# City of Guelph

**FINAL REPORT**

## Downtown Servicing Study

COLE ENGINEERING GROUP LTD.

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FEBRUARY 2021

**Feburary 17, 2021**
Reference No. 2017-0309

City of Guelph
1 Carden Street
Guelph, ON  N1H 3A1

Attention: Mary Angelo, P.Eng.
Manager, Infrastructure, Development and Environmental Engineering

**Downtown Servicing Study | Final Report**

Please find the enclosed draft final report by Cole Engineering Group Ltd. and C3 Water Inc. for the above noted project for your review. The analysis considers wastewater and servicing requirements to accommodate planned development within the City of Guelph's Downtown Secondary Plan area. An assessment of stormwater servicing to in the downtown area, completed as part of this project, was submitted under a separate cover.

Best Regards,

**COLE ENGINEERING GROUP LTD.**

Philip Gray P.Eng, P.E.
Service Sector Leader

PG/rs

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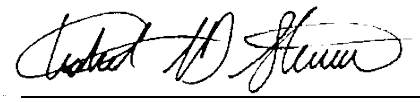

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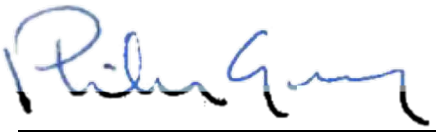

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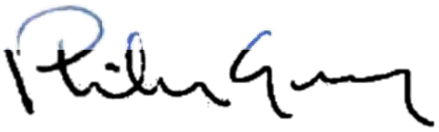

Philip Gray P.Eng, P.E.
Director, Infrastructure Planning

Issues and Revisions Registry

| Identification | Date | Description of issued and/or revision |
|---|---|---|
| Draft Report | January 8, 2020 | For internal review |
| Draft Report | January 10, 2020 | For client review |
| Final Report | February 17, 2021 | Final for Client |
| | | |
| | | |

## Statement of Conditions

This Report / Study (the “Work”) has been prepared at the request of, and for the exclusive use of, the Owner / Client, City of Guelph and its affiliates (the “Intended User”). No one other than the Intended User has the right to use and rely on the Work without first obtaining the written authorization of Cole Engineering Group Ltd. and its Owner. Cole Engineering Group Ltd. expressly excludes liability to any party except the Intended User for any use of, and/or reliance upon, the work.

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# Executive Summary

The City of Guelph (the "City") retained the services of Cole Engineering Group Ltd. (COLE) and C3 Water Inc. (C3W) to undertake the Downtown Servicing Study related to water, wastewater and stormwater services in the City's downtown area. The City initiated this project to determine the water, wastewater and stormwater servicing needs in support of existing and future development as the City works to implement the Downtown Secondary Plan and the associated draft Downtown Zoning By-law for the planned growth to 2031. The work completed provides recommendations and guidance with respect to all water services to improve the existing level of service, improve system resilience and to support redevelopment in the Downtown Area of the City.

Figure ES-1 shows the combination of water, wastewater and stormwater improvements for the downtown area. In reviewing the need and phasing of the various projects **Table ES-1** presents a consolidated list of infrastructure projects with proposed phasing taking into consideration where projects overlap.

## ES-1 Water

Water servicing alternatives were developed to address downtown areas that did not meet criteria when future demands were applied to the existing infrastructure. Areas of high head loss and low fire flow were the main concerns, while pressures were not greatly impacted. The prevalence of small diameter, old, cast iron watermains in the Downtown core is the main cause of high head loss and low flows, therefore several linear pipe upgrades are recommended to improve servicing for future developments to 2031.

Other projects were proposed to replace old cast iron watermains with 200mm pipes for servicing existing commercial land use and future developments. In total there are 7 of 20 projects that are based on existing system resilience and growth needs, while the balance of projects is driven by growth alone. The recommended upgrades also improve overall connectivity by creating strong looping around and throughout the downtown area by connecting sections of existing 300mm watermain. The estimated cost of water projects is $8,111,000.

## ES-2 Wastewater

With the planned development to 2031 there are no system improvements required under dry weather flow conditions, which include the existing dry weather flow plus peak design flow associated with development. However, improvements are required because of existing wet weather flow related to RDII to reduce the risk of system surcharge and flooding, which is aggravated by growth to 2031.

