Upsized	Continuity with ARP	200	250	4.8	2	2021	Collector	$1,210	1.1	$1,331	$6,435
75	PPE-1413D9	IMMEL ST		Pipe Upgrade	Continuity with ARP	150	250	41.5	2	2021	Provincial Highway	$1,210	1.3	$1,573	$65,267
75	PPE-515D9	IMMEL ST		Pipe Upgrade	Continuity with ARP	150	250	54.0	2	2021	Provincial Highway	$1,210	1.3	$1,573	$84,939
75	PPE-1405D9	IMMEL ST		Pipe Upgrade	Continuity with ARP	150	250	74.0	2	2021	Provincial Highway	$1,210	1.3	$1,573	$116,410
76	PPE-23D10	KENT AVE		Asset Replacement Program		100	200	44.5	2	N/A	Local	$1,140	0.9	$1,026	$45,659
76	PPE-673D10	KENT AVE		Asset Replacement Program		100	200	202.8	2	N/A	Local	$1,140	0.9	$1,026	$208,058
76	PPE-21D10	KENT AVE		Asset Replacement Program		150	200	56.7	3	N/A	Local	$1,140	0.9	$1,026	$58,169
76	PPE-20D10	KENT AVE		Asset Replacement Program		150	200	99.3	3	N/A	Local	$1,140	0.9	$1,026	$101,879
77	PPE-1D10	PEARL AVE		Asset Replacement Program		150	200	20.0	3	N/A	Local	$1,140	0.9	$1,026	$20,513
77	PPE-2D10	PEARL AVE		Asset Replacement Program		150	200	82.0	3	N/A	Local	$1,140	0.9	$1,026	$84,160
78	PPE-503D9	REDWOOD AVE		Asset Replacement Program		100	200	84.0	2	N/A	Local	$1,140	0.9	$1,026	$86,219
78	PPE-508D9	REDWOOD AVE		Asset Replacement Program		100	200	154.2	2	N/A	Local	$1,140	0.9	$1,026	$158,230
78	PPE-502D9	REDWOOD AVE		Asset Replacement Program		100	200	186.1	2	N/A	Local	$1,140	0.9	$1,026	$190,945
78	PPE-511D9	CAMELLIA CT		Asset Replacement Program		150	200	69.7	3	N/A	Local	$1,140	0.9	$1,026	$71,461
79	PPE-518D10	GLENSHIEL DR		Pipe Upgrade	Fire Flow	150	200	2.0	2	2016	Local	$1,140	0.9	$1,026	$2,052
79	PPE-522D10	GLENSHIEL DR		Pipe Upgrade	Fire Flow	150	200	34.4	2	2016	Local	$1,140	0.9	$1,026	$35,302
79	PPE-519D10	GLENSHIEL DR		Pipe Upgrade	Fire Flow	150	200	93.5	2	2016	Local	$1,140	0.9	$1,026	$95,956
79	PPE-523D10	GLENSHIEL DR		Pipe Upgrade	Fire Flow	150	200	131.6	2	2016	Local	$1,140	0.9	$1,026	$134,998
79	PPE-569D10	GLENSHIEL DR		Pipe Upgrade	Fire Flow	150	200	10.0	2	2016	Collector	$1,140	1.1	$1,254	$12,586
80	PPE-339D9	ALDERVIEW ST		Asset Replacement Program		150	200	8.8	2	N/A	Local	$1,140	0.9	$1,026	$9,040
80	PPE-343D9	WOODRIDGE CR		Asset Replacement Program		150	200	41.5	2	N/A	Local	$1,140	0.9	$1,026	$42,558
80	PPE-345D9	WOODRIDGE CR		Asset Replacement Program		150	200	84.4	2	N/A	Local	$1,140	0.9	$1,026	$86,626
80	PPE-680D9	ALDERVIEW ST		Asset Replacement Program		150	200	116.5	2	N/A	Local	$1,140	0.9	$1,026	$119,548
80	PPE-342D9	SPRUCE ST		Asset Replacement Program		150	200	122.4	2	N/A	Local	$1,140	0.9	$1,026	$125,571
80	PPE-684D9	ALDERVIEW ST		Asset Replacement Program	Continuity with ARP	150	200	22.7	3	N/A	Local	$1,140	0.9	$1,026	$23,315
80	PPE-685D9	ALDERVIEW ST		Asset Replacement Program	Continuity with ARP	150	200	32.4	3	N/A	Local	$1,140	0.9	$1,026	$33,237
80	PPE-682D9	ALDER ST		Asset Replacement Program	Continuity with ARP	150	200	8.0	3	N/A	Arterial	$1,140	1.2	$1,368	$11,011
80	PPE-344D9	WOODRIDGE CR		Asset Replacement Program		150	200	66.2	3	N/A	Arterial	$1,140	1.2	$1,368	$90,538
81	PPE-368D9	MENDHAM ST		Asset Replacement Program		150	200	38.9	2	N/A	Local	$1,140	0.9	$1,026	$39,871
81	PPE-364D9	MENDHAM ST		Asset Replacement Program		150	200	47.8	2	N/A	Local	$1,140	0.9	$1,026	$49,018
81	PPE-369D9	MENDHAM ST		Asset Replacement Program		150	200	55.4	2	N/A	Local	$1,140	0.9	$1,026	$56,861
81	PPE-363D9	MENDHAM ST		Asset Replacement Program		150	200	127.7	2	N/A	Local	$1,140	0.9	$1,026	$131,016
81	PPE-2042D9	BECK RD		Asset Replacement Program	Continuity with ARP	200	250	10.3	3	N/A	Local	$1,210	0.9	$1,089	$11,191
81	PPE-240775	BECK RD		Asset Replacement Program		200	250	26.4	3	N/A	Local	$1,210	0.9	$1,089	$28,750

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
81	PPE-298D9	BECK RD		Asset Replacement Program		200	250	59.0	3	N/A	Local	$1,210	0.9	$1,089	$64,211
81	PPE-297D9	BECK RD		Asset Replacement Program		200	250	105.2	3	N/A	Local	$1,210	0.9	$1,089	$114,515
81	PPE-1809D9	MENDHAM ST		Asset Replacement Program	Continuity with ARP	150	200	9.6	3	N/A	Collector	$1,140	1.1	$1,254	$11,991
81	PPE-1813D9	BECK RD		Asset Replacement Program	Continuity with ARP	200	250	10.3	3	N/A	Collector	$1,210	1.1	$1,331	$13,709
82	PPE-2175D9	SUMAS WAY		Asset Replacement Program	Continuity with ARP	150	200	4.2	3	N/A	Provincial Highway	$1,140	1.3	$1,482	$6,199
82	PPE-2158D9	FRASER ST		Asset Replacement Program	Continuity with ARP	150	200	4.6	3	N/A	Provincial Highway	$1,140	1.3	$1,482	$6,817
82	PPE-29D9	FRASER ST		Asset Replacement Program		150	200	2.8	2	N/A	Local	$1,140	0.9	$1,026	$2,888
82	PPE-22D9	FRASER ST		Asset Replacement Program		150	200	6.9	2	N/A	Local	$1,140	0.9	$1,026	$7,036
82	PPE-23D9	FRASER ST		Asset Replacement Program		150	200	6.9	2	N/A	Local	$1,140	0.9	$1,026	$7,036
82	PPE-1385D9	FRASER ST		Asset Replacement Program		150	200	8.5	2	N/A	Local	$1,140	0.9	$1,026	$8,727
82	PPE-258D9	FRASER ST		Asset Replacement Program		150	200	11.3	2	N/A	Local	$1,140	0.9	$1,026	$11,576
82	PPE-987D9	FRASER ST		Asset Replacement Program		150	200	14.4	2	N/A	Local	$1,140	0.9	$1,026	$14,780
82	PPE-30D9	FRASER ST		Asset Replacement Program		150	200	17.6	2	N/A	Local	$1,140	0.9	$1,026	$18,017
82	PPE-976D9	FRASER ST		Asset Replacement Program		150	200	49.2	2	N/A	Local	$1,140	0.9	$1,026	$50,521
82	PPE-25D9	FRASER ST		Asset Replacement Program		150	200	55.2	2	N/A	Local	$1,140	0.9	$1,026	$56,677
82	PPE-261D9	FRASER ST		Asset Replacement Program		150	200	56.2	2	N/A	Local	$1,140	0.9	$1,026	$57,691
82	PPE-897D9	FRASER ST		Asset Replacement Program		150	200	65.3	2	N/A	Local	$1,140	0.9	$1,026	$66,947
82	PPE-21D9	FRASER ST		Asset Replacement Program		150	200	97.1	2	N/A	Local	$1,140	0.9	$1,026	$99,592
82	PPE-973D9	FRASER ST		Asset Replacement Program		150	200	134.7	2	N/A	Local	$1,140	0.9	$1,026	$138,158
82	PPE-26D9	FRASER ST		Asset Replacement Program		150	200	153.0	2	N/A	Local	$1,140	0.9	$1,026	$156,938
83	PPE-1387D10	BLACKHAM DR		Pipe Upgrade	Fire Flow	150	250	2.4	2	2021	Local	$1,210	0.9	$1,089	$2,572
83	PPE-226D10	BLACKHAM DR		Pipe Upgrade	Fire Flow	150	250	17.9	2	2021	Local	$1,210	0.9	$1,089	$19,477
83	PPE-225D10	BLACKHAM DR		Pipe Upgrade	Fire Flow	150	250	129.0	2	2021	Local	$1,210	0.9	$1,089	$140,437
84	PPE-231C11	MARSHALL RD		Pipe Upgrade	Continuity with ARP	150	300	1.0	3	2016	Collector	$1,320	1.1	$1,452	$1,455
84	PPE-250C11	MARSHALL RD		Pipe Upgrade	Continuity with ARP	150	300	75.9	3	2016	Collector	$1,320	1.1	$1,452	$110,218
85	PPE-8C10	SANDSTONE DR		Asset Replacement Program		150	200	12.1	3	2016	Local	$1,140	0.9	$1,026	$12,430
85	PPE-10C10	SANDSTONE DR		Asset Replacement Program		150	200	22.9	3	2016	Local	$1,140	0.9	$1,026	$23,454
85	PPE-13C10	SANDSTONE DR		Asset Replacement Program		150	200	113.9	3	2016	Local	$1,140	0.9	$1,026	$116,851
85	PPE-399C10	SANDSTONE DR		Asset Replacement Program		150	200	133.6	3	2016	Local	$1,140	0.9	$1,026	$137,124
85	PPE-9C10	SANDSTONE DR		Asset Replacement Program		150	200	136.1	3	2016	Local	$1,140	0.9	$1,026	$139,627
85	PPE-397C10	MARSHALL RD		Asset Replacement Program		150	200	97.2	2	2016	Collector	$1,140	1.1	$1,254	$121,860
85	PPE-372C10	ORCHARD DR		Asset Replacement Program		150	200	111.9	3	2016	Arterial	$1,140	1.2	$1,368	$153,087
85	PPE-405C10	MARSHALL RD		Pipe Upgrade	Continuity with ARP	150	200	31.1	2	2016	Collector	$1,140	1.1	$1,254	$39,021
85	PPE-406C10	MARSHALL RD		Pipe Upgrade	Continuity with ARP	150	200	70.9	2	2016	Collector	$1,140	1.1	$1,254	$88,890
85	PPE-230C11	R/W W OF MARSHALL RD		Pipe Upgrade	Continuity with ARP	150	200	80.3	2	2016	Arterial	$1,140	1.2	$1,368	$109,860
86	PPE-371C10	ORCHARD DR		Asset Replacement Program		150	200	2.1	2	N/A	Local	$1,140	0.9	$1,026	$2,179
86	PPE-373C10	ORCHARD DR		Asset Replacement Program		150	200	44.8	2	N/A	Local	$1,140	0.9	$1,026	$46,011
86	PPE-374C10	ORCHARD DR		Asset Replacement Program		150	200	47.2	2	N/A	Local	$1,140	0.9	$1,026	$48,462
86	PPE-408C10	ORCHARD DR		Asset Replacement Program		100	200	117.7	2	N/A	Local	$1,140	0.9	$1,026	$120,780
86	PPE-376C10	ORCHARD DR		Asset Replacement Program		150	200	142.9	2	N/A	Local	$1,140	0.9	$1,026	$146,588
86	PPE-174C10	ORCHARD DR		Asset Replacement Program		150	200	30.5	3	N/A	Local	$1,140	0.9	$1,026	$31,332
86	PPE-177C10	ORCHARD DR		Asset Replacement Program		150	200	65.8	3	N/A	Local	$1,140	0.9	$1,026	$67,545
86	PPE-176C10	ORCHARD DR		Asset Replacement Program		150	200	85.6	3	N/A	Local	$1,140	0.9	$1,026	$87,805
86	PPE-175C10	ORCHARD DR		Asset Replacement Program		150	200	90.8	3	N/A	Local	$1,140	0.9	$1,026	$93,176
86	PPE-186C10	ORCHARD DR		Asset Replacement Program		150	200	97.3	3	N/A	Local	$1,140	0.9	$1,026	$99,871
86	PPE-396C10	ORCHARD DR		Asset Replacement Program		150	200	25.3	2	N/A	Collector	$1,140	1.1	$1,254	$31,724
87	PPE-203C10	OLYMPIA PL		Asset Replacement Program		150	200	19.8	3	2016	Local	$1,140	0.9	$1,026	$20,320
87	PPE-192C10	OLYMPIA PL		Asset Replacement Program		150	200	36.0	3	2016	Local	$1,140	0.9	$1,026	$36,951
87	PPE-178C10	OLYMPIA PL		Asset Replacement Program		150	200	109.7	3	2016	Local	$1,140	0.9	$1,026	$112,538
87	PPE-204C10	OLYMPIA PL		Asset Replacement Program		150	200	1.5	3	2016	Arterial	$1,140	1.2	$1,368	$2,085
87	PPE-209C10	OLYMPIA PL		Asset Replacement Program		150	200	4.0	3	2016	Arterial	$1,140	1.2	$1,368	$5,472
87	PPE-208C10	OLYMPIA PL		Asset Replacement Program		150	200	18.4	3	2016	Arterial	$1,140	1.2	$1,368	$25,204
87	PPE-206C10	OLYMPIA PL		Asset Replacement Program		150	200	35.4	3	2016	Arterial	$1,140	1.2	$1,368	$48,427
87	PPE-207C10	OLYMPIA PL		Asset Replacement Program		150	200	43.3	3	2016	Arterial	$1,140	1.2	$1,368	$59,189
87	PPE-212C10	ORCHARD DR		Asset Replacement Program		150	200	85.7	3	2016	Arterial	$1,140	1.2	$1,368	$117,213
87	PPE-205C10	OLYMPIA PL		Asset Replacement Program		150	200	146.0	3	2016	Arterial	$1,140	1.2	$1,368	$199,706
87	PPE-193C10	OLYMPIA PL		Pipe Upgrade	Continuity with ARP	150	200	2.4	2	2016	Local	$1,140	0.9	$1,026	$2,463
87	PPE-194C10	OLYMPIA PL		Pipe Upgrade	Continuity with ARP	150	200	5.7	2	2016	Arterial	$1,140	1.2	$1,368	$7,759
87	PPE-195C10	OLYMPIA PL		Pipe Upgrade	Continuity with ARP	150	200	60.4	2	2016	Arterial	$1,140	1.2	$1,368	$82,682
88	PPE-288C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	3.0	3	2016	Local	$1,140	0.9	$1,026	$3,127
88	PPE-287C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	25.2	3	2016	Local	$1,140	0.9	$1,026	$25,818
88	PPE-389C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	25.9	3	2016	Local	$1,140	0.9	$1,026	$26,544
88	PPE-280C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	45.5	3	2016	Local	$1,140	0.9	$1,026	$46,670
88	PPE-672C10	EVERETT RD		Asset Replacement Program	Fire Flow	150	200	62.9	3	2016	Local	$1,140	0.9	$1,026	$64,543
88	PPE-281C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	68.6	3	2016	Local	$1,140	0.9	$1,026	$70,336
88	PPE-282C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	68.6	3	2016	Local	$1,140	0.9	$1,026	$70,336
88	PPE-283C10	EVERETT ST		Asset Replacement Program	Fire Flow	150	200	137.0	3	2016	Local	$1,140	0.9	$1,026	$140,597
