City of Guelph

Water and Wastewater Servicing Master Plan

Technical Memorandum 3: Water and Wastewater Servicing Recommendations

June 2023

TECHNICAL MEMORANDUM

To:	**Colleen Gammie, P.Eng** **Infrastructure Planning Engineer**	Company:	**City of Guelph**
From:	**Sam Ziemann, P.Eng**	Project Ref. #:	**75-41-191370**
		Date:	**June 5, 2023**

Subject: **TM3 Water and Wastewater Servicing Recommendations**

City of Guelph

Water and Wastewater Servicing Master Plan

TM3 Water and Wastewater Servicing Recommendations

C3 WATER INC. / Stantec Consulting

June 5, 2023

SIGN OFF

VERSION	DATE	DESCRIPTION OF REVISIONS	REVISED BY	REVIEWED BY
1	September 17, 2022	TM3B (Proposed Infrastructure Analysis / Recommendations / Implications) Draft #1	Water: Michelle Scott Wastewater: Marty Anderson	Water: Sam Ziemann, Matt Philips, Dennis Mutti, Emily Stahl, Wayne Galliher Wastewater: Marc Telmosse, Adam Geldart General: Colleen Gammie, Mary Angelo
2	November 1, 2022	TM3 (Water & Wastewater Servicing Recommendations) Draft #1	Water: Michelle Scott Wastewater: Marty Anderson	Water: Sam Ziemann, Matt Philips Wastewater: Marc Telmosse, Adam Geldart General: Colleen Gammie
3	June 5, 2023	Final	Water: Michelle Scott Wastewater: Marty Anderson	Water: Sam Ziemann, Matt Philips Wastewater: Marc Telmosse

This document, entitled **"TM3 Water & Wastewater Servicing Recommendations"**, was prepared by C3 Water Inc. (C3W) and Stantec Consulting Ltd. (Stantec) for the **City of Guelph**.

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

The material herein reflects C3W and Stantec's best judgement based upon the information available at the time of preparation. Any use which a third party makes of this report or any reliance on or decisions made based on it, are the responsibilities of such third parties. C3W and Stantec accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based upon this report.

DATE: June 5, 2023

SEAL

Reviewed by: **Sam Ziemann, P.Eng, President**

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1.0 INTRODUCTION AND BACKGROUND

C3 Water Inc (C3W) and Stantec Consulting (Stantec) were retained by the City of Guelph (City) to complete the Water and Wastewater Servicing Master Plan (WWSMP). The purpose of this TM is to develop and evaluate potential water and wastewater servicing alternatives to meet servicing requirements under future growth projections. Future growth projections were previously modelled under existing infrastructure conditions and deficiencies were identified in *TM3A: Existing & Future Population, Employment & Land Use, and Servicing Implications*.

2.0 EVALUATION CRITERIA

The following criteria were used to evaluate proposed servicing alternatives presented in this TM. Full descriptions of the criteria are provided in Appendix A.

1. Environmental:
    a. Protects Environmental Features
    b. Protects Groundwater, Streams and Rivers
    c. Minimizes Impact on Climate Change
2. Social/Cultural:
    a. Minimizes Long-Term Impacts to the Community Related to Noise, Odour, Traffic and Aesthetics
    b. Minimizes Impacts to Businesses and Major Transportation Corridors
    c. Manages and Minimizes Short-Term Construction Impacts
    d. Protects Health and Safety
    e. Protects Cultural Heritage Resources
    f. Minimizes Risks to Historical Landfill Sites
3. Economic:
    a. Provides Low Lifecycle Costs
4. Technical:
    a. Meets Existing and Future Needs
    b. Provides Ease of Maintenance
    c. Aligns with Existing and Planned Infrastructure
    d. Aligns with Existing and Future Land Use
    e. Aligns with Efficient Approval and Permitting Process
    f. Manages and Minimizes Construction Risks
    g. Ability to Adapt to Climate Change

3.0 EXISTING SYSTEM SUMMARY OF DEFICIENCIES

The purpose of this section is to summarize the deficiencies that were identified under existing infrastructure conditions. Full results are reported in *TM3A: Existing & Future Population, Employment & Land Use, and Servicing Implications.*

3.1 Water System Deficiencies

Based on the analysis of the water system under existing and 2051+ Buildout demand conditions, the following conclusions were made:

1. Storage:

   a. Based on the desktop analysis, there is sufficient storage under existing and 2051+ demand conditions.
   b. Based on the hydraulic analysis, limitations were seen in the model in regard to balancing the Zone 1 storage between the Verney and Clair Elevated Tanks (ETs). The Verney ET was found to overflow while the Clair ET level dropped to 47% full under 2051+ maximum day demand (MDD) conditions. This is due to the hydraulic connectivity of the system as the Verney ET is located closer and is better connected to the F.M. Woods Pumping Station (PS) and Reservoir than the Clair ET. The F.M. Woods Reservoir also drained throughout the day as the Woods PS struggled to maintain the Clair ET level.
   c. The hydraulic analysis showed that in Zone 2, the Paisley Reservoir and Speedvale ET levels were maintained under existing and 2051+ conditions. The Clythe Reservoir was found to drop below 50% full during peak hour under existing conditions, but this was mitigated under 2051+ conditions with the expanded Clythe Reservoir, inflow from the Clythe Well and the additional supply sources on the east side of Zone 2.

2. Supply:
   a. The desktop analysis showed that the existing and planned future supply sources, as per the Water Supply Master Plan completed by AECOM Canada Ltd. (AECOM) in 2021 (2021 WSMP), are sufficient to meet the projected 2051+ demands.
   b. The hydraulic analysis showed that the sources which supply the Woods Reservoir via the Arkell Aqueduct (Arkell Wells, Glen Collector, Lower Collector and Carter Wells) were not sufficient to maintain the Woods Reservoir level under 2051+ MDD conditions. This was partially due to the Verney ET overflowing, causing water loss in the system as well as hydraulic limitations in the water system and some sources not able to operate 24 hours per day.
3. Pump Capacity:
   a. The desktop analysis showed sufficient pump capacity under existing and 2051+ conditions.
   b. The hydraulic analysis showed that under 2051+ MDD conditions, the pump capacity in the south end of Zone 1 was not sufficient to maintain the Clair ET level, while the north end of Zone 1 was being oversupplied, causing the Verney ET to overflow.
   c. The hydraulic analysis showed sufficient Zone 2 pump capacity under 2051+ MDD conditions, with Paisley, Robertson and Clythe PSs running well below their planed firm capacities.
   d. The Clair BPS was found to have sufficient capacity to supply the Zone 3 2051+ MDD.
4. Fire Flow
   a. Localized fire flow concerns were seen in the model under both existing and 2051+ conditions in areas with small cast iron watermains.
5. Watermain Capacity
   a. Limited watermain capacity and increased demands under 2051+ MDD conditions prevented the Woods PS from being able to supply the south end of Zone 1 to sufficiently maintain the Clair ET level.
   b. The headloss was found to exceed 2 m/km in a number of watermains throughout Zone 2 under 2051+ MDD conditions.
   c. Velocity was not found to exceed 3 m/s under existing or 2051+ conditions.
6. Pressure
   a. Under existing MDD conditions, pressure below 40 psi was seen in the model in pockets of Zone 1 with ground elevations above 344m and one high elevation area on the east side of Zone 2 with ground elevations above 357m.
   b. Under existing MDD conditions, pressure above 100 psi was seen in the model in areas of Zone 1 along the Speed River with elevations below 310m.
   c. Existing low pressure concerns in the south end of Zone 1 were found to worsen under 2051+ conditions when the Clair ET level dropped during peak hour

   d. Existing high pressure concerns along the Speed River in Zone 1 were found to worsen under 2051+ conditions when the Woods PS ran at a higher flow to meet demands and fill the Clair ET.
7. The water system failure analysis showed the following infrastructure to be critical to the system's performance and will be taken into consideration when developing proposed future projects:
   a. High Criticality:
      i. Woods PS
      ii. Arkell Aqueduct
   b. Medium Criticality:
      i. University Watermain River Crossing
      ii. Paisley PS and Reservoir
      iii. Clythe PS
      iv. Clair BPS (2051+ conditions only)

3.2 Wastewater System Deficiencies

Based on the analysis of the wastewater system under existing and 2051 growth conditions, the following conclusions were made:

1. There are no capacity issues under the DWF conditions for either the existing or future scenarios. There are isolated locations where sewers are identified as minimal or flat slopes, however no surcharging is identified in these locations. These locations may warrant additional maintenance though.
2. Seven (7) areas are identified with capacity constraints/bottlenecks under the WWF condition for both the existing and future scenarios, with surcharging observed. Specific reaches within these areas are considered for upgrade requirements.
3. The City's pump stations have adequate capacity for the DWF and WWF conditions under both the existing and future scenarios.
4. The failure analysis provides the extent of surcharge and the spill point for the 20 locations of interest provided by the City.

3.2.1 Updated Wastewater System Results

The wastewater system deficiencies are based on the level of service criteria that was agreed upon with the City during the Level of Service workshop held on August 11th, 2022. During that meeting, a "no-surcharge" approach was maintained for the wastewater collection system. System improvements are thus developed to ensure surcharge in the gravity system is addressed. In addition, the loading rate for residential population has been updated since the submission of TM3A, from 227 L/c/day to 300 L/c/day at the City's request, in order to better align with per capita rates used for planning at the WWTP. Updated model results for the Future System Dry Weather Flow (DWF) (Figure 3-1) and Wet Weather Flow (WWF) (Figure 3-2) are provided.

As shown, no new capacity issues have been identified under DWF conditions resulting from the increase of per capita loading rate from 227 L/c/day to 300 L/c/day. Figure 3-1 also provides a more detailed breakdown of the ratio of d/D during DWF to assist in identifying sewers that could pose potential maintenance issues. One new capacity issue was identified under WWF conditions as compared to the submission of TM3A. This occurs on Speedvale Ave and is further explored in Section 5.6.4.

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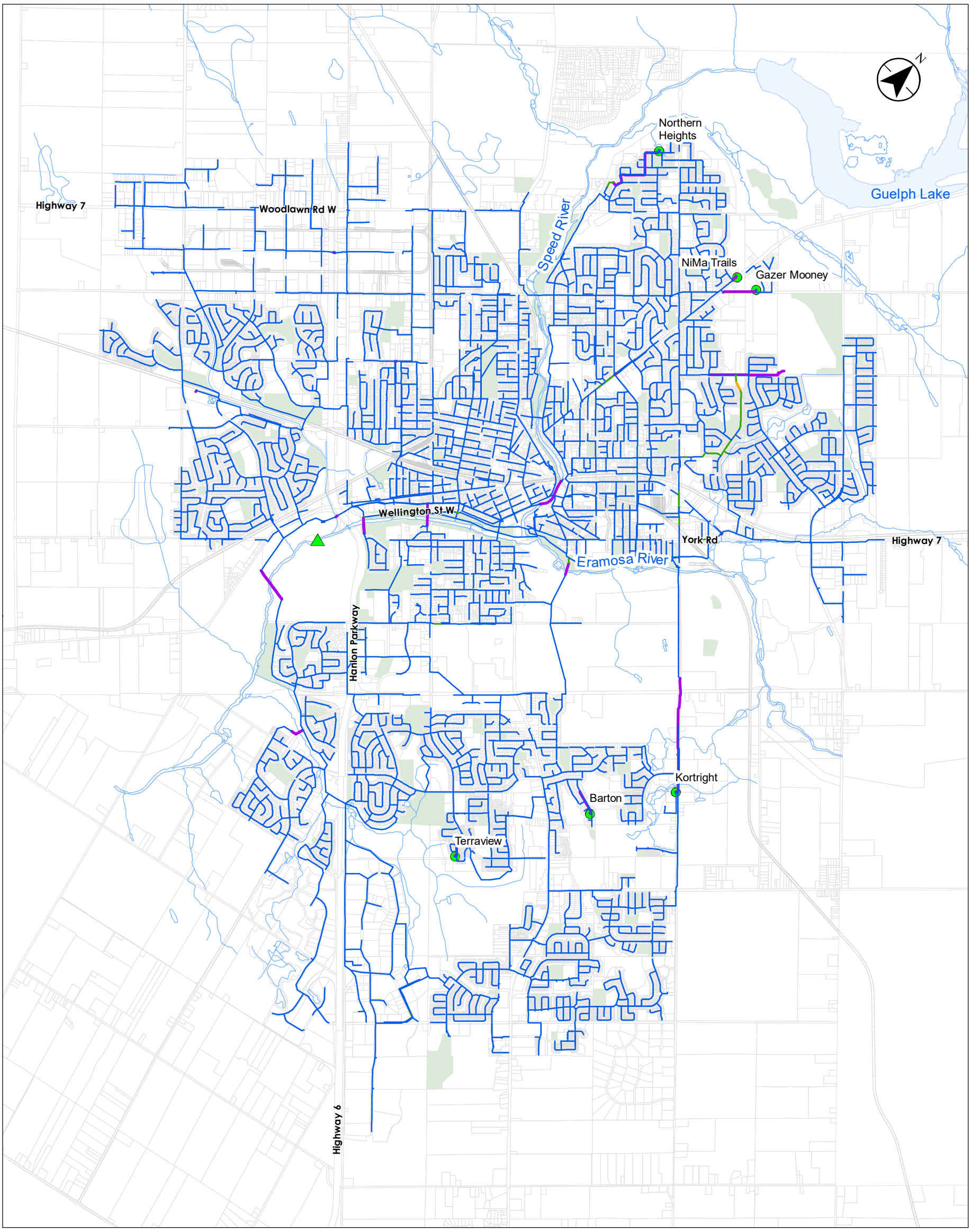

Legend

- Active Pump Station
- Water Resource Recovery Center
- Railway
- Watercourse
- Property
- Forcemain / Siphon

d / D

- <= 50%
- > 50% - 80%
- > 80% - 99%
- Surcharged

0 1,000 2,000 Meters

1:50,000 (At Original document size of 11x17)

Stantec

C3 Water

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
3-1

Title
Future Conditions DWF Results

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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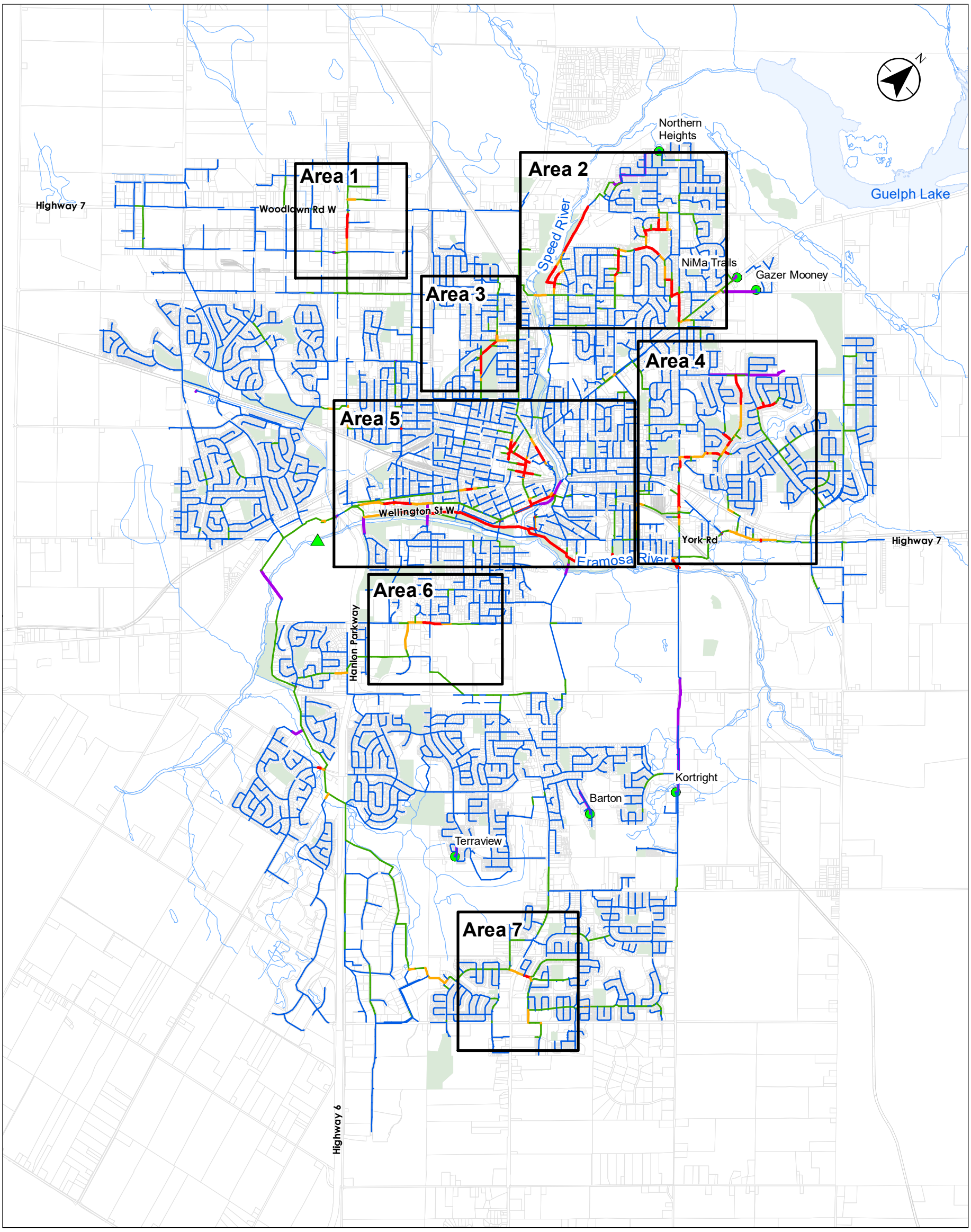

Legend

- Active Pump Station
- Water Resource Recovery Center
- Property
- Forcemain / Siphon

d / D

- <= 50%
- > 50% - 80%
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- Surcharged

0 1,000 2,000 Meters

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Stantec

C3 Water

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
3.2

Title
Future Conditions WWF Results

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

3.2.2 Siphon Assessment

There are currently ten (10) locations with active inverted siphons in the wastewater collection system. As noted in the *Design Criteria, LOS and Sensitivity Analysis Technical Memorandum (C3/Stantec, December 2020),* the City's 2019 Engineering Design Manual does not mention siphons and there are no established performance criteria. The 2022 MECP Guidelines provide several requirements and/or guidelines. Key requirements considered in our assessment (from a modelling perspective):'

- The minimum pipe size for inverted siphons shall be nominally 200mm in diameter.
- Pipes shall be sized such that a self-cleaning velocity between 1.1m/s to 1.3m/s is achieved at least once per day. Where the required velocities cannot be achieved, alternate means of flushing shall be incorporated in the design.
- Inverted siphons shall be designed with at least two (2) parallel barrels to accommodate flow variations. If a double barrel siphon is not feasible, a single barrel inverted siphon is acceptable provided that additional arrangements are incorporated in the design to facilitate inspection, operation, and maintenance.

For the purpose of this assessment, the performance of the siphons is evaluated based on the velocities observed under DWF conditions. Due to the nature of inverted siphons, if minimum flushing velocities are not attained regularly, deposition can occur resulting in a reduction in capacity. The maximum velocities under existing and future DWF conditions are provided in Table 3-1.

Table 3-1 Siphon Performance Results (DWF)

Siphon ID	Siphon Name	Number of Barrels	Diameter (mm)	Existing Max Velocity (m/s)	Future Max Velocity (m/s)
1	Alma-Mercer	1	600	0.46	0.59
2	Elizabeth-Beaumont	2	450	0.17	0.23
			450	0.17	0.23
3	Eramosa River	1	500	0.75	0.76
4	Hanlon-Massey-Campbell	2	200	0.05	0.07
			450	0.08	0.11
5	Ptarmigan	2	200	0.24	0.24
			150	0.29	0.30
6	Speed River - Crane Park	3	750	0.75	1.46
			300	0.65	1.00
			600	0.77	1.61
7	Speed River - Manor Park	1	400	0.20	0.21
8	Speed River - Municipal St	2	250	0.07	0.07
			150	0.20	0.20
9	Stevenson-Eramosa	1	200	0.35	0.41
10	Willow-Guelph	1	750	0.24	0.34

As shown, none of the City's existing siphons achieve the minimum required velocities specified by the MECP (1.1 m/s) in the existing conditions. In future conditions, only the Speed River – Crane Park siphon

exceeds the recommended flushing velocity. It is noted that the siphons are traditionally modelled and no special controls are included. It is understood that some of the City's siphons may have automated flushing systems (Speed River - Municipal St confirmed), which are not reflected in the results. Several locations also do not have the recommended double barrel requirement. Recommendations pertaining to the City's siphons are provided in Section 5.12.

4.0 WATER SYSTEM ALTERNATIVES DEVELOPMENT & EVALUATION

The purpose of this section is to develop and evaluate alternatives for meeting water servicing needs under 2051+ buildout conditions. The preferred alternative and proposed projects were then modelled and results are provided in Section 6.1.

4.1 Water System Servicing Alternatives

To address the system deficiencies identified in TM3A, the following water servicing alternatives were considered:

1. Do Nothing
2. Limit Community Growth
3. Water Conservation/Demand Management
4. Improvements to Existing System: New Facilities and Watermains

As a result of the failure analysis completed in TM3A, the Arkell Aqueduct and the F.M. Woods PS were both flagged as being highly critical for water servicing. It was found that if either were to fail, the existing system would run out of water in approximately 12-24 hours, under existing average day demand (ADD) conditions.

There are plans to upgrade the Woods PS to improve the resiliency of the facility. Upgrades are described in Section 4.4.1.1. This is currently in the design phase and construction is planned to be completed by 2025. While this project reduces the criticality of the Woods PS, the Arkell Aqueduct will still be a critical singular supply to Woods.

The Arkell Aqueduct is referred to in three (3) reaches:

1. Upper Reach from the Arkell Spring Grounds to Watson Road
2. Middle Reach from Watson Road to Scout Camp Station
3. Lower Reach from Scout Camp to F.M. Woods

The Arkell Aqueduct is of particular importance because it supplies approximately 60-80% of the City's drinking water on any given day. The aqueduct is approximately 6km long and a single non-redundant pipe, making this an extremely critical piece of infrastructure. Additionally, portions of the Aqueduct, specifically the Middle Reach, are of concern due to age and condition and are difficult to access for maintenance and repair.

A previous study has been completed for the City to assess how the redundancy of this key piece of infrastructure can be improved. This is summarized in the "Arkell Aqueduct – Redundancy & Resiliency" TM completed by AECOM Canada Ltd (AECOM) in 2019 (Aqueduct Redundancy TM). Two overall alternatives were considered including twinning the existing Aqueduct along the same alignment or directing a portion of the Arkell Wellfield supply towards the south end of the City.

Each of the two alternatives has a different impact on the water distribution system. Twinning the existing aqueduct would maintain the supply system with the F.M Woods PS continuing to be the largest point of entry (POE) into the distribution system. Adding a new connection from the Arkell Wellfield to the south end of the City's water system would provide a new large POE to the distribution system toward an area where significant growth is occurring. The decision on how to provide redundancy to the Arkell Wellfield will greatly impact the needs in the distribution system. Therefore, it is important to first determine the long-term plan for providing redundancy from the City's largest supply.

For the purposes of the WWSMP, the following sub-alternatives for *improvements to the existing system* were considered for redundancy/resiliency of the Arkell Wellfield:

A. Twin Existing Arkell Aqueduct – FM Woods WTP POE
B. New Watermain, Reservoir and Pump Station (new South end POE)

4.1.1 Do Nothing

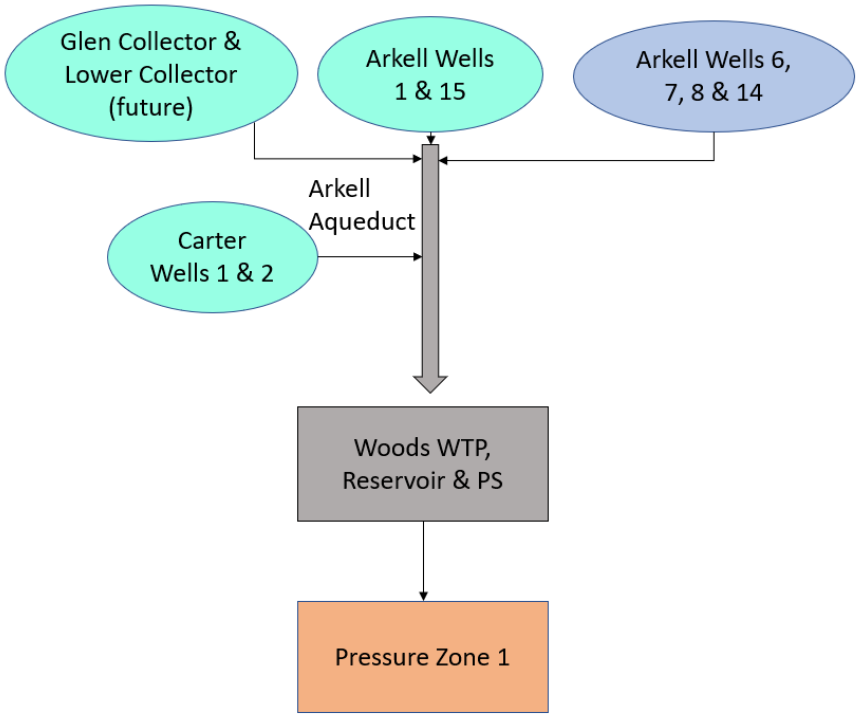
The *do nothing* alternative is that for which no improvements or changes would be undertaken to address water servicing requirements. This alternative does not address system deficiencies; however, it has been included as one of the potential solutions as it serves as a benchmark against which all other alternatives may be compared or evaluated. A decision to "Do Nothing" may be made if the financial and environmental costs of all other alternatives outweigh the benefits.

In this case, the *do nothing* alternative would fail to address existing system limitations as identified in TM3A and meet future growth requirements outlined by the City's Growth Management Strategy and the Province's Places to Grow. This alternative is not recommended as a viable solution as the level of service provided would not meet the City's criteria and will not be carried forward.

In terms of the Arkell Wellfield Redundancy/Resiliency, the *do nothing* represents existing conditions where the Arkell Wells, the Glen Collector and the Carter Wells feed into a single Aqueduct which supplies the Woods Reservoir. This alternative is summarized in Table 4-1 below. This alternative does not address the criticality of the Aqueduct or the F.M. Woods Reservoir and PS as these would still be single points of failure that have a significant impact on the City's overall ability to adequately supply the system. It was also found through the analysis completed in TM3A that, with the existing watermain infrastructure, there was a lack of watermain capacity to move water from the Woods PS to the Clair ET in the South end of Zone 1.

It has been identified in a previous study titled "Arkell Aqueduct Emptying Analysis PCSWMM Model" (C3W, 2018) that the existing Aqueduct capacity is limited to 538 L/s – 705 L/s depending on the level of the Woods Reservoir. While this limitation is greater than the total capacity of all existing and planned supplies into the Arkell Aqueduct (based on the WSMP), the limitation is still noted for consideration when evaluating alternatives.

Table 4-1 Arkell Wellfield Redundancy/Resiliency Concept 0: Do Nothing

Arkell Wellfield Redundancy Concept 0: Do Nothing	
Overview	
• Arkell Wells, Glen Collector, Carter Wells and future lower collector to feed into existing Arkell Aqueduct which supplies the Woods Reservoir. After treatment, water is then be supplied into Zone 1 via the Woods PS. <u>Infrastructure Upgrades Required:</u> • None	
Redundancy/Resiliency/ Criticality	• Does not reduce criticality or improve redundancy/resiliency of the Arkell Aqueduct or the Woods PS.
Pressure	• Does not address low pressures at south end of Zone 1. • Does not address high pressures along Speed River in Zone 1.
Watermain Capacity	• Limited watermain capacity in Zone 1 prevents Woods from adequately supplying the south end of Zone 1. • Limited capacity of existing Aqueduct.
Storage	• Woods Reservoir and Clair ET were found to fall below 50% full under 2051+ MDD conditions.
Pumping	• Woods pump station reaching firm capacity under 2051+ MDD conditions.

4.1.2 Limit Growth

This alternative involves reducing the future water servicing requirements by limiting distribution system demands. This would involve limiting future residential, industrial, commercial and institutional growth and does not conform with the City's ongoing Municipal Comprehensive Review (Shaping Guelph) project. This is not a feasible alternative.

4.1.3 Water Conservation

The *water conservation* alternative involves reducing water usage to decrease the system demand. Typically, water conservation is an economical method of delaying infrastructure costs. Examples of measures that can be taken include public education programs, irrigation reduction incentives, switching to water efficient water softeners and increasing water efficiency in gardens and pools. Improving water efficiency would help to reduce peak demands and overall water usage in the system. Additionally, water conservation would decrease the volume of sanitary flows produced. Water Conservation can be achieved in many ways. The City has been a leader in this area. Water use per person in Guelph is lower than many comparable municipalities. The City updated their Water Conservation Programs in 2016 and continues to pursue conservation efforts.

While water conservation could partially address the future supply deficiency, this alternative would be implemented in conjunction with other system improvements to meet demands. Additional supply and distribution infrastructure would still be required but timelines would be adjusted.

4.1.4 Improvements to Existing System: New Facilities and Watermains

The *improvements to existing system* alternative involves implementation of capital projects such as watermains, reservoirs and pump facilities to both address existing constraints and meet the needs to future growth. Further discussion, analysis and evaluation is carried out in Section 6.1. The following sections outline the Arkell Wellfield Redundancy concept sub-alternatives.

4.1.4.1 Arkell Wellfield Redundancy/Resiliency Concept A: Twin Existing Arkell Aqueduct

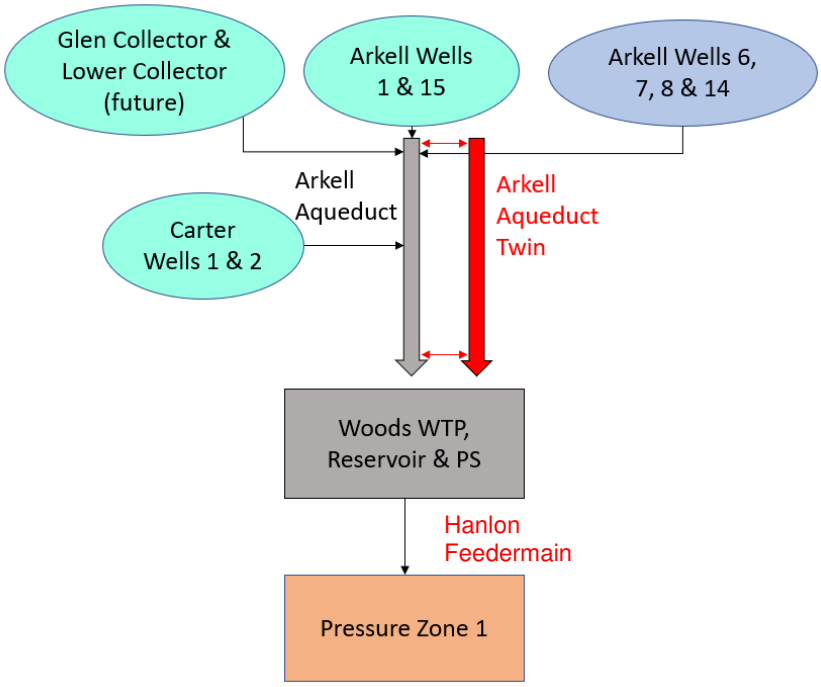
The first sub-alternative considered was to twin the existing Aqueduct along the same alignment and is summarized in Table 4-2 below. This would reduce the criticality of the existing Aqueduct and improve operational flexibility as one Aqueduct could remain operational while the other is isolated for maintenance.

While this alternative does provide redundancy to the existing Aqueduct, the resiliency is still limited. An extreme weather event has the potential to cause failure to or reduce access to both pipes as they would follow the same alignment and be subject to the same risks.

This alternative does not address the criticality of the F.M. Woods Reservoir and PS as this would still be the single POE for these sources into the distribution system. However, it is noted that the planned upgrades at the Woods PS, currently in the design phase, will significantly improve the redundancy of the PS.

Twinning the Aqueduct alone does not address the lack of capacity to move water from the Woods PS to the Clair ET in the South end of Zone 1. As such, the proposed feedermain on the Hanlon Parkway from Wellington Street to Clair Road is necessary in order for this alternative to be viable. This is a significant watermain project that would improve the transmission capacity between the Woods PS and the Clair ET. Previous studies have been completed for this project including the “Wellington – Clair Feedermain Municipal Class EA” by AECOM in 2020 (Wellington-Clair Feedermain EA).

Table 4-2 Arkell Wellfield Redundancy/Resiliency Concept A: Arkell Aqueduct Twin

Arkell Wellfield Redundancy Concept A: Arkell Aqueduct Twin	
Overview • New Aqueduct along same or similar alignment as existing Aqueduct. Arkell Wells, Glen Collector, Carter Wells and future lower collector to feed into existing and new parallel Arkell Aqueduct which fills the Woods Reservoir. After Ultraviolet treatment, water is then supplied into Zone 1 via the F.M. Woods PS. <u>Infrastructure Upgrades Required:</u> • New parallel Aqueduct • New Hanlon Parkway feedermain from Wellington to Clair	
Redundancy/Criticality	• Does not reduce criticality or improve redundancy of the F.M Woods PS. • Reduces criticality, improves redundancy and capacity of the existing Arkell Aqueduct. • Does not significantly improve resiliency of existing Arkell Aqueduct.
Pressure	• Improves but does not completely address low pressures at south end of Zone 1. • Improves but does not completely address high pressures along Speed River in Zone 1.
Watermain Capacity	• Hanlon Feedermain improves ability for Woods to supply the south end of Zone 1.
Storage	• Clair ET maintained above 60% full under 2051+ MDD due to improved transmission from Woods via Hanlon feedermain. Woods Reservoir found to fall below 50%.
Pumping	• Woods pump station reaching firm capacity under 2051+ MDD conditions.

4.1.4.2 Arkell Wellfield Redundancy/Resiliency Concept B: New Watermain, Reservoir and Pump Station

The second sub-alternative considered was a new direct POE into the distribution system at Arkell Road and Victoria Road from the Arkell Wellfield. This alternative includes a new watermain, Reservoir and PS. Sources from the Arkell Wellfield could be directed to a new Arkell reservoir and WTP facility. The water would then be pumped to the south end of Zone 1.

This alternative would reduce the criticality of both the existing Aqueduct and the F.M. Woods Reservoir and PS. This alternative improves the resiliency of supply to the system as likelihood of complete failure to supply Arkell sources would be significantly reduced.

As the new Arkell PS would supply directly into the south end of Zone 1, this would reduce the need for improved north-south linear capacity. While additional watermain upgrades may be beneficial to improve system performance, no distribution system upgrades were necessary for this concept to be viable.

Secondary benefits of this alternative include the opportunity to supply other potential users, such as Arkell Village along the watermain route. Consultation should be conducted with Puslinch and Wellington County to discuss the needs or interest to service Arkell.

Two concepts were developed for this sub-alternative:

- Concept B1: Redundancy of Groundwater Arkell Wells
- Concept B2: Redundancy of all Arkell Sources

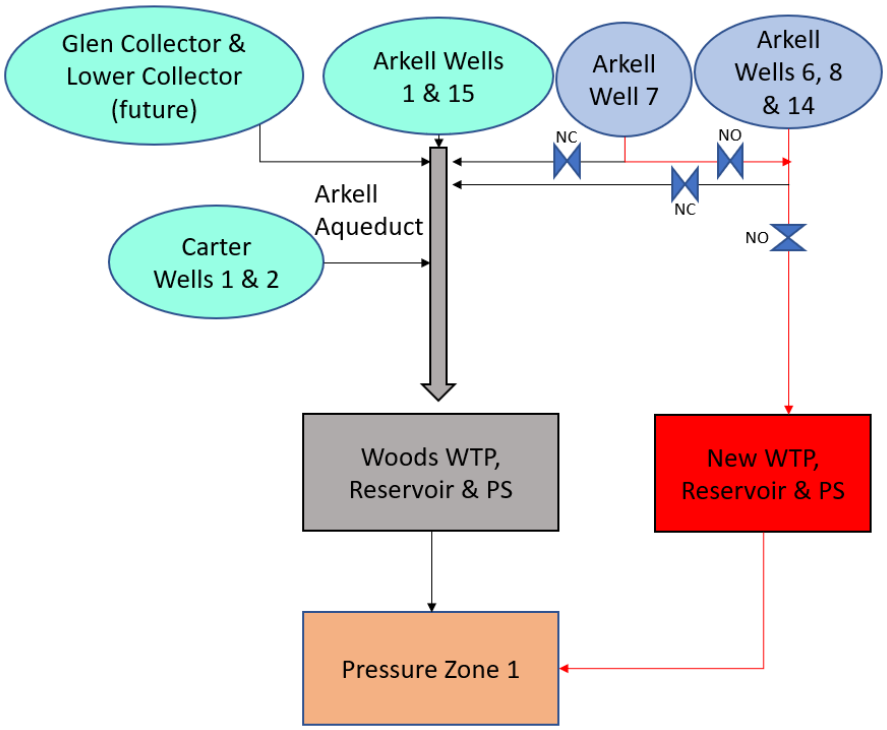
4.1.4.2.1 Arkell Wellfield Redundancy/Resiliency Concept B1: Redundancy of Groundwater Arkell Wells

A preliminary concept for this alternative would be for the Arkell Wells 6, 7, 8 & 14 to be redirected, using existing Valve Chamber 2 (VC2), to a new reservoir. Of the existing sources into the Aqueduct, Arkell Wells 6, 7, 8 & 14 are designated as groundwater (GW, category 1), while the remainder are designated as groundwater under the direct influence of surface water with effective filtration (GUDIWEF, category 2). Since the treatment requirements for GW are less intensive, and treatment requirements for those designated GUDIWEF are already provided at the F.M. Woods WTP, having only the GW wells directed to the new system is a simplified concept for this sub-alternative. This concept B1 is summarized in Table 4-3 below.

This concept does not provide complete redundancy for supplying the Arkell Sources as the conceptual plan for the proposed PS only has the ability to convey water from the GW Wells and not the GUDIWEF Wells, the Glenn Collector, the future Lower Road Collector, or the Carter Wells. GW sources could be conveyed to the system via either the existing Aqueduct and Woods facility or via the proposed PS, while the GUDIWEF sources could only be conveyed to the system via Woods.

A preliminary concept for this alternative is shown Figure 4-1 in and suggests the new Reservoir and PS be located on the existing Arkell Wellfield property near Arkell Road and the existing access road to the Arkell Wellfield. This would allow an easy to access site on City owned property. There's also the option of the reservoir drain line to discharge into the Glen Collector recharge pit, if needed for Reservoir maintenance. The watermain from the Wells to the reservoir could following the existing hydro-cut, allowing for vehicle access and minimizing the need for tree removal. The PS discharge feedermain could then follow the alignment of Arkell Road, connecting to the distribution system at Arkell Road and Victoria Road. This project would be subject to a Schedule C EA to determine site feature locations and watermain routing. As such, the preliminary layout is conceptual only.

Table 4-3 Arkell Wellfield Redundancy/Resiliency Concept B1: New Watermain, Pump Station and Reservoir (GW Only)

Arkell Wellfield Redundancy Concept B1: New Watermain, Pump Station and Reservoir (GW Only)	
Overview	
•Groundwater Arkell Wells (A6, 7, 8 & 14) are directed to new Reservoir and WTP. New pump station supplies to south end of Zone 1 via a new watermain. • GUDIWEF Arkell Wells (A1 & 15), Glen Collector, Carter Wells and future lower collector to feed into existing Arkell Aqueduct which supplies the Woods Reservoir. After treatment, water is then supplied into Zone 1 via the Woods PS. <u>Infrastructure Upgrades Required:</u> • New watermain, pump station and reservoir. • Replacement of existing pumps for Arkell Wells 6, 7, 8 & 14.	
Redundancy/Criticality	• Reduces criticality of Arkell Aqueduct and F.M. Woods PS. • Improves resiliency of system supply. • Provides partial redundancy of supply of Arkell sources.
Pressure	• Improves but does not completely address low pressures at south end of Zone 1. • Improves but does not completely address high pressures along Speed River in Zone 1.
Watermain Capacity	• Reduces need for improved watermain capacity in Zone 1.
Storage	• Woods Reservoir remained above 60% full and Clair ET maintained above 70% full under 2051+ MDD conditions.
Pumping	• Woods pump station operating below firm capacity under 2051+ MDD conditions.

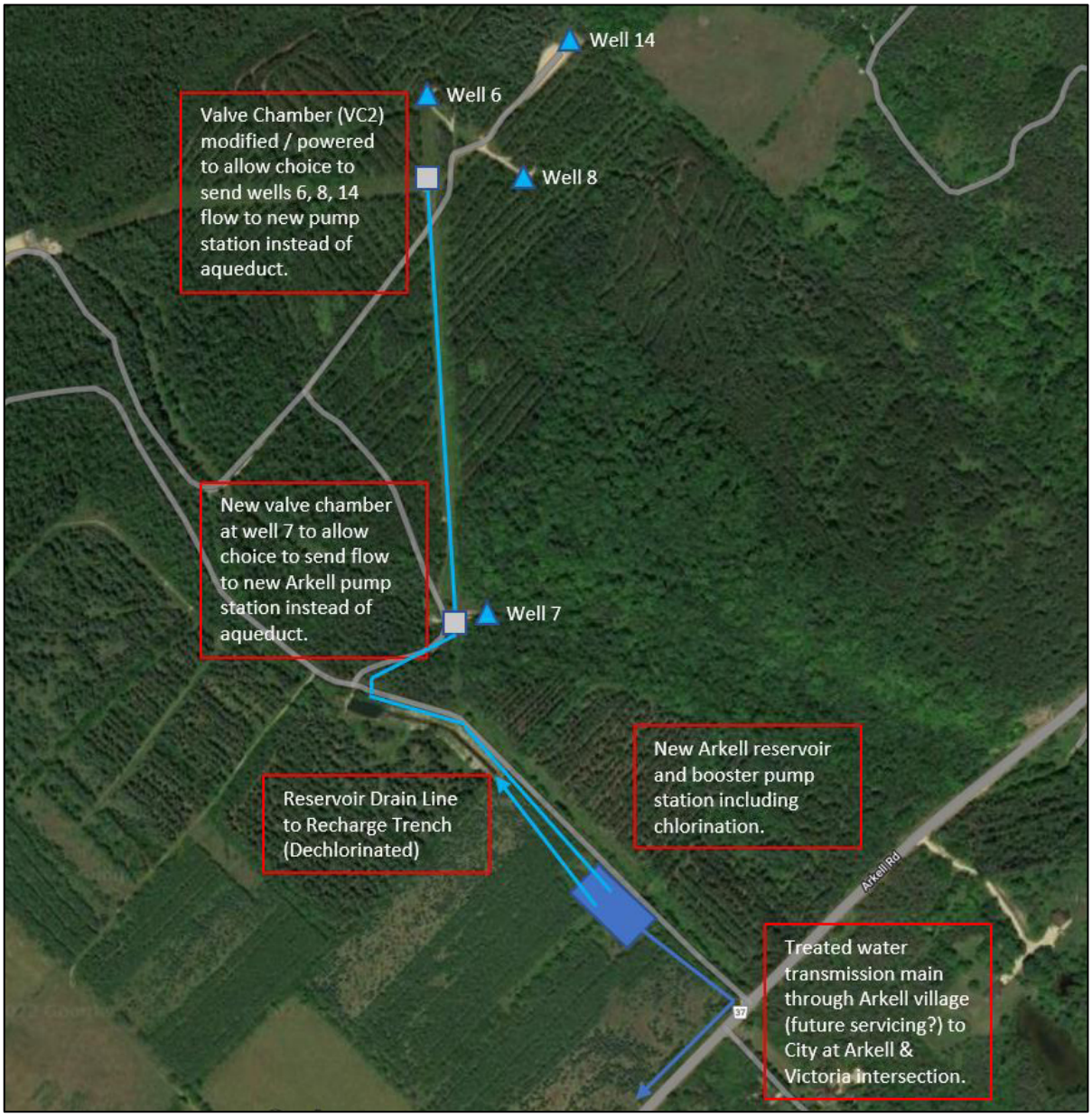


Figure 4-1 Arkell Wellfield Redundancy Concept B1: Preliminary Layout

4.1.4.2.2 Arkell Wellfield Redundancy/Resiliency Concept B2: Redundancy of All Arkell Sources

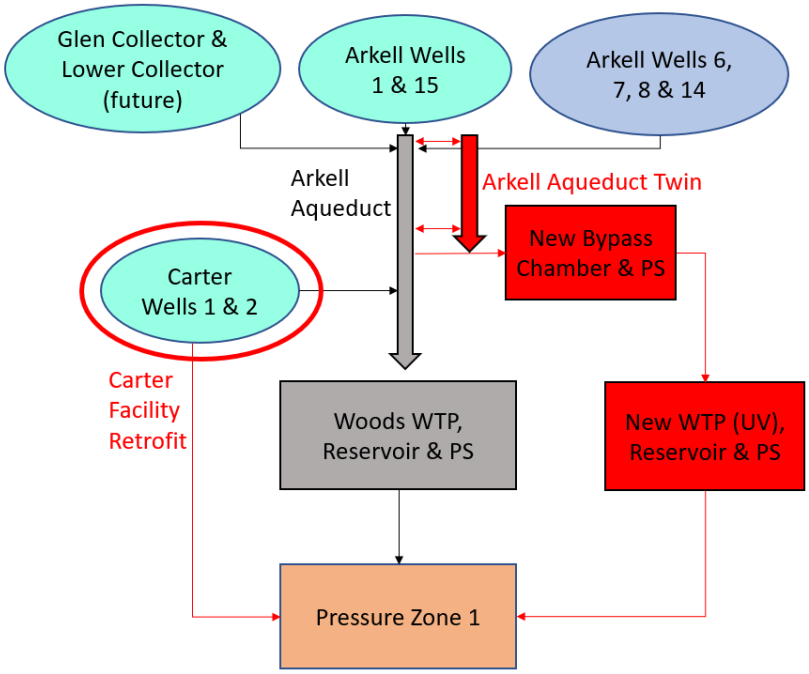
The second concept for this sub-alternative is to configure the Arkell infrastructure such that there is complete redundancy to supply all Arkell Sources in the event of a failure of the existing Aqueduct or the Woods facility. An overview is provided in Table 4-4 below.

Under this concept, the new watermain, reservoir, WTP and PS would be configured such that all Arkell wells and the Glen Collector can be redirected to the south end of Zone 1. This concept involves a bypass chamber off of the existing Aqueduct, east of Watson Road, to the proposed reservoir. The WTP facility would require UV as the sources would consist of both GW and GUDIWEF. For complete redundancy, the existing Aqueduct would need to be twinned upstream of the by-pass chamber. A preliminary layout for this concept is shown in Figure 4-2 blow. Under this concept, the existing Arkell well pumps would not need to

be replaced. All Arkell sources could be conveyed to the system via either the existing Aqueduct and Woods facility or via the proposed PS, with the exception of the Carter Wells.

Due to challenges associated with directing the Carter Wells to the new reservoir, it is suggested that a designated watermain is installed such that these wells can be redirected to Victoria Road and the distribution system, bypassing the existing Aqueduct and the Woods Reservoir. This would require a retrofit of the Carter facility to include UV treatment, nitrate treatment and pump upgrades.

Table 4-4 Arkell Wellfield Redundancy/Resiliency Concept B2: New Watermain, Pump Station and Reservoir (All Arkell Sources)

Arkell Wellfield Redundancy Concept B2: New Watermain, Pump Station and Reservoir (All Arkell Sources)	
Overview	
•Arkell Wells and Collectors can be directed to new Reservoir and WTP or to the existing Aqueduct. New pump station supplies to south end of Zone 1 via a new watermain. • Carter Wells can be directed directly to the distribution system or to the existing Aqueduct. • Existing Arkell Aqueduct supplies the Woods Reservoir. After treatment, water is then supplied into Zone 1 via the Woods PS. <u>Infrastructure Upgrades Required:</u> • New watermain, pump station, reservoir and treatment facility with UV. • Replacement of existing pumps for Carter Wells. Retrofit of Carter facility to include UV treatment. Designated watermain from Carter facility to distribution system. •Partial twinning of existing Aqueduct.	
Redundancy/Criticality	• Reduces criticality of Arkell Aqueduct and F.M. Woods PS. • Improves resiliency of system supply. • Provides complete redundancy of supply of Arkell sources.
Pressure	• Improves but does not completely address low pressures at south end of Zone 1. • Improves but does not completely address high pressures along Speed River in Zone 1.
Watermain Capacity	• Reduces need for improved watermain capacity in Zone 1.
Storage	• Woods Reservoir remained above 60% full and Clair ET maintained above 70% full under 2051+ MDD conditions.
Pumping	• Woods pump station operating below firm capacity under 2051+ MDD conditions.

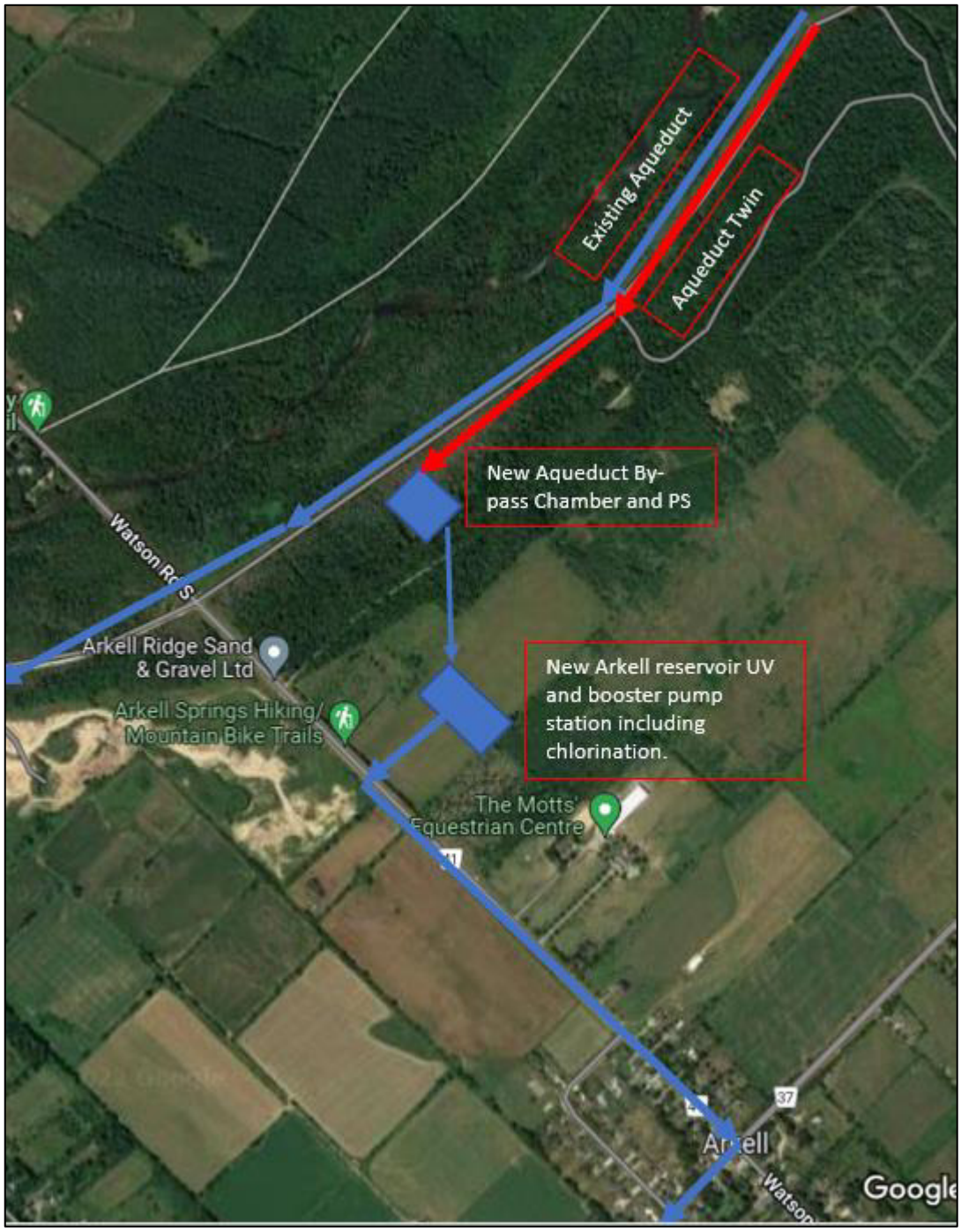


Figure 4-2 Arkell Wellfield Redundancy Concept B2: Preliminary Layout

4.2 Water System Servicing Evaluation

Each of the water servicing alternatives were evaluated using the following criteria, as discussed in Section 2.0:

1. Environmental
2. Social/Cultural
3. Economic
4. Technical

The water system alternatives are summarized in Table 4-5 below. The evaluation is described in the following sections.

Table 4-5 Water System Alternatives

Alternative		Description
1		Do Nothing
2		Limit Growth
3		Water Conservation
4	**A**	Improvements to Existing System – Twin Arkell Aqueduct
	B1	Improvements to Existing System – New Arkell Facility with South POE (GW sources only)
	B2	Improvements to Existing System – New Arkell Facility with South POE (All Arkell Sources)

4.2.1 Environmental

The *improvements to existing system* alternative is expected to have the largest impact on environmental features due to construction requirements. The *do nothing* alternative is expected to have no impact on environmental features compared to existing conditions. *Water conservation* has the potential to lessen the impact on water resources. *Limiting growth* is expected to have a minor impact on environmental features due to reduced development.

A significant portion of the existing Arkell Aqueduct is within a Grand River Conservation Authority (GRCA) floodplain and in close proximity to GRCA regulated wetlands. Additionally, much of the Aqueduct is within woodlots and designated Natural Heritage System (NHS). As such, Arkell Alternative A is not well aligned with the criteria to protect environmental features, groundwater, streams and rivers. Portions of the upgrades required for Arkell Alternative B would likely be within woodlots, NHS and GRCA regulated floodplain. However, the extent of Alternative B within these areas would be significantly less than under Alternative A, with new infrastructure installed in areas already mainly clear of trees; i.e., the existing hydro cut and access roads.

Under the Arkell Alternative B, B2 is expected to have a greater impact on environmental features than B1 due to the partial twinning of the Arkell Aqueduct and the additional construction at the Carter facility.

In terms of greenhouse gas emissions (GHGs), Alternative A is not expected to be significantly different compared to Do Nothing (existing conditions) as this scenario would not impact the operation of the well pumps or the Woods PS. However, the installation of the Hanlon Feedermain, under Alternative A, would likely decrease GHGs to some extent compared to existing conditions, due to the reduced headloss required to supply the south end of Zone 1.

Alternative B is also not expected to have significantly different GHGs compared to existing conditions, since energy used to pump from the new Arkell PS reduces energy used at Woods PS.

4.2.2 Social/Cultural

The *do nothing* alternative has high potential for negative effects on long-term business vitality, community growth and development as existing infrastructure does not have sufficient transmission capacity to meet growth targets and lacks redundancy and failure protection as outlined in TM3A.

Limiting growth would have limited impact on existing customers, however, it does not align with the Shaping Guelph requirements.

Water conservation measures have the potential to delay construction projects. The City has an ongoing Water Conservation program in effect which has been extremely successful. There may be limited opportunities in the future for significant Water Conservation benefits.

Improvements to existing infrastructure is expected to have the highest social/cultural impact related to construction projects.

Under Arkell Alternative A, the building of the twinned Aqueduct is expected to have some impact on residents and businesses near the lower reach, between Victoria Road and Woods. However, the majority of the aqueduct twinning is in rural areas and the operation of businesses during construction would not be impacted.

Under Alternative A, the construction of the Hanlon Feedermain is expected to have significant impact on residents and businesses due to required road closures.

Arkell Alternative B is expected to have some impact on residents and businesses during construction along Arkell Road, however, this is a rural road and disruptions would be expected to be less significant than those caused by the Hanlon Feedermain project or the lower reach of the aqueduct under Alternative A.

The New PS and Reservoir under Alternative B is expected to have some long-term impact on the existing community in this area such as slightly increased traffic by operations and maintenance, although staff visits to the Arkell Spring Grounds are already frequent. Alternative A is not expected to have long-term impacts on the community as the operations and visible infrastructure would not significantly change compared to existing conditions.

Both Alternatives A and B are expected to improve short-term and long-term business vitality and community growth and development through improved water supply, with Alternative B providing greater long-term water system security. An additional benefit of Alternative B is that it creates the opportunity for potential future servicing to the Arkell Village Community.

The *do nothing* alternative has low potential to minimize public health and safety as existing infrastructure may not have sufficient linear capacity to provide adequate water service under 2051+ conditions. Alternatives A and B are expected to reduce risks to water-supply related public health and safety due to the improved redundancy and security of supply.

Under the Arkell Alternative B, concept B2 would have a greater improvement in redundancy and security of supply than B1 due to the ability to supply any of the Arkell Sources if the Woods facility or the Arkell Aqueduct were offline.

There is not expected to be a significant impact to operator's health and safety between Arkell Alternative A and existing conditions as day-to-day operations are not expected to significantly change. Alternative B has a minor potential to increase risk of operator health and safety due to the operations of the new PS and sodium hypochlorite storage on-site, common to all treatment locations. Concept B2 also involves the operation of two (2) additional UV treatment facilities.

4.2.3 Economic

The *do nothing* and *limit growth* alternatives do not involve any capital costs, however there is potential for increased lifecycle costs due to system aging and replacement/emergency needs. Limiting future growth has the potential for reduced revenue from development charges and taxes.

Water conservation has limited implementation costs depending on the programs put in place.

Improvements to the existing system is expected to have major capital costs. However, there is potential for reduced lifecycle costs due to upgraded infrastructure. This alternative has the potential for cost sharing with developers.

Conceptual cost estimates were completed for each of the Arkell alternatives and are presented in Table 4-6 below. A detailed breakdown of the costs estimates is presented in Appendix B. The City has noted that land acquisition is required for the twinned Aqueduct alignment (Alternative A) and an easement is required for the proposed watermain on Arkell Road (Alternative B). Cost estimates for land requirements have been included in the capital costs.

Table 4-6 Arkell Wellfield Redundancy/Resiliency Cost Estimates

Arkell Alternative	Description	Capital Cost	Additional O&M** (50-yr)	Total 50-yr Lifecycle Cost
A	Twin Existing Aqueduct*	$85.2 M	$1.5 M	$86.7 M
B1	New Watermain, Reservoir and PS. (GW only)	$61.5 M	$3.5 M	$65.0 M
B2	New Watermain, Reservoir and PS. (All Arkell Sources)	$110.4 M	$3.5 M	$113.9

**Includes cost for Hanlon Feedermain*
***O&M Costs for comparison purposes only. Existing O&M costs common to both alternatives have not been included.*

4.2.4 Technical

While the *improvements to the existing system* alternative is expected to have the highest technical impact due to construction projects, it is the only alternative that meets existing and future system needs. Water conservation is expected to delay but not remove the need for infrastructure. No Construction is required for *do nothing* or *limit growth*.

In terms of level of service, *do nothing* does not meet long-term capacity requirements to service the projected population growth. As discussed in TM3A, the existing watermain infrastructure lacks the capacity to move water from Woods PS to Clair ET in the south end of Zone 1 leading to insufficient levels of service under 2051+ MDD conditions.

Based on model results, Arkell Alternatives A and B were both found to improve high pressure concerns along the Speed River and low-pressure concerns in the south end of Zone 1, but not completely mitigate them. Ultimately, the service pressures in these areas are limited by the ground elevation and the target hydraulic gradeline (HGL) of Zone 1.

Under Alternative A, model results showed that the Hanlon feedermain improved the ability for Woods to maintain the water level in the Clair ET, without over filling the Verney ET. Under Alternative B, the Clair ET level issue was further improved compared to Alternative A due to the proximity of the discharge feedermain from the new Arkell PS to the Clair ET.

Alternative B addresses the criticality concerns of the existing Arkell Aqueduct and the criticality of the F.M. Woods WTP, while Alternative A only addresses the criticality of the Arkell Aqueduct.

Alternative B has greater resiliency of supply than Alternative A. Alternative B1 provides a higher level of redundancy than Alternative A but does not provide complete redundancy for transmission of the Arkell Sources into the distribution system as this concept does not have the ability to treat/supply GUDIWEF sources.

Under Alternative B1, if the Arkell PS, reservoir or watermain were to fail, all Arkell Wells could be directed to the existing Aqueduct and operate as it does under existing conditions. If the Arkell Aqueduct or Woods WTP were to fail, the GUDIWEF sources would not be able to be supplied.

Under Alternative B2, there is complete redundancy for transmission of all of the Arkell Sources. If the Arkell Aqueduct or Woods WTP were to fail, the Arkell Wells and Glen and future Lower Collectors could continue to be supplied to the system via the proposed Arkell PS. The Carter Wells could supply the system via the proposed direct connection. If either the Arkell PS, reservoir or watermain or the Carter Wells direct connection were to fail, all sources could continue to be supplied to the system via the existing Arkell Aqueduct and Woods PS.

A summary of the available supply under each planning horizon is show in Figure 4-3 below. The green line represents the condition with Woods or the Arkell Aqueduct offline under Alternative B2. Under this alternative, all sources would be able to be supplied to the distribution system through alternative means and there would be no reduction to available supply caused by Woods or the Arkell Aqueduct being offline. The MDD could be met under all planning horizons.

The orange line represents a condition with Woods or the Arkell Aqueduct offline under Arkell Alternative B1. Under this condition, the GW Arkell wells can still be supplied to the distribution system via the new PS and the available supply exceeds the ADD for each horizon, but not the MDD.

The red line represents a condition with Woods or the Arkell Aqueduct offline under Arkell Alternative A. Under this condition, none of the Arkell sources can be supplied to the distribution system and the ADD cannot be met under any of the planning horizons. Although under this alternative, the Arkell sources could be supplied if there were a failure of the existing Aqueduct, through the twinned Aqueduct, none of the sources would be available if Woods were offline.

The criterion for future water supply redundancy is that MDD must be met with the Arkell Aqueduct or Woods PS out of service. Only concept B2 meets this criterion.

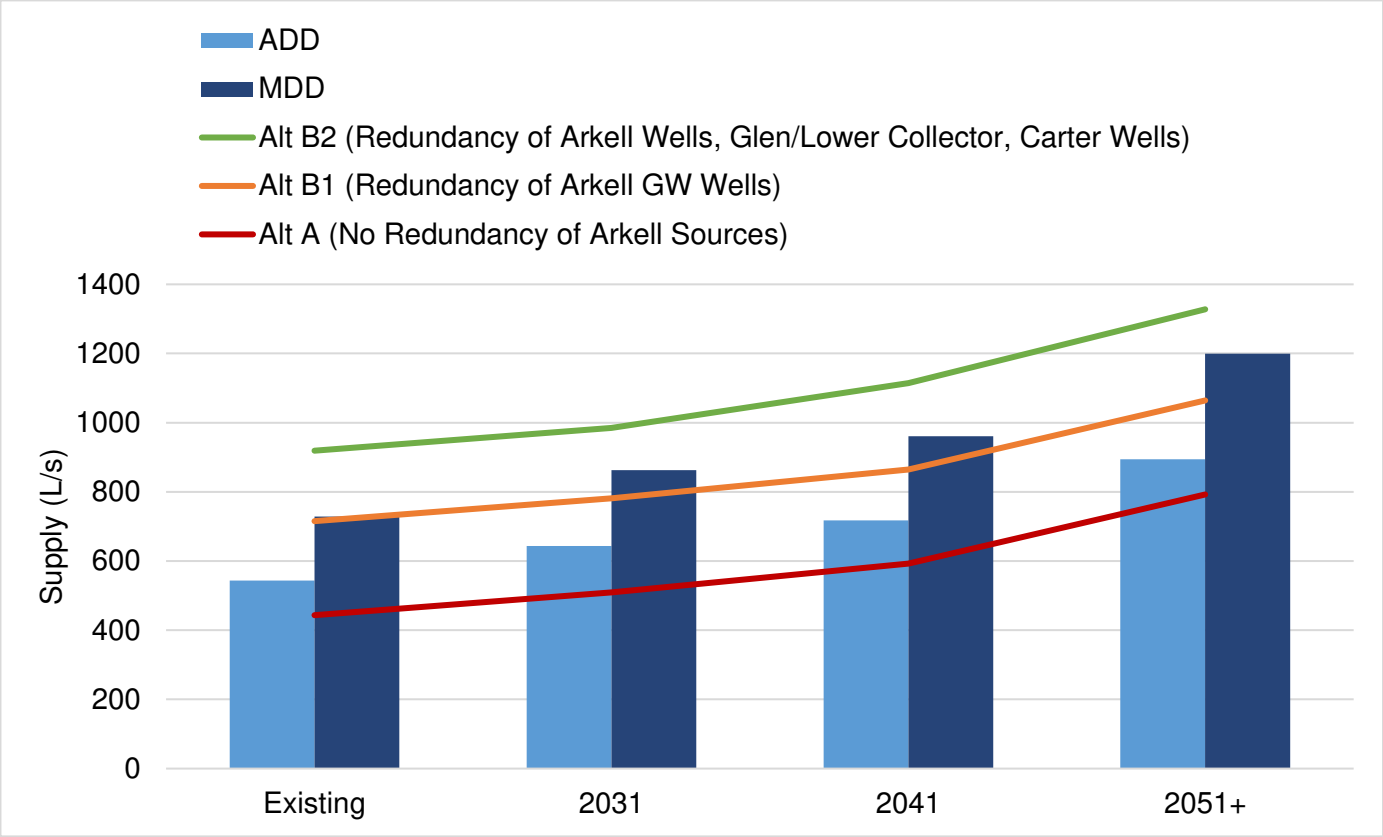


Figure 4-3 Available Supply With Woods/Arkell Aqueduct Offline

4.2.5 Water System Servicing Evaluation Summary

Of the alternatives assessed, *improvements to the existing system* is the only one that can meet the future requirements for the system while aligning with Shaping Guelph requirements. Therefore, this was carried forward as the preferred alternative.

Of the two Arkell Sub-Alternatives assessed, only Alternative B (New Watermain, Reservoir and PS) reduces the criticality of both the existing Aqueduct and the F.M. Woods PS, improves resiliency of supply of the Arkell Sources and provides some extent of redundancy of the Arkell Wellfield. The hydraulic performance associated with Alternative B was also superior to the other alternatives. Therefore, Alternative B was carried forward as the preferred alternative to build out the distribution system.

Under a scenario with the existing Arkell Aqueduct or the Woods PS offline, concept B2 could meet MDD while B1 could meet only ADD. The City's criterion for system redundancy is that MDD must be met with the Arkell Aqueduct or Woods PS out of service. Therefore, B2 is the preferred concept for this alternative.

Full evaluation is provided in Appendix A.

4.3 Opportunities for Service Pressure Improvements

There are areas of the system that experience operating pressures outside of the preferred range of 50-80 psi and have been identified in TM3A. Two additional areas, P-Lo-a & b, have been identified which were not flagged as pressure concerns but do have opportunity for improvement. An overview of the areas of concern for servicing pressure are show in Figure 4-4 and summarized in Table 4-7.

Table 4-7 Pressure Areas for Improvement

Area	Location	Existing Pressure Zone	Elevation (m)	Description	Solutions for Consideration
PLo-1	Stuart St from Hillcrest Dr to Spring St	1	346.1 - 348.5	Pressure will not exceed 40 psi at target Zone 1 HGL due to ground elevation. Cannot easily be transitioned into Zone 2 or Zone 3 due to location.	Potential to create new pressure Zone to maintain above 50 psi.
PLo-2	Shoemaker Cr	1	343.5 - 346.0	Pressure can be maintained above 40 psi if Verney ET level maintained above 84% full. Pressure will not exceed 50 psi at target Zone 1 HGL due to ground elevation.	Potential to transition area to Zone 2.
PLo-3	Eastview Drive and Summit Ridge Dr	2	362.0 - 362.2	Pressure can be maintained above 40 psi if target Zone 2 HGL maintained on east side of Zone 2. Pressure will not exceed 50 psi at target Zone 2 HGL due to ground elevation.	Potential to create new pressure Zone to maintain above 50 psi. .
PLo-4	Rickson Ave south of Darnell Rd	1	344.0 - 345.9	Pressure can be maintained above 40 psi if Clair ET level maintained above 83% full. Pressure will not exceed 50 psi at target Zone 1 HGL due to ground elevation. Cannot easily be transitioned into Zone 2 or Zone 3 due to location.	Potential to create new pressure Zone to maintain above 50 psi.

Area	Location	Existing Pressure Zone	Elevation (m)	Description	Solutions for Consideration
PLo-5	Crawley Rd and Southgate Dr South of Clair Rd	1	344.2 - 346.3	Pressure can be maintained above 40 psi if Clair ET level maintained above 83% full. Pressure will not exceed 50 psi at target Zone 1 HGL due to ground elevation.	Potential to transition area into Zone 3.
PHi-6	North side of Speed River east of McCrae Bv	1	305.1 - 308.7	Pressure can be maintained below 100 psi when Zone 1 target HGL not exceeded. Pressure will exceed 80 psi at Zone 1 Target HGL.	Potential to create new pressure Zone to maintain below 80 psi.
PHi-a	Watson Parkway and Fleming Road	2	327.3 - 338.8	Pressure will exceed 80 psi at Zone 2 Target HGL due to ground elevation.	Potential to transition area to Zone 1.
PLo-b	Speedvale Ave to Waverly Dr, east of Clive Ave	1	330.4 - 346.1	Areas above 340m will not exceed 50 psi at target Zone 1 HGL due to ground elevation.	Potential to transition area to Zone 2.

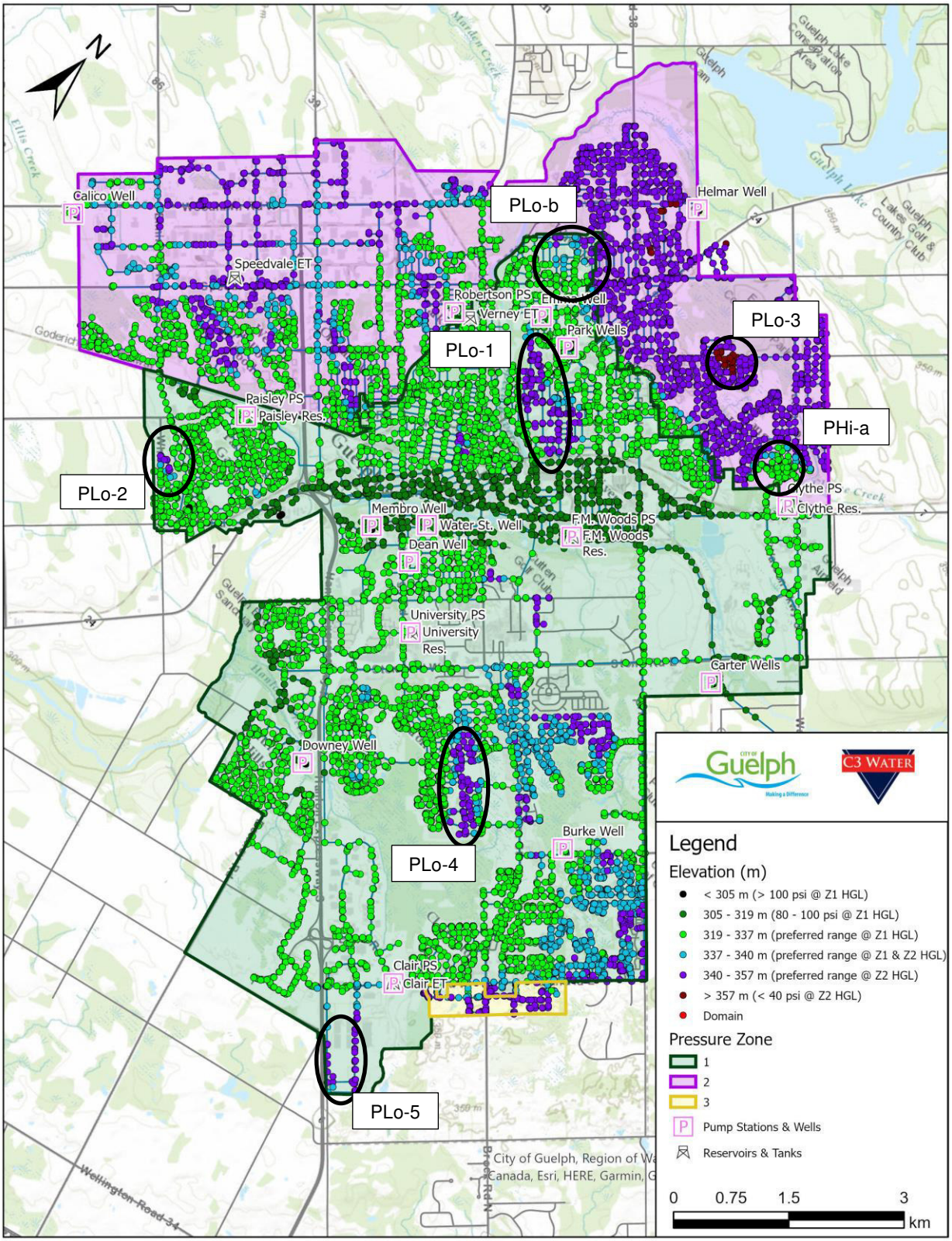


Figure 4-4 System Elevation and Areas of Concern for Pressure

4.3.1 PLo-1 Alternatives

The St George's Park area experiences low pressures caused by high elevation. Fire flows are generally good as there is a strong connection to the FM Woods PS through a 300mm watermain along Metcalf St. Small diameter cast iron watermains cause localized low fire flows. The following alternatives were considered for improving service pressures in area PLo-1:

1. Do Nothing
2. Create New Zone 2 area supplied by new PS at Park Wells facility. Concept shown in Figure 4-5 below.

The Do Nothing alternative involves leaving the area in Zone 1. Under this alternative, opportunities to minimize low pressures include maintaining a high water level at the Verney ET using operational strategies and improving watermain infrastructure in the area to reduce headloss. It is noted that under this alternative, the highest elevation areas are still expected to fall below 40 psi.

Due to the location of PLo-1, this area cannot be transitioned into Zone 2 by simply shifting the existing Zone 2 boundary as there are areas between PLo-1 and the existing Zone 2 boundary that have ground elevations that are not suitable for the Zone 2 HGL and would create areas with pressures greater than 100 psi.

There are plans to upgrade the Park PS to supply Zone 2. A feedermain has already been built on Metcalfe Road, north of the PS for this purpose. The alternative to create a new Zone 2 area involves building a new watermain from the Park PS Zone 2 discharge pipe to the south and connecting to the Metcalfe street within the PLo-1 area. Several system valves would need to be closed to isolate the zone. Drawbacks of closing system valves include, increased operational complexity, creation of dead-ends which can cause increased water age and reduced fire flow. Several check valves would also be added to allow for water into the new Zone 2 when a watermain break or shutdown occurs.

Based on the age of infrastructure in the area and the impact of higher pressures on older infrastructure as well as significant capital costs and operational challenges of creating a new pressure zone in this area, the preferred alternative is to do nothing. Low pressures due to high ground elevation should be taken into consideration when assessing new development proposals in this area.

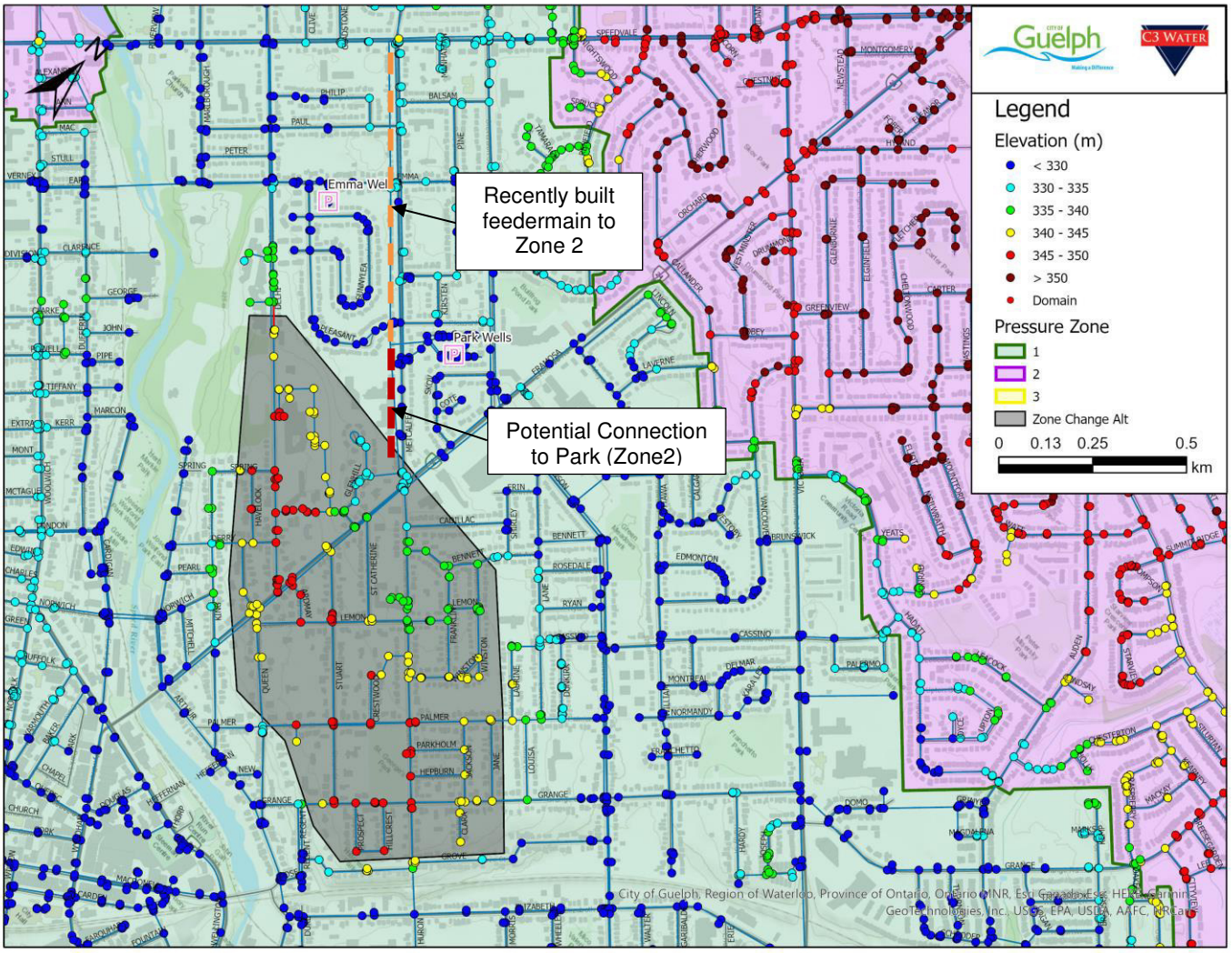


Figure 4-5 PLo-1 Pressure Zone Concept

4.3.2 PLo-2 Alternatives

The low pressures in the Shoemaker Crescent and Whitelaw Road area are created by high elevations. The following alternatives were considered for improving service pressures in area PLo-2:

1. Do Nothing
2. Transition area into Zone 2 (Figure 4-6)
    a. Adjust Zone 2 boundary to include areas north west of Elmira Road and West Acres Road by opening existing Elmira Zone Boundary Valve and closing additional system valves.
    b. Install new watermain from north of existing Elmira Zone Boundary Valve to north end of existing watermain on Whitelaw Road and close system valve on Whitelaw Road south of Shoemaker court.

It should be noted that the City is installing a 200mm watermain from Wellington Road 31 to Shoemaker Court that is not shown in the Figure below.

The Do Nothing alternative for this area involves leaving the area in Zone 1. Under this alternative, opportunities to minimize low pressures include maintaining a high water level in the Verney ET using

operational strategies and improving watermain infrastructure in the area to reduce headloss. It is noted that under this alternative, with operational and watermain improvements, the highest elevation areas are still expected to fall below 50 psi with a minimum pressure of 41 psi.

Alternative 2a would result in pressures above 80 psi in the majority of the new Zone 2 area due to the existing ground elevations along Elmira Road. Additionally, a new Zone Boundary check valve was recently installed at Elmira Road to improve emergency supply to Zone 2, which would no longer be operational under this alternative. As such, this is not the preferred alternative.

Alternative 2b involves significant capital costs to improve pressure for only a small number of customers. Additionally, this alternative creates a significant dead-end and would have the potential to have high water age and low chlorine residual.

Based on the significant capital costs with transitioning this area into Zone 2 and the small area of impact, the preferred alternative is to do nothing. Low pressures due to high ground elevation should be taken into consideration when assessing new development proposals in this area as there is land available for development within the City's urban boundary. Should significant development be proposed in the future a connection to Zone 2 may become more feasible in the future.