The recommended wastewater improvements are largely related to existing hydraulic issues and are not driven by new wastewater flows related to growth in the downtown area. Through redevelopment of the downtown area, RDII in sanitary sewers are expected to decline. Similarly, with the recommended improvements, RDII related to system deficiencies will also decline. It is recommended that the City advance their commitment to undertaking an I/I Reduction Program currently underway in the downtown area as the outcome of this work may defer or eliminate the need to system

improvements. In total there are 4 wastewater projects recommended in the downtown area. The estimated cost of wastewater projects is $2,437,000.

## ES-3 Stormwater

Storm services in the downtown area were never designed using current standards and therefore should not be expected to meet current stormwater guidelines. However, through redevelopment the post-redevelopment flows must not worsen pre-redevelopment conditions and if possible, improve quantity control and look at opportunities to introduce quality control where feasible.

The recommended improvements are designed to improve the level of service to mitigate surcharge and flooding conditions during the 5-year event as a minimum in the minor system. Secondly, improvements were considered to improve the level of control so the freeboard of greater than 1.8m is maintained during the 100-year event and the overland flow depth does not exceed 300mm in the right-of-way.

In preparing recommendations, local stormwater criteria or controls were considered in combination with system improvements (public realm) recognizing it is generally difficult to effectively retrofit/implement traditional stormwater management techniques for quantity and/or quality control as part of infill/intensification (private realm) involving individual land parcels in an established downtown area.

The outcome of the stormwater system assessment led to a combination of system improvements (public realm) and stormwater criteria to maximize the level of service and protect against flooding. The following summarizes the stormwater recommendations:

- **Dublin Street / Gordon Street**
  - Investigate overland flow drainage at Dublin Street and Wellington Street West.
  - Upgrade the local storm sewer on Dublin Street from Fountain Street to Wellington Street (ST-13: 137m of 750mm). This improvement is not considered critical and should be coordinated with other water or road improvements.
  - In the Dublin Street/Gordon Street area, limit post-development flows to a 5-year pre-development flow levels to improve hydraulic performance and minimize surcharge.
- **Quebec Street / Macdonell Street**
  - Implement local upgrades to provide a consistent level of performance with no surcharging under the 5-year event; freeboard greater than 1.8m for the 100-year event; and, ponding less than 300mm for the 100-year event in the downtown area.
  - Alternatively, without improvements, limit post-development flow to 25-year pre-development level.

- **The Ward**
  - The Ward currently has a <2-year level of service. Two alternatives are available, to control post development flow to 2-year level, or, implement improvements which will allow post development control to increase to 5-year.
  - It is recommended the City consider the local improvements (Alternative 2) and implement a 5-year control.
  - Upstream storm flows contribute to existing issues. As such, more restrictive stormwater controls should be considered for the upstream area outside of the downtown area.
- **LID-Controls -** Non-infiltration LIDs, such as green roofs, rainwater harvesting may be viable in the downtown area and should be promoted as part of redevelopment. Infiltration type LIDs are not recommended because of source water protection.
- **Water Quality -** There are limited opportunities to retrofit water quality controls. OGS located at three locations should be investigated as centralized facilities for the downtown area. LID controls will also provide a level of water quality control.
- **Stormwater Criteria -** Criteria have been proposed to guide the City in the process of reviewing proposals as they come forward. The criteria vary for different downtown areas given current performance.

The estimated cost of stormwater projects is $6,200,000 and in addition, the capital cost of OGS units is on the order of $309,000.