88	PPE-388C10	EVERETT RD		Asset Replacement Program	Fire Flow	150	200	10.1	2	2016	Collector	$1,140	1.1	$1,254	$12,613
88	PPE-386C10	MARSHALL RD		Asset Replacement Program	Fire Flow	150	200	17.0	2	2016	Collector	$1,140	1.1	$1,254	$21,348
88	PPE-387C10	MARSHALL RD		Asset Replacement Program	Fire Flow	150	200	81.1	2	2016	Collector	$1,140	1.1	$1,254	$101,671
88	PPE-398C10	MARSHALL RD		Asset Replacement Program	Fire Flow	150	200	128.3	2	2016	Collector	$1,140	1.1	$1,254	$160,892
89	PPE-1355C10	OAKHILL DR		Pipe Upgrade	Fire Flow	150	250	2.0	2	2016	Local	$1,210	0.9	$1,089	$2,178
89	PPE-182C10	OAKHILL DR		Pipe Upgrade	Fire Flow	150	250	20.7	2	2016	Local	$1,210	0.9	$1,089	$22,534
89	PPE-198C10	OAKHILL DR		Pipe Upgrade	Fire Flow	150	250	37.3	2	2016	Local	$1,210	0.9	$1,089	$40,655
89	PPE-199C10	OAKHILL DR		Pipe Upgrade	Fire Flow	150	250	54.8	2	2016	Local	$1,210	0.9	$1,089	$59,640
89	PPE-181C10	OAKHILL DR		Pipe Upgrade	Fire Flow	150	250	118.6	2	2016	Local	$1,210	0.9	$1,089	$129,172
90	PPE-73B14	VYE RD		Asset Replacement Program - Upsized		100	300	0.6	2	N/A	Collector	$1,320	1.1	$1,452	$929
90	PPE-111B13	COLE RD		Asset Replacement Program - Upsized		100	300	1.0	2	N/A	Collector	$1,320	1.1	$1,452	$1,516
90	PPE-108B13	COLE RD		Asset Replacement Program - Upsized		100	300	1.5	2	N/A	Collector	$1,320	1.1	$1,452	$2,177
90	PPE-8B14	VYE RD		Asset Replacement Program - Upsized		100	300	2.0	2	N/A	Collector	$1,320	1.1	$1,452	$2,894

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
90	PPE-13B13	VYE RD		Asset Replacement Program - Upsized		100	300	4.5	2	N/A	Collector	$1,320	1.1	$1,452	$6,469
90	PPE-25B14	VYE RD		Asset Replacement Program - Upsized		100	300	11.7	2	N/A	Collector	$1,320	1.1	$1,452	$16,945
90	PPE-5B14	VYE RD		Asset Replacement Program - Upsized		100	300	12.3	2	N/A	Collector	$1,320	1.1	$1,452	$17,887
90	PPE-37B13	VYE RD		Asset Replacement Program - Upsized		100	300	13.7	2	N/A	Collector	$1,320	1.1	$1,452	$19,908
90	PPE-7B14	VYE RD		Asset Replacement Program - Upsized		100	300	21.6	2	N/A	Collector	$1,320	1.1	$1,452	$31,356
90	PPE-12B13	VYE RD		Asset Replacement Program - Upsized		100	300	25.8	2	N/A	Collector	$1,320	1.1	$1,452	$37,501
90	PPE-30B13	VYE RD		Asset Replacement Program - Upsized		100	300	40.5	2	N/A	Collector	$1,320	1.1	$1,452	$58,793
90	PPE-6B14	VYE RD		Asset Replacement Program - Upsized		100	300	47.8	2	N/A	Collector	$1,320	1.1	$1,452	$69,443
90	PPE-45B14	VYE RD		Asset Replacement Program - Upsized		100	300	51.6	2	N/A	Collector	$1,320	1.1	$1,452	$74,951
90	PPE-42B14	VYE RD		Asset Replacement Program - Upsized		100	300	91.2	2	N/A	Collector	$1,320	1.1	$1,452	$132,418
90	PPE-4B14	VYE RD		Asset Replacement Program - Upsized		100	300	91.4	2	N/A	Collector	$1,320	1.1	$1,452	$132,771
90	PPE-20B13	VYE RD		Asset Replacement Program - Upsized		100	300	120.2	2	N/A	Collector	$1,320	1.1	$1,452	$174,567
90	PPE-19B13	VYE RD		Asset Replacement Program - Upsized		100	300	155.0	2	N/A	Collector	$1,320	1.1	$1,452	$225,061
90	PPE-114B13	VYE RD		Asset Replacement Program - Upsized		100	300	206.5	2	N/A	Collector	$1,320	1.1	$1,452	$299,851
90	PPE-18B13	VYE RD		Asset Replacement Program - Upsized		100	300	238.8	2	N/A	Collector	$1,320	1.1	$1,452	$346,749
90	PPE-46B14	VYE RD		Asset Replacement Program - Upsized		100	300	330.5	2	N/A	Collector	$1,320	1.1	$1,452	$479,848
90	PPE-27B14	VYE RD		Asset Replacement Program - Upsized		100	300	378.3	2	N/A	Collector	$1,320	1.1	$1,452	$549,297
90	PPE-43B14	VYE RD		Asset Replacement Program - Upsized		100	300	582.0	2	N/A	Collector	$1,320	1.1	$1,452	$845,079
91	PPE-43B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	2.4	2	N/A	Local	$1,140	0.9	$1,026	$2,498
91	PPE-50B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	6.0	2	N/A	Local	$1,140	0.9	$1,026	$6,156
91	PPE-51B12	FADDEN RD		Asset Replacement Program - Upsized		150	200	10.0	2	N/A	Local	$1,140	0.9	$1,026	$10,260
91	PPE-49B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	31.8	2	N/A	Local	$1,140	0.9	$1,026	$32,651
91	PPE-75B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	83.9	2	N/A	Local	$1,140	0.9	$1,026	$86,060
91	PPE-44B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	136.2	2	N/A	Local	$1,140	0.9	$1,026	$139,708
91	PPE-1B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	209.9	2	N/A	Local	$1,140	0.9	$1,026	$215,378
91	PPE-77B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	280.6	2	N/A	Local	$1,140	0.9	$1,026	$287,854
91	PPE-76B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	6.0	2	N/A	Collector	$1,140	1.1	$1,254	$7,524
91	PPE-78B12	FADDEN RD		Asset Replacement Program - Upsized		100	200	6.0	2	N/A	Collector	$1,140	1.1	$1,254	$7,524
92	PPE-15G17	NO.3 RD		Asset Replacement Program - Upsized		100	200	2.5	2	N/A	Collector	$1,140	1.1	$1,254	$3,135
92	PPE-23G17	NO.3 RD		Asset Replacement Program - Upsized		100	200	14.8	2	N/A	Collector	$1,140	1.1	$1,254	$18,504
92	PPE-12G17	NO.3 RD		Asset Replacement Program - Upsized		100	200	205.4	2	N/A	Collector	$1,140	1.1	$1,254	$257,580
92	PPE-36G17	NO.3 RD		Asset Replacement Program - Upsized		100	200	295.5	2	N/A	Collector	$1,140	1.1	$1,254	$370,616
92	PPE-37G17	NO.3 RD		Asset Replacement Program - Upsized		100	200	525.8	2	N/A	Collector	$1,140	1.1	$1,254	$659,408
93	PPE-1575D8	SOUTH FRASER WAY	City Center	Asset Replacement Program		200	250	4.3	3	2041	Arterial	$1,210	1.2	$1,452	$6,200
93	PPE-59D8	SOUTH FRASER WAY	City Center	Asset Replacement Program		200	250	9.2	3	2041	Arterial	$1,210	1.2	$1,452	$13,319
93	PPE-1527D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	18.4	3	2041	Arterial	$1,210	1.2	$1,452	$26,686
93	PPE-21D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	19.2	3	2041	Arterial	$1,210	1.2	$1,452	$27,941
93	PPE-845D8	SOUTH FRASER WAY	City Center	Asset Replacement Program		200	250	27.6	3	2041	Arterial	$1,210	1.2	$1,452	$40,032
93	PPE-57D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	27.6	3	2041	Arterial	$1,210	1.2	$1,452	$40,053
93	PPE-60D8	SOUTH FRASER WAY	City Center	Asset Replacement Program		200	250	33.9	3	2041	Arterial	$1,210	1.2	$1,452	$49,150
93	PPE-823D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	48.1	3	2041	Arterial	$1,210	1.2	$1,452	$69,777
93	PPE-56D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	49.6	3	2041	Arterial	$1,210	1.2	$1,452	$71,977
93	PPE-62D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	83.6	3	2041	Arterial	$1,210	1.2	$1,452	$121,347
93	PPE-77D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	89.7	3	2041	Arterial	$1,210	1.2	$1,452	$130,262
93	PPE-63D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	91.8	3	2041	Arterial	$1,210	1.2	$1,452	$133,279
93	PPE-31D8	SOUTH FRASER WAY	City Center	Asset Replacement Program	Fire Flow	200	250	138.9	3	2041	Arterial	$1,210	1.2	$1,452	$201,752
94	PPE-CCNP-01	VENTURA LANE	City Center	New Pipe Loop	Fire Flow	N/A	250	199.4	3	2036	Urban Lane	$1,210	0.75	$908	$180,998
95	PPE-465D7	WILLINGDON CR	City Center	Asset Replacement Program	Fire Flow	150	200	177.1	3	2031	Local	$1,140	0.9	$1,026	$181,689
95	PPE-466D7	WILLINGDON CR	City Center	Asset Replacement Program	Fire Flow	150	200	192.0	3	2031	Local	$1,140	0.9	$1,026	$197,030
96	PPE-CCNP-03	LANDEAU PL	City Center	New Pipe Loop	Fire Flow	N/A	250	105.1	3	2036	Local	$1,210	0.9	$1,089	$114,456
97	PPE-429D7	ROSSLAND PL	City Center	Asset Replacement Program	Fire Flow	200	200	57.1	3	2026	Local	$1,140	0.9	$1,026	$58,598
97	PPE-428D7	ROSSLAND PL	City Center	Asset Replacement Program	Fire Flow	200	200	94.0	3	2026	Local	$1,140	0.9	$1,026	$96,403
97	PPE-427D7	ROSSLAND PL	City Center	Asset Replacement Program	Fire Flow	200	200	149.3	3	2026	Local	$1,140	0.9	$1,026	$153,178
98	PPE-CCNP-02	HILLCREST AVE	City Center	New Pipe Loop	Fire Flow	N/A	250	55.7	2	2016	Collector	$1,210	1.1	$1,331	$74,098
99	PPE-610D7	LILAC CR	City Center	Asset Replacement Program		150	200	174.0	3	N/A	Local	$1,140	0.9	$1,026	$178,570
99	PPE-609D7	LILAC CR	City Center	Asset Replacement Program		150	200	89.0	3	N/A	Local	$1,140	0.9	$1,026	$91,297
99	PPE-608D7	LILAC CR	City Center	Asset Replacement Program		150	200	161.6	3	N/A	Local	$1,140	0.9	$1,026	$165,816
100	PPE-611D7	SUGARPINE ST	City Center	Asset Replacement Program	Fire Flow	200	200	12.5	3	2021	Local	$1,140	0.9	$1,026	$12,872
100	PPE-604D7	SUGARPINE ST	City Center	Asset Replacement Program	Fire Flow	200	200	54.5	3	2021	Local	$1,140	0.9	$1,026	$55,870
100	PPE-605D7	SUGARPINE ST	City Center	Asset Replacement Program	Fire Flow	200	200	61.6	3	2021	Local	$1,140	0.9	$1,026	$63,165
100	PPE-614D7	SUGARPINE ST	City Center	Asset Replacement Program	Fire Flow	200	200	116.3	3	2021	Local	$1,140	0.9	$1,026	$119,341
100	PPE-615D7	SUGARPINE ST	City Center	Asset Replacement Program	Fire Flow	200	200	159.7	3	2021	Local	$1,140	0.9	$1,026	$163,839
101	PPE-623D7	TULIP CR	City Center	Asset Replacement Program		150	200	11.2	3	N/A	Local	$1,140	0.9	$1,026	$11,491
101	PPE-621D7	TULIP CR	City Center	Asset Replacement Program		150	200	72.1	3	N/A	Local	$1,140	0.9	$1,026	$74,012
101	PPE-622D7	TULIP CR	City Center	Asset Replacement Program		150	200	242.2	3	N/A	Local	$1,140	0.9	$1,026	$248,522
102	PPE-541D7	ADELAIDE ST	City Center	Asset Replacement Program		150	200	36.6	2	N/A	Local	$1,140	0.9	$1,026	$37,533
102	PPE-543D7	ADELAIDE ST	City Center	Asset Replacement Program		150	200	118.5	3	N/A	Local	$1,140	0.9	$1,026	$121,565
102	PPE-535D7	ADELAIDE ST	City Center	Asset Replacement Program		150	200	164.0	3	N/A	Local	$1,140	0.9	$1,026	$168,249
103	PPE-562D7	ADELAIDE ST	City Center	Asset Replacement Program		150	200	77.3	2	N/A	Local	$1,140	0.9	$1,026	$79,261
104	PPE-1340D8	FAIRLANE ST	City Center	Asset Replacement Program - Upsized	Fire Flow	100	250	13.2	1	2021	Local	$1,210	0.9	$1,089	$14,399
104	PPE-490D8	FAIRLANE ST	City Center	Asset Replacement Program - Upsized	Fire Flow	100	250	105.7	1	2021	Local	$1,210	0.9	$1,089	$115,136
104	PPE-494D8	FAIRLANE ST	City Center	Asset Replacement Program - Upsized	Fire Flow	150	250	16.4	2	2021	Local	$1,210	0.9	$1,089	$17,828
104	PPE-493D8	FAIRLANE ST	City Center	Asset Replacement Program - Upsized	Fire Flow	150	250	54.2	2	2021	Local	$1,210	0.9	$1,089	$59,014
105	PPE-550D7	JAMES ST	City Center	Asset Replacement Program		150	200	2.7	2	N/A	Local	$1,140	0.9	$1,026	$2,770
105	PPE-545D7	JAMES ST	City Center	Asset Replacement Program		150	200	113.2	2	N/A	Local	$1,140	0.9	$1,026	$116,114
105	PPE-549D7	JAMES ST	City Center	Asset Replacement Program		150	200	126.9	2	N/A	Local	$1,140	0.9	$1,026	$130,199
106	PPE-548D7	PINEVIEW AVE	City Center	Asset Replacement Program - Upsized		100	200	73.1	2	N/A	Local	$1,140	0.9	$1,026	$74,981
107	PPE-547D7	LYNDEN ST	City Center	Asset Replacement Program - Upsized		100	200	72.4	2	N/A	Local	$1,140	0.9	$1,026	$74,265
107	PPE-546D7	LYNDEN ST	City Center	Asset Replacement Program - Upsized		100	200	13.9	2	N/A	Collector	$1,140	1.1	$1,254	$17,413
108	PPE-563D7	LYNDEN ST	City Center	Asset Replacement Program		150	200	155.0	2	N/A	Local	$1,140	0.9	$1,026	$158,995

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
109	PPE-1167D8	MILL LAKE RD	City Center	Asset Replacement Program		200	200	4.5	2	N/A	Local	$1,140	0.9	$1,026	$4,615