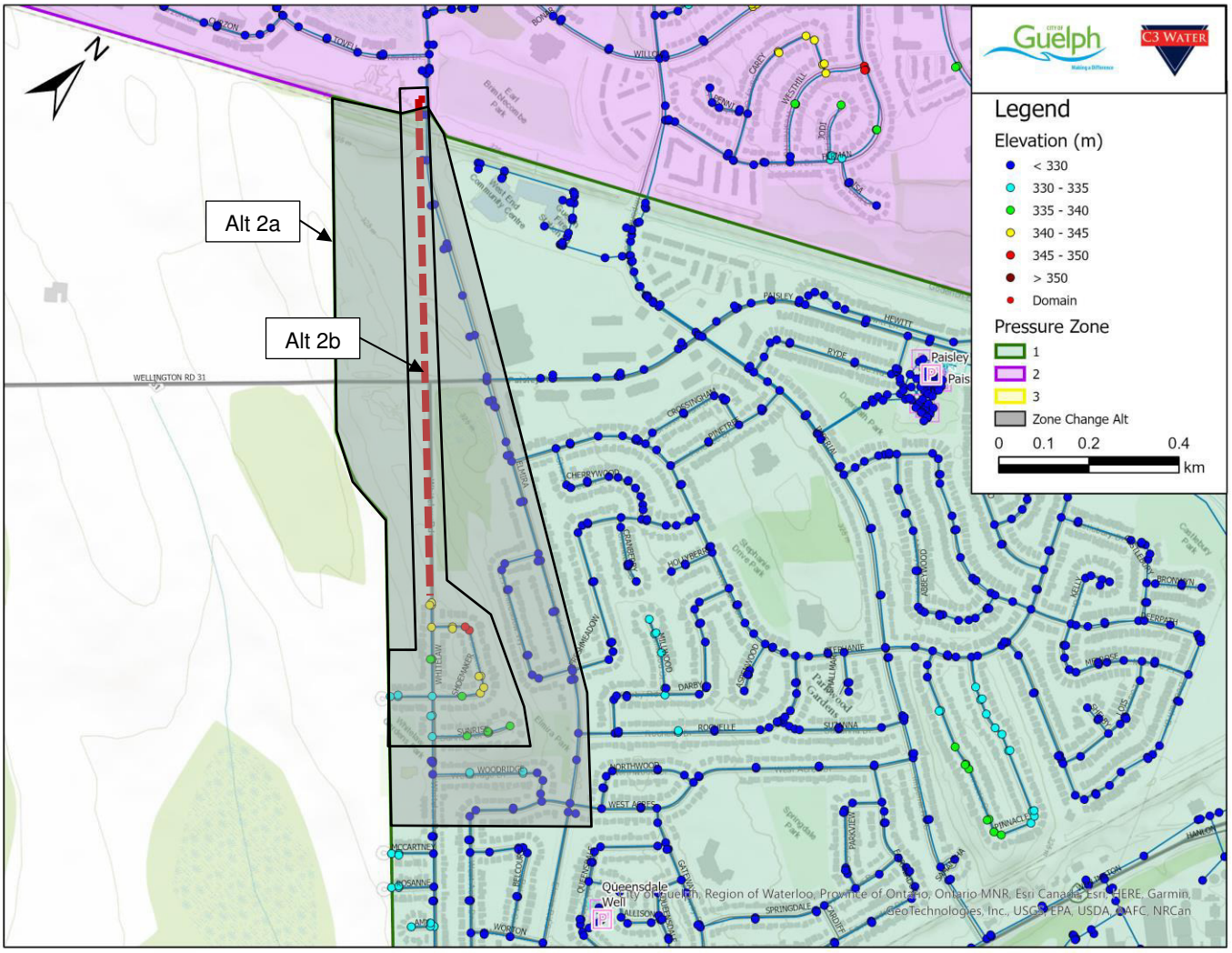


Figure 4-6 PLo-1 Zone 2 Transition Concepts

4.3.3 PLo-3 Alternatives

The area near Summit Ridge Drive and Eastview Road is located in Zone 2 and is an area of low pressure based on high elevations in the area.

Area PLo-3 was found to have improved minimum pressures under 2051+ conditions once more supply sources and east west watermain capacities were added to Zone 2. By improving supply and watermain capacity to the east side of Zone 2, such that the target Zone 2 HGL is maintained in the PLo-3 area, the pressure is expected to be maintained above 40 psi. It is noted that at the highest points within this area, the pressure cannot be maintained above 50 psi at the Zone 2 HGL.

The option of creating a new pressure Zone for PLo-3 was not considered due to the potential for pressures above 40 psi by implementing other zone upgrades and the significant capital costs that would be associated with this area and the future improvements planned for Zone 2.

Low pressures due to high ground elevation should be taken into consideration when assessing new development proposals in this area.

4.3.4 PLo-4 Alternatives

This south portion of Rickson Avenue is an area of high elevation and experiences pressures less than 40 psi during high demand periods.

The following alternatives were considered for improving service pressures in area PLo-4:

1. Do Nothing
2. Create New Pressure Zone supplied by new in-line BPS. Concept shown in Figure 4-7 below.

The Do Nothing alternative involves leaving the area in Zone 1. Under this alternative, opportunities to maintain pressures above 40 psi include maintaining a high water level in the Clair ET using operational strategies and improving watermain infrastructure in the area to reduce headloss. It is noted that under this alternative, with operational and watermain improvements, the highest elevation areas are still expected to fall below 50 psi.

Due to the location of PLo-4, this area cannot feasibly be transitioned into Zone 2 or 3.

The alternative to create a new pressure zone would involve building a new pumping station and closing system valves to isolate the boosted zone. As such, high capital costs are associated with this alternative and drawbacks include increased operational complexity and creation of dead-ends which can cause increased water age and reduced fire flow. In the future with improved infrastructure, the Clair ET is expected to maintain higher water levels which will improve pressures in this area.

Based on the significant capital costs and operational challenges of creating a new pressure zone in this area, the preferred alternative is to do nothing. Low pressures due to high ground elevation should be taken into consideration when assessing new development proposals in this area.

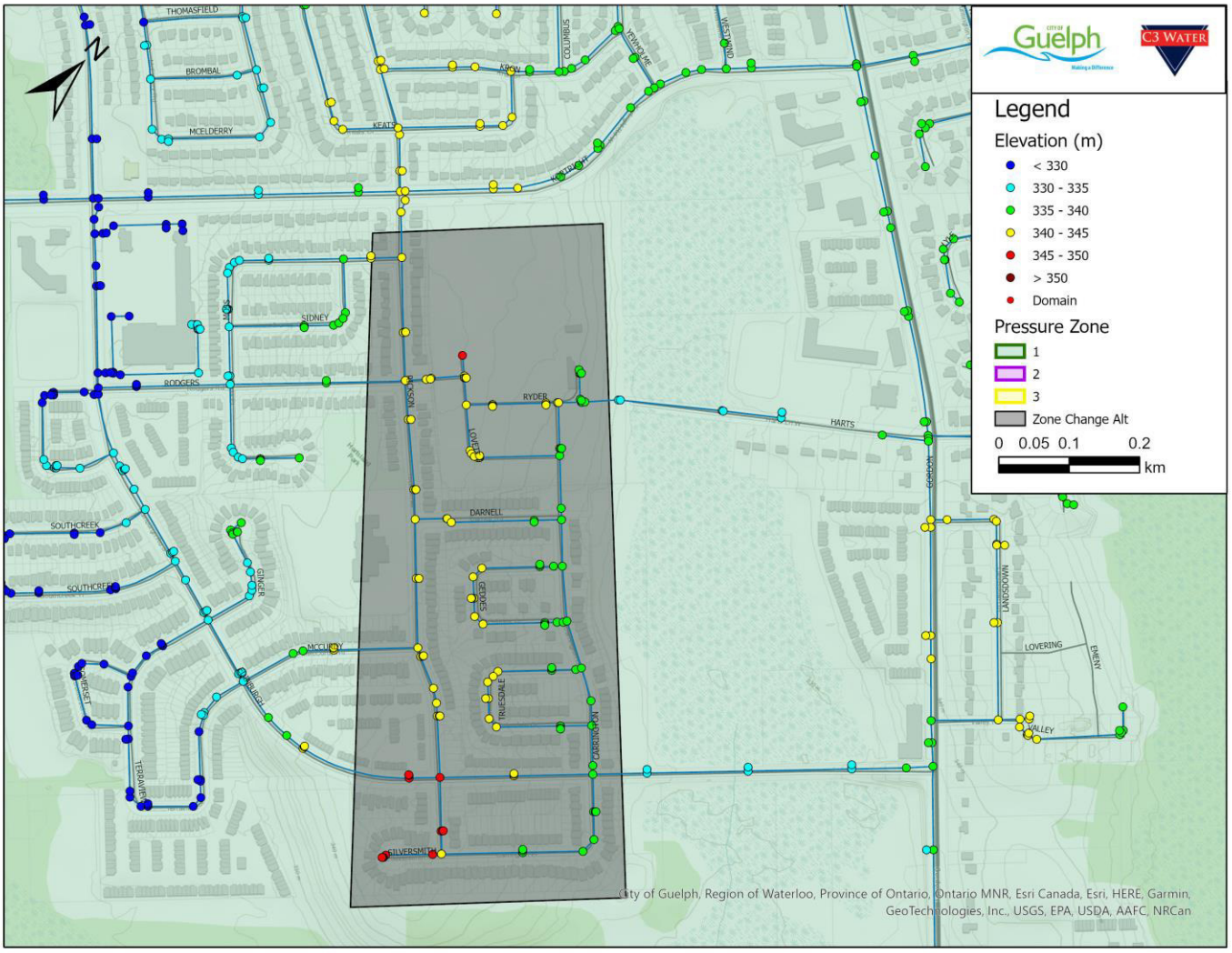


Figure 4-7 PLo-4 Pressure Zone Concept

4.3.5 PLo-5 Alternatives

The Southgate Drive area experiences low pressures due to high elevations. The following alternatives were considered for improving service pressures in area PLo-5:

1. Do Nothing
2. Transition area into Zone 3 (Figure 4-8)

The Do Nothing alternative involves leaving the area in Zone 1. Under this alternative, opportunities to minimize low pressures include maintaining a high water level in the Clair ET using operational strategies and improving watermain infrastructure in the area to reduce headloss. It is noted that under this alternative, with operational and watermain improvements, the highest elevation areas are still expected to fall below 50 psi.

Adjusting the existing Zone 3 boundary to include this area involves minor costs to modify valve potitions at Crawley Road and Southgate Road connections to Clair Road. Previous trials to transition this area into Zone 3 resulted in challenges for the existing customers. Customers in this area are predominantly ICI and buildings are equipped with fire suppression system which were designed based on Zone 1 conditions. Due

to the relatively low existing demand in Zone 3 and lack of floating storage, pressures were found to be inconsistent. As such, the timing of transitioning the Zone boundary should be based on additional growth in Zone 3, leading to more stable operating pressures. Pressure stability will be further improved with the implementation of the Clair Maltby ET.

Due to the increase in service pressure associated with transitioning this area into Zone 3, consultation with existing customers would be required and fire suppression systems may need to be adjusted.

Due to the feasibility and the low capital cost associated with transitioning this area into Zone 3, this was carried forward as the preferred alternative for PLo-5. The timing of the zone transition would be planned to occur when the Zone 3 ET is commissioned.

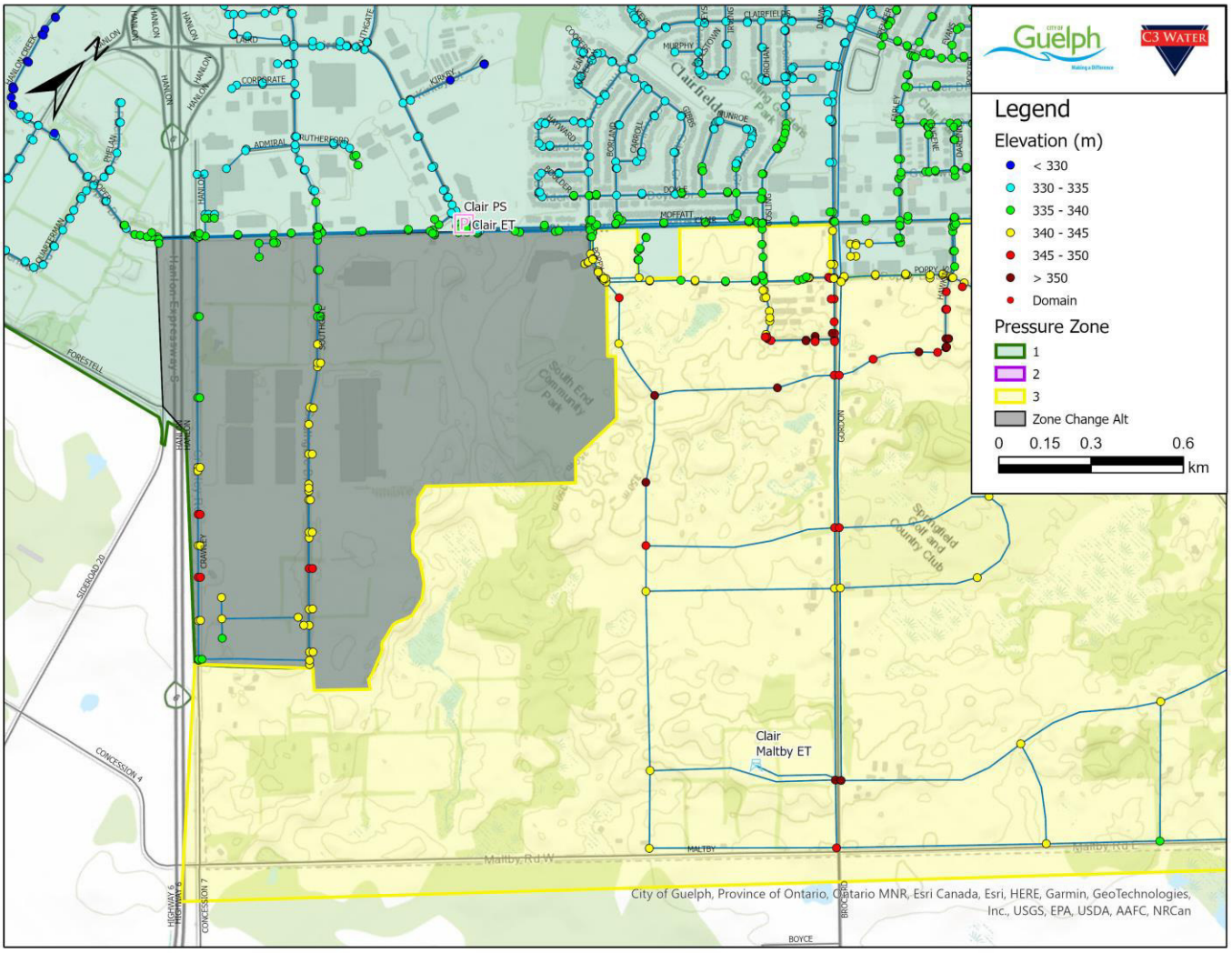


Figure 4-8 PLo-5 Zone 3 Transition Concept

4.3.6 PHi-6 Alternatives

Areas of high pressure exist along Wellington Road due to low elevations in Zone 1. Area PHi-6 was found to have small areas of pressure slightly above 100 psi under existing demand conditions. Under 2051+

conditions with existing infrastructure, the high pressures in this area were found to significantly worsen due to watermain capacity limitations causing the north areas of Zone 1 to over pressurize. City staff have expressed concern over high pressure in this area due to risk of watermain breaks. Opportunities to minimize high pressures include improving watermain infrastructure to reduce headloss across the system. Additionally, there are planned upgrades at the Woods PS which include transient protection and are therefore expected to help mitigate the risk of watermain breaks in this area. In the future, the addition of the Arkell PS to the south end of the system will limit the capacity requirements in this portion of the system.

The option of creating a new pressure zone for PHi-6 was not considered as this would result in significant challenges to adequately convey water to the west and the south.

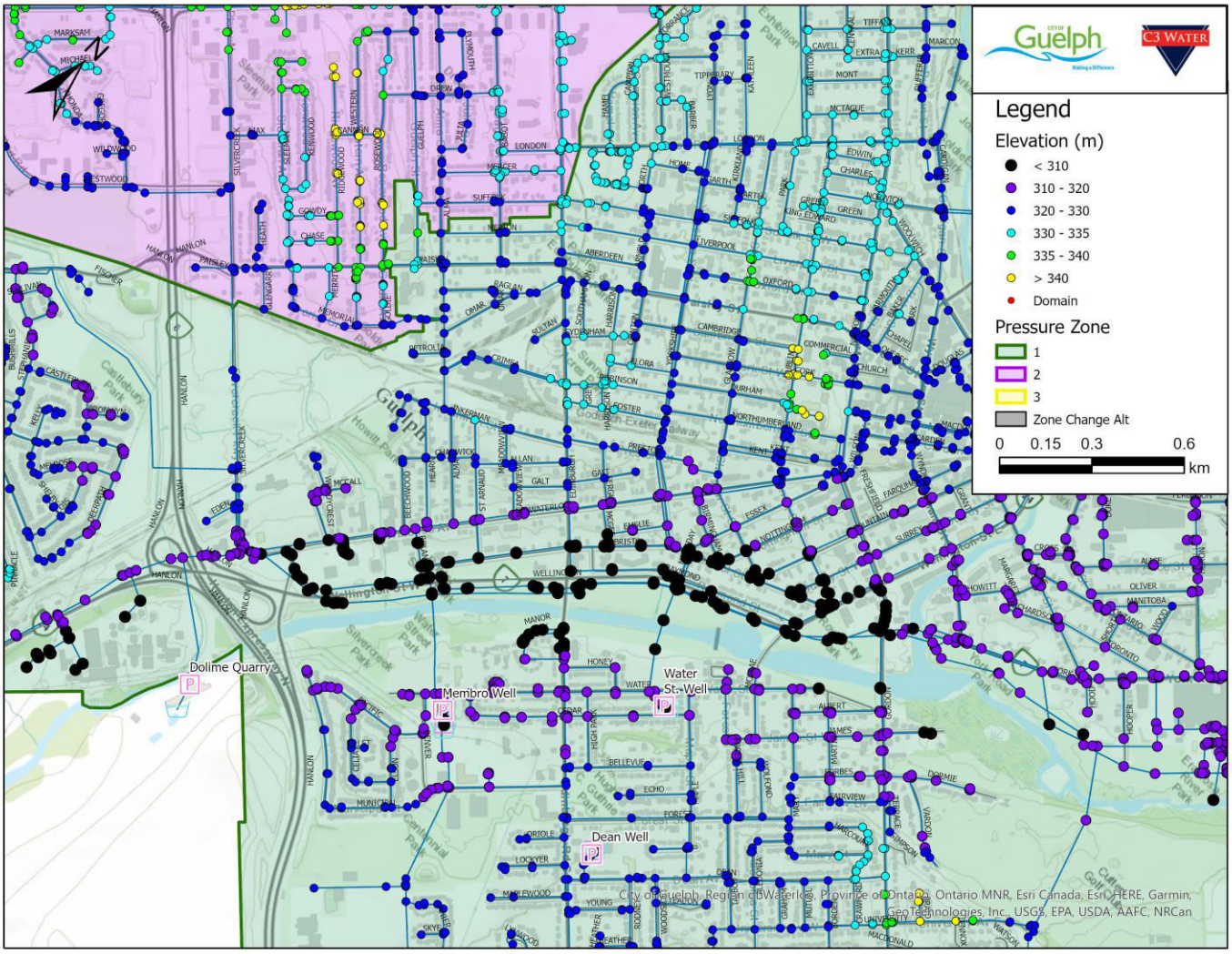


Figure 4-9 PHi-6

4.3.7 PHi-a Alternatives

The existing Zone 2 area south of Watson Parkway and Fleming Road has ground elevations that are more suitable for the Zone 1 HGL. Within Zone 2, this area will be expected to have service pressure consistently above 80 psi. City staff have expressed concern over high pressure in this area sure to aging infrastructure and risk of watermain breaks. As such, it is recommended that this area is transitioned into Zone 1. This will

require adjustment of valves and installation of a new Clythe PS discharge feedermain from the PS to north of Fleming Road. This feedermain project would allow for increased discharge capacity with the planned upgrades at the Clythe PS. A new pipe segment would be installed on Watson Road at the PS discharge to bypass the PS and the existing Clythe discharge feedermain on Watson Road would become a Zone 1 watermain. Further analysis is required to confirm the preferred boundary for this area to limit dead-ends and optimize service pressures.

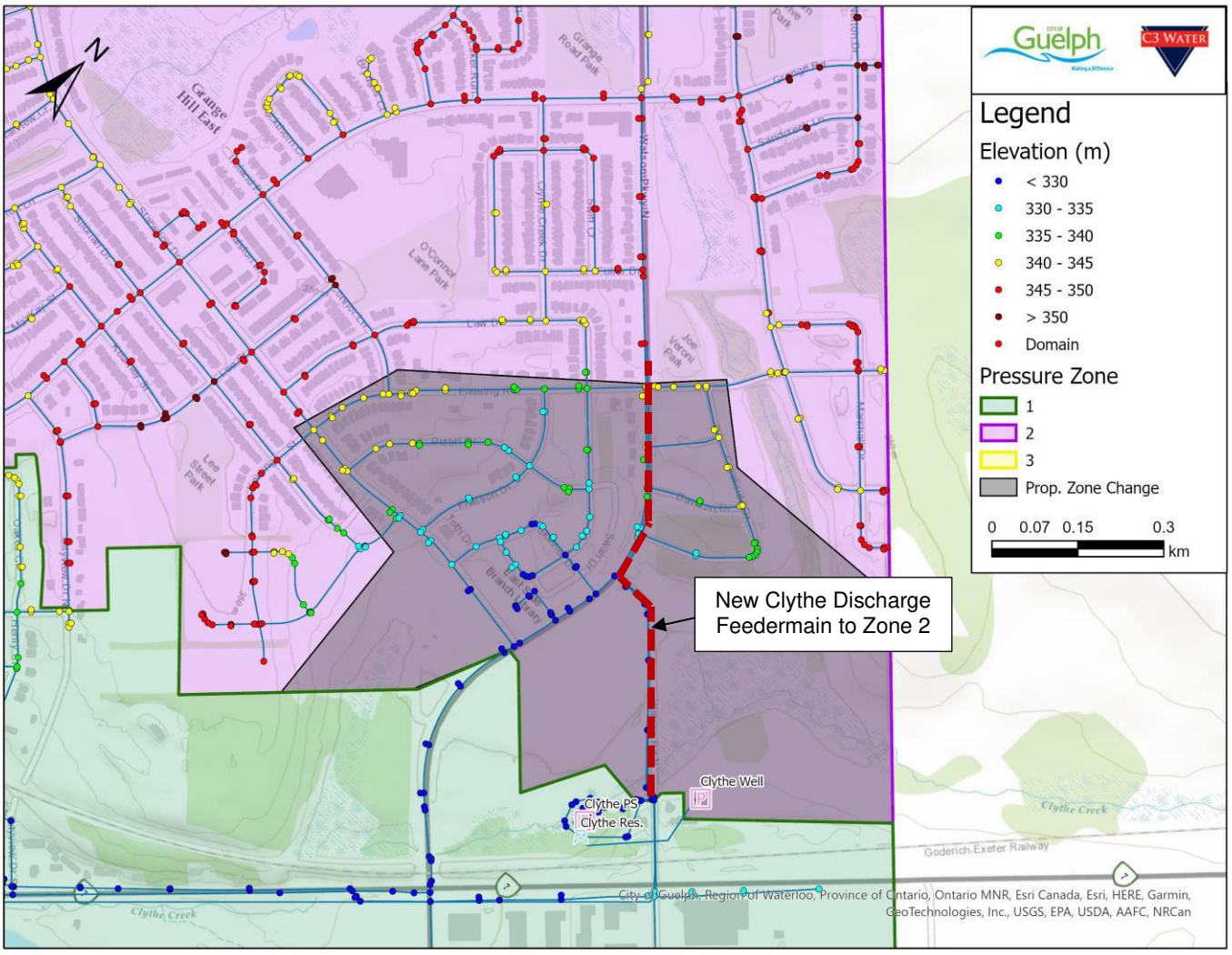


Figure 4-10 PHi-a Transition Concept

4.3.8 PLo-b Alternatives

The existing Zone 1 area from Speedvale Avenue to Waverly Drive, east of Clive Avenue, has ground elevations that are more suitable for Zone 2. High elevation areas are expected to consistently be below 50 psi at the Zone 1 HGL. As such, it is recommended that this area is transitioned into Zone 2. This will require adjustment of Zone boundary valves and removal of the Waverly Drive check valve.

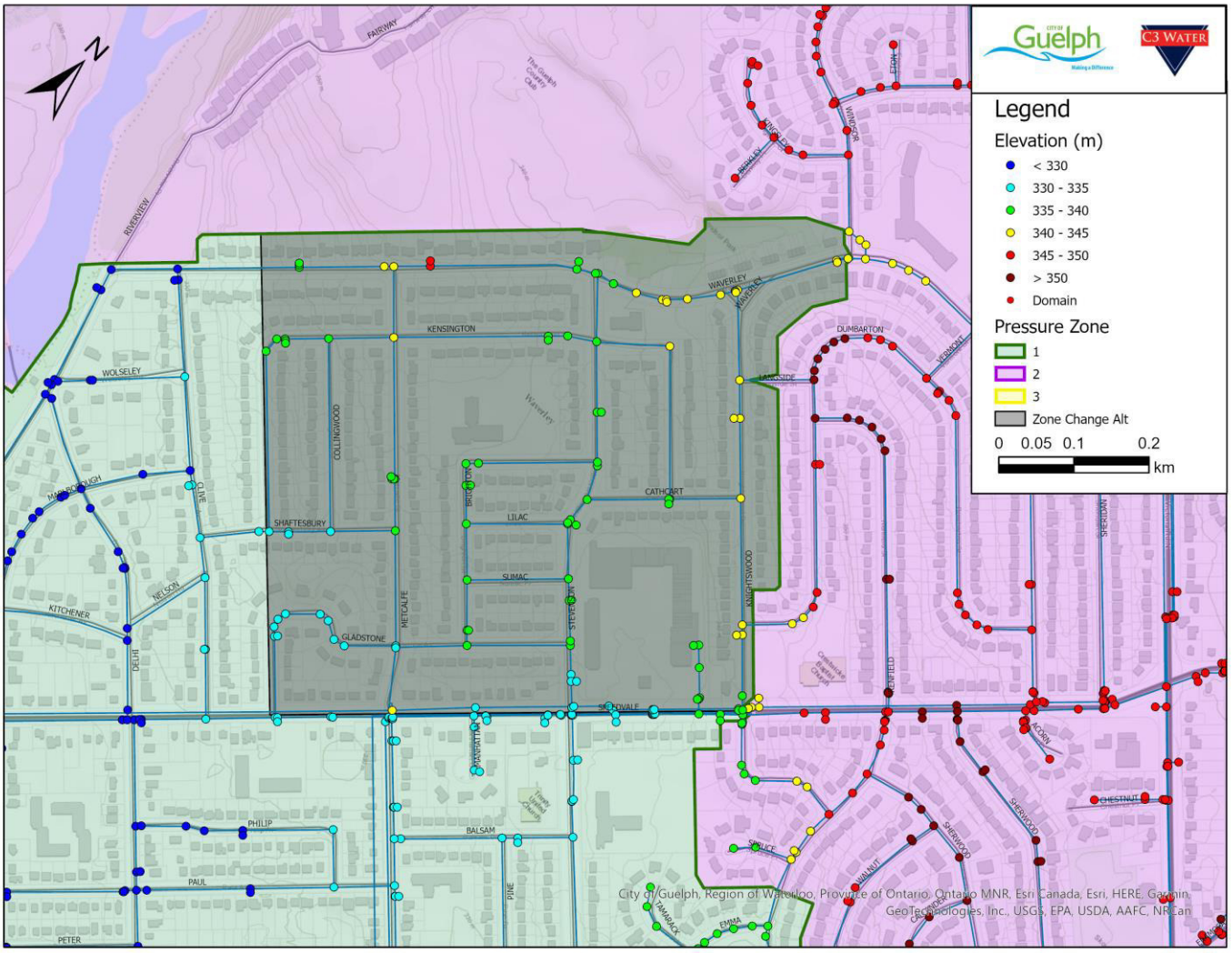


Figure 4-11 PLo-b Transition Concept

4.3.9 Summary of Recommended Pressure Zone Adjustments

Based on the considerations discussed above, the following Zone boundary adjustments are recommended, as shown in Figure 4-12 below:

- PLo-5 from Zone 1 to Zone 3 (Southgate). Timing based on Clair Maltby ET.
- PHi-a from Zone 2 into Zone 1 (Fleming). Timing based on Clythe PS upgrades.
- PLo-b from Zone 1 to Zone 2 (Waverly). Timing based on Speedvale feedermain.

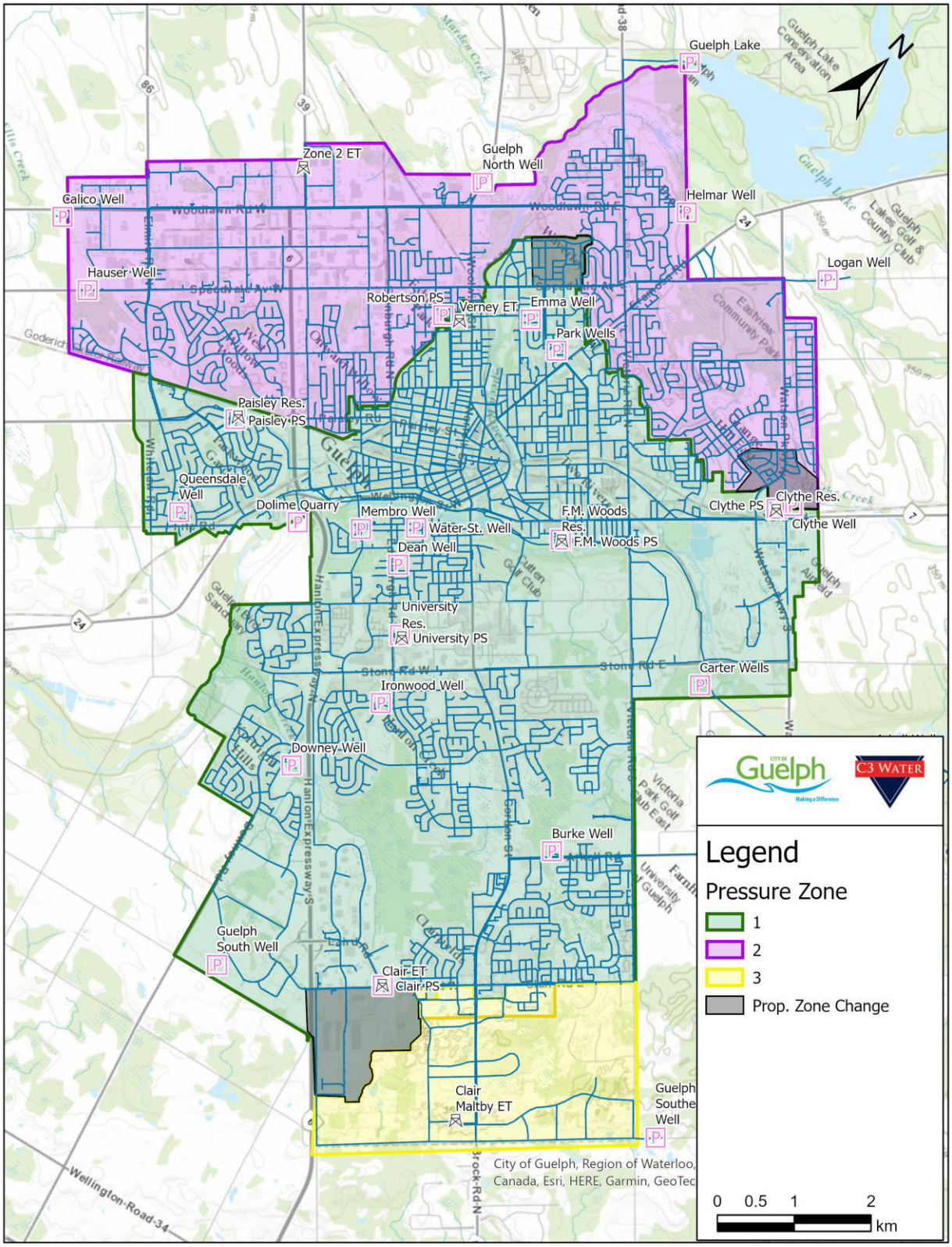


Figure 4-12 Proposed Zone Boundary Adjustments

4.4 Zone 1 Upgrades

A key deficiency that was identified under 2051+ MDD conditions with existing water distribution infrastructure was a lack of capacity to move water from the Woods PS to the Clair ET in the South end of Zone 1. This was identified with Clair ET dropping below 50% full while the Verney ET was overflowing in the model. Additionally, high headloss was seen in a number of locations throughout Zone 1. This was found to be significantly improved with the Arkell Wellfield Redundancy Concept B with the New Arkell PS supply directly to the south end of Zone 1, reducing the need for north/south transmission throughout the Zone. The recommended upgrades for Zone 1 were developed based on the new Arkell PS, reservoir and watermain with a POE at the south end of Zone 1, as the preferred Arkell Wellfield Redundancy Concept.

An existing deficiency in Zone 1 is limited watermain capacity in the downtown area and the Old University area. This was considered when developing recommended watermain upgrades to improve transmission. Other considerations include the criticality of the existing University watermain river crossing and connectivity to facilities such as the Paisley Reservoir, the Clythe Reservoir and the Clair ET. The proposed upgrades are shown in Figure 4-13 below.

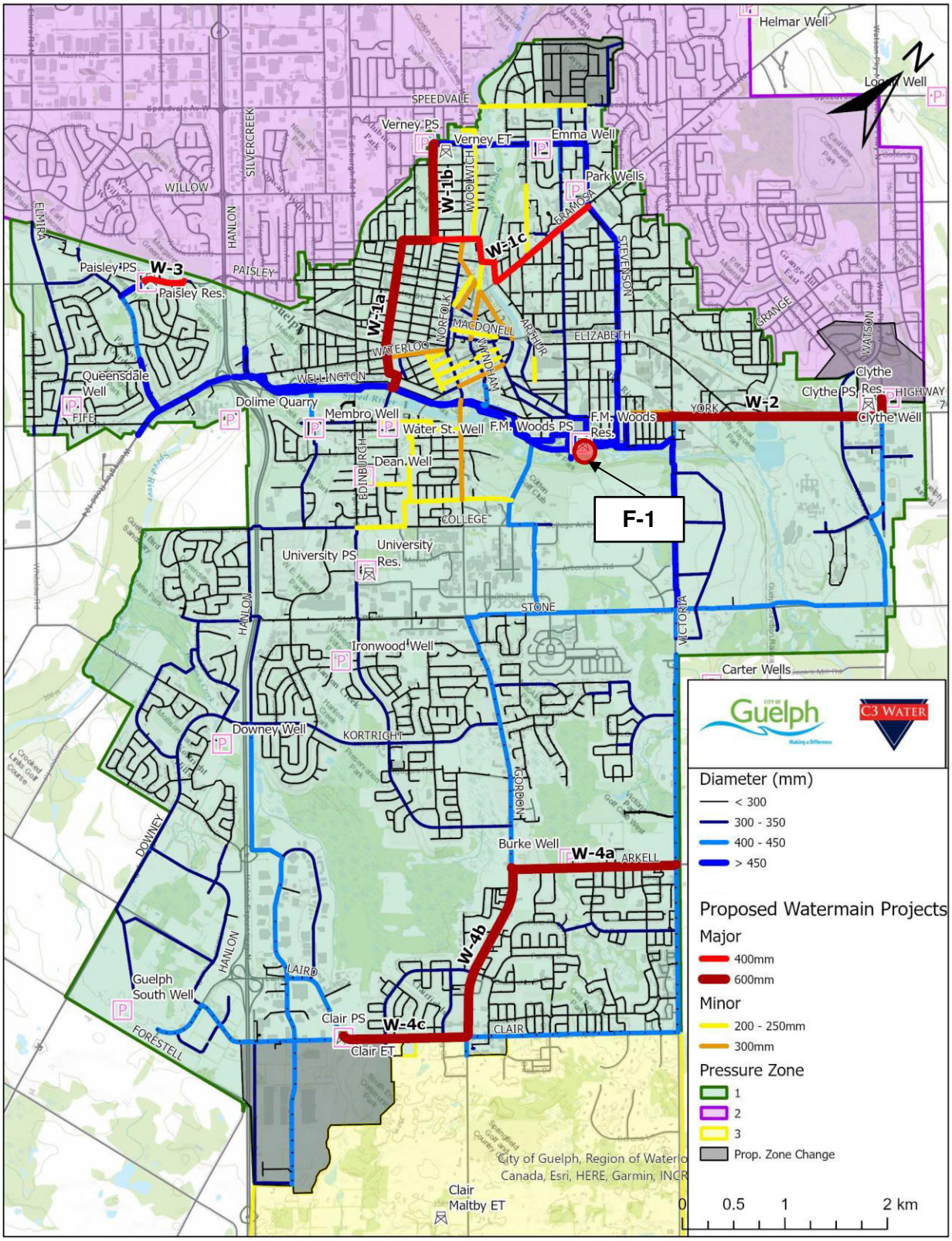


Figure 4-13 Zone 1 Watermains and Proposed Upgrades

4.4.1 Zone 1 Facilities

4.4.1.1 F.M. Woods WTP

A design project is currently in progress to complete upgrades to the existing F.M Woods PS. The conceptual design includes replacing the existing pumps with two sets of three (3) pumps, each pump rated at 350 L/s. The upgraded pump station will have two discharge headers, one to the south and one to the north. Each of the two sets of pumps will be configured so that they can supply to either the north discharge, the south discharge or both, for complete redundancy.

A conceptual design report titled “FM Woods Water Treatment Plant Facility, Electrical and High Lift Pump Station Upgrades” was completed by C3W in 2018.The conceptual cost estimate for the upgrades to the Woods facility was $19.6 M, equivalent to a capital cost of $23.9 M in 2022. The costs for upgrades to the Heritage building were not included as this upgrade has already been completed. The costs for the proposed upgrades have been previously approved by Council.

4.4.2 Zone 1 Watermain Upgrades

4.4.2.1 Zone 1 Major Watermains

Project W-1 was recommended to improve watermain capacity in the downtown area and create looping between the Wellington Feedermain and the Verney Feedermain. This project also includes a crossing of the Speed River which would improve connectivity between the east and west sides of downtown.

Project W-2 was recommended to improve connectivity between the Woods PS and the Clythe PS and Reservoir and improve transmission to the east side of Zone 1. Similarly, project W-3 is recommended to improve connectivity between the F.M. Woods PS and the Paisley Reservoir and horizontal in-line (HI) pump station suction line. Project W-3 is a continuation of the recently installed 400mm Hanlon crossing watermain from Waterloo Avenue to Paisley Road that was recently built. This project is also expected to improve supply and redundancy to the north west area of Zone 1.

Project W-4 is recommended to improve transmission between the Clair ET and the proposed New PS and aqueduct connection to the south end of Zone 1. While this project was not found to be necessary for the Arkell Wellfield Redundancy Alternative B to function, it was found to reduce headloss and improve transmission in the area. Timing and alignment of this project would be dependent on the Arkell Wellfield Redundancy Alternative B and the buildout of the Clair Maltby area.

4.4.2.2 Zone 1 Minor Watermains

Minor (< 400mm) watermain upgrade projects were identified in areas with known capacity constraints, including downtown and the Old University area.

Proposed projects in the Downtown area are shown in Figure 4-14 below. Many of these projects were established though the Downtown Servicing Study (Cole Engineering Group Ltd & C3W, 2021) and were further confirmed through this study.

Projects W-M-1, 6, 13 & 15 create a 300mm loop around the downtown area and provide good connectivity to the proposed project W-1. W-M-3 provides strong connectivity to the Quebec Street mall high-density area.

Proposed 200mm downtown projects provide localized capacity improvements to adequately service this existing high density area and support future growth.

North of downtown, a number of 200mm projects that were previously identified in the “Linear Capital Upgrades Prioritization” project completed by C3W in 2018 were carried forward in this study for localized

capacity improvements. Project W-M-19 involves replacing the existing Zone 1 Speedvale watermain with a new 200mm to improve east/west connectivity in this area. This project is aligned with the proposed Zone 2 Speedvale feedermain (W-8) discussed in Section 4.5.2 below. This project is currently in the design phase with planned construction within the next 5-years.

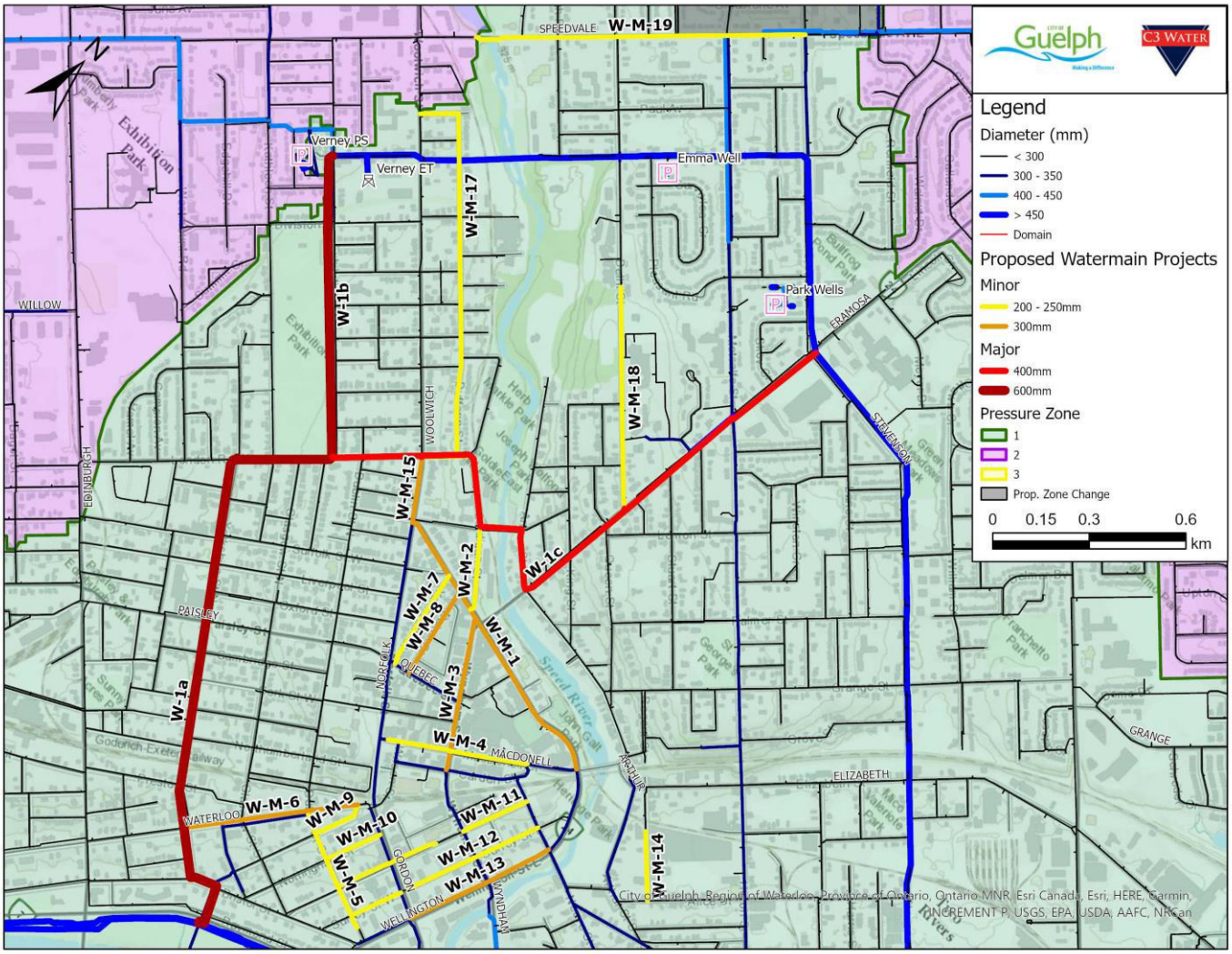


Figure 4-14 Downtown Watermains and Proposed Linear Upgrades

Project W-M-16 located on Gordon Street was recommended to improve connectivity between the Woods PS and the south side of the Speed River. The existing river crossing to University Avenue was flagged as being critical in TM3A. This proposed project would help to reduce the criticality and improve redundancy of the existing river crossings. This project was also identified in the 2021 Downtown Servicing Study.

Within the Old University area (Figure 4-15), a number of 200mm projects were identified to improve overall looping and capacity of the area. Portions of projects W-M-20, 22 & 23 were previously identified in the 2018 Linear Capital Upgrades Prioritization project.

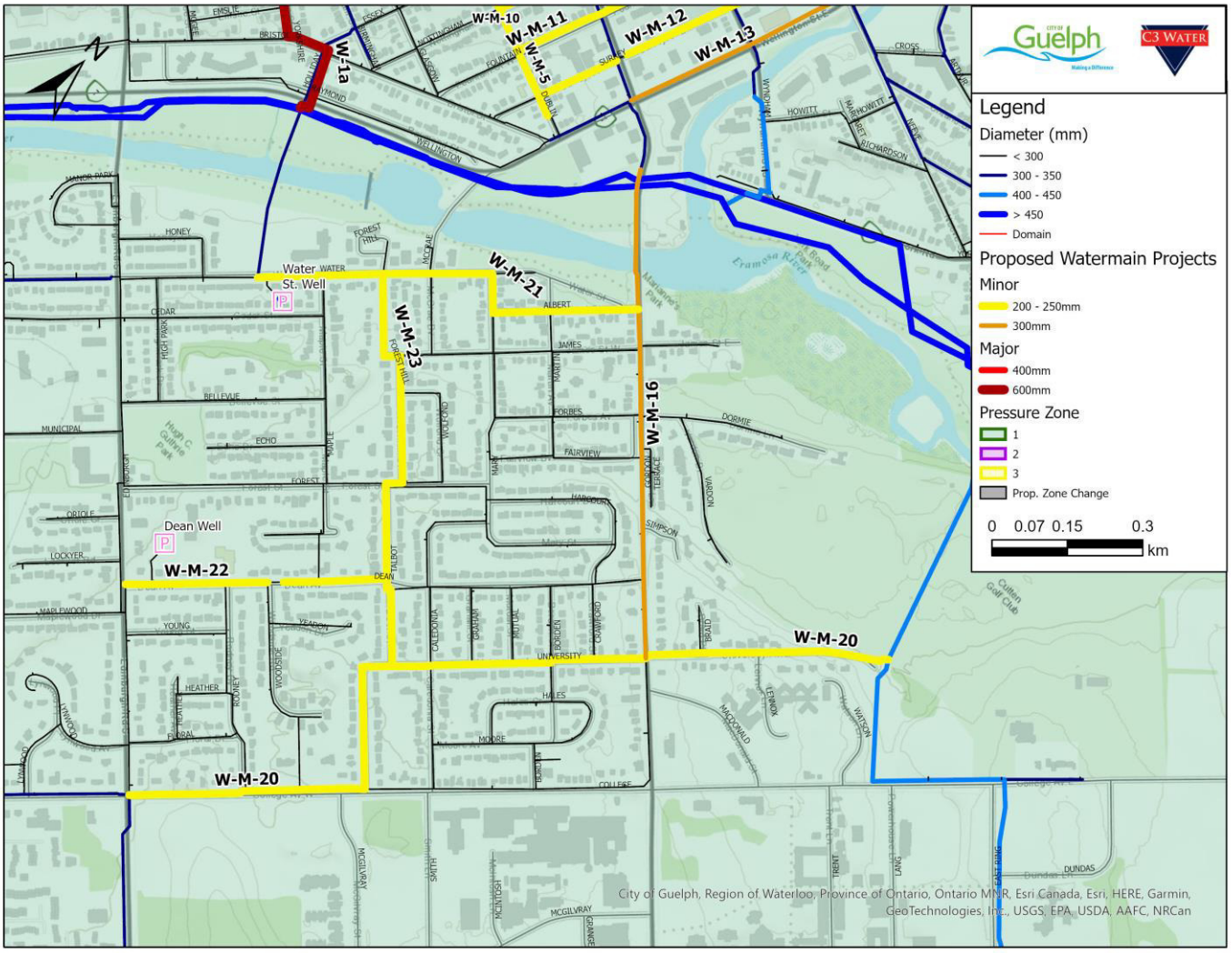


Figure 4-15 University Area Watermain Upgrades

4.4.3 Zone 1 North/South Split

As discussed, a deficiency that was identified under 2051+ MDD conditions with the existing water distribution infrastructure was a lack of capacity to move water from the Woods PS to the Clair ET in the South end of Zone 1 causing Clair ET to drain while the Verney ET overflowed. The new watermain, Arkell PS and reservoir identified under the preferred Arkell Wellfield Redundancy Alternative B greatly improves the consistency of the HGL across Zone 1 and balances the Zone 1 ETs. However, the new Arkell Reservoir, PS and watermain is a significant project that may not be feasible to implement within the short-term horizon. As an interim solution, splitting Zone 1 into a separate North and South Zone was considered. A preliminary concept is shown in Figure 4-16 below. The proposed operating strategy is for one set of the Woods pumps to supply Zone 1 North based on the Verney ET level, while the other set of pumps supply Zone 1 south based on the Clair ET level. This proposed operational strategy complements the proposed upgrades at the F.M. Woods WTP. The suggested Zone 1 split would be approximately along Wellington Road with one of the Wellington Road feedermains connected to Zone 1N and the other to Zone 1S.

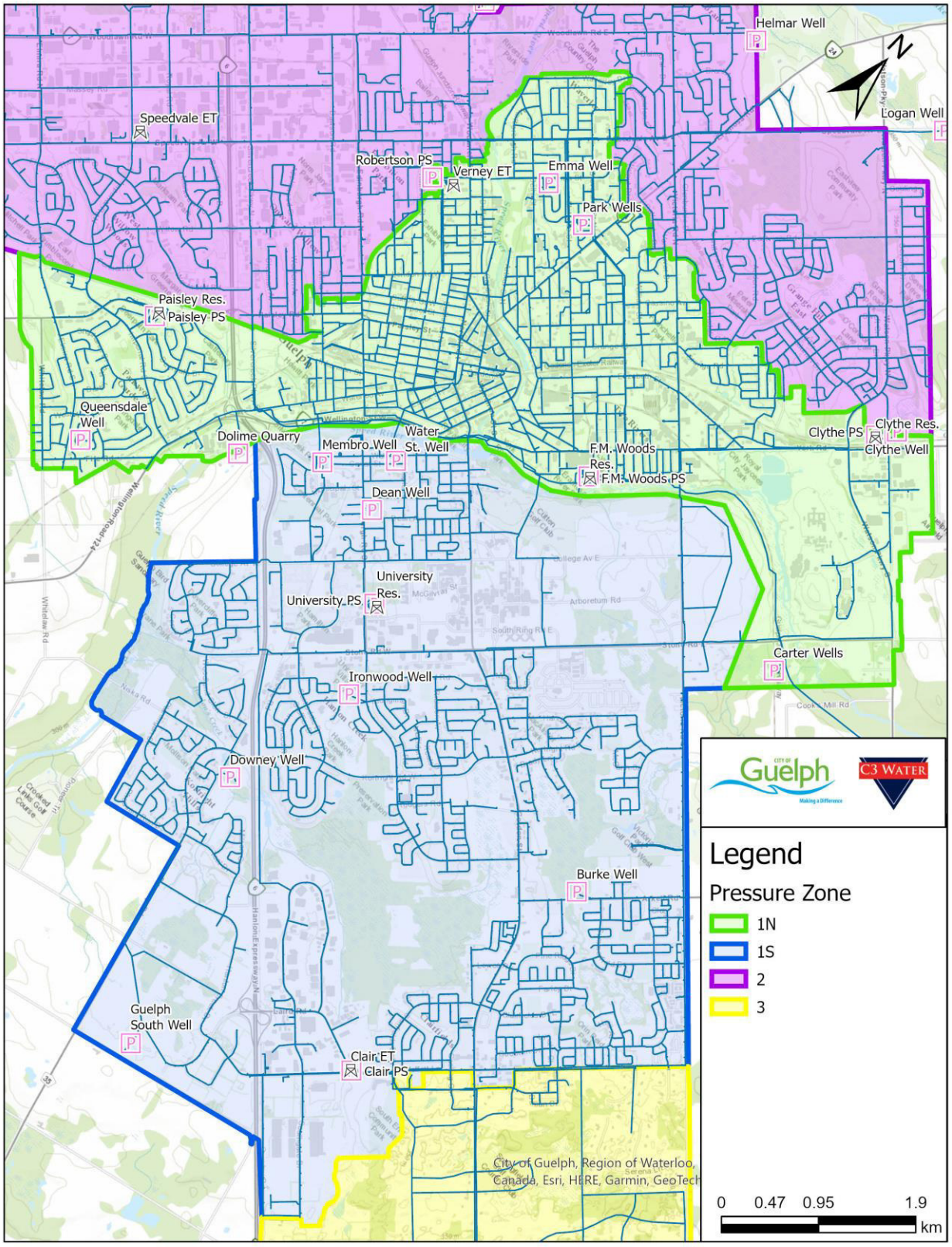


Figure 4-16 Zone 1 North/South Split Concept

4.5 Zone 2 Upgrades

Based on the failure analysis completed in TM3A, both the Paisley and Clythe PSs were flagged with a medium criticality score. Under existing infrastructure conditions, there is only a single 300mm watermain connection (Woodlawn Road) between the west and east side of Zone 2. As such, if the Paisley or Clythe PS experiences a failure, there is limited watermain capacity to supply from one side of the Zone to the other. A key driver for watermain upgrades in Zone 2 is to improve looping throughout the Zone to reduce the reliance on any one of the three PSs. The proposed upgrades are shown in Figure 4-17 below.

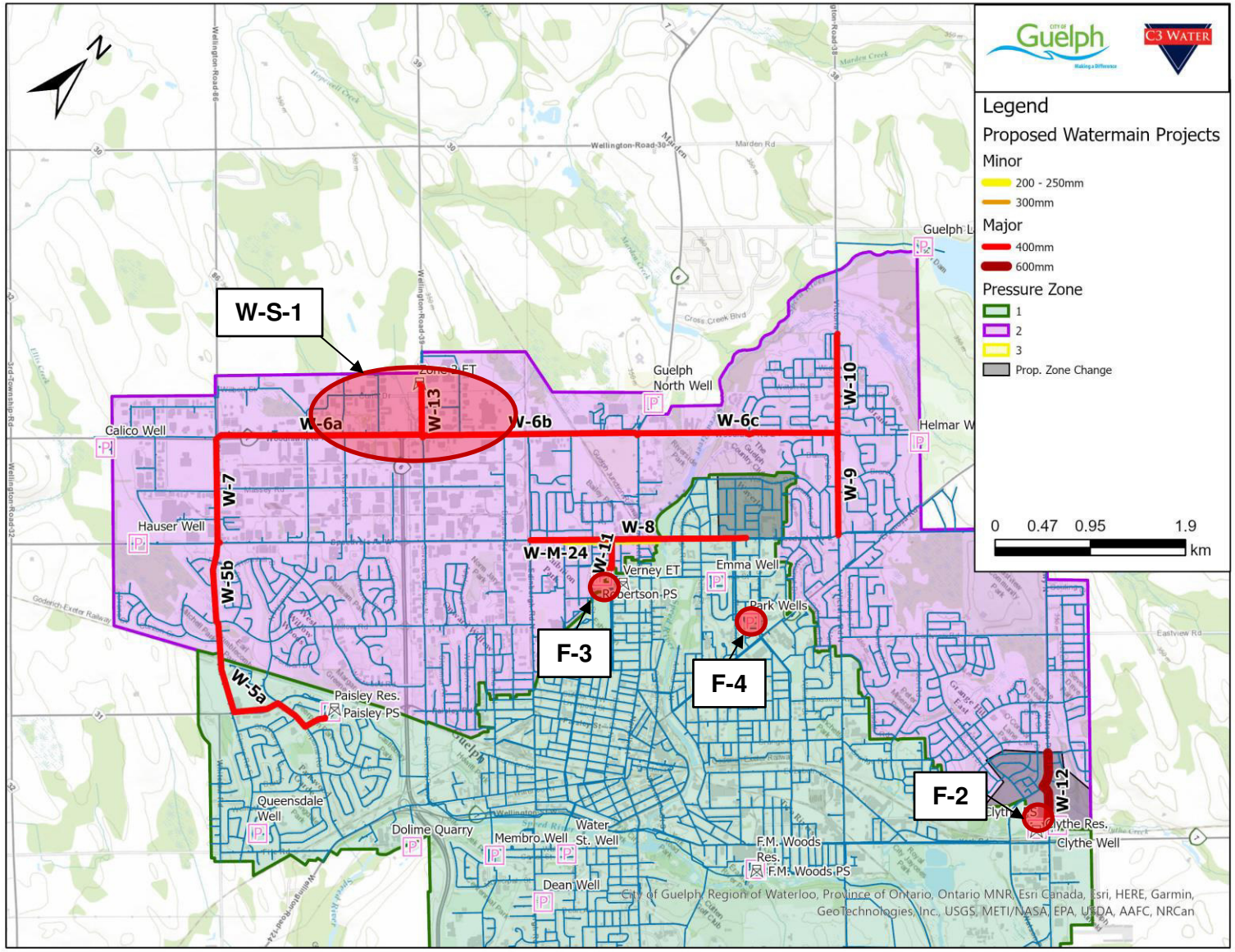


Figure 4-17 Zone 2 Watermains and Proposed Upgrades

4.5.1 Zone 2 Facilities

4.5.1.1 Verney PS

The existing Roberson Booster Pumping Station (BPS) is an important POE for Zone 2. Due to its central location, it provides redundancy and operational flexibility for both Paisley and Clythe PS by allowing water to move both east and west along the Speedvale Feedermain.

Replacement of the Robertson BPS with a new Verney BPS was recommended through the 2008 WWSMP. Further studies were completed as part of the Zone 2 Study and Proposed Infrastructure Plan (Zone 2 Study) completed by C3W in 2015. Through this study, a project to upgrade the Robertson BPS to the new Verney BPS was ranked as a high priority.

A Verney Booster Pump Station Municipal Class Environmental Assessment (Robertson PS EA) was completed by GM BluePlan Engineering (GMBP) in 2021. A number of alternatives were evaluated for the location of the upgraded BPS. The preferred alternative was to build a new PS at 36 Verney Street, the current site of Verney ET.

The conceptual design was developed by GMBP including four (4) inline centrifugal pumps with VFDs, each rated for 80 L/s based on an initial station firm capacity of 240 L/s. Sufficient space is included to allow for pump replacement with larger models as demand increases, for a future firm capacity of 320 L/s.

The estimated capital cost from the EA was $6.7 M. Inflated to 2022, the conceptual cost estimate for this upgrade is $7.6M.

4.5.1.2 Clythe PS

The existing Clythe PS operates to transfer water from Zone 1 to Zone 2. There is an existing Clythe Well which was operated between 1990 and 1999 but was taken offline due to water quality concerns related to iron, manganese and sulphides. A Clythe Well Treatment Upgrades Municipal Class EA (Clythe Well Treatment EA) was completed by GMBP in 2018. A number of treatment facility location alternatives were evaluated. The preferred location was found to be 25 Watson Road Industrial, across the Road from the existing Clythe PS. A conceptual design was completed as part of the Clythe Well Treatment EA and included a new treatment facility, a raw watermain from the well to the treatment facility, treated water transmission main from the treatment facility to the existing Clythe Reservoir and PS, a well pump for the existing Clythe Well and upgrades to the existing Clythe PS. The conceptual cost estimate was $7.9 M. Inflated to 2022, this conceptual cost is estimated to be $9.6 M.

A Zone 2 East Water Storage Study was completed by AECOM in 2020. Through this study, the following approach was recommended to address Zone 2 storage and low pressure areas in the eastern portion of Zone 2:

- Continue to operate Zone 2 as a single pressure zone,
- Include expanded in-ground storage at the proposed Clythe St. Water Treatment Plant (WTP)

A study titled “Clythe Pump Station Storage and Pump Analysis” was completed by C3W in 2021 and provided preliminary recommendations for reservoir volume and pump capacity. A total reservoir volume of 6.9 ML was recommended to satisfy the requirements for backwashing and meet emergency supply needs. For the new PS, four (4) 85 L/s vertical turbine pumps were recommended to meet a range of demand and emergency conditions, for a firm capacity of 255 L/s. A conceptual cost estimate for the pump station and reservoir was completed and was calculated to be approximately $10.7 M. It is understood that the costs for this project have been previously approved by Council.

A design project for the new treatment facility, well pump, reservoir and booster pump and required yard piping commenced in 2022.

4.5.1.3 Park Wells

Upgrades to the Park Wells facility have been identified including replacing existing pumps with Zone 2 pumps and a watermain connection to Zone 2. The Zone 2 watermain was installed in 2022. Due to the criticality of the Clythe PS and the limited east/west transmission capacity in Zone 2, the upgraded Park PS provides a great opportunity to improve security of supply to the east side of Zone 2. It is recommended that the upgraded Park PS is designed with the ability to transition to supply Zone 1 if needed. In the future, once sources such as the Logan Well and the Guelph Lake WTP come online, the benefit of the Park Wells supply to Zone 2 will decrease and there may be value in transitioning this back to a Zone 1 supply so that it is able to operate 24 hours a day during high demand periods. A conceptual cost estimate for this PS upgrade is $2.6 M.

4.5.2 Zone 2 Watermain Upgrades

4.5.2.1 Zone 2 Major Watermains

Project W-5 is recommended to provide redundancy for the Paisley PS discharge. Under existing conditions, the Paisley PS is critical as a Zone 2 supply. It is recommended that the second Paisley PS discharge pipe not follow the same alignment as the existing 500mm, to increase the overall resilience of the discharge transmission.

Project W-6 was recommended to improve east/west transmission in Zone 2 and improve connectivity between the Paisley and Clythe PSs. This watermain would also provide redundancy to the existing Speed River crossing on Woolwich Street. Projects W-7 and W-9 are recommended to improve connectivity between the Speedvale Avenue and Woolwich Street watermains and create a 400mm Zone 2 east west loop.

Project W-8 is recommended to complete the 400mm Speedvale Avenue feedermain. The Edinburgh Road to Westmount Road portion has been designed. Glenwood to east of the Guelph Junction Railway tracks has been designed and awarded for construction. The remaining segments are currently in the design phase and are planned for construction within the next 5-years.

Project W-10 is recommended to improve the capacity at the discharge of the Guelph Lakes PS. The timing and location of this project are dependent on the details of the future Guelph Lake supply. Project W-11 is recommended to improve the watermain capacity at the proposed Verney PS. W-12 is required for transitioning area PHi-a into Zone 1 and would serve as a designated feedermain from Clythe PS to Zone 2.

4.5.2.2 Zone 2 Minor Watermains

One minor watermain project is recommended in Zone 2 which is a 200mm to replace the existing watermain on Speedvale Avenue from Westmount drive to the Zone 2 boundary. This project aligns with W-8.

4.5.3 Zone 2 Storage

The existing Speedvale ET is an aging piece of infrastructure, installed in 1969. It is expected that rehabilitation recently completed will keep the ET operational to approximately 2036. It is recommended that the existing Speedvale ET be decommissioned and replaced with a new, larger ET at the north end of Zone 2 in the future.

The existing ET is in a poor location hydraulically as it is in the middle of the Zone, creating a hydraulic break between the Paisley PS and the north end of Zone 2. The existing location of the Speedvale ET limits the

amount of water that can be supplied by either the future Verney BPS or the Paisley PS to the north end of the City. As the PS increases flows and pressure, the flow will preferentially go to the ET, limiting how much water is able to be supplied to a specific location during an emergency. By relocating the floating storage to the edge of the system, the system HGL is more stable across the Zone, and water can more easily be supplied to all customers during emergency events.

The existing Speedvale ET has a small usable volume of 2ML. While the desktop analysis presented in TM3A showed that there is expected to be sufficient storage in Zone 2 with the Paisley and Clythe reservoirs and the existing Speedvale ET, only 2ML of the future 12 ML required is floating storage. Additional floating storage would allow more flexibility in operations and allow the ET to cycle, provide opportunities for energy optimization, water quality benefits and reduce pump cycling.

A summary of the available storage and the required storage for Zone 2 is presented in Table 4-8 and Table 4-9 below, respectively. With all storage facilities available, the future available storage exceeds the future required storage. However, if the Paisley Reservoir was unavailable, either due to the Reservoir itself being out of service or Paisley Vertical Turbines (VTs) being offline, the 2051+ required storage would exceed the available storage by 4 ML. A volume of 6ML is recommended for the new ET, to increase the total Zone 2 storage by 4 ML.

Table 4-8 Zone 2 Available Storage

		Available Volume (ML)	
Facility	**Type**	**Existing**	**2051+**
Zone 2			
Speedvale Elevated Tank	Floating	2	2
Clythe Reservoir	Pumped	1	7
Paisley Reservoir	Pumped	13	13
Summary - Total Storage			
Total Zone 2 Available Storage		**16**	**22**

Table 4-9 Zone 2 Required Storage

	Required Storage (ML)	
Storage Requirements	**Existing**	**2051+**
Zone 2		
A - Fire Storage	3	3
B - Equalization Storage (25% of MDD)	5	6
C - Emergency Storage (25% of A+B)	2	2
Summary		
Zone 2 Required Storage	**10**	**11**

4.6 Zone 3 Upgrades

Proposed watermain upgrades in Zone 3 have been established through the Clair Maltby MESP and were not revisited through this project as no servicing concerns were identified through the analysis completed in

TM3A. One additional watermain project was established through this study. The planned future watermains are shown in Figure 4-18 below.

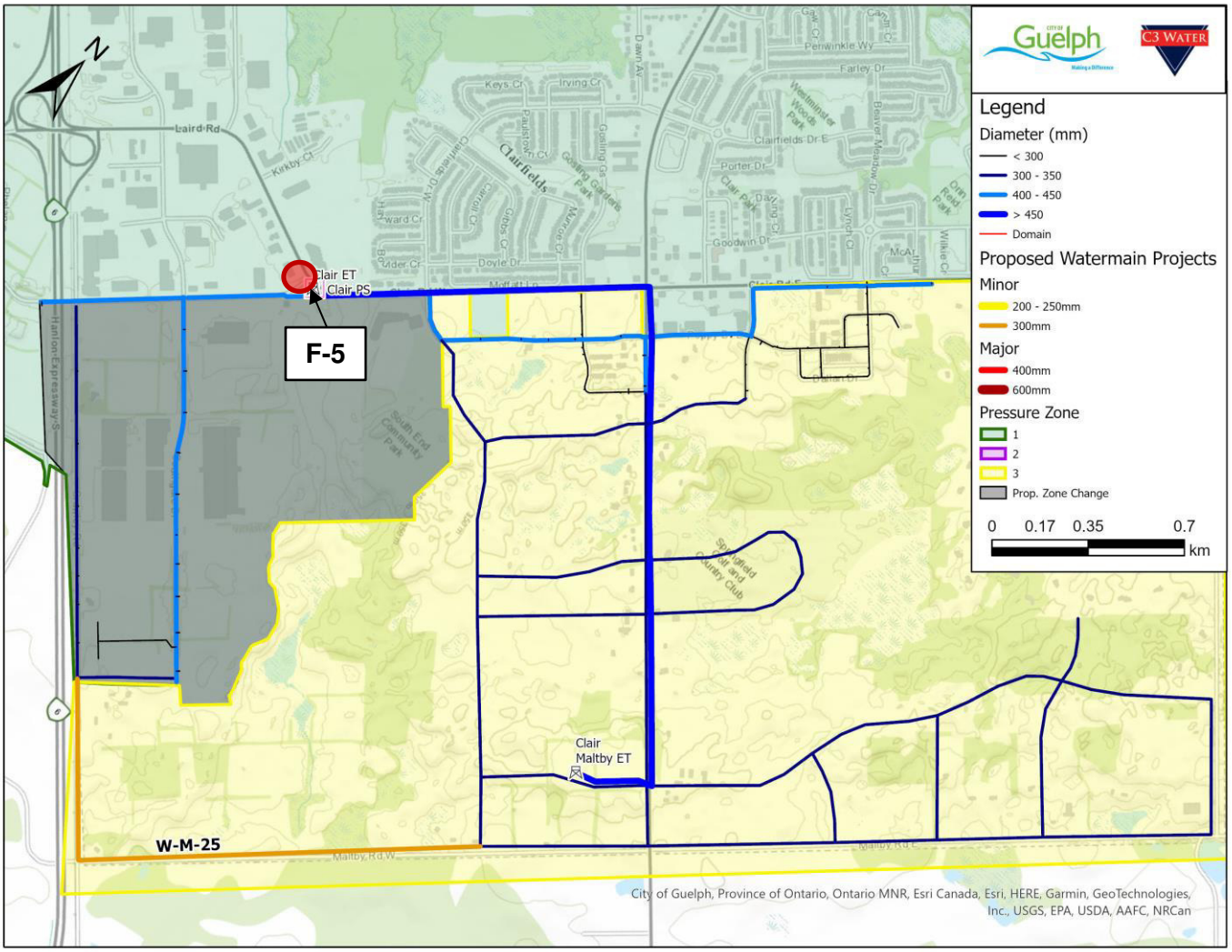


Figure 4-18 Zone 3 Future Watermains

4.6.1 Zone 3 Facilities

4.6.1.1 Clair BPS

The Clair BPS has an existing firm capacity of 345 L/s and consists of two 35 L/s pumps, one 75 L/s pump and two 200 L/s fire pumps. The firm capacity exceeds the 2051+ MDD (106 L/s) by approximately 240 L/s. Once the Clair Maltby ET is built, the need for pump capacity to meet fire flow demands will be reduced as the ET will be able to supply a portion of these demands. Pumps need to be exercised regularly to remain operational. This is challenging when the pump capacity exceeds the typical demands of Zone 3. It is recommended that once the Clair Maltby ET is built, the pump sizes are revisited and replaced with equally sized pumps that can be rotated for daily operations. Fire flow requirements can be met by operating multiple pumps at once and using the available storage in the ET.

A conceptual cost estimate for this upgrade was estimated to be $0.5 M.

4.6.2 Zone 3 Watermains

One watermain project (W-M-25) was established for Zone 3. This project is related to the proposed boundary change to transition the Southgate ICI (PLo-5) area into Zone 3. Project W-M-3 would increase capacity to this area and create a looped system on the west side of the zone.

4.6.3 Zone 3 Storage and Redundancy

The Clair BPS was identified as a critical facility under 2051+ conditions. Existing check valves on the Zone 1/3 boundary provide some level of redundancy for Zone 3 but are limited by the Zone 1 HGL. The ground elevations in the CMSP area are expected to range from 331.5m and 357.5m. While the target HGL of Zone 1 is 375m, the actual HGL fluctuates due to cycling of tanks and losses throughout Zone 1. The Clair ET often has a water level of 70% full or lower, equivalent to an HGL of approximately 374m. At Zone 1 HGL of 374, areas in Zone 3 with an elevation of 345.9m or higher would fall below 40 psi to approximately 23 psi.

Criticality of the Clair BPS will be reduced once the ET is built. If the Clair BPS fails, the new ET would provide supply and pressure for approximately 17 hours during 2051+ ADD. The preferred location of the proposed Clair Maltby ET was established through Clair Maltby MESP. The preliminary proposed volume is 5ML. In the interim, an in-line BPS has been recommended through the Clair Maltby MESP to provide redundancy to phase 1 development in Zone 3.

The required and available storage for Zone 3 is summarized in Table 4-10 and Table 4-11 below, respectively. Under 2051+ conditions, the total required storage for Zone 3 was calculated to be 7 ML. With the Clair ET and the proposed Clair Maltby ET, the future available storage is 10 ML. However, the availability of the Clair ET storage volume is dependent on the Clair BPS. Additionally, the Clair ET is also used to supply Zone 1. It is recommended that a storage volume equivalent to the MECP fire storage (A-3ML) and equalization storage (B-2ML) for Zone 3 be floating storage in Zone 3. Based on this methodology, the preliminary volume for the Clair Maltby ET of 5ML was found to be sufficient for Zone 3 demands. The emergency storage volume could be supplied by the Clair ET in Zone 1. The addition of the Clair Maltby ET will also reduce the reliance on Zone 1 infrastructure. The Clair Maltby ET will help supply peak demands, reducing the peak flowrate from the Clair BPS, thereby reducing the amount of water required from Zone 1.

Table 4-10 Zone 3 Required Storage

	Required Storage (ML)	
Storage Requirements	**Existing**	**2051+**
Zone 3		
A - Fire Storage	3	3
B - Equalization Storage (25% of MDD)	0	2
C - Emergency Storage (25% of A+B)	1	1
Summary		
Zone 3 Required Storage	4	7

Table 4-11 Zone 3 Available Storage

Facility	Type	Available Volume (ML)	
		Existing	2051+
Zone 3			
Clair Elevated Tank	Zone 1 (Through PS or CV)	4.5	4.5
Clair Maltby Elevated Tank	Floating	0	5
Summary - Total Storage			
Total Zone 3 Available Storage		**4.5**	**9.5**

4.7 Cast Iron Replacement Program

The existing water distribution system consists of a significant amount of aging cast iron (CI) watermains. Although many CI pipes are in very good condition structurally, CI pipe is subject to tuberculation of the inner pipe walls over time, leading to high roughness and reduced capacity. Capacity constraints are most significant in small diameter pipes of less than 200mm.

Based on the City's GIS records, there is currently approximately 194 km of CI pipe in the distribution system. Over 60% of this was installed prior to 1960 (over 60-years old). Approximately 65%, or 125km, is less than 200mm.

It is recommended that the City implement a 30-year CI replacement program to replace small diameter CI with 150mm PVC pipe. The proposed program is summarized in Table 4-12 below.

Table 4-12 Proposed Small Diameter Cast Iron Replacement Program

Existing CI Pipe < 200mm (m)	124,800
Unit cost replacement ($/m)	$ 768.00
Total Replacement Cost	**$95,900,000.00**
Duration of program (years)	30
Cost/year	**$ 3,200,000.00**
Length replaced per year (m)	4,160

A number of CI pipes have been identified through study this as high priority for replacement and are shown in Figure 4-19 below. The majority of these pipes are 100-150mm and upgrades were found to be required in order to meet localized fire flow requirements. Additionally, the 300mm CI pipe on Huron Street from York Road to Alice Street was flagged as high priority due to high headloss and proximity to the Woods PS. The total length of the high priority CI replacement projects was found to be approximately 14 km. It is recommended that these projects are completed within the first 10-years of the 30-year program. A list of the high-priority CI replacement projects is provided in Appendix D.

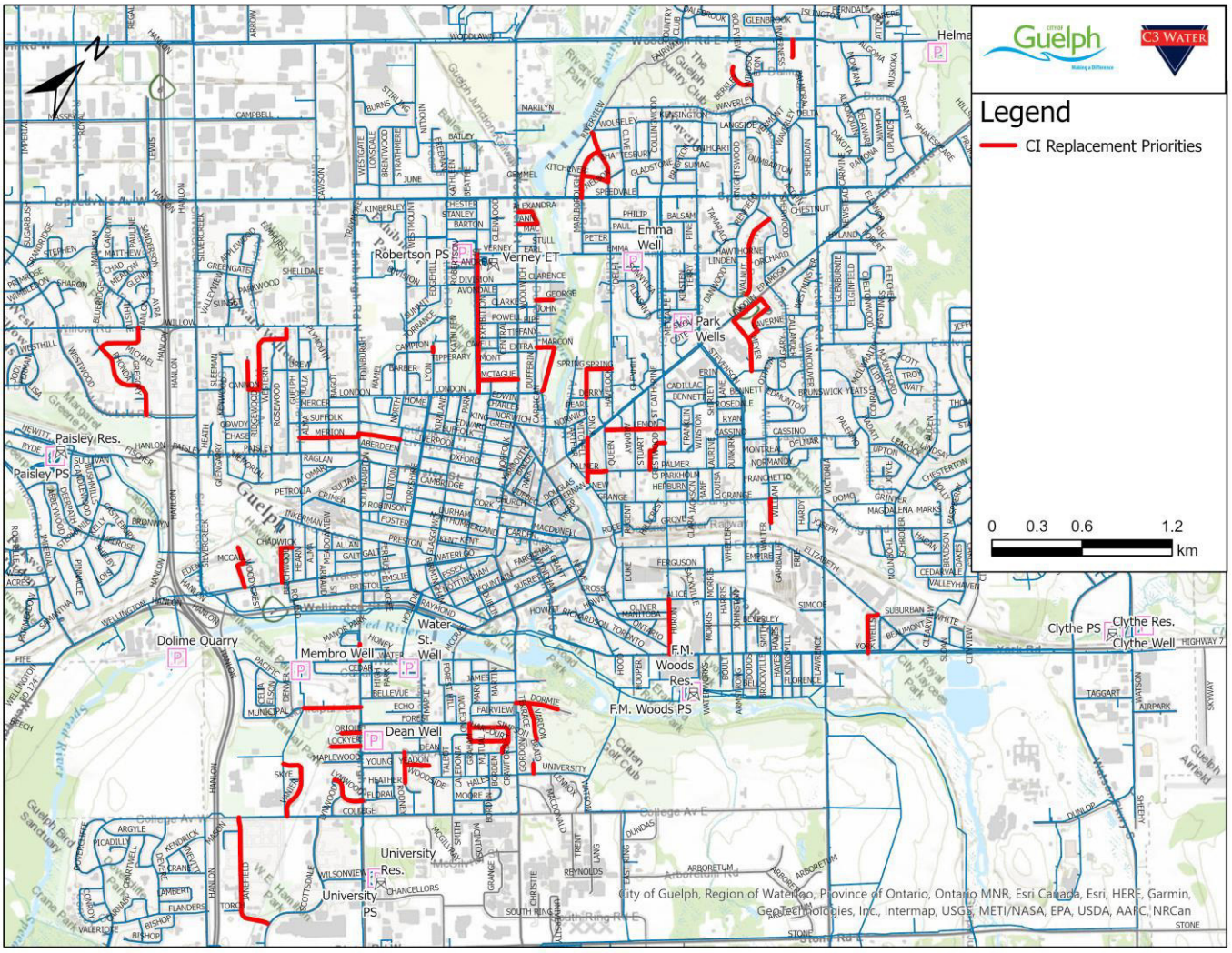


Figure 4-19 CI Replacement High Priority

5.0 WASTEWATER SYSTEM ALTERNATIVES DEVELOPMENT

5.1 Wastewater Collection System Servicing Alternatives

To address the system deficiencies identified in TM3A, the following servicing alternatives were considered, in keeping with the framework of the original Master Plan:

1. Do Nothing
2. Limit Growth
3. I/I Reduction and Re-Use Alternatives
4. Improvements to Existing System: New Trunk Sewers
5. Improvements to Existing System: Pumping Station(s) & Forcemains(s)

5.1.1 Do Nothing

The *do nothing* alternative maintains the existing wastewater collection system “as is". This alternative does not address system deficiencies; however, it is included as a benchmark against which all other alternatives

may be considered. A decision to *do nothing* may be made if the financial and environmental costs of all other alternatives outweigh the benefits.

In this case, the *do nothing* alternative fails to address existing system limitations as identified in TM3A and meet future growth requirements outlined by the City's Growth Management Strategy and the Province's Places to Grow Act. This alternative is not recommended as a viable solution as the level of service provided would not meet the City's criteria, and therefore will not be carried forward.

5.1.2 Limit Growth

This alternative essentially reduces or eliminates future wastewater servicing requirements by limiting collection system flow generation. This would involve limiting future residential, industrial, commercial and institutional growth and does not conform with the City's ongoing Municipal Comprehensive Review (Shaping Guelph) project. Additionally, this alternative does not address system limitations under existing conditions. Therefore, this is not a feasible alternative.

5.1.3 Inflow and Infiltration (I/I) Reduction

In tandem with the *water conservation* alternative in Section 4.1.3, reducing water usage to decrease the system demand via water conservation actions would decrease the volume of sanitary flows produced. However, the City cannot rely on water efficiency measures alone to offset the larger contributing factor of wet weather infiltration and inflow (I/I).

I/I remains a contributor to elevated flows during wet weather and during spring melt conditions as measured at the Water Resource Recovery Centre (WRRC), where despite reduction in water usage per capita there is a trend towards increasing I/I volumes. I/I reduction is an ongoing effort by the City of Guelph, to monitor and manage the impact of extraneous clean water sources from compromising existing system capacity in the collection system, with the additional benefit of reduced volumetric impact at the WRRC. To date, the City has completed an I/I Strategy document and commenced with ongoing temporary flow monitoring programs to provide supporting data to characterize relative system performance against key performance indicators in dry and wet weather conditions. The City has advanced a pilot I/I study in the downtown core completing systematic field investigations to identify sources on both public and private property. This work provides a framework for completing additional field investigation programs; however, there is a need to update and formalize the I/I strategy to integrate I/I considerations in activities across the organization, in keeping with the One Water initiative. It is proposed that the I/I Strategy be updated with input from the rainfall and flow monitoring data collection activities, findings of the pilot field investigation studies, and observations at the WRRC.

I/I reduction alone cannot resolve existing conveyance deficiencies nor offset future growth demands. Nonetheless, I/I reduction and mitigation is a prudent measure of collection system management that compliments conveyance system upgrades, building in resiliency to uncertain implications of climate change. *I/I reduction* and mitigation is therefore considered a viable strategy to be carried forward in the Master Plan recommendations.

5.1.4 Improvements to Existing System: Gravity Sewers

The improvements to *existing system: gravity sewers* alternative involves implementation of capital projects such as upgraded sewers, twinned sewers, inline/offline storage, and/or modifications to existing infrastructure to both address existing constraints and meet the needs to future growth.

In most cases, the approach identifies a gravity solution (i.e., a new or upgraded new sewer) as preferred to one requiring a new pumping station and accompanying forcemains. This is due to a range of benefits (overall) from environmental, social/cultural, economic, technical, and financial perspectives. In general,

improvements to the City's existing wastewater collection system by replacing/upgrading sewers is the preferred approach for local system deficiencies.

5.1.5 Improvements to Existing System: Pumping Station(s) & Forcemains(s)

The *improvements to existing system: pumping station(s) & forcemains(s)* alternative strategy involves implementation of pumping station facilities to both address existing constraints and meet the needs to future growth. This strategy considers the introduction of additional pump stations and forcemains to collect flows and have more control over discharge to receiving sewers where residual capacity already exists, or to avoid gravity / siphon crossings of watercourses. Although technically feasible, additional pumping stations are more costly and introduces further risk and overall components to maintain over the lifecycle of the assets.

Although not preferred as an overall servicing strategy for the City, the addition of pumping stations may be considered if the alternative gravity solution is found to be especially challenging or introduces risks that could be mitigated with a strategic pumping station.

5.2 Wastewater Collection System Servicing Evaluation

5.2.1 Environmental

The *improvements to existing system: gravity sewers* and *improvements to existing system: pumping station(s) & forcemains(s)* alternatives are expected to have the largest impact on environmental features due to construction requirements. The *do nothing* alternative is expected to have no impact on environmental features compared to existing conditions. *I/I reduction and re-use* has the potential to lessen the flows into the City's wastewater collection system. *Limiting future* growth is expected to have a minor impact on environmental features due to reduced development.

The *improvements to existing system* alternatives would both increase GHGs during construction activities. These alternatives would also introduce the risk that certain trees would need removal. These could be replanted to renew the resource.

5.2.2 Social/Cultural

The *do nothing* alternative has high potential for negative effects on long-term business vitality, community growth and development as existing infrastructure does not have sufficient capacity.

Limiting future growth would have limited impact on existing residents, however, it does not align with the Shaping Guelph requirements.

I/I reduction measures have the potential to lessen the servicing needs and extend the lifecycle of existing infrastructure. The sewer flow monitoring analysis completed as part of this Master Plan Update showed little to negligible I/I in the local collection system. As such, it is not expected that this alternative is very effective as an overall approach. However, it is understood that at the trunk level and at the WRRC that I/I does remain an operational issue, and while no evidence to date of significant flood risk, elevated I/I rates in the system can lead to sewer back-up and spill to the environment, affecting the socio-cultural environments.

Improvements to the existing infrastructure (Gravity Sewer & Pump Station) alternatives are expected to have the highest social/cultural impact related to construction projects. These construction projects would be short-term in duration; however, it is expected that a Pump Station strategy would result in an increased operational and maintenance activity requirement that could prove to have a higher impact than the Gravity Sewer upgrade alternative.

5.2.3 Economic

The *do nothing* and *limiting future growth* do not involve any capital costs, however there is potential for increased lifecycle costs due to system aging and replacement/emergency needs. *Limiting future growth* has the potential for reduced revenue from development charges and taxes.

I/I reduction would conceptually require limited cost (when compared to infrastructure needs for the Gravity Sewer and/or Pumping alternatives). The potential gain from this alternative is not expected to be significant by comparison, but is part of an overall strategic approach to improved system management that may help to defer capital projects should significant public I/I sources be found with a direct mitigation measure of smaller scale. It is acknowledged that in the downtown pilot I/I study, no such large public sources were readily discovered.

Improvements to the existing system (Gravity Sewer and Pumping Station) is expected to have major capital costs. These alternatives have the potential for cost sharing with developers.

The Pumping Station approach is expected to be significantly more expensive initially and also in the long-term due to additional operations and maintenance requirements. Conceptually, introducing larger pumping stations may delay the needed to replace existing trunk sewers, but these will eventually require renewal, nonetheless. Thus, the overall cost is significantly more as it is a combined increase due to new pumping station(s) and the increase O&M needs, plus the renewal needs of existing infrastructure that would be unchanged.

5.2.4 Technical

The *do nothing*, *limiting future growth* and *I/I reduction* alternatives are all the easiest to implement. They all however significantly do not meet the Technical requirements and are therefore not satisfactory within the context of satisfying the City's long-term servicing needs.

A comparison of the alternatives that introduce improvements to the existing system (Gravity Sewers vs. New Pumping Stations & Forcemains) shows that these are two feasible approaches that would be able to satisfy the City's commitment to existing residents and enable growth to occur. The inclusion of new pumping stations, however, is always more complex and introduces the need for additional considerations. I/I reduction measures should be considered where feasible, as part of an overarching I/I Strategy.

5.2.5 Wastewater System Servicing Evaluation Summary

Of the alternatives assessed, *improvements to the existing system (Gravity Sewers and/or Pumping Stations & Forcemains)* are the only alternatives that can meet the future requirements for the system while confirming with Shaping Guelph. Therefore, a hybrid of these was carried forward as the preferred alternative.

Two (2) overall strategies were considered. One that is gravity based with consideration for new Trunk Sewers, and the other which considered "Pumping Station(s) & Forcemains". The pump station strategy is feasible but is found to be more expensive and less favorable overall. As such, a hybrid of these was carried forward as the preferred alternative for the wastewater collection system. I/I reduction and mitigation measures are proposed to compliment the recommended solution, through update to the City's I/I Strategy including long-term monitoring, integrated data management and data analytical performance indicators.

Full evaluation is provided in Appendix A.

5.3 Approach – Gravity Sewers

The wastewater system assessment completed in TM3A identified multiple capacity constraints in the gravity system. These locations area shown in greater detail in Figure 5-1. To address the capacity constraints, several improvement alternatives were considered for feasibility, and are summarized as follows:

1. Alternative 1: Sewer Replacement – Assumes existing sewers are removed and replaced with larger diameter sewers to address capacity constraint. This approach can solve localized capacity constraints but can impact the capacities of downstream infrastructure. These impacts must be accommodated for when applying this approach.
2. Alternative 2: Sewer Twinning / Storage – Assumes existing sewers remain in place, new parallel/adjacent sewers installed to address capacity constraint. These may be oversized with a controlled discharge to provide storage if downstream capacity restrictions are prohibitive.
3. Alternative 3: Flow Diversion – Assumes excess flows are diverted upstream of capacity constraint to either existing infrastructure with sufficient residual capacity or construction of new sewers.

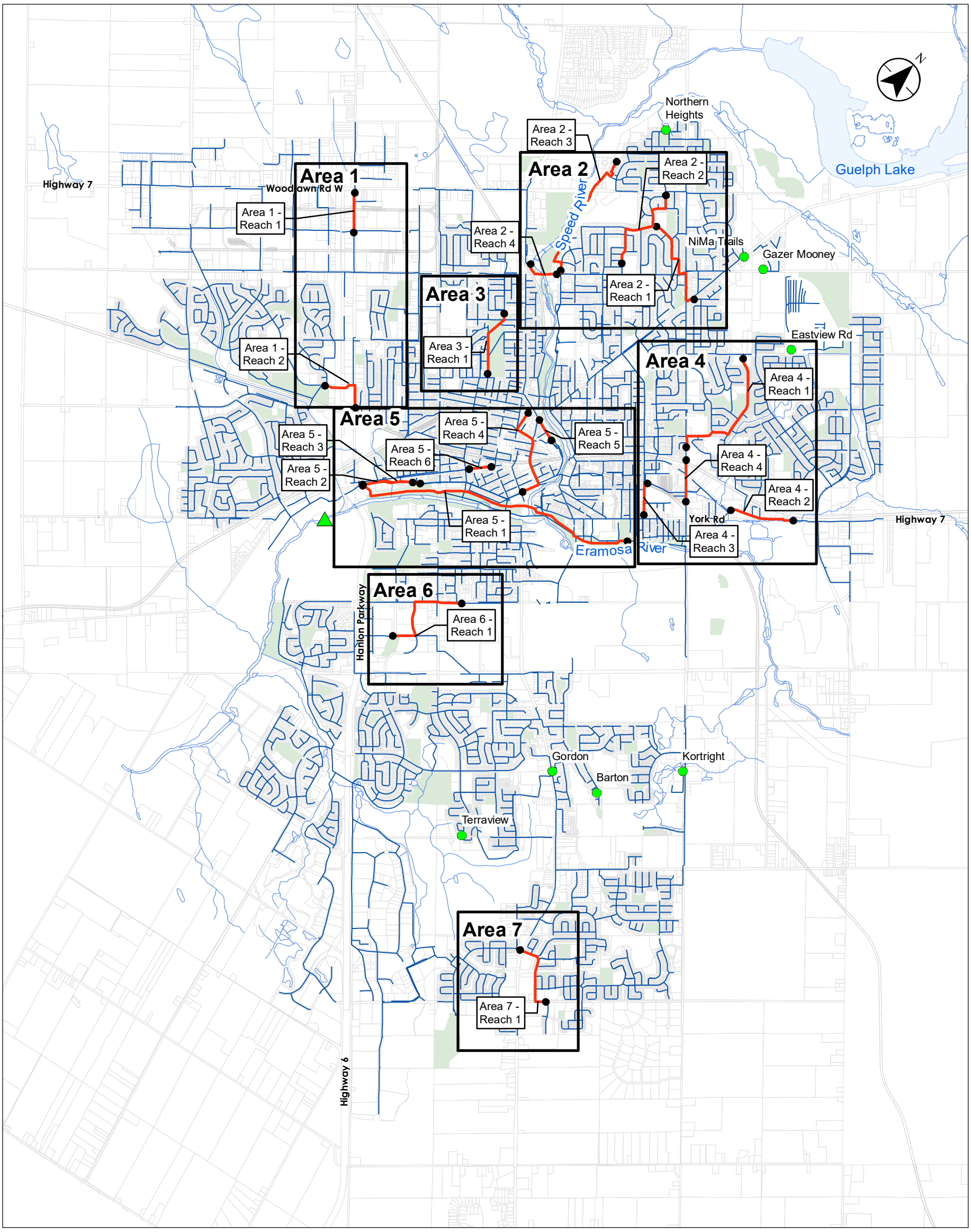
Sewer Replacement is the preferred improvement alternative for most of the system deficiencies as they are primarily discrete sections of local sewers with diameters ranging from 200 mm to 450 mm (with some exceptions) with few downstream implications or constraints.

Sewer Twinning and/or Storage can achieve similar improvements as Sewer Replacement but generally are less preferred for a range of reasons:

- Sewer Twinning results in the addition of another conduit which increases the expected operation and/or maintenance needs for the area. It also typically requires a larger area to construct/add the twinned sewer. Notwithstanding, twinning can be an appropriate approach when existing infrastructure placement or natural topographic characteristics prove challenging design constraints to navigate.
- Similarly, introducing Storage (in-line or off-line) can also help achieve LOS targets by temporarily providing a volume in the collection system that mitigates conveyance restrictions that would otherwise result in surcharge. Introducing storage as part of the solution generally requires a larger area for construction and also introduces a perpetual flushing and sediment removal component. Pumps are sometimes required to drain the storage when used as well. Introducing storage as part of the infrastructure solution is sometimes considered if there are connectivity restrictions that limit the potential benefits from sewer replacement and/or twinning approaches alone.

Flow Diversion options were considered to determine if the required residual capacity in nearby adjacent sewers may be available.

V:\165640298\active_165640298\preliminary\3_Report\TM3R\Figures\103\fig_5_1_Guelph_Wastewater_Improvement_Areas_103.mxd Revised: 2022-10-30 By: MoAnderson



Legend

- Pump Station
- Water Resource Recovery Center
- Watercourse
- Railway
- Property
- Sanitary Sewer
- Area - Reach Location

0 1 2 Km

1:50,000 (At Original document size of 11x17)

Stantec

C3 WATER

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
5-1

Title
Wastewater - Improvement Areas

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

5.4 Refinement of Alternatives Through the Design Phases

Wastewater system improvements were developed for the 7 general locations identified. The following sections provide details on the deficiencies, the improvement option that was implemented, and the achieved resultant benefit. The identified upgrades have been sized to satisfy the City's LOS target for the future WWF conditions.

The recommended improvements are considered conceptual at this stage of evaluation. As their consideration progresses through functional, preliminary, and detailed design stages, these should be re-evaluated as site constraints (utility conflicts, existing natural environment constraints, etc.) become further understood. A single system upgrade is identified for each of the system deficiencies within the identified areas.

5.4.1 Alternative Solutions

In addition to the system improvements presented in the sections that follow, some alternative solutions have been requested by the City to address capacity constraints as well as take advantage of opportunistic timing of City works already planned.

5.5 Area 1 System Improvements

The first location, noted as Area 1 on Figure 5-1, includes two reaches in the northwest of the City.

5.5.1 Reach 1-1

The first reach includes 300 mm and 525 mm diameter sewers along Silvercreek Parkway North between Woodlawn Road West and Speedvale Avenue W. The HGL profile under future WWF conditions is shown below on Figure 5-2. Surcharging was observed under existing and future WWF conditions.

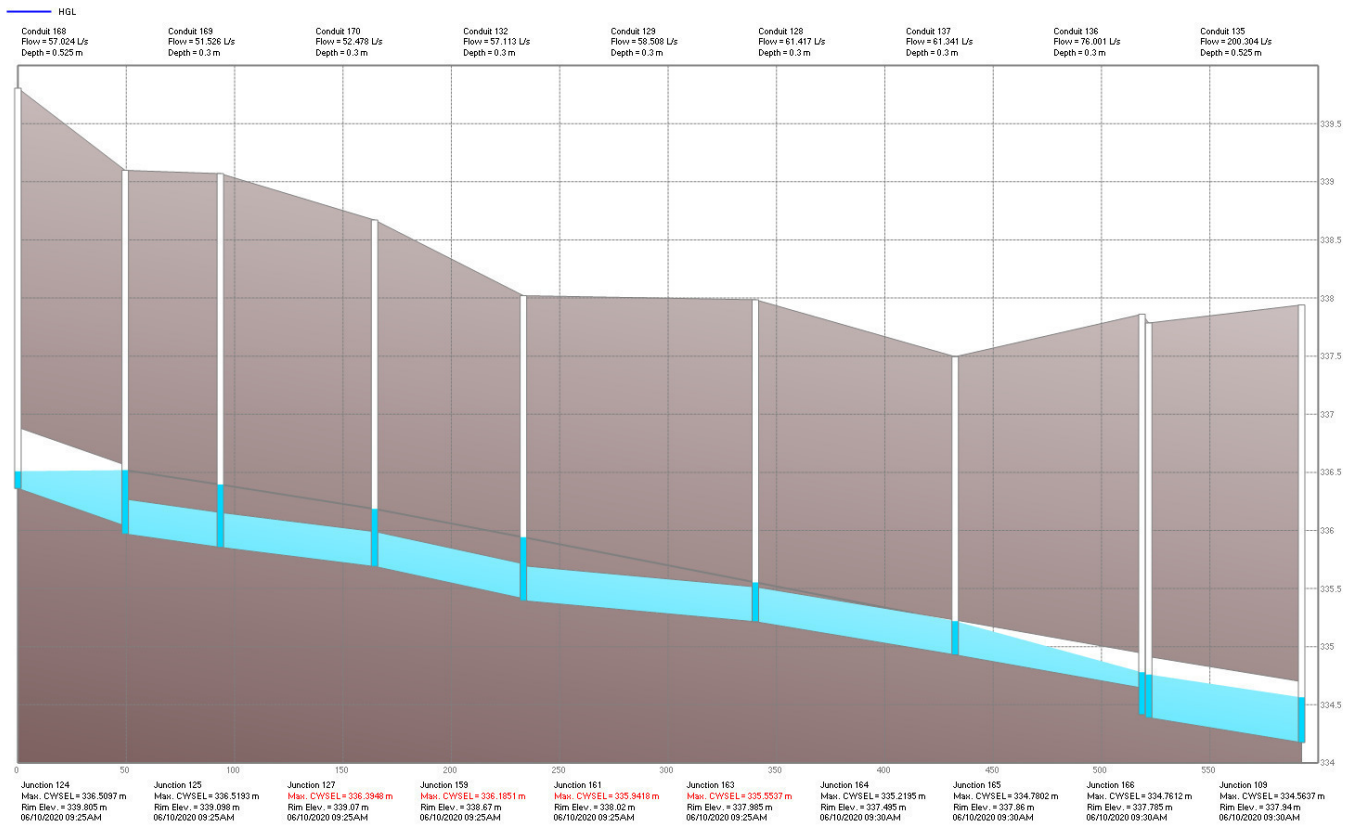


Figure 5-2 Future Conditions HGL Profile Area 1 Reach 1 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 300 mm sewers with 375 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-3.

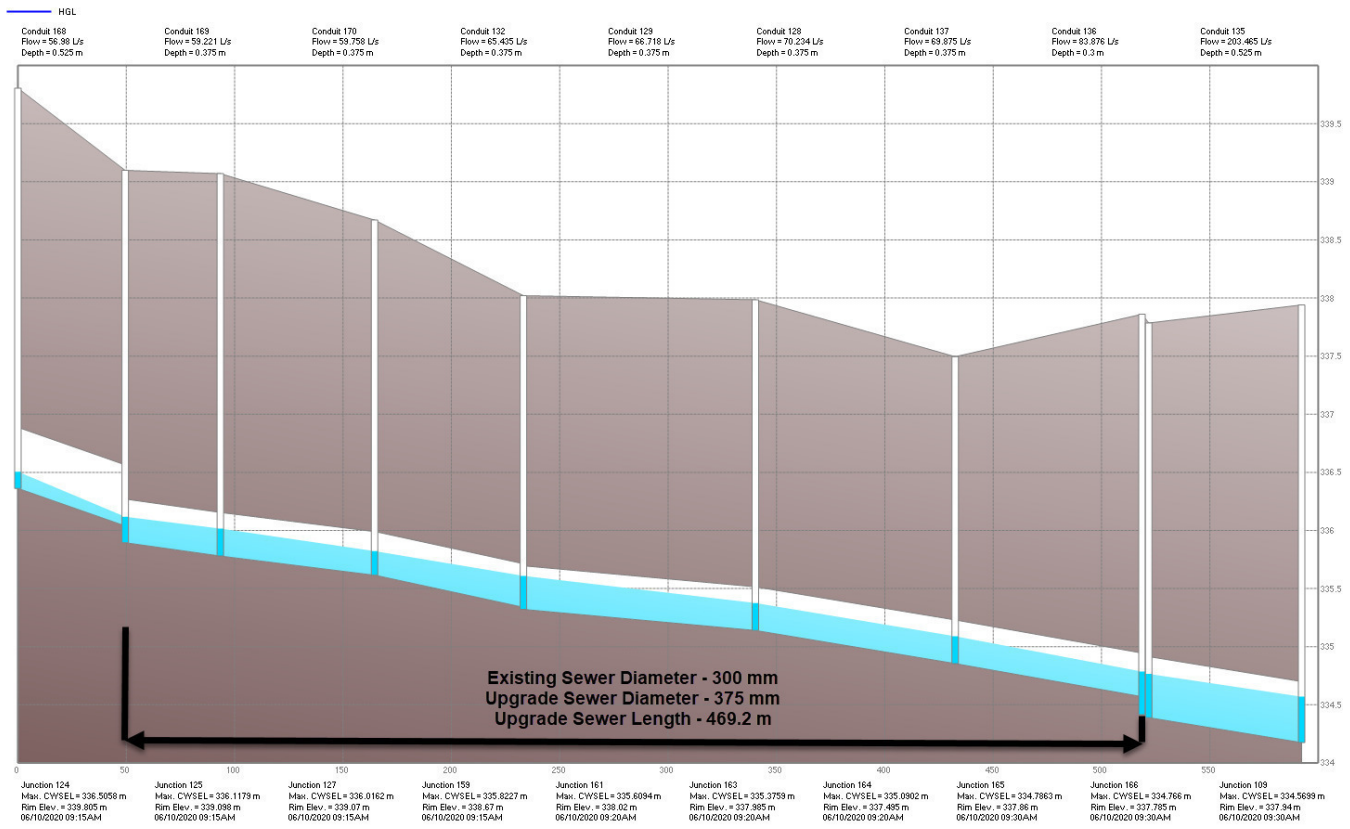


Figure 5-3 Future Conditions HGL Profile Area 1 Reach 1 (Post-Upgrade)

5.5.2 Reach 1-2

The second reach includes sewers ranging from 225 mm to 375 mm along Silvercreek Pkwy and Westwood Rd. The HGL profile under future WWF conditions is shown below on Figure 5-4. Surcharging was observed under future WWF conditions.

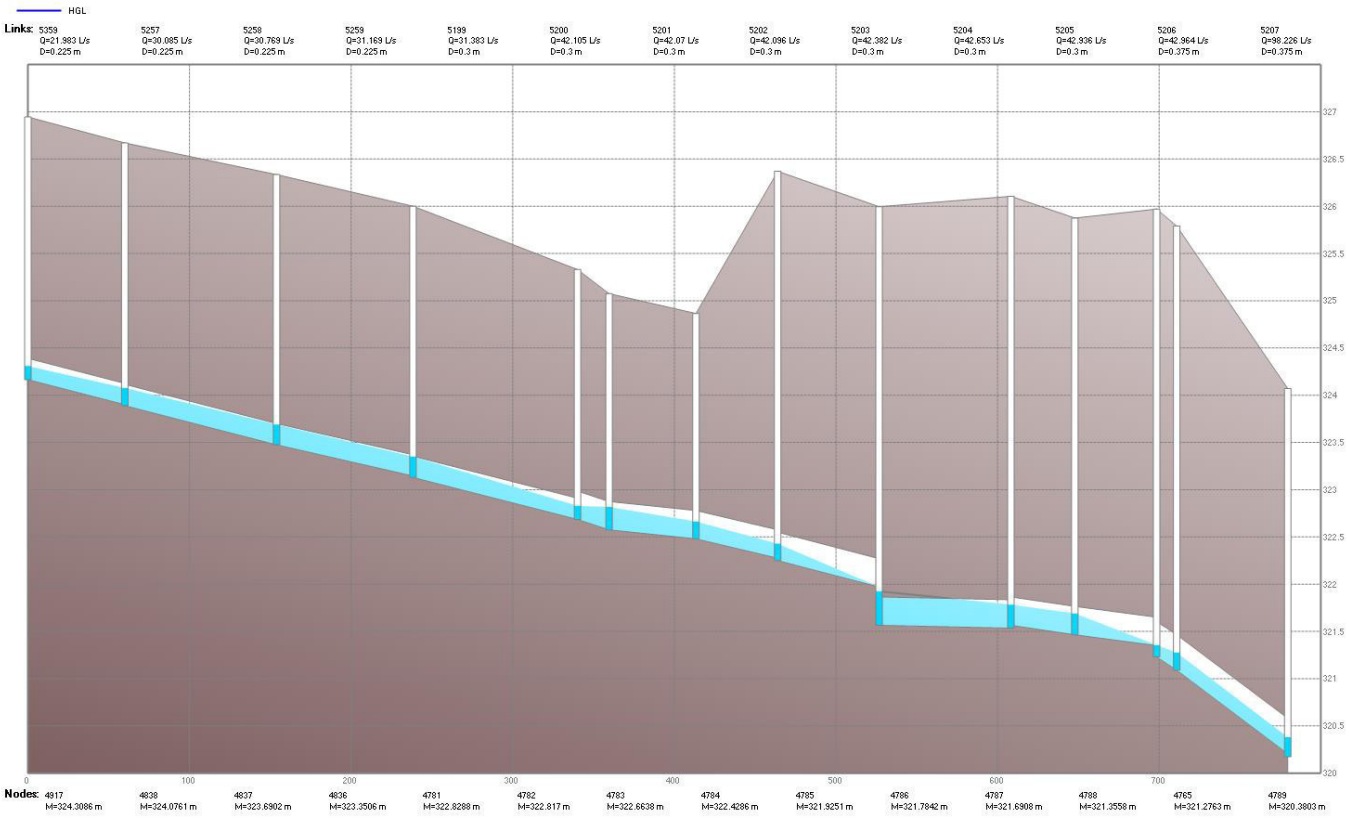


Figure 5-4 Future Conditions HGL Profile Area 1 Reach 2 (Existing Infrastructure)

Gravity sewer replacement by means of slope adjustment was selected as the improvement option in this location. Adjusting the slope of the deficient sewer provides sufficient capacity to eliminate surcharging, as shown on Figure 5-5.

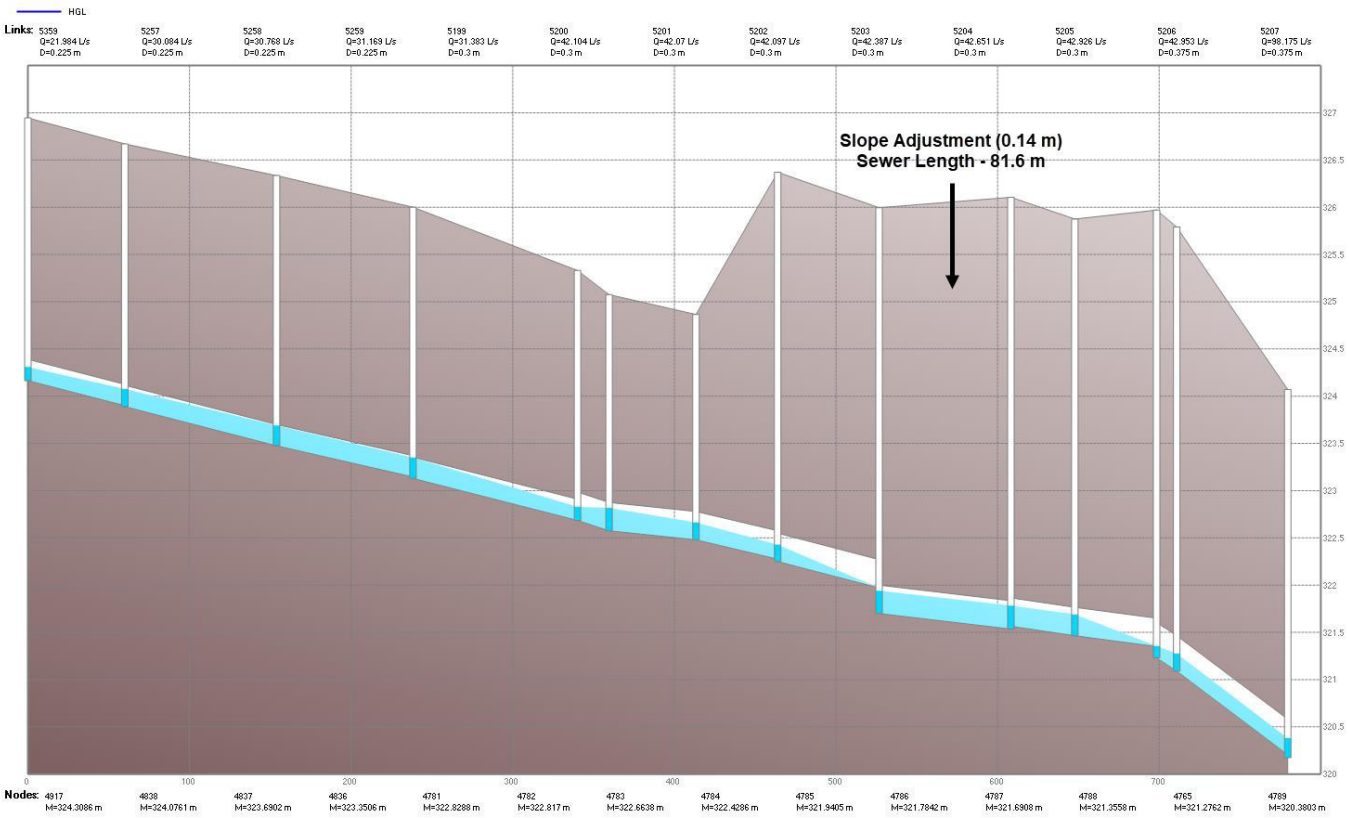


Figure 5-5 Future Conditions HGL Profile Area 1 Reach 2 (Post-Upgrade)

5.6 Area 2 System Improvements

The second location, noted as Area 2 on Figure 5-1, includes multiple reaches in the northeast of the City.

5.6.1 **Reach 2-1**

The first reach ranges from 225 mm to 375 mm travelling from Eramosa Road northwest along Victoria Road and Waverley Drive. The HGL profile under future WWF conditions is shown below on Figure 5-6. Surcharging was observed under existing and future WWF conditions.

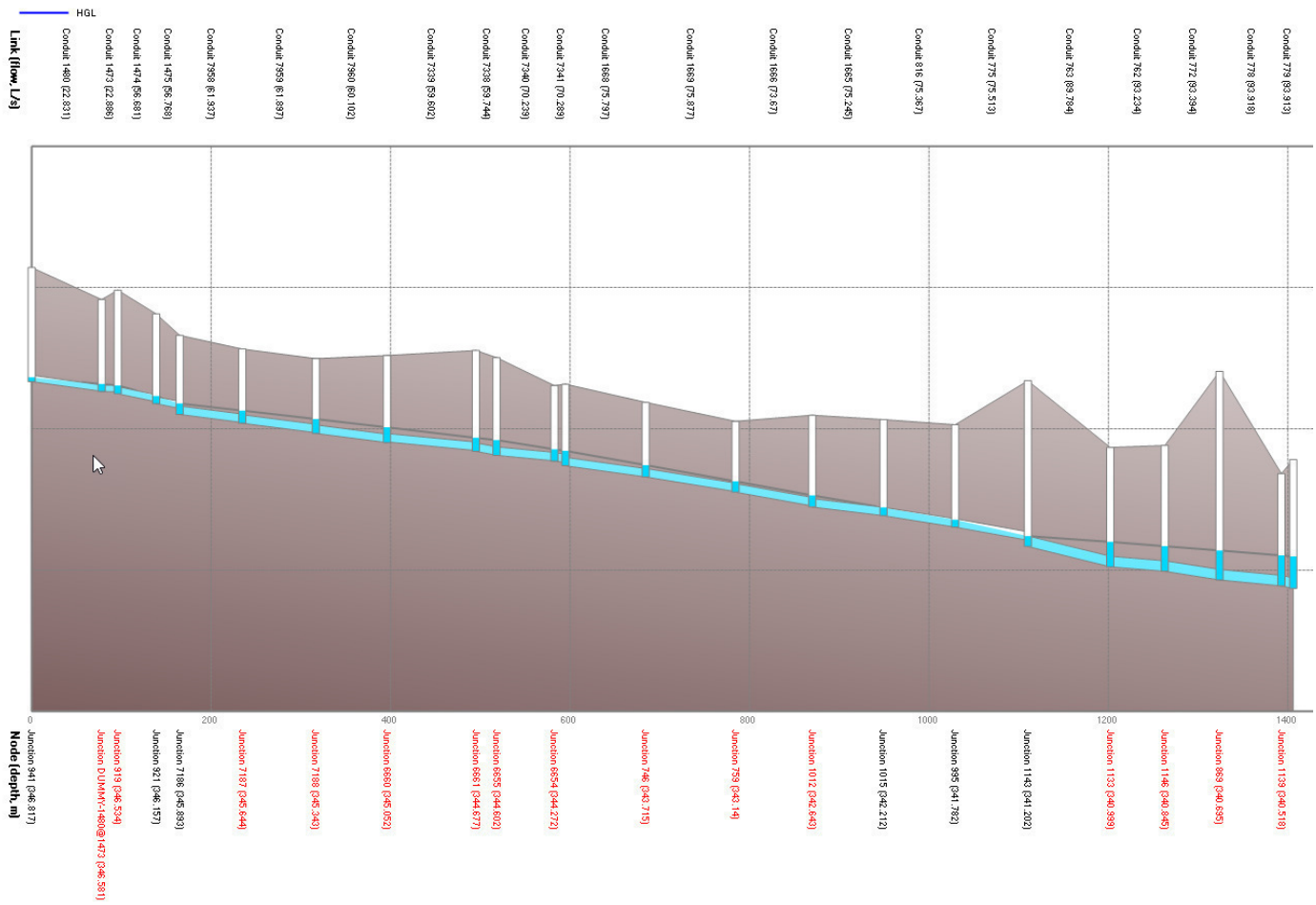


Figure 5-6 Future Conditions HGL Profile Area 2 Reach 1 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 225 mm and 300 mm sewers with 300 mm and 375 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-7. It is worth noting that the surcharging observed at the downstream end of the reach shown on Figure 5-6 is a result of backwater effects and addressed through modifications in other reaches within area 2.

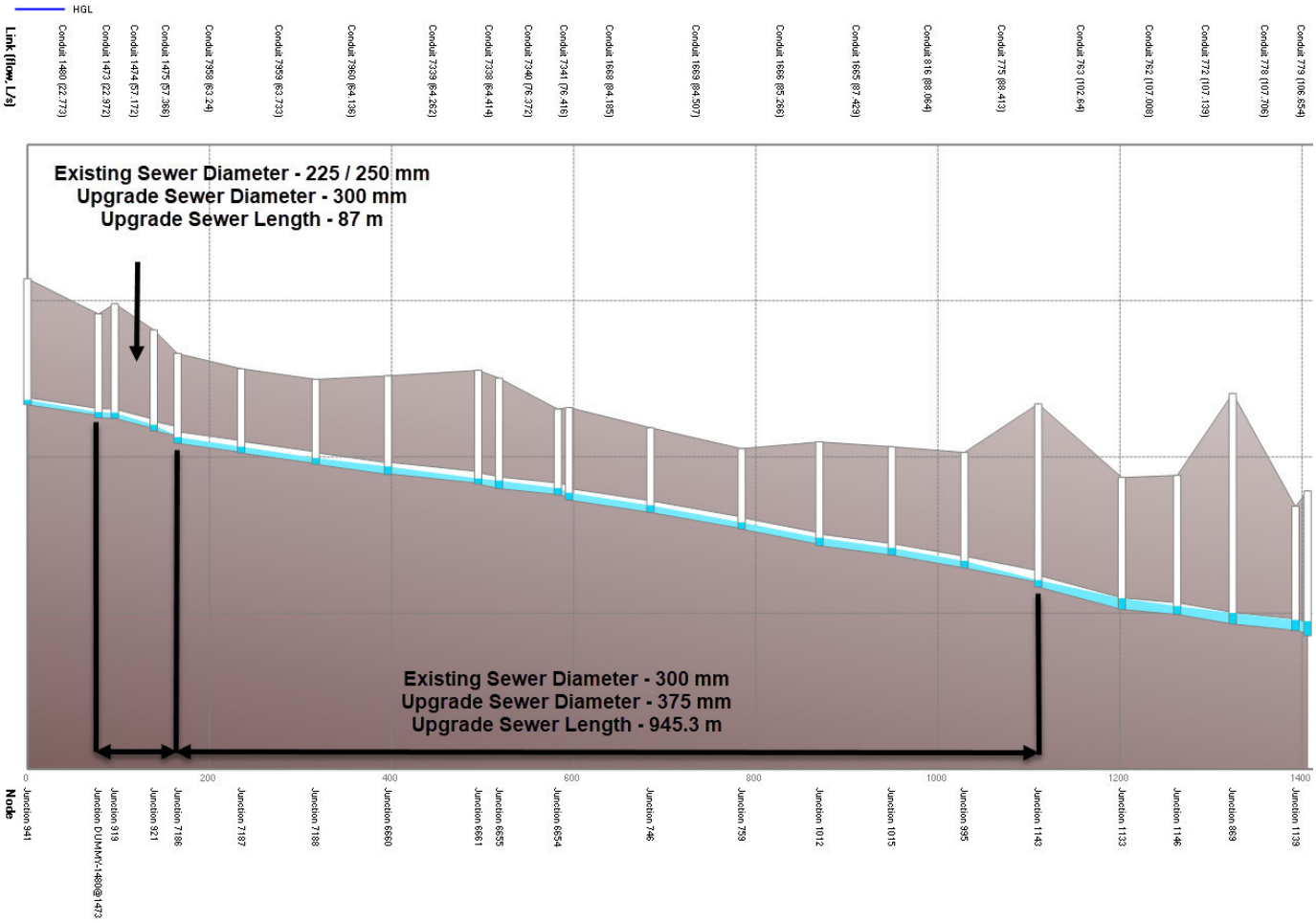


Figure 5-7 Future Conditions HGL Profile Area 2 Reach 1 (Post-Upgrade)

5.6.1.1 Alternative Solution - Reach 2-1

An alternate system improvement was evaluated in this location as there was interest in modifications to the alignment / routing of flow. The sewer was rerouted to the south on Eramosa road at the intersction of Victoria Road. This would require construction of approximately 335 m of new 300 mm sewers to connect to the existing sewers north of Callander Drive, as well as increasing the existing 200 mm sewers downstream to 300 mm and 375 mm. Additional sewer upgrades are required downstream of this location. Approximately 586 m of exsting 600 mm sewers along Stevenson St from Ferguson St to York Rd require upgrade to 675 mm to manage the additional flow. Plan and profile views of the proposed improvements can be seen below. It is worth noting that this additional improvement would involve crossing the Guelph Junction Railway track between Alice St and Ferguson. This system improvement reduces the extent of upgrades required on Reach 2-2, shown in the following section.

Figure 5-8 Reach 2-1 Sewer Realignment

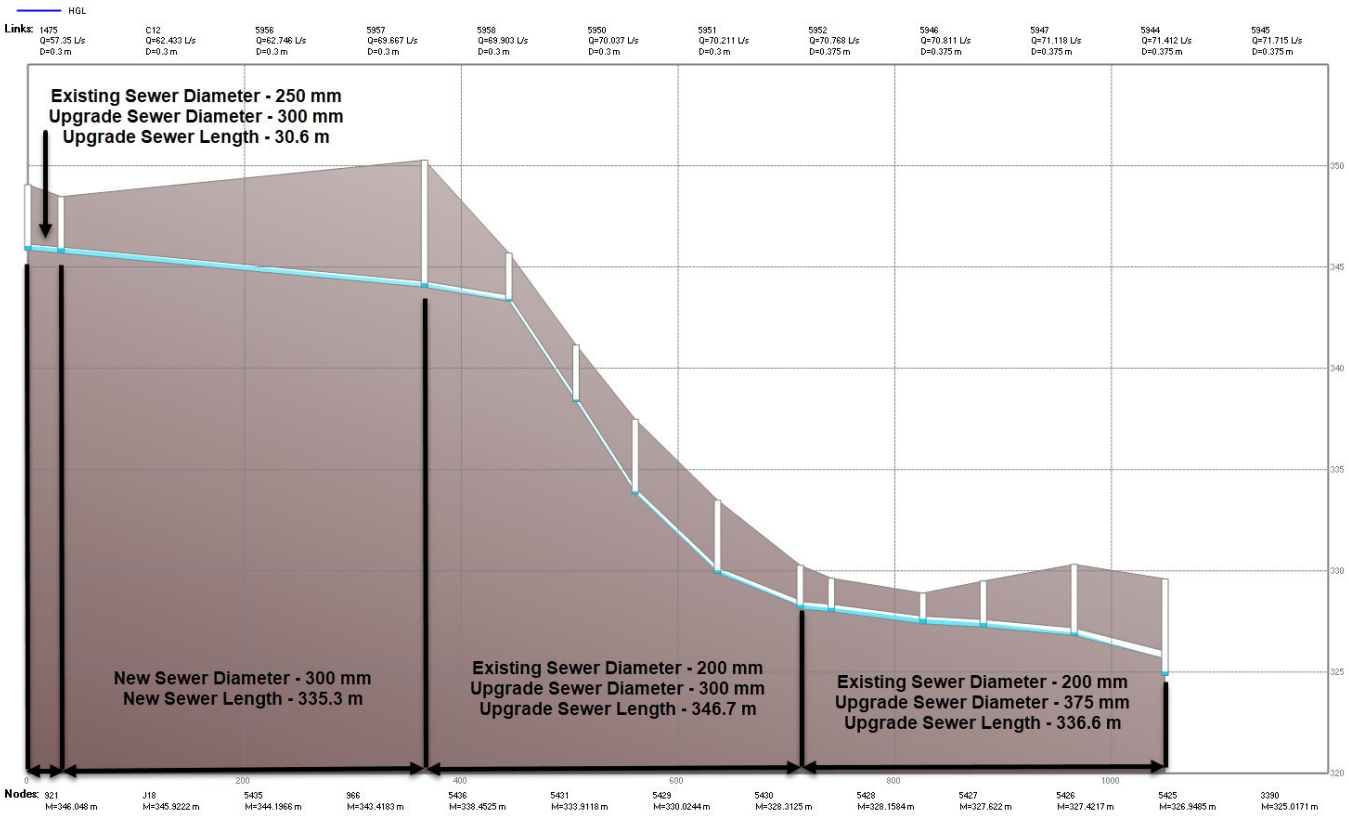


Figure 5-9 Future Conditions HGL Profile Area 2 Reach 1 (Alternate Post-Upgrade)

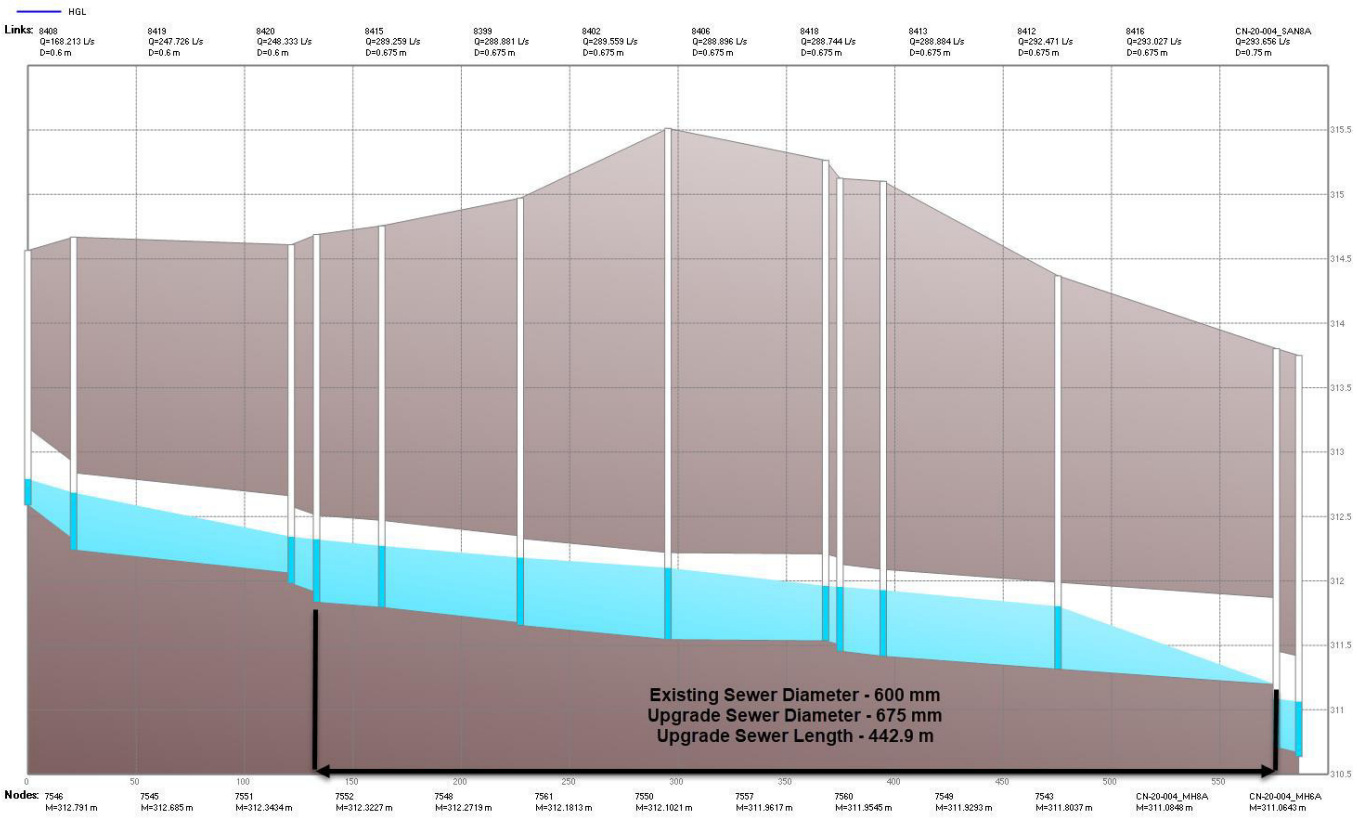


Figure 5-10 Future Conditions HGL Profile Stevenson St Downstream (Alternate Post-Upgrade)

5.6.2 Reach 2-2

The second reach in Area 2 includes 300 mm and 375 mm diameter sewers from Woodlawn Road East to Speedvale Avenue. The HGL profile under future WWF conditions is shown below on Figure 5-11. Surcharging was observed under existing and future WWF conditions.

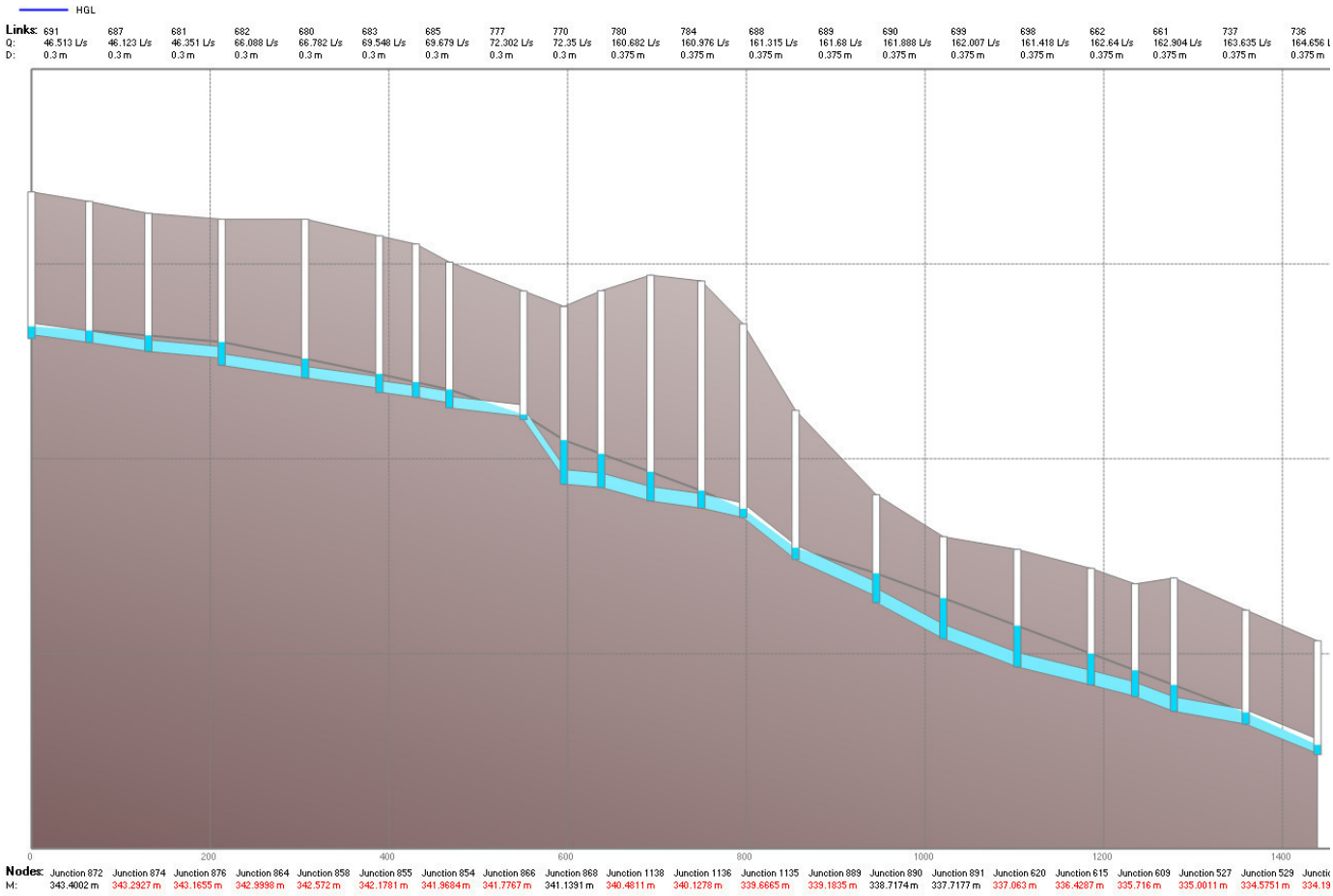


Figure 5-11 Future Conditions HGL Profile Area 2 Reach 2 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 300 mm and 375 mm sewers with 375 mm and 450 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-12.

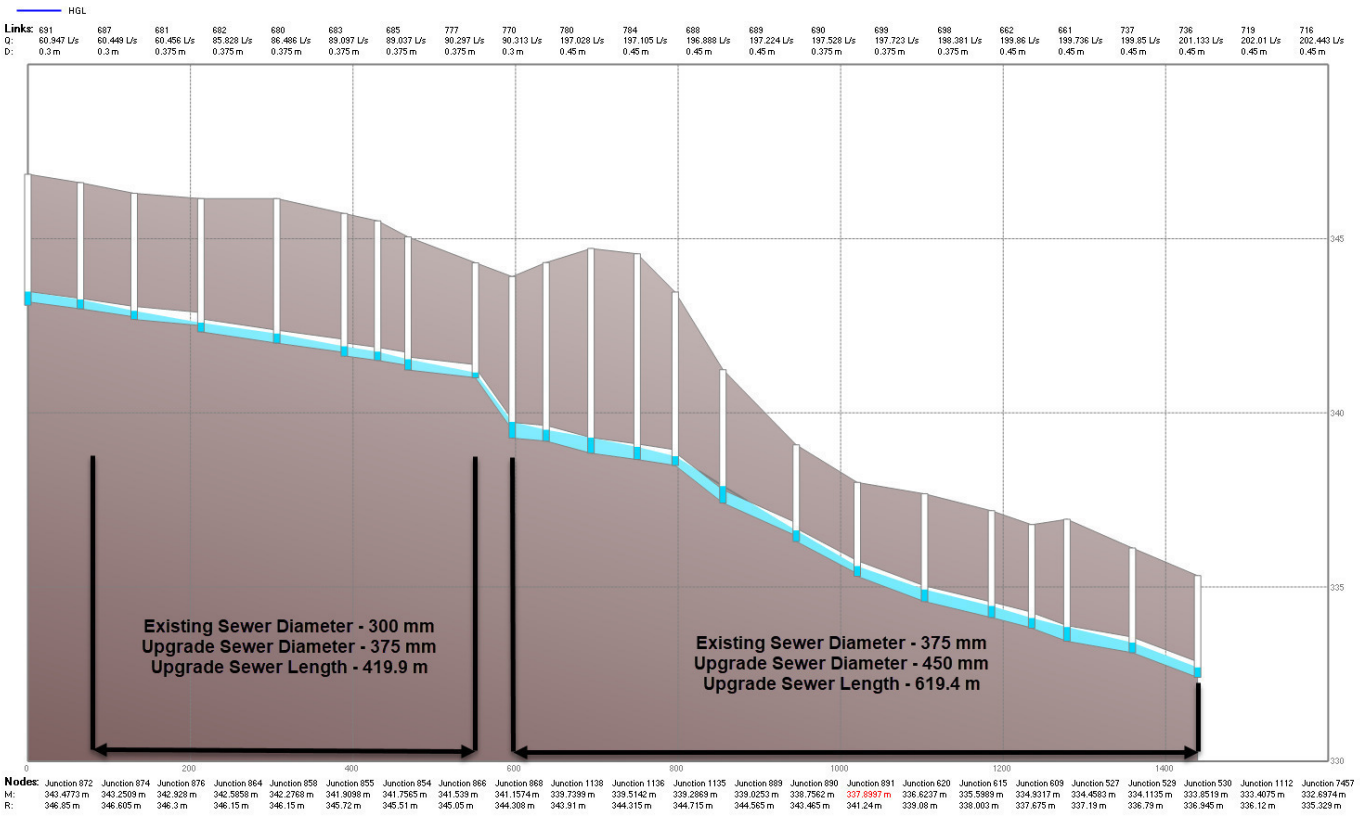


Figure 5-12 Future Conditions HGL Profile Area 2 Reach 2 (Post-Upgrade)

Using the alternate improvement for Reach 2-1, as discussed in the previous section, impacts the extent of improvements required for Reach 2-1. The redirection of flow south on Eramosa results in a reduction in flows observed in this location. The revised HGL profile and improvements for Reach 2-2 are shown below.

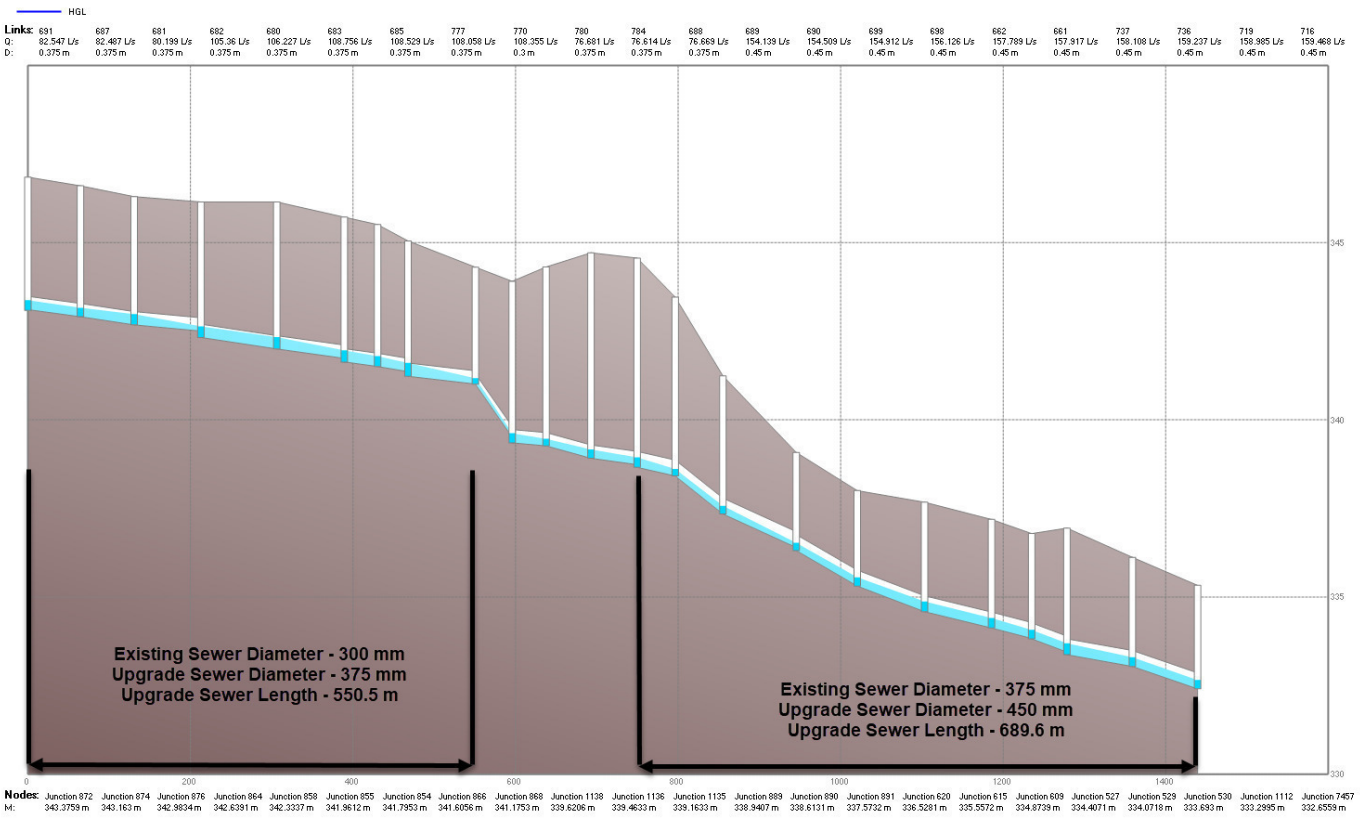


Figure 5-13 Future Conditions HGL Profile Area 2 Reach 2 (Alternate Post-Upgrade)

5.6.3 Reach 2-3

The third reach in Area 2 ranges in diameter from 225 mm to 300 mm sewers from Pondview Crescent to the south across Woodlawn Road East and along Riverview Drive to Speedvale Avenue. The HGL profile under future WWF conditions is shown below on Figure 5-14. Surcharging was observed under existing and future WWF conditions.

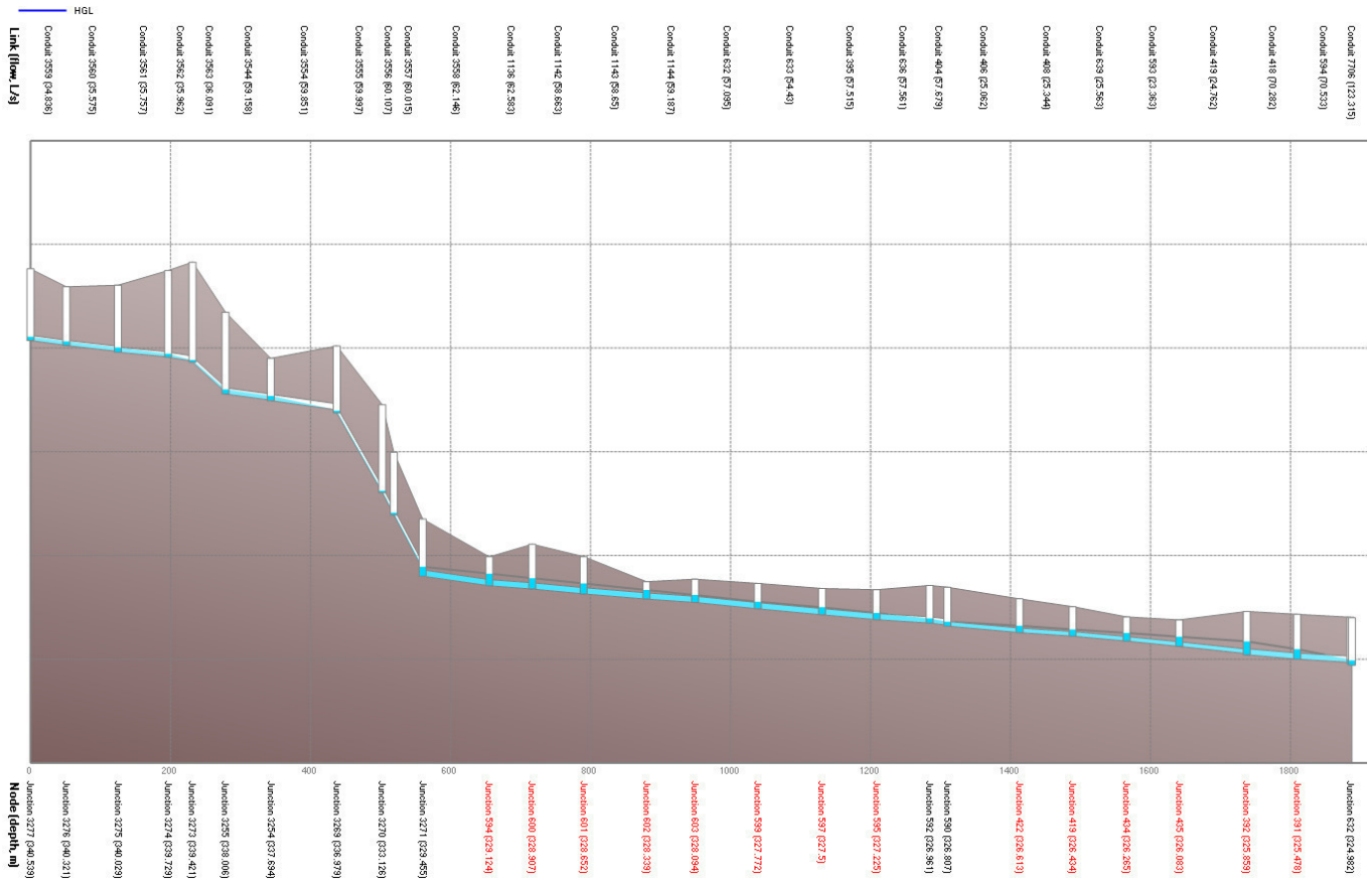


Figure 5-14 Future Conditions HGL Profile Area 2 Reach 3 (Existing Infrastructure)

Sewer replacement was reviewed at this location for feasibility. The sewer location near the Speed River through natural areas make in-situ upgrade challenging. Residual capacity in the sewer system upstream of this location was identified therefore an upstream diversion of the Northern Heights PS flow was selected as the improvement option in this location. Diverting the flow away from the receiving trunk via a new forcemain allows use of residual capacity in existing infrastructure and eliminates surcharge at the same time as shown on Figure 5-15. This approach results in approximately 150 m on Marlborough Rd and an additional 174.3 m on Speedvale Ave (not shown). Without the diversion in place, an additional 629.3 m of 300 mm sewers, and 427.6 m of 225 mm sewers would require replacement to address the surcharging. The point of diversion is at the intersection of Ingram Dr and Wilton Rd, with the concept shown below on Figure 5-16.

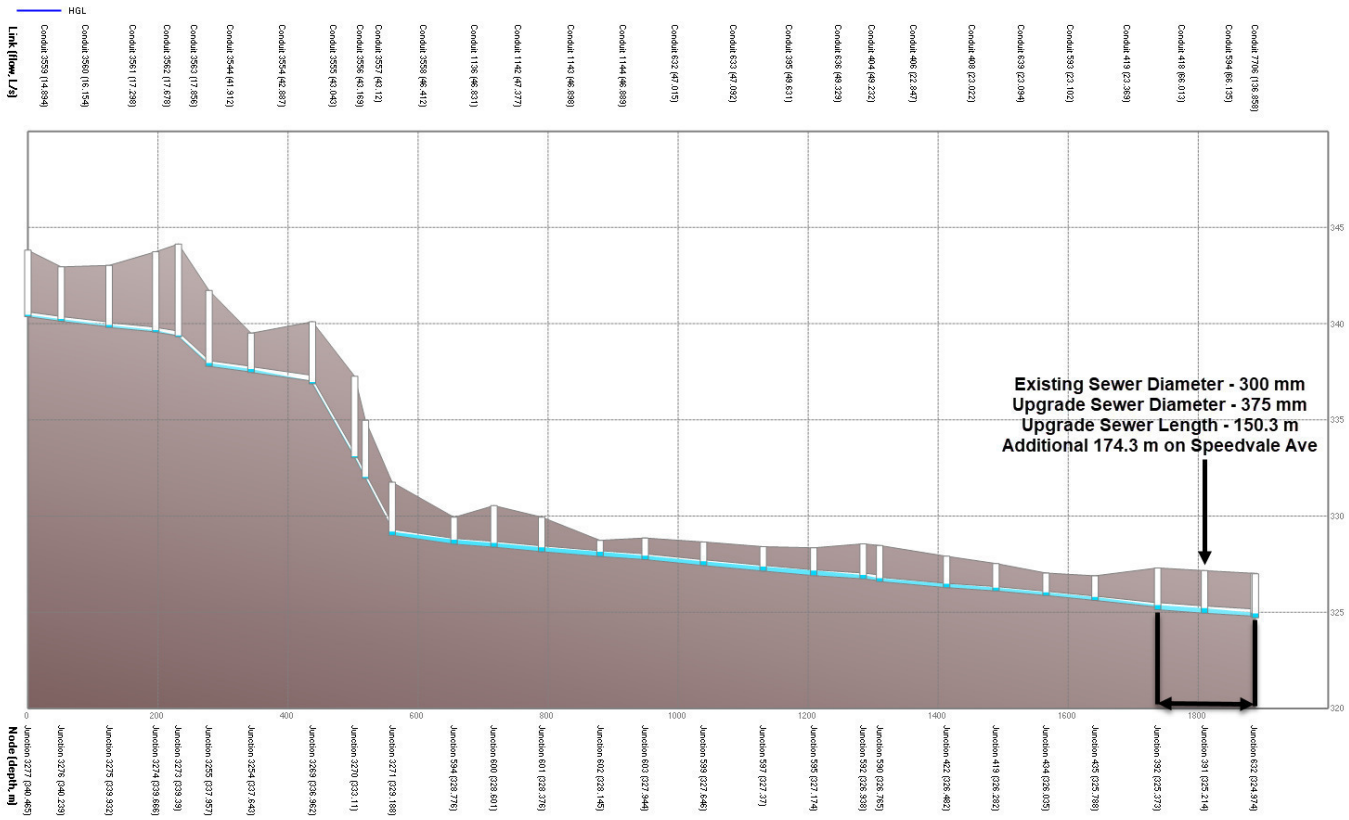


Figure 5-15 Future Conditions HGL Profile Area 2 Reach 3 (Post-Upgrade)

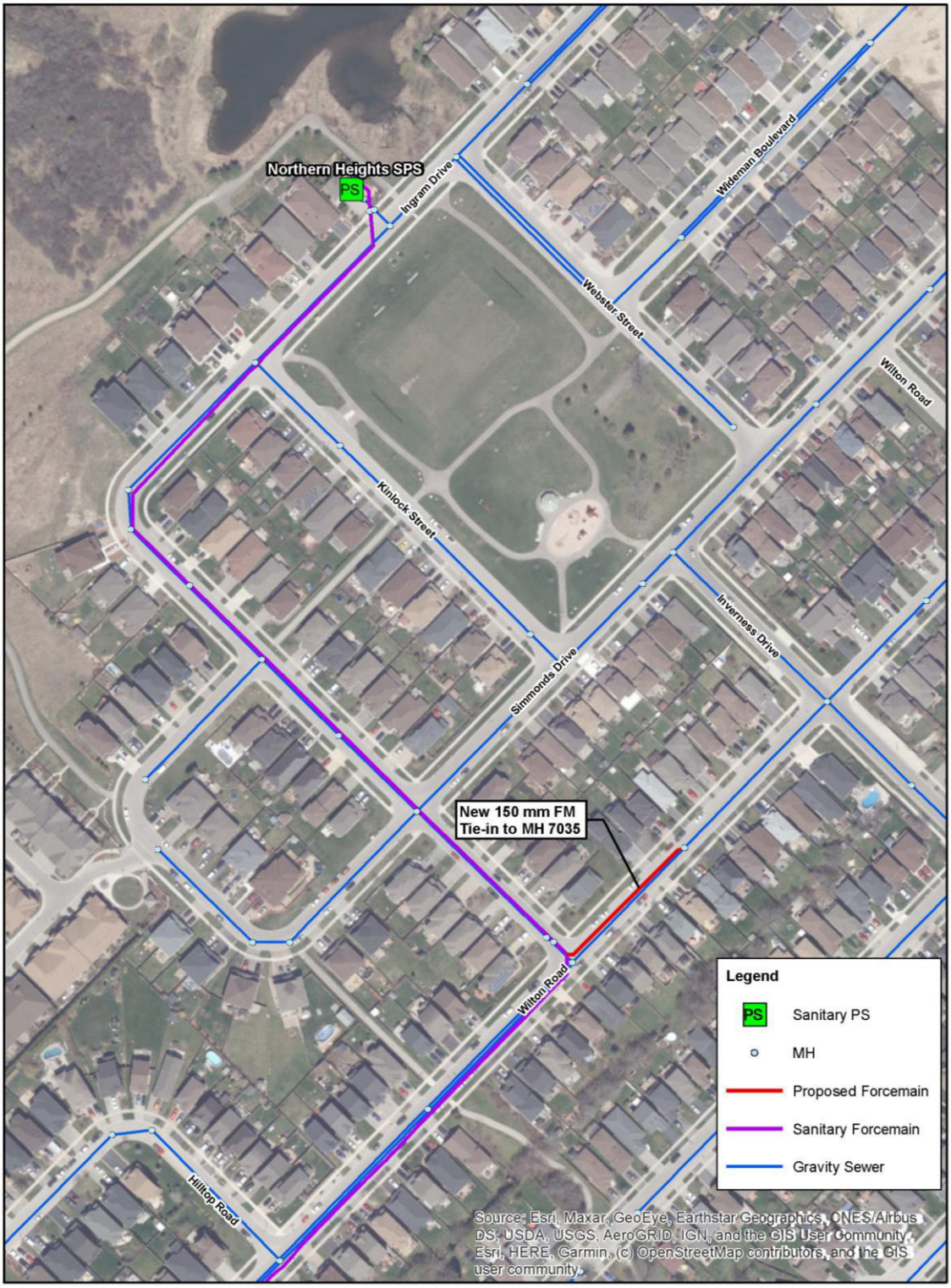


Figure 5-16 Northern Heights PS Diversion Concept

5.6.3.1 Alternative Solution - Reach 2-3

The requested alternate system improvement in this location was the installation of a new sewer south on Riverview Dr to provide new front of lot servicing for the parcels with rear-lot servicing on Riverview Dr. The existing 225 mm sewer on Kitchener Ave could be abandoned. The proposed realignment will function adequately with the other recommended improvements in this location. The interest for this alternative addition to the solution for this area are operational. The concept is shown on Figure 5-17.

Figure 5-17 Reach 2-3 Sewer Realignment

5.6.4 Reach 2-4

The fourth reach in Area 2 includes 300 mm and 375 mm sewers on Speedvale Ave E from Woolwich St to Marlborough Rd. The HGL profile under future WWF conditions is shown below on Figure 5-18. Surcharging is observed in only one MH (437) as shown below.

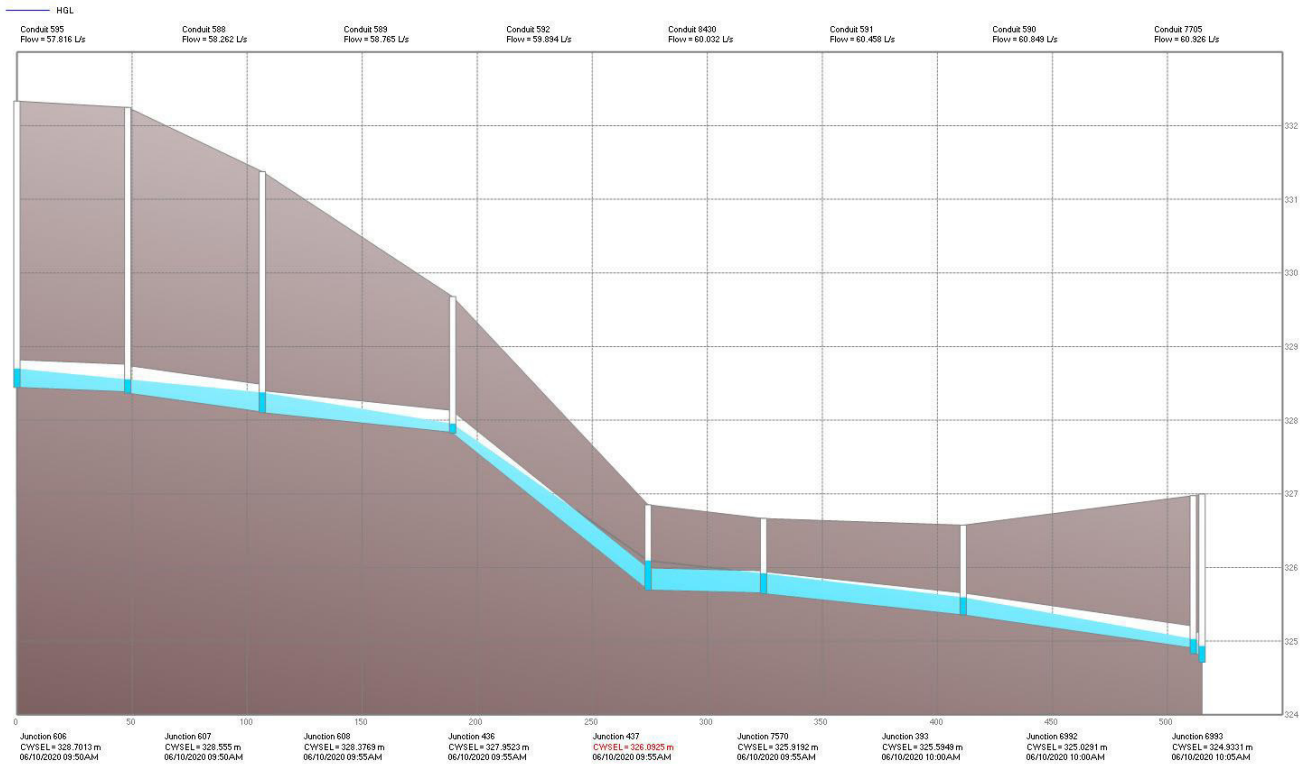


Figure 5-18 Future Conditions HGL Profile Area 2 Reach 4 (Existing Infrastructure)

Gravity sewer replacement in conjunction with an adjustment to the sewer slope was selected as the improvement option in this location. Replacing the undersized 300 mm sewers with 375 mm while also adjusting the slopes to 0.33% provides sufficient capacity to eliminate surcharging, as shown on Figure 5-19.

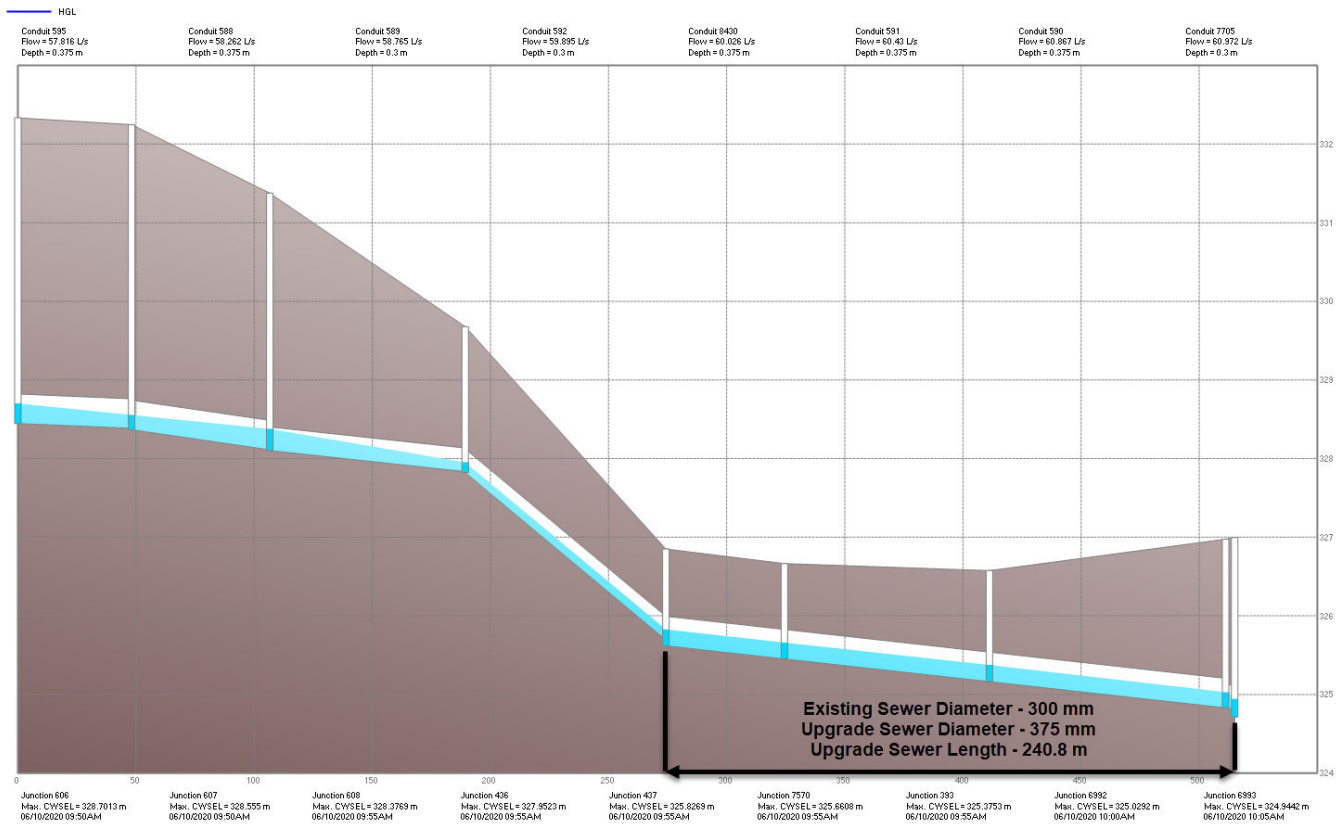


Figure 5-19 Future Conditions HGL Profile Area 2 Reach 4 (Post Upgrade)

5.7 Area 3 System Improvements

The third location, noted as Area 3 on Figure 5-1 is a reach of 375 mm sewers from Division Street to London Road W along Kathleen Street. The HGL profile under future WWF conditions is shown below on Figure 5-20.

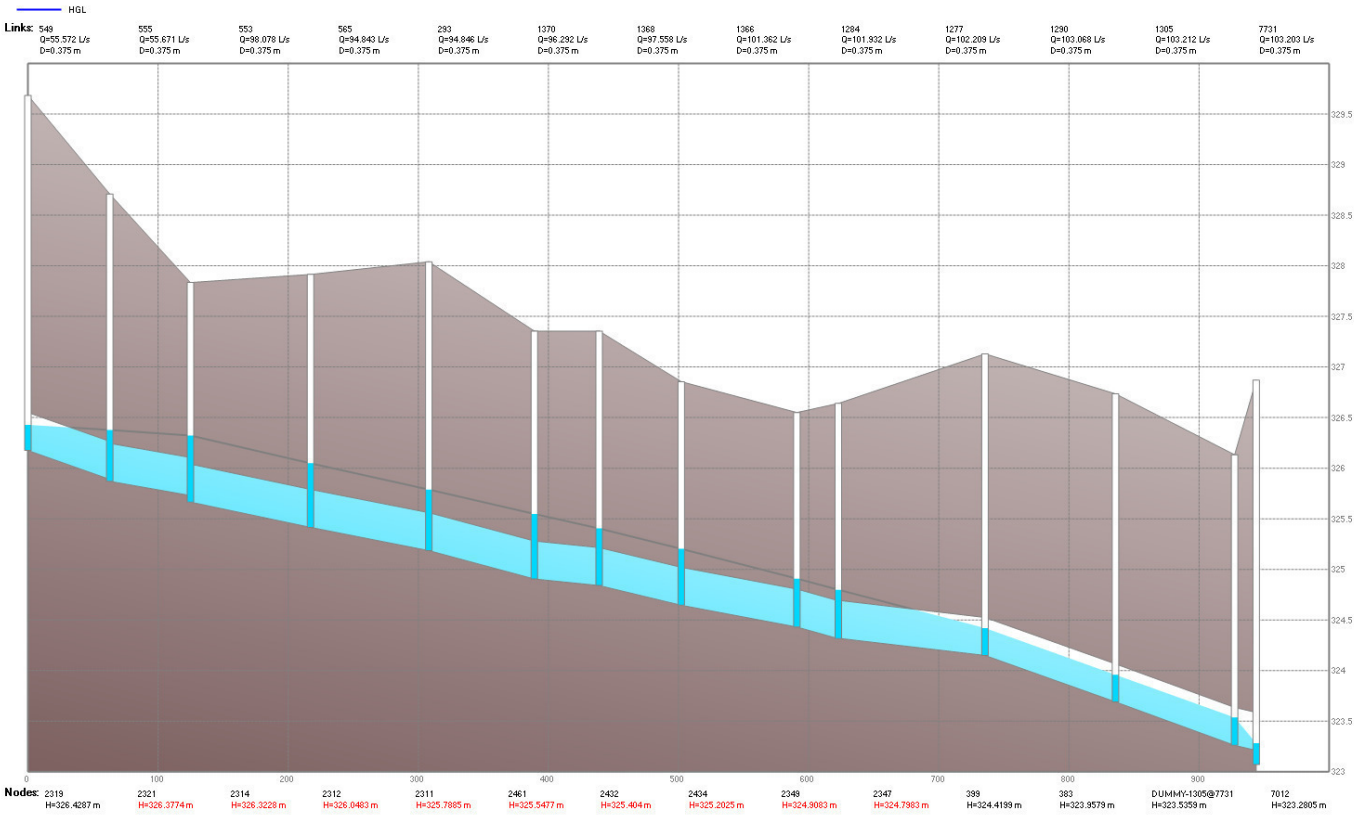


Figure 5-20 Future Conditions HGL Profile Area 3 Reach 1 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 375 mm sewers with 450 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-21. In order to meet City engineering standards and avoid sewer diameter decreasing, three sewers at the end of the reach require replacement even though they have sufficient capacity.