109	PPE-82D8	MILL LAKE RD	City Center	Asset Replacement Program		200	200	66.9	2	N/A	Local	$1,140	0.9	$1,026	$68,628
110	PPE-491D8	YUKON CR	City Center	Asset Replacement Program - Upsized	Fire Flow	100	250	71.8	1	2021	Local	$1,210	0.9	$1,089	$78,177
110	PPE-492D8	YUKON CR	City Center	Asset Replacement Program - Upsized	Fire Flow	100	250	178.1	1	2021	Local	$1,210	0.9	$1,089	$194,003
111	PPE-459D7	HOLLYWOOD AVE	City Center	Asset Replacement Program	Fire Flow	150	200	13.5	3	2031	Local	$1,140	0.9	$1,026	$13,819
111	PPE-460D7	HOLLYWOOD AVE	City Center	Asset Replacement Program	Fire Flow	150	200	13.5	3	2031	Local	$1,140	0.9	$1,026	$13,820
111	PPE-458D7	HOLLYWOOD AVE	City Center	Asset Replacement Program	Fire Flow	150	200	68.2	3	2031	Local	$1,140	0.9	$1,026	$69,928
111	PPE-461D7	HOLLYWOOD AVE	City Center	Asset Replacement Program	Fire Flow	150	200	168.2	3	2031	Local	$1,140	0.9	$1,026	$172,559
112	PPE-642D8	HORN ST	City Center	Asset Replacement Program - Upsized	Fire Flow	150	250	81.8	1	2021	Local	$1,210	0.9	$1,089	$89,091
112	PPE-641D8	HORN ST	City Center	Asset Replacement Program - Upsized	Fire Flow	150	250	116.6	1	2021	Local	$1,210	0.9	$1,089	$126,986
112	PPE-640D8	HORN ST	City Center	Asset Replacement Program - Upsized	Fire Flow	150	250	6.7	1	2021	Arterial	$1,210	1.2	$1,452	$9,692
113	PPE-620D7	MAGNOLIA CR	City Center	Asset Replacement Program	Fire Flow	150	200	21.7	3	2021	Local	$1,140	0.9	$1,026	$22,213
113	PPE-624D7	MAGNOLIA CR	City Center	Asset Replacement Program	Fire Flow	150	200	71.2	3	2021	Local	$1,140	0.9	$1,026	$73,093
113	PPE-617D7	MAGNOLIA CR	City Center	Asset Replacement Program	Fire Flow	150	200	90.6	3	2021	Local	$1,140	0.9	$1,026	$92,943
113	PPE-619D7	MAGNOLIA CR	City Center	Asset Replacement Program	Fire Flow	150	200	172.6	3	2021	Local	$1,140	0.9	$1,026	$177,090
114	PPE-274D7	SIMON AVE	City Center	Asset Replacement Program		200	250	2.7	2	N/A	Collector	$1,210	1.1	$1,331	$3,560
114	PPE-272D7	SIMON AVE	City Center	Asset Replacement Program		200	250	7.4	2	N/A	Collector	$1,210	1.1	$1,331	$9,863
114	PPE-271D7	SIMON AVE	City Center	Asset Replacement Program		200	250	24.9	2	N/A	Collector	$1,210	1.1	$1,331	$33,117
114	PPE-263D7	SIMON AVE	City Center	Asset Replacement Program		200	250	49.7	2	N/A	Collector	$1,210	1.1	$1,331	$66,155
114	PPE-255D7	SIMON AVE	City Center	Asset Replacement Program		200	250	49.8	2	N/A	Collector	$1,210	1.1	$1,331	$66,237
114	PPE-275D7	SIMON AVE	City Center	Asset Replacement Program		200	250	52.9	2	N/A	Collector	$1,210	1.1	$1,331	$70,470
115	PPE-629D7	MURRAY AVE	City Center	Pipe Upgrade	Fire Flow	150	250	5.2	2	2016	Local	$1,210	0.9	$1,089	$5,626
115	PPE-633D7	MURRAY AVE	City Center	Pipe Upgrade	Fire Flow	150	250	8.6	2	2016	Local	$1,210	0.9	$1,089	$9,365
115	PPE-632D7	MURRAY AVE	City Center	Pipe Upgrade	Fire Flow	150	250	168.4	2	2016	Local	$1,210	0.9	$1,089	$183,347
116	PPE-533D8	VENTURA LANE	City Center	Pipe Upgrade	Fire Flow	150	250	2.0	3	2036	Urban Lane	$1,210	0.75	$908	$1,815
116	PPE-532D8	VENTURA LANE	City Center	Pipe Upgrade	Fire Flow	150	250	52.2	3	2036	Urban Lane	$1,210	0.75	$908	$47,376
116	PPE-466D8	VENTURA LANE	City Center	Pipe Upgrade	Fire Flow	150	250	70.2	3	2036	Urban Lane	$1,210	0.75	$908	$63,687
117	PPE-HDNP-02	CANNON AVE	Historic Downtown	New Pipe Loop	Fire Flow	N/A	300	59.9	2	2021	Local	$1,320	0.9	$1,188	$71,165
118	PPE-733D9	LAUREL ST	Historic Downtown	Asset Replacement Program - Upsized		100	250	72.5	3	N/A	Local	$1,210	0.9	$1,089	$78,962
119	PPE-207D8	LANE W OF MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized		150	250	41.5	3	N/A	Urban Lane	$1,210	0.75	$908	$37,665
119	PPE-209D8	LANE W OF MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized		150	250	44.9	3	N/A	Urban Lane	$1,210	0.75	$908	$40,764
120	PPE-244361	LANE W OF MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized		150	250	14.1	2	N/A	Urban Lane	$1,210	0.75	$908	$12,794
120	PPE-208D8	LANE W OF MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized		150	250	46.1	3	N/A	Urban Lane	$1,210	0.75	$908	$41,859
120	PPE-1014D8	LANE W OF MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized		150	250	46.9	3	N/A	Urban Lane	$1,210	0.75	$908	$42,591
121	PPE-HDNP-07	MCCALLUM RD	Historic Downtown	New Pipe Loop	PZ 103 and PZ 123 Rezoning	N/A	300	37.7	2	2021	Arterial	$1,320	1.2	$1,584	$59,668
121	PPE-HDNP-06	MCCALLUM RD	Historic Downtown	New Pipe Loop	PZ 103 and PZ 123 Rezoning	N/A	300	77.5	2	2021	Arterial	$1,320	1.2	$1,584	$122,823
121	PPE-HDNP-05	MCCALLUM RD	Historic Downtown	New Pipe Loop	PZ 103 and PZ 123 Rezoning	N/A	300	81.5	2	2021	Arterial	$1,320	1.2	$1,584	$129,139
122	PPE-370C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	0.9	2	2021	Arterial	$1,320	1.2	$1,584	$1,408
122	PPE-369C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	1.8	2	2021	Arterial	$1,320	1.2	$1,584	$2,897
122	PPE-662C8_1	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	15.8	2	2021	Arterial	$1,320	1.2	$1,584	$24,971
122	PPE-387C8_1	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	18.2	2	2021	Arterial	$1,320	1.2	$1,584	$28,853
122	PPE-682C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	41.6	2	2021	Arterial	$1,320	1.2	$1,584	$65,826
122	PPE-488C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	50.7	2	2021	Arterial	$1,320	1.2	$1,584	$80,309
122	PPE-387C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	52.5	2	2021	Arterial	$1,320	1.2	$1,584	$83,158
122	PPE-662C8_2	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	79.1	2	2021	Arterial	$1,320	1.2	$1,584	$125,226
122	PPE-498C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	100	300	79.3	2	2021	Arterial	$1,320	1.2	$1,584	$125,534
122	PPE-438C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	100	300	107.0	2	2021	Arterial	$1,320	1.2	$1,584	$169,450
122	PPE-1357C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	0.6	2	2021	Arterial	$1,320	1.2	$1,584	$871
122	PPE-681C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	2.0	2	2021	Arterial	$1,320	1.2	$1,584	$3,166
122	PPE-375C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	200	300	2.0	2	2021	Arterial	$1,320	1.2	$1,584	$3,168
122	PPE-1356C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	100	300	2.1	2	2021	Arterial	$1,320	1.2	$1,584	$3,265
122	PPE-375C8_1	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	200	300	3.4	2	2021	Arterial	$1,320	1.2	$1,584	$5,360
122	PPE-978C8	MAYFAIR AVE	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	3.8	2	2021	Arterial	$1,320	1.2	$1,584	$6,090
122	PPE-389C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	200	300	57.5	2	2021	Arterial	$1,320	1.2	$1,584	$91,156
122	PPE-662C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	150	300	30.4	2	2021	Arterial	$1,320	1.2	$1,584	$48,181
122	PPE-389C8_1	MCCALLUM RD	Historic Downtown	Asset Replacement Program - Upsized	PZ 103 and PZ 123 Rezoning	200	300	43.0	2	2021	Arterial	$1,320	1.2	$1,584	$68,155
123	PPE-648D9	MONTVUE AVE	Historic Downtown	Asset Replacement Program - Upsized		100	250	46.4	3	N/A	Local	$1,210	0.9	$1,089	$50,561
123	PPE-180D9	MONTVUE AVE	Historic Downtown	Asset Replacement Program - Upsized		100	250	58.0	3	N/A	Local	$1,210	0.9	$1,089	$63,139
124	PPE-300D8	MOUNTVIEW ST	Historic Downtown	Asset Replacement Program - Upsized		100	200	263.9	2	N/A	Local	$1,140	0.9	$1,026	$270,737
125	PPE-259D9	PARK DR	Historic Downtown	Asset Replacement Program	Fire Flow	200	250	115.2	2	2021	Local	$1,210	0.9	$1,089	$125,494
126	PPE-169D9	PINE ST	Historic Downtown	Asset Replacement Program - Upsized		200	250	12.3	2	N/A	Local	$1,210	0.9	$1,089	$13,446
126	PPE-163D9	PINE ST	Historic Downtown	Asset Replacement Program - Upsized		200	250	28.3	2	N/A	Local	$1,210	0.9	$1,089	$30,787
126	PPE-159D9	PINE ST	Historic Downtown	Asset Replacement Program - Upsized		150	250	45.9	2	N/A	Local	$1,210	0.9	$1,089	$49,973
126	PPE-162D9	PINE ST	Historic Downtown	Asset Replacement Program - Upsized		200	250	1.5	3	N/A	Local	$1,210	0.9	$1,089	$1,634
127	PPE-164D9	TRINITY ST	Historic Downtown	Asset Replacement Program - Upsized		150	250	2.4	3	N/A	Local	$1,210	0.9	$1,089	$2,577
127	PPE-166D9	TRINITY ST	Historic Downtown	Asset Replacement Program - Upsized		150	250	5.0	3	N/A	Local	$1,210	0.9	$1,089	$5,443
127	PPE-900D9	TRINITY ST	Historic Downtown	Asset Replacement Program - Upsized		150	250	44.9	3	N/A	Local	$1,210	0.9	$1,089	$48,946
127	PPE-168D9	TRINITY ST	Historic Downtown	Asset Replacement Program - Upsized		150	250	65.0	3	N/A	Local	$1,210	0.9	$1,089	$70,752
128	PPE-436C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program	Fire Flow	150	200	5.9	3	2016	Arterial	$1,140	1.2	$1,368	$8,127
128	PPE-437C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program	Fire Flow	150	200	56.6	3	2016	Arterial	$1,140	1.2	$1,368	$77,400
128	PPE-439C8	MCCALLUM RD	Historic Downtown	Asset Replacement Program	Fire Flow	150	200	98.4	3	2016	Arterial	$1,140	1.2	$1,368	$134,556
129	PPE-HDNP-03	SOUTH FRASER WAY	Historic Downtown	New Pipe Loop		N/A	200	120.2	2	2016	Arterial	$1,140	1.2	$1,368	$164,492
130	PPE-HDNP-04	BRAUN AVE	Historic Downtown	New Pipe Loop		N/A	250	32.9	3	2036	Arterial	$1,210	1.2	$1,452	$47,732
131	PPE-251655	CAR-LIN LANE	Historic Downtown	Pipe Upgrade	Fire Flow	150	250	1.3	3	2041	Urban Lane	$1,210	0.75	$908	$1,164
131	PPE-251644	CAR-LIN LANE	Historic Downtown	Pipe Upgrade	Fire Flow	200	250	111.0	3	2041	Urban Lane	$1,210	0.75	$908	$100,694
131	PPE-251666	CAR-LIN LANE	Historic Downtown	Pipe Upgrade	Fire Flow	200	250	1.0	3	2041	Local	$1,210	0.9	$1,089	$1,089
132	PPE-HDNP-01	CAR-LIN LANE	Historic Downtown	New Pipe Loop	Fire Flow	N/A	250	84.9	3	2041	Urban Lane	$1,210	0.75	$908	$77,044
133	PPE-250260	ESSENDENE AVE	Historic Downtown	Pipe Upgrade	Fire Flow	150	250	2.7	3	2041	Local	$1,210	0.9	$1,089	$2,921
133	PPE-246D9	ESSENDENE AVE	Historic Downtown	Pipe Upgrade	Fire Flow	150	250	11.9	3	2041	Local	$1,210	0.9	$1,089	$12,934
133	PPE-245D9	ESSENDENE AVE	Historic Downtown	Pipe Upgrade	Fire Flow	150	250	30.3	3	2041	Local	$1,210	0.9	$1,089	$33,016

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
133	PPE-244D9	ESSENDENE AVE	Historic Downtown	Pipe Upgrade	Fire Flow	150	250	36.3	3	2041	Local	$1,210	0.9	$1,089	$39,484
134	PPE-295D8	George Ferguson Way	Historic Downtown	Asset Replacement Program - Upsized	Fire Flow	150	300	2.0	2	2021	Arterial	$1,320	1.2	$1,584	$3,139
134	PPE-380D8	George Ferguson Way	Historic Downtown	Asset Replacement Program - Upsized	Fire Flow	150	300	30.6	2	2021	Arterial	$1,320	1.2	$1,584	$48,394
134	PPE-381D8	George Ferguson Way	Historic Downtown	Asset Replacement Program - Upsized	Fire Flow	150	300	32.5	2	2021	Arterial	$1,320	1.2	$1,584	$51,401
134	PPE-296D8	George Ferguson Way	Historic Downtown	Asset Replacement Program - Upsized	Fire Flow	150	300	33.4	2	2021	Arterial	$1,320	1.2	$1,584	$52,853
134	PPE-379D8	George Ferguson Way	Historic Downtown	Asset Replacement Program - Upsized	Fire Flow	150	300	56.3	2	2021	Arterial	$1,320	1.2	$1,584	$89,192
134	PPE-378D8	George Ferguson Way	Historic Downtown	Asset Replacement Program - Upsized	Fire Flow	150	300	69.4	2	2021	Arterial	$1,320	1.2	$1,584	$109,945
135	PPE-156D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	4.8	2	N/A	Arterial	$1,210	1.2	$1,452	$7,028
135	PPE-764D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	5.6	2	N/A	Arterial	$1,210	1.2	$1,452	$8,172
135	PPE-759D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	14.1	2	N/A	Arterial	$1,210	1.2	$1,452	$20,435
135	PPE-176D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	29.8	2	N/A	Arterial	$1,210	1.2	$1,452	$43,286
135	PPE-175D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	35.7	2	N/A	Arterial	$1,210	1.2	$1,452	$51,842
135	PPE-145D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	38.6	2	N/A	Arterial	$1,210	1.2	$1,452	$56,065
135	PPE-995D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	42.0	2	N/A	Arterial	$1,210	1.2	$1,452	$61,026
135	PPE-155D9	GEORGE FERGUSON WAY	Historic Downtown	Asset Replacement Program - Upsized		150	250	46.6	2	N/A	Arterial	$1,210	1.2	$1,452	$67,672
136	PPE-330D8	HUGGINS AVE	Historic Downtown	Asset Replacement Program		150	200	44.5	3	N/A	Local	$1,140	0.9	$1,026	$45,624
136	PPE-331D8	HUGGINS AVE	Historic Downtown	Asset Replacement Program		150	200	57.4	3	N/A	Local	$1,140	0.9	$1,026	$58,908
137	PPE-301D8	LANE E OF MOUNTVIEW ST	Historic Downtown	Asset Replacement Program - Upsized		100	200	296.9	3	N/A	Urban Lane	$1,140	0.75	$855	$253,830
138	PRV-P-BRADNER1	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	200	10.5	2	2024	Collector	$1,140	1.1	$1,254	$13,185
138	PRV-P-BRADNER2	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	200	10.7	2	2024	Collector	$1,140	1.1	$1,254	$13,384
138	PPE-SSA-01	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	35.2	2	2024	Collector	$1,320	1.1	$1,452	$51,093
138	PPE-SSA-07	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	420.7	2	2024	Collector	$1,320	1.1	$1,452	$610,862
138	PPE-SSA-05	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	465.4	2	2024	Collector	$1,320	1.1	$1,452	$675,794
138	PPE-SSA-06	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	737.8	2	2024	Collector	$1,320	1.1	$1,452	$1,071,280
138	PPE-SSA-09	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	809.1	2	2024	Collector	$1,320	1.1	$1,452	$1,174,749
138	PPE-SSA-04	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	809.8	2	2024	Collector	$1,320	1.1	$1,452	$1,175,875
138	PPE-SSA-12	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	1505.8	2	2024	Collector	$1,320	1.1	$1,452	$2,186,435
138	PPE-SSA-10	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	1625.7	2	2024	Collector	$1,320	1.1	$1,452	$2,360,559
138	PPE-SSA-02	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	1760.3	2	2024	Collector	$1,320	1.1	$1,452	$2,555,983
138	PPE-SSA-11	BRADNER RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	66.5	2	2024	Arterial	$1,320	1.2	$1,584	$105,293
139	PPE-SSA-03	TOWNSHIPLINE RD	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	1621.2	2	2024	Collector	$1,320	1.1	$1,452	$2,353,969
140	PPE-SSA-14	56TH AVE	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	621.8	2	2024	Collector	$1,320	1.1	$1,452	$902,814
140	PPE-47H2	58TH AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	2.1	2	2024	Collector	$1,320	1.1	$1,452	$3,054
140	PPE-43H2	58TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	6.0	2	2024	Collector	$1,320	1.1	$1,452	$8,738
140	PPE-13H2	58TH AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	6.2	2	2024	Collector	$1,320	1.1	$1,452	$9,056
140	PPE-12H1	56TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	50	300	44.6	2	2024	Collector	$1,320	1.1	$1,452	$64,721
140	PPE-11H1	56TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	50	300	49.8	2	2024	Collector	$1,320	1.1	$1,452	$72,283
140	PPE-14H2	58TH AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	226.7	2	2024	Collector	$1,320	1.1	$1,452	$329,134
140	PPE-37H2	58TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	308.3	2	2024	Collector	$1,320	1.1	$1,452	$447,705
140	PPE-15H2	58TH AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	404.6	2	2024	Collector	$1,320	1.1	$1,452	$587,431
140	PPE-38H2	58TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	493.4	2	2024	Collector	$1,320	1.1	$1,452	$716,395
140	PPE-13H1	56TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	50	300	527.4	2	2024	Collector	$1,320	1.1	$1,452	$765,807
141	PPE-36G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	45.5	2	2024	Local	$1,320	0.9	$1,188	$54,048
141	PPE-30G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	98.3	2	2024	Local	$1,320	0.9	$1,188	$116,734
141	PPE-31G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	107.5	2	2024	Local	$1,320	0.9	$1,188	$127,741
141	PPE-3G1	MYRTLE AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	138.5	2	2024	Local	$1,320	0.9	$1,188	$164,523
141	PPE-32G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	180.7	2	2024	Local	$1,320	0.9	$1,188	$214,710
141	PPE-28G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	182.1	2	2024	Local	$1,320	0.9	$1,188	$216,385
141	PPE-14G1	MYRTLE AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	198.8	2	2024	Local	$1,320	0.9	$1,188	$236,166
141	PPE-27G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	202.6	2	2024	Local	$1,320	0.9	$1,188	$240,698
141	PPE-6G1	BAYNES ST	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	50	300	203.2	2	2024	Local	$1,320	0.9	$1,188	$241,362
141	PPE-37G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	50	300	223.9	2	2024	Local	$1,320	0.9	$1,188	$265,973
141	PPE-4G1	BAYNES ST	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	249.9	2	2024	Local	$1,320	0.9	$1,188	$296,918
141	PPE-34G1	LEFEUVRE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	263.3	2	2024	Local	$1,320	0.9	$1,188	$312,784
141	PPE-2G1	MYRTLE AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	276.5	2	2024	Local	$1,320	0.9	$1,188	$328,433
141	PPE-5G1	BAYNES ST	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	100	300	299.4	2	2024	Local	$1,320	0.9	$1,188	$355,704
141	PPE-22G1	TOWNSHIPLINE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	4.0	2	2024	Collector	$1,320	1.1	$1,452	$5,823
141	PPE-25G1	TOWNSHIPLINE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	5.0	2	2024	Collector	$1,320	1.1	$1,452	$7,260
141	PPE-23G1	TOWNSHIPLINE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	9.6	2	2024	Collector	$1,320	1.1	$1,452	$13,916
141	PPE-39G1	TOWNSHIPLINE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	28.5	2	2024	Collector	$1,320	1.1	$1,452	$41,382
141	PPE-9H1	56TH. AVE	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	50	300	229.0	2	2024	Collector	$1,320	1.1	$1,452	$332,467
141	PPE-20G1	TOWNSHIPLINE RD	Special Study Area A	Pipe Upgrade	Pressure & Fire Flow	150	300	304.6	2	2024	Collector	$1,320	1.1	$1,452	$442,288
141	PPE-SSA-13	BAYNES ST	Special Study Area A	New Pipe Loop	Pressure & Fire Flow	N/A	300	1091.9	2	2024	Arterial	$1,320	1.2	$1,584	$1,729,648
142	PPE-SSA-20	ROTOR DR	Special Study Area B	New Pipe Loop	Fire Flow	N/A	250	12.7	2	2024	Collector	$1,210	1.1	$1,331	$16,945
142	PPE-SSA-15	QUEEN ST	Special Study Area B	New Pipe Loop	Fire Flow	N/A	250	18.1	2	2024	Collector	$1,210	1.1	$1,331	$24,148
142	PPE-SSA-19	QUEEN ST	Special Study Area B	New Pipe Loop	Fire Flow	N/A	250	48.6	2	2024	Collector	$1,210	1.1	$1,331	$64,745
142	PPE-SSA-18	THRESHOLD DR	Special Study Area B	New Pipe Loop	Fire Flow	N/A	250	64.9	2	2024	Collector	$1,210	1.1	$1,331	$86,361
142	PPE-SSA-17	THRESHOLD DR	Special Study Area B	New Pipe Loop	Fire Flow	N/A	250	109.2	2	2024	Collector	$1,210	1.1	$1,331	$145,402
142	PPE-SSA-16	THRESHOLD DR	Special Study Area B	New Pipe Loop	Fire Flow	N/A	250	128.8	2	2024	Collector	$1,210	1.1	$1,331	$171,400
142	PPE-264C5	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	2.1	2	2024	Collector	$1,210	1.1	$1,331	$2,832
142	PPE-79C5	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	5.5	2	2024	Collector	$1,210	1.1	$1,331	$7,347
142	PPE-1535B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	9.2	2	2024	Collector	$1,210	1.1	$1,331	$12,220
142	PPE-76C5_2	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	24.7	2	2024	Collector	$1,210	1.1	$1,331	$32,854
142	PPE-69B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	43.1	2	2024	Collector	$1,210	1.1	$1,331	$57,418
142	PPE-65B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	48.0	2	2024	Collector	$1,210	1.1	$1,331	$63,915
142	PPE-66B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	55.5	2	2024	Collector	$1,210	1.1	$1,331	$73,873
142	PPE-67B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	55.6	2	2024	Collector	$1,210	1.1	$1,331	$73,998
142	PPE-75C5	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	61.3	2	2024	Collector	$1,210	1.1	$1,331	$81,600
142	PPE-77C5	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	66.4	2	2024	Collector	$1,210	1.1	$1,331	$88,406
142	PPE-1250B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	75.0	2	2024	Collector	$1,210	1.1	$1,331	$99,798

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
142	PPE-78C5	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	86.6	2	2024	Collector	$1,210	1.1	$1,331	$115,258
142	PPE-71B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	300	89.3	2	2024	Collector	$1,320	1.1	$1,452	$129,671
142	PPE-64B5	THRESHOLD DR	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	107.8	2	2024	Collector	$1,210	1.1	$1,331	$143,528
142	PPE-76C5	QUEEN ST	Special Study Area B	Pipe Upgrade	Fire Flow	150	250	137.1	2	2024	Collector	$1,210	1.1	$1,331	$182,476
143	PPE-SSA-22	MARSHALL RD	Special Study Area B	New Pipe Loop	New Services	N/A	250	78.0	2	2024	Collector	$1,210	1.1	$1,331	$103,773
143	PPE-SSA-21	MT LEHMAN RD	Special Study Area B	New Pipe Loop	New Services	N/A	250	238.5	2	2024	Collector	$1,210	1.1	$1,331	$317,508
144	PPE-255E4	AUTOMALL DR		Pipe Upgrade	Fire Flow	250	300	1.0	2	2026	Collector	$1,320	1.1	$1,452	$1,452
144	PPE-250E4	AUTOMALL DR		Pipe Upgrade	Fire Flow	200	300	1.0	2	2026	Collector	$1,320	1.1	$1,452	$1,480
144	PPE-210D4	MT LEHMAN RD		Pipe Upgrade	Fire Flow	200	300	3.2	2	2026	Collector	$1,320	1.1	$1,452	$4,588
144	PPE-748E5	CARDINAL AVE		Pipe Upgrade	Fire Flow	250	300	4.3	2	2026	Collector	$1,320	1.1	$1,452	$6,302
144	PPE-30E4	AUTOMALL DR		Pipe Upgrade	Fire Flow	250	300	85.4	2	2026	Collector	$1,320	1.1	$1,452	$124,060
145	PPE-256D4	SOUTH FRASER WAY		Asset Replacement Program - Upsized		150	250	11.8	2	N/A	Provincial Highway	$1,210	1.3	$1,573	$18,623
145	PPE-257D4	OLD YALE RD		Asset Replacement Program - Upsized	Continuity with ARP	100	250	0.5	3	N/A	Provincial Highway	$1,210	1.3	$1,573	$787
146	PPE-MP-1002	OLD YALE RD		New Pipe Loop	Fire Flow	N/A	300	1.9	2	2026	Collector	$1,320	1.1	$1,452	$2,759
146	PPE-88D4	OLD YALE RD		Pipe Upgrade	Fire Flow	150	300	85.4	2	2026	Collector	$1,320	1.1	$1,452	$123,953
146	PPE-118D4	OLD YALE RD		Pipe Upgrade	Fire Flow	150	300	110.8	2	2026	Collector	$1,320	1.1	$1,452	$160,893
146	PPE-86D4	OLD YALE RD		Pipe Upgrade	Fire Flow	150	300	227.4	2	2026	Collector	$1,320	1.1	$1,452	$330,243