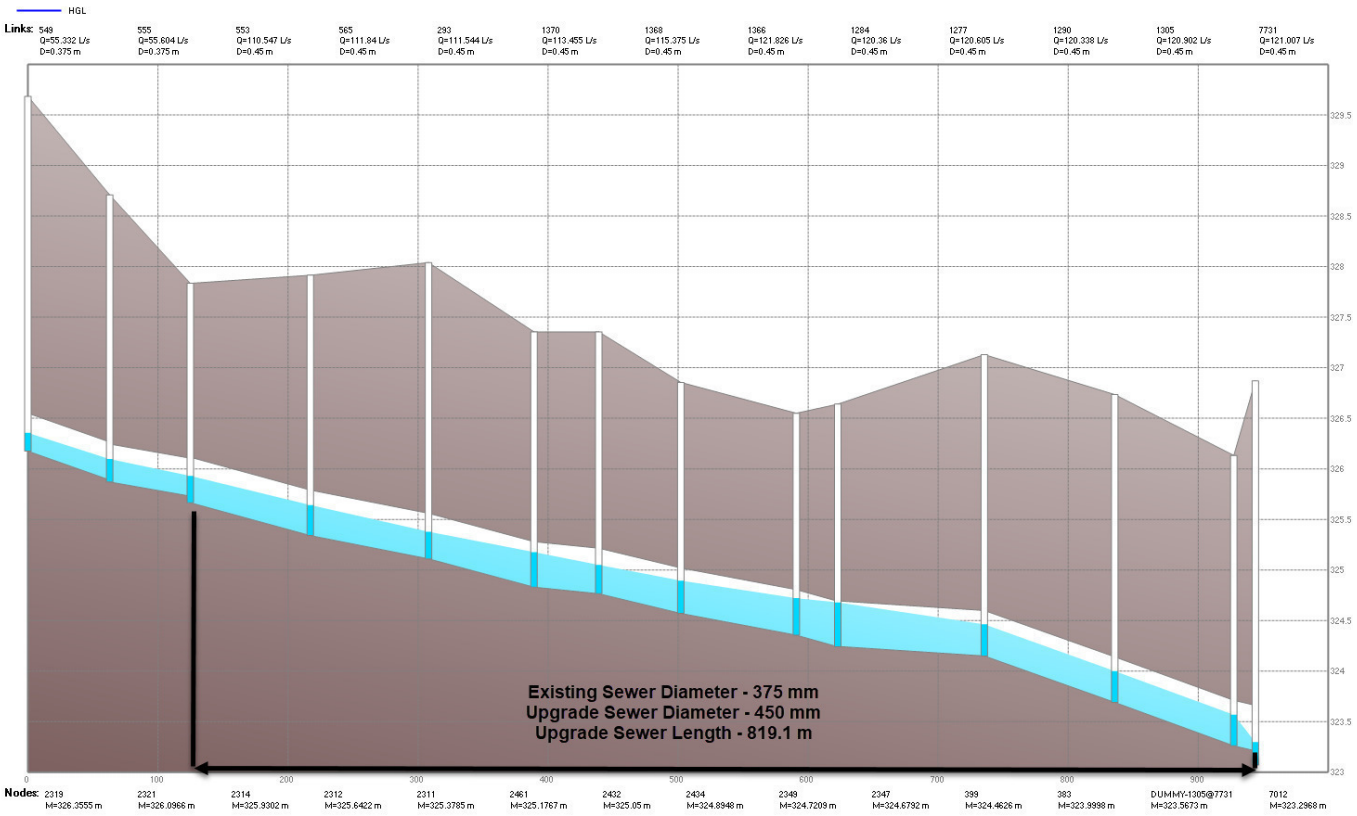


Figure 5-21 Future Conditions HGL Profile Area 3 Reach 1 (Post-Upgrade)

5.7.1.1 Alternative Solution - Reach 3-1

The requested change to the system improvement in this location was the realignment of sewers from the easements through Exhibition Park, and reroute flow south on Exhibition St and London Rd. The intent is to provide the necessary capacity upgrades will also eliminating sewers in the easements through the park. This would require new 450 mm sewers from the intersection of Division St and Exhibition St to London Rd and Kathleen St, as shown below on Figure 5-22. The post-upgrade HGL profile is shown on Figure 5-23. An alternate to this alignment would be to follow Division Street southwest, then southeast along Kathleen Street to London Road. The exact configuration should be determined through more detailed pre-design in this area.

Figure 5-22 Reach 3-1 Sewer Realignment

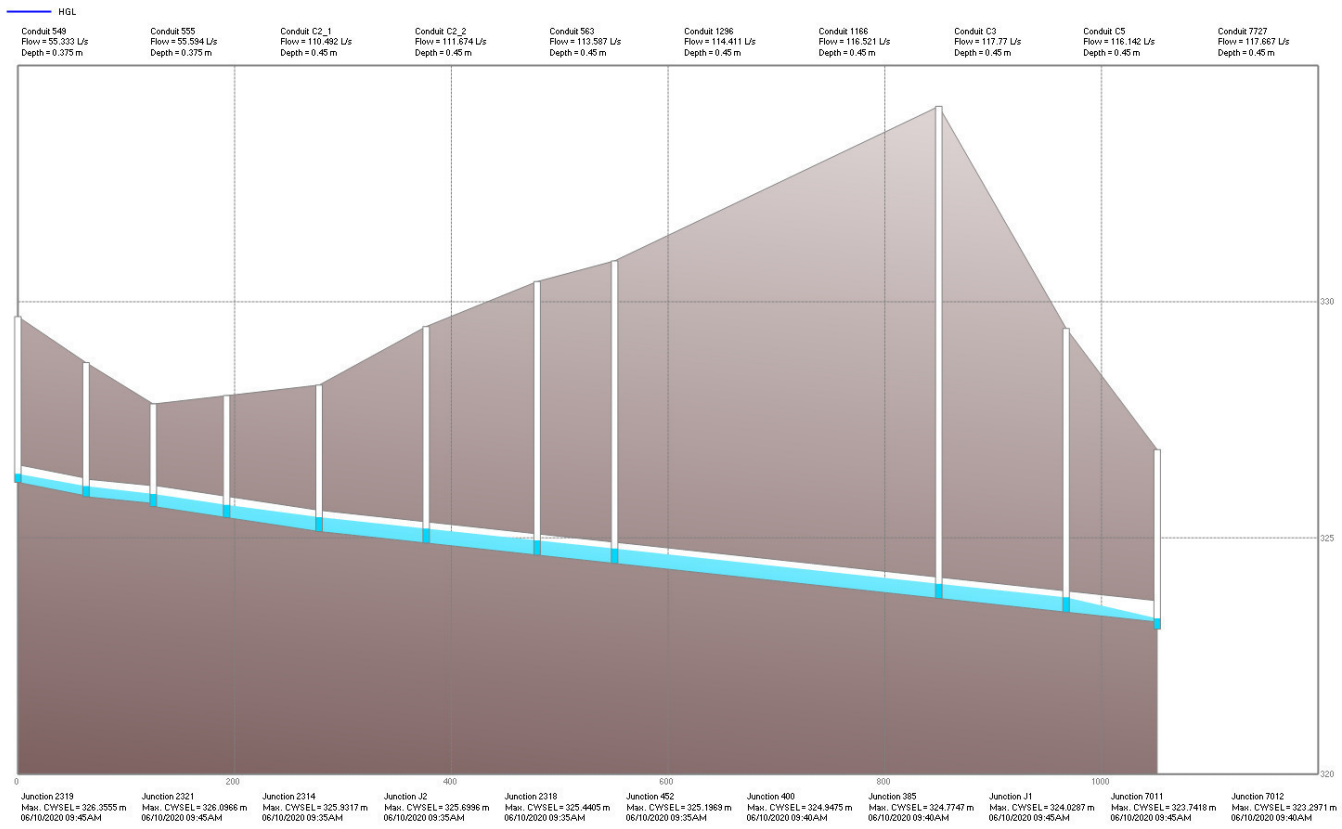


Figure 5-23 Future Conditions HGL Profile Area 3 Reach 1 (Alternate Post-Upgrade)

This proposed improvement does provide sufficient capacity to address surcharging and has the added benefit of facilitating the removal of sewers in easements. It does result in some deep sewers with depths up to 10 m.

5.8 Area 4 System Improvements

The fourth location, noted as Area 4 on Figure 5-1 includes multiple reaches of sewers in the eastern part of the City.

5.8.1 Reach 4-1

The first reach includes sewers with diameters ranging from 200 mm to 350 mm, from Eastview Road to Victoria Road. The HGL profile under future WWF conditions is shown on Figure 5-24 below.

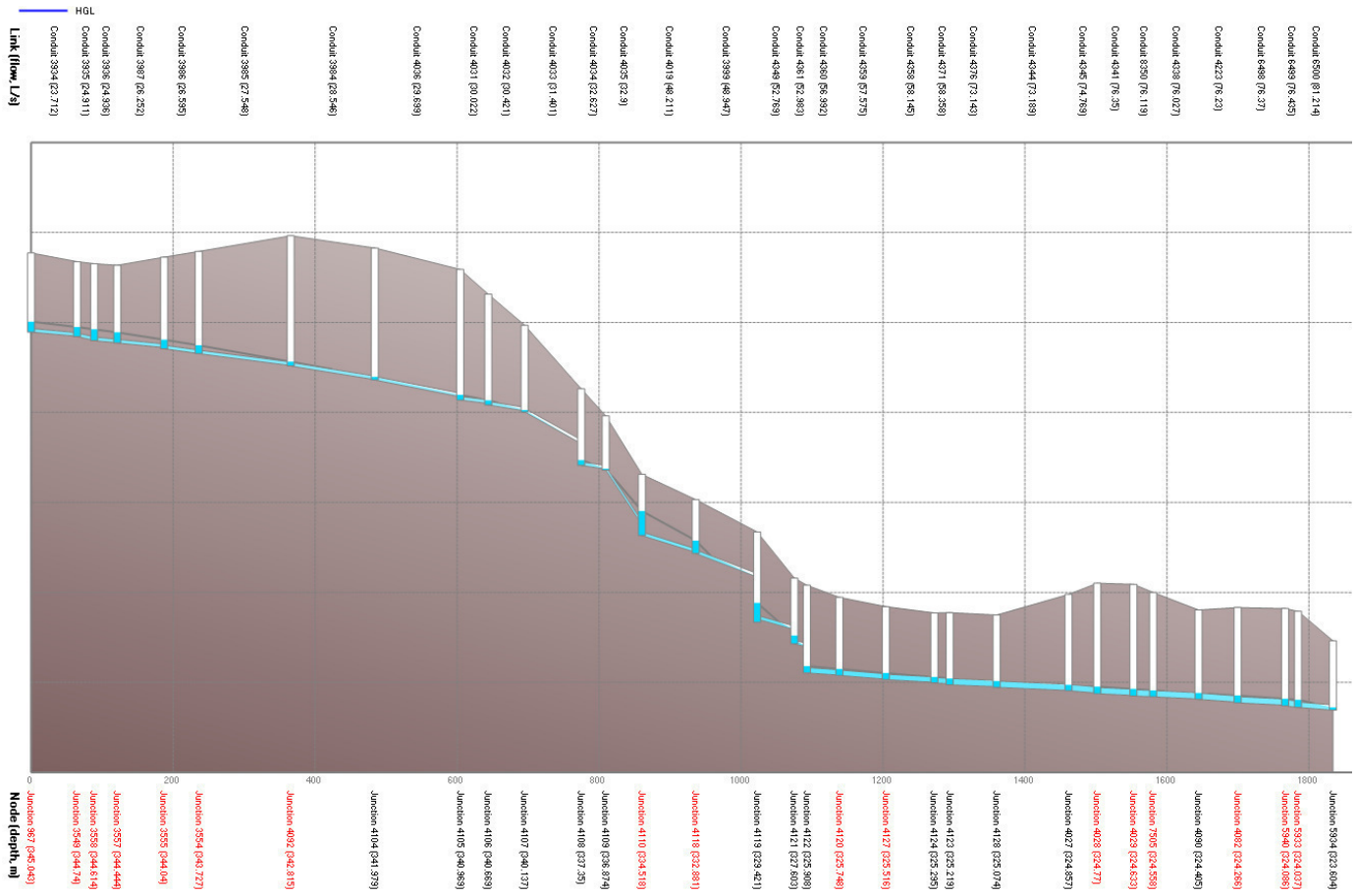


Figure 5-24 Future Conditions HGL Profile Area 4 Reach 1 (Existing Infrastructure)

Sewer replacement was reviewed at this location for feasibility. Given the extent of surcharge observed and the relatively small diameter and small flow causing the surcharge, an alternate approach to sewer replacement was considered. Residual capacity in the sewer system upstream of this location was identified therefore a full flow diversion of the Landfill Site on Eastview PS flow upstream of this location was explored. Diverting the flow away from the receiving trunk via a new connection to an alternate gravity sewer allows use of residual capacity in existing infrastructure and eliminates most of the surcharge. Two 200 mm sewers and one 300 mm sewer require replacement with 300 mm and 375 mm following this approach (Figure 5-26). Four additional 300 mm sewers require replacement with 375 mm in order to meet the City's engineering design standards. The point of diversion is at the intersection of Eastview Rd and Starwood Dr, as shown on Figure 5-25. Without the diversion in place, an additional 885.5 m of 200 mm sewers, 250 m of 300 mm sewers, and 432 m of 350 mm sewers would require replacement to address the surcharging.

Figure 5-25 Easview Road PS Diversion Concept

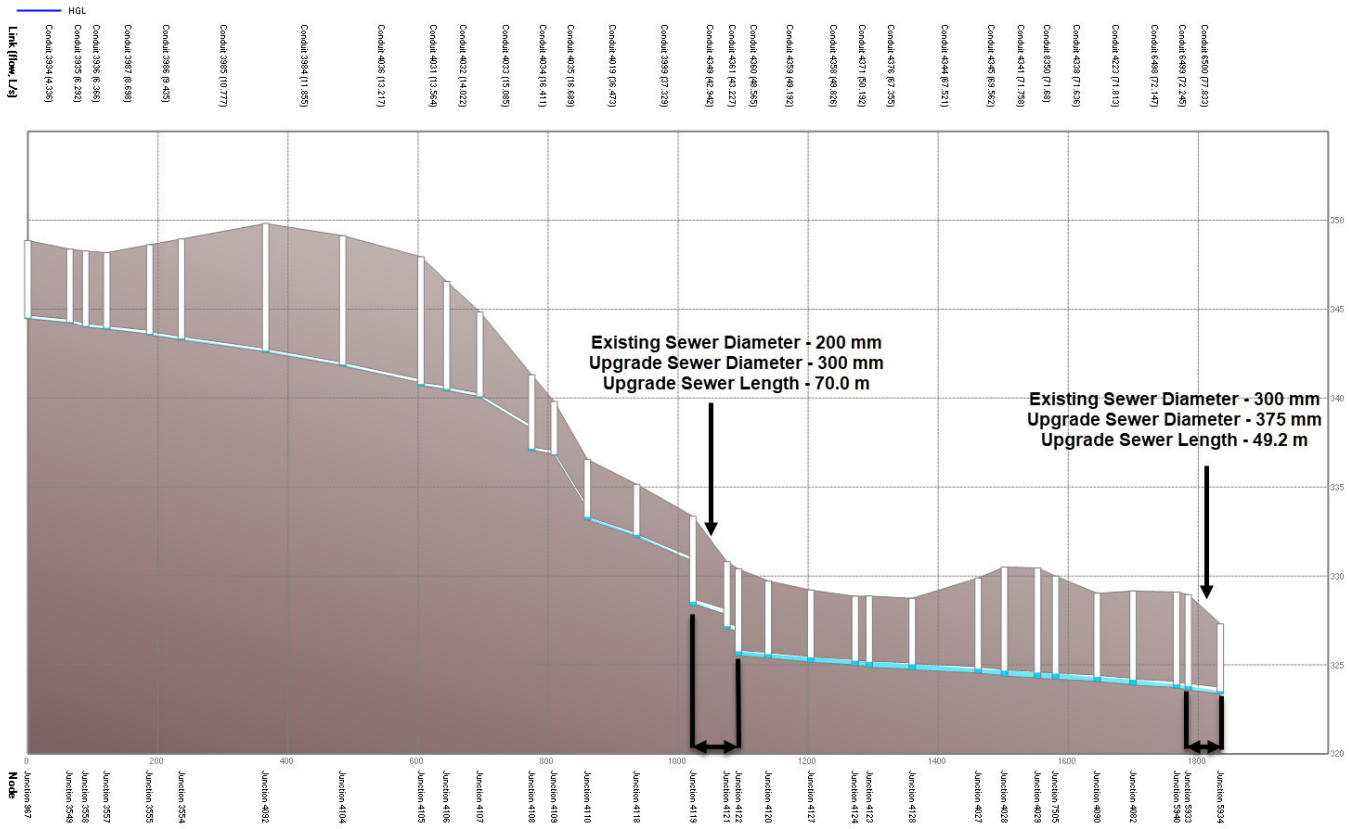


Figure 5-26 Future Conditions HGL Profile Area 4 Reach 1 (Post Upgrade)

5.8.2 Reach 4-2

The second reach in Area 4 includes 675 mm sewers along York Rd and Beaumont Cres. The HGL profile under future WWF conditions is shown below on Figure 5-27.

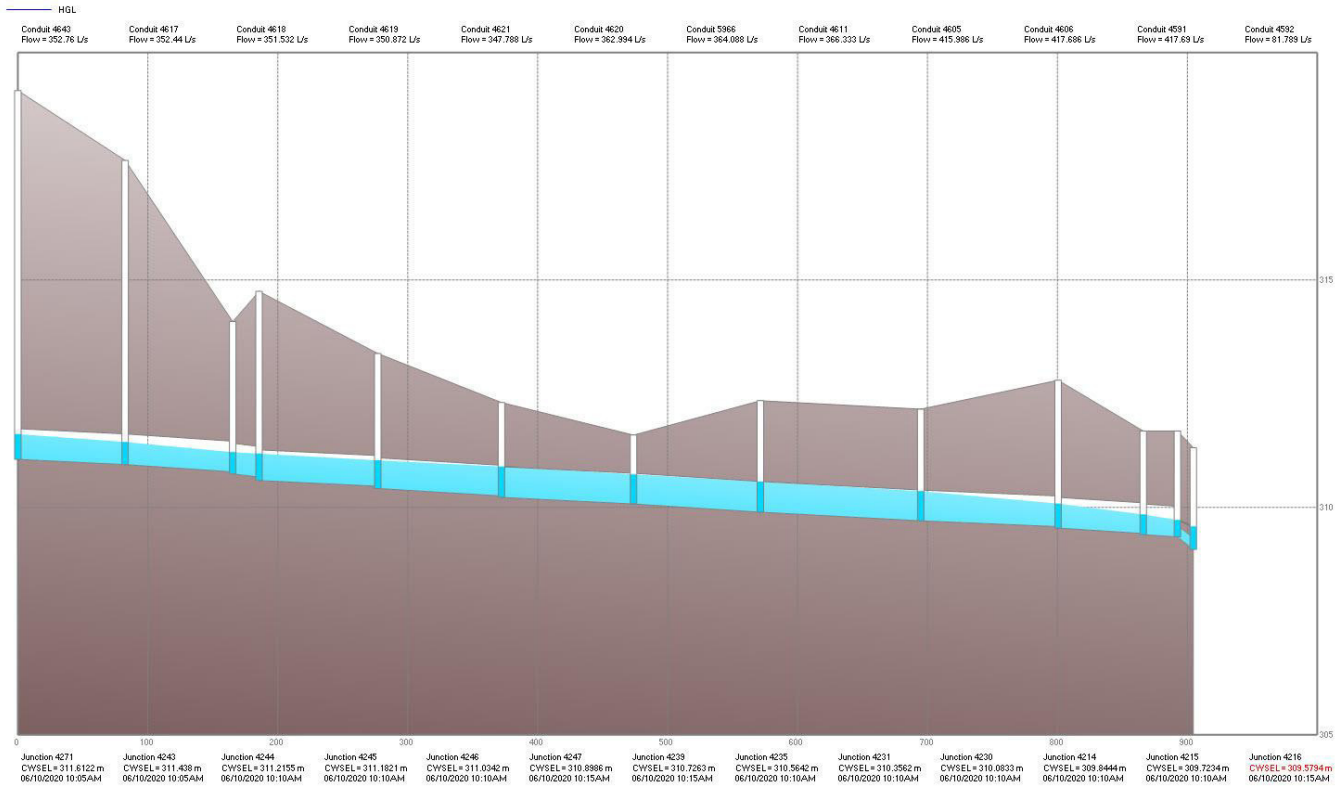


Figure 5-27 Future Conditions HGL Profile Area 4 Reach 2 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 675 mm sewers with 750 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-28. The surcharging in this location was minor however given the relative shallowness of the MHs in this location a system upgrade was recommended.

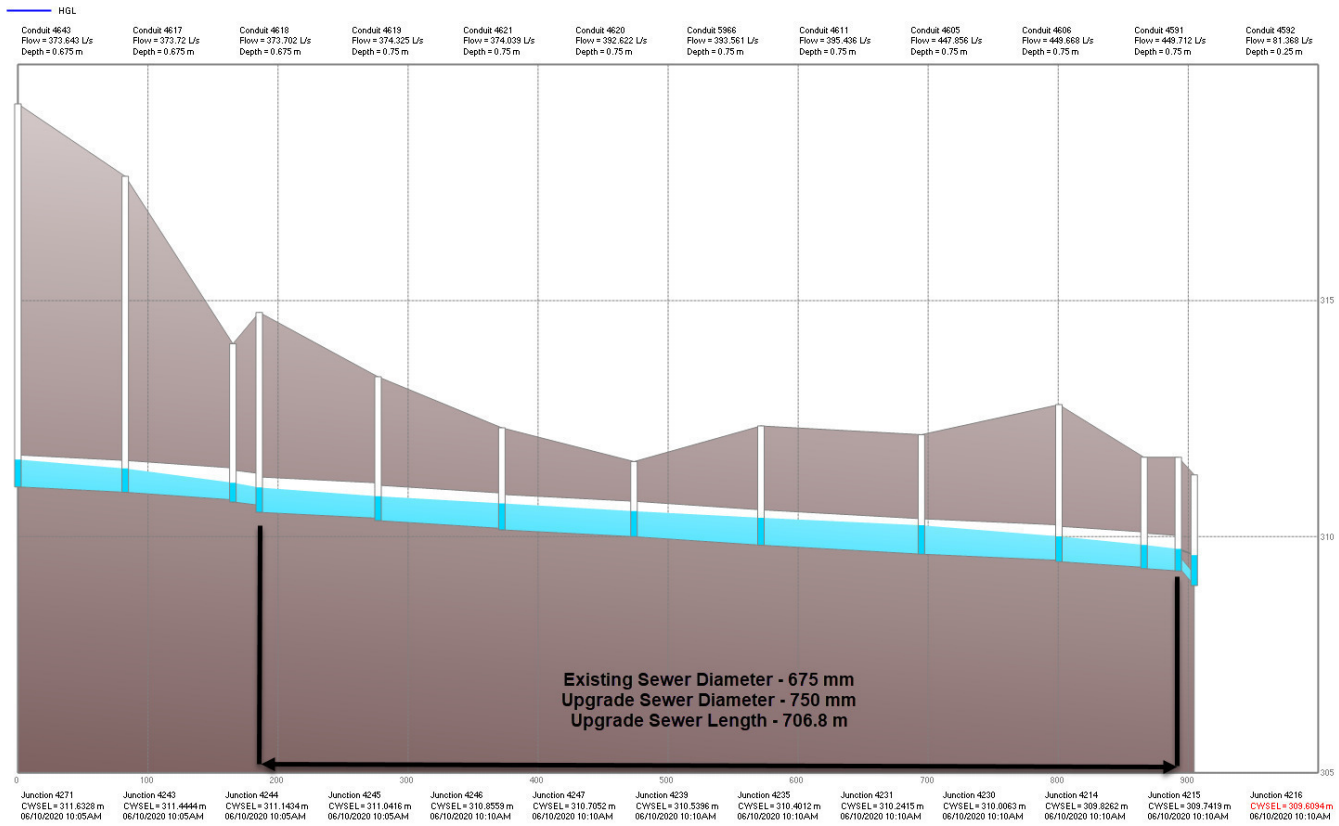


Figure 5-28 Future Conditions HGL Profile Area 4 Reach 2 (Post-Upgrade)

5.8.3 Alternative Solution - Reach 4-2

The alternate system improvement in this location is the construction of a new 675 mm and 900 mm trunk along York Rd and Victoria Rd. The intent is to provide the necessary capacity upgrades while also eliminating the easements of the existing alignments. The City is currently working on designs for York Rd Phase 4 so this provides an opportunity to take advantage of the timing of this work. Plan and profile views of the proposed realignment are shown below on Figure 5-29 and Figure 5-30.

Figure 5-29 Reach 4-2 Sewer Realignment

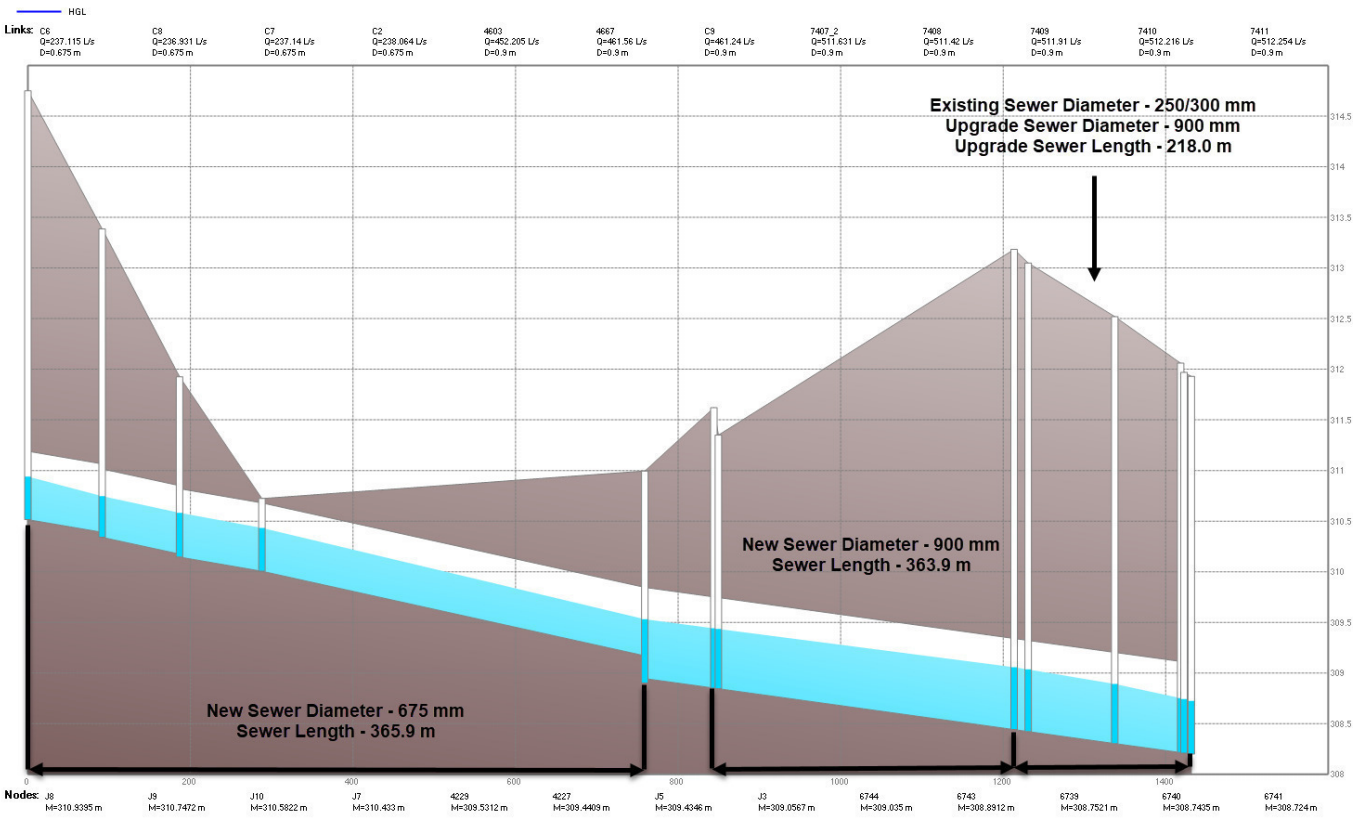


Figure 5-30 Future Conditions HGL Profile Area 4 Reach 2 (Alternate Post-Upgrade)

As shown in the profile above, there is potential grade/surface cover issue with this alignment. Additional topographic and SUE analysis is required to confirm if this is feasible through subsequent study.

5.8.4 Reach 4-3

The third reach in Area 4 includes 375 mm and 600 mm sewers along Stevenson St S. The HGL profile under future WWF conditions is shown below on Figure 5-31. Surcharging is observed in only one MH. This location also sees benefit from the diversion of the Landfill Site on Eastview PS. System improvements are not recommended at this location. The HGL profile under post-Improvement conditions is shown on Figure 5-32.

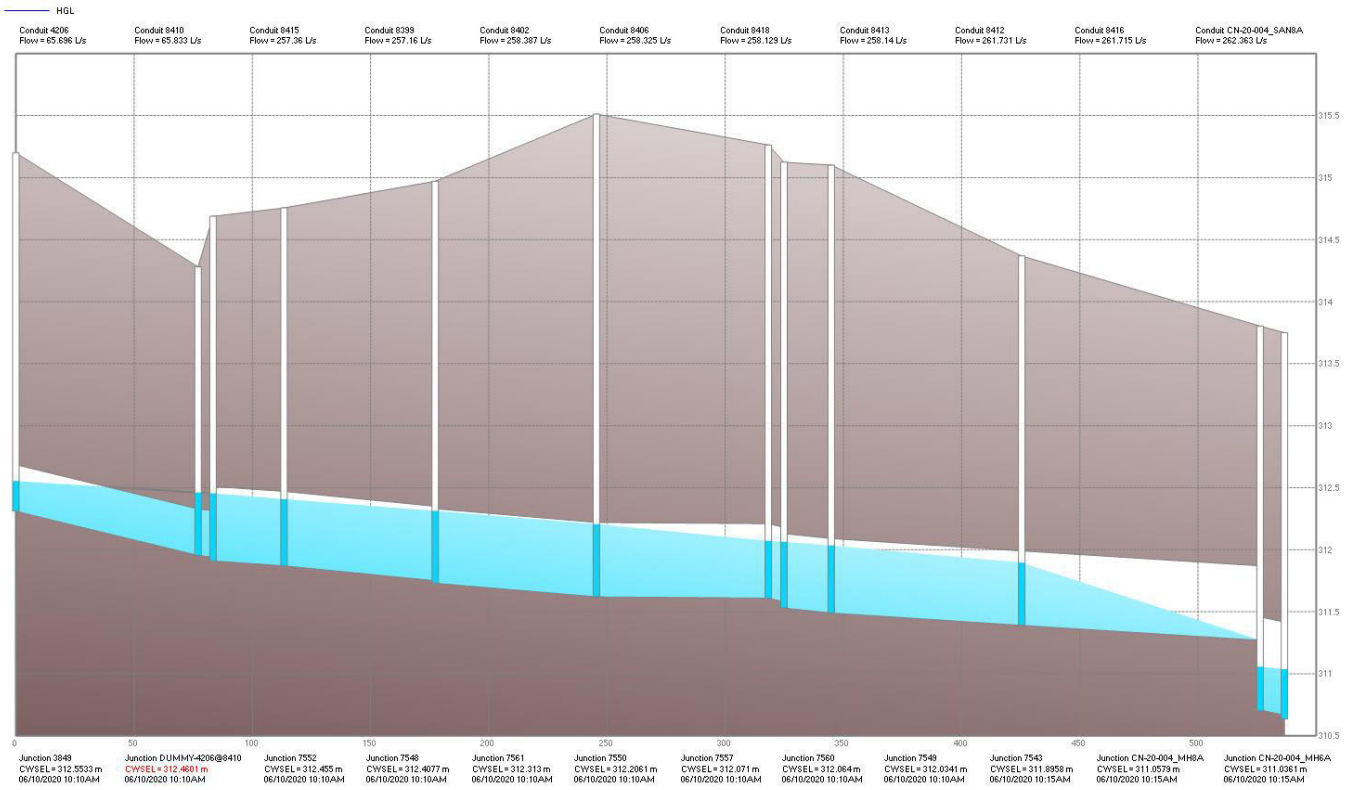


Figure 5-31 Future Conditions HGL Profile Area 4 Reach 3 (Existing Infrastructure)

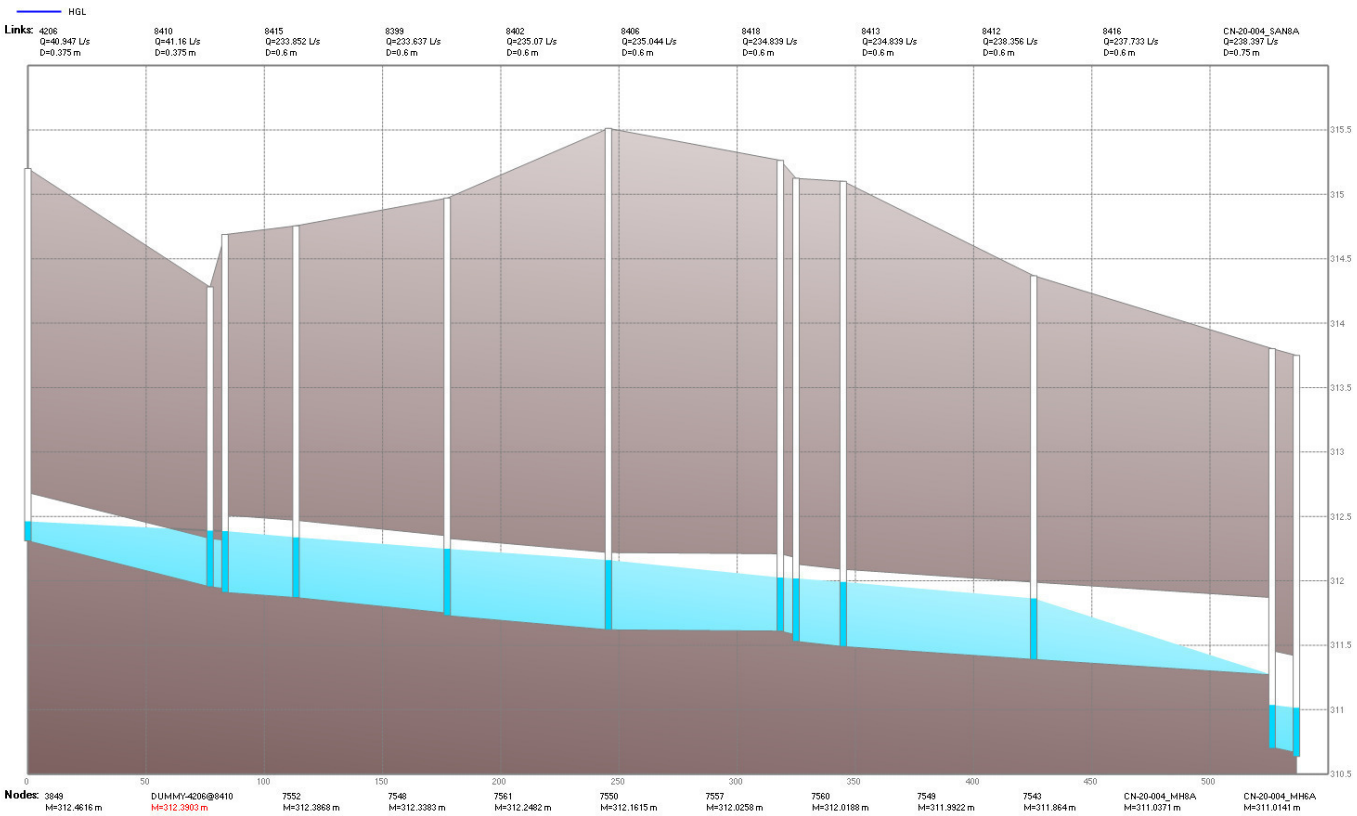


Figure 5-32 Future Conditions HGL Profile Area 4 Reach 3 (Post-Upgrade)

5.8.5 Reach 4-4

The fourth location in Area 4 includes 225 mm and 300 mm sewers on Victoria Rd S. The HGL profile under future WWF conditions is shown below on Figure 5-33.

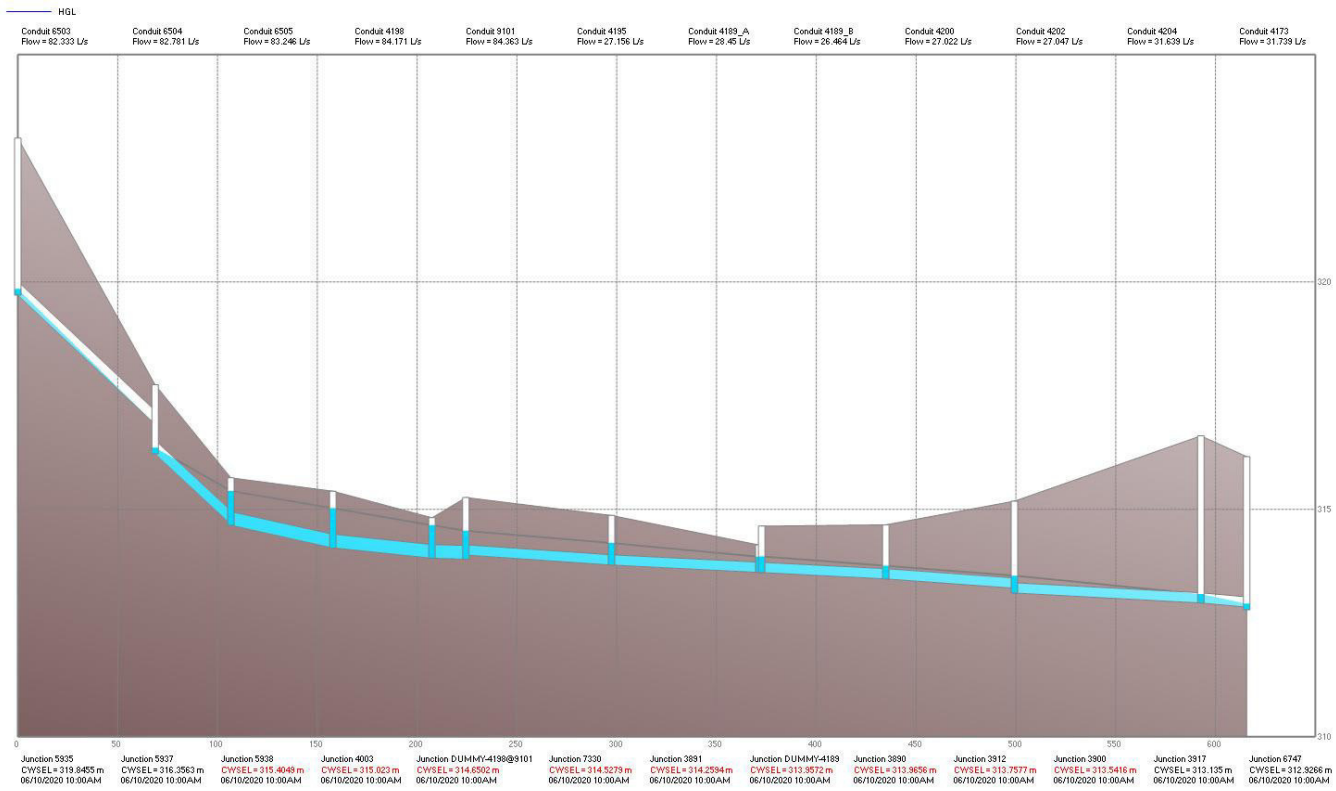


Figure 5-33 Future Conditions HGL Profile Area 4 Reach 4 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 300mm and 225mm sewers with 375mm and 300mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-34. This reach is downstream of 4-1, which requires upgrading to 375 mm sewers. In order to meet the City's engineering standards, all sewers would require upgrading with 375 mm sewers to match diameters.

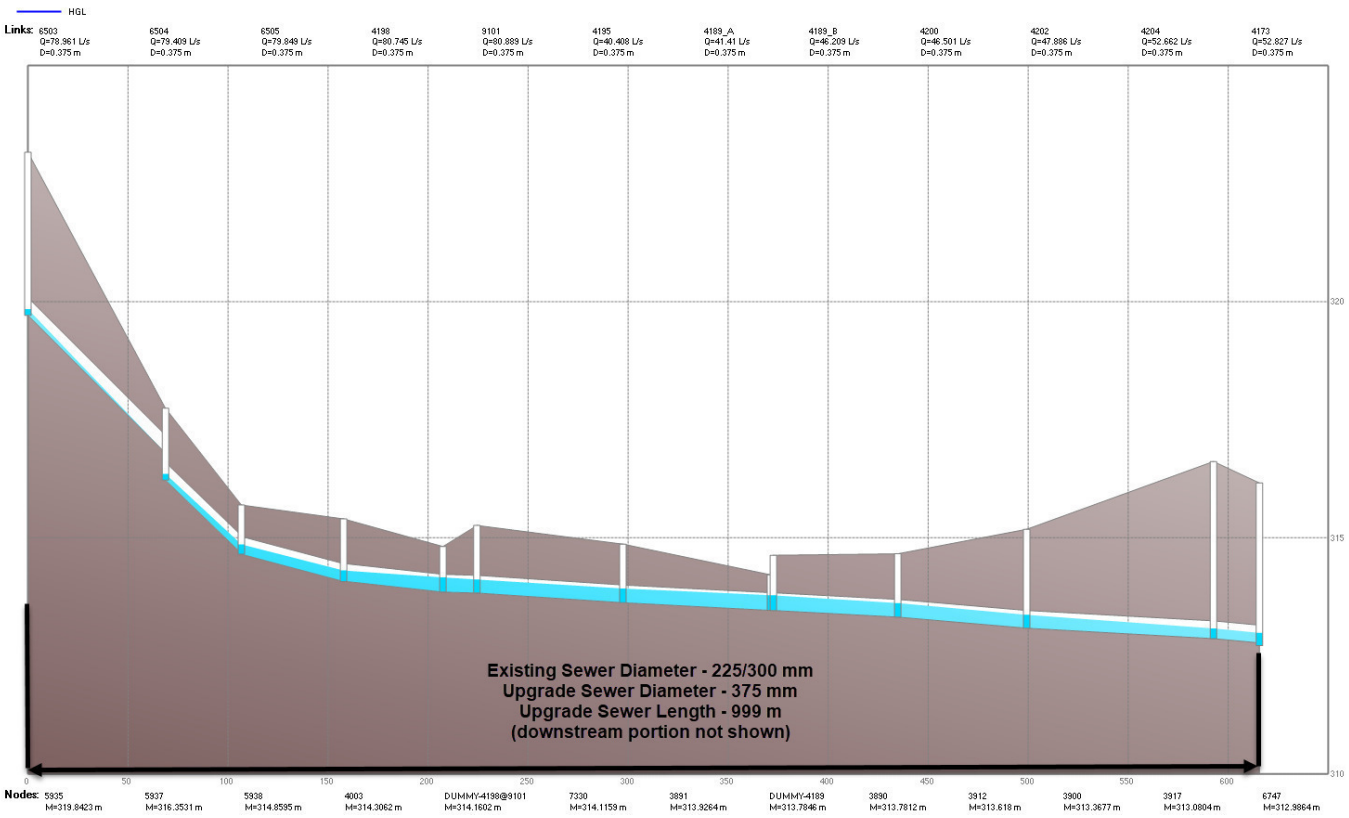


Figure 5-34 Future Conditions HGL Profile Area 4 Reach 4 (Post-Upgrade)

5.8.6 Reach 4-5

The fifth location in Area 4 includes 200 mm sewers on Creighton Ave and Summit Ridge Dr. The HGL profile under future WWF conditions is shown below on Figure 5-35.

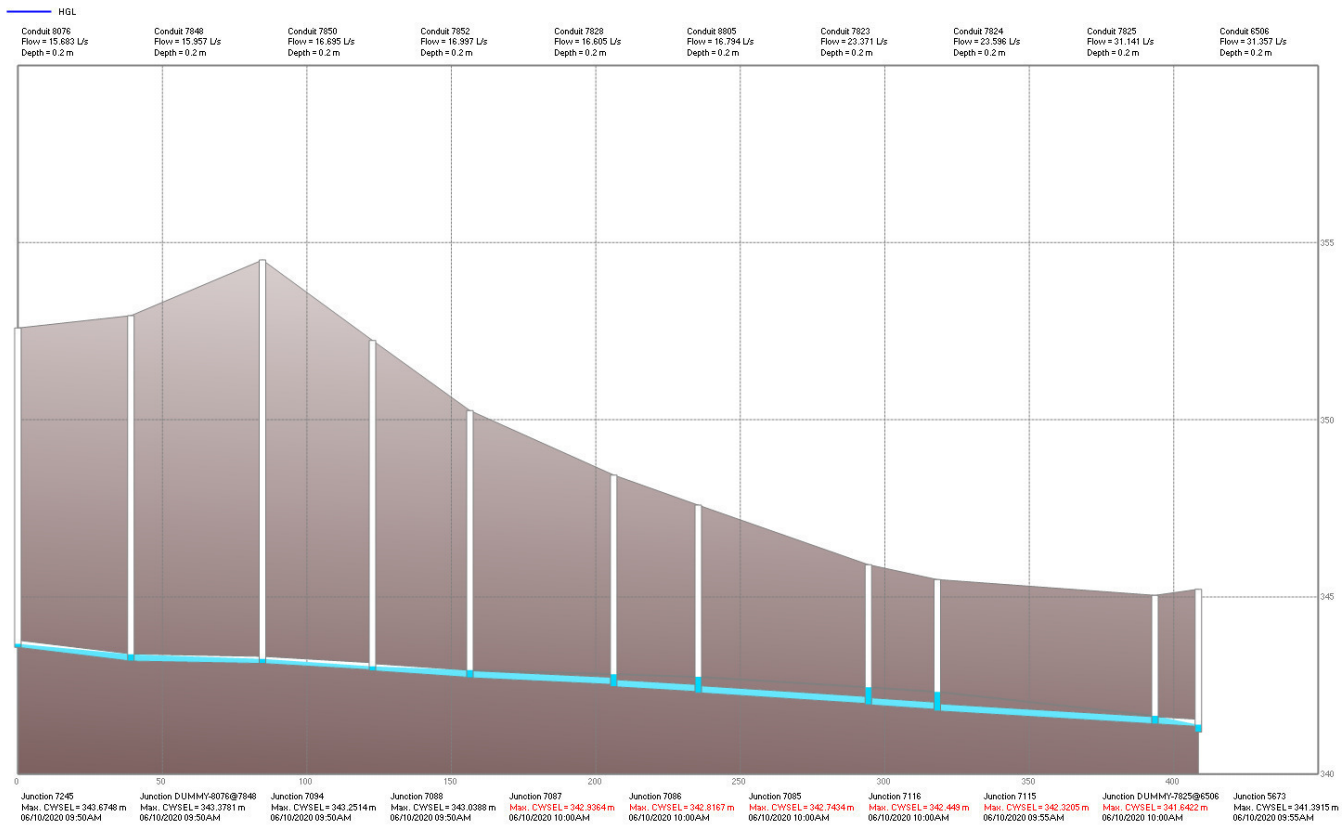


Figure 5-35 Future Conditions HGL Profile Area 4 Reach 5 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 200 mm sewers with 300 mm provides sufficient capacity and eliminates the surcharge at this location.

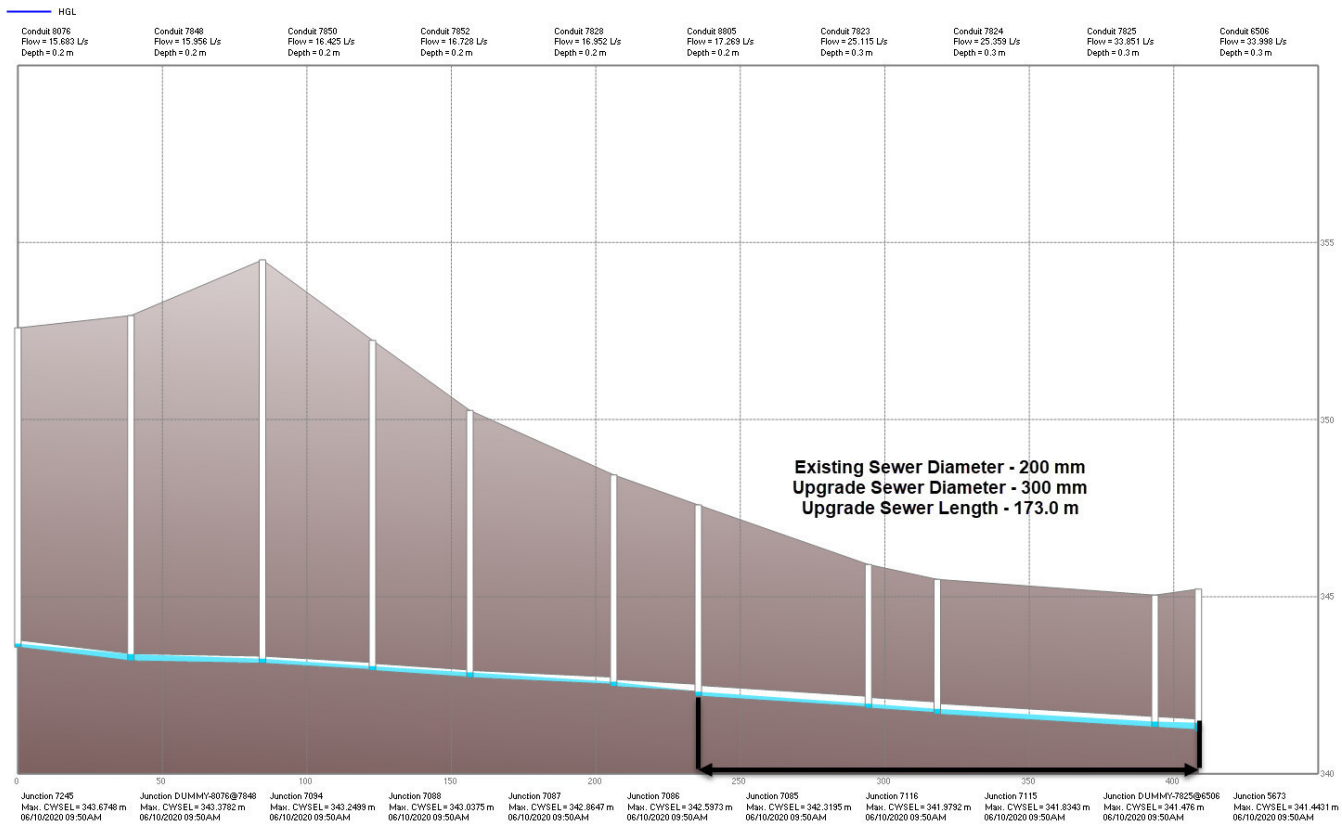


Figure 5-36 Future Conditions HGL Profile Area 4 Reach 5 (Post-Upgrade)

5.9 Area 5 System Improvements

The fifth location, noted as Area 5 on Figure 5-1 includes multiple reaches in the City Centre.

5.9.1 Reach 5-1

The first reach includes sewers ranging in diameter from 1050 mm to 1350 mm, along the Eramosa River and Wellington Street, from Boult Avenue to the Hanlon Expressway. The HGL profile under future WWF conditions is shown below on Figure 5-37.

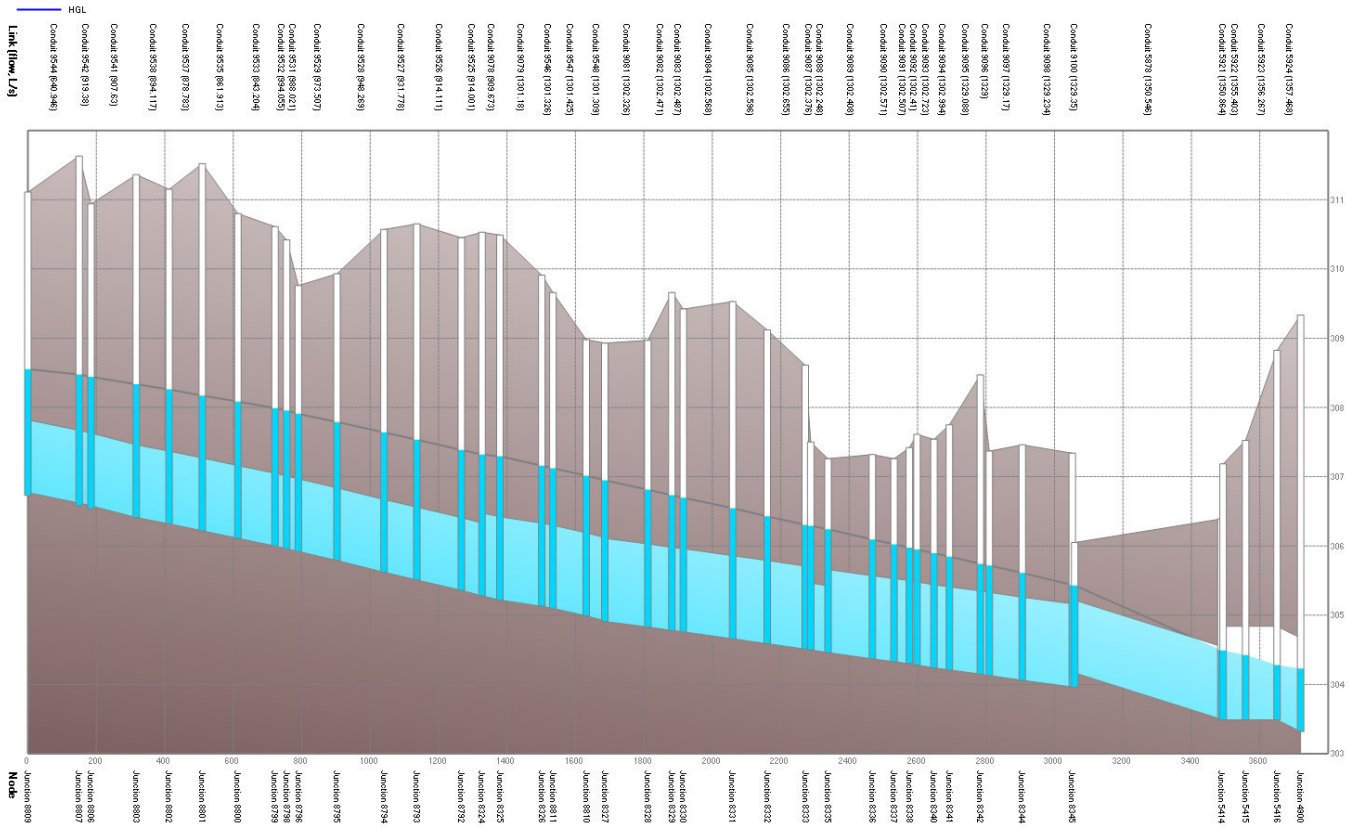


Figure 5-37 Future Conditions HGL Profile Area 5 Reach 1 (Existing Infrastructure)

This stretch of sanitary sewers was also previously identified by the Stormwater Master Plan team as exposed sanitary sewer at certain stormwater outlet discharge points to the Eramosa River. It is understood that the City completed emergency repairs at these locations in 2020/2021. These repairs were considered short- or medium-term solutions, with the Wastewater component of this Master Plan to address the long-term solution. The City's ongoing Stormwater Master Plan identified exposed sanitary sewer trunks crossing watercourses. One of these sewers is an existing 1050 mm trunk along Wellington Rd near the Hanlon Expressway, located as shown on Figure 5-38.

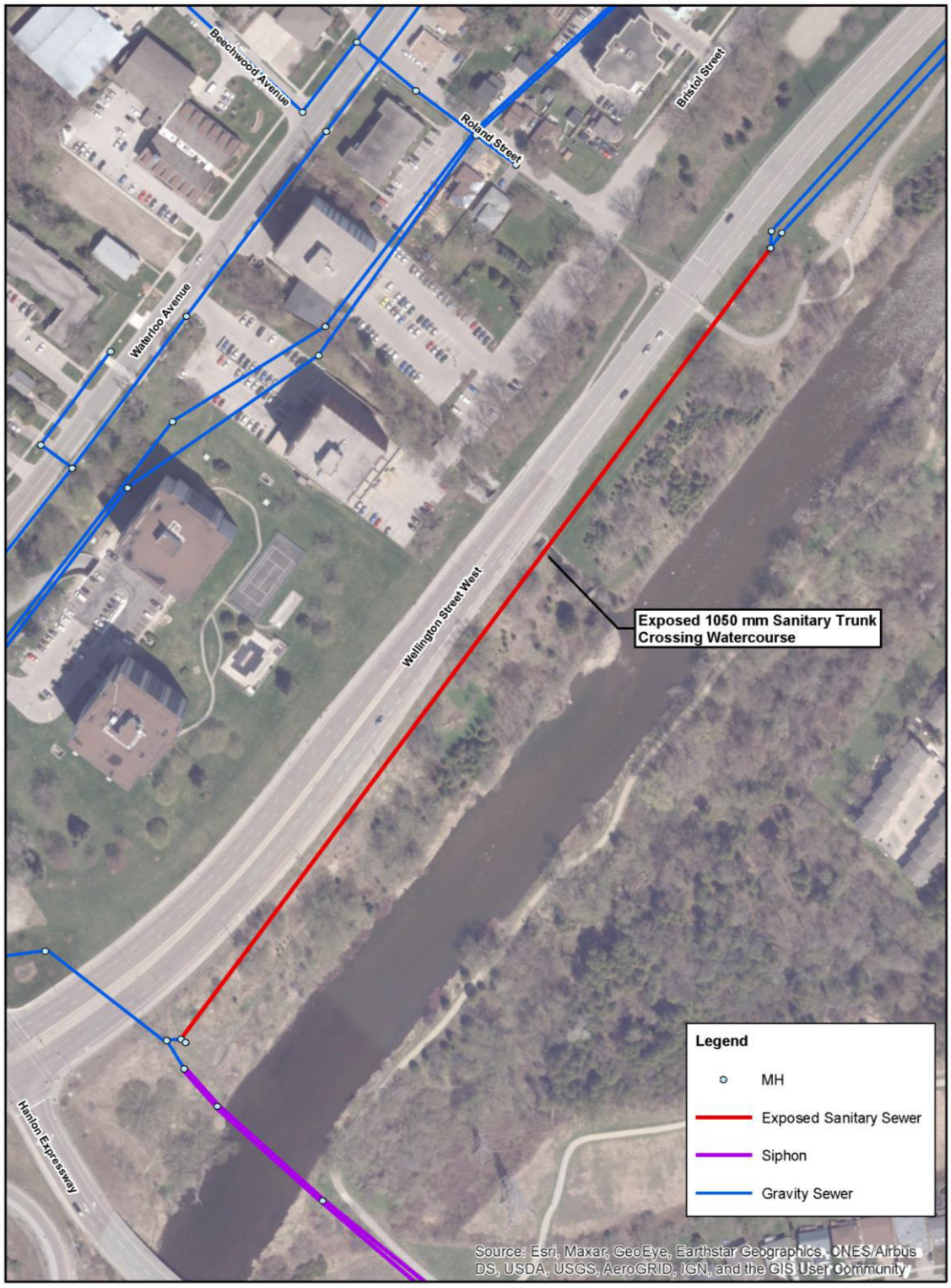


Figure 5-38 Exposed Sanitary Trunk

It is understood that the City has undertaken remediation activities to stabilize the sewer to mitigate/minimize the risk of deterioration of this sewer, however a permanent solution must be developed. One option is to lower the

sewer by approximately 2 m, which will provide 1.0 m of cover over the currently exposed sewer and reduce the probability and impact of failure.

Our subsequent review of this location included considerations for diverting portions of the flows to new infrastructure that could act as a wet weather relief in lieu of costly repairs to the large trunk sewers. The feasibility for options along this stretch of trunk sewers should consider:

- The 2020/2021 emergency repairs were structural in nature and focused on the retaining walls. The sewers themselves were considered in good condition. Is this satisfactory to the City as a long-term solution for this stretch of sewer? If yes, then exploring a wet-weather relief option may be of interest.
    - If no, then replacing and lowering the sewer by ~2 m will be the preferred approach for this area.

Based on the 2020/2021 exchanges between the City, the Stormwater MP, and the Wastewater MP teams, it is assumed that upsizing and lowering of this sewer is preferred. Replacing the undersized 1200 mm and 1050 mm sewers with 1200 mm and 1350 mm sewers, provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-39.

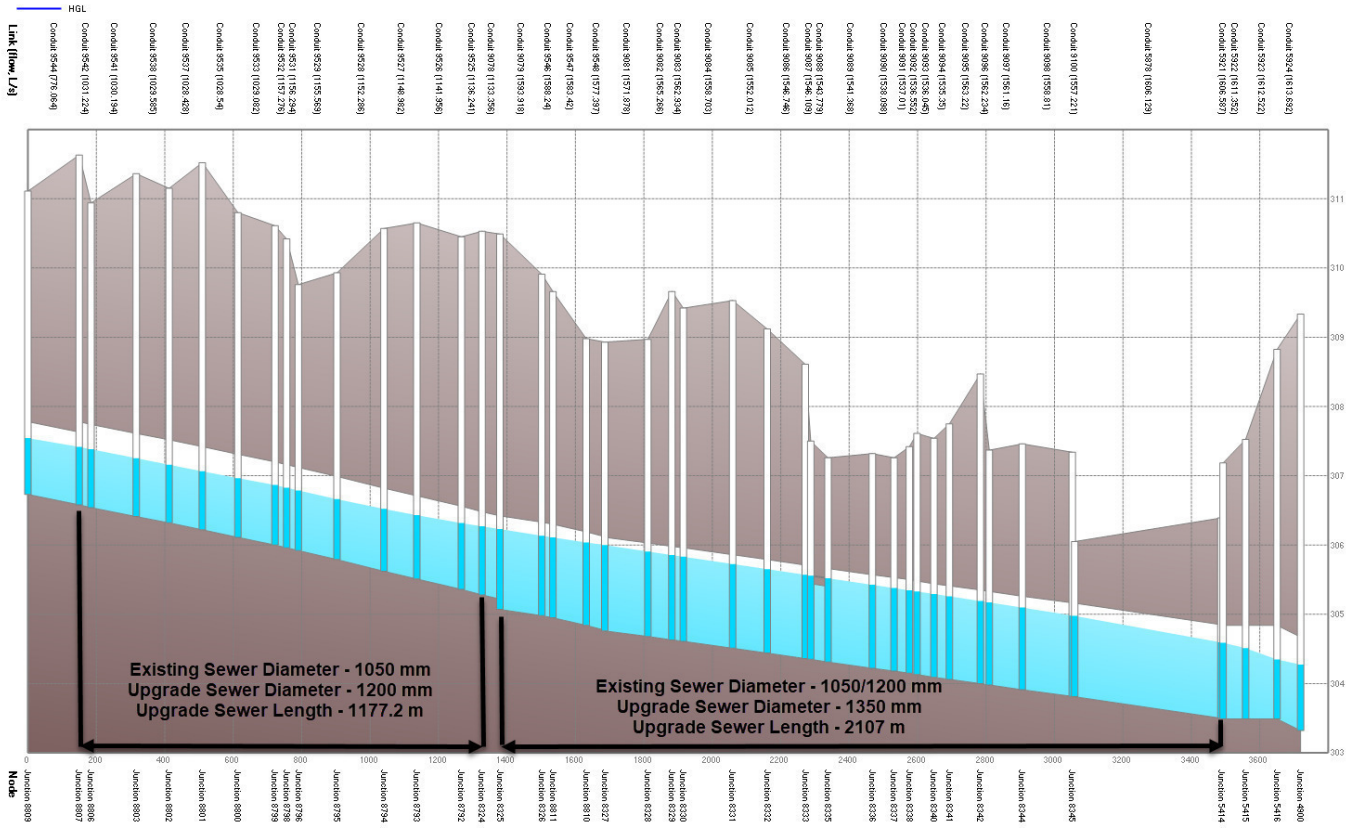


Figure 5-39 Future Conditions HGL Profile Area 5 Reach 1 (Post-Upgrade)

5.9.2 Reach 5-2

The second reach in Area 5 includes 750 mm diameter sewers between Bristol St and Waterloo Ave. The HGL profile under future WWF conditions is shown below on Figure 5-40.

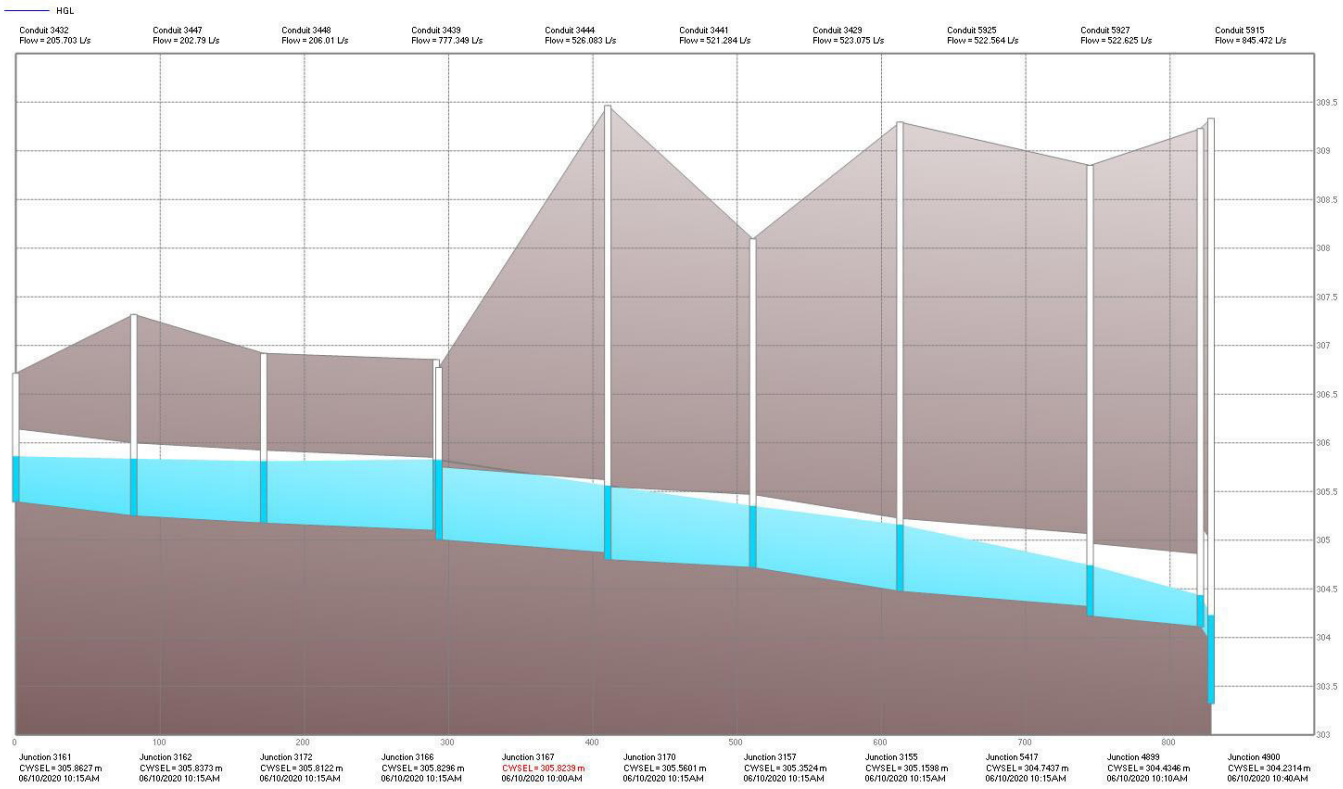


Figure 5-40 Future Conditions HGL Profile Area 5 Reach 2 (Existing Infrastructure)

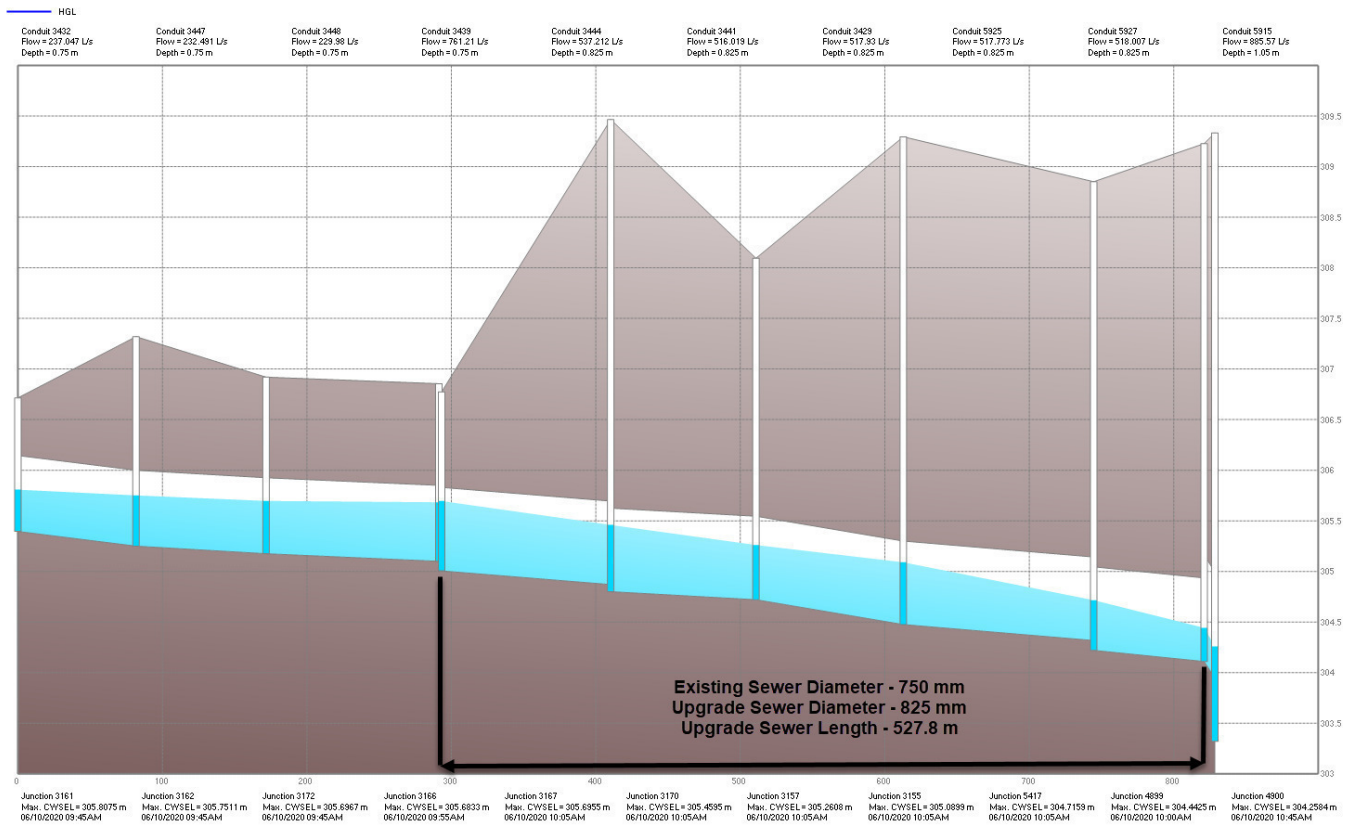


Figure 5-41 Future Conditions HGL Profile Area 5 Reach 2 (Post-Upgrade)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 750 mm sewers with 825 mm provides sufficient capacity and eliminates the surcharge at this location.

5.9.3 Reach 5-3

The third reach in Area 5 includes 500 mm diameter sewers parallel to reach #2, between Bristol St and Waterloo Ave. The HGL profile under future WWF conditions is shown below on Figure 5-42.

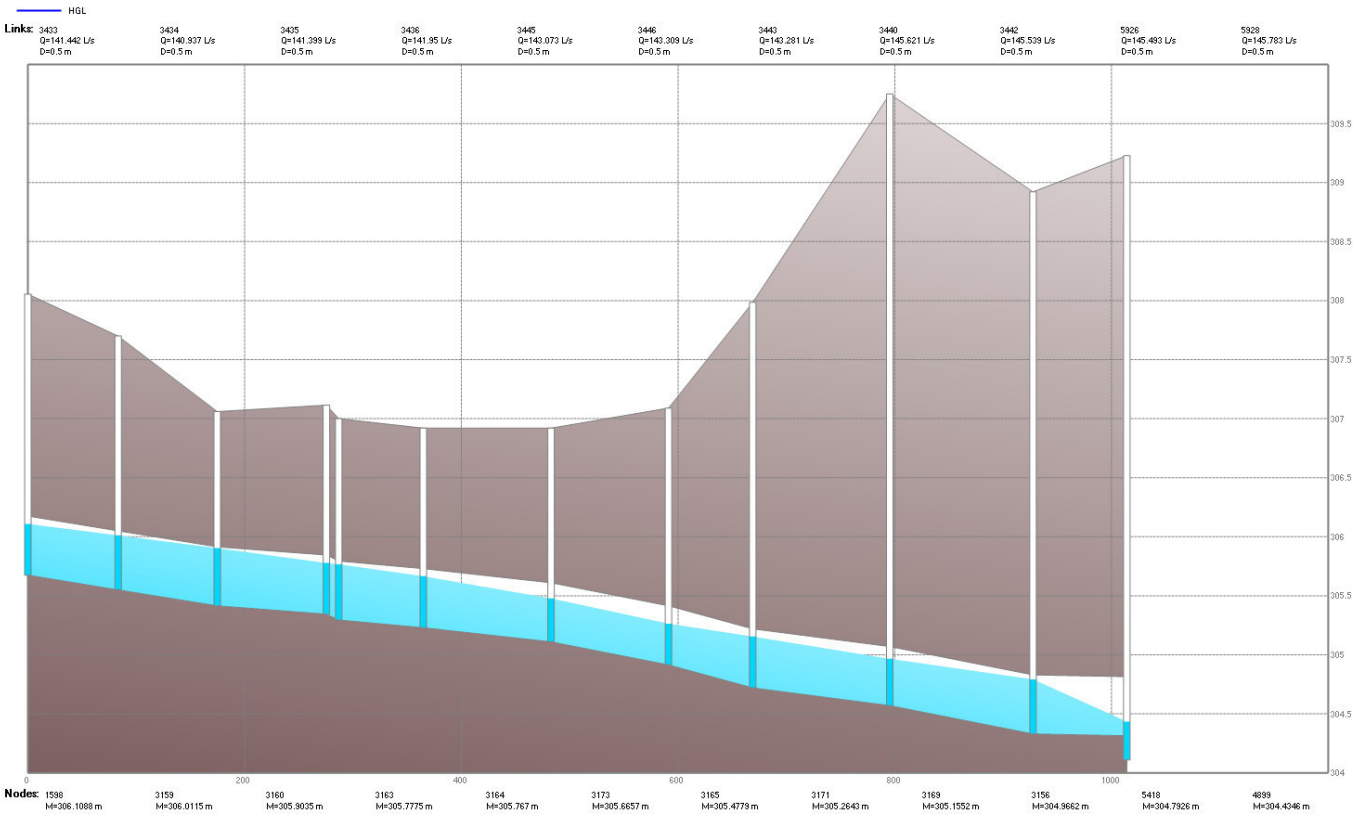


Figure 5-42 Future Conditions HGL Profile Area 5 Reach 3 (Existing Infrastrucutre)

Although no surcharge is observed at this location sewers are modelled as operating over capacity and the HGL is within 0.04 m in several locations. As a result, gravity sewer replacement is the recommended improvement at this location. Replacing the undersized 500 mm sewers with 600 mm provides the necessary additional capacity for this reach.

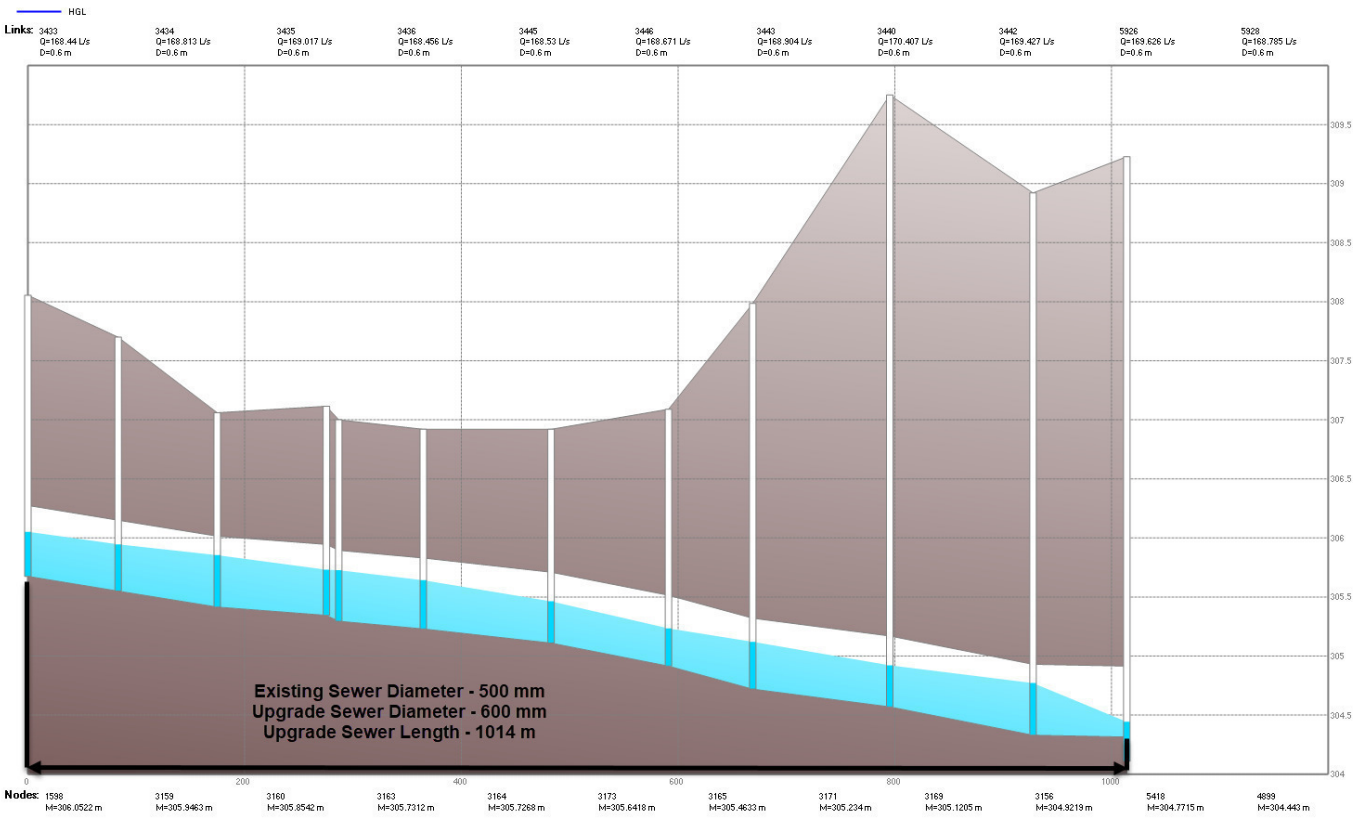


Figure 5-43 Future Conditions HGL Profile Area 5 Reach 2 (Post-Upgrade)

5.9.4 Reach 5-4

The fourth reach in Area 5 includes sewers with diameters ranging from 200 mm to 600 mm, along Yarmouth St, Quebec St, Wyndham St N and Wellington St. The HGL profile under future WWF conditions is shown below on Figure 5-44.

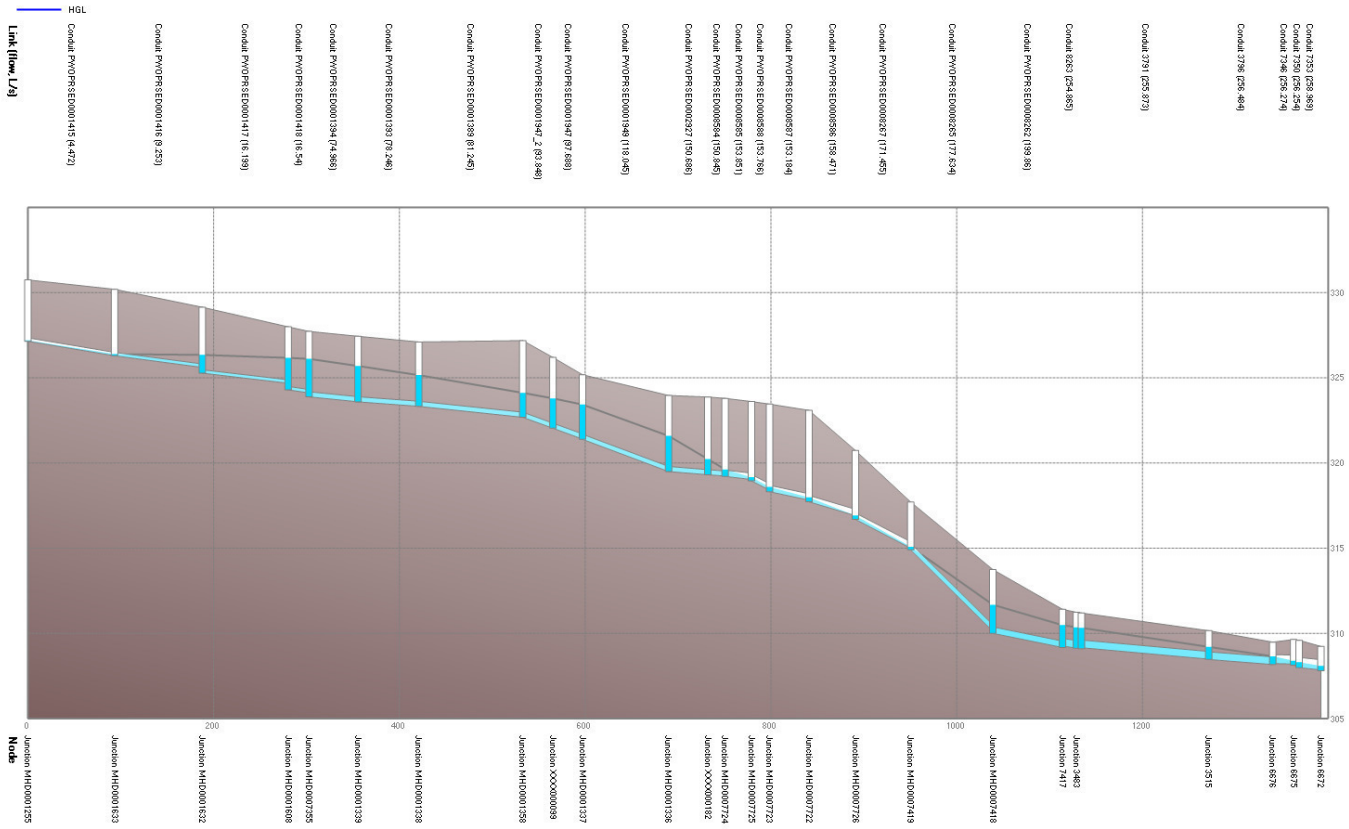


Figure 5-44 Future Conditions HGL Profile Area 5 Reach 4 (Existing Infrastructure)

Gravity sewer replacement in conjunction with slope modifications was selected as the improvement option in this location. Replacing the undersized sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-45.