147	PPE-96D3	SUNVALLEY CR		Asset Replacement Program	Continuity with ARP	150	200	174.6	3	N/A	Local	$1,140	0.9	$1,026	$179,157
147	PPE-85D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	0.5	2	N/A	Local	$1,140	0.9	$1,026	$518
147	PPE-84D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	4.7	2	N/A	Local	$1,140	0.9	$1,026	$4,778
147	PPE-82D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	42.3	2	N/A	Local	$1,140	0.9	$1,026	$43,380
147	PPE-99D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	48.7	2	N/A	Local	$1,140	0.9	$1,026	$49,919
147	PPE-81D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	94.9	2	N/A	Local	$1,140	0.9	$1,026	$97,386
147	PPE-73D3	DUNCAN AVE		Asset Replacement Program - Upsized		100	200	145.4	2	N/A	Local	$1,140	0.9	$1,026	$149,149
147	PPE-100D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	211.6	2	N/A	Local	$1,140	0.9	$1,026	$217,110
147	PPE-77D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	222.6	2	N/A	Local	$1,140	0.9	$1,026	$228,420
147	PPE-72D3	DUNCAN AVE		Asset Replacement Program - Upsized		100	200	240.0	2	N/A	Local	$1,140	0.9	$1,026	$246,201
147	PPE-79D3	SUNVALLEY CR		Asset Replacement Program - Upsized		100	200	246.8	2	N/A	Local	$1,140	0.9	$1,026	$253,175
148	PPE-28E3	MACLURE RD		Asset Replacement Program - Upsized		100	200	203.7	2	N/A	Local	$1,140	0.9	$1,026	$208,950
148	PPE-51E3	MACLURE RD		Asset Replacement Program - Upsized		100	200	1.0	2	N/A	Collector	$1,140	1.1	$1,254	$1,254
149	PPE-MP-1003	FRASER HWY		New Pipe Loop	Fire Flow	N/A	400	10.8	3	2031	Arterial	$1,550	1.2	$1,860	$20,043
149	PPE-MP-1004	FRASER HWY		New Pipe Loop	Fire Flow	N/A	400	15.4	3	2031	Arterial	$1,550	1.2	$1,860	$28,594
149	PPE-235D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	1.0	3	2031	Arterial	$1,550	1.2	$1,860	$1,860
149	PPE-18D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	30.5	3	2031	Arterial	$1,550	1.2	$1,860	$56,728
149	PPE-43D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	45.3	3	2031	Arterial	$1,550	1.2	$1,860	$84,291
149	PPE-24D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	45.5	3	2031	Arterial	$1,550	1.2	$1,860	$84,697
149	PPE-219D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	45.9	3	2031	Arterial	$1,550	1.2	$1,860	$85,296
149	PPE-1D3	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	48.7	3	2031	Arterial	$1,550	1.2	$1,860	$90,571
149	PPE-343D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	105.9	3	2031	Arterial	$1,550	1.2	$1,860	$196,996
149	PPE-23D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	109.9	3	2031	Arterial	$1,550	1.2	$1,860	$204,408
149	PPE-21D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	116.9	3	2031	Arterial	$1,550	1.2	$1,860	$217,391
149	PPE-19D2	FRASER HWY		Pipe Upgrade	Fire Flow	250	400	440.0	3	2031	Arterial	$1,550	1.2	$1,860	$818,396
150	PPE-97C11	EAGLECREST DR		Pipe Upgrade	Fire Flow	150	200	6.3	2	2016	Local	$1,140	0.9	$1,026	$6,413
150	PPE-95C11	EAGLECREST DR		Pipe Upgrade	Fire Flow	150	200	113.9	2	2016	Local	$1,140	0.9	$1,026	$116,833
150	PPE-96C11	EAGLECREST DR		Pipe Upgrade	Fire Flow	150	200	169.8	2	2016	Local	$1,140	0.9	$1,026	$174,199
151	PPE-11D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	200	8.5	2	2021	Arterial	$1,140	1.2	$1,368	$11,669
151	PPE-8D1	PULLMAN AVE		Pipe Upgrade	Fire Flow	150	200	9.1	2	2021	Arterial	$1,140	1.2	$1,368	$12,504
151	PPE-10D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	200	11.3	2	2021	Arterial	$1,140	1.2	$1,368	$15,491
151	PPE-16D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	200	13.3	2	2021	Arterial	$1,140	1.2	$1,368	$18,127
151	PPE-9D1	PULLMAN AVE		Pipe Upgrade	Fire Flow	150	200	45.6	2	2021	Arterial	$1,140	1.2	$1,368	$62,340
151	PPE-13D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	200	57.0	2	2021	Arterial	$1,140	1.2	$1,368	$77,992
151	PPE-14D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	200	82.3	2	2021	Arterial	$1,140	1.2	$1,368	$112,595
151	PPE-15D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	200	94.3	2	2021	Arterial	$1,140	1.2	$1,368	$128,960
151	PPE-5D1	PULLMAN AVE		Pipe Upgrade	Fire Flow	150	200	100.9	2	2021	Arterial	$1,140	1.2	$1,368	$138,013
151	PPE-17D1	FRASER HWY		Pipe Upgrade	Fire Flow	150	250	20.3	2	2021	Arterial	$1,210	1.2	$1,452	$29,415
152	PPE-39A10	LANE N OF 1ST AVE		Pipe Upgrade	Fire Flow	150	250	152.4	2	2036	Urban Lane	$1,210	0.75	$908	$138,283
152	PPE-13A10	LANE N OF 1ST AVE		Pipe Upgrade	Fire Flow	150	250	161.0	2	2036	Urban Lane	$1,210	0.75	$908	$146,081
152	PPE-322A10	2ND AVE		Pipe Upgrade	Fire Flow	150	300	12.9	2	2036	Local	$1,320	0.9	$1,188	$15,332
152	PPE-337A10	2ND AVE		Pipe Upgrade	Fire Flow	200	300	22.4	2	2036	Local	$1,320	0.9	$1,188	$26,634
152	PPE-256A10	2ND AVE		Pipe Upgrade	Fire Flow	200	300	92.2	2	2036	Local	$1,320	0.9	$1,188	$109,503
152	PPE-101A10	2ND AVE		Pipe Upgrade	Fire Flow	200	300	130.2	2	2036	Local	$1,320	0.9	$1,188	$154,692
152	PPE-47A10	2ND AVE		Pipe Upgrade	Fire Flow	200	300	146.3	2	2036	Local	$1,320	0.9	$1,188	$173,755
152	PPE-48A10	2ND AVE		Pipe Upgrade	Fire Flow	150	250	54.5	2	2036	Arterial	$1,210	1.2	$1,452	$79,166
152	PPE-14A10	LANE N OF 1ST AVE		Pipe Upgrade	Fire Flow	150	250	16.2	2	2036	Provincial Highway	$1,210	1.3	$1,573	$25,457
152	PPE-247A10	SUMAS WAY		Pipe Upgrade	Fire Flow	250	300	1.0	2	2036	Provincial Highway	$1,320	1.3	$1,716	$1,716
152	PPE-28A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	1.0	2	2036	Provincial Highway	$1,320	1.3	$1,716	$1,716
152	PPE-315A10	SUMAS WAY		Pipe Upgrade	Fire Flow	250	300	1.0	2	2036	Provincial Highway	$1,320	1.3	$1,716	$1,716
152	PPE-245A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	13.5	2	2036	Provincial Highway	$1,320	1.3	$1,716	$23,133
152	PPE-31A10_2	1ST AVE		Pipe Upgrade	Fire Flow	150	300	17.6	2	2036	Provincial Highway	$1,320	1.3	$1,716	$30,272
152	PPE-40A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	17.9	2	2036	Provincial Highway	$1,320	1.3	$1,716	$30,710
152	PPE-31A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	35.4	2	2036	Provincial Highway	$1,320	1.3	$1,716	$60,702
152	PPE-41A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	40.2	2	2036	Provincial Highway	$1,320	1.3	$1,716	$69,024
152	PPE-42A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	43.1	2	2036	Provincial Highway	$1,320	1.3	$1,716	$73,956
152	PPE-29A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	56.5	2	2036	Provincial Highway	$1,320	1.3	$1,716	$96,981
152	PPE-30A10	SUMAS WAY		Pipe Upgrade	Fire Flow	150	300	99.6	2	2036	Provincial Highway	$1,320	1.3	$1,716	$170,920
153	PPE-106A10	LANE N OF 3RD AVE		Pipe Upgrade	Fire Flow	150	250	159.6	2	2026	Arterial	$1,210	1.2	$1,452	$231,675
153	PPE-382A10	4TH AVE		Pipe Upgrade	Fire Flow	150	300	2.2	2	2026	Collector	$1,320	1.1	$1,452	$3,199
153	PPE-66A10	WEST RAILWAY ST		Pipe Upgrade	Fire Flow	150	300	34.0	2	2026	Collector	$1,320	1.1	$1,452	$49,369
153	PPE-71A10	D ST		Pipe Upgrade	Fire Flow	150	300	52.3	2	2026	Collector	$1,320	1.1	$1,452	$76,003
153	PPE-67A10	WEST RAILWAY ST		Pipe Upgrade	Fire Flow	150	300	62.9	2	2026	Collector	$1,320	1.1	$1,452	$91,395

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
154	PPE-322A9	RIVERSIDE RD		Pipe Upgrade	Fire Flow	200	300	1.8	2	2016	Collector	$1,320	1.1	$1,452	$2,563
154	PPE-341A9	RIVERSIDE RD		Pipe Upgrade	Fire Flow	150	300	2.0	2	2016	Collector	$1,320	1.1	$1,452	$2,850
154	PPE-323A9	RIVERSIDE RD		Pipe Upgrade	Fire Flow	200	300	4.1	2	2016	Collector	$1,320	1.1	$1,452	$5,976
155	PPE-44A9	MANUFACTURERS WAY		Pipe Upgrade	Fire Flow	200	300	21.1	2	2016	Collector	$1,320	1.1	$1,452	$30,644
156	PPE-54A9	INDUSTRIAL WAY		Pipe Upgrade	Fire Flow	200	250	18.6	2	2016	Collector	$1,210	1.1	$1,331	$24,723
156	PPE-35A9	INDUSTRIAL WAY		Pipe Upgrade	Fire Flow	200	250	19.7	2	2016	Collector	$1,210	1.1	$1,331	$26,154
156	PPE-246302	INDUSTRIAL WAY		Pipe Upgrade	Fire Flow	200	250	20.7	2	2016	Collector	$1,210	1.1	$1,331	$27,501
156	PPE-57A9	INDUSTRIAL WAY		Pipe Upgrade	Fire Flow	200	250	25.5	2	2016	Collector	$1,210	1.1	$1,331	$33,974
156	PPE-58A9	INDUSTRIAL WAY		Pipe Upgrade	Fire Flow	200	250	102.9	2	2016	Collector	$1,210	1.1	$1,331	$136,904
156	PPE-53A9	INDUSTRIAL WAY		Pipe Upgrade	Fire Flow	200	250	116.4	2	2016	Collector	$1,210	1.1	$1,331	$154,918
157	PPE-374B9	MCCONNELL RD		Asset Replacement Program - Upsized		250	250	1.0	3	N/A	Arterial	$1,210	1.2	$1,452	$1,452
157	PPE-87B9	MCCONNELL RD		Asset Replacement Program - Upsized		250	250	1.0	3	N/A	Arterial	$1,210	1.2	$1,452	$1,452
157	PPE-84B9	MCCONNELL RD		Asset Replacement Program - Upsized		250	250	2.6	3	N/A	Arterial	$1,210	1.2	$1,452	$3,748
157	PPE-170B9	MCCONNELL RD		Asset Replacement Program - Upsized		250	250	183.1	3	N/A	Arterial	$1,210	1.2	$1,452	$265,834
158	PPE-383B9	RIVERSIDE RD		Asset Replacement Program		250	250	1.0	2	N/A	Collector	$1,210	1.1	$1,331	$1,331
158	PPE-464B9	RIVERSIDE RD		Asset Replacement Program		250	250	1.3	2	N/A	Collector	$1,210	1.1	$1,331	$1,786
158	PPE-171B9	RIVERSIDE RD		Asset Replacement Program		250	250	64.8	2	N/A	Collector	$1,210	1.1	$1,331	$86,234
158	PPE-328B9	RIVERSIDE RD		Asset Replacement Program		250	250	93.0	2	N/A	Collector	$1,210	1.1	$1,331	$123,730
158	PPE-212B9	RIVERSIDE RD		Asset Replacement Program		250	250	132.2	2	N/A	Collector	$1,210	1.1	$1,331	$176,005
158	PPE-35C9	RIVERSIDE RD		Asset Replacement Program		250	250	147.3	2	N/A	Collector	$1,210	1.1	$1,331	$196,112
158	PPE-213B9	RIVERSIDE RD		Asset Replacement Program		250	250	171.9	2	N/A	Collector	$1,210	1.1	$1,331	$228,750
158	PPE-211B9	RIVERSIDE RD		Asset Replacement Program		250	250	172.3	2	N/A	Collector	$1,210	1.1	$1,331	$229,369
158	PPE-96B9_2	RIVERSIDE RD		Asset Replacement Program		250	250	106.6	3	N/A	Collector	$1,210	1.1	$1,331	$141,842
158	PPE-96B9_4	RIVERSIDE RD		Asset Replacement Program		250	250	109.8	3	N/A	Collector	$1,210	1.1	$1,331	$146,092
159	PPE-111B10	MCCLARY AVE		Asset Replacement Program - Upsized		150	250	32.2	2	N/A	Local	$1,210	0.9	$1,089	$35,027
159	PPE-112B10	MCCLARY AVE		Asset Replacement Program - Upsized	Continuity with ARP	150	250	5.3	3	N/A	Local	$1,210	0.9	$1,089	$5,776
160	PPE-247237	MCCLARY AVE		Asset Replacement Program - Upsized		150	250	2.3	2	N/A	Local	$1,210	0.9	$1,089	$2,461
161	PPE-571C9	MCKENZIE RD		Pipe Upgrade	Fire Flow	150	200	11.8	2	2021	Local	$1,140	0.9	$1,026	$12,151
162	PPE-222C9	GILMOUR DR		Asset Replacement Program		150	200	6.1	3	N/A	Local	$1,140	0.9	$1,026	$6,254
162	PPE-586C9	GILMOUR DR		Asset Replacement Program	Continuity with ARP	150	200	13.7	3	N/A	Local	$1,140	0.9	$1,026	$14,046
162	PPE-229C9	GILMOUR DR		Asset Replacement Program		150	200	19.5	3	N/A	Local	$1,140	0.9	$1,026	$20,014
162	PPE-225C9	GILMOUR DR		Asset Replacement Program		150	200	60.0	3	N/A	Local	$1,140	0.9	$1,026	$61,599
162	PPE-221C9	GILMOUR DR		Asset Replacement Program		150	200	73.6	3	N/A	Local	$1,140	0.9	$1,026	$75,505
162	PPE-579C9	GILMOUR DR		Asset Replacement Program		150	200	79.0	3	N/A	Local	$1,140	0.9	$1,026	$81,080
163	PPE-193C9	SHANNON DR		Asset Replacement Program		150	200	8.7	3	N/A	Local	$1,140	0.9	$1,026	$8,927