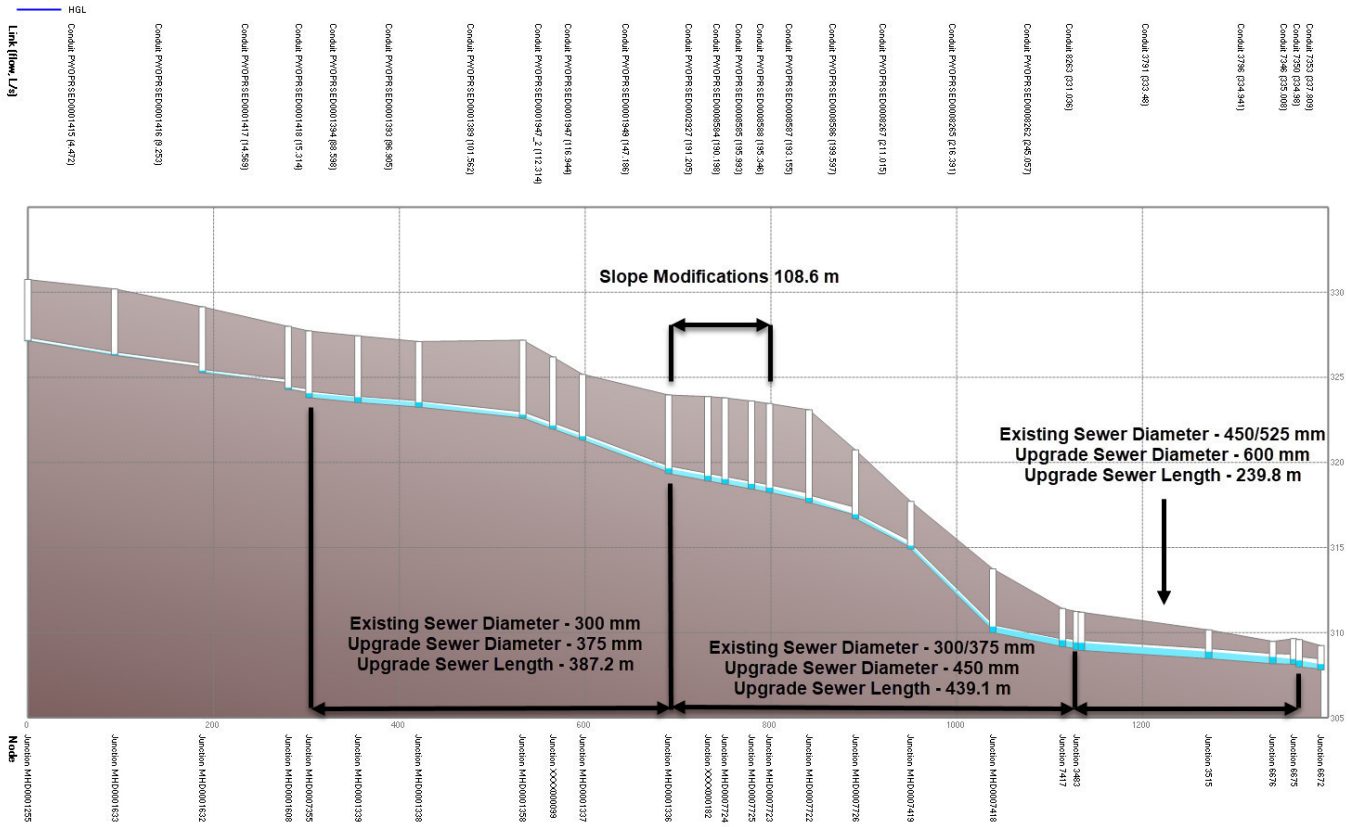


Figure 5-45 Future Conditions HGL Profile Area 5 Reach 4 (Post-Upgrade)

5.9.5 Reach 5-5

The fifth reach in Area 5 includes 225 mm sewers on Woolwich St. The HGL profile under future WWF conditions is shown below on Figure 5-46.

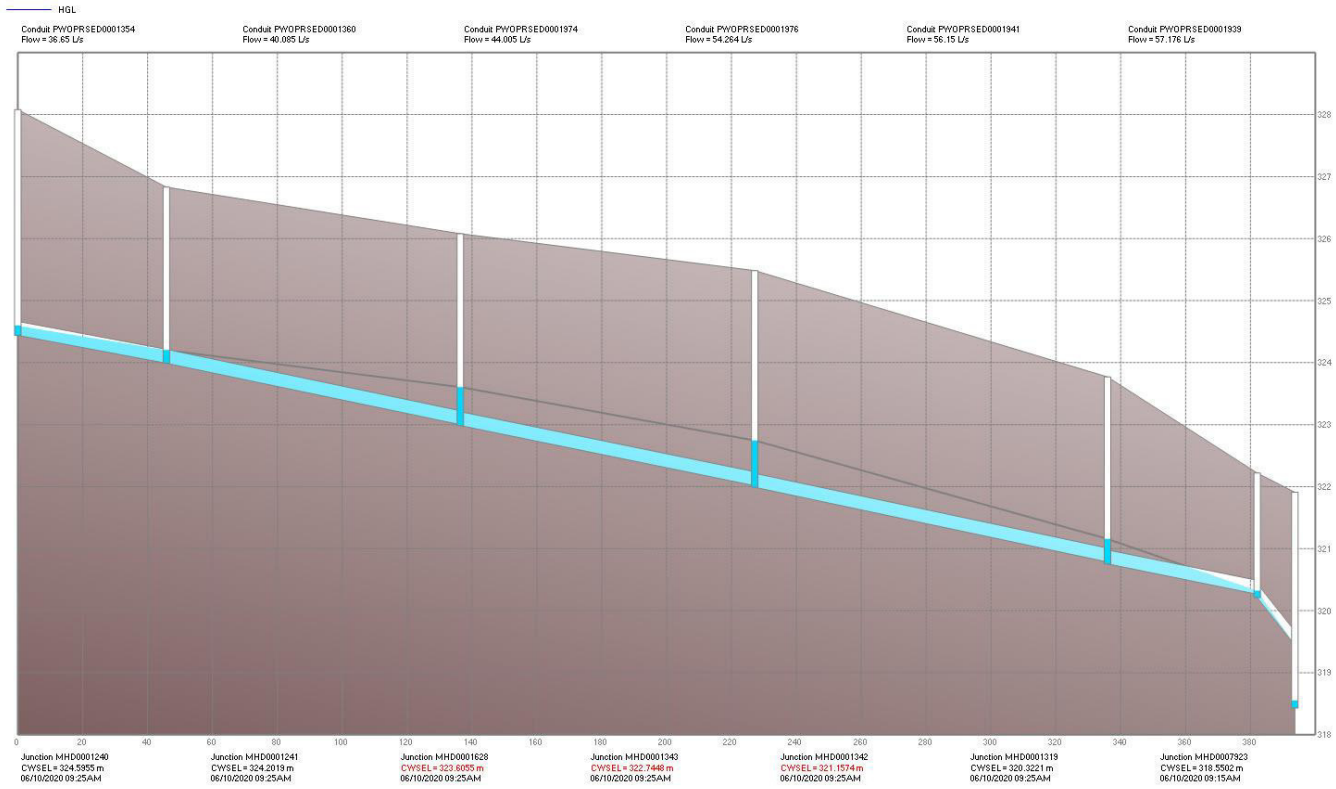


Figure 5-46 Future Conditions HGL Profile Area 5 Reach 5 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 225 mm sewers with 300 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-47.

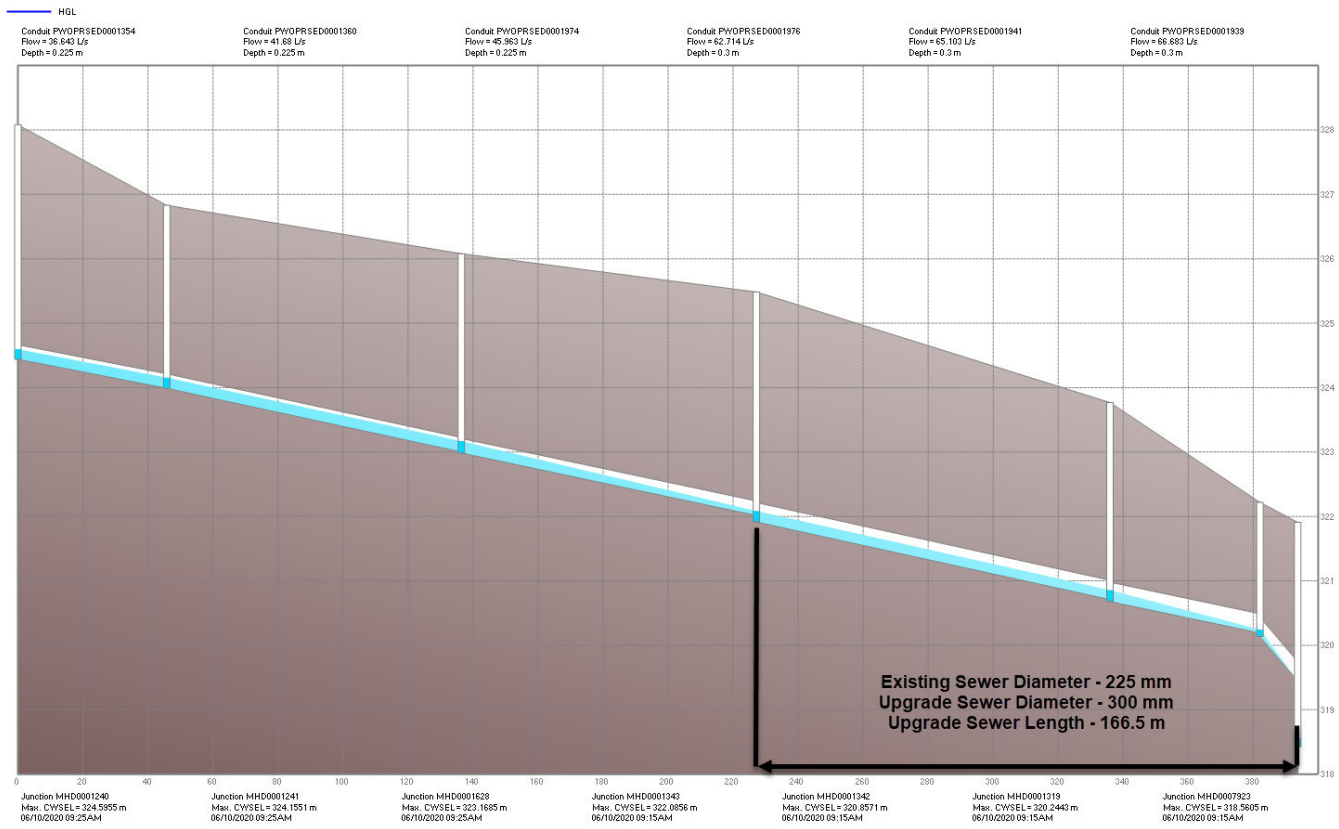


Figure 5-47 Future Conditions HGL Profile Area 5 Reach 5 (Post-Upgrade)

5.9.6 Reach 5-6

The sixth reach in Area 5 includes 225 mm sewers on Waterloo Ave. The HGL profile under future WWF conditions is shown below on Figure 5-48.

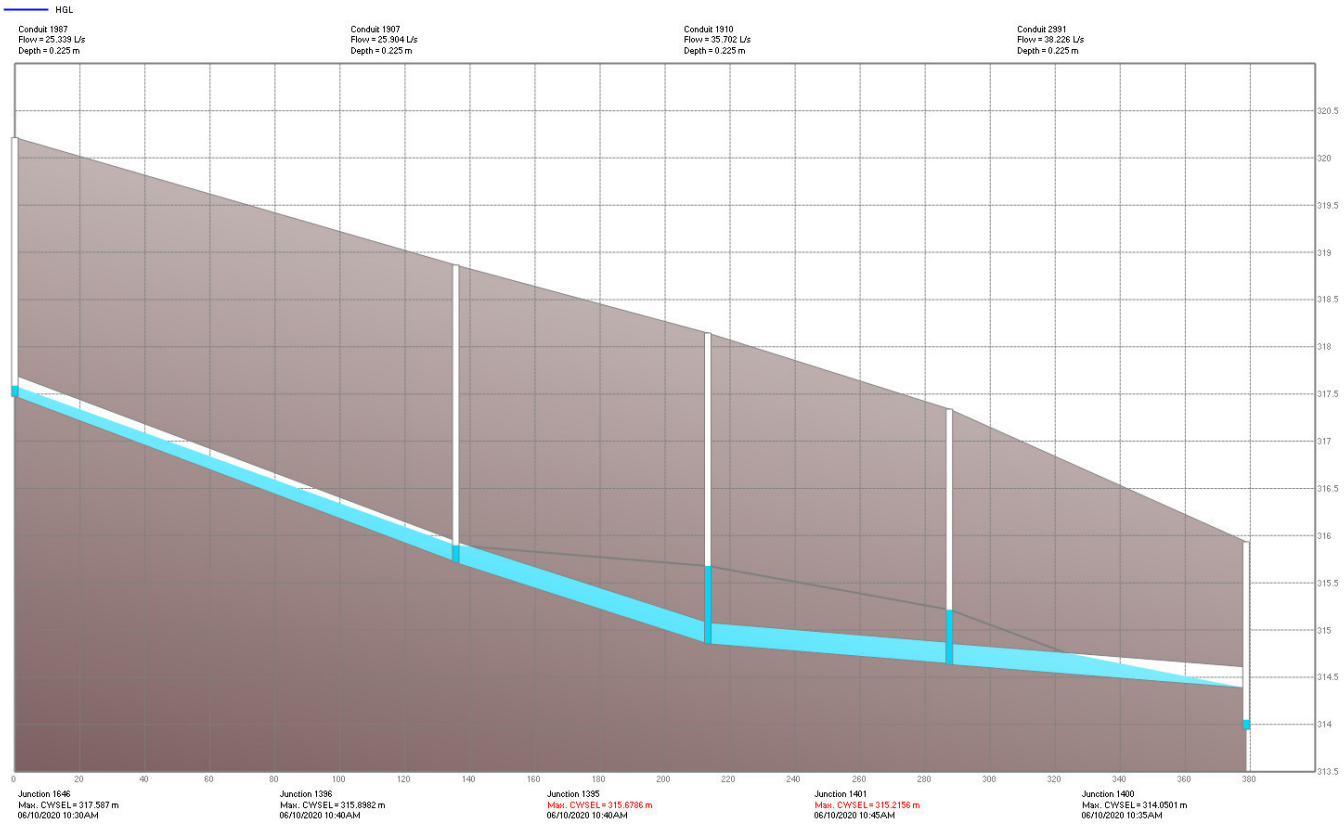


Figure 5-48 Future Conditions HGL Profile Area 5 Reach 6 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 225 mm sewers with 300 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-49.

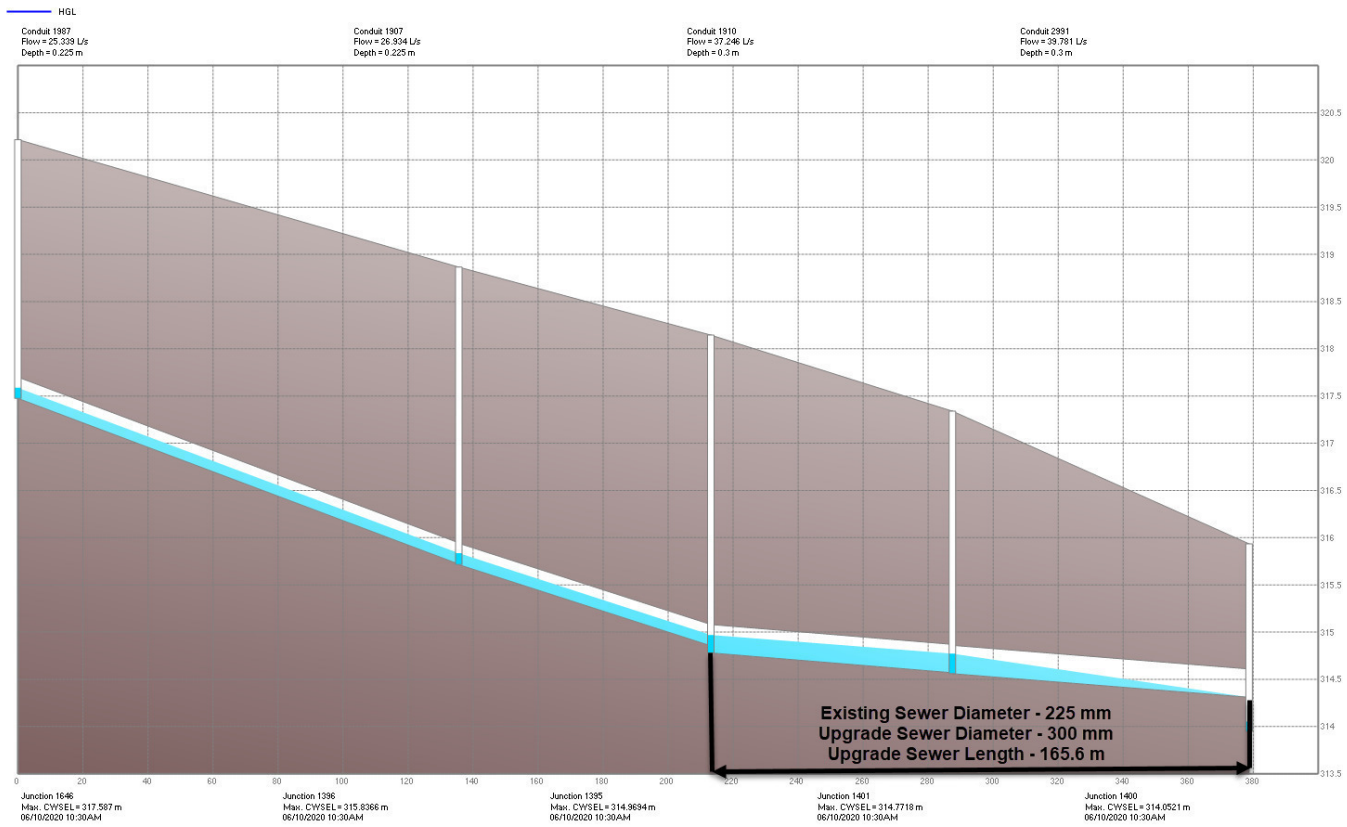


Figure 5-49 Future Conditions HGL Profile Area 5 Reach 6 (Post-Upgrade)

5.9.7 Recommended Further Study

Further study is warranted for Area 5. There are several options that warrant consideration beyond what has been considered in this Master Plan Update:

- Recent emergency works completed to stabilize the existing trunk sewer should be incorporated in a long-term solution. A long-term solution which results in these recent mitigative investments being replaced are to be avoided.
- There appears to be available elevation for lowering of the connection(s) to the WWTP. This provides the opportunity to consider lowered trunk infrastructure to satisfy the servicing needs for the area. This also provides a potential opportunity to explore modifications to the City's existing siphons.
- Gravity solutions may benefit from use of adjacent parallel roads/easements for alleviation of surcharge. These alignment options warrant further consideration. In particular, Reaches 5-2 and 5-3 would not likely be replaced in their current location as some sewers are located beneath buildings. Preference would be to move these sewers into roadway ROWs such as Bristol Street and/or Waterloo Avenue.
- A diversion structure may be of benefit. This might be used to convey flow above the existing system's capacity to the WWTP. The diversion could be to a lowered trunk sewer, or to a new bypass pump station.

As such, the assessments and findings presented in the Master Plan Update for Area 5 should be considered as preliminary and used to help form the basis for further study of the Area.

5.10 Area 6 System Improvements

The sixth location, noted as Area 6 on Figure 5-1 is a reach including sewers ranging in diameter from 250 mm to 675 mm along College Avenue and Scottsdale Drive, and across W.E. Hamilton Park. The HGL profile under future WWF conditions is shown below on Figure 5-50.

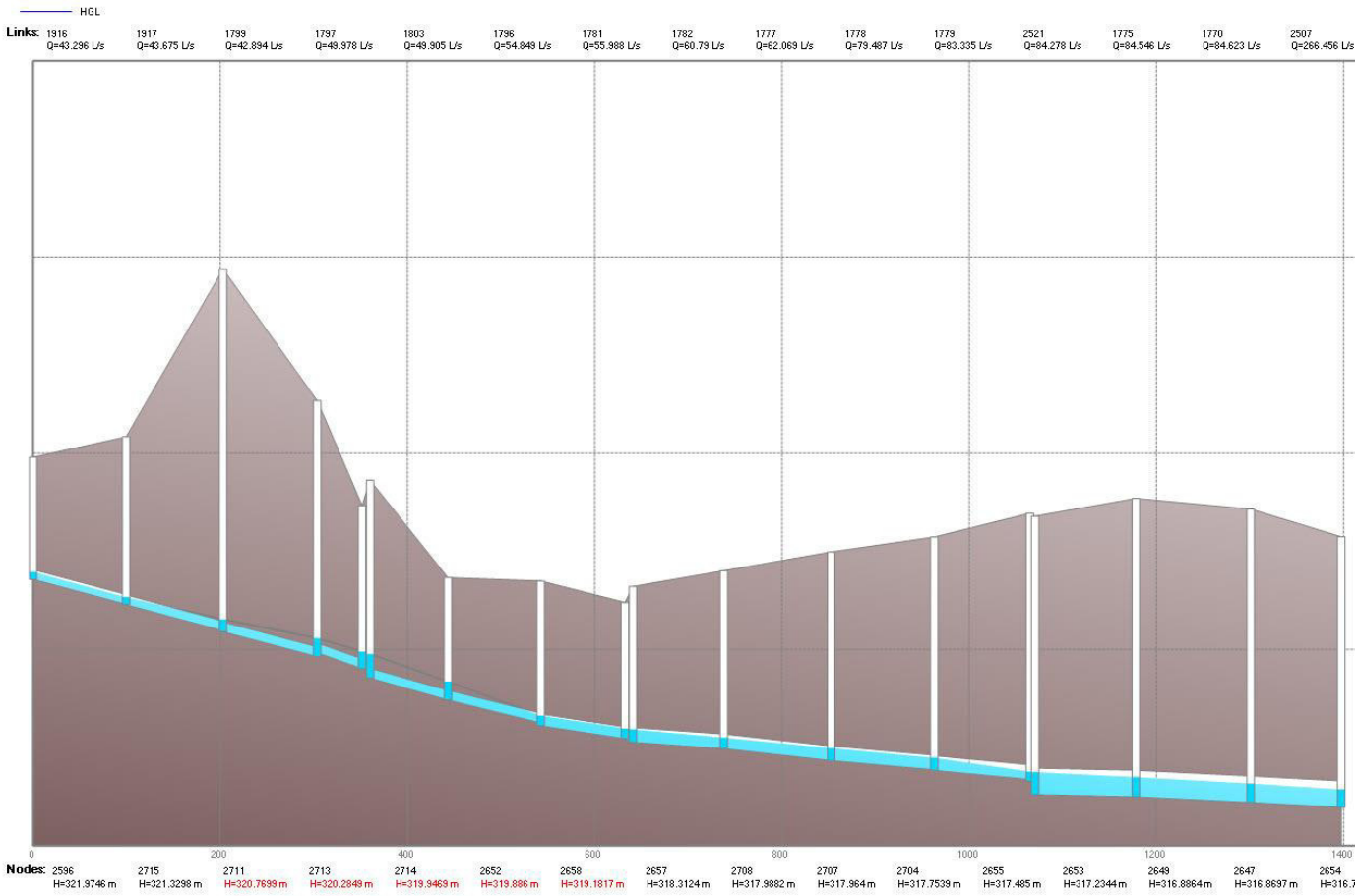


Figure 5-50 Future Conditions HGL Profile Area 6 Reach 1 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 250 mm and 300 mm sewers with 300 mm and 375 mm sewers provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-51.

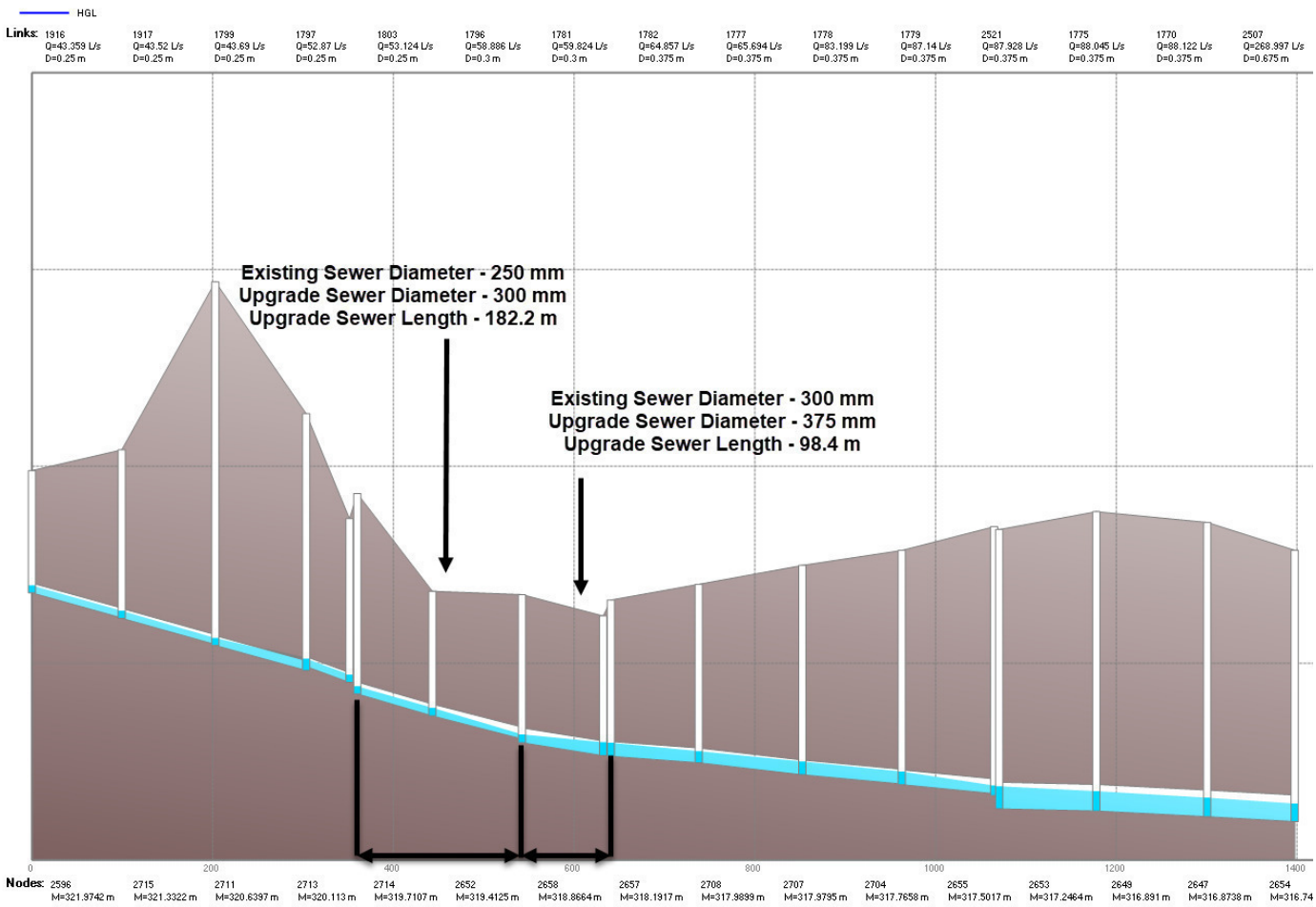


Figure 5-51 Future Conditions HGL Profile Area 6 Reach 1 (Post-Upgrade)

5.10.1 Alternative Solution - Reach 6-1

The alternate system improvement in this location is the realignment of the sewer along College Ave and Janefield Ave in order to remove the easement through the park. This would involve construction of new 525 mm, 600 mm and 675 mm sewers. It also involves reversing the flow direction along Scottsdale Dr north of Wilsonview Ave, and along College Ave to Janefield Ave. Plan and profile views of the proposed realignment are shown below on Figure 5-52 and Figure 5-53.

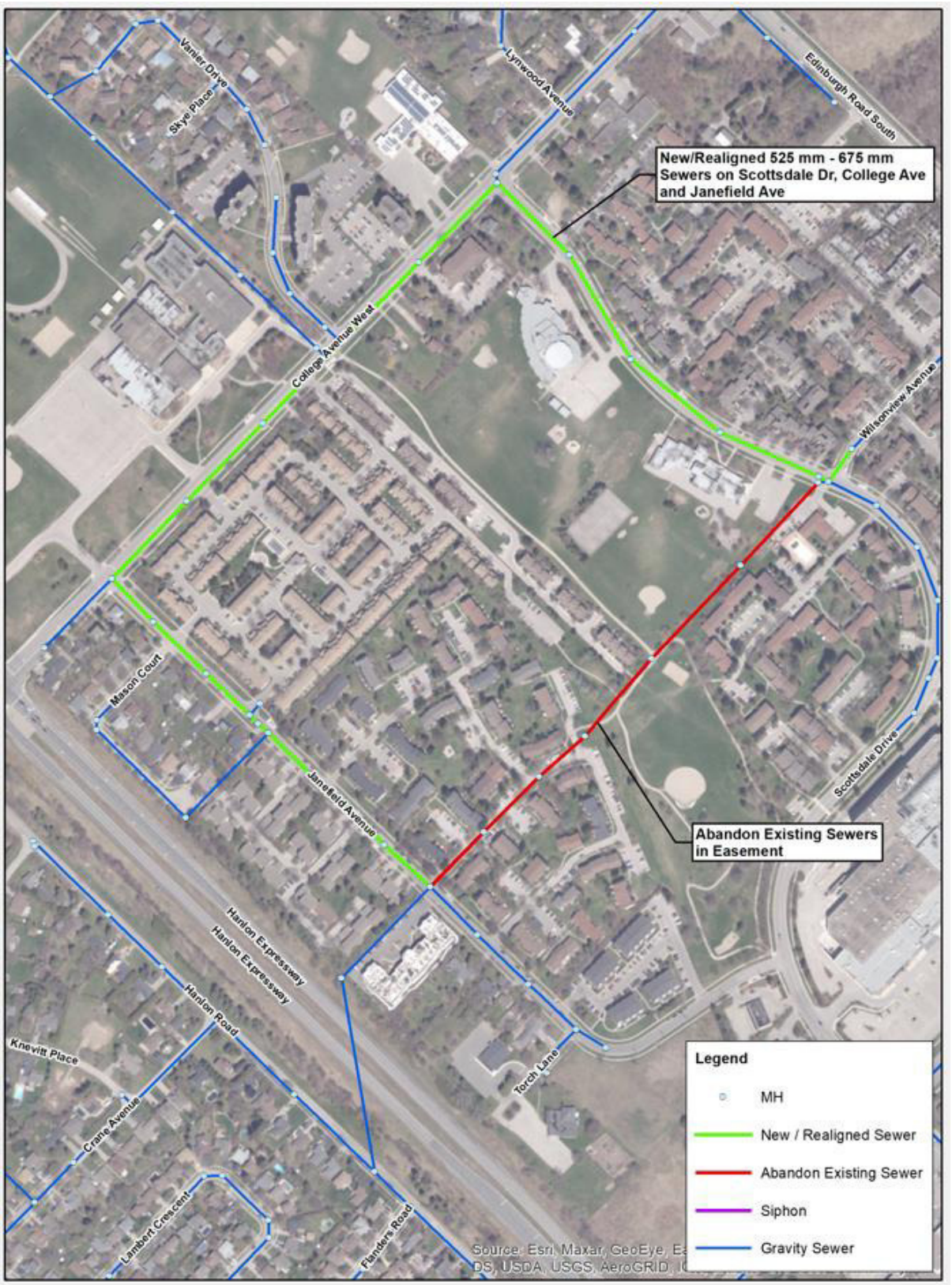


Figure 5-52 Reach 6-1 Sewer Realignment

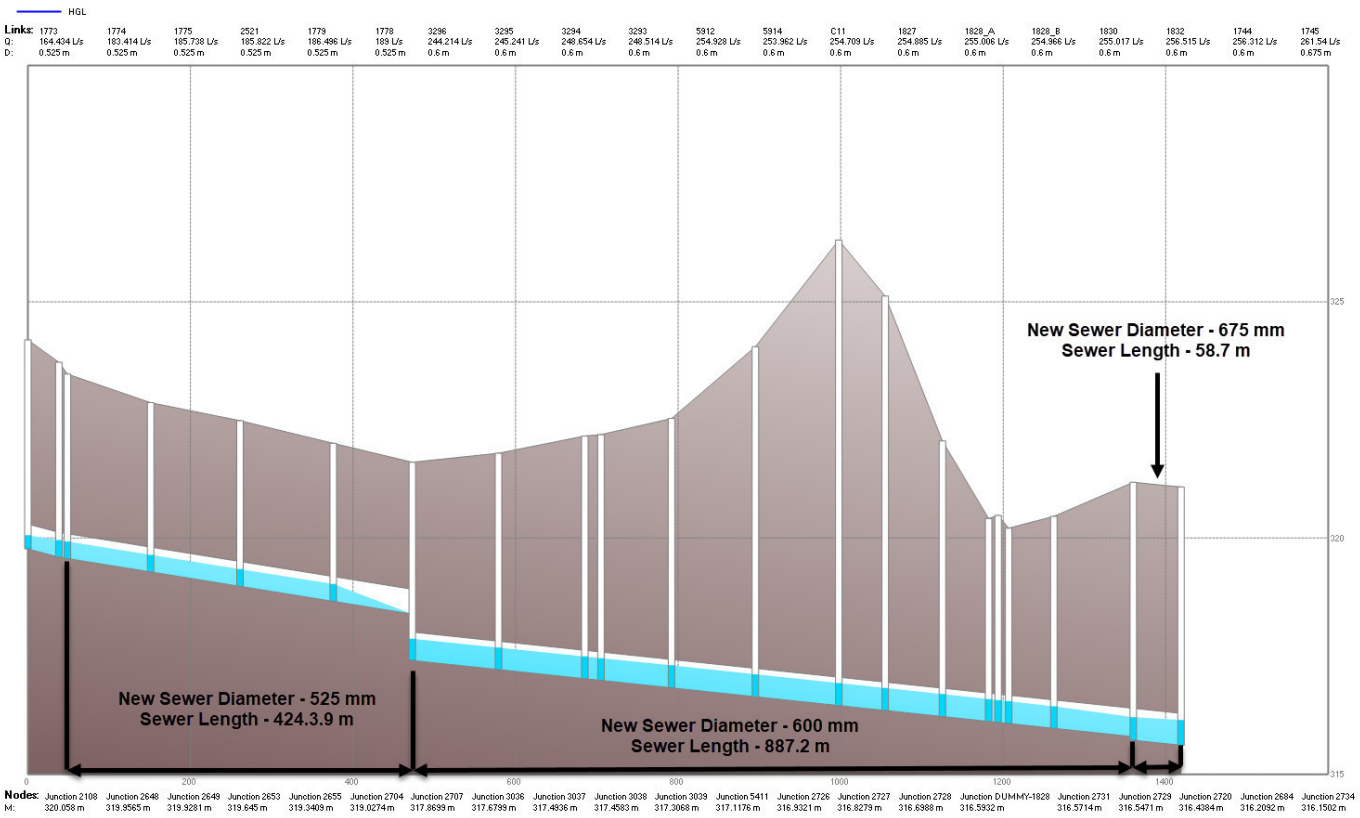


Figure 5-53 Future Conditions HGL Profile Area 6 Reach 1 (Alternate Post-Upgrade)

5.11 Area 7 System Improvements

The seventh and final location, noted as Area 7 on Figure 5-1 is a reach of 200 mm and 450 mm sewers along Farley Drive and Clairfields Drive West. The HGL profile under future WWF conditions is shown below on Figure 5-54.

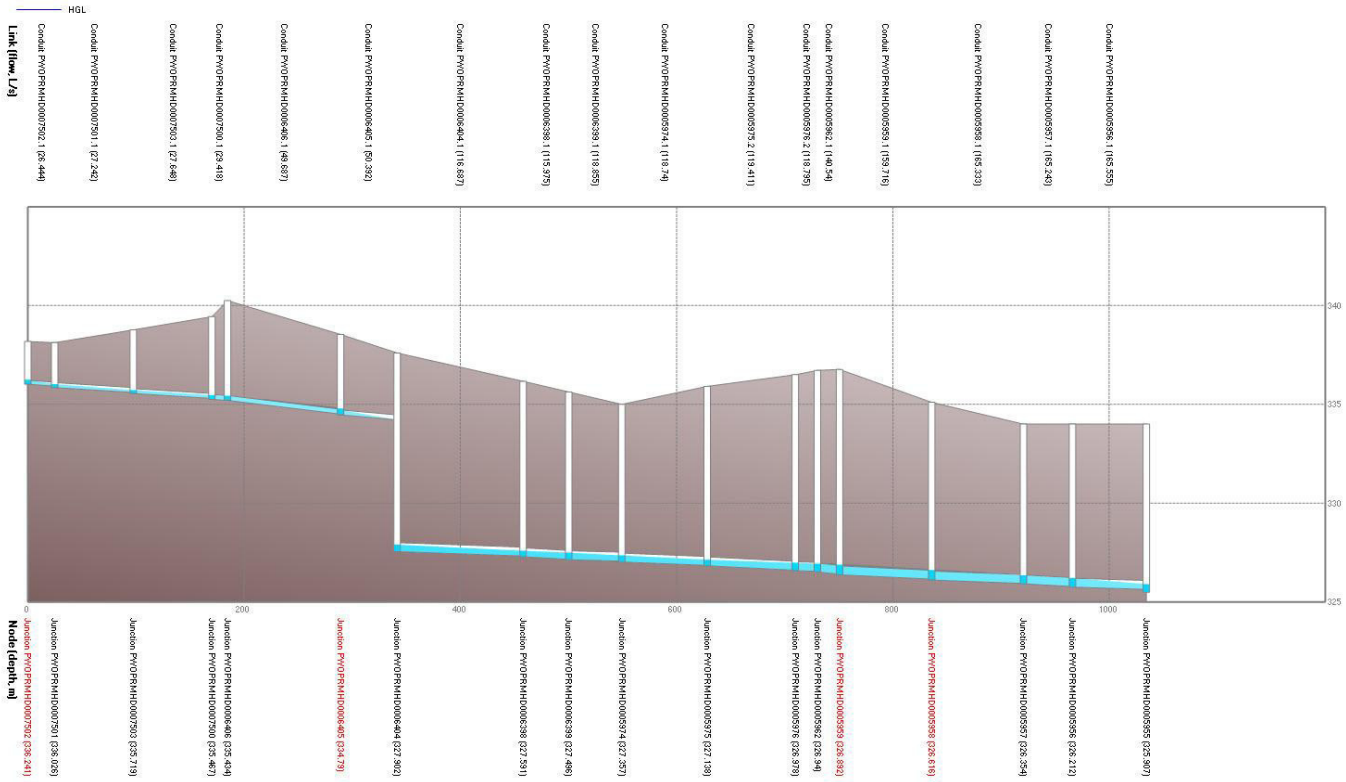


Figure 5-54 Future Conditions HGL Profile Area 7 Reach 1 (Existing Infrastructure)

Gravity sewer replacement was selected as the improvement option in this location. Replacing the undersized 200 mm, 250 mm and 450 mm sewers with 250 mm, 300 mm and 525 mm sewers, provides sufficient additional capacity to eliminate surcharging, as shown on Figure 5-55.

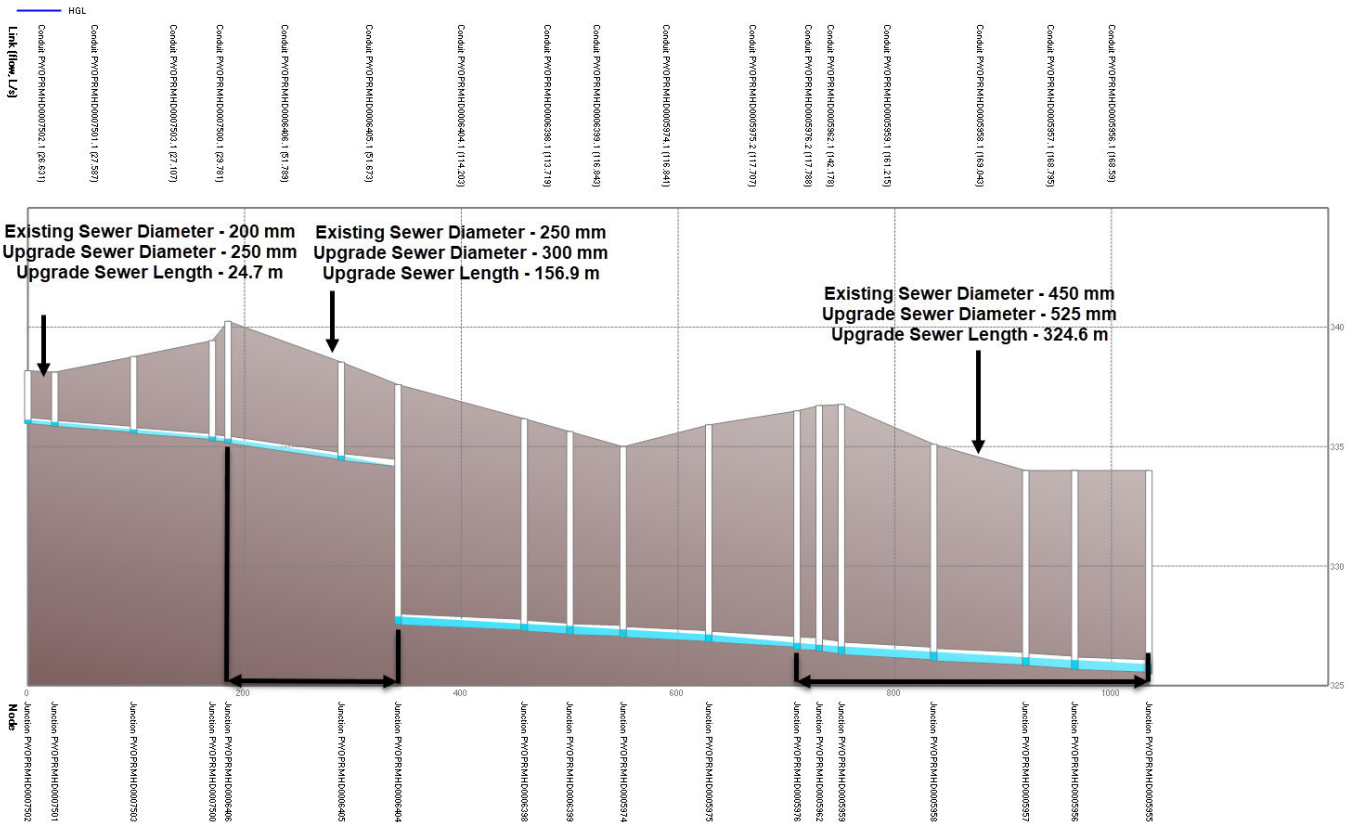


Figure 5-55 Future Conditions HGL Profile Area 7 Reach 1 (Post-Upgrade)

5.11.1 Alternate Solution - Reach 7-1

The alternate system improvement in this location is the construction of a new sewer along Clair Road as it will be widened as part of the Clair Maltby Secondary Plan Phase 2. This would address capacity issues and avoid construction in deep sewers. This would involve construction of new 250 mm and 300 mm sewers, with connection to the future Clair-Maltby Trunk. Plan and profile views of the proposed realignment are shown below on Figure 5-56 and Figure 5-57

Figure 5-56 Reach 7-1 New Sewer

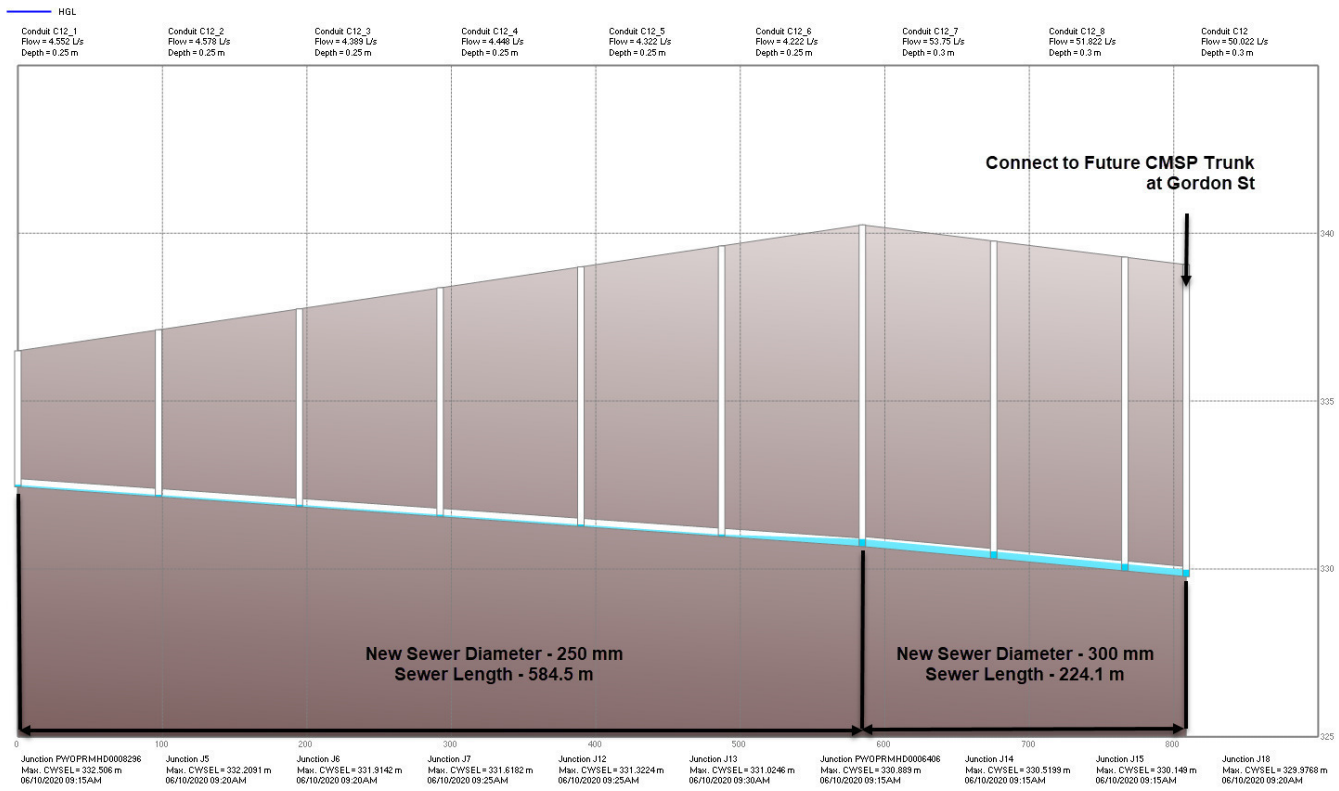


Figure 5-57 Future Conditions HGL Profile Area 7 Reach 1 (Alternate Post-Upgrade)

The overall post-upgrade system results can be seen on Figure 5-58 and Figure 5-59 (alternate improvements), which demonstrate the proposed infrastructure upgrades address the capacity issues and eliminate system surcharge. It is worth noting there is still one sewer showing surcharge in the post-upgrade results, which is the elliptical sewer in Reach 5-1. It is assumed the irregular cross-section is necessary for a utility conflict and does not impact the hydraulic capacity.

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Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Highway 7
Woodlawn Rd W
Speed River
Northern Heights
Guelph Lake
NiMa Trails
Gazer Mooney
Eastview Rd
Wellington St W
York Rd
Highway 7
Eramosa River
Hanlon Parkway
Gordon
Barton
Kortright
Terraview
Highway 6

Legend

- Pump Station
- Water Resource Recovery Center
- Watercourse
- Railway
- Property
- Forcemain / Siphon

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- > 50 % - 80 %
- > 80 % - 99 %
- Surcharged

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Stantec

C3 Water

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
5-58

Title
Wastewater Performance - Post Upgrades

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Area 1 - Reach 2
Highway 7
Woodlawn Rd W
Northern Heights
Guelph Lake
Speed River
NiMa Trails
Gazer Mooney
Eastview Rd
Wellington St W
York Rd
Highway 7
Eramosa River
Hanlon Parkway
Kortright
Barton
Terraview
Highway 6

Legend

- Pump Station
- Water Resource Recovery Center
- Watercourse
- Railway
- Property
- Forcemain / Siphon

d / D

- <= 50 %
- > 50 % - 80 %
- > 80 % - 99 %
- Surcharged

0 1 2 Km
1:50,000 (At Original document size of 11x17)

Stantec

C3 Water

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
5-59

Title
Wastewater Performance - Post Upgrades (Alternate Improvements)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

5.12 Siphons

The model results suggest the City's siphons are not achieving the minimum MECP velocity of 1.1-1.3 m/s daily (i.e., during DWF) under existing conditions. Under future buildout conditions this finding is essentially maintained for all but the Crane Park crossing. Additionally, there are 5 crossings that are currently single barreled where the MECP guideline suggest a minimum of 2 barrels be provided.

Recommendations are as follows:

- Ensure regular visits and inspections of all the City's siphons are scheduled and completed. Focuses during these visits should include establishing if an accumulation of sediment is occurring and/or worsening. It is possible that regular increased flows experienced from frequent rainfall occurrences are adequate to maintain the functionality of the siphons.
    - Should these inspections show that sediment accumulation is an ongoing issue, then it is recommended the City proceed with a regular flushing program to clean out the siphons.

- The Alma-Mercer, Eramosa River, Eramosa Stevenson, and Willow-Guelph siphons are understood to be comprised of a single barrel. If this is indeed representative of their configuration, then this does not satisfy the MECP Guideline of ensuring at least 2 barrels being provided for siphons.
    - Our recommendation for these locations is to prioritize the inspection of these (over those locations with 2 or more barrels) to ensure they are operating effectively.
    - We additionally recommend further study to establish if these crossings could be updated to included 2 barrels and thus satisfy the MECP Guideline, or, even better, if these crossings could be abandoned for an alternative servicing configuration.

- The Manor Park siphon crossing is understood to have already been studied and a project to update the crossing at this location has been developed. Construction is planned for 2028 at an estimated cost of $1.5M.

- The Municipal Street siphon has also been recently studied. The recommendations from this effort include connection to the upgraded Manor Park siphon and elimination of the existing Municipal Street siphon. The estimated cost of this project is $2.7-$4.0M. The timeline for this project is yet to be determined.

The above recommendations are provided within the context of satisfying the MECP's Guidelines and ongoing City interests. It is appreciated that the City may not be having issues with all their existing siphons. The overall suggested approach is to inspect and track performance of these hydraulic structures. Tactical maintenance may be sufficient to maintain their operation. Replacement/modification when concurrent opportunities arise may also be strategic.

5.13 Miscellaneous Wastewater Collection System Recommendations

The recommendations provided include infrastructure upgrades to satisfy the City's targeted level of service. These recommendations remain based on the results of calibrated hydraulic models which consider the needs of both existing and projected growth needs. There are several ongoing activities the City is recommended to continue in an effort to refine these findings and maintain and increase the confidence in the results of the developed models:

- Continue annual strategic sewer flow monitoring. The focus of these efforts should be to further understand how the City's wastewater collection system responds to rainfall and ongoing growth. Additional interest in obtaining data nearby to areas where upgrades are identified is also strategic.

This data may help confirm the timing and/or actual need for these upgrades. Sewer flow monitoring data analysis also allows the City to understand its I/I profile and where any leakier areas may be present in the City. The sewer flow monitoring analysis completed as part of this Master Plan showed minimal to null I/I in the data collected. It is valuable to continue with similar analysis to ensure this is representative of the entire City.

- Correlation of any basement flooding reports to the results of the City's hydraulic modelling findings. Combined with an understanding of the return period of the corresponding rainfall, this correlation can help validate the model's predictive findings, or identify that additional calibration is warranted. This data is also valuable in establishing and confirming project prioritization.

- Confirm the location and distribution of building lateral connections to the City's sewers through field measurements/inspections. Currently the City's design/development guidelines do not allow any surcharging of sewers. This may be overly conservative depending on the building lateral connection details. The City's sewers are also known to be shallow in certain areas, notably the City Centre / core area. An understanding of where there are basements and associated lateral connection to the shallow network would allow an understanding of the risk of allowing surcharging and possibly allow the City to allow surcharge in certain areas.

- Regularly update the City's hydraulic model as sewer flow monitoring data is collected. The City's model should also be updated with growth and infrastructure updates as these occurs.

- Align the City's development review tracking methods to use the hydraulic model and track cumulative demands.

6.0 IMPLEMENTATION PLANNING

This section outlines the high-level proposed timing of each of the identified projects based on the planning horizons defined for this study. A summary of the equivalent population for each planning horizon is shown in Table 6-1 below. The reference populations for 2031 and 2041 horizons are consistent with the WSMP, while the 2051+ horizon is based on the Shaping Guelph ultimate buildout population.

Table 6-1 Planning Horizon Projected Reference Populations

Horizon	2031	2041	2051+
Population	164,852	183,926	239,770
Employment	94,906	105,453	126,198

6.1 Water Servicing Implementation

6.1.1 Short Term Recommendations (Present – 2031)

Water projects recommended in the short term are intended to address existing capacity constraints as well as meet growth requirements to 2031.

The new Arkell PS and watermain is recommended for 2031 due to the existing criticality concerns of the Arkell Aqueduct.

All minor water projects (W-M-1 to W-M-24) excluding W-M-25 are recommended for implementation within the short-term horizon. These projects address existing capacity constraints in areas of concern. The majority of these projects have been previously recommended through other studies.

In Zone 1, major watermain projects W-1a & W-1b are recommended in the short term to improve transmission to the Verney ET and the Verney BPS and reduce headloss through the downtown area. Project W-2 is recommended to improve transmission to the Clythe PS. This project is currently in the design phase and is planned to be completed within the next 5-years. Project W-3 is recommended in the short-term to complete the recent Hanlon crossing project and reduce existing high headloss in the area, to supply the Paisley PS and Reservoir.

The Woods PS upgrades are currently in the design phase and this project is expected to be complete by approximately 2025.

In Zone 2, project W-5a is recommended in the short-term to reduce the criticality of the existing Paisley discharge feedermain. Project W-8 (Speedvale Feedermain) is recommended in the short term and reduces the criticality of all Zone 2 PSs by improving east-west transmission. This project is currently in the design phase and is planned to be completed within the next 5-years.

The new Verney BPS project is recommended to be completed within the short-term horizon as this project has been flagged as high priority for improving the security of supply to Zone 2, due to its central location. As such, linear project W-11 is recommended in the short term.

Upgrades to the Clythe PS are currently in the design phase and it is expected that this project will be completed by 2031. As such, linear project W-12 is recommended in the short term. W-12 was also found to be beneficial for improving low pressures in PLo-3 (Eastview & Summit) by reducing headloss in this area during peak demands.

Upgrades to the Park PS to supply Zone 2 are recommended in the short term so that this facility can be used to supply the east-side of Zone 2 and reduce the criticality of the Clythe PS.

The proposed short-term projects are summarized in Figure 6-1 below.

6.1.1.1 Short Term Performance

Model results for the 2031 horizon are presented in Appendix C and are summarized in Table 6-2 below. These proposed projects were found to provide acceptable LOS for this horizon.

Table 6-2 2031 Model Results Summary

Result	Results Summary
Pressure	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 38 psi in PLo-1. Max pressure in PHi-6 of 103 psi.
Linear Capacity	Headloss maintained under 2m/km with exception of Dunlop Dr and Huron from York to Alice. Huron has been flagged as CI replacement priority.
Storage	All ETs maintained above 80% full. All reservoirs maintained above 60% full. Woods & Arkell Res minimum levels 62%.
Pump Station Flow	All PSs operated below firm capacity. Max flow at Woods of 600 L/s. Max flow at Arkell of 240 L/s.

Although the Arkell PS and watermain project has been recommended for the short term, it is understood that it may not be feasible for a project of this size, complexity and cost to be completed by 2031. As such, a sensitivity analysis was completed without this project in place during a 2031 MDD. The results are summarized in Table 6-3 below. Due to the planned implementation of the Ironwood Well and South Well by 2031, there is expected to be additional supply in the South end of Zone 1, compared to existing conditions. As such it was found that the Clair ET was maintained at an acceptable level under this horizon, without the Arkell PS and Reservoir. In the event that the Ironwood Well and South Well are not brought online within the short-term, the Zone 1 split described in Section 4.4.3 may be considered for improving supply from the Woods PS to the Clair ET.

Table 6-3 2031 Model Results Summary – Arkell PS Offline

Result	Results Summary
Pressure	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 37 psi in PLo-1. Max pressure in PHi-6 of 104 psi.
Linear Capacity	Headloss maintained under 2m/km with exception of Dunlop drive.
Storage	All ETs maintained above 75% full. All reservoirs maintained above 60% full. Woods Res minimum level 62%.
Pump Station Flow	All PSs operated below firm capacity. Max flow at Woods of 710 L/s.

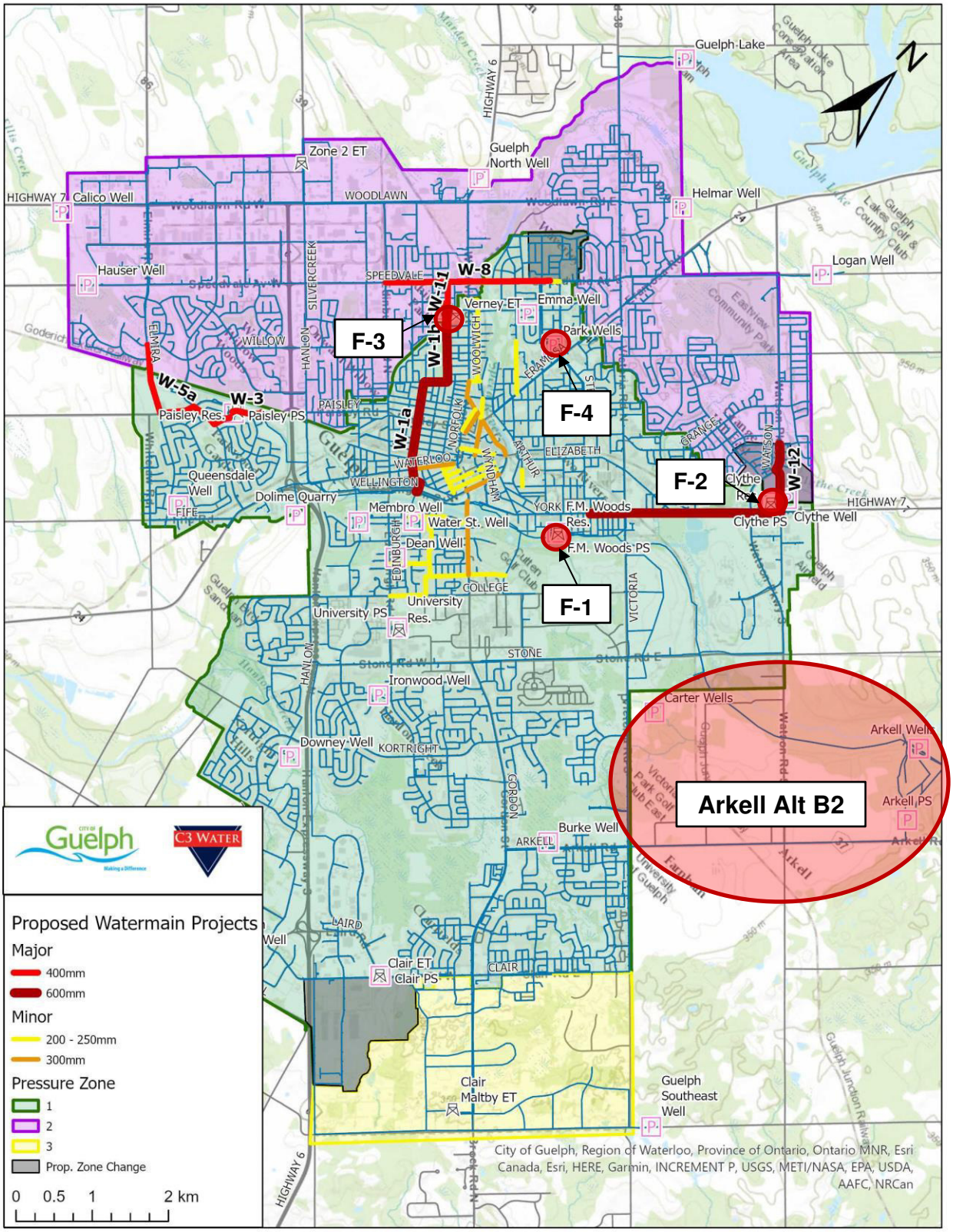

Figure 6-1 Water Projects – Short Term (2031)

6.1.2 Mid Term Recommendations (2032 – 2041)

Water projects recommended in the mid-term are intended to meet growth requirements up to 2041.

In Zone 1, project W-1c is recommended to complete the large watermain connection through the downtown between the Stevenson feedermain and proposed feedermain projects W-1a and W-1b. W-4a is recommended to improve watermain capacity in the south end of Zone 1 as the required discharge flow from the Arkell PS increases to meet growth demands.

In Zone 2, the Zone 2 ET is recommended by 2041, as the existing Speedvale ET has a remaining service life of approximately 20-years. Watermain projects W-5b, W-7, W-6a and W-13 are recommended within this time horizon to provide strong transmission between the Paisley PS and the Zone 2 ET.

For Zone 3, timing of retrofitting of the Clair BPS, transition of area PLo-5 (Southgate ICI) and the minor linear project W-M-25 is associated with the Clair Maltby ET and Zone 3 growth.

The proposed mid-term projects are summarized in Figure 6-2 below.

6.1.2.1 Mid Term Performance

Model results for the 2041 horizon are presented in Appendix C and summarized in Table 6-4 below. These proposed projects were found to provide acceptable LOS for this horizon.

Table 6-4 2041 Model Results Summary

Result	Results Summary
Pressure	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 37 psi in PLo-1. Max pressure in PHi-6 of 103 psi.
Linear Capacity	Headloss maintained under 2m/km with exception of Dunlop Dr and Huron from York to Alice. Huron has been flagged as CI replacement priority.
Storage	All ETs maintained above 75% full. All reservoirs maintained above 60% full. Woods Res minimum level 60%. Arkell Res minimum level 72%.
Pump Station Flow	All PSs operated below firm capacity. Max flow at Woods of 600 L/s. Max flow at Arkell of 330 L/s.

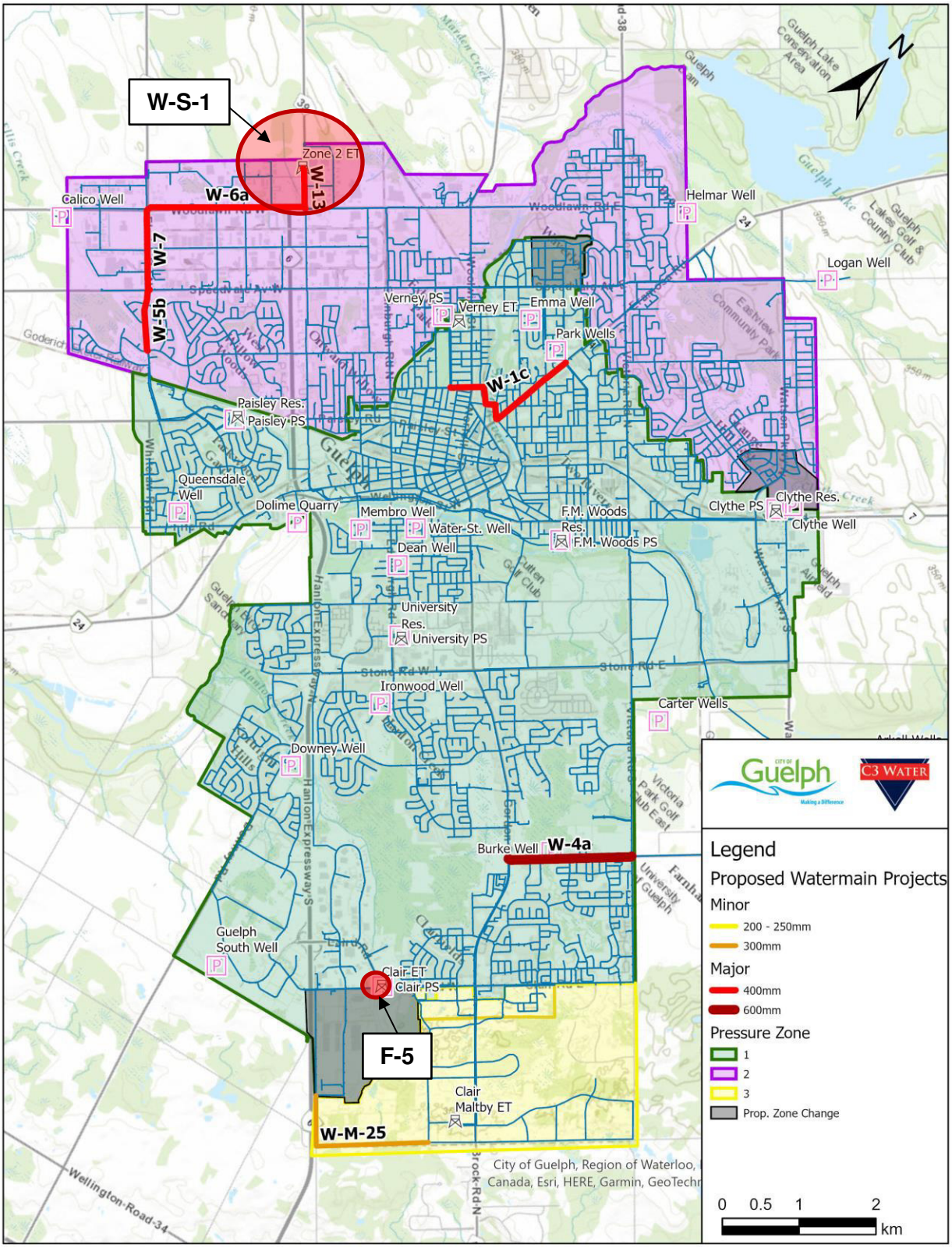

Figure 6-2 Water Projects – Mid Term

6.1.3 Long-Term Recommendations (2042 – 2051+)

Water projects recommended in the long-term are intended to meet growth requirements up to the ultimate buildout growth.

In Zone 1, projects W-3b & W-4c are recommended to complete the transmission main from the Arkell PS to the Clair ET as growth and demands increase in the south end of the system.

In Zone 2, projects W-6b & W-6c are recommended to complete the east-west transmission main along Woolwich Street and improve capacity between the Zone 2 ET and the east side of Zone 2. Project W-9 is recommended to improve transmission between Speedvale and Woodlawn. Project W-10 is required to improve transmission from the Guelph Lake WTP.

The proposed long-term projects are summarized in Figure 6-3 below.

6.1.3.1 Long-Term Performance

Model results for the 2051+ ultimate buildout horizon are summarized in Table 6-5 below. Fire flow results are discussed in the following section.

Table 6-5 2051+ Model Results Summary

Result	Figure	Results Summary
Pressure	Figure 6-4 & Figure 6-5	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 38 psi in PLo-1. Max pressure in PHi-6 of 103 psi.
Linear Capacity	Figure 6-6	Headloss maintained under 2m/km with exception of Dunlop Dr.
Storage	Figure 6-7 & Figure 6-8	All ETs maintained above 75% full. Woods & Arkell Res minimum levels 58%.
Pump Station Flow	Figure 6-9 & Figure 6-10	All PSs operated below firm capacity. Max flow at Woods of 840 L/s. Max flow at Arkell of 350 L/s.

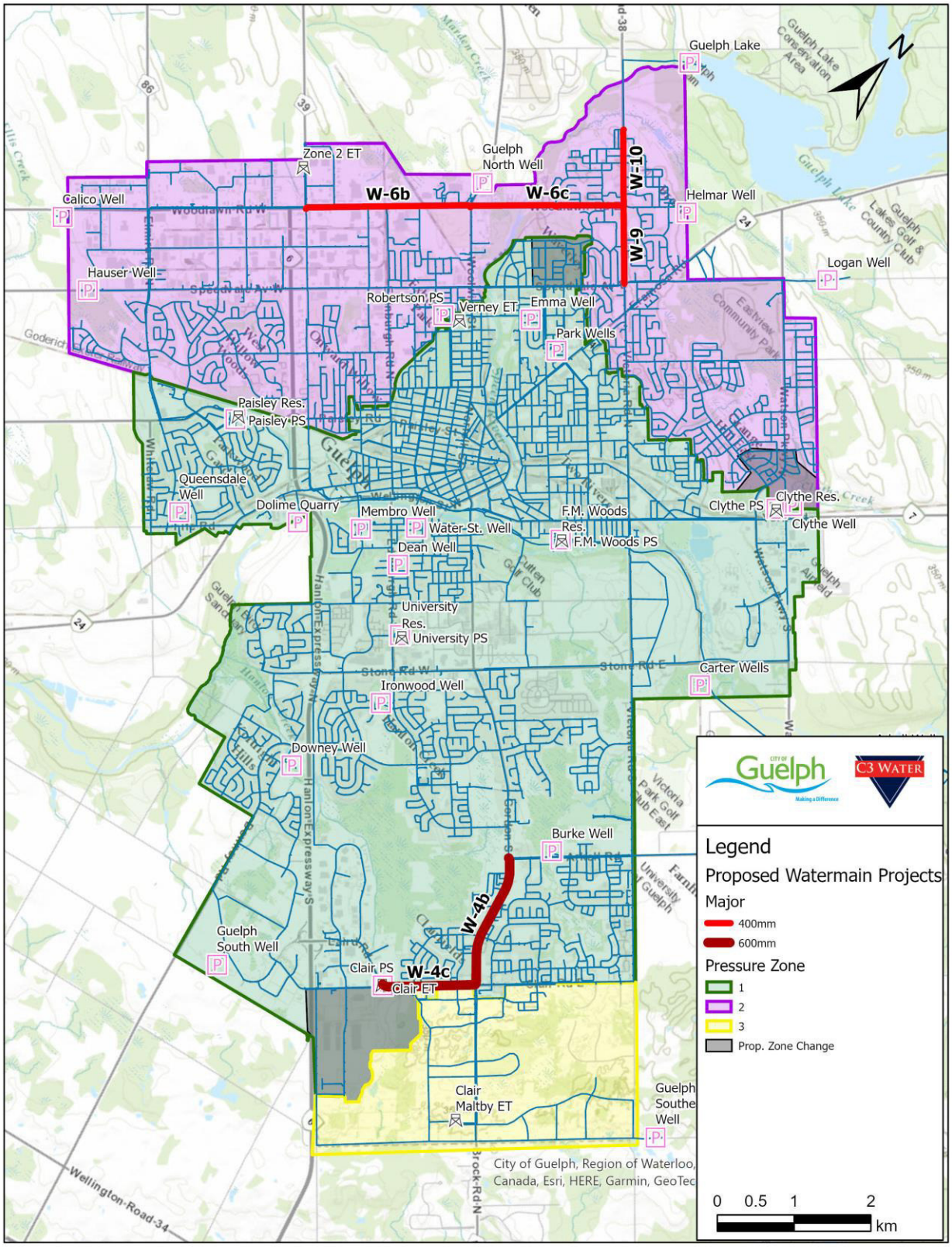

Figure 6-3 Water Projects – Long Term

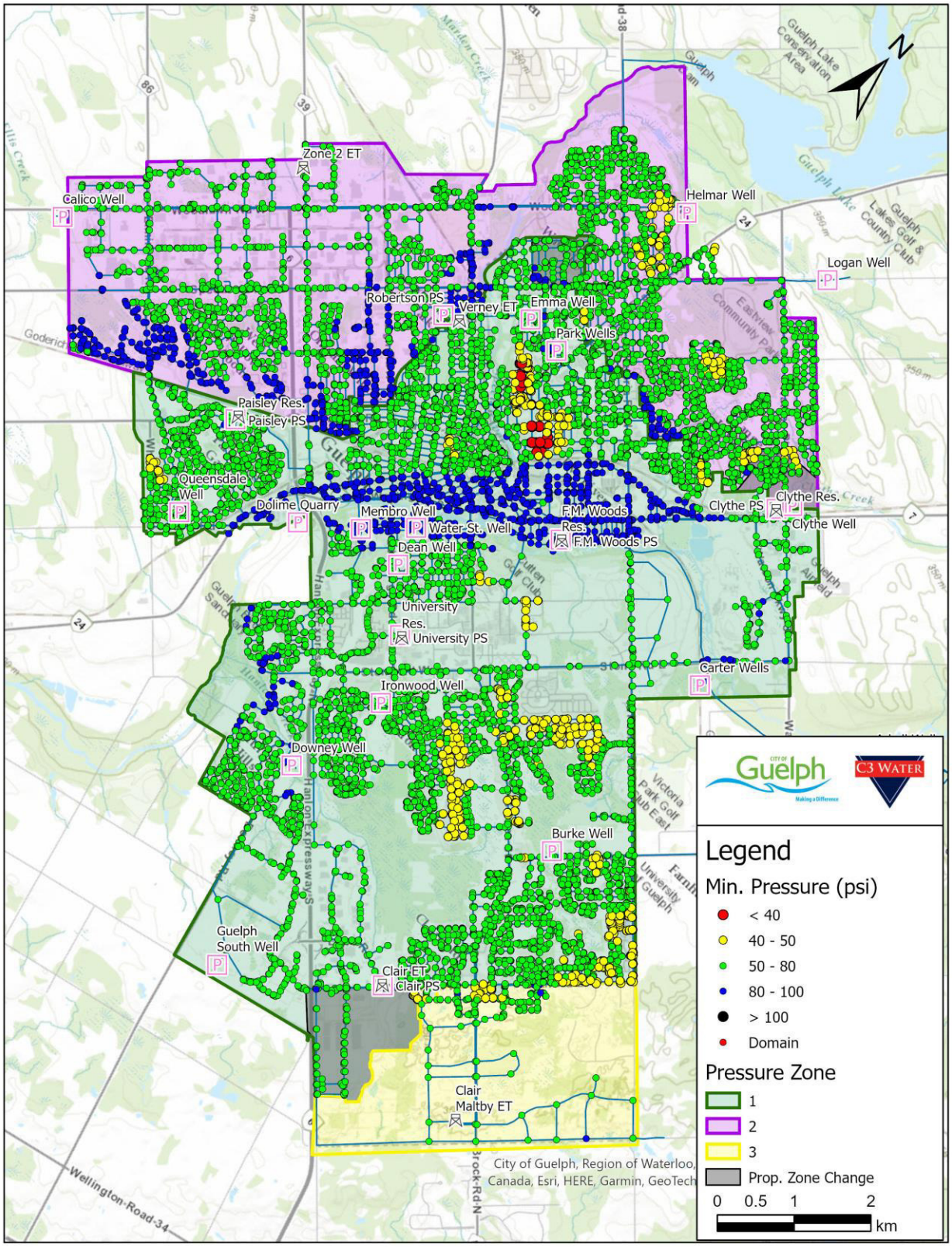

Figure 6-4 2051+ MDD Minimum Pressure – Proposed Upgrades

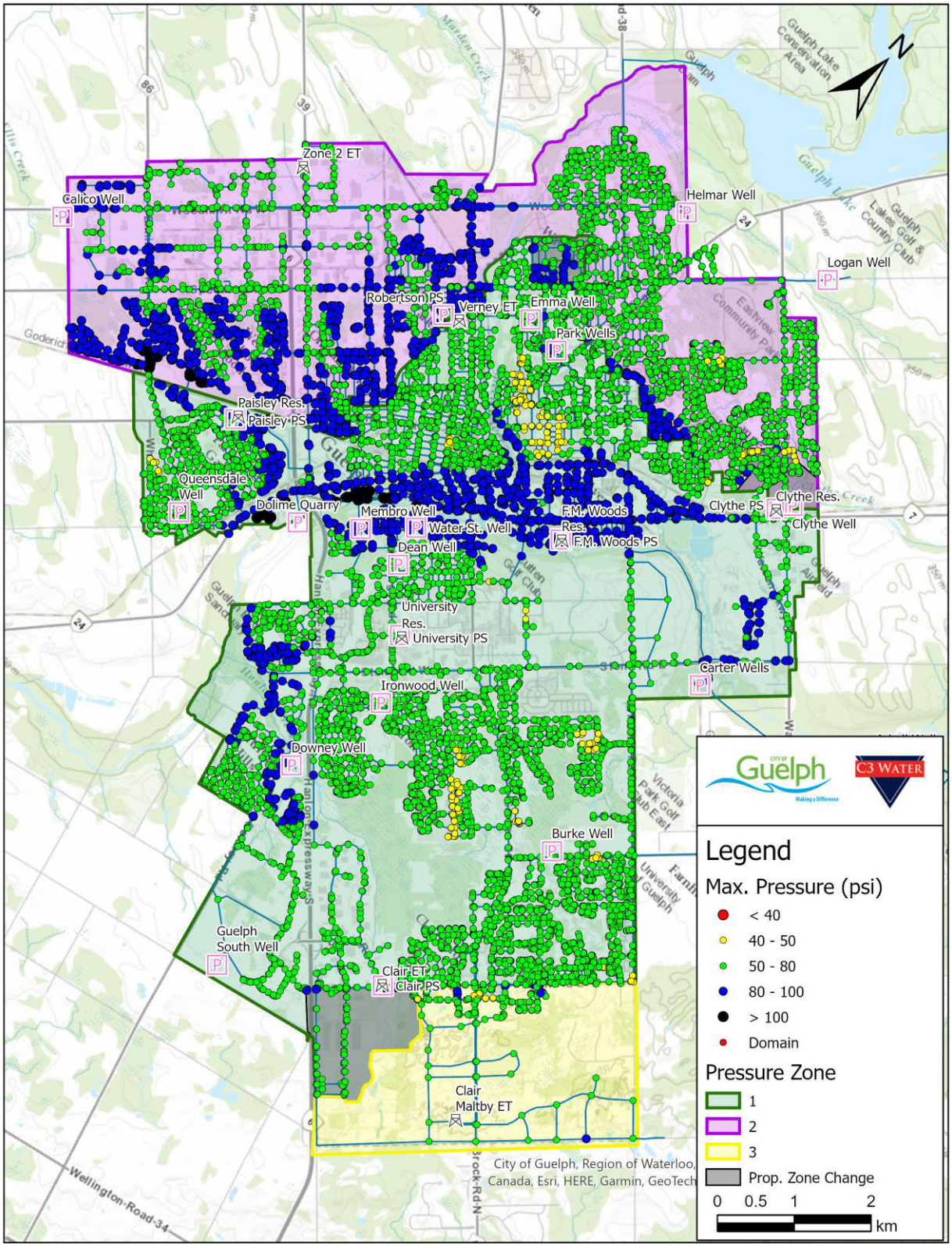

Figure 6-5 2051+ MDD Maximum Pressure – Proposed Upgrades

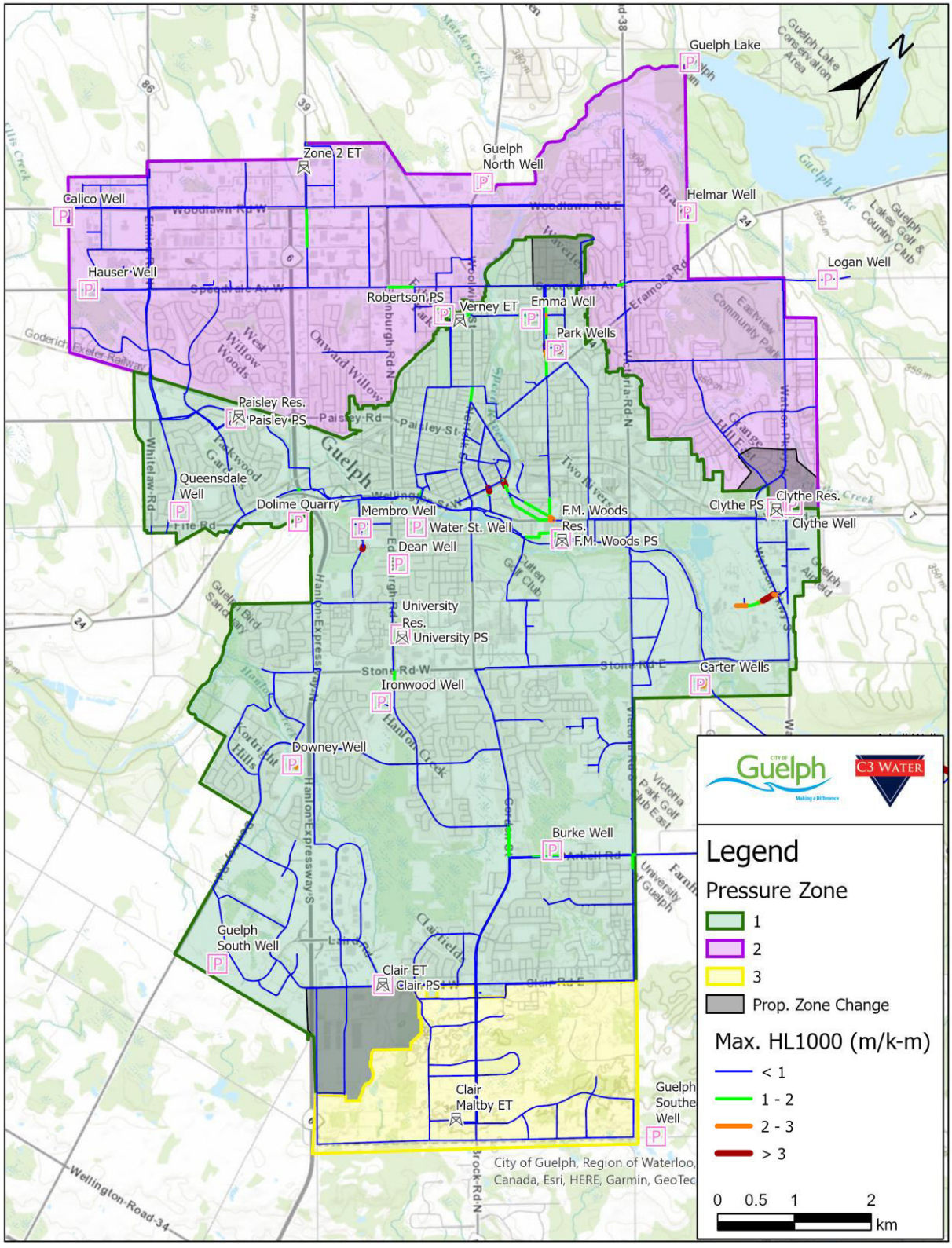

Figure 6-6 2051+ MDD Max Headloss – Proposed Upgrades

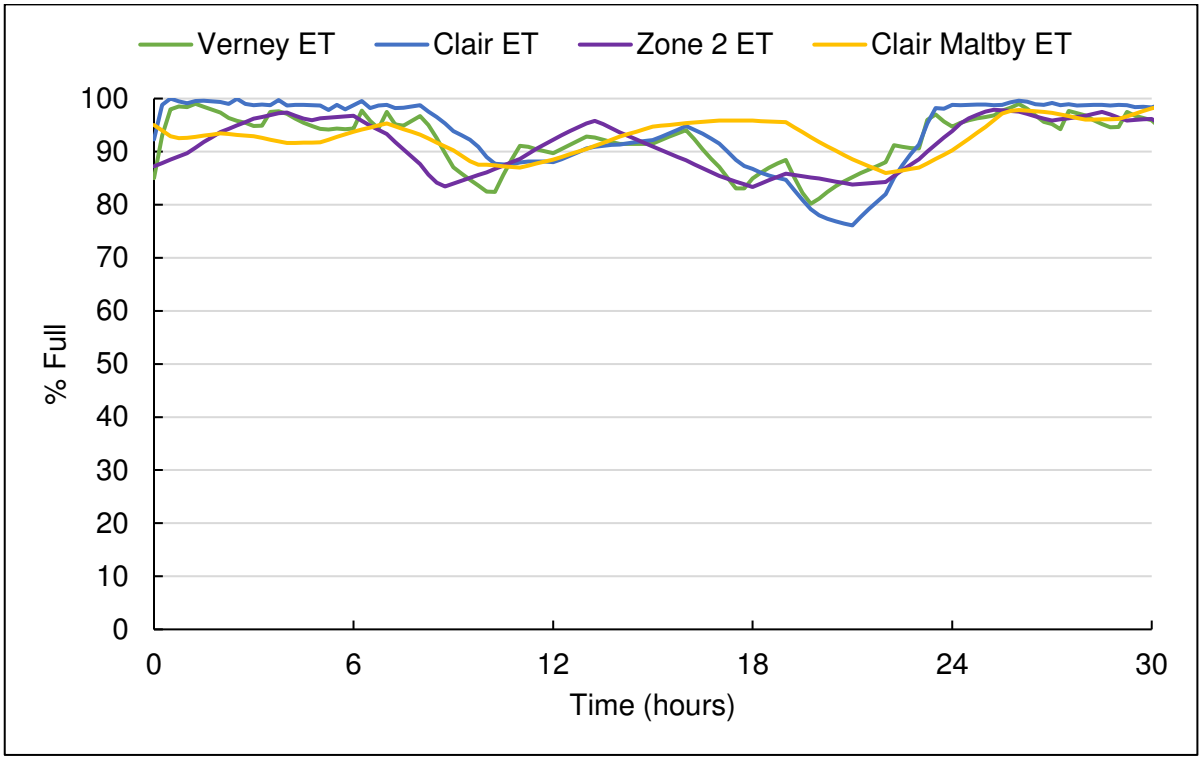

Figure 6-7 2051+ MDD ET Levels – Proposed Upgrades

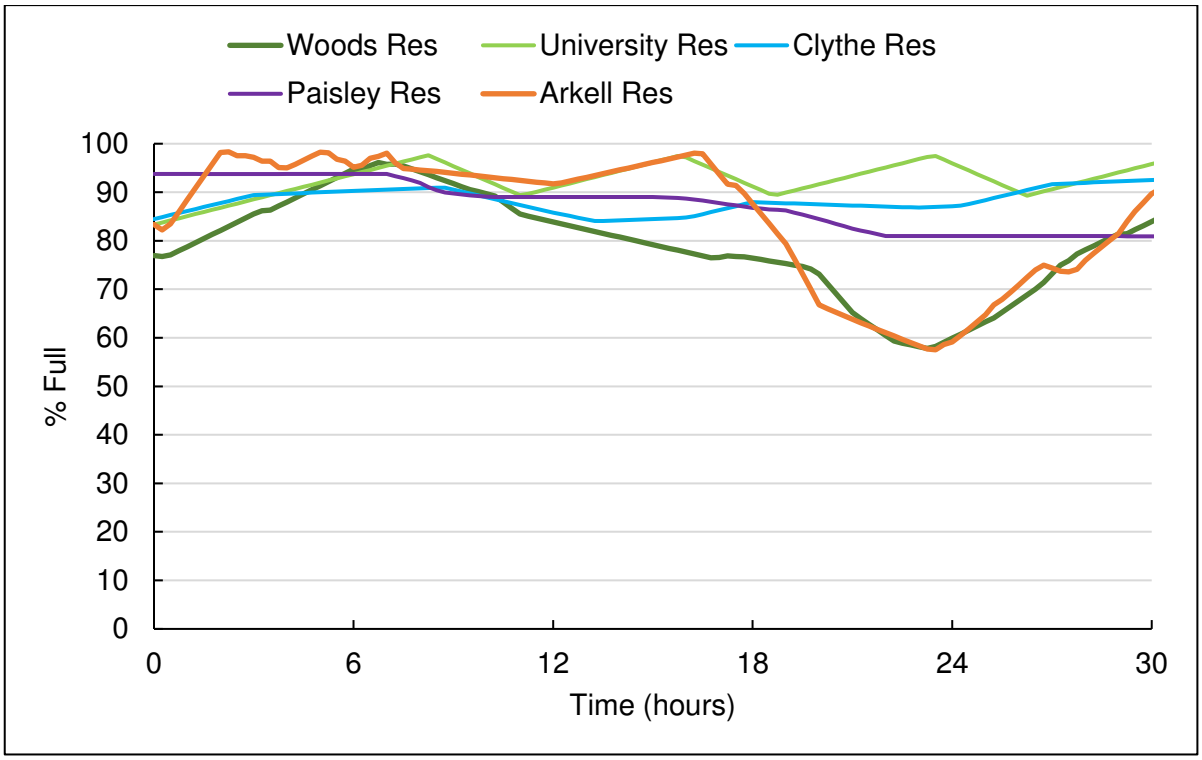

Figure 6-8 2051+ MDD Reservoir Levels – Proposed Upgrades

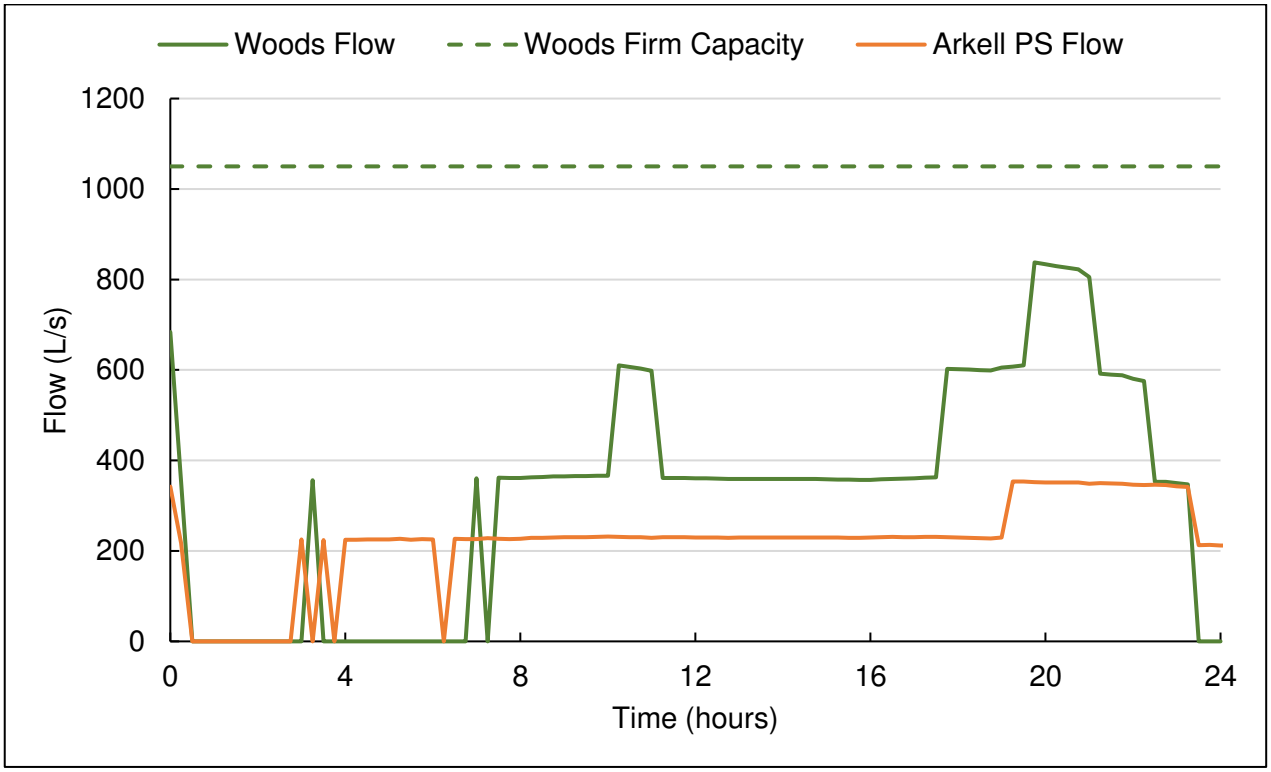

Figure 6-9 2051+ MDD PS Flows – Proposed Upgrades

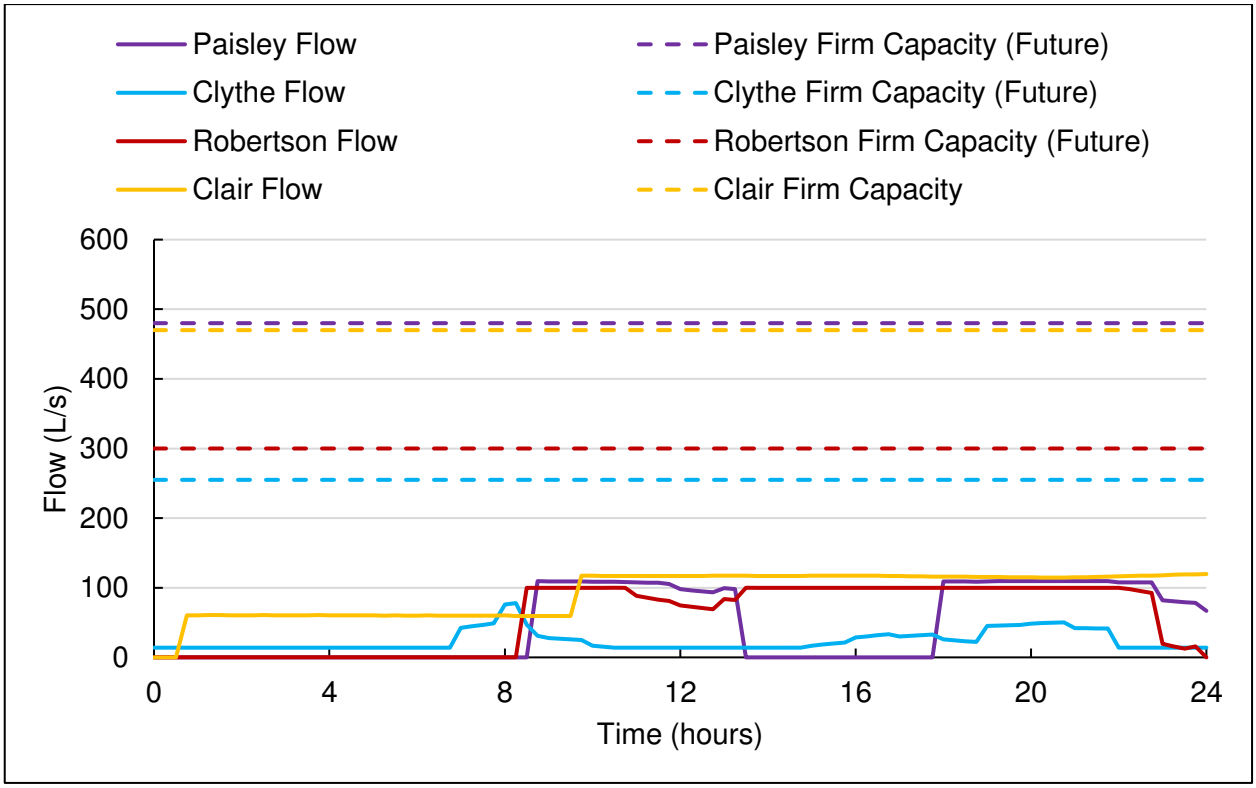

Figure 6-10 2051+ MDD PS Flows – Proposed Upgrades

6.1.3.1.1 *Long-Term Performance – Fire Flow*

Fire Flow results under 2051+ MDD conditions are presented in Figure 6-11 below. For this analysis, the CI replacement program was complete.

The minimum fire flow requirement of 30 L/s was met throughout the system. Areas with available flow of less than 80 L/s were found to be single-family residential.

Areas that were flagged as fire flow concerns in TM3A are highlighted in Figure 6-12 below.

- F1: Upgrades in the Old University residential area resulted in fire flows above 80 L/s at all locations with the exception of three (3) dead-ends. A number of CI replacement priorities were flagged in this area and are critical for achieving fire flow above 30 L/s. Hydrants along proposed 200mm watermains exceeded 150 L/s.
- F2: Upgrades resulted in fire flows primarily above 80 L/s in this. Proposed upgrades to Delhi Street resulted in fire flows above 250 L/s in the General Hospital area.
- F3: Upgrades resulted in fire flow above 80 L/s at all locations. Significantly improved capacity in this area due to upgrades on Exhibition, Woolwich and Speedvale.
- F4: Fire flows maintained above 80 L/s in this residential area due to CI replacement projects with the exception of three (3) dead-ends.
- Downtown: Fire flows in the Downtown area were primary above the highest requirement of 367 L/s as a result of the proposed downtown projects.

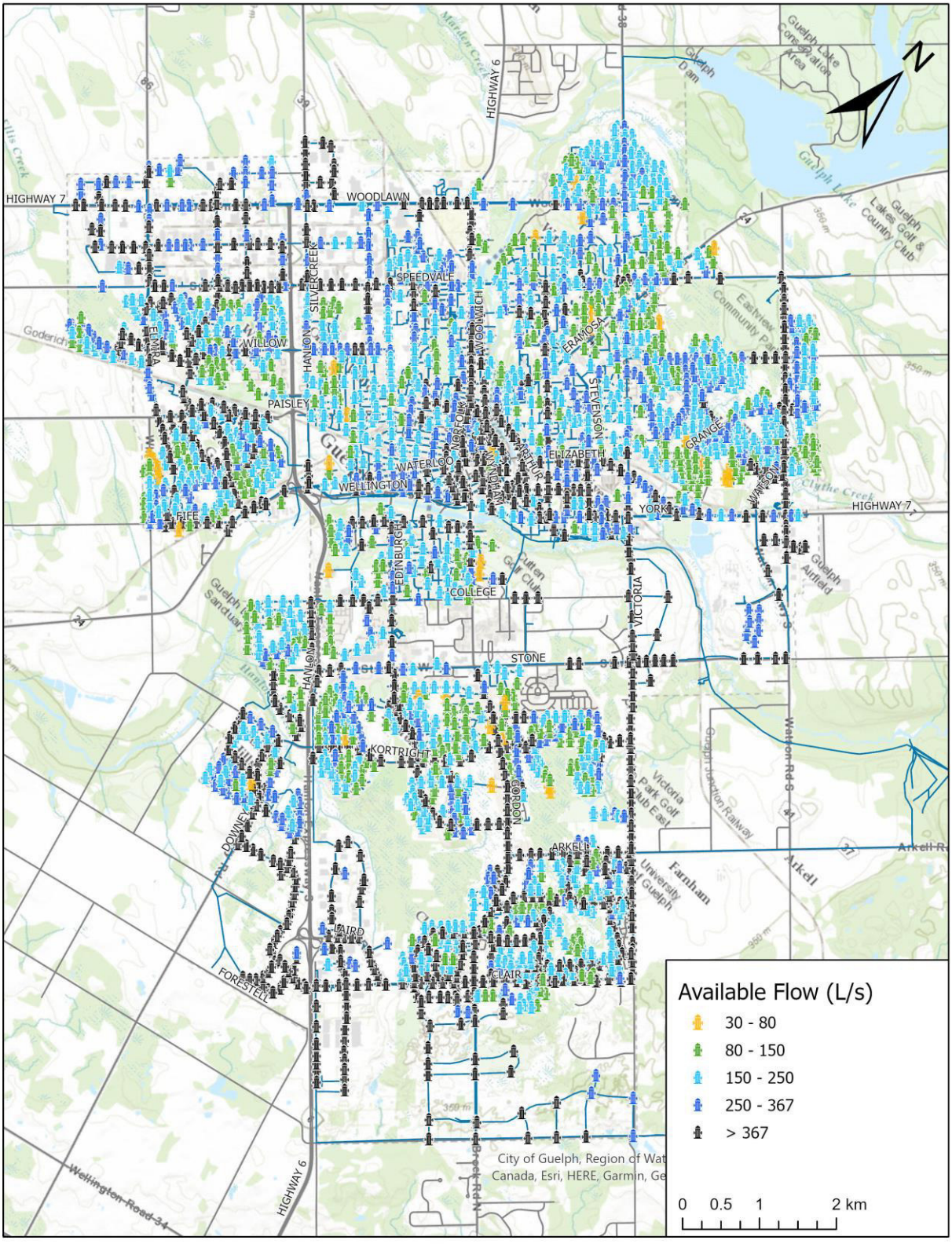

Figure 6-11 2051+ MDD Available Fire Flow – Proposed Upgrades Active –CI Replacement Complete

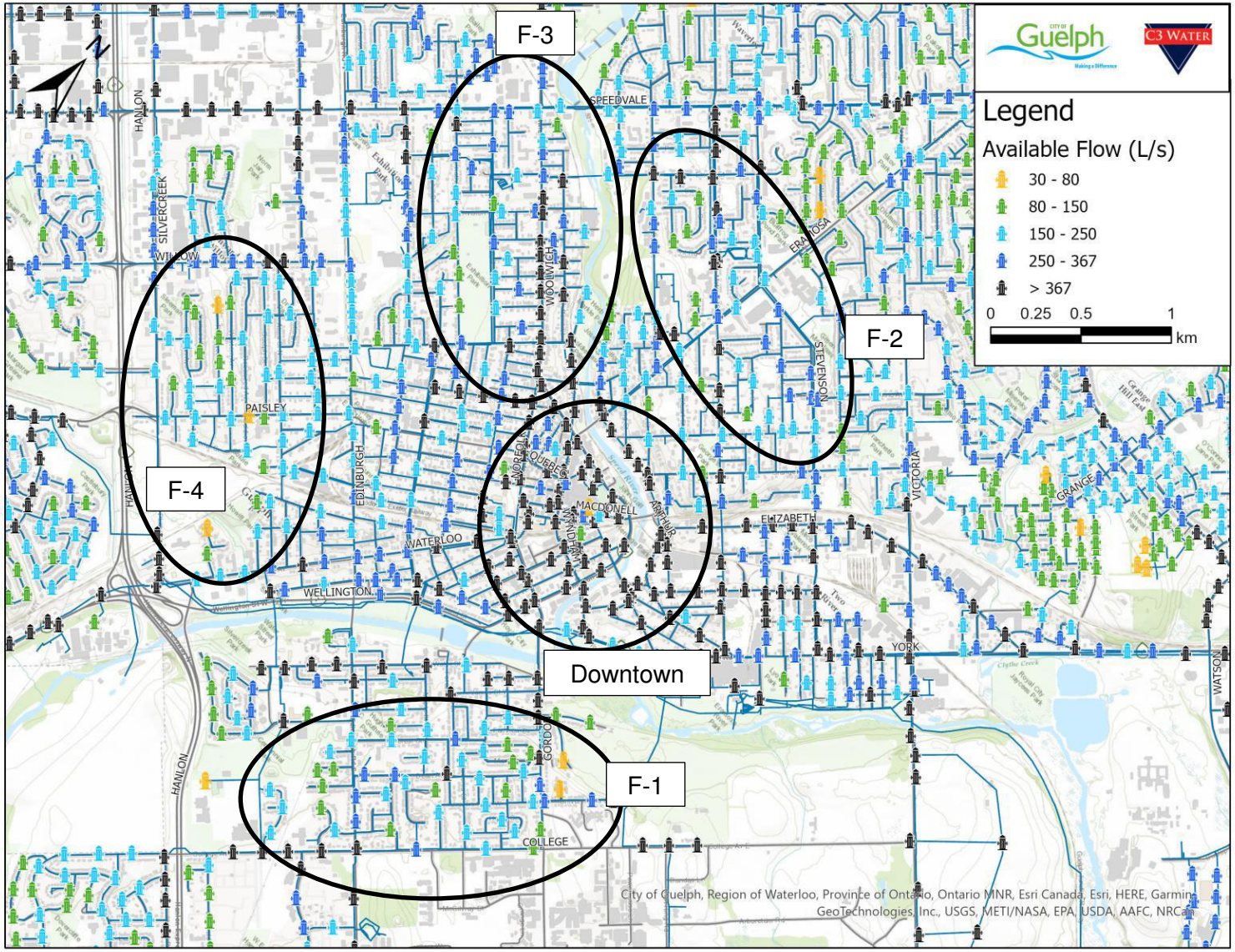

Figure 6-12 2051+ MDD Available Fire Flow – Proposed Upgrades Active –CI Replacement Complete

6.1.3.1.1.1 Fire Flow Analysis by Land Use

Fire flow results were assessed based on land use. For simplicity, land use was split into two categories: residential and industrial, commercial, institutional (ICI). Based on the criteria established in TM5 Design Criteria, LOS and Sensitivity Analysis, the fire flow requirements for future developments are:

- Residential: 80 – 200 L/s
- ICI: 150 – 250 L/s

The minimum fire flow requirement is 30 L/s for existing development based on Ontario Building Code (OBC) guidelines.

For this analysis, all proposed upgrades were complete including the CI replacement program.

The fire flow results for hydrants within residential land use areas in presented in Figure 6-13 below. A fire flow of greater than 200 L/s was achieved at most locations. The available fire flow was below 80 L/s dead-ends only.

The fire flow results for hydrants within ICI land use areas are present in Figure 6-14 below. The fire flow was above 250 L/s at the majority of ICI hydrants. Hydrants below 150 L/s were dead-ends.

Overall, the proposed upgrades were found to achieve sufficient available fire flows throughout the distribution system to meet the land use requirements.

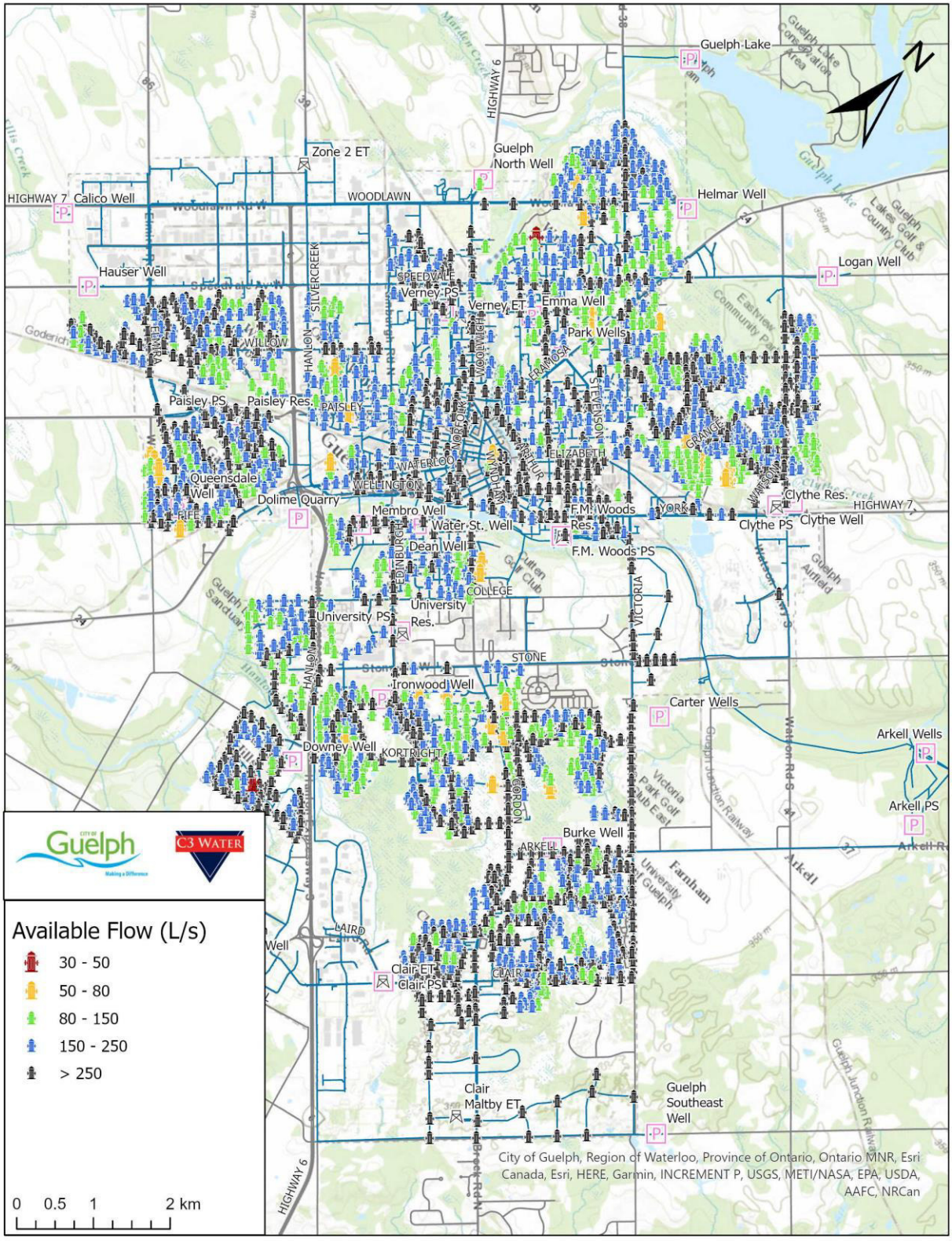

Figure 6-13 2051+ MDD Available Fire Flow – Proposed Upgrades Active –CI Replacement Complete – Residential Only

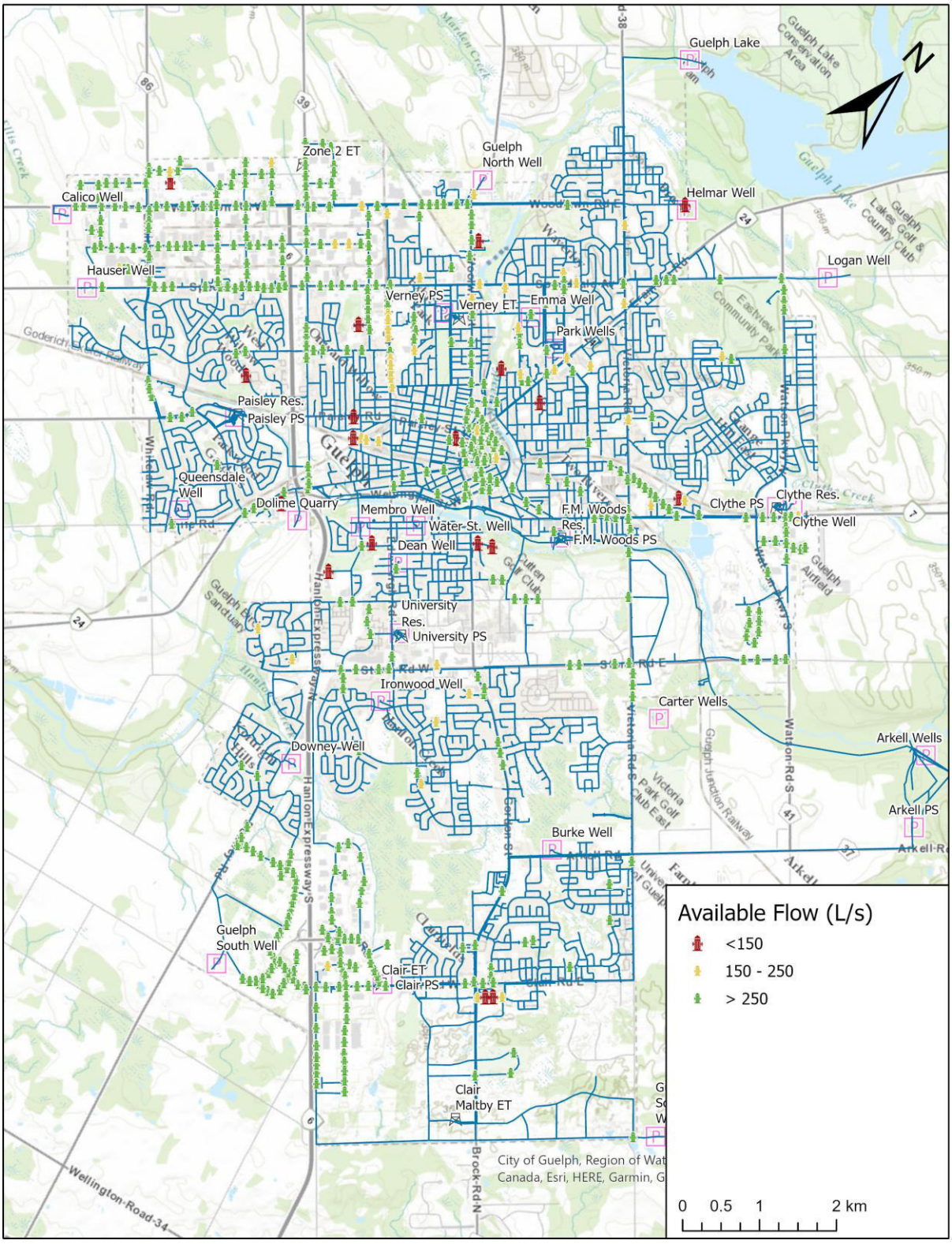

Figure 6-14 2051+ MDD Available Fire Flow – Proposed Upgrades Active –CI Replacement Complete – ICI Only

6.1.4 Water Projects Summary

Proposed watermain projects are shown in Figure 6-15 and summarized in Table 6-7 below. An estimated cost summary by time horizon is presented in Table 6-6 below.

Table 6-6 Summary of Water Cost Estimates by Time Horizon

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Major Linear (> 300mm)	$23,800,000	$14,000,000	$19,600,000	**$57,400,000**
Minor Linear (<= 300mm)	$14,300,000	$2,200,000	$0	**$16,500,000**
CI Replacement	$31,900,000	$32,000,000	$32,000,000	**$95,900,000**
Facilities	$10,200,000	$10,900,000	$0	**$21,100,000**
Arkell PS, Res & Watermain (B2)	$110,400,000	$0	$0	**$110,400,000**
Total	**$190,600,000**	**$59,100,000**	**$51,600,000**	**$301,300,000**

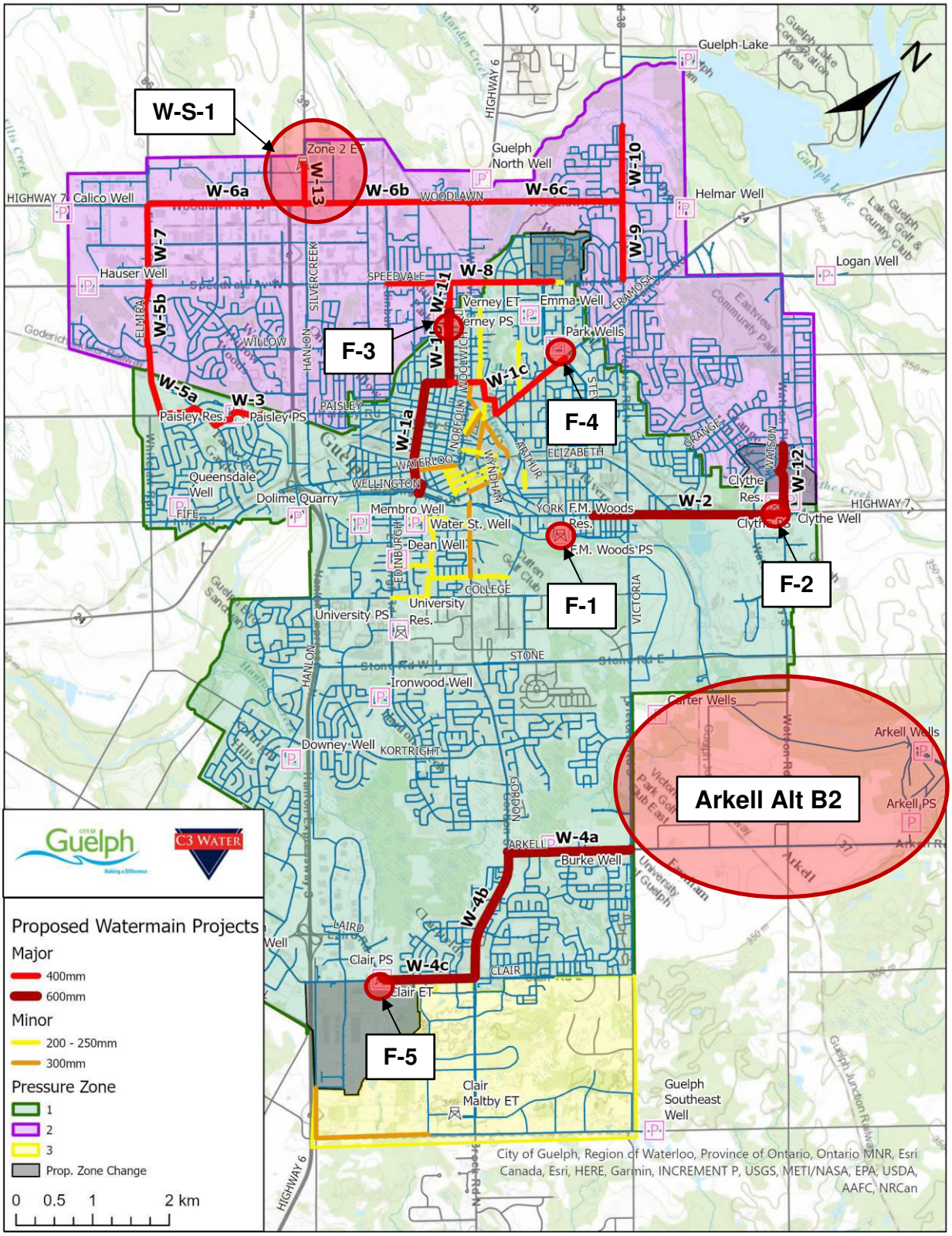

Figure 6-15 Summary of Water System Upgrades

Table 6-7 Summary of Water System Upgrades

Infrastructure Projects							
Project Number	**Timing**	**Triggers/Sequencing**	**Location**	**Summary of Upgrades**		**Purpose**	**Cost *****
Facilities							
F-1	Short-Term		F.M. Woods WTP	Upgrades to pump station, dual discharge feedermains. Upgrades to office spaces.		Replace aging infrastructure and improve redundancy within facility.	N/A*
F-2	Short-Term		Clythe WTP. PS & Reservoir	New WTP, Pump Station and 6.9 ML Reservoir		Bring Clythe Well online. Increase storage in Zone 2 and pump capacity on east side of Zone 2.	N/A*
F-3	Short-Term		Verney BPS	New BPS to replace existing Robertson		Increase pump capacity	$ 7,600,000
F-4	Short-Term	Prior to Clythe Upgrades (F-2)	Park Zone 2 PS	New PS at Park Wells Site		Supply to the east side of Zone 2	$ 2,600,000
F-5	Mid-Term	Clair Maltby ET	Clair BPS	Retrofit Existing PS		Replace existing pumps with suitable size once Clair Maltby ET is online.	$ 400,000
W-S-1	Mid-Term	Speedvale ET Lifecycle	North end of Zone 2.	6ML Elevated Tank		New ET to Improve Zone 2 floating storage. Increased volume and improved location.	$ 10,500,000
Arkell Alt B2	Short-Term	Existing Criticality	New Arkell PS, Reservoir and WM	New PS, Reservoir and Watermain		Transfer water from Arkell/Carter Wellfields supply redundancy/resiliency	$ 110,400,000
Project Number	**Timing**	**Triggers/Sequencing**	**Location**	**Size (mm)**	**Length (m)**	**Purpose**	**Cost****
Major Linear							
W-1a	Short-Term	Growth	Yorkshire from Wellington to London & Exhibition	600	1850	Improves downtown looping and connectivity to Verney ET. Reduces high headloss associated with future growth.	$ 4,900,000
W-1b	Short-Term	Growth	Exhibition from London to Verney	600	940		$ 2,500,000
W-1c	Mid-Term	Growth	London/Eramosa from Exhibition to Stevenson	400	2140		$ 3,600,000
W-2	Short-Term	Growth	York from Brockville to Watson	600	2500	Improve connectivity to Clythe PS fill.	$ 6,700,000
W-3	Short-Term	Growth	Paisley from Hanlon to Paisley PS	400	400	Improve Connectivity to Paisley PS fill.	$ 600,000
W-4a	Mid-Term	Arkell PS & Growth	Arkell from Gordon to Victoria	600	1600	Improve connectivity between future Arkell PS and Clair ET.	$ 4,300,000
W-4b	Long Term	Growth	Gordon from Arkell to Clair	600	1760		$ 4,700,000
W-4c	Long Term	Growth	Clair from Gordon to ET	600	1200		$ 3,200,000
W-5a	Short-Term	Existing Criticality	Imperial/Elmira from Paisley PS to Willow	400	1970	Redundancy for Paisley PS discharge.	$ 3,100,000
W-5b	Mid-Term	Zone 2 ET	Elmira from Speedvale to Willow	400	800		$ 1,300,000
W-6a	Mid-Term	Zone 2 ET	Woodlawn from Elmira to Silvercreek	400	2030	Improve East/West transmission. Reduce criticality of Paisley and Clythe PSs. Redundancy for Speed River Crossing.	$ 3,200,000
W-6b	Long Term	Growth	Woodlawn from Silvercreek to Woolwich	400	2160		$ 3,400,000
W-6c	Long Term	Growth	Woodlawn from Woolwich to Victoria	400	2022		$ 3,400,000
W-7	Long Term	Growth	Elmira from Speedvale to Woodlawn	400	1070	Improve system looping.	$ 1,700,000
W-8	Short-Term	Existing Criticality & Growth	Speedvale from Edinburgh to Manhattan	400	2150	Complete east/west Speedvale transmission main.	$ 3,400,000

Project Number	Timing	Triggers/Sequencing	Location	Size (mm)	Length (m)	Purpose	Cost**
W-9	Long Term	Growth	Victoria from Speedvale to Woodlawn	400	1010	Improve system looping.	$ 1,600,000
W-10	Long Term	Guelph Lake WTP	Victoria from Woodlawn to Goldenview Drive	400	1000	Connectivity to Guelph Lake supply.	$ 1,600,000
W-11	Short-Term	Verney BPS (F-3)	Exhibition from Robertson/Verney PS to Speedvale	400	375	Improve watermain capacity at Verney PS discharge	$ 600,000
W-12	Short-Term	Clythe PS (F-2) and Zone Boundary Change	Watson from Clythe PS to Grange	600	760	Improve watermain capacity at Clythe PS discharge	$ 2,000,000
W-13	Mid-Term	Zone 2 ET	Silvercreek from Woodlawn to Proposed Zone 2 ET	400	900	Connection to proposed Zone 2 ET	$ 1,600,000
Minor Linear							
W-M-1	Short-Term	Existing Capacity/Growth	Woolwich from Norfolk to Macdonnell	300	930	Improve Downtown Looping	$ 1,000,000
W-M-2	Short-Term	Existing Capacity/Growth	Cardigan from Norwich to Woolwich	200	260	Local Downtown Improvements	$ 200,000
W-M-3	Short-Term	Existing Capacity/Growth	Wyndham from Woolwich to Carden	300	480	Local Downtown Improvements	$ 500,000
W-M-4	Short-Term	Existing Capacity/Growth	Macdonell from Norfolk to Carden	200	440	Local Downtown Improvements	$ 400,000
W-M-5	Short-Term	Existing Capacity/Growth	Dublin from Waterloo to Wellington	200	400	Local Downtown Improvements	$ 300,000
W-M-6	Short-Term	Existing Capacity/Growth	Waterloo from Yorkshire to Essex	300	500	Improve Downtown Looping	$ 500,000
W-M-7	Short-Term	Growth	Yarmouth from Woolwich to Quebec	200	320	Local Downtown Improvements	$ 300,000
W-M-8	Short-Term	Growth	Baker from Woolwich to Quebec	300	300	Local Downtown Improvements	$ 300,000
W-M-9	Short-Term	Growth	Essex from Dublin to Waterloo	200	170	Local Downtown Improvements	$ 100,000
W-M-10	Short-Term	Growth	Nottingham from Dublin to Gordon	200	180	Local Downtown Improvements	$ 200,000
W-M-11	Short-Term	Growth	Fountain from Dublin to Neeve	200	550	Local Downtown Improvements	$ 500,000
W-M-12	Short-Term	Growth	Surrey from Dublin to Neeve	200	610	Local Downtown Improvements	$ 500,000
W-M-13	Short-Term	Growth	Wellington from Gordon to Neeve	300	480	Improve Downtown Looping	$ 500,000
W-M-14	Short-Term	Growth	Duke from Alice to existing PVC	200	220	Local Downtown Improvements	$ 200,000
W-M-15	Short-Term	Growth	Woolwich from London to Norwich	300	210	Improve Downtown Looping. Connection to W-1	$ 200,000
W-M-16	Short-Term	Existing Criticality/Growth	Gordon from York to University	300	1110	Reduce criticality of University River Crossing.	$ 1,400,000
W-M-17	Short-Term	Existing Capacity Constraints	Dufferin from Mac to London	200	1300	Connectivity between London and Woolwich. Local FF improvements.	$ 1,100,000
W-M-18	Short-Term	Existing Capacity Constraints	Delhi from Eramosa to existing 250mm	250	690	Connectivity between W-1 on Eramosa and Verney Feedermain. Improve fire flow capacity to Hospital	$ 600,000
W-M-19	Short-Term	W-8	Speedvale from East of Woolwich to Stevenson	200	1020	Improved transmission north end of Zone 1 and connectivity to Stevenson	$ 900,000
W-M-20	Short-Term	Existing Capacity Constraints	University/College from River Crossing to Edinburgh	200	1760	Improve Capacity and Looping in University Area	$ 1,500,000
W-M-21	Short-Term	Existing Capacity Constraints	Water/Albert from River Crossing to Gordon	200	790	Improve Capacity and Looping in University Area	$ 700,000
W-M-22	Short-Term	Existing Capacity Constraints	Dean from Edinburgh to Talbot	200	520	Improve Capacity and Looping in University Area	$ 400,000
W-M-23	Short-Term	Existing Capacity Constraints	Talbot/Forest Hill from Water to University	200	850	Improve Capacity and Looping in University Area	$ 700,000
W-M-24	Short-Term	W-8	Speedvale from Westmount to east of Woolwich	200	930	Improve watermain capacity near Robertson PS discharge	$ 800,000
W-M-25	Mid-Term	Clair Maltby ET	Crawley to Maltby	300	2130	Improve West Zone 3 Looping	$ 2,200,000
W-M-26	Short-Term	W-2	York Road from Brockville to Clythe PS	300	450	Improve HL & FF	$ 500,000

Project Number	Timing	Triggers/Sequencing	Location	Size (mm)	Length (m)	Purpose	Cost**
W-CI-1a	Short-Term	Existing Capacity Constraints	Small Diameter CI WMs throughout system	150	13600	Improve existing fire flow constraints	$ 10,400,000
W-CI-1b	Short-Term	Existing Capacity Constraints	Small Diameter CI WMs throughout system	150	28000	Improve existing fire flow constraints	$ 21,500,000
W-CI-2	Mid-Term	Existing Capacity Constraints	Small Diameter CI WMs throughout system	150	41600	Improve existing fire flow constraints	$ 32,000,000
W-CI-3	Long Term	Existing Capacity Constraints	Small Diameter CI WMs throughout system	150	41600	Improve existing fire flow constraints	$ 32,000,000
Infrastructure Total							**$ 301,300,000**

*Costs not included for projects previously approved through WSMP.
** Watermain unit costs include 20% Contingency & 15% Engineering
***Facility costs include 50% Contingency & 15% Engineering

6.2 Wastewater Servicing Implementation

6.2.1 Short Term Recommendations (Present – 2031)

There are a total of 15 projects required in the short term to address capacity constraints and eliminate system surcharge. Other than the Manor Park Siphon upgrade, all projects are required under existing WWF conditions. No system upgrades are required under existing DWF conditions. The projects required in the short term include the following:

Table 6-8 Short Term Wastewater Improvements

Project Number	Timing	Location
WW1-1	Short-Term	Silvercreek Parkway
WW1-2	Short-Term	Westwood Rd
WW2-1	Short-Term	Victoria Rd & Waverley Dr
WW2-2	Short-Term	Waverley Dr & Stevenson St
WW2-3	Short-Term	Wilton Rd, Inverness Dr & Speedvale Ave
WW3-1	Short-Term	Exhibition Park / Kathleen St
WW4-1	Short-Term	Audin Rd & Victoria Rd
WW4-4	Short-Term	Victoria Rd
WW4-5	Short-Term	Summit Ridge Dr
WW5-1	Short-Term	York Rd & Wellington St
WW5-4	Short-Term	Quebec St & Wyndham St
WW5-5	Short-Term	Woolwhich St
WW5-6	Short-Term	Waterloo Ave
WW6-1	Short-Term	College Ave
S1	Short-Term	Manor Park Crescent / Speed River Siphon
S2	Short-Term	Municipal Street Siphon Decommissioning

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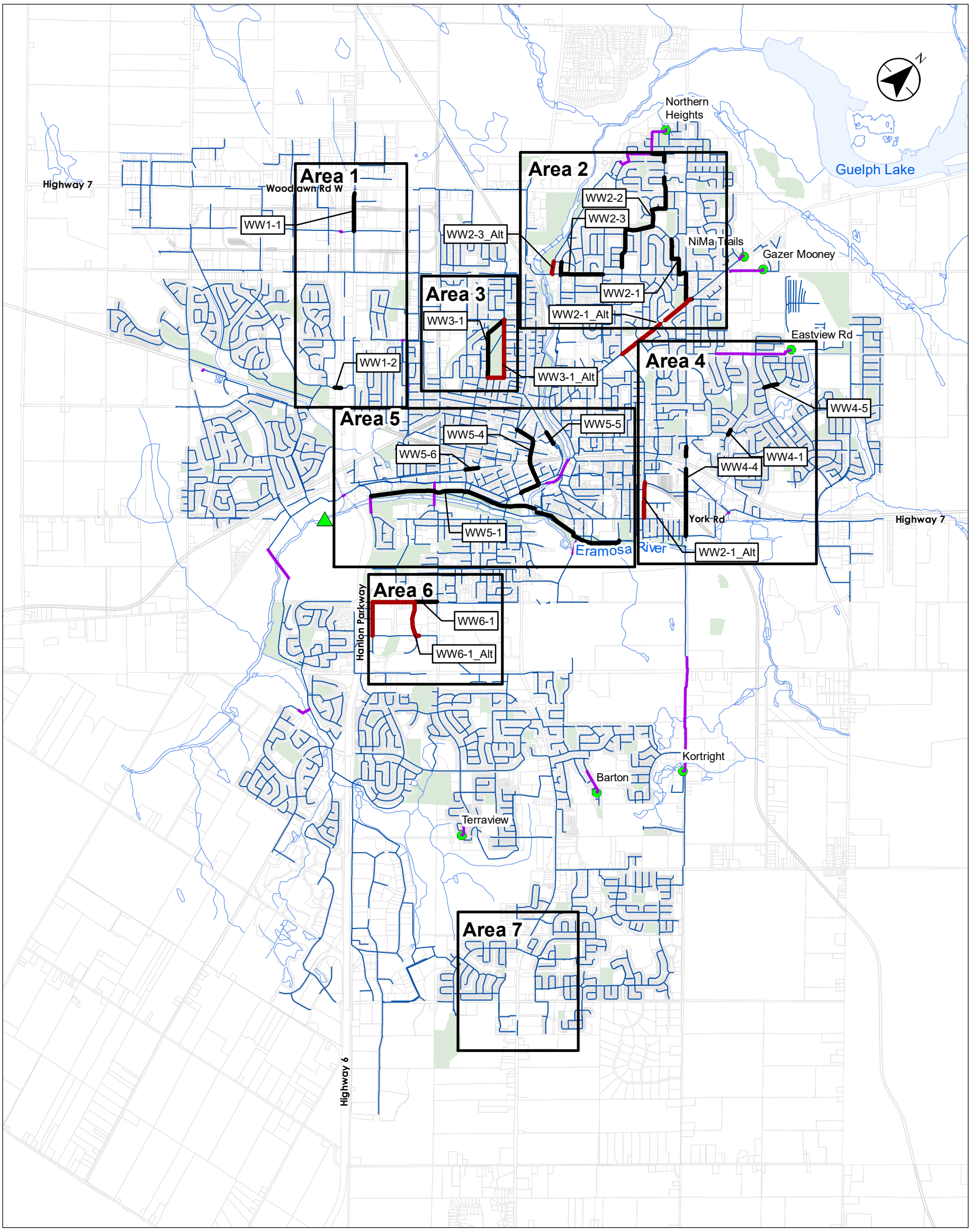

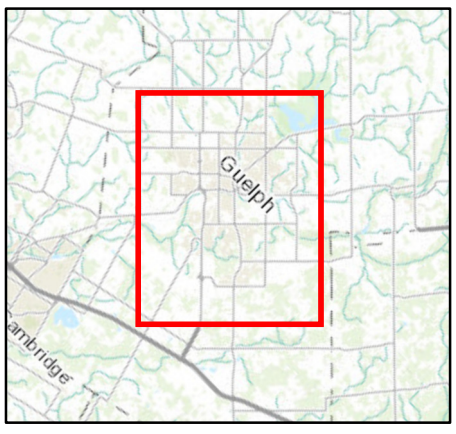

Legend

- Wastewater Upgrade
- Wastewater Upgrade (Alternate)
- Pump Station
- Water Resource Recovery Center
- Watercourse
- Railway
- Property
- Sanitary Sewer
- Forcemain / Siphon

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Stantec

C3 WATER

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
6-16

Title
Wastewater Short Term Upgrades

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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6.2.2 Mid Term Recommendations (2032 – 2041)

There are a total of 4 projects required in the mid-term to address capacity constraints and eliminate system surcharge. The projects required in the mid-term include the following:

Table 6-9 Mid Term Wastewater Improvements

Project Number	Timing	Location
WW2-4	Mid-Term	Speedvale Ave
WW4-2	Mid-Term	York Rd & Beaumont Cres.
WW5-2	Mid-Term	Waterloo Ave
WW7-1	Mid-Term	Clair Rd, Farley Dr & Clairfields Dr / Clair Rd (Alternate)

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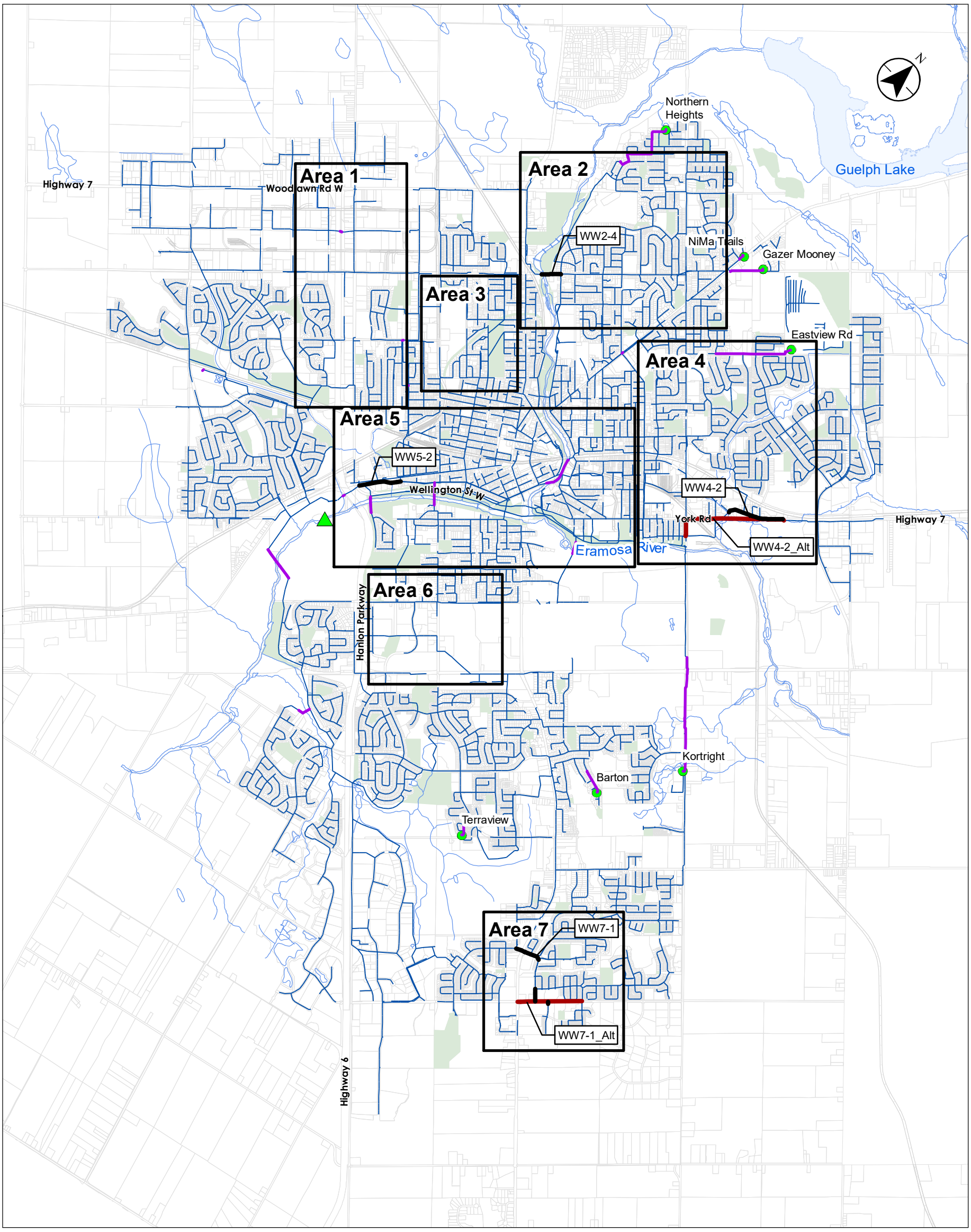

Legend

- Wastewater Upgrade
- Wastewater Upgrade (Alternate)
- Pump Station
- Water Resource Recovery Center
- Watercourse
- Railway
- Property
- Sanitary Sewer
- Forcemain / Siphon

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Stantec

C3 WATER

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
6-17

Title
Wastewater Mid Term Upgrades

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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6.2.3 Long-Term Recommendations (2042 – 2051+)

Only 1 (one) project is required in the long-term to address capacity constraints and eliminate system surcharge. This is project 5-3 along Bristol St and Waterloo Ave.

Table 6-10 Long Term Wastewater Improvements

Project Number	Timing	Location
5-3	Long Term	Bristol St

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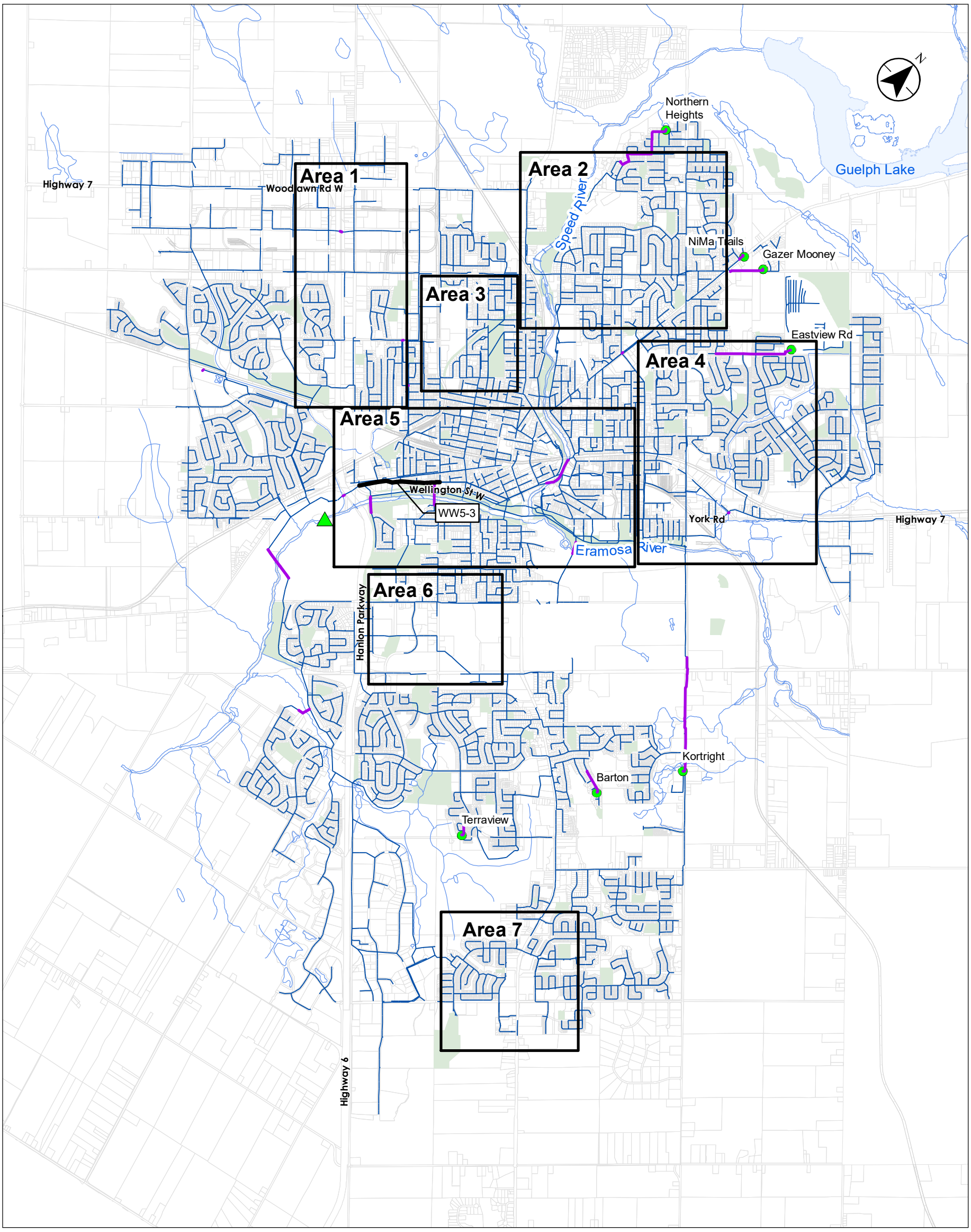

Legend

- Wastewater Upgrade
- Pump Station
- Water Resource Recovery Center
- Watercourse
- Railway
- Property
- Sanitary Sewer
- Forcemain / Siphon

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Notes

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Stantec

C3 WATER

Project Location
City of Guelph

165640298

Client/Project
CITY OF GUELPH WATER AND WASTEWATER SERVICING MASTER PLAN – TM3 WATER AND WASTEWATER SERVICING RECOMMENDATIONS

Figure No.
6-18

Title
Wastewater Long Term Upgrades

6.2.4 Wastewater Projects Summary

In total there are 20 projects identified for the wastewater system to address capacity constraints, eliminate system surcharge, address operational issues. Alternate improvements concepts were identified and tested in 7 locations. These alternate improvements are intended to take advantage of existing/planned City works, improve operational efficiency / flexibility, and to move existing sewers/trunks into transportation ROWs and out of easements. An overall system improvement summary, including sewer lengths, diameters and cost estimates is provided below in Table 6-13 and Table 6-14 (alternate improvements).

The following tables summarize the proposed infrastructure upgrade costs by type and development horizon.

Table 6-11 Wastewater System Upgrades Cost Summary Horizon

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Major Linear (> 300mm)	$57,990,000	$8,180,000	$3,680,000	**$69,850,000**
Minor Linear (<= 300mm)	$4,260,000	$0	$0	**$4,260,000**
Capital Works	$5,500,000	$0	$0	**$5,500,000**
Total	**$67,750,000**	**$8,180,000**	**$3,680,000**	**$79,610,000**

Table 6-12 Wastewater System Upgrades Cost Summary Horizon (Alternate Improvements)

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Major Linear (> 300mm)	$65,220,000	$14,230,000	$3,680,000	**$83,130,000**
Minor Linear (<= 300mm)	$4,260,000	$0	$0	**$4,260,000**
Capital Works	$5,500,000	$0	$0	**$5,500,000**
Total	**$74,980,000**	**$14,230,000**	**$3,680,000**	**$92,890,000**

Table 6-13 Summary of Wastewater System Upgrades

Project Number	Timing	Location	Size (mm)	Length (m)	Purpose	Cost
WW1-1	Existing	Silvercreek Parkway	375	472	Capacity	$3,340,000
WW1-2	Existing	Westwood Rd	300	82	Capacity	$2,710,000
Area 1 Total						**$6,050,000**
WW2-1	Existing	Victoria Rd & Waverley Dr	300 / 375	1032	Capacity	$3,240,000
WW2-2	Existing / Future	Waverley Dr & Stevenson St	300 / 375 / 450	1593	Capacity	$5,260,000
WW2-3	Existing	Wilton Rd, Inverness Dr & Speedvale Ave	150 / 300 / 375	1110	Capacity	$3,610,000
WW2-4	Future	Speedvale Ave	375	237	Capacity	$740,000
Area 2 Total						**$12,850,000**
WW3-1	Existing	Exhibition Park / Kathleen St	375 / 450	819	Capacity	$2,710,000
Area 3 Total						**$2,710,000**
WW4-1	Existing	Audin Rd & Victoria Rd	300 / 375	186	Capacity	$680,000
WW4-2	Future	York Rd & Beaumont Cres.	750	707	Capacity	$3,130,000
WW4-4	Existing	Victoria Rd	375	999	Capacity	$5,030,000
WW4-5	Existing	Summit Ridge Dr	300	173	Capacity	$530,000
Area 4 Total						**$9,370,000**
WW5-1	Existing	York Rd & Wellington St	1200 / 1350	3284	Capacity	$27,820,000
WW5-2	Future	Waterloo Ave	825	528	Capacity	$2,660,000
WW5-3	Future	Bristol St	600	1014	Capacity	$3,680,000
WW5-4	Existing	Quebec St & Wyndham St	375 - 600	1066	Capacity	$5,450,000
WW5-5	Existing	Woolwhich St	300	167	Capacity	$510,000
WW5-6	Existing	Waterloo Ave	300	166	Capacity	$510,000
Area 5 Total						**$40,630,000**
WW6-1	Existing	College Ave	300 / 375	281	Capacity	$850,000
Area 6 Total						**$850,000**
WW7-1	Future	Clair Rd, Farley Dr & Clairfields Dr	250 / 300 / 525	506	Capacity	$1,650,000
Area 7 Total						**$1,650,000**
S1	Future	Manor Park Crescent / Speed River	250	130	Operational / Redundancy	$1,500,000
S2	Future	Municipal Street / Speed River	250 / 300 / 450 / 525	1113	Operational / Redundancy	$4,000,000
Operational Total						**$5,500,000**
Grand Total						**$79,610,000**

Table 6-14 Summary of Wastewater System Upgrades (Alternate Improvements)

Project Number	Timing	Location	Size (mm)	Length (m)	Purpose	Cost
WW1-1	Existing	Silvercreek Parkway	375	472	Capacity	$3,340,000
WW1-2	Existing	Westwood Rd	300	82	Capacity	$2,710,000
Area 1 Total						**$6,050,000**
WW2-1	Existing	Eramosa Rd & Stevenson St	300 / 375 / 675	1534	Capacity / Operational	$5,220,000
WW2-2	Existing / Future	Waverley Dr & Stevenson St	300 / 375 / 450	1517	Capacity	$4,930,000
WW2-3	Existing	Wilton Rd, Inverness Dr & Speedvale Ave	150 / 300 / 375	1127	Capacity / Operational	$3,830,000
WW2-4	Future	Speedvale Ave	375	237	Capacity	$740,000
Area 2 Total						**$14,720,000**
WW3-1	Existing	Exhibition St / London Rd	375 / 450	926	Capacity / Operational	$3,110,000
Area 3 Total						**$3,110,000**
WW4-1	Existing	Audin Rd & Victoria Rd	300 / 375	186	Capacity	$680,000
WW4-2	*Existing*	York Rd & Victoria Rd	675 / 900	1364	Capacity / Operational	$8,460,000
WW4-4	Existing	Victoria Rd	375	999	Capacity	$5,030,000
WW4-5	Existing	Summit Ridge Dr	300	173	Capacity	$530,000
Area 4 Total						**$14,700,000**
WW5-1	Existing	York Rd & Wellington St	1200 / 1350	3284	Capacity	$27,820,000
WW5-2	Future	Waterloo Ave	825	528	Capacity	$2,660,000
WW5-3	Future	Bristol St	600	1014	Capacity	$3,680,000
WW5-4	Existing	Quebec St & Wyndham St	375 - 600	1066	Capacity	$5,450,000
WW5-5	Existing	Woolwhich St	300	167	Capacity	$510,000
WW5-6	Existing	Waterloo Ave	300	166	Capacity	$510,000
Area 5 Total						**$40,630,000**
WW6-1	Existing	Scottsdale Dr, College Ave & Janefield Ave	300 - 675	1699	Capacity / Operational	$5,810,000
Area 6 Total						**$5,810,000**
WW7-1	Future	Clair Rd	250 / 300	834	Capacity / Operational	$2,370,000
Area 7 Total						**$2,370,000**
S1	Future	Manor Park Crescent / Speed River	250	130	Operational / Redundancy	$1,500,000
S2	Future	Municipal Street / Speed River	250 / 300 / 450 / 525	1113	Operational / Redundancy	$4,000,000
Operational Total						**$5,500,000**
Grand Total						**$92,890,000**

7.0 NEXT STEPS

The proposed water and wastewater projects to meet 2051+ buildout growth requirements as well as high-level timing recommendations have been presented in this TM. Following this TM, TM4 will look into integration of asset renewal planning requirements based on condition assessment priorities to evaluate the required funding strategies. Projects identified in TM3, will undergo a prioritization on the basis of key factors such as growth timing, capital and life-cycle cost, likelihood/consequence of asset failure, funding opportunities and project type (rehabilitation vs. replacement).

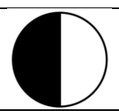
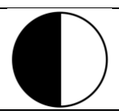
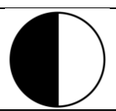
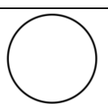
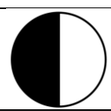
The proposed water and wastewater servicing strategies will be presented to the public at the Public Information Centre (PIC) #2.

APPENDIX A –

Alternative Evaluation Matrix

Evaluation of Water Servicing Alternatives

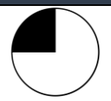
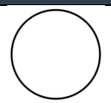
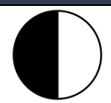
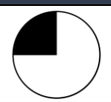
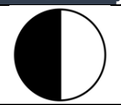
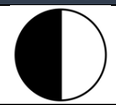
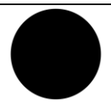
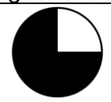
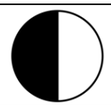
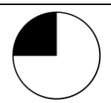
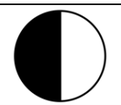
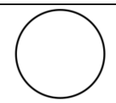
Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
ENVIRONMENTAL							
Protects Environmental Features	• Protect sensitive natural features and regulated areas. • Minimize the potential impact from construction and operation to existing terrestrial and aquatic habitats/features, species at risk, vegetation, wetlands, woodlots, and steep slopes. • Allow for scheduling and roll-out of construction activities in a way and at a time of year that would limit the negative impacts on the vegetation of the site and surrounding area.	• Environmental features, wildlife and species at risk would remain in their current conditions, as no construction/upgrades are completed. • Risk of intrusive emergency repairs is higher.	• Environmental features, wildlife and species at risk would remain in their current conditions, as no construction/upgrades are completed.	• Environmental features, wildlife and species at risk would remain in their current conditions, as no construction/upgrades are completed.	• Significant portion of project within woodlots and designated Natural Heritage System (NHS).	• Well and VC2 upgrades within woodlots, but in locations already clear of trees. • Minor portion of project within designated NHS. • Most of project can occur along existing hydrocut or access roads.	• Partial Arkell twinning and by-pass chamber within Woodlots and designated NHS. • Portion of project can occur along existing hydrocut or access roads.
Protects Groundwater, Streams and Rivers	• Protect groundwater / surface water, and meet Clean Water Act requirements. • Minimize sewage discharge to the environment during design conditions, and mitigate spills during extreme rainfall. • Minimize impacts within GRCA regulated areas.	• Groundwater, streams, and rivers would remain in their current conditions, as no construction/upgrades are completed. • Risk of intrusive emergency repairs is higher.	• Groundwater, streams, and rivers would remain in their current conditions, as no construction/upgrades are completed.	• Groundwater, streams, and rivers would remain in their current conditions. • Lessen the impact on water resources.	• Portions of Project within Grand River Conservation Authority (GRCA) regulatory floodplain and within close proximity to GRCA regulated wetlands.	• Well 7 piping and piping to VC2 within GRCA regulatory floodplain. • Portions of pipe between VC2 and reservoir cross GRCA river valley slopes, but where infrastructure already exists.	• Partial Arkell twinning and Carter Wells facility within GRCA regulatory floodplain and within close proximity to GRCA regulated wetlands • Work within GRCA regulated areas is more significant than 4B1 but less significant than 4A.
Minimizes Impact on Climate Change	• Minimize GHG emissions and negative impacts on the landscape which may	• Low potential to reduce GHG emissions as	• Low potential to reduce GHG emissions as	• Potential to minimize GHG	• Low potential to reduce GHG emissions as	• Potential to minimize negative impacts on the	• Potential to minimize negative impacts on the

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
	alter the ecosystems' ability to remove carbon dioxide from the atmosphere (e.g., changes vicinity plant cover). • Prioritize energy and water conservation and efficiency measures and/or adaptive re-use of buildings or structures to reduce new energy or material demands. • Evaluate contributions to or investments in natural spaces that offset or mitigate the alternative's climate change impacts.	infrastructure would remain in current conditions. • No additional GHG emissions for operations compared to existing conditions.	infrastructure would remain in current conditions.	emissions related to water supply.	infrastructure would remain in current conditions. • No additional GHG emissions for operations compared to existing conditions. • Watermain requirements are more significant than Alt 3. • Doubling the width of land devoted to aqueduct transmission will result in significant tree removals.	landscape as in ground reservoir and buried watermain, existing ground cover would be restored • Significant new infrastructure requirements, which will create GHG emissions, but will be offset by not requiring Hanlon transmission main construction and reduced watermain upgrade requirements.	landscape as in ground reservoir and buried watermain, existing ground cover would be restored • Significant new infrastructure requirements, which will create GHG emissions, but will be offset by not requiring Hanlon transmission main construction and reduced watermain upgrade requirements. • Doubling the width of land devoted to aqueduct transmission will result in significant tree removals. As only partial Aqueduct twinning is required, tree removed is less significant than Alt 4A.
ENVIRONMENTAL SUMMARY							
SOCIAL/CULTURAL							
Minimizes Long-Term Impacts to the Community Related to Noise,	• Minimize noise, odour, and traffic affecting the community during system	• Low potential of impacts to residents related to noise, odour, traffic,	• Low potential of impacts to residents related to noise, odour, traffic, and	• Low potential of impacts to residents related to noise, odour,	• No anticipated impacts/changes to aesthetic, noise,	• Underground reservoir and watermain,	• Underground reservoir and watermain,

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
Odour, Traffic and Aesthetics	operation and maintenance. • Maintain access to, and aesthetics of, public spaces. • Minimize negative impacts that may result due to changes to the neighbourhood characteristics (e.g., recreational features, green space, property values).	and aesthetics as infrastructure would remain in current conditions. • Higher risk of intrusive emergency repairs when required.	aesthetics as infrastructure would remain in current conditions. •	traffic, and aesthetics as infrastructure would remain in current conditions. •	odour or traffic at site.	maintains site aesthetic. • No anticipated impacts to noise at existing site. • Maintenance and operational checks required for PS and reservoir may increase traffic slightly, but visits to the Spring Grounds are already frequent. • Provides better long-term water supply and transmission security to the City, compared to Alt 4A, reducing need for Hanlon Feedermain transmission project.	maintains site aesthetic. • No anticipated impacts to noise at existing site. • Maintenance and operational checks required for PS and reservoir and Carter facility may increase traffic slightly, but visits to the Spring Grounds are already frequent. • Provides best long-term water supply and transmission security to the City, reducing need for Hanlon Feedermain transmission project.
Minimizes Impacts to Businesses and Major Transportation Corridors	• Maintain access for businesses during construction and system operation. • Minimize potential negative effects on short-term and long-term business vitality, and community growth and development. • Minimize potential negative impacts on major transportation corridors and bus routes	• No impacts to business operations are anticipated. • High potential for negative effects on long-term business vitality, community growth and development as existing infrastructure may not have sufficient transmission capacity and lacks	• No impacts to business operations for construction. • Does not meet short-term and long-term community growth and development. •	• No impacts to business operations for construction. • No impacts to business vitality and community growth.	• Twinned Aqueduct: No impacts to businesses and business operations anticipated during construction with the exception of the lower reach. • Hanlon Feedermain: High potential to impact major transportation corridor during construction	• New Pipe: Minimal to no impacts to businesses and business operations within the City anticipated during construction (transmission main down Arkell Road). • Some short-term impact for businesses along Arkell Road during construction.	• Partial Twinned Aqueduct: No impacts to businesses and business operations anticipated during construction. • New Pipe: Minimal to no impacts to businesses and business operations within the City anticipated during construction

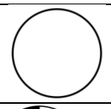
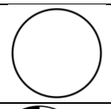
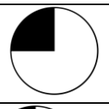
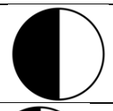
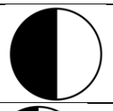
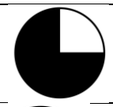
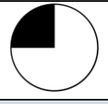
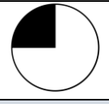
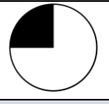
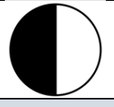
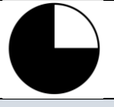
Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
		redundancy and failure protection.			• Reduces short-term and long-term risks to business vitality and community growth and development through improved Arkell transmission redundancy. Woods Pumping Station remains a critical distribution source.	• Reduces short-term and long-term risks to business vitality and community growth and development through improved water supply transmission to both north and south Zone 1.	(transmission main down Arkell Road). • Some short-term impact for businesses along Arkell Road during construction. • Reduces short-term and long-term risks to business vitality and community growth and development through improved water supply transmission to both north and south Zone 1.
Manages and Minimizes Short-Term Construction Impacts	• Minimize noise, odour, road closures, and truck traffic affecting the community during construction.	• No construction required as infrastructure would remain in existing condition. • Higher risk of intrusive emergency repairs when required.	No construction required.	No construction required.	Aqueduct Twin • Low potential for noise impacts to nearby adjacent residential properties during construction. • No or minimal anticipated road closures required during construction. Hanlon Watermain • High potential for noise impacts to nearby adjacent residential properties during construction. • Significant anticipated road	• Low potential for noise impacts to nearby adjacent residential properties during construction inside Spring Grounds. • Some noise and moderate anticipated road closures required during construction of transmission main along Arkell Road to Victoria Road.	Partial Aqueduct Twin • Low potential for noise impacts to nearby adjacent residential properties during construction. • No or minimal anticipated road closures required during construction. • Low potential for noise impacts to nearby adjacent residential properties during construction inside Spring Grounds and at Carter facility. • Some noise and moderate

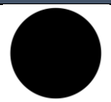
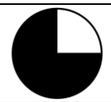
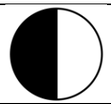
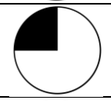
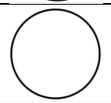
Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
					closures required during construction.		anticipated road closures required during construction of transmission main along Arkell Road to Victoria Road.
Protects Health and Safety	• Minimize the potential risk to public health and safety, particularly on downstream users (including for recreation and tourism). • Minimize the potential risk to operator and maintenance staff health and safety.	• Low potential to minimize public health and safety as existing infrastructure may not have sufficient transmission capacity to provide adequate water service under 2051 conditions. • Higher risk of intrusive emergency repairs when required.	• No anticipated impacts to operator health and safety compared to existing operations. •	• No anticipated impacts to operator health and safety compared to existing operations. •	• No anticipated impacts to operator health and safety compared to existing operations.	• Low potential impacts to operator health and safety due to sodium hypochlorite storage on site, within secured facility. Common to all treatment sites.	• Low potential impacts to operator health and safety due to sodium hypochlorite storage on site, within secured facility. Common to all treatment sites.
Protects Cultural Heritage Resources	• Minimize potential impact to cultural heritage resources.	• No anticipated impacts to cultural heritage features as no construction is required.	• No anticipated impacts to cultural heritage features as no construction is required. •	• No anticipated impacts to cultural heritage features as no construction is required. •	• No anticipated impacts to cultural heritage features as none are known to exist along a widened, twinned aqueduct route.	• Low to no risk of impacts to cultural heritage resources along Arkell Road transmission main route.	• Low to no risk of impacts to cultural heritage resources along Arkell Road transmission main route and partial twinned aqueduct route.
Minimizes Risks to Historical Landfill Sites	• Minimize potential impact to known historical landfill sites.	• No anticipated impacts to historical landfill sites as no construction is required.	No anticipated impacts to historical landfill sites as no construction is required. •	• No anticipated impacts to historical landfill sites as no construction is required.	• Risk of impacts to historical landfill sites in park lands along the Eramosa River, upstream of Woods Station.	• No anticipated impacts to historical landfill sites.	• No anticipated impacts to historical landfill sites.