163	PPE-196C9	SHANNON DR		Asset Replacement Program	Continuity with ARP	150	200	13.2	3	N/A	Local	$1,140	0.9	$1,026	$13,501
163	PPE-195C9	SHANNON DR		Asset Replacement Program		150	200	81.4	3	N/A	Local	$1,140	0.9	$1,026	$83,466
164	PPE-351C9	DAHL CR		Asset Replacement Program		150	200	1.5	2	N/A	Local	$1,140	0.9	$1,026	$1,551
164	PPE-268C9	DAHL CR		Asset Replacement Program		150	200	10.0	2	N/A	Local	$1,140	0.9	$1,026	$10,236
164	PPE-352C9	DAHL CR		Asset Replacement Program		150	200	30.2	2	N/A	Local	$1,140	0.9	$1,026	$30,957
164	PPE-273C9	ALMA ST		Asset Replacement Program		150	200	34.7	2	N/A	Local	$1,140	0.9	$1,026	$35,598
164	PPE-269C9	DAHL CR		Asset Replacement Program		150	200	50.0	2	N/A	Local	$1,140	0.9	$1,026	$51,257
164	PPE-276C9	ALMA ST		Asset Replacement Program		150	200	65.9	2	N/A	Local	$1,140	0.9	$1,026	$67,663
164	PPE-286C9	DAHL CR		Asset Replacement Program		150	200	67.3	2	N/A	Local	$1,140	0.9	$1,026	$69,087
164	PPE-582C9	DAHL CR		Asset Replacement Program		100	200	81.2	2	N/A	Local	$1,140	0.9	$1,026	$83,271
164	PPE-267C9	DAHL CR		Asset Replacement Program		100	200	106.2	2	N/A	Local	$1,140	0.9	$1,026	$108,946
164	PPE-265C9	DAHL CR		Asset Replacement Program		100	200	129.2	2	N/A	Local	$1,140	0.9	$1,026	$132,529
164	PPE-239918	DAHL CRES		Asset Replacement Program	Continuity with ARP	150	200	1.4	3	N/A	Local	$1,140	0.9	$1,026	$1,404
164	PPE-239919	DAHL CRES		Asset Replacement Program	Continuity with ARP	150	200	5.0	3	N/A	Local	$1,140	0.9	$1,026	$5,148
164	PPE-584C9	DAHL CR		Asset Replacement Program	Continuity with ARP	100	200	12.7	3	N/A	Local	$1,140	0.9	$1,026	$13,064
164	PPE-272C9	KELMER CR		Asset Replacement Program		150	200	39.5	3	N/A	Local	$1,140	0.9	$1,026	$40,569
165	PPE-354C9	ABBOTSFORD WAY		Pipe Upgrade	Fire Flow	150	250	7.7	2	2016	Local	$1,210	0.9	$1,089	$8,423
166	PPE-241560	ABBOTSFORD WAY		Pipe Upgrade	Fire Flow	200	250	1.4	2	2016	Local	$1,210	0.9	$1,089	$1,545
166	PPE-341C9	ABBOTSFORD WAY		Pipe Upgrade	Fire Flow	200	250	40.1	2	2016	Local	$1,210	0.9	$1,089	$43,679
166	PPE-337C9	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	200	250	44.0	2	2016	Arterial	$1,210	1.2	$1,452	$63,929
166	PPE-335C9	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	150	250	44.3	2	2016	Arterial	$1,210	1.2	$1,452	$64,316
166	PPE-340C9	SOUTH FRASER WAY		Pipe Upgrade	Fire Flow	200	250	139.3	2	2016	Arterial	$1,210	1.2	$1,452	$202,319
167	PPE-1186C10	SUMAS WAY		Asset Replacement Program - Upsized		150	250	1.0	2	N/A	Provincial Highway	$1,210	1.3	$1,573	$1,551
167	PPE-1559C10	SUMAS WAY		Asset Replacement Program - Upsized		150	250	2.6	2	N/A	Provincial Highway	$1,210	1.3	$1,573	$4,044
167	PPE-931C10	SUMAS WAY		Asset Replacement Program - Upsized		150	250	14.1	2	N/A	Provincial Highway	$1,210	1.3	$1,573	$22,153
167	PPE-1029C10	SUMAS WAY		Asset Replacement Program - Upsized		150	250	21.7	2	N/A	Provincial Highway	$1,210	1.3	$1,573	$34,177
167	PPE-595C10	SUMAS WAY		Asset Replacement Program - Upsized		150	250	166.7	2	N/A	Provincial Highway	$1,210	1.3	$1,573	$262,180
167	PPE-1453C10	SUMAS WAY		Asset Replacement Program - Upsized	Continuity with ARP	150	250	3.9	3	N/A	Provincial Highway	$1,210	1.3	$1,573	$6,177
167	PPE-1026C10	SUMAS WAY		Asset Replacement Program - Upsized	Continuity with ARP	150	250	14.1	3	N/A	Provincial Highway	$1,210	1.3	$1,573	$22,244
168	PPE-1079C10	WALKER CR		Asset Replacement Program - Upsized		100	200	1.0	2	2031	Local	$1,140	0.9	$1,026	$1,026
168	PPE-659C10	SKYLINE DR		Asset Replacement Program - Upsized		100	200	1.0	2	2031	Local	$1,140	0.9	$1,026	$1,026
168	PPE-655C10	WALKER CR		Asset Replacement Program - Upsized		100	200	8.6	2	2031	Local	$1,140	0.9	$1,026	$8,827
168	PPE-652C10	GRIFFITH RD		Asset Replacement Program - Upsized		150	250	36.3	2	2031	Local	$1,210	0.9	$1,089	$39,536
168	PPE-653C10	GRIFFITH RD		Asset Replacement Program - Upsized		150	250	50.8	2	2031	Local	$1,210	0.9	$1,089	$55,333
168	PPE-658C10	SKYLINE DR		Asset Replacement Program - Upsized		100	200	88.3	2	2031	Local	$1,140	0.9	$1,026	$90,631
168	PPE-657C10	GRIFFITHS RD		Asset Replacement Program - Upsized		150	250	105.5	2	2031	Local	$1,210	0.9	$1,089	$114,921
168	PPE-656C10	WALKER CR		Asset Replacement Program - Upsized		100	200	115.8	2	2031	Local	$1,140	0.9	$1,026	$118,821
168	PPE-544C10	DELAIR RD		Asset Replacement Program - Upsized	Continuity with ARP	150	250	14.7	3	2031	Collector	$1,210	1.1	$1,331	$19,550
168	PPE-1451C10	GRIFFITHS RD		Asset Replacement Program - Upsized	Continuity with ARP	150	250	8.3	3	2031	Arterial	$1,210	1.2	$1,452	$11,996
168	PPE-1439C10	GRIFFITHS RD		Pipe Upgrade	Continuity with ARP	200	250	12.5	3	2031	Arterial	$1,210	1.2	$1,452	$18,160
169	PPE-1119C10	CAROL ST		Asset Replacement Program - Upsized		200	200	2.3	2	N/A	Local	$1,140	0.9	$1,026	$2,338
169	PPE-528C10	HAMON DR		Asset Replacement Program - Upsized		100	200	9.0	2	N/A	Local	$1,140	0.9	$1,026	$9,261
169	PPE-523C10	HAMON DR		Asset Replacement Program - Upsized		100	200	14.0	2	N/A	Local	$1,140	0.9	$1,026	$14,386
169	PPE-535C10	HAMON DR		Asset Replacement Program - Upsized		100	200	18.7	2	N/A	Local	$1,140	0.9	$1,026	$19,194
169	PPE-527C10	HAMON DR		Asset Replacement Program - Upsized		100	200	19.8	2	N/A	Local	$1,140	0.9	$1,026	$20,326

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
169	PPE-526C10	HAMON DR		Asset Replacement Program - Upsized		100	200	67.0	2	N/A	Local	$1,140	0.9	$1,026	$68,792
169	PPE-529C10	HAMON DR		Asset Replacement Program - Upsized		100	200	73.0	2	N/A	Local	$1,140	0.9	$1,026	$74,921
169	PPE-524C10	HAMON DR		Asset Replacement Program - Upsized		100	200	97.0	2	N/A	Local	$1,140	0.9	$1,026	$99,497
169	PPE-522C10	CAROL ST		Asset Replacement Program - Upsized		100	200	97.4	2	N/A	Local	$1,140	0.9	$1,026	$99,918
169	PPE-536C10	HAMON DR		Asset Replacement Program - Upsized		100	200	100.2	2	N/A	Local	$1,140	0.9	$1,026	$102,828
169	PPE-782C10	HAMON DR		Asset Replacement Program - Upsized		100	200	137.8	2	N/A	Local	$1,140	0.9	$1,026	$141,418
169	PPE-525C10	HAMON DR		Asset Replacement Program - Upsized		100	200	153.3	2	N/A	Local	$1,140	0.9	$1,026	$157,290
169	PPE-500C10	HAMON DR		Asset Replacement Program - Upsized	Continuity with ARP	100	200	11.0	3	N/A	Local	$1,140	0.9	$1,026	$11,286
170	PPE-481C10	DELAIR RD		Asset Replacement Program - Upsized		200	200	19.8	2	N/A	Collector	$1,140	1.1	$1,254	$24,813
170	PPE-482C10	DELAIR RD		Asset Replacement Program - Upsized		200	200	50.6	2	N/A	Collector	$1,140	1.1	$1,254	$63,451
170	PPE-478C10	DELAIR RD		Asset Replacement Program - Upsized		200	200	150.8	2	N/A	Collector	$1,140	1.1	$1,254	$189,143
171	PPE-472C10	SPENCER ST		Asset Replacement Program		150	200	9.8	3	N/A	Local	$1,140	0.9	$1,026	$10,008
171	PPE-489C10	SPENCER ST		Asset Replacement Program		150	200	54.4	3	N/A	Local	$1,140	0.9	$1,026	$55,772
171	PPE-471C10	SPENCER ST		Asset Replacement Program		150	200	141.0	3	N/A	Local	$1,140	0.9	$1,026	$144,643
172	PPE-423C10	PANORAMA DR		Asset Replacement Program		150	200	17.1	3	N/A	Local	$1,140	0.9	$1,026	$17,589
172	PPE-1191C10	PANORAMA DR		Asset Replacement Program	Continuity with ARP	150	200	21.7	3	N/A	Local	$1,140	0.9	$1,026	$22,241
172	PPE-431C10	EVERETT RD		Asset Replacement Program		150	200	21.7	3	N/A	Local	$1,140	0.9	$1,026	$22,266
172	PPE-425C10	PANORAMA DR		Asset Replacement Program		150	200	30.5	3	N/A	Local	$1,140	0.9	$1,026	$31,274
172	PPE-439C10	PANORAMA DR		Asset Replacement Program	Continuity with ARP	150	200	37.0	3	N/A	Local	$1,140	0.9	$1,026	$37,971
172	PPE-437C10	PANORAMA DR		Asset Replacement Program	Continuity with ARP	150	200	38.0	3	N/A	Local	$1,140	0.9	$1,026	$38,974
172	PPE-458C10	EVERETT RD		Asset Replacement Program		150	200	44.9	3	N/A	Local	$1,140	0.9	$1,026	$46,045
172	PPE-430C10	EVERETT RD		Asset Replacement Program		150	200	78.1	3	N/A	Local	$1,140	0.9	$1,026	$80,142
172	PPE-829C10	PANORAMA DR		Asset Replacement Program	Continuity with ARP	150	200	86.7	3	N/A	Local	$1,140	0.9	$1,026	$88,943
172	PPE-438C10	PANORAMA DR		Asset Replacement Program	Continuity with ARP	150	200	97.0	3	N/A	Local	$1,140	0.9	$1,026	$99,567
172	PPE-428C10	PANORAMA DR		Asset Replacement Program		150	200	124.9	3	N/A	Local	$1,140	0.9	$1,026	$128,135
172	PPE-827C10	PANORAMA DR		Asset Replacement Program - Upsized		100	200	53.9	2	N/A	Local	$1,140	0.9	$1,026	$55,320
172	PPE-817C10	EVERETT RD		Asset Replacement Program - Upsized		150	200	2.9	3	N/A	Local	$1,140	0.9	$1,026	$2,990
172	PPE-427C10	PANORAMA DR		Asset Replacement Program - Upsized		150	200	3.9	3	N/A	Local	$1,140	0.9	$1,026	$3,987
172	PPE-1430C10	EVERETT ST		Asset Replacement Program - Upsized	Continuity with ARP	150	200	8.0	3	N/A	Local	$1,140	0.9	$1,026	$8,208
172	PPE-812C10	EVERETT RD		Asset Replacement Program - Upsized		150	200	9.8	3	N/A	Local	$1,140	0.9	$1,026	$10,047
173	PPE-155C11	ROCKWELL DR		Asset Replacement Program		150	200	4.5	3	N/A	Local	$1,140	0.9	$1,026	$4,593
173	PPE-171C11	ROCKWELL DR		Asset Replacement Program		200	200	16.8	3	N/A	Local	$1,140	0.9	$1,026	$17,217
173	PPE-157C11	ROCKWELL DR		Asset Replacement Program		150	200	20.9	3	N/A	Local	$1,140	0.9	$1,026	$21,461
173	PPE-172C11	ROCKWELL DR		Asset Replacement Program		200	200	21.0	3	N/A	Local	$1,140	0.9	$1,026	$21,524
173	PPE-167C11	ROCKWELL DR		Asset Replacement Program		200	200	31.1	3	N/A	Local	$1,140	0.9	$1,026	$31,877
173	PPE-162C11	KNOX CR		Asset Replacement Program		200	200	44.8	3	N/A	Local	$1,140	0.9	$1,026	$45,954
173	PPE-160C11	KNOX CR		Asset Replacement Program		200	200	64.6	3	N/A	Local	$1,140	0.9	$1,026	$66,273
173	PPE-158C11	ROCKWELL DR		Asset Replacement Program		150	200	73.5	3	N/A	Local	$1,140	0.9	$1,026	$75,378
173	PPE-161C11	KNOX CR		Asset Replacement Program		200	200	91.7	3	N/A	Local	$1,140	0.9	$1,026	$94,095
173	PPE-169C11	ROCKWELL DR		Asset Replacement Program		200	200	100.5	3	N/A	Local	$1,140	0.9	$1,026	$103,151
173	PPE-165C11	KNOX CR		Asset Replacement Program		200	200	101.0	3	N/A	Local	$1,140	0.9	$1,026	$103,579
173	PPE-168C11	ROCKWELL DR		Asset Replacement Program		200	200	123.0	3	N/A	Local	$1,140	0.9	$1,026	$126,162
173	PPE-156C11	ROCKWELL DR		Asset Replacement Program		150	200	128.4	3	N/A	Local	$1,140	0.9	$1,026	$131,690
173	PPE-1062C10	MARSHALL RD		Asset Replacement Program		200	200	1.6	2	N/A	Collector	$1,140	1.1	$1,254	$1,969
173	PPE-351C11	ROCKWELL DR		Asset Replacement Program		200	200	36.6	2	N/A	Collector	$1,140	1.1	$1,254	$45,846
173	PPE-287C11	ROCKWELL DR		Asset Replacement Program		200	200	41.5	3	N/A	Arterial	$1,140	1.2	$1,368	$56,751
173	PPE-411C10	MARSHALL RD		Asset Replacement Program		200	200	129.0	3	N/A	Arterial	$1,140	1.2	$1,368	$176,527
174	PPE-135C10	ELLIOT AVE		Asset Replacement Program		150	200	7.4	3	N/A	Local	$1,140	0.9	$1,026	$7,583
174	PPE-130C10	ST MATTHEWS WAY		Asset Replacement Program		150	200	7.8	3	N/A	Local	$1,140	0.9	$1,026	$8,050
174	PPE-120C10	GUILFORD DR		Asset Replacement Program		150	200	39.1	3	N/A	Local	$1,140	0.9	$1,026	$40,139
174	PPE-129C10	ST MATTHEWS WAY		Asset Replacement Program		150	200	41.9	3	N/A	Local	$1,140	0.9	$1,026	$42,963
174	PPE-133C10	ELLIOT AVE		Asset Replacement Program		150	200	48.9	3	N/A	Local	$1,140	0.9	$1,026	$50,165
174	PPE-127C10	GUILFORD DR		Asset Replacement Program		150	200	50.4	3	N/A	Local	$1,140	0.9	$1,026	$51,725
174	PPE-128C10	GUILFORD DR		Asset Replacement Program		150	200	75.3	3	N/A	Local	$1,140	0.9	$1,026	$77,207
174	PPE-134C10	ELLIOT AVE		Asset Replacement Program		150	200	82.3	3	N/A	Local	$1,140	0.9	$1,026	$84,396
174	PPE-588C10	GUILFORD WAY		Asset Replacement Program		150	200	107.2	3	N/A	Local	$1,140	0.9	$1,026	$109,984
174	PPE-136C10	ST MATTHEWS WAY		Asset Replacement Program		150	200	115.2	3	N/A	Local	$1,140	0.9	$1,026	$118,194
174	PPE-1411C10	GUILFORD DR		Asset Replacement Program	Continuity with ARP	150	200	2.0	3	N/A	Arterial	$1,140	1.2	$1,368	$2,736
174	PPE-1514C10	GUILFORD DR		Asset Replacement Program	Continuity with ARP	150	200	4.5	3	N/A	Arterial	$1,140	1.2	$1,368	$6,090
174	PPE-143C10	ELLIOT AVE		Asset Replacement Program	Continuity with ARP	150	200	46.0	3	N/A	Arterial	$1,140	1.2	$1,368	$62,928
175	PPE-112C10	MOSS CT		Asset Replacement Program		150	200	43.3	3	N/A	Local	$1,140	0.9	$1,026	$44,473
175	PPE-118C10	MAYWOOD CT		Asset Replacement Program		150	200	43.4	3	N/A	Local	$1,140	0.9	$1,026	$44,554
175	PPE-115C10	MOWBRAY CT		Asset Replacement Program		150	200	46.0	3	N/A	Local	$1,140	0.9	$1,026	$47,179
175	PPE-124C10	MILA ST		Asset Replacement Program		150	200	67.1	3	N/A	Local	$1,140	0.9	$1,026	$68,799
175	PPE-121C10	MILA ST		Asset Replacement Program		150	200	83.3	3	N/A	Local	$1,140	0.9	$1,026	$85,503
175	PPE-122C10	MILA ST		Asset Replacement Program		150	200	85.6	3	N/A	Local	$1,140	0.9	$1,026	$87,783
175	PPE-123C10	MILA ST		Asset Replacement Program		150	200	85.6	3	N/A	Local	$1,140	0.9	$1,026	$87,783
175	PPE-125C10	MILA ST		Asset Replacement Program		150	200	21.3	2	N/A	Arterial	$1,140	1.2	$1,368	$29,118
176	PPE-71C10	GUILFORD DR		Asset Replacement Program		150	200	150.5	2	N/A	Local	$1,140	0.9	$1,026	$154,434
176	PPE-72C10	GUILFORD DR		Asset Replacement Program		150	200	20.7	3	N/A	Local	$1,140	0.9	$1,026	$21,195
176	PPE-70C10	GUILFORD DR		Asset Replacement Program		150	200	44.4	3	N/A	Local	$1,140	0.9	$1,026	$45,508
176	PPE-108C10	GUILFORD DR		Asset Replacement Program		150	200	62.4	3	N/A	Local	$1,140	0.9	$1,026	$64,025
176	PPE-109C10	GUILFORD DR		Asset Replacement Program		150	200	101.6	3	N/A	Local	$1,140	0.9	$1,026	$104,270
177	PPE-98C10	BLATCHFORD WAY		Asset Replacement Program		150	200	35.0	2	N/A	Local	$1,140	0.9	$1,026	$35,951
177	PPE-76C10	ANORA DR		Asset Replacement Program		150	200	1.5	3	N/A	Local	$1,140	0.9	$1,026	$1,543
177	PPE-105C10	ANORA DR		Asset Replacement Program		150	200	7.6	3	N/A	Local	$1,140	0.9	$1,026	$7,816
177	PPE-84C10	ANORA DR		Asset Replacement Program		150	200	7.6	3	N/A	Local	$1,140	0.9	$1,026	$7,816
177	PPE-75C10	ANORA DR		Asset Replacement Program		150	200	18.7	3	N/A	Local	$1,140	0.9	$1,026	$19,221
177	PPE-106C10	ANORA DR		Asset Replacement Program		150	200	19.8	3	N/A	Local	$1,140	0.9	$1,026	$20,319
177	PPE-92C10	BREWSTER PL		Asset Replacement Program		150	200	35.0	3	N/A	Local	$1,140	0.9	$1,026	$35,951

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
177	PPE-83C10	ANORA DR		Asset Replacement Program		150	200	39.9	3	N/A	Local	$1,140	0.9	$1,026	$40,964
177	PPE-86C10	ANORA DR		Asset Replacement Program		150	200	50.3	3	N/A	Local	$1,140	0.9	$1,026	$51,577
177	PPE-90C10	ANORA DR		Asset Replacement Program		150	200	53.9	3	N/A	Local	$1,140	0.9	$1,026	$55,337
177	PPE-88C10	ANORA DR		Asset Replacement Program		150	200	62.4	3	N/A	Local	$1,140	0.9	$1,026	$64,057
177	PPE-315C10	ANORA DR		Asset Replacement Program		150	200	75.2	3	N/A	Local	$1,140	0.9	$1,026	$77,202
177	PPE-80C10	BREWSTER PL		Asset Replacement Program		150	200	90.4	3	N/A	Local	$1,140	0.9	$1,026	$92,757
177	PPE-87C10	ANORA DR		Asset Replacement Program		150	200	116.7	3	N/A	Local	$1,140	0.9	$1,026	$119,729
177	PPE-82C10	ANORA DR		Asset Replacement Program		150	200	130.3	3	N/A	Local	$1,140	0.9	$1,026	$133,717
177	PPE-91C10	ANORA DR		Asset Replacement Program		150	200	131.5	3	N/A	Local	$1,140	0.9	$1,026	$134,894
177	PPE-78C10	ANORA DR		Asset Replacement Program		150	200	136.2	3	N/A	Local	$1,140	0.9	$1,026	$139,716
177	PPE-314C10	MCMILLAN RD		Asset Replacement Program		200	200	11.2	2	N/A	Arterial	$1,140	1.2	$1,368	$15,327
177	PPE-313C10	MCMILLAN RD		Asset Replacement Program		200	200	61.3	2	N/A	Arterial	$1,140	1.2	$1,368	$83,815
178	PPE-60C10	BLATCHFORD WAY		Asset Replacement Program		150	200	4.3	2	N/A	Local	$1,140	0.9	$1,026	$4,377
178	PPE-59C10	BLATCHFORD WAY		Asset Replacement Program		150	200	21.8	2	N/A	Local	$1,140	0.9	$1,026	$22,408
178	PPE-61C10	BLATCHFORD WAY		Asset Replacement Program		150	200	51.6	2	N/A	Local	$1,140	0.9	$1,026	$52,990
178	PPE-58C10	BLATCHFORD WAY		Asset Replacement Program		150	200	109.2	2	N/A	Local	$1,140	0.9	$1,026	$112,009
178	PPE-66C10	MIRUS DR		Asset Replacement Program		150	200	7.3	3	N/A	Local	$1,140	0.9	$1,026	$7,459
178	PPE-68C10	MIRUS DR		Asset Replacement Program		150	200	43.9	3	N/A	Local	$1,140	0.9	$1,026	$45,022
178	PPE-67C10	MIRUS DR		Asset Replacement Program		150	200	62.3	3	N/A	Local	$1,140	0.9	$1,026	$63,900
178	PPE-65C10	BLATCHFORD WAY		Asset Replacement Program		150	200	97.5	3	N/A	Local	$1,140	0.9	$1,026	$100,084
179	PPE-323C10	BLATCHFORD WAY		Asset Replacement Program		150	200	10.2	2	N/A	Local	$1,140	0.9	$1,026	$10,442
179	PPE-101C10	BLATCHFORD WAY		Asset Replacement Program		150	200	27.7	2	N/A	Local	$1,140	0.9	$1,026	$28,458
179	PPE-103C10	BLATCHFORD WAY		Asset Replacement Program		150	200	42.0	2	N/A	Local	$1,140	0.9	$1,026	$43,130
179	PPE-800C10	BLATCHFORD WAY		Asset Replacement Program		150	200	56.0	2	N/A	Local	$1,140	0.9	$1,026	$57,493
179	PPE-1034C10	BLATCHFORD WAY		Asset Replacement Program		150	200	62.0	2	N/A	Local	$1,140	0.9	$1,026	$63,627
179	PPE-104C10	BLATCHFORD WAY		Asset Replacement Program		150	200	70.1	2	N/A	Local	$1,140	0.9	$1,026	$71,918
179	PPE-95C10	BLATCHFORD WAY		Asset Replacement Program		150	200	145.0	3	N/A	Local	$1,140	0.9	$1,026	$148,806
179	PPE-321C10	BLATCHFORD WAY		Asset Replacement Program		150	200	18.4	2	N/A	Arterial	$1,140	1.2	$1,368	$25,132
180	PPE-49C10	GUILFORD DR		Asset Replacement Program		150	200	15.3	2	N/A	Local	$1,140	0.9	$1,026	$15,664
180	PPE-52C10	MIRAUN CR		Asset Replacement Program		150	200	21.6	2	N/A	Local	$1,140	0.9	$1,026	$22,202
180	PPE-48C10	GUILFORD DR		Asset Replacement Program		150	200	69.5	2	N/A	Local	$1,140	0.9	$1,026	$71,285
180	PPE-53C10	MIRAUN CR		Asset Replacement Program		150	200	147.4	2	N/A	Local	$1,140	0.9	$1,026	$151,214
180	PPE-50C10	MIRAUN CR		Asset Replacement Program		150	200	19.8	3	N/A	Local	$1,140	0.9	$1,026	$20,331
180	PPE-74C10	GUILFORD DR		Asset Replacement Program	Continuity with ARP	150	200	68.3	3	N/A	Local	$1,140	0.9	$1,026	$70,030
180	PPE-51C10	MIRAUN CR		Asset Replacement Program		150	200	111.5	3	N/A	Local	$1,140	0.9	$1,026	$114,413
181	PPE-15C10	MIDAS ST		Asset Replacement Program		150	200	41.1	3	N/A	Local	$1,140	0.9	$1,026	$42,151
181	PPE-16C10	MIDAS ST		Asset Replacement Program		150	200	45.7	3	N/A	Local	$1,140	0.9	$1,026	$46,874
181	PPE-39C10	MIDAS ST		Asset Replacement Program		150	200	89.6	3	N/A	Local	$1,140	0.9	$1,026	$91,912
182	PPE-18C10	MERLIN DR		Asset Replacement Program		150	200	17.3	3	N/A	Local	$1,140	0.9	$1,026	$17,709
182	PPE-43C10	MERLIN PL		Asset Replacement Program		150	200	25.8	3	N/A	Local	$1,140	0.9	$1,026	$26,437
182	PPE-41C10	MERLIN DR		Asset Replacement Program		150	200	28.1	3	N/A	Local	$1,140	0.9	$1,026	$28,856
182	PPE-17C10	MERLIN DR		Asset Replacement Program		150	200	32.4	3	N/A	Local	$1,140	0.9	$1,026	$33,202
182	PPE-40C10	MERLIN DR		Asset Replacement Program		150	200	85.7	3	N/A	Local	$1,140	0.9	$1,026	$87,916
182	PPE-46C10	MERLIN DR		Asset Replacement Program		150	200	119.4	3	N/A	Local	$1,140	0.9	$1,026	$122,496
183	PPE-68D10	MIDAS ST		Asset Replacement Program		150	200	96.0	3	N/A	Local	$1,140	0.9	$1,026	$98,525
183	PPE-84D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	2.0	2	N/A	Provincial Highway	$1,320	1.3	$1,716	$3,432
183	PPE-240778	OLD YALE RD		Asset Replacement Program - Upsized		250	300	5.8	2	N/A	Provincial Highway	$1,320	1.3	$1,716	$9,989
183	PPE-85D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	21.3	2	N/A	Provincial Highway	$1,320	1.3	$1,716	$36,613
183	PPE-650D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	35.8	2	N/A	Provincial Highway	$1,320	1.3	$1,716	$61,428
183	PPE-651D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	37.2	2	N/A	Provincial Highway	$1,320	1.3	$1,716	$63,796
183	PPE-1431D10	OLD YALE RD		Asset Replacement Program - Upsized	Continuity with ARP	250	300	1.0	3	N/A	Provincial Highway	$1,320	1.3	$1,716	$1,690
183	PPE-240633	OLD YALE RD		Asset Replacement Program - Upsized	Continuity with ARP	250	300	1.5	3	N/A	Provincial Highway	$1,320	1.3	$1,716	$2,497
183	PPE-1429D10	OLD YALE RD		Asset Replacement Program - Upsized	Continuity with ARP	250	300	59.0	3	N/A	Provincial Highway	$1,320	1.3	$1,716	$101,261
183	PPE-83D10	OLD YALE RD		Asset Replacement Program - Upsized	Continuity with ARP	250	300	78.0	3	N/A	Provincial Highway	$1,320	1.3	$1,716	$133,848
183	PPE-119D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	22.0	2	N/A	Arterial	$1,320	1.2	$1,584	$34,886
183	PPE-88D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	61.9	2	N/A	Arterial	$1,320	1.2	$1,584	$98,088
183	PPE-120D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	68.7	2	N/A	Arterial	$1,320	1.2	$1,584	$108,764
183	PPE-91D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	74.2	2	N/A	Arterial	$1,320	1.2	$1,584	$117,574
184	PPE-47C10	GUILFORD DR		Asset Replacement Program		150	200	36.5	3	N/A	Local	$1,140	0.9	$1,026	$37,432
184	PPE-76D10	GUILFORD DR		Asset Replacement Program		150	200	37.4	3	N/A	Local	$1,140	0.9	$1,026	$38,423
184	PPE-77D10	GUILFORD DR		Asset Replacement Program		150	200	39.9	3	N/A	Local	$1,140	0.9	$1,026	$40,911
184	PPE-69D10	ALADDIN CR		Asset Replacement Program		150	200	40.9	3	N/A	Local	$1,140	0.9	$1,026	$41,995
184	PPE-78D10	GUILFORD DR		Asset Replacement Program		150	200	41.4	3	N/A	Local	$1,140	0.9	$1,026	$42,455
184	PPE-73D10	ALADDIN CR		Asset Replacement Program		150	200	53.9	3	N/A	Local	$1,140	0.9	$1,026	$55,257
184	PPE-71D10	ALADDIN CR		Asset Replacement Program		150	200	68.6	3	N/A	Local	$1,140	0.9	$1,026	$70,358
184	PPE-89D10	GUILFORD DR		Asset Replacement Program		150	200	84.4	3	N/A	Local	$1,140	0.9	$1,026	$86,544
184	PPE-79D10	GUILFORD DR		Asset Replacement Program		150	200	96.8	3	N/A	Local	$1,140	0.9	$1,026	$99,313
184	PPE-74D10	ALADDIN CR		Asset Replacement Program		150	200	117.6	3	N/A	Local	$1,140	0.9	$1,026	$120,609
184	PPE-70D10	ALADDIN CR		Asset Replacement Program		150	200	142.9	3	N/A	Local	$1,140	0.9	$1,026	$146,576
185	PPE-90D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	1.5	2	N/A	Arterial	$1,320	1.2	$1,584	$2,414
185	PPE-782D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	5.1	2	N/A	Arterial	$1,320	1.2	$1,584	$8,007
185	PPE-111D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	8.5	2	N/A	Arterial	$1,320	1.2	$1,584	$13,518