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
SOCIAL/CULTURAL SUMMARY							
ECONOMIC							
Provides Low Lifecycle Costs	• Minimize capital, operation and maintenance (life cycle) costs over a 50-year period.	• Estimated Capital Cost: $0 • Estimated Additional 50-Year Lifecycle Costs: $0	• No capital costs. • Potential for increased lifecycle costs due to system aging and replacement/emergency needs. • Reduced revenue from development charges and taxes.	• Minor capital costs for programs. • Potential for increased lifecycle costs due to system aging and replacement/emergency needs.	• Estimated Capital Cost: $85.2M Estimated 50-Year Lifecycle Costs: $86.7M	• Estimated Capital Cost: $61.5M Estimated 50-Year Lifecycle Costs: $65.0M	• Estimated Capital Cost: $110.4M • Estimated 50-Year Lifecycle Costs: $113.9M
ECONOMIC SUMMARY							
TECHNICAL							
Meets Existing and Future Needs	• Addresses the existing system capacity constraints. • Mitigate the impact on level-of-service performance of existing infrastructure. • Meets the long-term capacity requirements to service the projected population growth to 2051.	• Does not meet long-term transmission capacity requirements to service the projected population growth or provide operational redundancy.	• Does not address existing constraints. • Does not meet long-term capacity requirements to service the projected population growth to 2051.	• Does not address existing constraints. • Potential to delay but not eliminate infrastructure needs for long-term capacity requirements to service the projected population growth to 2051.	• Anticipated to meet long term transmission capacity requirements to service projected population growth. • Anticipated to improve redundancy and security of supply to the Woods Reservoir but does not improve redundancy of the Woods PS and Reservoir.	• Anticipated to meet long term transmission capacity requirements to service projected population growth. • Anticipated to improve redundancy and security of supply. • Provides redundancy of supply sufficient to meet ADD in event of Woods or Arkell Aqueduct offline.	• Anticipated to meet long term transmission capacity requirements to service projected population growth. • Anticipated to improve redundancy and security of supply. • Provides redundancy of supply sufficient to meet MDD in event of Woods or Arkell Aqueduct offline. • **Only alternative that meets the**

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
							City's criterion to supply MDD under Woods/Arkell offline scenario.
Provides Ease of Maintenance	• Provide operational redundancy to allow for safe and efficient maintenance activities. • Minimize increases in operational and/or maintenance complexity of the system.	• Portions of aqueduct route are not easily accessible, and maintenance can be challenging. • No redundancy of existing aqueduct. • No impacts to operational complexity compared to existing operations.	• No improvement to operational redundancy. • No impacts to operational complexity compared to existing operations.	• No improvement to operational redundancy. • No impacts to operational complexity compared to existing operations.	• Portions of aqueduct route are not easily accessible, and maintenance can be challenging. • Minimal anticipated impacts to operational complexity compared to existing operations. • Improves operational redundancy as one aqueduct can remain active while maintenance is being completed on the other.	• Provides appropriate site access from existing well site. • Increases operational complexity to decide and assign GW wells to Woods or new Arkell pump station. • Significant staff impact to operate and maintain new treatment and booster station. • Improves operational redundancy as one aqueduct/watermain, pump station or reservoir can remain active while maintenance is being completed on the other. • Allows for GW Wells to supply to either the New Reservoir or the existing Woods Reservoir	• Provides appropriate site access from existing well sites. • Increases operational complexity to decide and assign sources to Woods or new Arkell pump station. • Significant staff impact to operate and maintain new treatment and booster stations and WTPs. • Improves operational redundancy as one aqueduct/watermain, pump station or reservoir can remain active while maintenance is being completed on the other. • Allows for Arkell Wells and collectors to supply to either the New Reservoir or the existing Woods Reservoir • Allows Carter wells to supply either direct to system or

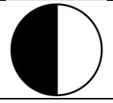
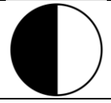
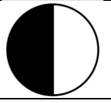
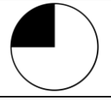
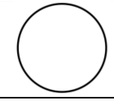
Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
							to the existing Woods Reservoir
Aligns with Existing and Planned Infrastructure	• Optimize existing infrastructure investment. • Minimize requirement for upgrades/expansion to recent infrastructure • Align with other planned infrastructure initiatives (Trails, Transportation, Stormwater Master Plans, Capital projects). • Ability to implement in a phased manner over time.	• Does not optimize existing infrastructure. • Does not align with planned initiatives to improve redundancy of existing Aqueduct.	• Minimize requirement for upgrades/expansion to recent infrastructure • Does not optimize existing infrastructure. • Does not align with planned infrastructure initiatives.	• Potential to minimize requirement for upgrades/expansion to recent infrastructure • Does not optimize existing infrastructure. • Does not align with planned infrastructure initiatives.	• Aligns with planned initiatives to improve redundancy of existing Aqueduct. • Aligns with Hanlon Feedermain capital project.	• Aligns with planned initiatives to improve redundancy of existing Aqueduct. • Greatly improves Guelph source supply for the future. • Improves transmission of treated water to south Guelph to meet its anticipated higher population density and water demand.	• Aligns with planned initiatives to improve redundancy of existing Aqueduct. • Greatly improves Guelph source supply for the future. • Improves transmission of treated water to south Guelph to meet its anticipated higher population density and water demand.
Aligns with Existing and Future Land Use	• Evaluate need to acquire land for new/expanded utility corridors or facilities (pumping stations, storage tanks) including ownership requirements.	• Does not require additional land as infrastructure will remain in current conditions.	• Does not require additional land as infrastructure will remain in current conditions.	• Does not require additional land as infrastructure will remain in current conditions.	• New land required for twinned Aqueduct. •	• If located in Spring Grounds, additional property acquisition not required for new PS. • Utility corridor required for new Arkell Road transmission main outside City limits. Easement required.	• If located in Spring Grounds, additional property acquisition not required for new PS. • Utility corridor required for new Arkell Road transmission main outside City limits. Easement required.
Aligns with Efficient Approval and Permitting Process	• Minimize the complexity and time spent to obtain approvals from various regulatory agencies.	• Does not require approvals or permits as no improvements will be completed.	• Does not require approvals or permits as no improvements will be completed.	• Does not require approvals or permits as no improvements will be completed.	• GRCA permitting required for improvements within GRCA regulation limit and GRCA watercourse. • Dewatering approval required.	• GRCA permitting required for improvements within GRCA regulation limit.	• GRCA permitting required for improvements within GRCA regulation limit and GRCA watercourse. • Dewatering approval required.

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 Water Conservation	Alt 4 A Twin Existing Arkell Aqueduct	Alt 4 B1 New Watermain, Pump Station and Reservoir (GW Wells Only)	Alt 4 B2 New Watermain, Pump Station and Reservoir (All Arkell Sources)
Manages and Minimizes Construction Risks	• Minimize complexity of construction and maximize ability to maintain adequate water/wastewater servicing during construction.	• No impacts to services as no improvements are proposed.	• No impacts to services as no improvements are proposed.	• No impacts to services as no improvements are proposed.	• High potential for existing Aqueduct and Woods to remain operational during construction.	• High potential for existing Aqueduct and Woods to remain operational during construction.	• High potential for existing Aqueduct and Woods to remain operational during construction.
Ability to Adapt to Climate Change	• Promote resiliency to extreme weather events. • Prioritize climate change adaptation to minimize risk associated with variation in climate parameters (temperature, precipitation, wind gusts, or other) and natural hazards (flooding, high river levels, or other). • Prioritize the surrounding area's ability to be resilient and maintain its adaptive capacity to climate change.	• Does not promote resiliency to extreme weather events or minimize risk associated with variation in climate parameters.	• Does not promote resiliency to extreme weather events or minimize risk associated with variation in climate parameters.	• Does not promote resiliency to extreme weather events or minimize risk associated with variation in climate parameters.	• Potential for site access impacts as a result of a flooding event due to proximity to river.	• Increased storage and pump capacity improves resiliency to water supply. • Improves resiliency to extreme weather events and potential flooding along the existing Aqueduct route.	• Increased storage and pump capacity improves resiliency to water supply. • Improves resiliency to extreme weather events and potential flooding along the existing Aqueduct route.
TECHNICAL SUMMARY							
SUMMARY							
Alternative Ranking							Most Aligned with Criteria

s	Description
	Very well aligned with criteria
	Well aligned with criteria
	Somewhat aligned with criteria
	Not well aligned with criteria
	Low alignment with criteria

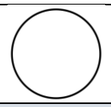
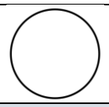
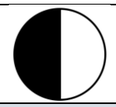
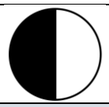
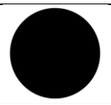
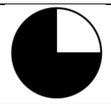
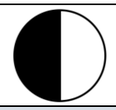
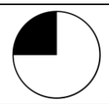
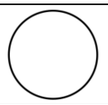
Evaluation of Wastewater Servicing Alternatives

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
ENVIRONMENTAL						
Protects Environmental Features	• Protect sensitive natural features and regulated areas. • Minimize the potential impact from construction and operation to existing terrestrial and aquatic habitats/features, species at risk, vegetation, wetlands, woodlots, and steep slopes. • Allow for scheduling and roll-out of construction activities in a way and at a time of year that would limit the negative impacts on the vegetation of the site and surrounding area.	• Environmental features, wildlife and species at risk would remain in their current conditions, as no construction/upgrades are completed. • Risk of intrusive emergency repairs is higher.	• Environmental features, wildlife and species at risk would remain in their current conditions, as no construction/upgrades are completed.	• Environmental features, wildlife and species at risk would remain in their current conditions, as no construction/upgrades are completed.	• Refinement of preferred alignments and routes can be optimized to reduce or eliminate impacts.	• Refinement of preferred alignments and routes can be optimized to reduce or eliminate impacts.
Protects Groundwater, Streams and Rivers	• Protect groundwater / surface water, and meet Clean Water Act requirements. • Minimize sewage discharge to the environment during design conditions, and mitigate spills during extreme rainfall. • Minimize impacts within GRCA regulated areas.	• Groundwater, streams, and rivers would remain in their current conditions, as no construction/upgrades are completed. • Risk of intrusive emergency repairs is higher.	• Groundwater, streams, and rivers would remain in their current conditions, as no construction/upgrades are completed.	• Groundwater, streams, and rivers would remain in their current conditions, as no construction/upgrades are completed.	• Portions of projects within Grand River Conservation Authority (GRCA) regulatory floodplain and within close proximity to GRCA regulated wetlands.	• Portions of projects within Grand River Conservation Authority (GRCA) regulatory floodplain and within close proximity to GRCA regulated wetlands.
Minimizes Impact on Climate Change	• Minimize GHG emissions and negative impacts on the	• Low potential to reduce GHG emissions as infrastructure would	• Low potential to reduce GHG emissions as infrastructure would	• Activities to remove I/I would be expected to add to GHG emissions in the	• Trunk sewer upgrades would be expected to	• Pump Station & Forcemain upgrades would be

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
	landscape which may alter the ecosystems' ability to remove carbon dioxide from the atmosphere (e.g., changes vicinity plant cover). • Prioritize energy and water conservation and efficiency measures and/or adaptive re-use of buildings or structures to reduce new energy or material demands. • Evaluate contributions to or investments in natural spaces that offset or mitigate the alternative's climate change impacts.	remain in current conditions. • No additional GHG emissions for operations compared to existing conditions.	remain in current conditions. • No additional GHG emissions for operations compared to existing conditions.	short term. (low in comparison to Alternatives 4 and 5)	add to GHG emissions in the short term. (Similar to Alternative 5, but more than Alternative 3). • No additional GHG emissions for operations compared to existing conditions. • Conceptually would result in tree removal in certain instances. These could be replanted to renew the resource.	expected to add to GHG emissions in the short term (Similar to Alternative 4, but more than Alternative 3). • Increased GHG emissions for operations compared to existing conditions as well as Alternative 4 due to ongoing need for pump station use. • Conceptually would result in tree removal in certain instances. These could be replanted to renew the resource.
ENVIRONMENTAL SUMMARY						
SOCIAL/CULTURAL						
Minimizes Long-Term Impacts to the Community Related to Noise, Odour, Traffic and Aesthetics	• Minimize noise, odour, and traffic affecting the community during system operation and maintenance. • Maintain access to, and aesthetics of, public spaces.	• Low potential of impacts to residents related to noise, odour, traffic, and aesthetics as infrastructure would remain in current conditions.	• Low potential of impacts to residents related to noise, odour, traffic, and aesthetics as infrastructure would remain in current conditions.	• Low potential of impacts to residents related to noise, odour, traffic, and aesthetics as infrastructure would remain in current conditions.	• Moderate potential of impacts to residents related to noise, odour, traffic, during construction (not expected to	• Moderate potential of impacts to residents related to noise, odour, traffic, during construction (not expected to influence long-term)

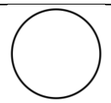
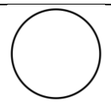
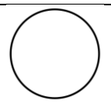
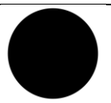
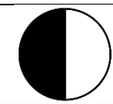
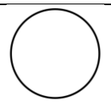
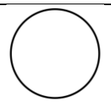
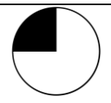
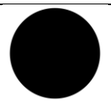
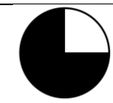
Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
	• Minimize negative impacts that may result due to changes to the neighbourhood characteristics (e.g., recreational features, green space, property values).	• Higher risk of intrusive emergency repairs when required.			influence long-term). • Aesthetics would be returned to existing conditions following construction.	• Permanent pump station(s) would require additional maintenance activity. • This alternative also introduces the potential of unpleasant odour issues. • Aesthetics would be returned to existing conditions following construction.
Minimizes Impacts to Businesses and Major Transportation Corridors	• Maintain access for businesses during construction and system operation. • Minimize potential negative effects on short-term and long-term business vitality, and community growth and development. • Minimize potential negative impacts on major transportation corridors and bus routes	• No impacts to business operations are anticipated. • High potential for negative effects on long-term business vitality, community growth and development as existing infrastructure may not have sufficient transmission capacity and lacks redundancy and failure protection.	• No impacts to business operations for construction. • Does not meet short-term and long-term community growth and development.	• No impacts to business operations for construction. • No impacts to business vitality and community growth.	• Impacts to businesses and business operations anticipated during construction expected. • Reduces short-term and long-term risks to business vitality and community growth and development through improved level of service.	• Impacts to businesses and business operations anticipated during construction expected. These may be less than Alternative 4 if trenchless construction is possible and impacts to existing roadways minimized. • Reduces short-term and long-term risks to business vitality and community growth and development through improved level of service.

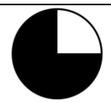
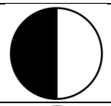
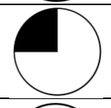
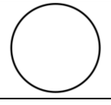
Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
Manages and Minimizes Short-Term Construction Impacts	• Minimize noise, odour, road closures, and truck traffic affecting the community during construction.	• No construction required as infrastructure would remain in existing condition. • Higher risk of intrusive emergency repairs when required.	No construction required.	No construction required.	• Normal construction impacts expected.	• Normal construction impacts expected. • Potential for reduced impact compared to Alternative 4 if trenchless found to be feasible.
Protects Health and Safety	• Minimize the potential risk to public health and safety, particularly on downstream users (including for recreation and tourism). • Minimize the potential risk to operator and maintenance staff health and safety.	• Low potential to minimize public health and safety as existing infrastructure may not have capacity to provide adequate wastewater service under 2051 conditions. • Higher risk of intrusive emergency repairs when required.	• No anticipated impacts to operator health and safety compared to existing operations.	• No anticipated impacts to operator health and safety compared to existing operations.	• Short-term potential increased risk during construction activities. • No long-term anticipated impacts to operator health and safety compared to existing operations.	• Short-term potential increased risk during construction activities. • Increases impacts long-term anticipated to operator health and safety compared to existing operations due to additional pump station entry requirements.
Protects Cultural Heritage Resources	• Minimize potential impact to cultural heritage resources.	• No anticipated impacts to cultural heritage features as no construction is required.	• No anticipated impacts to cultural heritage features as no construction is required.	• No anticipated impacts to cultural heritage features as no construction is required.	• Low risk of impacts to cultural heritage features during construction activities along existing easements.	• Moderate risk of impacts to cultural heritage features during construction activities along new alignments
Minimizes Risks to Historical Landfill Sites	• Minimize potential impact to known historical landfill sites.	• No anticipated impacts to historical landfill sites as	No anticipated impacts to historical landfill sites as	• No anticipated impacts to historical landfill sites as	• Low risk of impacts to historical landfill	• Moderate risk of impacts to historical landfill

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
		no construction is required.	no construction is required. •	no construction is required.	sites with construction activities along existing easements.	sites with construction activities along new alignments.
SOCIAL/CULTURAL SUMMARY						
ECONOMIC						
Provides Low Lifecycle Costs	• Minimize capital, operation and maintenance (life cycle) costs over a 50-year period.	• Estimated Capital Cost: $0 • Estimated Additional 50-Year Lifecycle Costs: $0	• No capital costs. • Potential for increased lifecycle costs due to system aging and replacement/emergency needs. • Reduced revenue from development charges and taxes.	• Minor capital costs for programs. • Potential for increased lifecycle costs due to system aging and replacement/emergency needs.	• Estimated Capital Cost: $68.5-82.2M Estimated 50-Year Lifecycle Costs: $0 (No increase over existing)	• Estimated Capital Cost: Significantly higher than Alternative 4. Estimated 50-Year Lifecycle Costs: Significantly higher than Alternative 4.
ECONOMIC SUMMARY						
TECHNICAL						
Meets Existing and Future Needs	• Addresses the existing system capacity constraints. • Mitigate the impact on level-of-service performance of existing infrastructure. • Meets the long-term capacity requirements to service the projected population growth to 2051.	• Does not meet long-term collection system capacity requirements to service the projected population growth or provide existing targeted level of service.	• Does not address existing constraints. • Does not meet long-term capacity requirements to service the projected population growth to 2051.	• I/I reduction is not of sufficient magnitude to address existing constraints.	• Meets long-term wastewater collection capacity requirements to service projected population growth.	• Meets long-term wastewater collection capacity requirements to service projected population growth.

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
Provides Ease of Maintenance	• Provide operational improvements to allow for safe and efficient maintenance activities. • Minimize increases in operational and/or maintenance complexity of the system.	• Portions of wastewater collection system are not easily accessible, and maintenance can be challenging. • No impacts to operational complexity compared to existing operations.	• No impacts to operational complexity compared to existing operations.	• No impacts to operational complexity compared to existing operations.	• Certain upgrades introduce redundancy to the system and may facilitate the City's existing maintenance activities. • Minimal anticipated impacts to operational complexity compared to existing operations.	• Significantly Increases operational complexity with the introduction of additional pump stations, forcemains, and possible isolation gates. • Significant staff impact to operate and maintain new pump stations. • Improves operational redundancy pump stations could be configured to allow isolation of the system to facilitate access.
Aligns with Existing and Planned Infrastructure	• Optimize existing infrastructure investment. • Minimize requirement for upgrades/expansion to recent infrastructure • Align with other planned infrastructure initiatives (Trails, Transportation, Stormwater Master Plans, Capital projects). • Ability to implement in a phased manner over time.	• Does not optimize existing infrastructure. • Does not align with planned initiatives.	• Minimize requirement for upgrades/expansion to recent infrastructure • Does not optimize existing infrastructure. • Does not align with planned infrastructure initiatives.	• Slight potential to minimize requirement for upgrades/expansion to recent infrastructure • Does not optimize existing infrastructure. • Does not align with planned infrastructure initiatives.	• Aligns with planned initiatives to provide high and consistent level of service • Can be configured to work with recent and planned City projects and commitments.	• Aligns with planned initiatives to provide high and consistent level of service. • A departure and significant investment in a redundant approach that will result in significantly increases operation and maintenance investment.

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
Aligns with Existing and Future Land Use	• Evaluate need to acquire land for new/expanded utility corridors or facilities (pumping stations, storage tanks) including ownership requirements.	• Does not require additional land as infrastructure will remain in current conditions.	• Does not require additional land as infrastructure will remain in current conditions.	• Does not require additional land as infrastructure will remain in current conditions.	• Does not require additional land as upgraded infrastructure can be placed in existing easements.	• Additional land needed for new easements (potential)
Aligns with Efficient Approval and Permitting Process	• Minimize the complexity and time spent to obtain approvals from various regulatory agencies.	• Does not require approvals or permits as no improvements will be completed.	• Does not require approvals or permits as no improvements will be completed.	• Does not require approvals or permits as no improvements will be completed.	• GRCA permitting required for improvements within GRCA regulation limit and GRCA watercourse.	GRCA permitting required for improvements within GRCA regulation limit and GRCA watercourse.
Manages and Minimizes Construction Risks	• Minimize complexity of construction and maximize ability to maintain adequate water/wastewater servicing during construction.	• No impacts to services as no improvements are proposed.	• No impacts to services as no improvements are proposed.	• No impacts to services as no improvements are proposed.	• Standard construction risk expected.	• Standard construction risk expected. • Potential for river crossing increased risk.
Ability to Adapt to Climate Change	• Promote resiliency to extreme weather events. • Prioritize climate change adaptation to minimize risk associated with variation in climate parameters (temperature, precipitation, wind gusts, or other) and natural hazards (flooding, high river levels, or other). • Prioritize the surrounding area's ability to be resilient and	• Does not promote resiliency to extreme weather events or minimize risk associated with variation in climate parameters.	• Does not promote resiliency to extreme weather events or minimize risk associated with variation in climate parameters.	• Does not promote resiliency to extreme weather events or minimize risk associated with variation in climate parameters.	• Can be sized to include resiliency to extreme weather events.	• Can be sized to include resiliency to extreme weather events. • Inclusion of additional pumping station(s) introduces a need for additional power sources. Back power requirements, etc.

Environment and Criteria Categories	Criteria Indicators	Alt 1 Do Nothing	Alt 2 Limit Future Growth	Alt 3 I/I Reduction and Re-Use Alternatives	Alt 4 Improvements to Existing System: New Trunk Sewers	Alt 5 Improvements to Existing System: Pumping Station & Forcemain
	maintain its adaptive capacity to climate change.					
TECHNICAL SUMMARY						
SUMMARY						
Alternative Ranking					Most Aligned with Criteria	

s		Description
		Very well aligned with criteria
		Well aligned with criteria
		Somewhat aligned with criteria
		Not well aligned with criteria
		Low alignment with criteria

APPENDIX B –

Cost Estimates

Table A.3 Arkell Wellfield Alternative A Cost Estimate: Twin Existing Aqueduct

Item	Description	Units	Quantity	Unit Price	Total*	Source/Assumptions
0	**Preliminary Studies and Approvals**					
0.1	Preliminary Study	LS	1	$55,497	$60,000	Arkell Aqueduct TM inflated to 2022
0.2	Environmental Approvals & Mitigation	LS	1	$277,485	$280,000	Arkell Aqueduct TM inflated to 2022
0.3	Land Acquisition	m2	24000	$222	$5,320,000	Unit price based on $198/m2 from CM MESP, inflated to 2022. Assumed 4m width.
	Subtotal	**Preliminary Studies and Approvals**			**$5,660,000**	
1	**Site Works**					
1.1	CPP - 900mm - Reach 1	m	1600	$2,956	$4,730,000	Watermain material and Installation with Topsoil Restoration based on previous project experience.
1.2	CPP - 900mm - Reach 2	m	1400	$2,956	$4,140,000	Watermain material and Installation with Topsoil Restoration based on previous project experience.
1.3	Reach 2 Increased Excavation with Forested Area	m2	5600	$13	$70,000	Additional 4m wide working easement through forest. Unit price based on previous project experience.
	Reach 2 Increased Fill (If Swamp)	m	1400	$17	$20,000	Unit price estimate based on previous project experience.
1.4	CPP - 1050mm - Reach 3A	m	2306	$3,429	$7,910,000	Watermain material and Installation with Topsoil Restoration based on previous project experience.
	CPP - 1050mm - Reach 3B (Victoria to Woods)	m	694	$3,429	$2,380,000	Watermain material and Installation with Topsoil Restoration based on previous project experience.
1.5	CPP - 600mm - Railroad crossing (Reach 3A)	LS	1	$350,000	$350,000	Unit price estimate based on previous project experience.
1.6	CPP - 600mm - River crossing (Reach 3A)	LS	1	$3,333,883	$3,330,000	Arkell Aqueduct TM inflated to 2022
1.7	Reach 3A Increased Excavation	m2	9224	$13	$120,000	Additional 4m wide working easement through forest. Unit price based on previous project experience.
	Reach 3A Increased Backfill	m	2306	$17	$40,000	Unit price estimate based on previous project experience.
1.8	Geotechnical - allowance for pilings	LS	1	$3,049,283	$3,050,000	Arkell Aqueduct TM inflated to 2022
1.9	Manholes	ea	20	$25,000	$500,000	Unit price estimate based on previous project experience.
1.1	Tie-ins - valves/pipe	locations	4	$717,478	$2,870,000	Arkell Aqueduct TM inflated to 2022
	Subtotal	**Site Works**			**$29,510,000**	
	SUBTOTAL				**$35,170,000**	
	Contractor overhead and profit on SubTotal (15%)				$5,275,500	
	Estimating Contingencies on Sub Total (50%)				$17,585,000	
	TOTAL				**$58,030,500**	
	Engineering Design and Construction Services on Total (15%)				$8,704,575	
	GRAND TOTAL				**$66,735,075**	
	Other Capital Works Required					
	Hanlon - Wellington Clair Feedermain				**$18,480,000**	Wellington Feedermain EA TM inflated to 2022
	GRAND TOTAL Including Hanlon Feedermain				**$85,215,075**	

*Rounded to nearest $10,000

O&M Cost	Units	Quantity	Unit Price	Frequency (years)	Total Cost/year
Aqueduct					
Valve Exercising	km	6	$500	1	**$3,000**
Swabbing	ea	1	$20,000	5	**$4,000**
Hanlon Feedermain					
Valve Exercising	km	7	$500	1	**$3,500**
Air relief valve maintenance	ea	3	$5,000	1	**$15,000**
Swabbing	ea	1	$20,000	5	**$4,000**
SUBTOTAL					
				Cost per Year	**$29,500**
				50-Year Cost	**$1,475,000**

Table A.4 Arkell Wellfield Alternative B1 Cost Estimate: New PS, Res and Watermain (GW Only)

Item	Description	Units	Quantity	Unit Price	Total*	Source/Assumptions
0	**Preliminary Studies and Approvals**					
0.1	Preliminary Study	LS	1	$55,497	$60,000	Arkell Aqueduct TM inflated to 2022
0.2	Environmental Approvals & Mitigation	LS	1	$55,497	$60,000	Arkell Aqueduct TM inflated to 2022
0.3	Land Acquisition	LS	1	$554,970	$550,000	Arkell Aqueduct TM inflated to 2022
Subtotal	**Preliminary Studies and Approvals**				**$670,000**	
1	**Site Works**					
1.1	Piping to Bypass VC2	m	460	$2,291	$1,050,000	WM material and Installation with Topsoil Restoration based on prev proj experience.
1.2	Well Pump Upgrades	ea	4	$90,000	$360,000	Unit price estimate based on previous project experience.
1.3	Well 7 Piping Upgrades	m	100	1,182.27	$120,000	WM material and Installation with Topsoil Restoration based on prev proj experience.
1.4	PVC - 600mm - From VC2 to Reservoir	m	1700	$2,291	$3,890,000	WM material and Installation with Topsoil Restoration based on prev proj experience.
1.5	PS at Arkell Reservoir	LS	1	$5,600,000	$5,600,000	Based on previous project experience and estimated installed HP.
1.6	Chlorination System at Arkell Reservoir	LS	1	$20,000	$20,000	Unit price estimate based on previous project experience.
1.7	Reservoir - 10 ML	ML	10	$989,343	$9,890,000	Unit price based on previous project experience.
1.8	PVC - 600mm -From Reservoir PS to Arkell & Victoria	m	3700	$2,675	$9,900,000	Watermain material and Installation with Asphalt Restoration based on previous project experience.
1.9	PVC - 600mm - Railroad Crossing (Arkell between Watson and Carter)	LS	1	$350,000	$350,000	Unit price estimate based on previous project experience.
1.10	Air release chambers	ea	4	$119,580	$480,000	Arkell Aqueduct TM inflated to 2022
1.11	Connections	LS	1	$59,790	$60,000	Arkell Aqueduct TM inflated to 2022
Subtotal	**Site Works**				**$31,720,000**	
SUBTOTAL					**$32,390,000**	
	Contractor overhead and profit on Site Works SubTotal (15%)				$4,858,500	
	Estimating Contingencies on Sub Total (50%)				$16,195,000	
TOTAL					**$53,443,500**	
	Engineering Design and Construction Services on Total (15%)				$8,016,525	
GRAND TOTAL					**$61,460,025**	

*Rounded to nearest $10,000

O&M Cost	Units	Quantity	Unit Price	Frequency (years)	Total Cost/year
Reservoir					
ROV Inspections	ea	1	$10,000	5	$2,000
In-person Inspections	ea	1	$20,000	10	$2,000
Rehab	ea	1	$25,000	10	$2,500
Pump Station					
Operations	ea	1	$10,400	1	$10,400
Treatment					
Instrumentation Maintenance	ea	1	$26,000	1	$26,000
Watermain					
Valve Exercising	km	5.5	$500	1	$2,750
Air relief valve maintenance	ea	4	$5,000	1	$20,000
Swabbing	ea	1	$20,000	5	$4,000
SUBTOTAL					
				Cost per Year	$69,650
				50-Year Cost	$3,482,500

Table A.5 Arkell Wellfield Alternative B2 Cost Estimate: New PS, Res and Watermain

Item	Description	Units	Quantity	Unit Price	Total*	Source/Assumptions
0	**Preliminary Studies and Approvals**					
0.1	Preliminary Study	LS	1	$55,497	$60,000	Arkell Aqueduct TM inflated to 2022
0.2	Environmental Approvals & Mitigation	LS	1	$55,497	$60,000	Arkell Aqueduct TM inflated to 2022
0.3	Land Acquisition	LS	1	$554,970	$550,000	Arkell Aqueduct TM inflated to 2022
	Subtotal	**Preliminary Studies and Approvals**			**$670,000**	
1	**Site Works**					
1.1	Carter Well direct to System					
1.1.1	Carter Pump Station Retrofit (UV, pump upgrades, nitrate treatment)		1	$5,000,000	$5,000,000	
1.1.2	Watermain from Carter to Victoria Road 300mm	m	500	$768.48	$380,000	500m distance
1.2	Bypass Chamber and PS	LS	1	$8,000,000	$8,000,000	Includes bypass on Aqueduct, Large pumping chamber and BPS
1.3	PS at Arkell Reservoir	LS	1	$10,000,000	$10,000,000	Based on previous project experence and estimated installed HP.
1.4	WTP (UV) at Arkell Reservoir	LS	1	$4,000,000	$4,000,000	Unit price estimate based on previous project experience.
1.5	Reservoir - 20 ML	ML	20	$675,000	$13,500,000	Unit price based on previous project experience.
1.6	900mm Aqueduct Twinning from Arkell 15 to Bypass Chamber	m	1270	$2,956	$3,750,000	Unit price based on previous project experience.
1.7	Watermain From By-pass Chamber to Victoria Road 900mm	m	3600	$3,296	$11,860,000	Watermain material and Installation with Asphalt Restoration based on previous project experience.
1.8	Watermain - 900mm - Railroad Crossing (Arkell between Watson and Carter)	LS	1	$500,000	$500,000	Unit price estimate based on previous project experience. Scaled up to a 900mm.
1.9	Air release chambers	ea	4	$119,580	$480,000	Arkell Aqueduct TM inflated to 2022
1.10	Connections	LS	1	$59,790	$60,000	Arkell Aqueduct TM inflated to 2022
	Subtotal	**Site Works**			**$57,530,000**	
SUBTOTAL					**$58,200,000**	
	Contractor overhead and profit on Site Works SubTotal (15%)				$8,730,000	
	Estimating Contingencies on Sub Total (50%)				$29,100,000	
TOTAL					**$96,030,000**	
	Engineering Design and Construction Services on Total (15%)				$14,404,500	
GRAND TOTAL					**$110,434,500**	

*Rounded to nearest $10,000

O&M Cost		Units	Quantity	Unit Price	Frequency (years)	Total Cost/year
	Reservoir					
	ROV Inspections	ea	1	$10,000	5	$2,000
	In-person Inspections	ea	1	$20,000	10	$2,000
	Rehab	ea	1	$25,000	10	$2,500
	Pump Station					
	Operations	ea	1	$10,400	1	$10,400
	Treatment					
	Instrumentation Maintenance	ea	1	$26,000	1	$26,000
	Watermain					
	Valve Exercising	km	4.101	$500	1	$2,051
	Air relief valve maintenance	ea	4	$5,000	1	$20,000
	Swabbing	ea	1	$20,000	5	$4,000
SUBTOTAL						
					Cost per Year	$68,951
					50-Year Cost	$3,447,525

Table A.6 - Water Projects Summary

Project Number	Summary of Upgrades					Cost
F-1	Upgrades to pump station, dual discharge feedermains. Upgrades to office spaces.					N/A*
Project Number	**Size (mm)**	**Length (m)**	**Linear Unit Cost ($/m)****	**Base Cost**	**River Crossings**	**Cost**
Major Linear						
W-1a	600	1850	$ 2,674.89	$ 4,948,545.06	$ -	$ 4,900,000.00
W-1b	600	940	$ 2,674.89	$ 2,514,395.87	$ -	$ 2,500,000.00
W-1c	400	2140	$ 1,566.51	$ 3,352,330.78	$ 250,000.00	$ 3,600,000.00
W-2	600	2500	$ 2,674.89	$ 6,687,223.05	$ -	$ 6,700,000.00
W-3	400	400	$ 1,566.51	$ 626,603.88	$ -	$ 600,000.00
W-4a	600	1600	$ 2,674.89	$ 4,279,822.75	$ -	$ 4,300,000.00
W-4b	600	1760	$ 2,674.89	$ 4,707,805.03	$ -	$ 4,700,000.00
W-4c	600	1200	$ 2,674.89	$ 3,209,867.06	$ -	$ 3,200,000.00
Minor Linear						
W-M-1	300	930	$ 1,049.27	$ 975,817.32	$ -	$ 1,000,000.00
W-M-2	200	260	$ 842.37	$ 219,015.79	$ -	$ 200,000.00
W-M-3	300	480	$ 1,049.27	$ 503,647.65	$ -	$ 500,000.00
W-M-4	200	440	$ 842.37	$ 370,642.11	$ -	$ 400,000.00
W-M-5	200	400	$ 842.37	$ 336,947.37	$ -	$ 300,000.00
W-M-6	300	500	$ 1,049.27	$ 524,632.97	$ -	$ 500,000.00
W-M-7	200	320	$ 842.37	$ 269,557.90	$ -	$ 300,000.00
W-M-8	300	300	$ 1,049.27	$ 314,779.78	$ -	$ 300,000.00
W-M-9	200	170	$ 842.37	$ 143,202.63	$ -	$ 100,000.00
W-M-10	200	180	$ 842.37	$ 151,626.32	$ -	$ 200,000.00
W-M-11	200	550	$ 842.37	$ 463,302.64	$ -	$ 500,000.00
W-M-12	200	610	$ 842.37	$ 513,844.74	$ -	$ 500,000.00
W-M-13	300	480	$ 1,049.27	$ 503,647.65	$ -	$ 500,000.00
W-M-14	200	220	$ 842.37	$ 185,321.05	$ -	$ 200,000.00
W-M-15	300	210	$ 1,049.27	$ 220,345.85	$ -	$ 200,000.00
W-M-16	300	1110	$ 1,049.27	$ 1,164,685.19	$ 250,000.00	$ 1,400,000.00
W-M-17	200	1300	$ 842.37	$ 1,095,078.96	$ -	$ 1,100,000.00
W-M-18	250	690	$ 931.04	$ 642,416.76	$ -	$ 600,000.00
W-M-19	200	1020	$ 842.37	$ 859,215.80	$ -	$ 900,000.00
W-M-20	200	1760	$ 842.37	$ 1,482,568.43	$ -	$ 1,500,000.00
W-M-21	200	790	$ 842.37	$ 665,471.06	$ -	$ 700,000.00
W-M-22	200	520	$ 842.37	$ 438,031.58	$ -	$ 400,000.00
W-M-23	200	850	$ 842.37	$ 716,013.16	$ -	$ 700,000.00
W-M-24	200	930	$ 842.37	$ 783,402.64	$ -	$ 800,000.00
W-M-26	300	450	$ 1,049.27	$ 472,169.67	$ -	$ 500,000.00
Zone 1 Total						**$ 44,800,000.00**
Project Number	**Summary of Upgrades**					**Cost**
F-2	New WTP, Pump Station and 6.9 ML Reservoir					N/A*

F-3	New BPS to replace existing Robertson					$ 7,600,000.00
F-4	New PS at Park Wells Site					$ 2,600,000.00
Project Number	**Size (mm)**	**Length (m)**	**Linear Unit Cost ($/m)****	**Base Cost**	**River Crossings**	**Cost**
Major Linear						
W-5a	400	1970	$ 1,566.51	$ 3,086,024.13	$ -	$ 3,100,000.00
W-5a	400	800	$ 1,566.51	$ 1,253,207.77	$ -	$ 1,300,000.00
W-6a	400	2030	$ 1,566.51	$ 3,180,014.71	$ -	$ 3,200,000.00
W-6b	400	2160	$ 1,566.51	$ 3,383,660.97	$ -	$ 3,400,000.00
W-6c	400	2022	$ 1,566.51	$ 3,167,482.63	$ 250,000.00	$ 3,400,000.00
W-7	400	1070	$ 1,566.51	$ 1,676,165.39	$ -	$ 1,700,000.00
W-8	400	2150	$ 1,566.51	$ 3,367,995.87	$ -	$ 3,400,000.00
W-9	400	1010	$ 1,566.51	$ 1,582,174.81	$ -	$ 1,600,000.00
W-10	400	1000	$ 1,566.51	$ 1,566,509.71	$ -	$ 1,600,000.00
W-11	400	375	$ 1,566.51	$ 587,441.14	$ -	$ 600,000.00
W-12	600	760	$ 2,674.89	$ 2,032,915.81	$ -	$ 2,000,000.00
W-13	400	1000	$ 1,566.51	$ 1,566,509.71	$ -	$ 1,600,000.00
Minor Linear						
W-M-24	200	930	$ 842.37	$ 783,402.64	$ -	$ 800,000.00
Project Number	**Size (ML)**					**Cost**
W-S-1	6					$ 10,500,000.00
Zone 2 Total						**$ 48,400,000.00**
Project Number	**Size (mm)**	**Length (m)**	**Linear Unit Cost ($/m)****	**Base Cost**	**River Crossings**	**Cost**
W-M-25	300	2130	$ 1,049.27	$ 2,234,936.45	$ -	$ 2,200,000.00
Project Number	**Summary of Upgrades**					**Cost**
F-5	Retrofit Existing PS					$ 400,000.00
Zone 3 Total						**$ 2,600,000.00**
Small Diameter Cast Iron Replacement Program						**$ 96,000,000.00**
Arkell Wellfield Redundancy Alternative 3: New PS, Reservoir and Watermain						**$ 110,400,000.00**
Grand Total						**$ 301,300,000.00**

*Costs not included for projects previously approved by council.

** Watermain unit costs include 20% Contingency & 15% Engineering

Rounded to nearest $100k

Item	Description		Units	Quantity	Unit Price	Total
0	**Preliminary Studies and Approvals**					
0.1	Preliminary Study		Study Areas	6	$ 50,000.00	$300,000
0.2	Preliminary Study (Area 5)		Study Areas	1	$ 100,000.00	$100,000
0.3	Environmental Approvals & Mitigation		Study Areas	7	$ 150,000.00	$1,050,000
0.4	Annual Flow Monitoring / I&I Studies		Years	30	$ 50,000.00	$1,500,000
0.5	Land Acquisition		Study Areas	7	$0	$0
	Subtotal		**Preliminary Studies and Approvals**			**$2,950,000**
Project Number	**Site Works**	**Diameter**				
WW1-1	Sewer Replacement @ 375 mm	375	m	472	$1,450	$680,000
	Manholes	300-750	ea	5	$20,000	$100,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW1-2	Sewer Replacement @ 375 mm	300	m	82	$1,400	$110,000
	Manholes	300-750	ea	1	$20,000	$20,000
	Highway Crossing	-	m	200	$6,500	$1,300,000
					Area Subtotal	**$3,190,000**
WW2-1	Sewer Replacement @ 300 mm	300	m	87	$1,400	$120,000
	Sewer Replacement @ 375 mm	375	m	945	$1,450	$1,370,000
	Manholes	300-750	ea	11	$20,000	$220,000
	Sewer Replacement @ 375 mm	375	m	595	$1,450	$860,000
	Sewer Replacement @ 450 mm	450	m	997	$1,550	$1,550,000
	Manholes	300-750	ea	18	$20,000	$360,000
WW2-3	New Forcemain @ 150 mm	150	m	70	$1,500	$110,000
	Forcemain Diversion Chamber		LS	1	$50,000	$50,000
	Sewer Replacement @ 300 mm	300	m	193	$1,400	$270,000
	Sewer Replacement @ 375 mm	375	m	848	$1,450	$1,230,000
	Manholes	300-750	ea	12	$20,000	$240,000
WW2-4	Sewer Replacement @ 375 mm	300	m	237	$1,400	$330,000
	Manholes	300-750	ea	3	$20,000	$60,000
					Area Subtotal	**$6,770,000**
WW3-1	Sewer Replacement @ 375 mm	375	m	208	$1,450	$300,000
	Sewer Replacement @ 450 mm	450	m	610	$1,550	$950,000
	Manholes	300-750	ea	9	$20,000	$180,000
					Area Subtotal	**$1,430,000**
WW4-1	Forcemain Diversion Chamber		LS	1	$50,000	$50,000
	Sewer Replacement @ 300 mm	300	m	70	$1,400	$100,000
	Sewer Replacement @ 375 mm	375	m	116	$1,450	$170,000
	Manholes	300-750	ea	2	$20,000	$40,000
WW4-2	Sewer Replacement @ 750 mm	750	m	707	$2,000	$1,410,000
	Manholes	300-750	ea	8	$30,000	$240,000
WW4-4	Sewer Replacement @ 375 mm	375	m	999	$1,450	$1,450,000
	Manholes	300-750	ea	11	$20,000	$220,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW4-5	Sewer Replacement @ 300 mm	300	m	173	$1,400	$240,000
	Manholes	300-750	ea	2	$20,000	$40,000
					Area Subtotal	**$4,940,000**
WW5-1	Sewer Replacement @ 1200 mm	1200	m	1228	$3,400	$4,180,000
	Sewer Replacement @ 1350 mm	1350	m	2057	$3,550	$7,300,000
	Manholes	825-1200	ea	10	$40,000	$400,000
	Manholes	1350-1800	ea	10	$50,000	$500,000
	River Crossing	-	m	150	$6,500	$980,000
	Highway Crossing	-	m	200	$6,500	$1,300,000
WW5-2	Sewer Replacement @ 825 mm	825	m	528	$2,500	$1,320,000
	Manholes	825-1200	ea	4	$20,000	$80,000
WW5-3	Sewer Replacement @ 600 mm	600	m	1014	$1,700	$1,720,000
	Manholes	300-750	ea	11	$20,000	$220,000
WW5-4	Sewer Replacement @ 375 mm	375	m	387	$1,450	$560,000
	Sewer Replacement @ 450 mm	450	m	424	$1,550	$660,000
	Sewer Replacement @ 525 mm	525	m	15	$1,650	$20,000
	Sewer Replacement @ 600 mm	600	m	240	$1,700	$410,000
	Manholes	300-750	ea	12	$20,000	$240,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW5-5	Sewer Replacement @ 300 mm	300	m	167	$1,400	$230,000
	Manholes	300-750	ea	2	$20,000	$40,000
WW5-6	Sewer Replacement @ 300 mm	300	m	166	$1,400	$230,000
	Manholes	300-750	ea	2	$20,000	$40,000
					Area Subtotal	**$21,410,000**
WW6-1	Sewer Replacement @ 300 mm	300	m	182	$1,400	$250,000
	Sewer Replacement @ 375 mm	375	m	98	$1,450	$140,000
	Manholes	300-750	ea	3	$20,000	$60,000
					Area Subtotal	**$450,000**
WW7-1	Sewer Replacement @ 250 mm	250	m	25	$1,250	$30,000
	Sewer Replacement @ 300 mm	300	m	157	$1,400	$220,000
	Sewer Replacement @ 525 mm	525	m	325	$1,650	$540,000
	Manholes	300-750	ea	4	$20,000	$80,000
					Area Subtotal	**$870,000**
Siphons	Alma Mercer	600	m	80	$1,700	$140,000
	Elizabeth-Beaumont	450	m	22	$5,050	$110,000
	Eramosa River	500	m	150	$5,100	$770,000
	Hanlon-Massey-Campbell	450	m	22	$5,050	$110,000
	Ptarmigan	200	m	162	$4,500	$730,000
	Speed River Crane Park	750	m	307	$5,500	$1,690,000
	Stevenson-Eramosa	200	m	23	$1,000	$20,000
	Willow-Guelph	750	m	19	$2,000	$40,000
					Siphon Subtotal	**$3,610,000**
	Subtotal		**Site Works (All Areas)**			**$42,670,000**
	SUBTOTAL (Site Works + Studies)					**$45,620,000**
	Contractor overhead and profit on SubTotal (15%)					$6,840,000
	Estimating Contingencies on Sub Total (50%)					$22,810,000
	TOTAL					**$75,270,000**
	Engineering Design and Construction Services on Total (15%)					$11,290,000
	GRAND TOTAL					**$86,560,000**
	Other Capital Works Required					
S1 (Manor Crescent Siphon)	Siphon Renewal / Replacement	-	-	-	-	$1,500,000
S2 (Municipal St Siphon)	Gravity Diversion / Siphon Decommissioning	-	-	-	-	$4,000,000
	GRAND TOTAL					**$92,060,000**

Item	Description		Units	Quantity	Unit Price	Total
0	**Preliminary Studies and Approvals**					
0.1	Preliminary Study		Study Areas	6	$ 50,000.00	$300,000
0.2	Preliminary Study (Area 5)		Study Areas	1	$ 100,000.00	$100,000
0.3	Environmental Approvals & Mitigation		Study Areas	7	$ 150,000.00	$1,050,000
0.4	Annual Flow Monitoring / I&I Studies		Years	30	$ 50,000.00	$1,500,000
0.5	Land Acquisition		Study Areas	7	$0	$0
	Subtotal		**Preliminary Studies and Approvals**			**$2,950,000**
Project Number	**Site Works**	**Diameter**				
WW1-1	Sewer Replacement @ 375 mm	375	m	472	$1,450	$680,000
	Manholes	300-750	ea	5	$20,000	$100,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW1-2	Sewer Replacement @ 375 mm	300	m	82	$1,400	$110,000
	Manholes	300-750	ea	1	$20,000	$20,000
	Highway Crossing	-	m	200	$6,500	$1,300,000
					Area Subtotal	**$3,190,000**
WW2-1	Sewer Replacement @ 300 mm	300	m	755	$1,400	$1,060,000
	Sewer Replacement @ 375 mm	375	m	337	$1,450	$490,000
	Sewer Replacement @ 675 mm	675	m	443	$1,950	$860,000
	Manholes	300-750	ea	17	$20,000	$340,000
WW2-2	Sewer Replacement @ 300 mm	300	m	123	$1,400	$170,000
	Sewer Replacement @ 375 mm	375	m	704	$1,450	$1,020,000
	Sewer Replacement @ 450 mm	450	m	690	$1,550	$1,070,000
	Manholes	300-750	ea	17	$20,000	$340,000
WW2-3	New Forcemain @ 150 mm	150	m	70	$1,500	$110,000
	Forcemain Diversion Chamber		LS	1	$50,000	$50,000
	Sewer Replacement @ 300 mm	300	m	350	$1,400	$490,000
	Sewer Replacement @ 375 mm	375	m	708	$1,450	$1,030,000
	Service Relocation	200	m	100	$1,000	$100,000
	Manholes	300-750	ea	12	$20,000	$240,000
WW2-4	Sewer Replacement @ 375 mm	300	m	237	$1,400	$330,000
	Manholes	300-750	ea	3	$20,000	$60,000
					Area Subtotal	**$7,760,000**
WW3-1	Sewer Replacement @ 450 mm	450	m	926	$1,550	$1,440,000
	Manholes	300-750	ea	10	$20,000	$200,000
					Area Subtotal	**$1,640,000**
WW4-1	Forcemain Diversion Chamber		LS	1	$50,000	$50,000
	Sewer Replacement @ 300 mm	300	m	70	$1,400	$100,000
	Sewer Replacement @ 375 mm	375	m	116	$1,450	$170,000
	Manholes	300-750	ea	2	$20,000	$40,000
WW4-2	Sewer Replacement @ 675 mm	675	m	777	$1,950	$1,520,000
	Sewer Replacement @ 900 mm	900	m	587	$2,700	$1,580,000
	Manholes	300-750	ea	9	$20,000	$180,000
	Manholes	825-1200	ea	5	$40,000	$200,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW4-4	Sewer Replacement @ 375 mm	375	m	999	$1,450	$1,450,000
	Manholes	300-750	ea	11	$20,000	$220,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW4-5	Sewer Replacement @ 300 mm	300	m	173	$1,400	$240,000
	Manholes	300-750	ea	2	$20,000	$40,000
					Area Subtotal	**$7,750,000**
WW5-1	Sewer Replacement @ 1200 mm	1200	m	1228	$3,400	$4,180,000
	Sewer Replacement @ 1350 mm	1350	m	2057	$3,550	$7,300,000
	Manholes	825-1200	ea	10	$40,000	$400,000
	Manholes	1350-1800	ea	10	$50,000	$500,000
	River Crossing	-	m	150	$6,500	$980,000
	Highway Crossing	-	m	200	$6,500	$1,300,000
WW5-2	Sewer Replacement @ 825 mm	825	m	528	$2,500	$1,320,000
	Manholes	825-1200	ea	4	$20,000	$80,000
WW5-3	Sewer Replacement @ 600 mm	600	m	1014	$1,700	$1,720,000
	Manholes	300-750	ea	11	$20,000	$220,000
WW5-4	Sewer Replacement @ 375 mm	375	m	387	$1,450	$560,000
	Sewer Replacement @ 450 mm	450	m	424	$1,550	$660,000
	Sewer Replacement @ 525 mm	525	m	15	$1,650	$20,000
	Sewer Replacement @ 600 mm	600	m	240	$1,700	$410,000
	Manholes	300-750	ea	12	$20,000	$240,000
	Railway Crossing	-	m	150	$6,500	$980,000
WW5-5	Sewer Replacement @ 300 mm	300	m	167	$1,400	$230,000
	Manholes	300-750	ea	2	$20,000	$40,000
WW5-6	Sewer Replacement @ 300 mm	300	m	166	$1,400	$230,000
	Manholes	300-750	ea	2	$20,000	$40,000
					Area Subtotal	**$21,410,000**
WW6-1	Sewer Replacement @ 300 mm	300	m	182	$1,400	$250,000
	Sewer Replacement @ 375 mm	375	m	98	$1,450	$140,000
	Sewer Replacement @ 450 mm	450	m	473	$1,550	$730,000
	Sewer Replacement @ 525 mm	525	m	887	$1,650	$1,460,000
	Sewer Replacement @ 600 mm	600	m	59	$1,700	$100,000
	Manholes	300-750	ea	19	$20,000	$380,000
					Area Subtotal	**$3,060,000**
WW7-1	Sewer Replacement @ 250 mm	250	m	610	$1,250	$760,000
	Sewer Replacement @ 300 mm	300	m	224	$1,400	$310,000
	Manholes	300-750	ea	9	$20,000	$180,000
					Area Subtotal	**$1,250,000**
Siphons	Alma Mercer	600	m	80	$1,700	$140,000
	Elizabeth-Beaumont	450	m	22	$5,050	$110,000
	Eramosa River	500	m	150	$5,100	$770,000
	Hanlon-Massey-Campbell	450	m	22	$5,050	$110,000
	Ptarmigan	200	m	162	$4,500	$730,000
	Speed River Crane Park	750	m	307	$5,500	$1,690,000
	Stevenson-Eramosa	200	m	23	$1,000	$20,000
	Willow-Guelph	750	m	19	$2,000	$40,000
					Siphons Subtotal	**$3,610,000**
	Subtotal		**Site Works (All Areas)**			**$49,670,000**
	SUBTOTAL (Site Works + Studies)					**$52,620,000**
	Contractor overhead and profit on SubTotal (15%)					$7,890,000
	Estimating Contingencies on Sub Total (50%)					$26,310,000
	TOTAL					**$86,820,000**

	Engineering Design and Construction Services on Total (15%)					$13,020,000
GRAND TOTAL						**$99,840,000**
Other Capital Works Required						
S1 (Manor Crescent Siphon)	Siphon Renewal / Replacement	-	-	-	-	$1,500,000
S2 (Municipal St Siphon)	Gravity Diversion / Siphon Decommissioning	-	-	-	-	$4,000,000
GRAND TOTAL						**$105,340,000**

APPENDIX C –

Water Model Results

Water model results under each of the defined planning horizons are presented in this Appendix.

C.1 Short Term Analysis (2031)

The proposed short-term projects are shown in C-2031-1 below. Model results under this horizon are presented in Table C-2031-1 below. For this analysis, the proposed projects shown in C-2031-1 were included. CI replacement projects were not included. The Arkell PS and watermain were active for this scenario. As a sensitivity analysis, this horizon was also run without the Arkell PS and results are presented in the following section (C.1.1).

Table C-2031-1 2031 Short Term Results Summary

Result	Figure	Results Summary
Pressure	C-2031-2	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 38 psi in PLo-1. Max pressure in PHi-6 of 103 psi.
Linear Capacity	C-2031-3	Headloss maintained under 2m/km with exception of Dunlop Dr and Huron from York to Alice. Huron has been flagged as CI replacement priority.
Storage	C-2031-4 & C-2031-5	All ETs maintained above 80% full. All reservoirs maintained above 60% full. Woods & Arkell Res minimum levels 62%.
Pump Station Flow	C-2031-6 & C-2031-7	All PSs operated below firm capacity. Max flow at Woods of 600 L/s. Max flow at Arkell of 240 L/s.

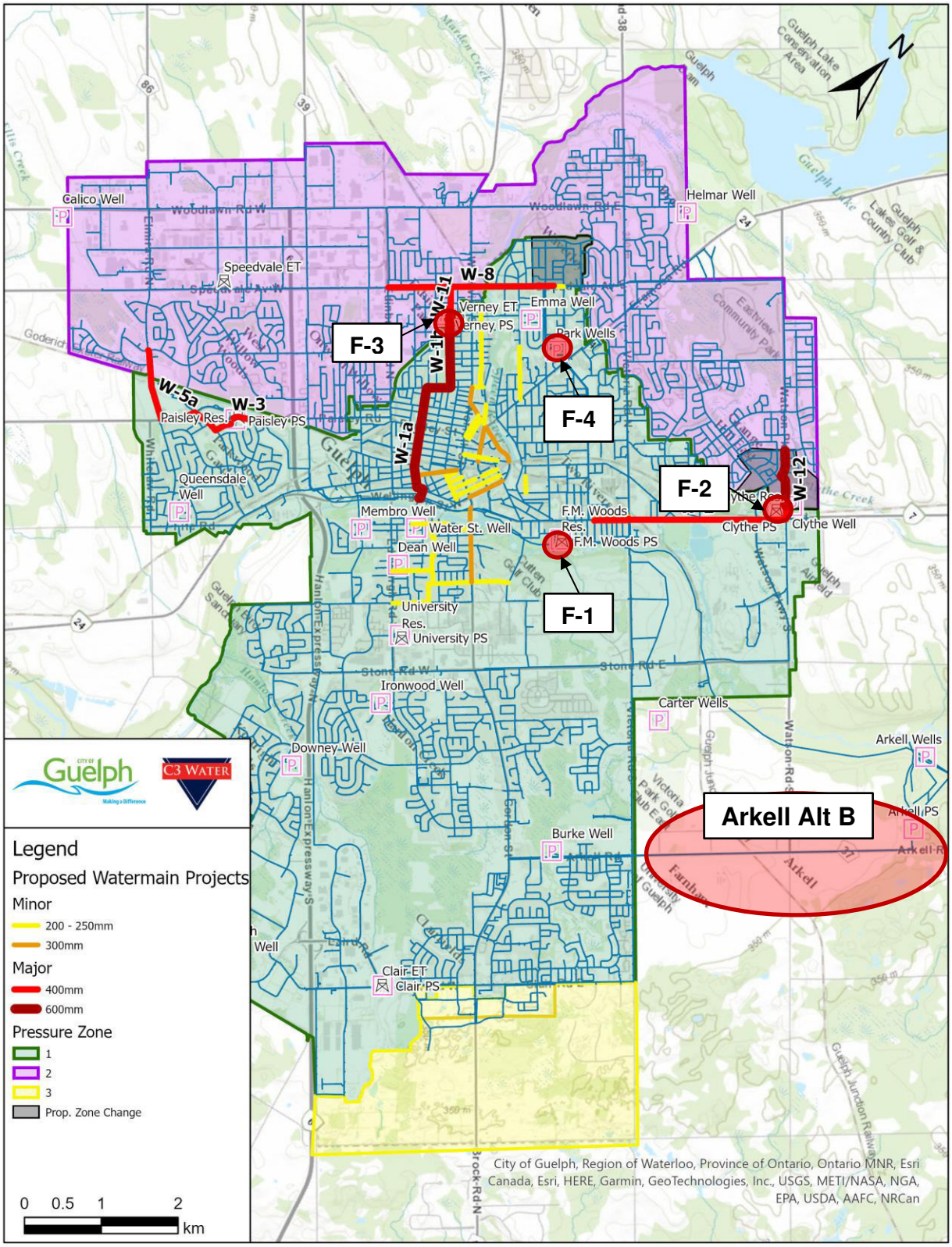


Figure C-2031-1 Proposed Short Term Water Projects

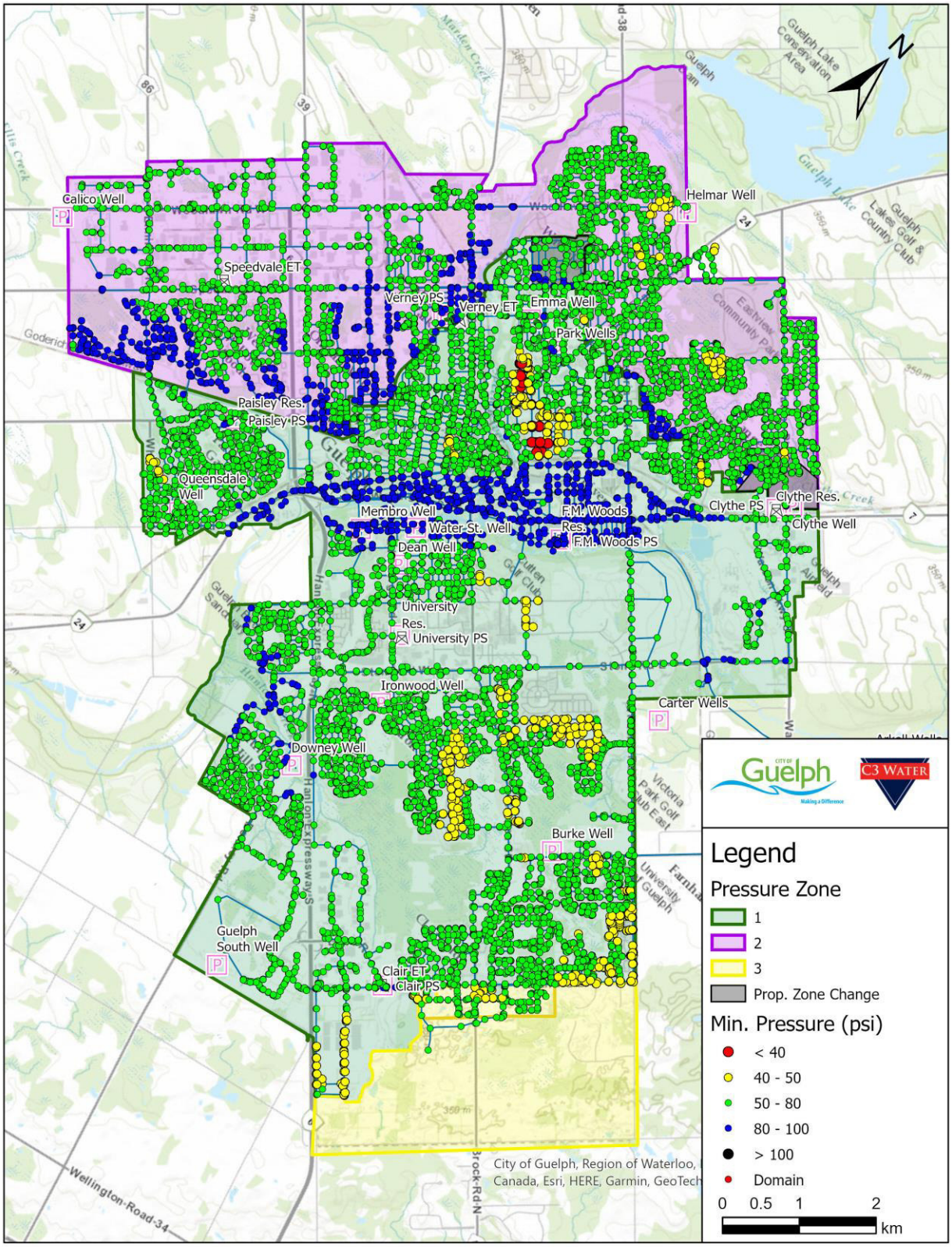


Figure C-2031-2 2031 MDD Minimum Pressure – Proposed Upgrades Active

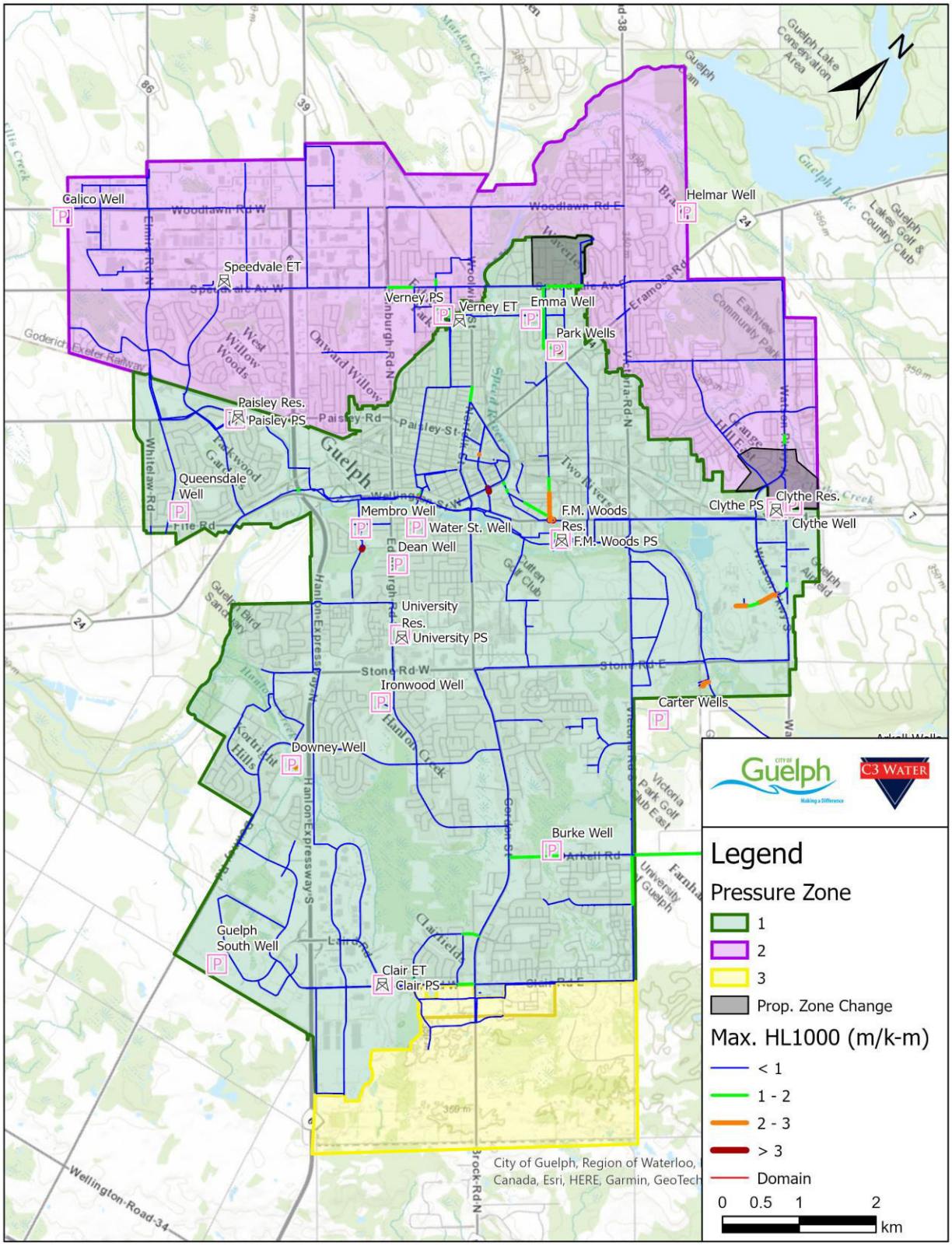


Figure C-2031-3 2031 MDD Max Headloss – Proposed Upgrades Active

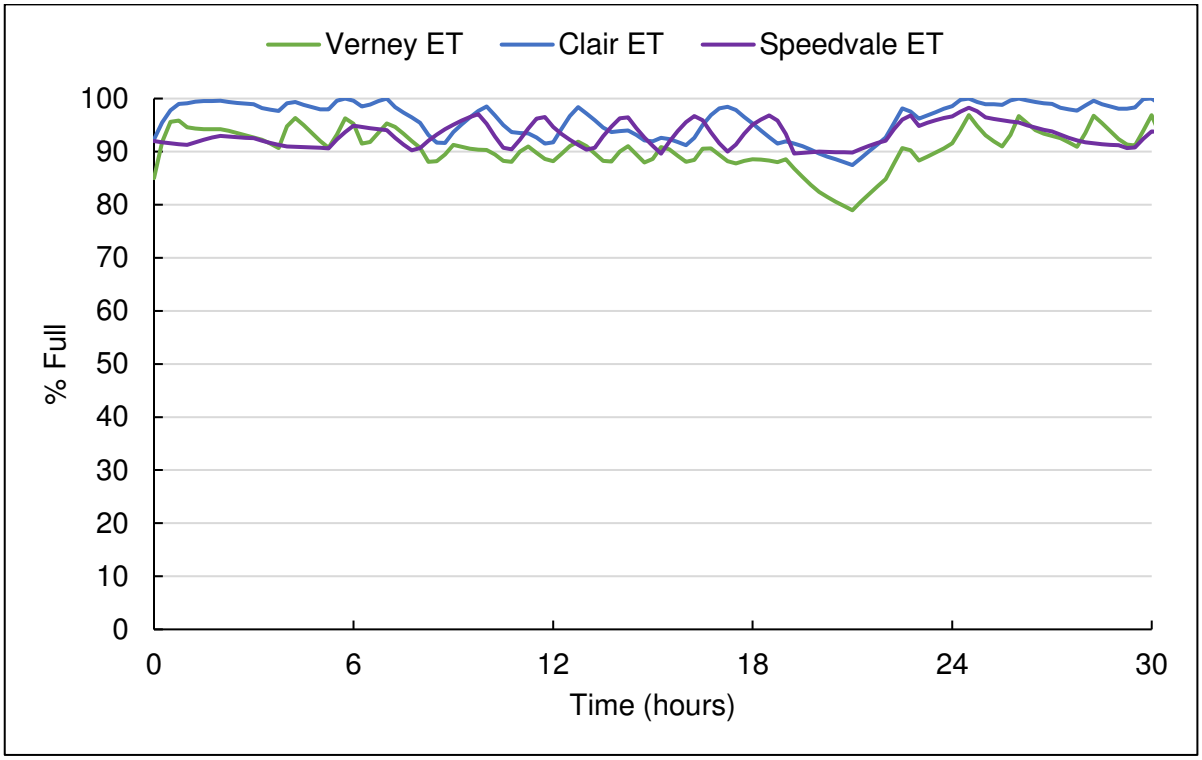


Figure C-2031-4 2031 MDD ET Levels – Proposed Upgrades Active

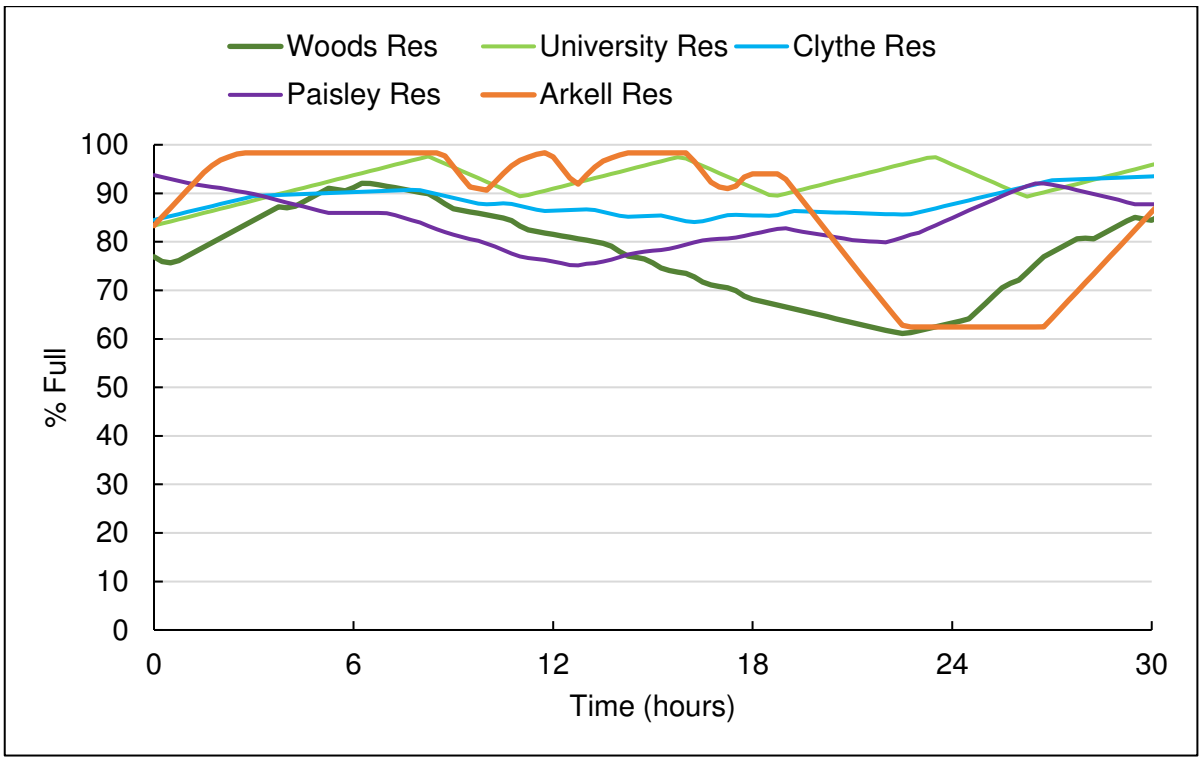


Figure C-2031-5 2031 MDD Reservoir Levels – Proposed Upgrades Active

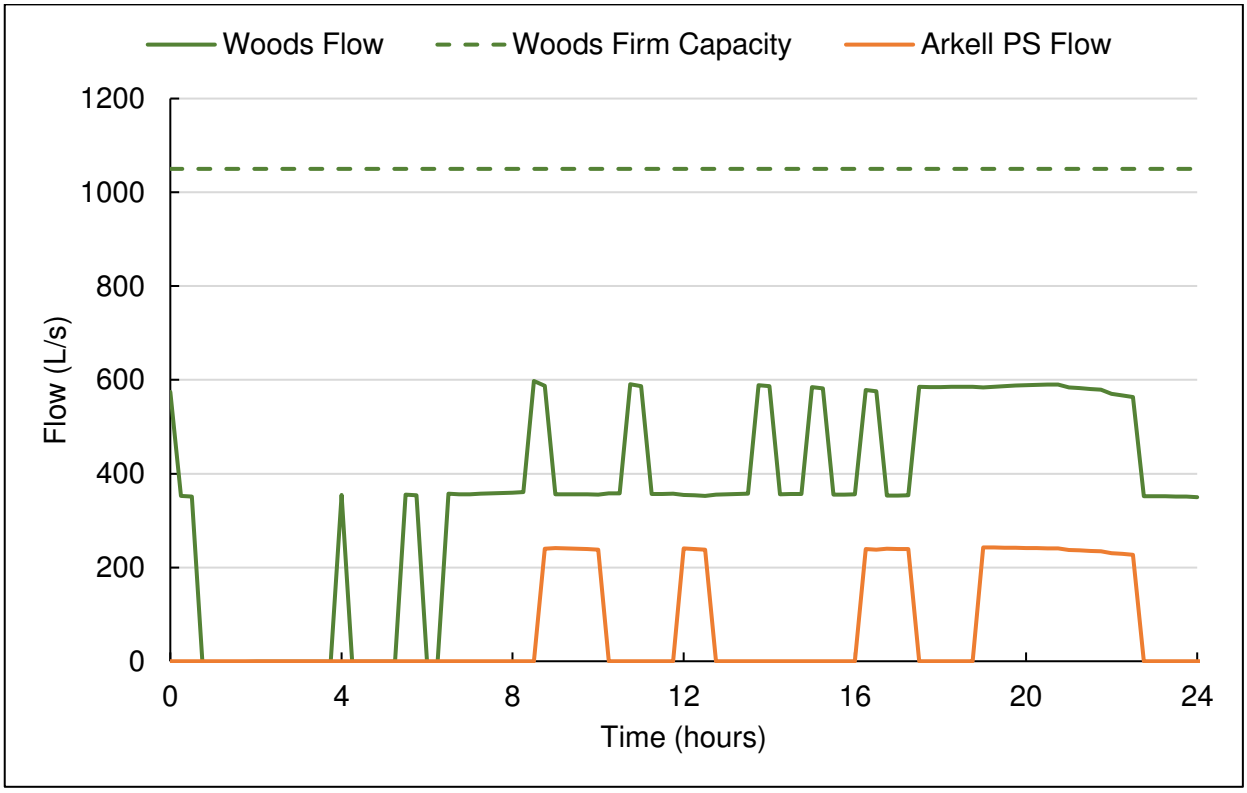


Figure C-2031-6 2031 MDD PS Flows – Proposed Upgrades Active

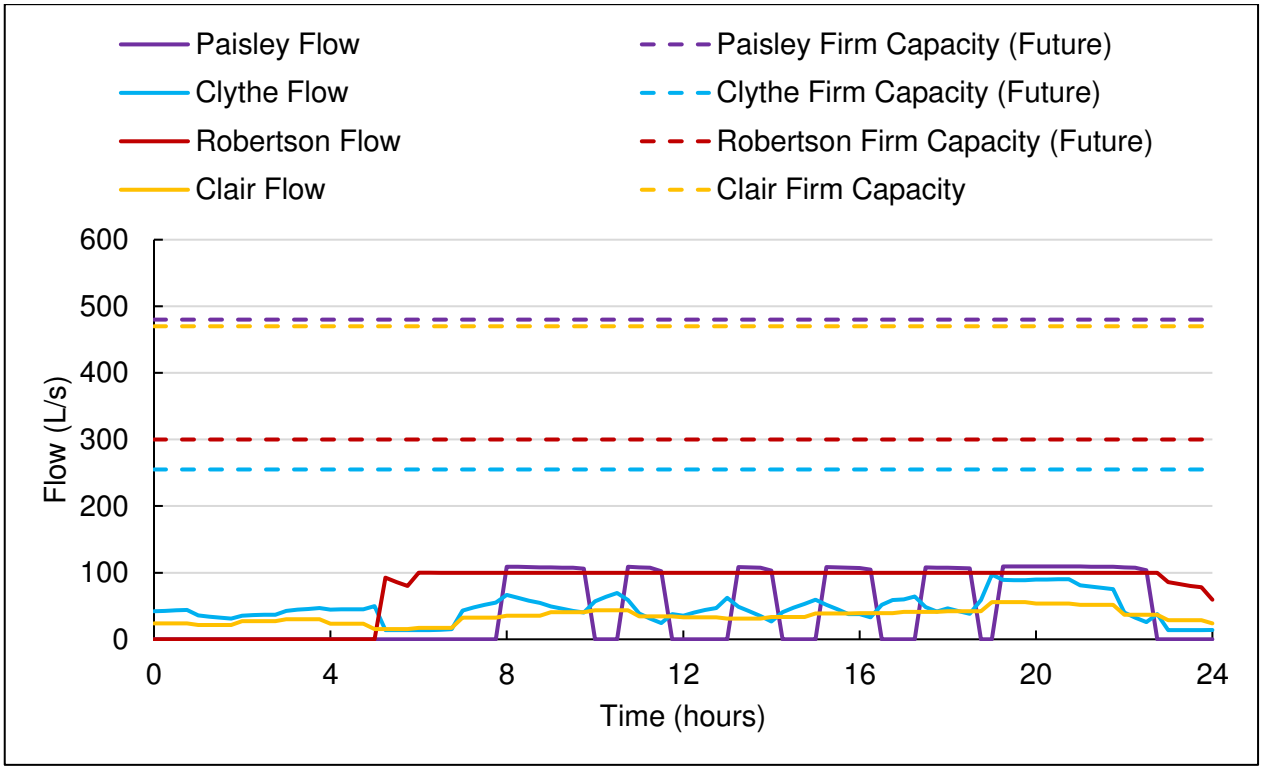


Figure C-2031-7 2031 MDD PS Flows – Proposed Upgrades Active

C.1.1 Short Term Analysis (2031) – Arkell PS Offline

Although the proposed Arkell PS and watermain have been recommended for short-term implementation, it may not be feasible for this project to be completed by 2031 due to its significant size. As such, the 2031 scenario was also modelled with the Arkell PS offline.

Under 2031 conditions, it was found that an acceptable LOS was able to be maintained without the Arkell PS. Service in the south end of Zone 1 and the Clair ET level was found to be improved compared to existing conditions due to the implementation of the Ironwood and Southwest Wells.

Model results under this horizon are presented in Table C-2031-2 below.

Table C-2031-2 2031 Short Term Results Summary – Arkell PS Offline

Result	Figure	Results Summary
Pressure	C-2031-8	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 37 psi in PLo-1. Max pressure in PHi-6 of 104 psi.
Linear Capacity	C-2031-9	Headloss maintained under 2m/km with exception of Dunlop drive.
Storage	C-2031-10 & C-2031-11	All ETs maintained above 75% full. All reservoirs maintained above 60% full. Woods Res minimum level 62%.
Pump Station Flow	C-2031-12 & C-2031-13	All PSs operated below firm capacity. Max flow at Woods of 710 L/s.

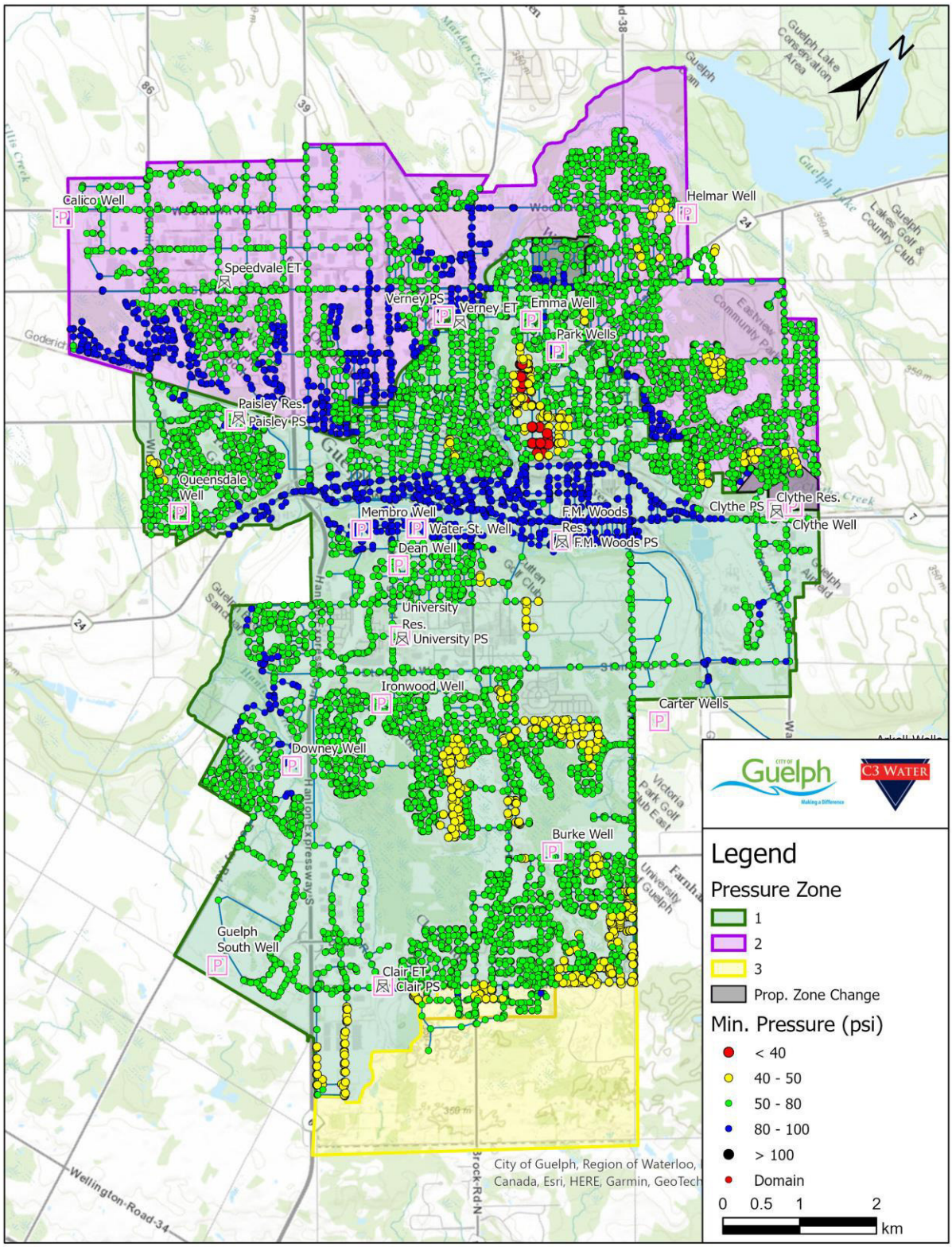


Figure C-2031-8 2031 MDD Minimum Pressure – Proposed Upgrades Active – Arkell PS Offline

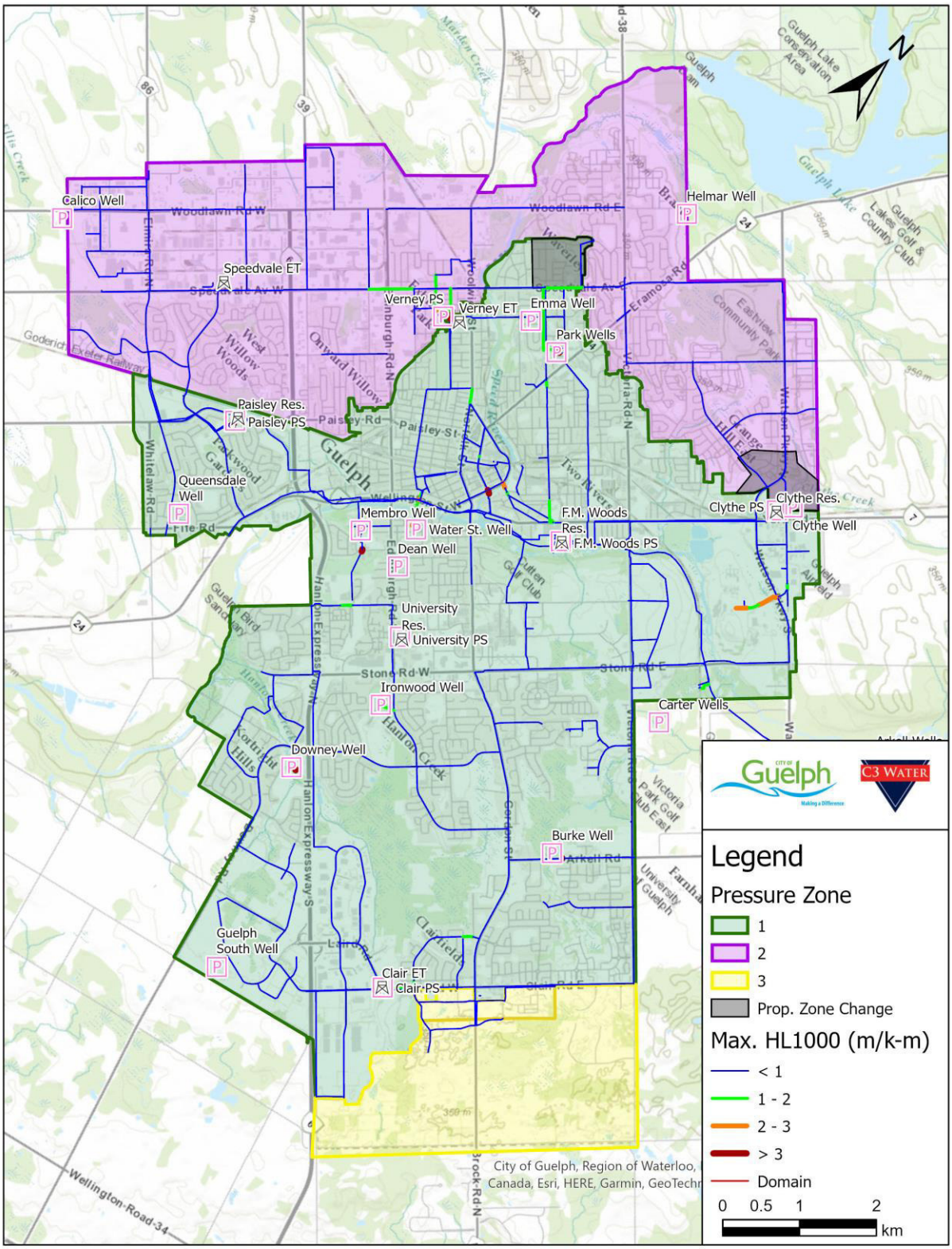


Figure C-2031-9 2031 MDD Max Headloss – Proposed Upgrades Active – Arkell PS Offline

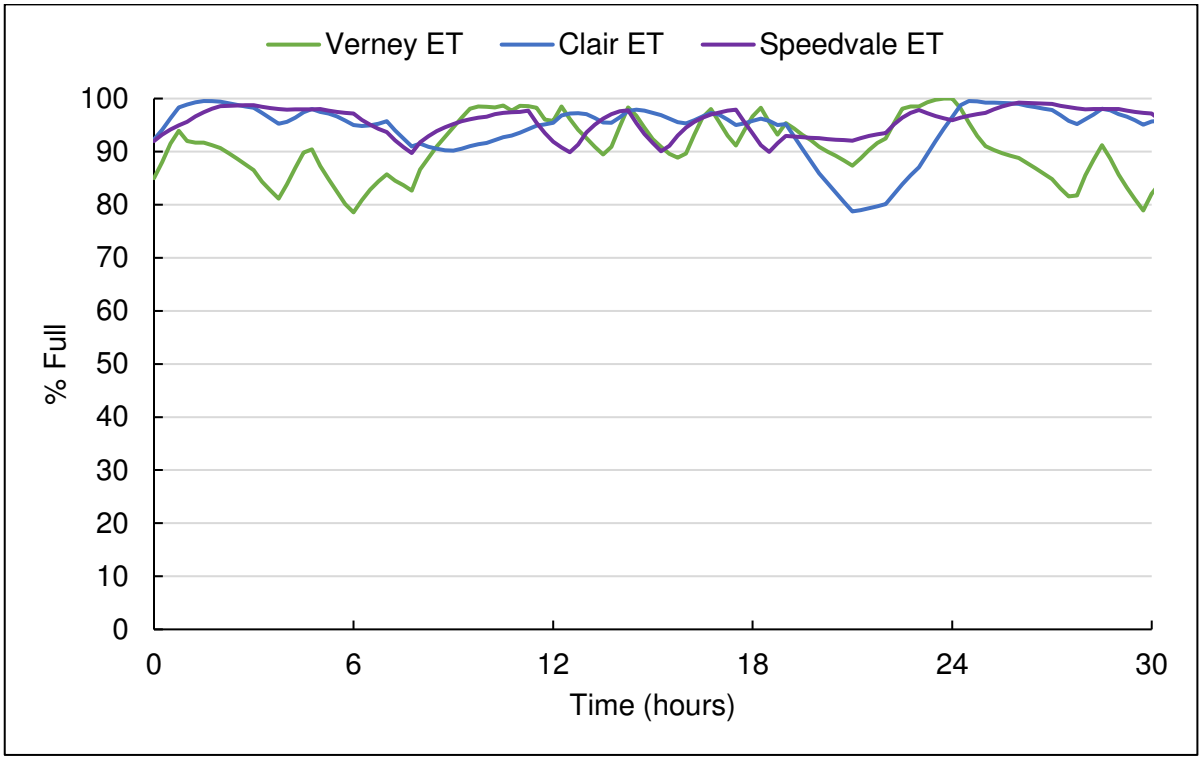


Figure C-2031-10 2031 MDD ET Levels – Proposed Upgrades Active – Arkell PS Off

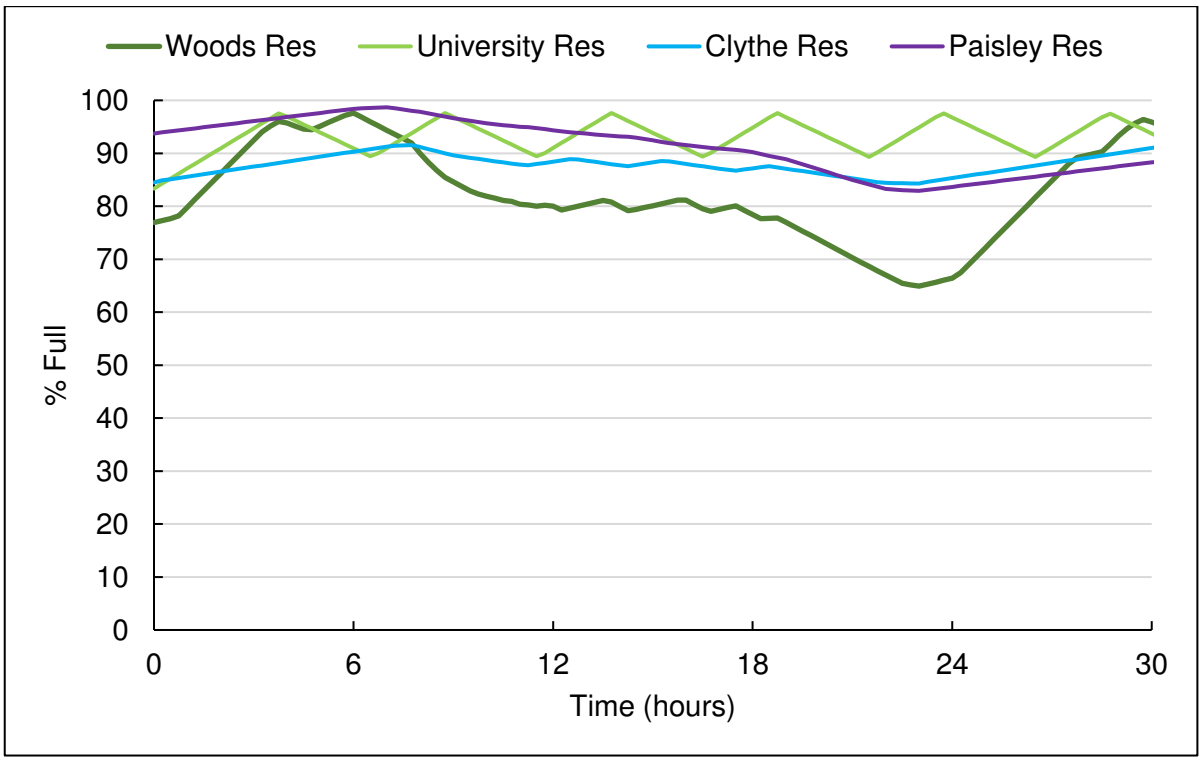


Figure C-2031-111 2031 MDD Reservoir Levels – Proposed Upgrades Active – Arkell PS Off

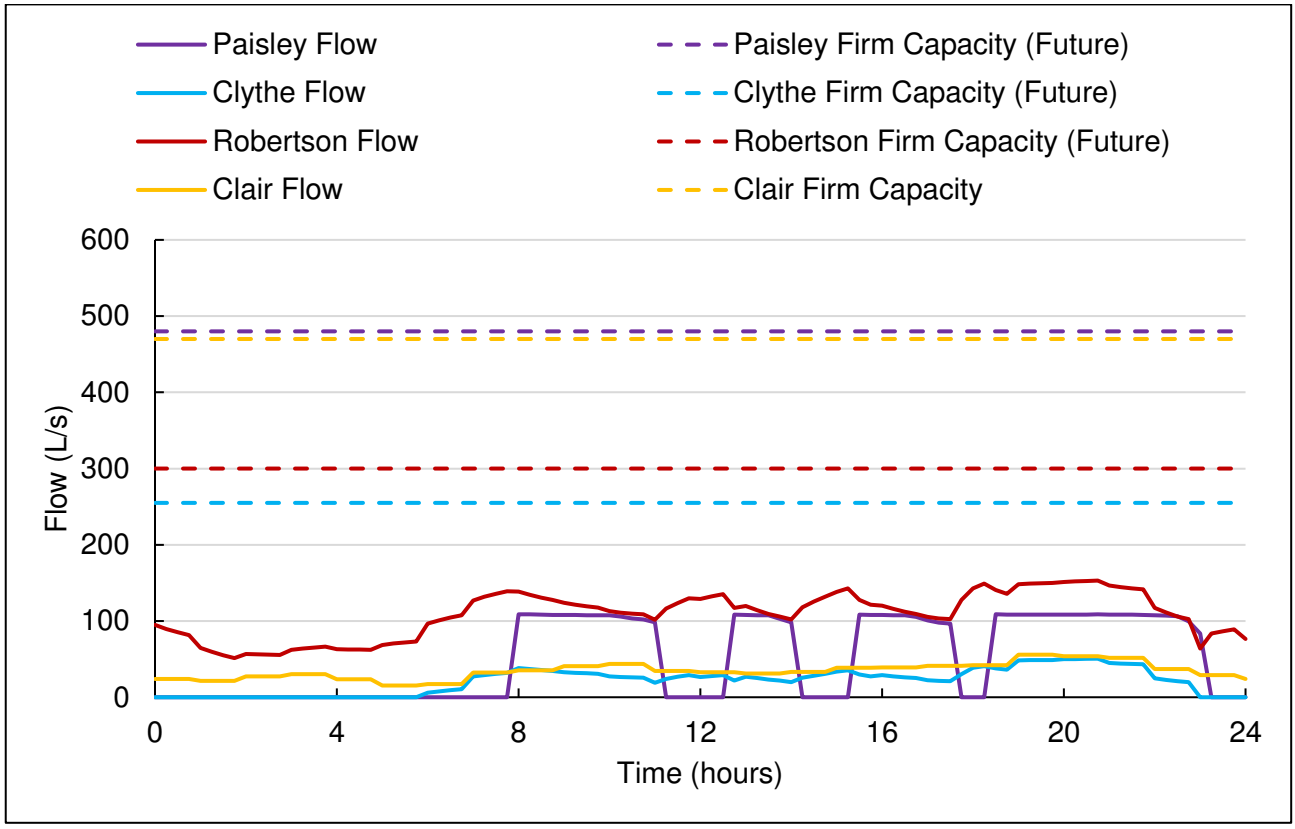


Figure C-2031-12 2031 MDD PS Flows – Proposed Upgrades Active – Arkell PS Off

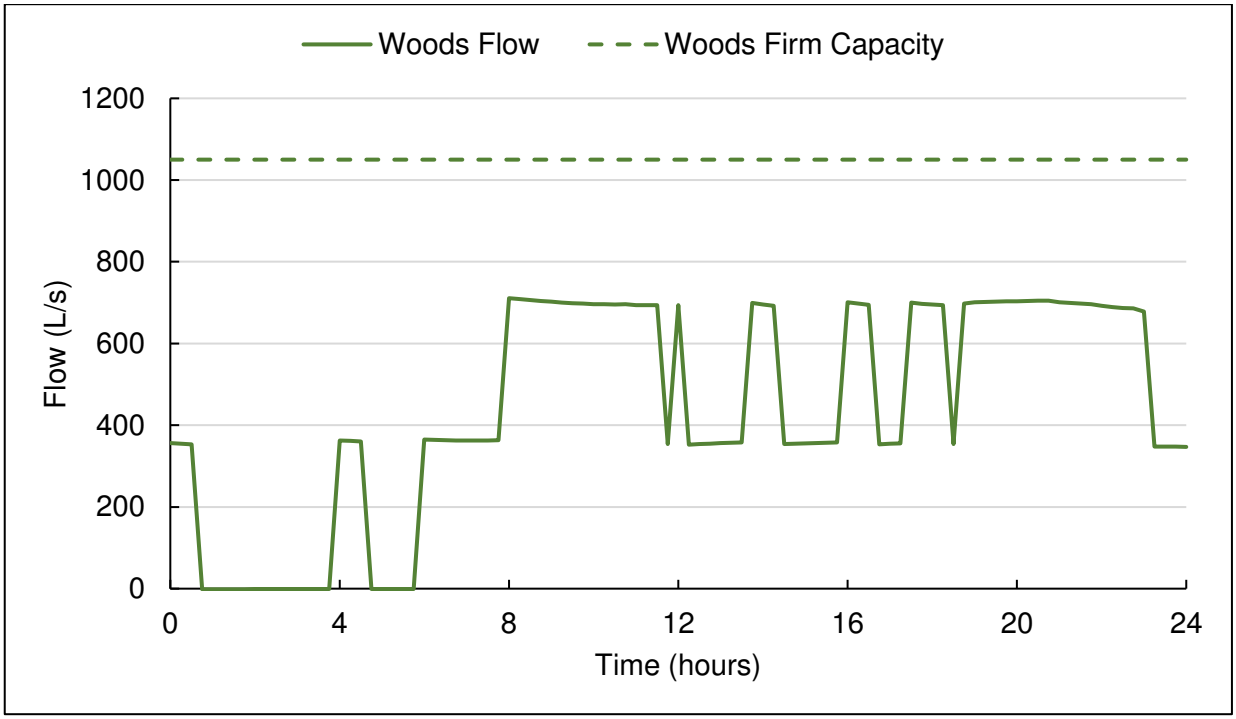


Figure C-2031-14 2031 MDD PS Flows – Proposed Upgrades Active – Arkell PS Off

C.2 Mid-Term Analysis (2041)

The proposed mid-term projects are shown in C-2041-1 below. Model results under this horizon are presented in Table C-2041-1 below. For this analysis, the proposed projects shown in C-2041-1 were included. CI replacement projects were not included. The Arkell PS and watermain were active for this scenario.

Table C-2041-1 2041 Mid-Term Results Summary

Result	Figure	Results Summary
Pressure	C-2041-2	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 37 psi in PLo-1. Max pressure in PHi-6 of 103 psi.
Linear Capacity	C-2041-3	Headloss maintained under 2m/km with exception of Dunlop Dr and Huron from York to Alice. Huron has been flagged as CI replacement priority.
Storage	C-2041-4 & C-2041-5	All ETs maintained above 75% full. All reservoirs maintained above 60% full. Woods Res minimum level 60%. Arkell Res minimum level 72%.
Pump Station Flow	C-2041-6 & C-2041-7	All PSs operated below firm capacity. Max flow at Woods of 600 L/s. Max flow at Arkell of 330 L/s.

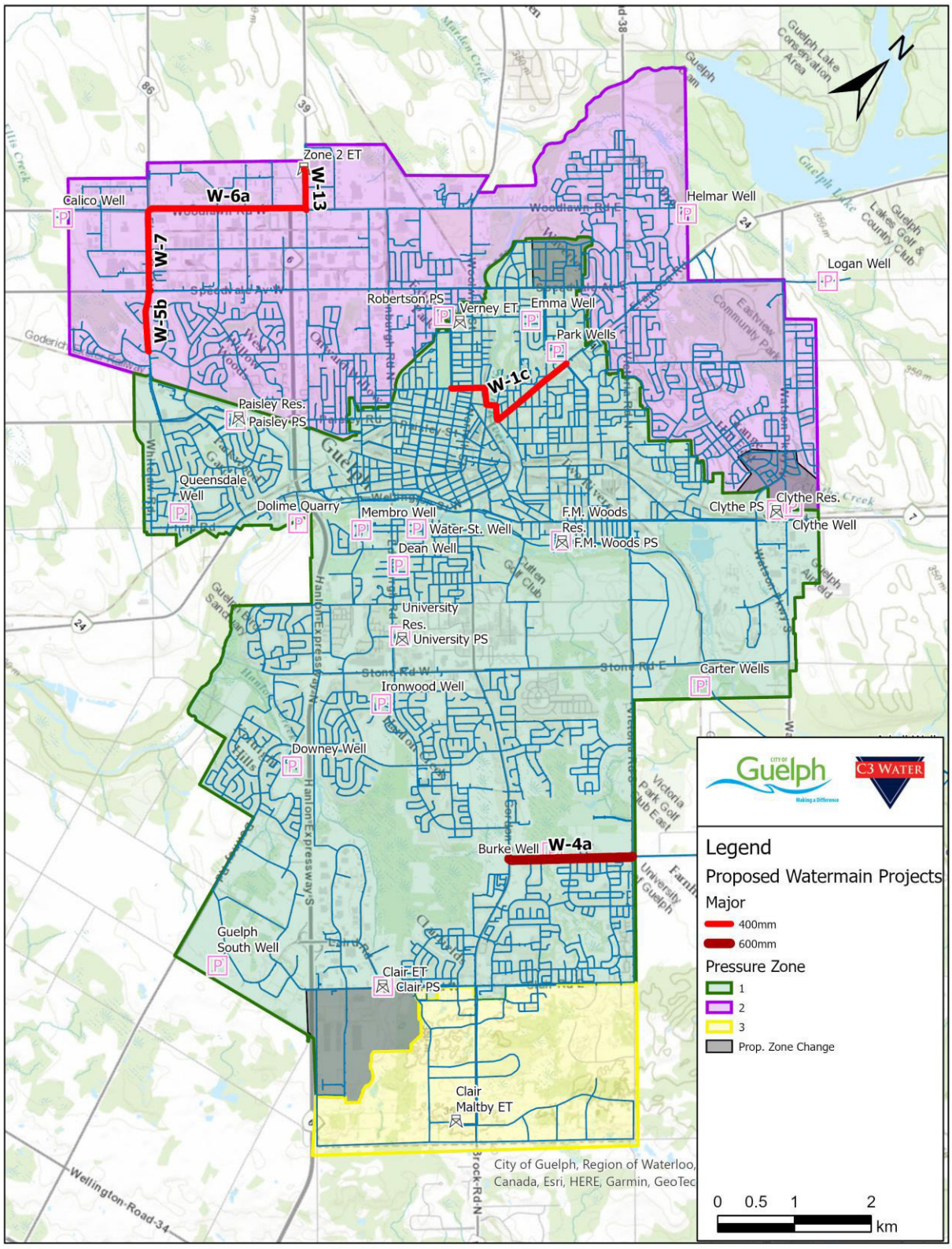


Figure C-2041-1 Proposed Mid-Term Water Projects

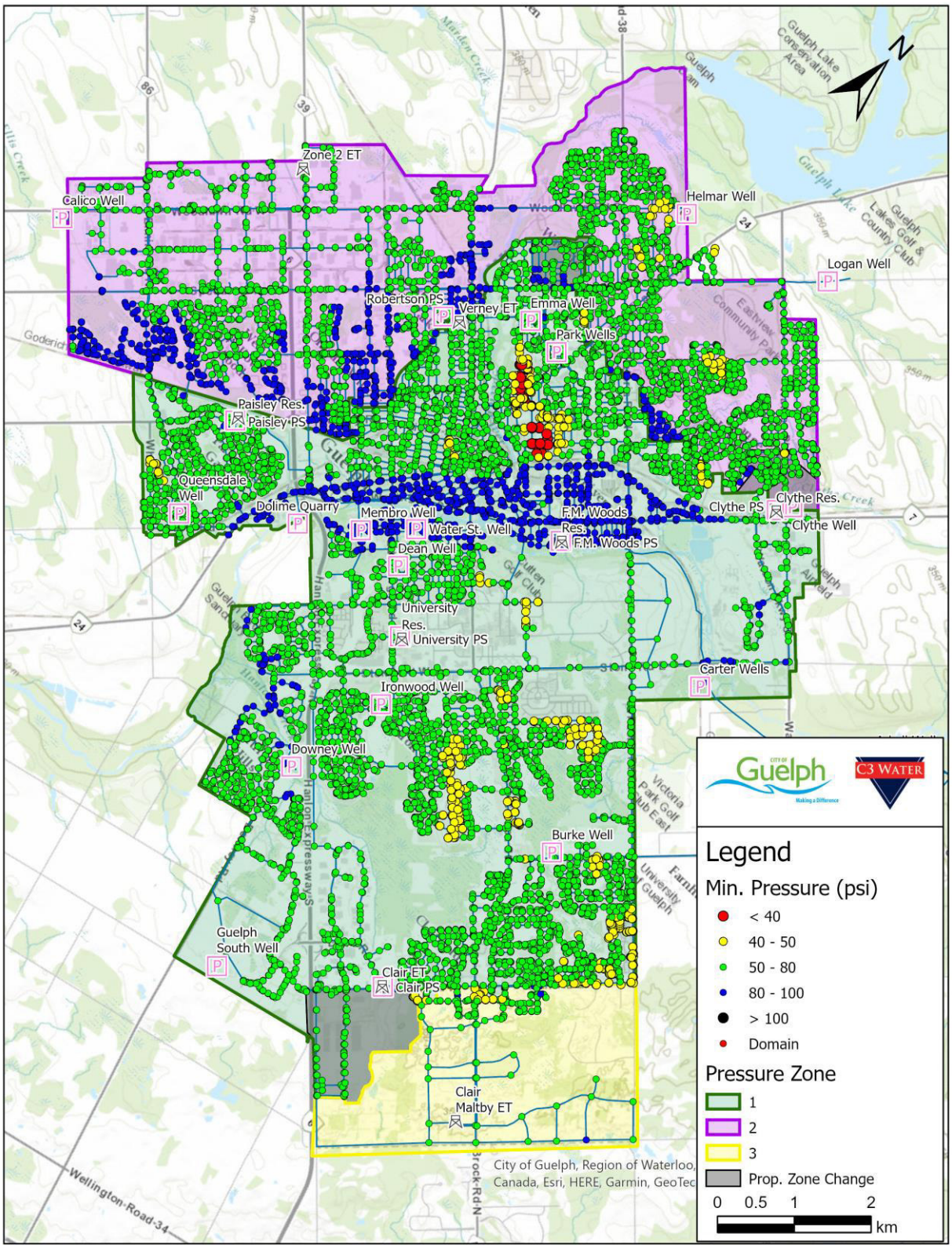


Figure C-2041-2 2041 MDD Minimum Pressure – Proposed Upgrades Active

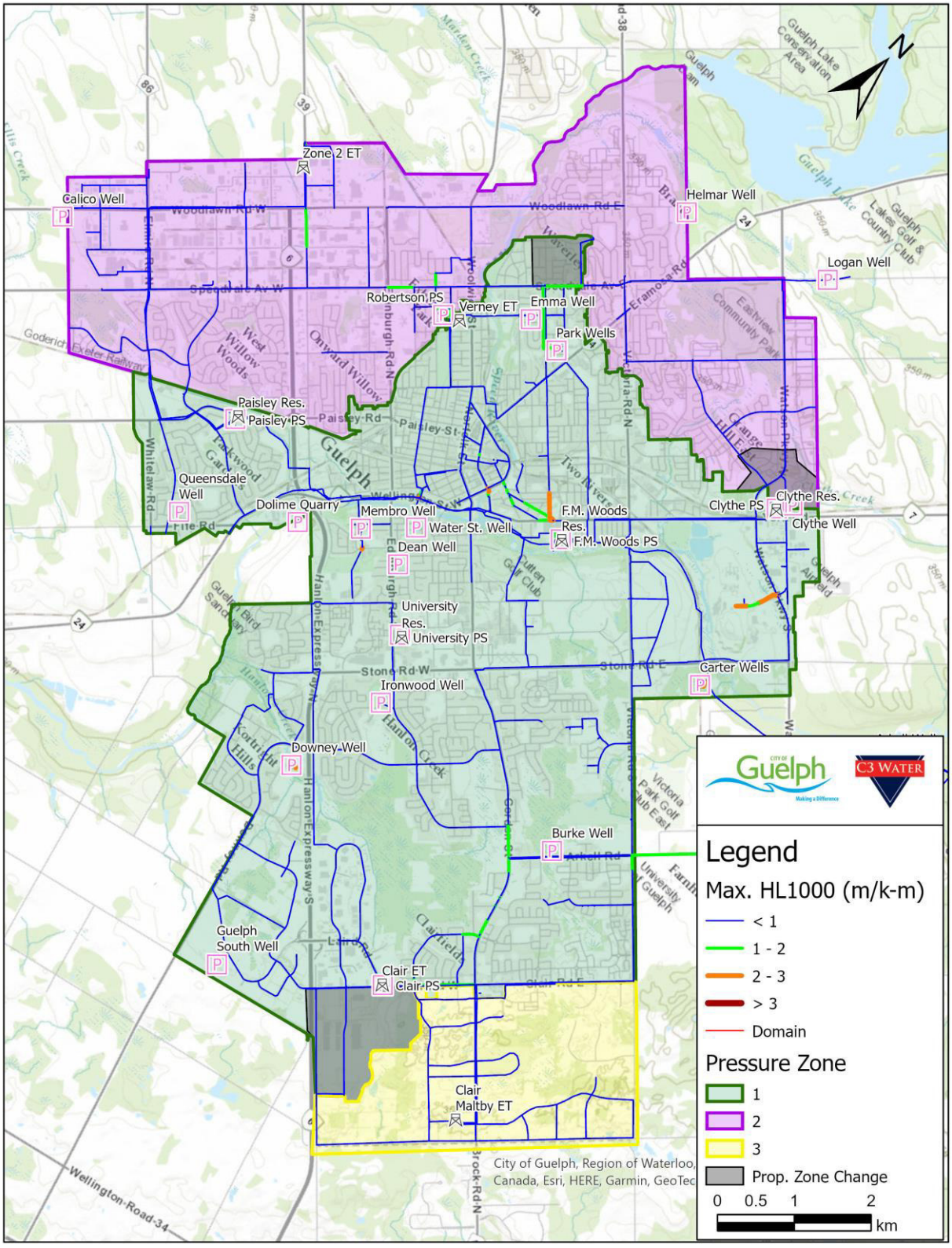


Figure C-2041-3 2041 MDD Max Headloss – Proposed Upgrades Active

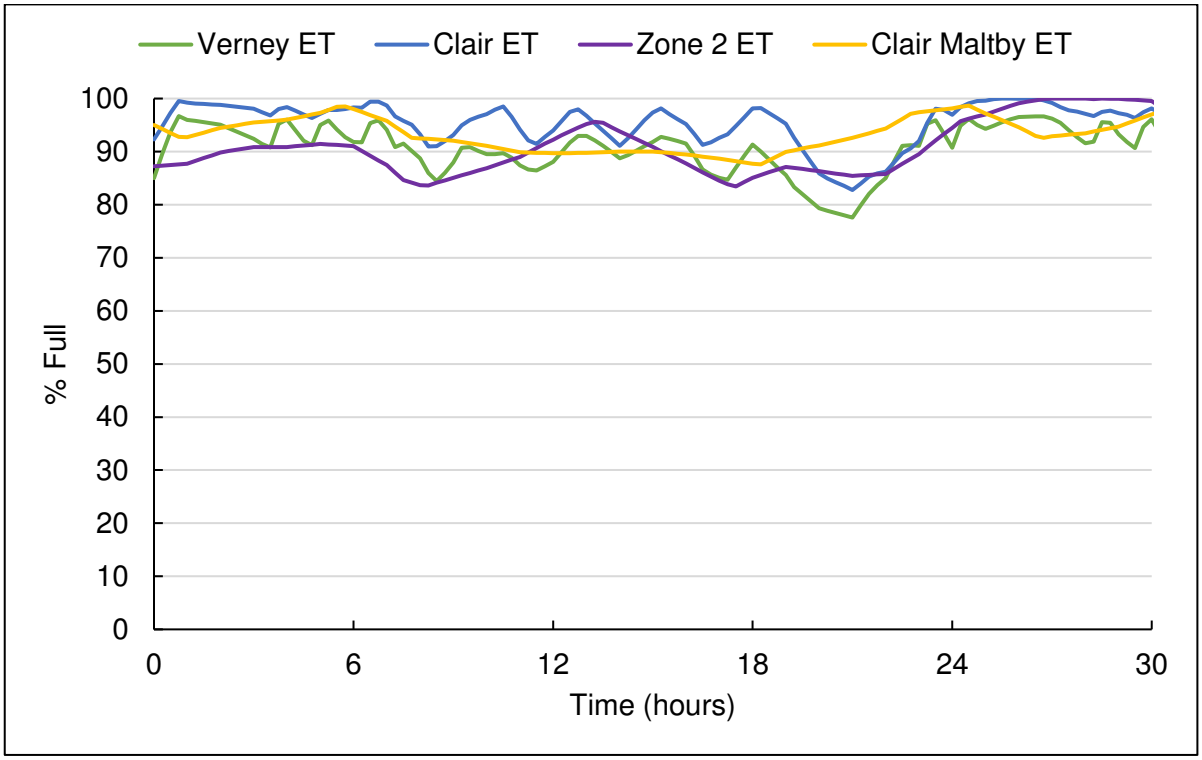


Figure C-2041-4 2041 MDD ET Levels – Proposed Upgrades Active

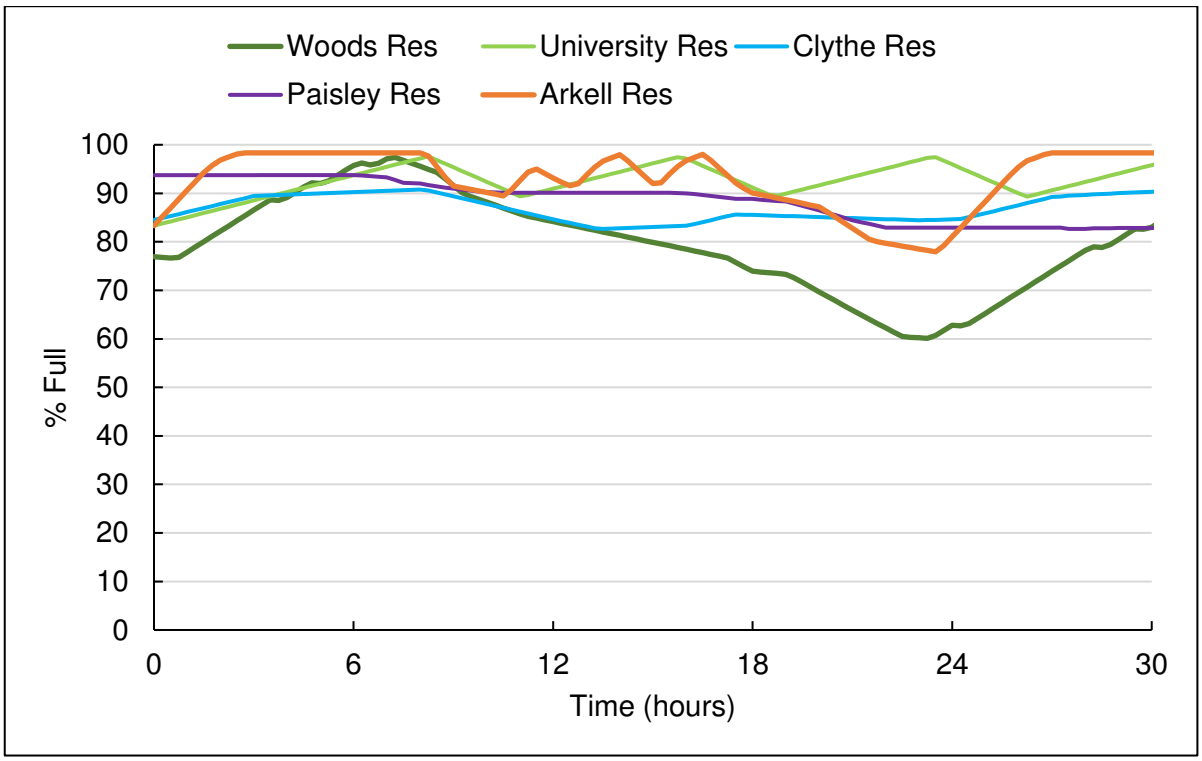


Figure C-2041-5 2041 MDD Reservoir Levels – Proposed Upgrades Active

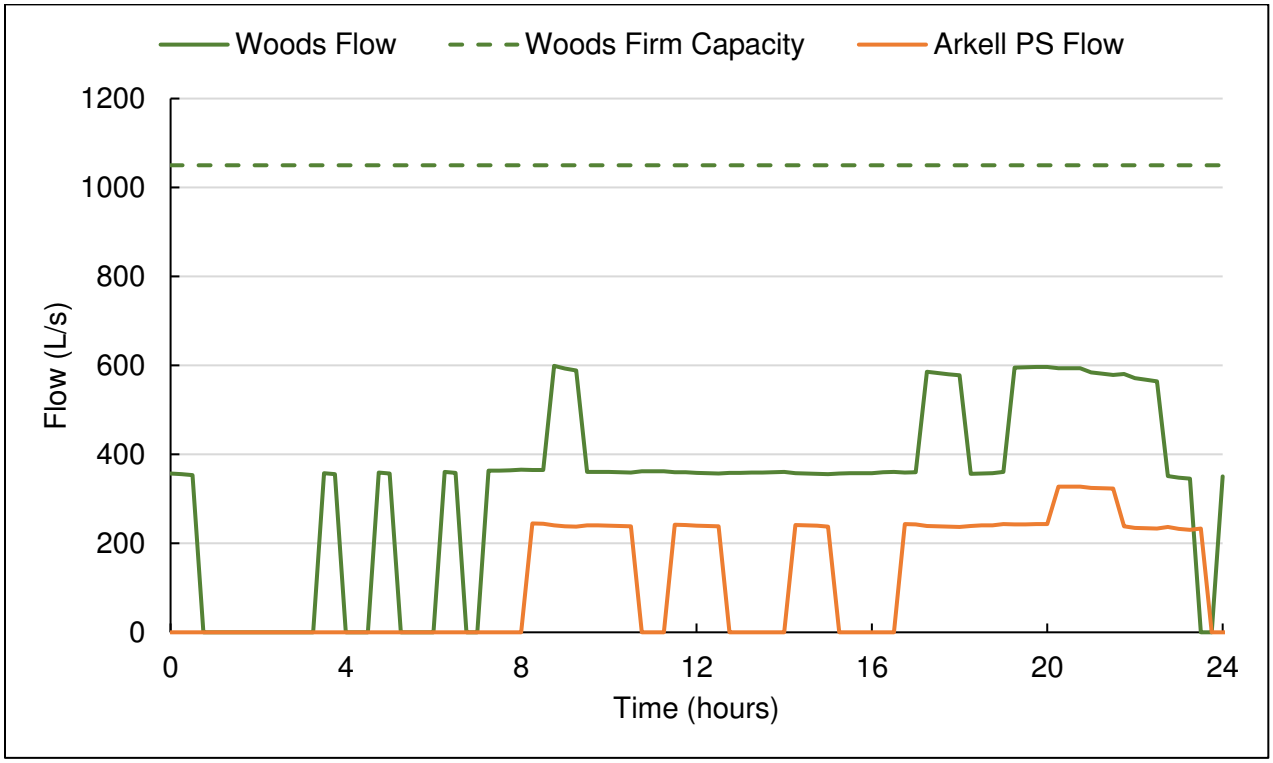


Figure C-2041-6 2041 MDD PS Flows – Proposed Upgrades Active

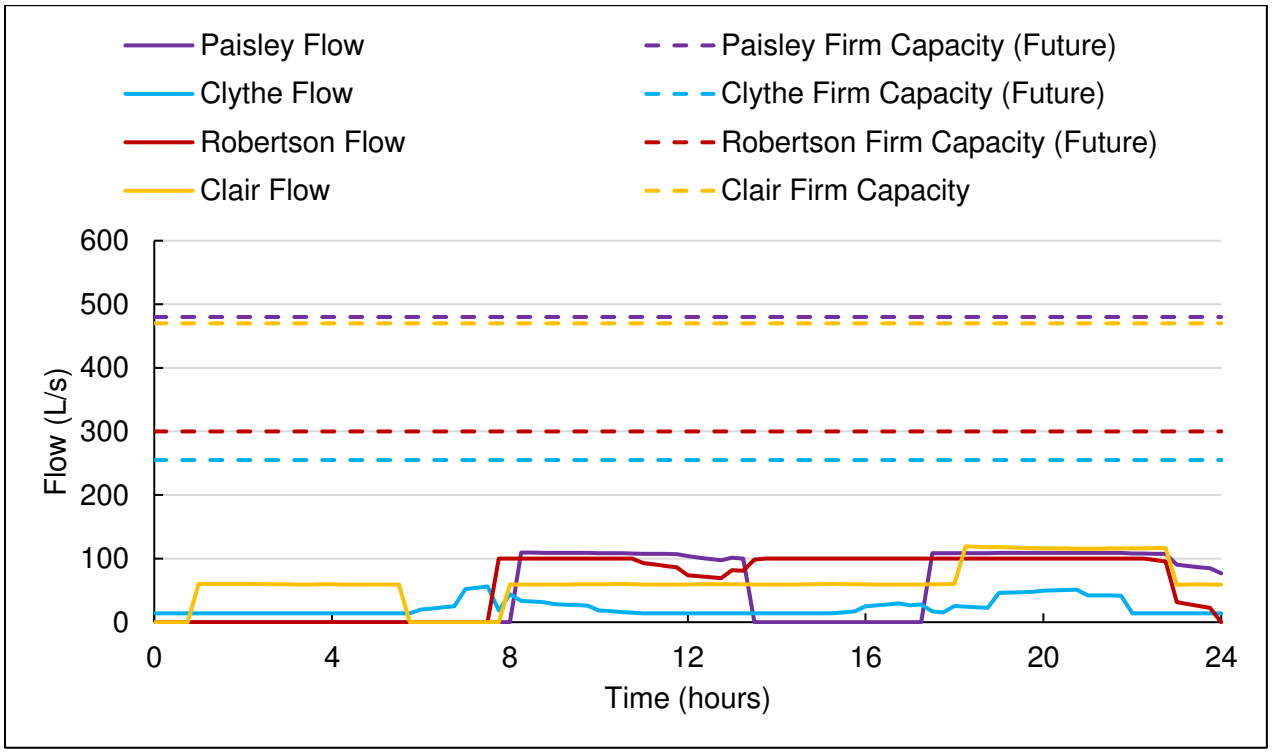


Figure C-2041-7 2041 MDD PS Flows – Proposed Upgrades Active

C.3 Long Term Analysis (2051+)

The proposed long-term projects are shown in C-2051+-1 below. Model results under this horizon are presented in Table C-2051+-1 below. For this analysis, the proposed projects shown in C-2051+-1 were included. CI replacement projects were not included. The Arkell PS and watermain were active for this scenario. Fire flow results are presented and discussed below in Section C.3.1.

Table C-2051+-1 2051+ Long Term Results Summary

Result	Figure	Results Summary
Pressure	C-2051+-2 & C-2051+-3	Minimum pressure maintained above 40 psi throughout system with exception of PLo-1. Min pressure of 38 psi in PLo-1. Max pressure in PHi-6 of 103 psi.
Linear Capacity	C-2051+-4	Headloss maintained under 2m/km with exception of Dunlop Dr.
Storage	C-2041-5 & C-2041-6	All ETs maintained above 75% full. Woods & Arkell Res minimum levels 58%.
Pump Station Flow	C-2041-7 & C-2041-8	All PSs operated below firm capacity. Max flow at Woods of 840 L/s. Max flow at Arkell of 350 L/s.

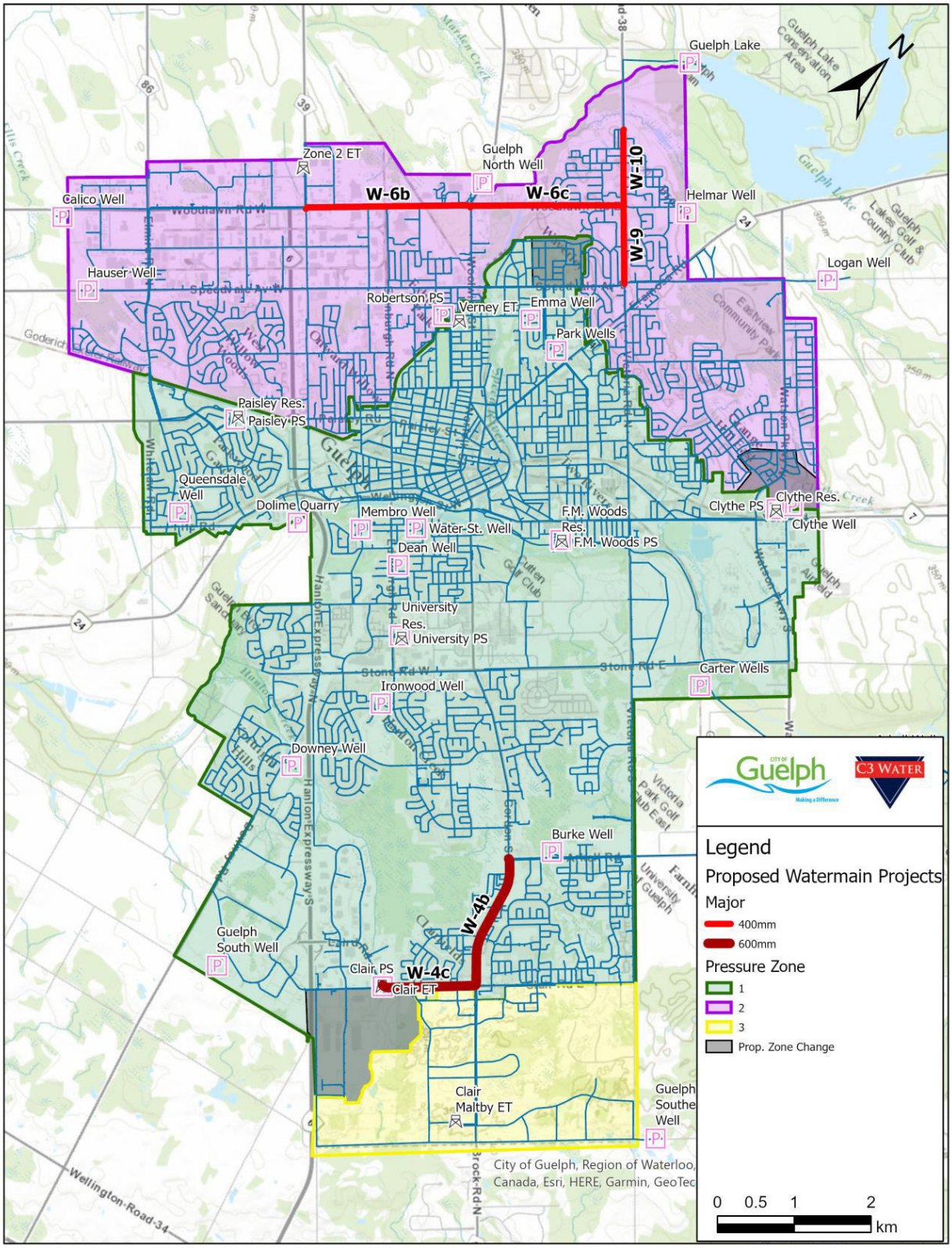


Figure C-2051+-1 Proposed Long Term Water Projects

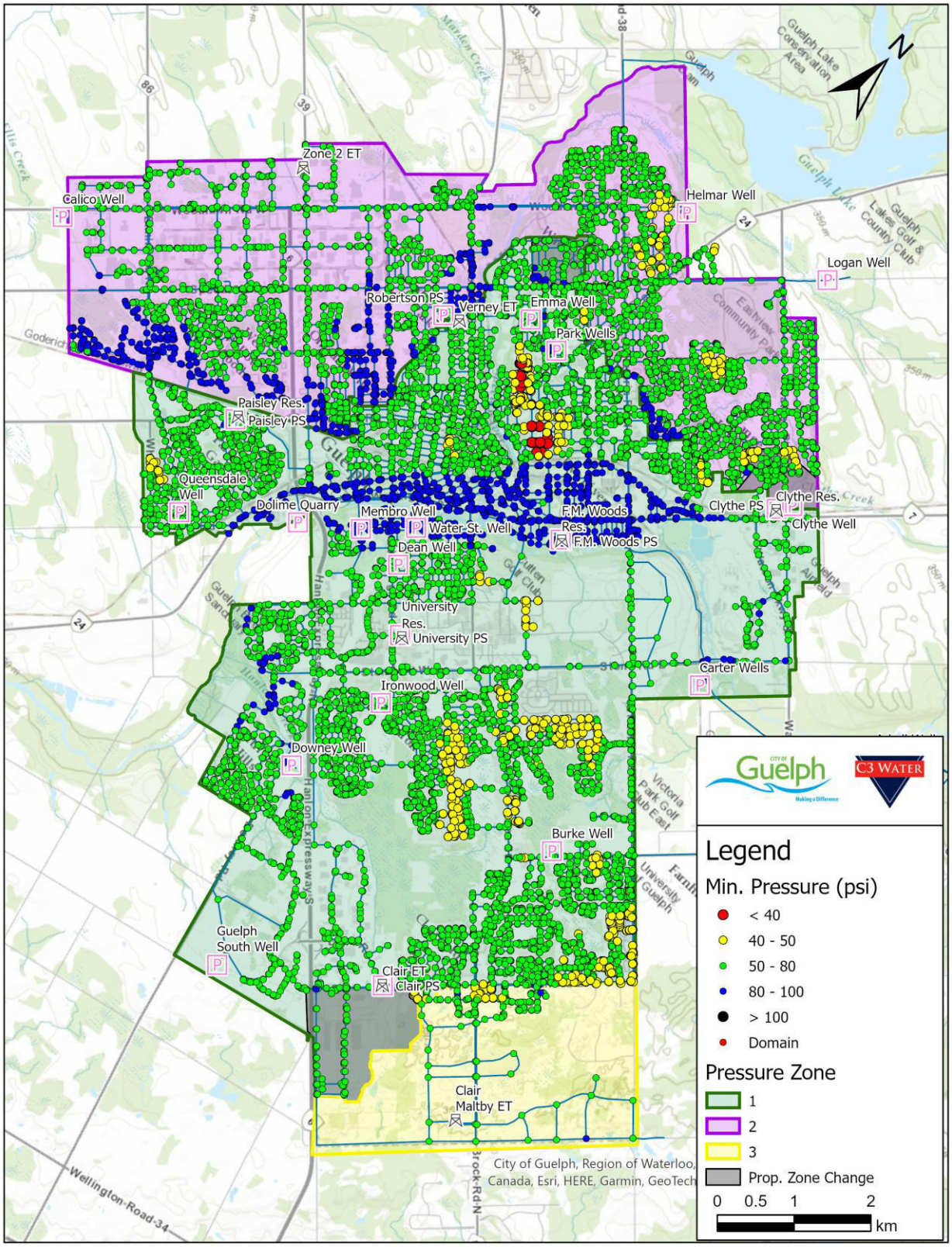


Figure C-2051+-2 2051+ MDD Minimum Pressure – Proposed Upgrades Active

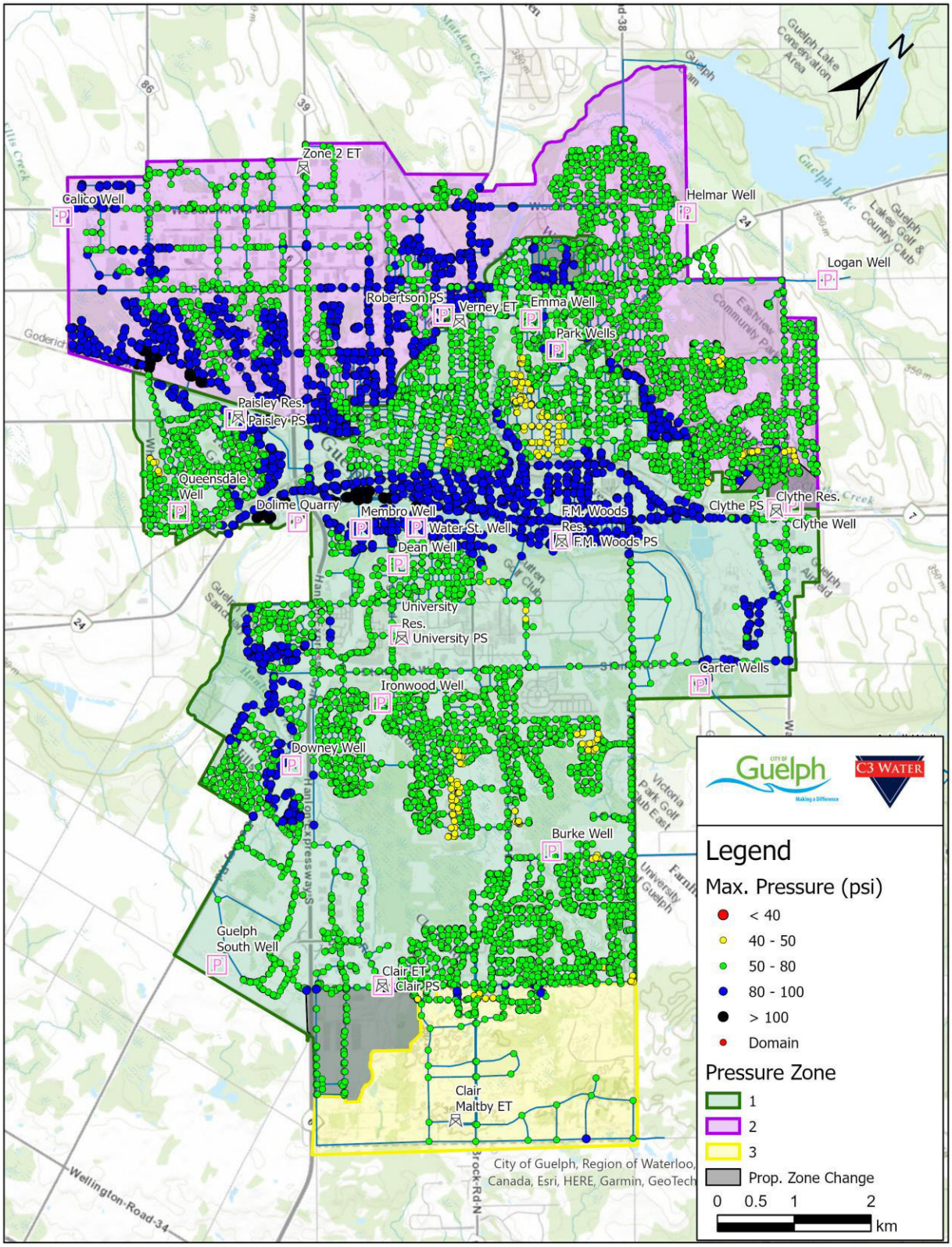


Figure C-2051+-3 2051+ MDD Maximum Pressure – Proposed Upgrades Active

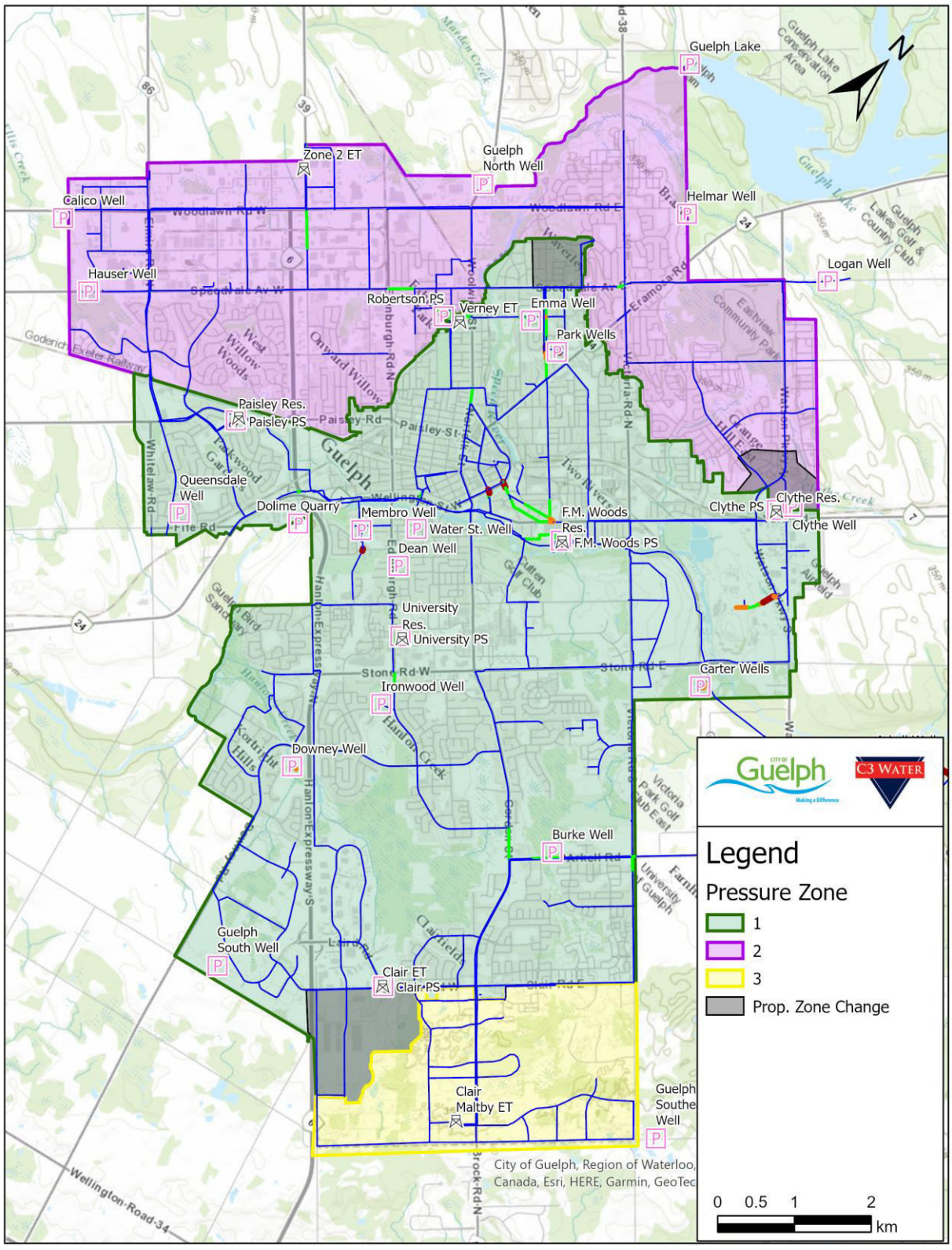


Figure C-2051+-4 2051+ MDD Max Headloss – Proposed Upgrades Active

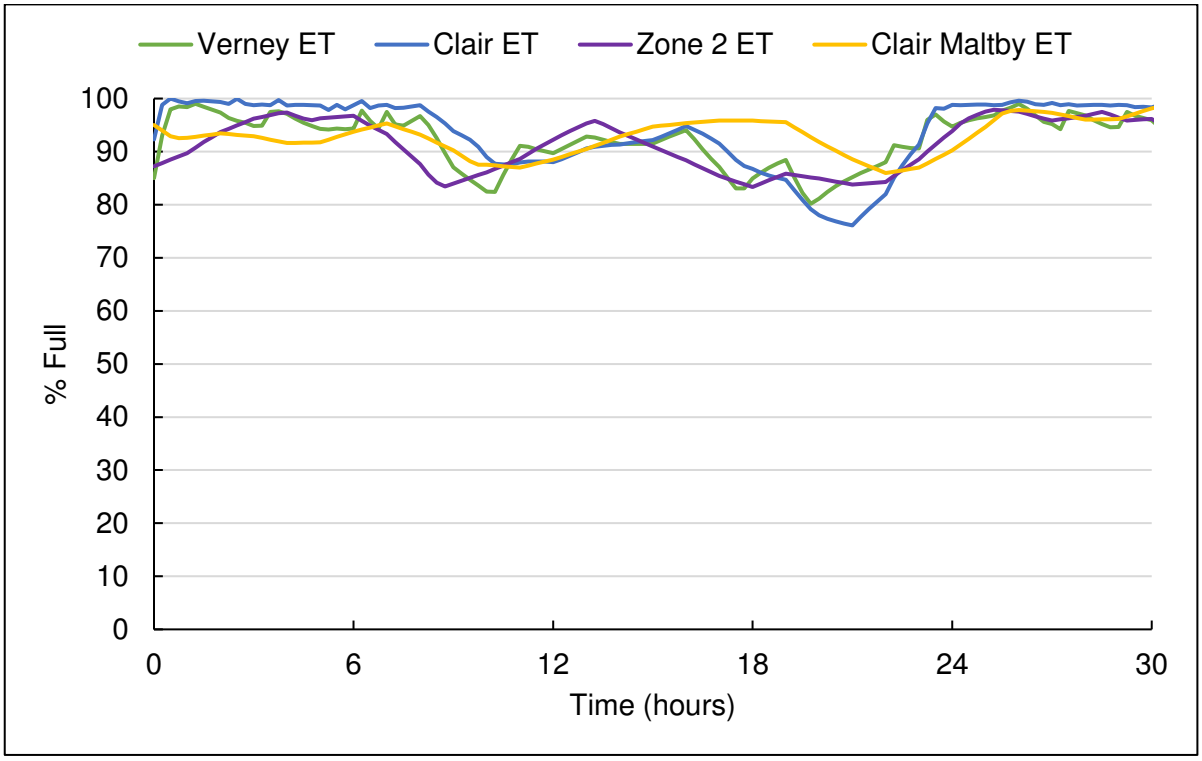


Figure C-2051+-5 2051+ MDD ET Levels – Proposed Upgrades Active

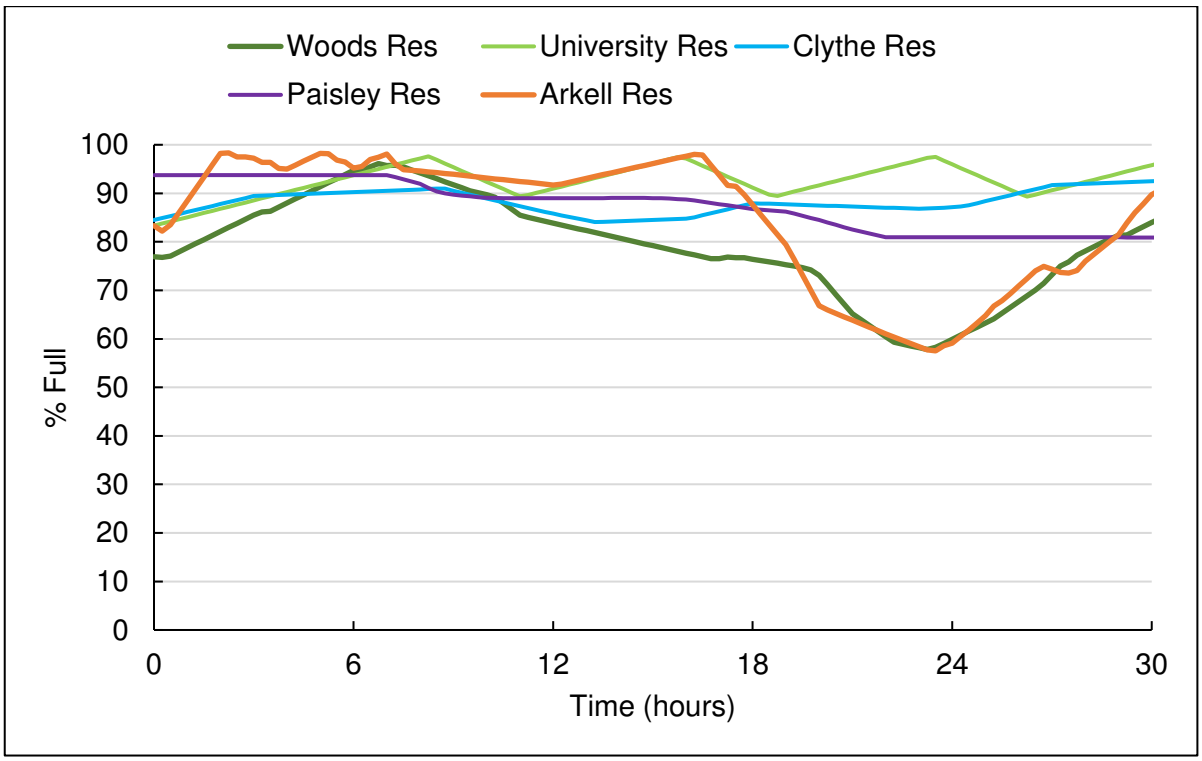


Figure C-2051+-6 2051+ MDD Reservoir Levels – Proposed Upgrades Active

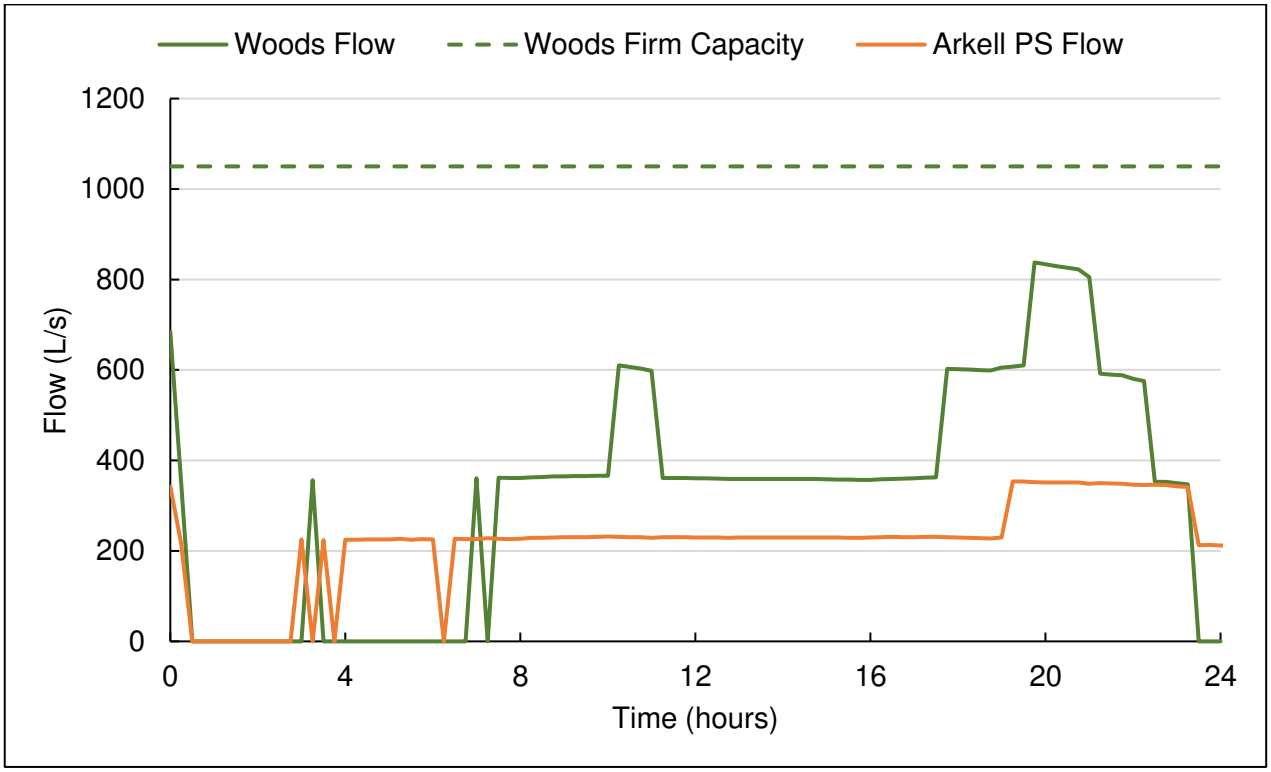


Figure C-2051+-7 2051+ MDD PS Flows – Proposed Upgrades Active

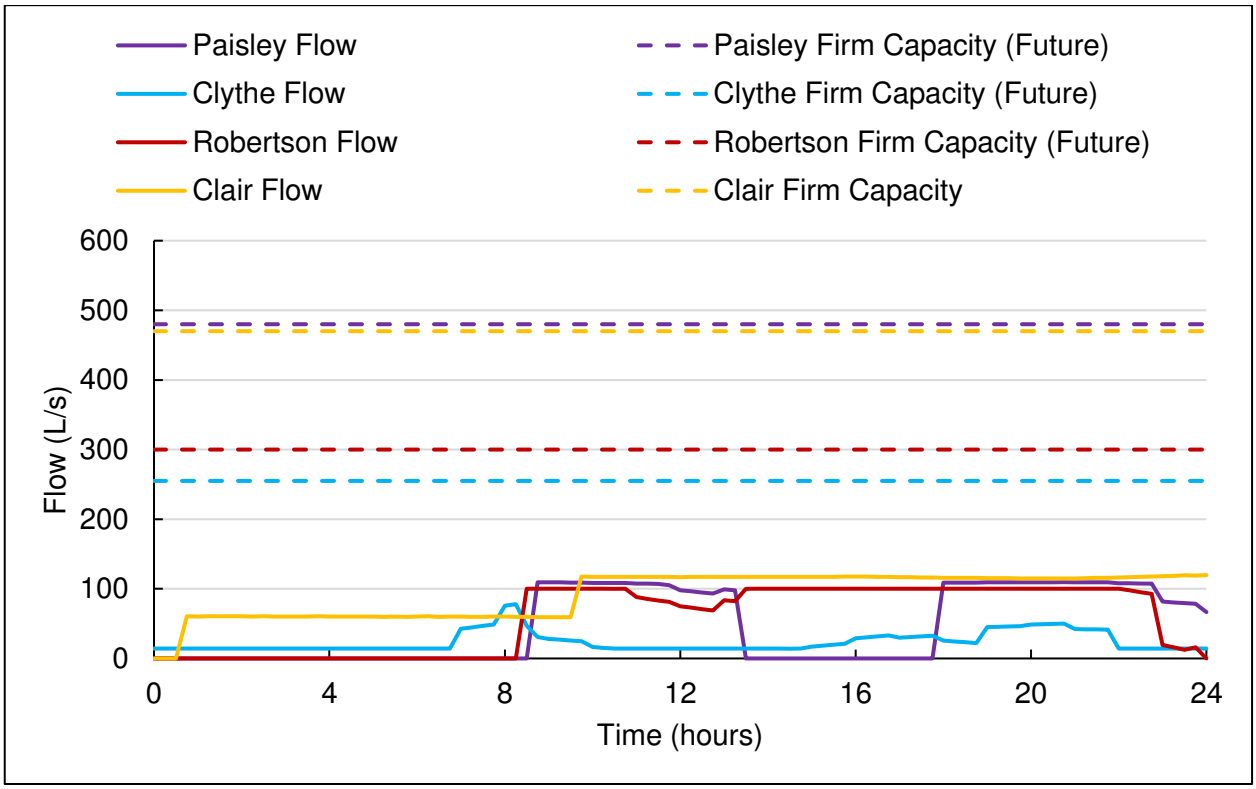


Figure C-2051+-8 2051+ MDD PS Flows – Proposed Upgrades Active

C.3.1 Long Term Analysis (2051+) – Fire Flow Results

Fire Flow results under 2051+ MDD conditions are presented in Figure C-2051+-9 below. For this analysis, the CI replacement program was complete.

The minimum fire flow requirement of 30 L/s was exceeded throughout the system. Areas with available flow of less than 80 L/s were found to be single-family residential.

Areas that were flagged as fire flow concerns in TM3A are highlighted in Figure C-2051+-10 below.

- F1: Upgrades in the Old University residential area resulted in fire flows above 80 L/s at all locations with the exception of three (3) dead-ends. A number of CI replacement priorities were flagged in this area and are critical for achieving fire flow above 30 L/s. Hydrants along proposed 200mm watermains exceeded 150 L/s.
- F2: Upgrades resulted in fire flows primarily above 80 L/s in this. Proposed upgrades to Delhi Street resulted in fire flows above 250 L/s in the General Hospital area.
- F3: Upgrades resulted in fire flow above 80 L/s at all locations. Significantly improved capacity in this area due to upgrades on Exhibition, Woolwich and Speedvale.
- F4: Fire flows maintained above 80 L/s in this residential area due to CI replacement projects with the exception of three (3) dead-ends.
- Downtown: Fire flows in the Downtown area were primary above the highest requirement of 367 L/s as a result of the proposed downtown projects.

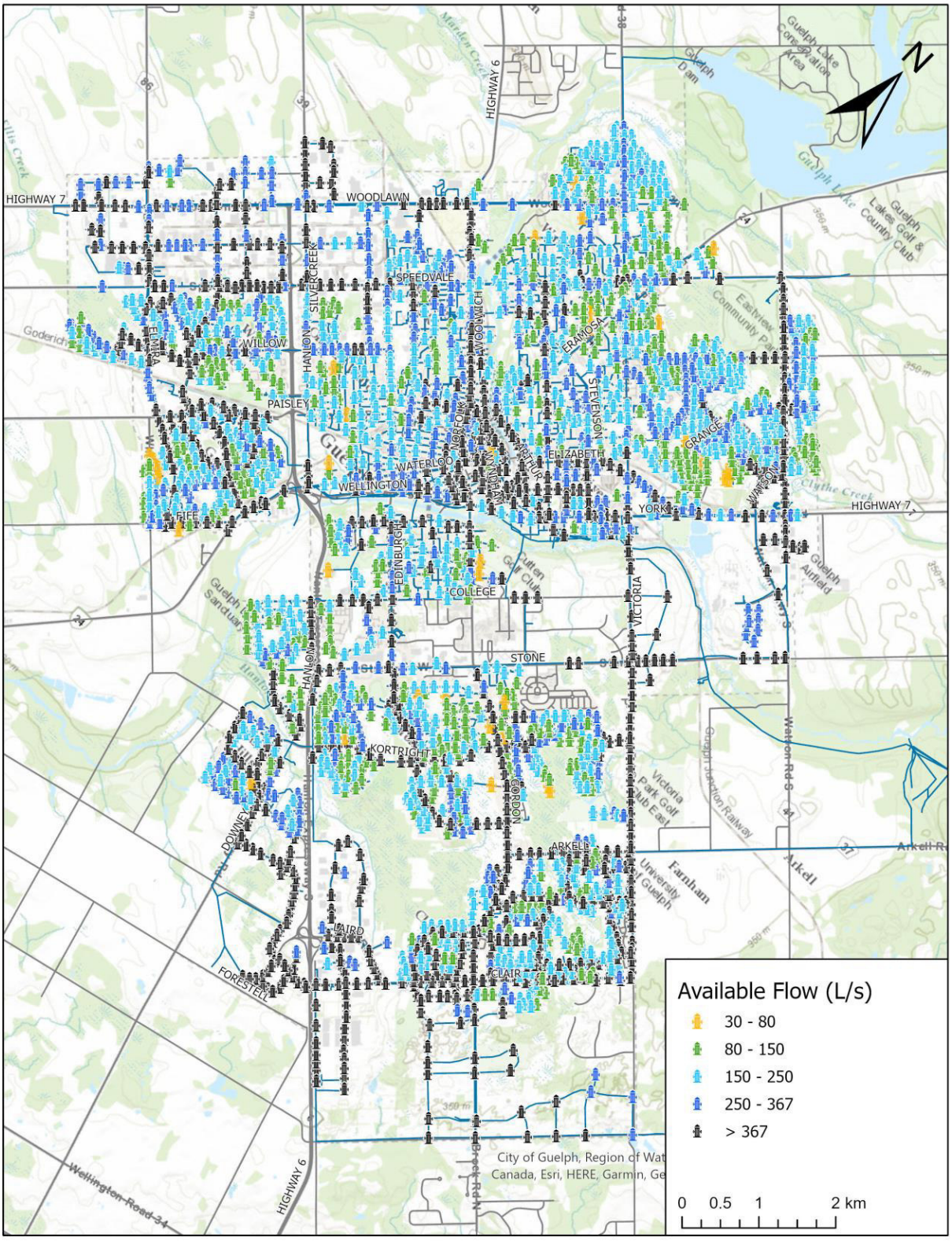


Figure C-2051+-9 2051+ MDD Available Fire Flow – Proposed Upgrades Active –CI Replacement Complete

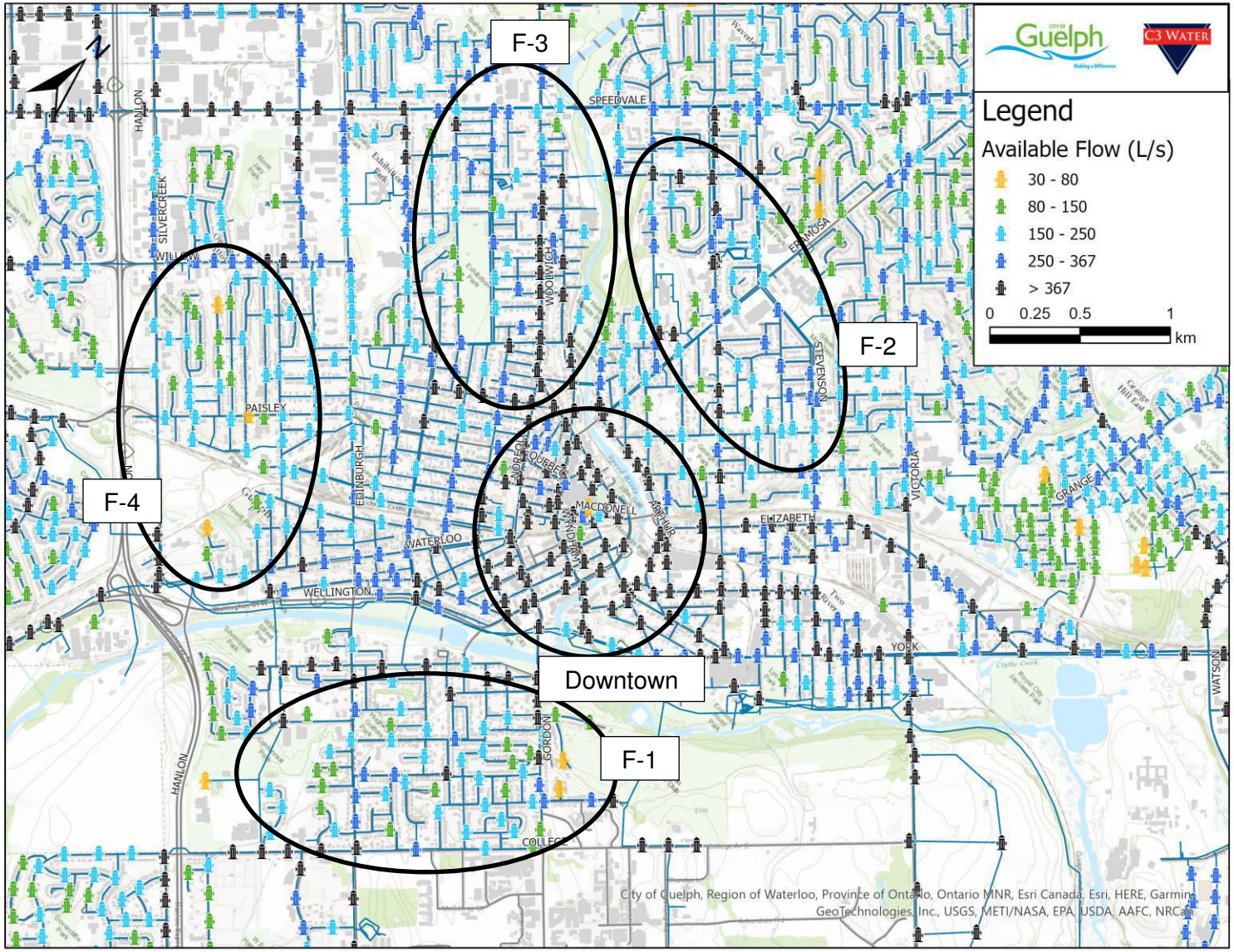


Figure C-2051+-9 2051+ MDD Available Fire Flow – Proposed Upgrades Active –CI Replacement Complete

APPENDIX D –

High Priority Cast Iron Replacement Projects

Table D-1 High Priority Cast Iron Replacement Projects

Street	From	To	Length (m)
Windermere Court	Woodlawn Road East	Windermere Court (dead end)	117
Kingsley Court	Windsor Street	Kingsley Court (dead end)	214
Marlborough Road	Speedvale Avenue East	Kitechener Avenue	148
Marlborough Road	Kitchener Avenue	Delhi Street	209
Delhi Street	Speedvale Avenue East	Marlborough Road	217
Delhi Street	Marlborough Road	Riverview Drive	137
Ann Street	Woolwich Street	Ann Street (Dead End)	128
Alexandra Street	Woolwich Street	Alexandra Street (Dead End)	89
Railroad tracks	Ann Street	Alexandra Street	90
George Street	Dufferin Street	George Street (Dead End)	114
Walnut Drive	Sherwood Drive	Renfield Street	569
Lincoln Court	Laverne Avenue	Meyer Court	519
Laverne Avenue	Meyer Drive	Lincoln Court	83
Meyer Drive	Meyer Drive (corner)	Lincoln Court / HWY 24	373
Spring Street	Delhi Street	King Street	167
King Street	Spring Street	Derry Street	192
Marcon Street (cul-de-sac loop)	Dufferin Street	Cardigan Street	419
McTague Street	Woolwich Street	Exhibition Street	263
Exhibition Street	London Road West	Verney Street/Wright Court	921
Lemon Street	Queen Street	Metcalfe Street	388
King Street	Arthur Street North	HWY 24	294
Palmer Street	King Street	Queen Street	127
Crestwood Place	Plamer Street	Crestwood Place (Dead End)	127
Connection from Crestwood Place to Metcalfe Street	Crestwood Place	Metcalfe Street	133
William Street	Grange Street	William Street (Dead End)	159
Wells Street	HWY 7	Wells Street (Dead End)	247
Connection from Wells Street to Elizabeth Street	Wells Street	Elizabeth Street	73
Huron Street	HWY 7	Alice Street	365
Valden Drive	Dormie Line	Valden Drive (Dead End)	251
Dormie Line	Gordon Street	Dormie Line (Dead End)	284
Braid Place	University Avenue	Braid Place (Dead End)	63
Mary Street	Forest Street	Harcourt Drive	364

Street	From	To	Length (m)
Harcourt Drive	Dean Avenue	Mary Street	430
Woodside Road	Dean Avenue	Woodside Road (Dead End)	204
Yeadon Drive	Woodside Road	Yeadon Drive (Dead End)	162
Municipal Street	Edinburgh Road South	Denver Road	381
Lynwood Avenue	Edinburgh Road South	Intersection between Lynwood Avenue / Lynwood Place	153
Lynwood Place	Lynwood Avenue	Lynwood Place (Dead End)	127
Vanier Drive	College Avenue West	Vanier Drive (Dead End)	485
Janefield Avenue	College Avenue West	Scottsdale Drive	847
Merion Street	Alma Street North	Edinburgh Road North	392
Edinburgh Road North	Merion Street	Liverpool Street	24
Liverpool Street	Edinburgh Road North	Arnold Street	281
Woodycrest Drive	Waterloo Avenue	Woodycrest Drive (Dead End)	312
Beechwood Avenue	Waterloo Avenue	Chadwick Avenue	231
Chadwick Avenue	Beechwood Avenue	Hearn Avenue	77
Ridgewood Avenue	Cannon Street	Ridgewood Avenue (Dead End)	189
Cannon Street	Ridgewood Avenue	Western Avenue	74
Western Avenue	Cannon Street	Guelph Street	498
Guelph Street	Western Avenue	Willow Road	66