185	PPE-990D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	8.9	2	N/A	Arterial	$1,320	1.2	$1,584	$14,123
185	PPE-100D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	10.2	2	N/A	Arterial	$1,320	1.2	$1,584	$16,146
185	PPE-719D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	11.5	2	N/A	Arterial	$1,320	1.2	$1,584	$18,210
185	PPE-1321D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	13.1	2	N/A	Arterial	$1,320	1.2	$1,584	$20,773
185	PPE-112D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	15.3	2	N/A	Arterial	$1,320	1.2	$1,584	$24,232
185	PPE-99D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	22.2	2	N/A	Arterial	$1,320	1.2	$1,584	$35,097
185	PPE-94D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	29.2	2	N/A	Arterial	$1,320	1.2	$1,584	$46,303
185	PPE-115D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	34.3	2	N/A	Arterial	$1,320	1.2	$1,584	$54,369

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
185	PPE-193D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	34.6	2	N/A	Arterial	$1,320	1.2	$1,584	$54,779
185	PPE-194D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	52.9	2	N/A	Arterial	$1,320	1.2	$1,584	$83,773
185	PPE-101D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	68.2	2	N/A	Arterial	$1,320	1.2	$1,584	$108,043
185	PPE-987D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	70.9	2	N/A	Arterial	$1,320	1.2	$1,584	$112,347
185	PPE-114D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	82.7	2	N/A	Arterial	$1,320	1.2	$1,584	$131,073
186	PPE-1411D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	1.0	2	N/A	Arterial	$1,320	1.2	$1,584	$1,543
186	PPE-1035D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	6.4	2	N/A	Arterial	$1,320	1.2	$1,584	$10,074
186	PPE-177D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	7.0	2	N/A	Arterial	$1,320	1.2	$1,584	$11,129
186	PPE-473D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	19.2	2	N/A	Arterial	$1,320	1.2	$1,584	$30,334
186	PPE-472D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	29.4	2	N/A	Arterial	$1,320	1.2	$1,584	$46,551
186	PPE-320C10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	34.2	2	N/A	Arterial	$1,320	1.2	$1,584	$54,105
186	PPE-461D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	40.5	2	N/A	Arterial	$1,320	1.2	$1,584	$64,093
186	PPE-434D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	107.9	2	N/A	Arterial	$1,320	1.2	$1,584	$170,931
186	PPE-429D10	MCMILLAN RD		Asset Replacement Program - Upsized		250	300	157.1	2	N/A	Arterial	$1,320	1.2	$1,584	$248,902
186	PPE-1084C10	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	250	300	1.0	3	N/A	Arterial	$1,320	1.2	$1,584	$1,573
187	PPE-425D10	ORCHARD DR		Asset Replacement Program		150	200	14.9	2	N/A	Local	$1,140	0.9	$1,026	$15,318
187	PPE-426D10	ORCHARD DR		Asset Replacement Program		150	200	104.9	2	N/A	Local	$1,140	0.9	$1,026	$107,601
187	PPE-433D10	ORCHARD DR		Asset Replacement Program		150	200	112.6	2	N/A	Local	$1,140	0.9	$1,026	$115,496
187	PPE-1658D10	ORCHARD DR		Asset Replacement Program	Continuity with ARP	150	200	3.0	3	N/A	Local	$1,140	0.9	$1,026	$3,070
187	PPE-1655D10	ORCHARD DR		Asset Replacement Program	Continuity with ARP	150	200	3.3	3	N/A	Local	$1,140	0.9	$1,026	$3,382
187	PPE-1652D10	ORCHARD DR		Asset Replacement Program	Continuity with ARP	150	200	6.0	3	N/A	Local	$1,140	0.9	$1,026	$6,156
187	PPE-455D10	WOODSTOCK DR		Asset Replacement Program		150	200	15.2	3	N/A	Local	$1,140	0.9	$1,026	$15,636
187	PPE-161C10	WOODSTOCK DR		Asset Replacement Program		150	200	19.8	3	N/A	Local	$1,140	0.9	$1,026	$20,318
187	PPE-23C10	DAMSON AVE		Asset Replacement Program		150	200	21.6	3	N/A	Local	$1,140	0.9	$1,026	$22,143
187	PPE-32C10	WOODSTOCK DR		Asset Replacement Program		150	200	43.7	3	N/A	Local	$1,140	0.9	$1,026	$44,835
187	PPE-451D10	WOODSTOCK DR		Asset Replacement Program		150	200	74.0	3	N/A	Local	$1,140	0.9	$1,026	$75,896
187	PPE-22C10	ORCHARD DR		Asset Replacement Program		150	200	75.2	3	N/A	Local	$1,140	0.9	$1,026	$77,194
187	PPE-460D10	WOODSTOCK DR		Asset Replacement Program		150	200	89.5	3	N/A	Local	$1,140	0.9	$1,026	$91,862
187	PPE-456D10	ORCHARD DR		Asset Replacement Program		150	200	89.6	3	N/A	Local	$1,140	0.9	$1,026	$91,950
187	PPE-160C10	DAMSON AVE		Asset Replacement Program		150	200	99.9	3	N/A	Local	$1,140	0.9	$1,026	$102,448
187	PPE-452D10	WOODSTOCK DR		Asset Replacement Program		150	200	116.3	3	N/A	Local	$1,140	0.9	$1,026	$119,316
188	PPE-449D10	CAMERON CR		Asset Replacement Program		150	200	26.6	3	N/A	Local	$1,140	0.9	$1,026	$27,337
188	PPE-670C10	CAMERON CR		Asset Replacement Program		150	200	28.4	3	N/A	Local	$1,140	0.9	$1,026	$29,094
188	PPE-444D10	CAMERON CR		Asset Replacement Program		150	200	34.6	3	N/A	Local	$1,140	0.9	$1,026	$35,473
188	PPE-448D10	CAMERON CR		Asset Replacement Program		150	200	36.0	3	N/A	Local	$1,140	0.9	$1,026	$36,933
188	PPE-457D10	CAMERON CR		Asset Replacement Program		150	200	42.6	3	N/A	Local	$1,140	0.9	$1,026	$43,656
188	PPE-443D10	CAMERON CR		Asset Replacement Program		150	200	46.2	3	N/A	Local	$1,140	0.9	$1,026	$47,369
188	PPE-440D10	CAMERON CR		Asset Replacement Program		150	200	87.6	3	N/A	Local	$1,140	0.9	$1,026	$89,907
188	PPE-438D10	CAMERON CR		Asset Replacement Program		150	200	93.9	3	N/A	Local	$1,140	0.9	$1,026	$96,291
188	PPE-458D10	CAMERON CR		Asset Replacement Program		150	200	123.2	3	N/A	Local	$1,140	0.9	$1,026	$126,436
188	PPE-445D10	CAMERON CR		Asset Replacement Program		150	200	148.7	3	N/A	Local	$1,140	0.9	$1,026	$152,544
188	PPE-439D10	CAMERON CR		Asset Replacement Program		150	200	8.6	2	N/A	Arterial	$1,140	1.2	$1,368	$11,728
189	PPE-414D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	2.4	2	N/A	Arterial	$1,320	1.2	$1,584	$3,862
189	PPE-415D10	OLD YALE RD		Asset Replacement Program - Upsized		100	300	2.6	2	N/A	Arterial	$1,320	1.2	$1,584	$4,096
189	PPE-176D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	5.8	2	N/A	Arterial	$1,320	1.2	$1,584	$9,130
189	PPE-417D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	12.7	2	N/A	Arterial	$1,320	1.2	$1,584	$20,058
189	PPE-463D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	24.1	2	N/A	Arterial	$1,320	1.2	$1,584	$38,114
189	PPE-416D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	25.0	2	N/A	Arterial	$1,320	1.2	$1,584	$39,600
189	PPE-464D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	37.8	2	N/A	Arterial	$1,320	1.2	$1,584	$59,877
189	PPE-172D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	99.9	2	N/A	Arterial	$1,320	1.2	$1,584	$158,275
189	PPE-418D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	109.2	2	N/A	Arterial	$1,320	1.2	$1,584	$172,908
189	PPE-1065D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	165.2	2	N/A	Arterial	$1,320	1.2	$1,584	$261,702
189	PPE-485D10	OLD YALE RD		Asset Replacement Program - Upsized		250	300	343.0	2	N/A	Arterial	$1,320	1.2	$1,584	$543,304
190	PPE-170D10	MACBETH CR		Asset Replacement Program		150	200	1.5	3	N/A	Local	$1,140	0.9	$1,026	$1,539
190	PPE-162D10	MACBETH CR		Asset Replacement Program		150	200	19.7	3	N/A	Local	$1,140	0.9	$1,026	$20,247
190	PPE-171D10	MACBETH CR		Asset Replacement Program		150	200	40.5	3	N/A	Local	$1,140	0.9	$1,026	$41,583
190	PPE-168D10	MACBETH CR		Asset Replacement Program		150	200	40.6	3	N/A	Local	$1,140	0.9	$1,026	$41,633
190	PPE-166D10	MACBETH CR		Asset Replacement Program		150	200	63.3	3	N/A	Local	$1,140	0.9	$1,026	$64,896
190	PPE-165D10	MACBETH CR		Asset Replacement Program		150	200	84.4	3	N/A	Local	$1,140	0.9	$1,026	$86,583
190	PPE-161D10	MACBETH CR		Asset Replacement Program		150	200	122.5	3	N/A	Local	$1,140	0.9	$1,026	$125,681
190	PPE-183D10	MACBETH CR		Asset Replacement Program		150	200	14.6	2	N/A	Collector	$1,140	1.1	$1,254	$18,346
190	PPE-778D10	MACBETH CR		Asset Replacement Program		150	200	18.0	2	N/A	Collector	$1,140	1.1	$1,254	$22,593
191	PPE-247171	MCMILLAN RD		Asset Replacement Program - Upsized		200	300	18.4	2	N/A	Collector	$1,320	1.1	$1,452	$26,699
191	PPE-250D10	MCMILLAN RD		Asset Replacement Program - Upsized		200	300	25.4	2	N/A	Collector	$1,320	1.1	$1,452	$36,908
191	PPE-972D10	MCMILLAN RD		Asset Replacement Program - Upsized		200	200	38.5	2	N/A	Collector	$1,140	1.1	$1,254	$48,309
191	PPE-249D10	MCMILLAN RD		Asset Replacement Program - Upsized		200	300	39.9	2	N/A	Collector	$1,320	1.1	$1,452	$58,006
191	PPE-1026D10	MCMILLAN RD		Asset Replacement Program - Upsized		200	300	51.6	2	N/A	Collector	$1,320	1.1	$1,452	$74,923
191	PPE-971D10	MCMILLAN RD		Asset Replacement Program - Upsized		200	300	55.8	2	N/A	Collector	$1,320	1.1	$1,452	$80,971
191	PPE-180D10	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	200	300	3.2	3	N/A	Collector	$1,320	1.1	$1,452	$4,610
191	PPE-247320	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	200	300	4.0	3	N/A	Collector	$1,320	1.1	$1,452	$5,865
191	PPE-181D10	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	200	300	17.6	3	N/A	Collector	$1,320	1.1	$1,452	$25,496
191	PPE-1007D10	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	200	300	35.5	3	N/A	Collector	$1,320	1.1	$1,452	$51,507
191	PPE-1030D10	MCMILLAN RD		Asset Replacement Program - Upsized		200	300	29.5	2	N/A	Arterial	$1,320	1.2	$1,584	$46,739
192	PPE-277D10	MARBLE HILL DR		Pipe Upgrade	Fire Flow	150	200	1.8	2	2016	Local	$1,140	0.9	$1,026	$1,804
192	PPE-266D10	MARBLE HILL DR		Pipe Upgrade	Fire Flow	150	200	36.6	2	2016	Local	$1,140	0.9	$1,026	$37,527
192	PPE-263D10	MARBLE HILL DR		Pipe Upgrade	Fire Flow	150	200	42.7	2	2016	Local	$1,140	0.9	$1,026	$43,819
192	PPE-264D10	MARBLE HILL DR		Pipe Upgrade	Fire Flow	150	200	98.1	2	2016	Local	$1,140	0.9	$1,026	$100,680
192	PPE-262D10	MARBLE HILL DR		Pipe Upgrade	Fire Flow	150	200	99.1	2	2016	Local	$1,140	0.9	$1,026	$101,691
193	PPE-317C10	MCMILLAN RD		Asset Replacement Program - Upsized	Continuity with ARP	150	300	6.9	3	N/A	Arterial	$1,320	1.2	$1,584	$10,957
193	PPE-197C10	MCMILLAN RD		Asset Replacement Program - Upsized		150	300	10.6	3	N/A	Arterial	$1,320	1.2	$1,584	$16,797

Project ID	GIS Pipe ID	Location	Study Area	Upgrade Type	Upgrade Reason	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Priority	Timing*	Risk_Road_Class	Conventional Unit Rate ($/m)	Multiplier	Adjusted Unit Rate ($/m)	Total Cost ($)
193	PPE-1141C10	MCMILLAN RD		Asset Replacement Program - Upsized		150	300	56.5	3	N/A	Arterial	$1,320	1.2	$1,584	$89,445
193	PPE-325C10	MCMILLAN RD		Asset Replacement Program - Upsized		150	300	307.6	3	N/A	Arterial	$1,320	1.2	$1,584	$487,175
194	PPE-233B10	COUTTS WAY		Pipe Upgrade	Fire Flow	200	250	4.4	3	2016	Collector	$1,210	1.1	$1,331	$5,878
194	PPE-26B10	COUTTS WAY		Pipe Upgrade	Fire Flow	200	250	19.0	3	2016	Collector	$1,210	1.1	$1,331	$25,289
194	PPE-344B10	COUTTS WAY		Pipe Upgrade	Fire Flow	200	250	19.1	3	2016	Collector	$1,210	1.1	$1,331	$25,387
194	PPE-163B10	COUTTS WAY		Pipe Upgrade	Fire Flow	200	250	63.7	3	2016	Collector	$1,210	1.1	$1,331	$84,721
														Total	**$119,268,001**

* The projects with "N/A" indicated for timing are asset replacement projects that are not required hydraulically to address capacity issues in the system.