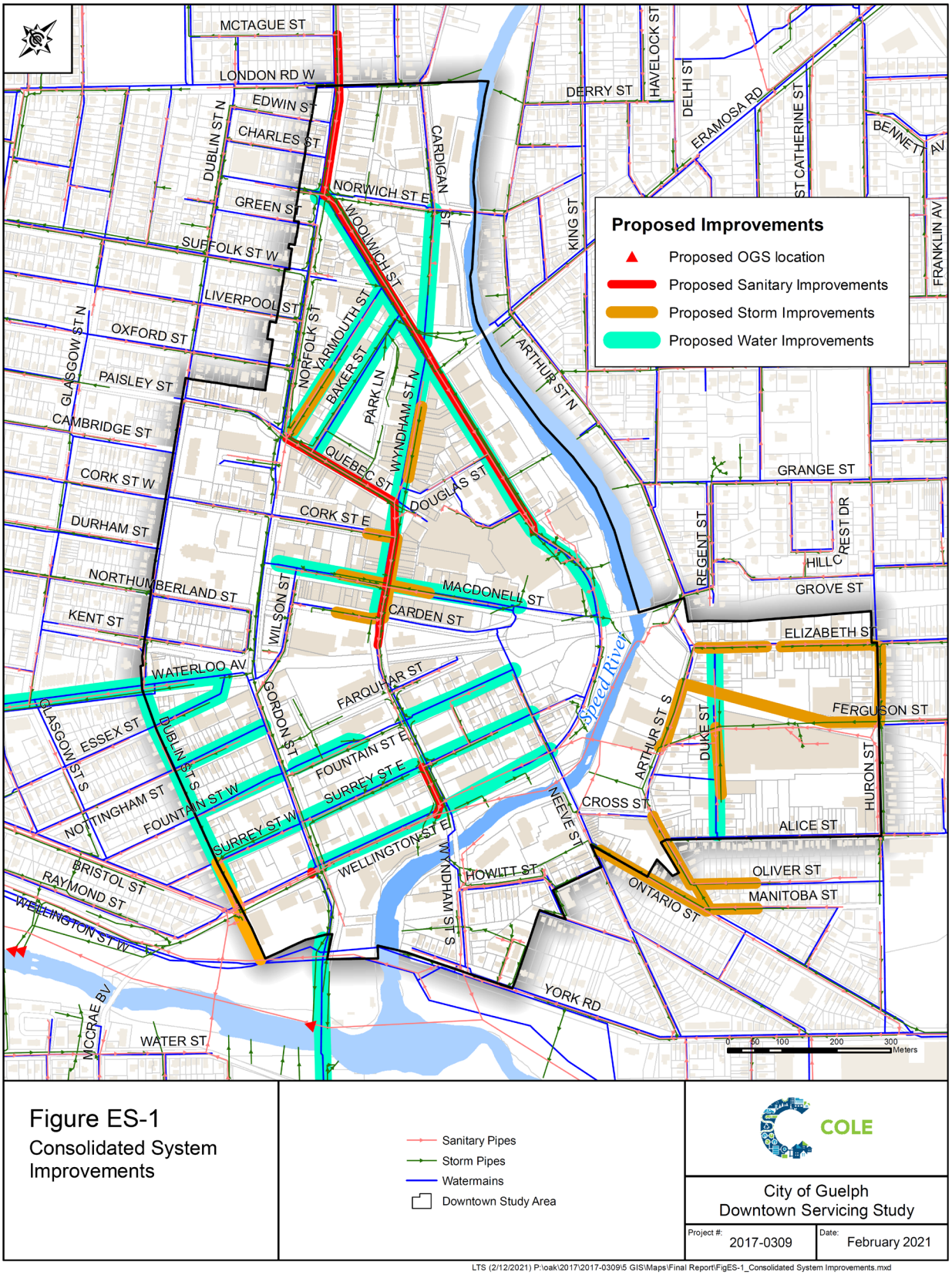


**Figure ES-1 Consolidated System Improvement**

**Table ES.1 Consolidated Project List**

| Project | Type | Size (mm) | Location | Overlap | Cost |
|---|---|---|---|---|---|
| **2018 - 2022** | | | | | |
| W-1 | water | 300 | Woolwich Street | SAN-1 | $875,000 |
| W-3-N | water | 300 | Wyndham Street N | ST-1 | $329,000 |
| W-3-S | water | 300 | Wyndham Street N | SAN-2, ST-2, ST-3 | $250,000 |
| W-11 | water | 200 | Fountain Street | | $201,000 |
| W-12 | water | 200 | Fountain Street | | $187,000 |
| W-14 | water | 200 | Surrey Street E | | $203,000 |
| W-17 | water | 300 | Wellington Street E | | $321,000 |
| W-8 | water | 200 | Baker Street | | $331,000 |
| SAN-1 | sanitary | 300 | Norfolk Street / Woolwich Street | W-1 | $1,392,000 |
| SAN-2 | sanitary | 375 | Quebec Street / Wyndham Street | W-3, ST-2, ST-3 | $868,000 |
| ST-1 | storm | 525 | Wyndham Street | W-3-N | $237,000 |
| ST-2 | storm | 1350 | Wyndham Street | SAN-2, W-3-S | $494,000 |
| ST-3 | storm | 825 | Cork Street E | | $122,000 |
| **TOTAL (2018-2022)** | | | | | **$5,810,000** |
| **2023 - 2027** | | | | | |
| W-2 | water | 200 | Cardigan Street | | $292,000 |
| W-4 | water | 200 | Macdonell Street | ST-4 | $546,000 |
| W-6 | water | 300 | Waterloo Avenue | | $653,000 |
| W-7 | water | 200 | Yarmouth Street | ST-6 | $298,000 |
| W-9 | water | 200 | Essex Street | | $192,000 |
| W-13 | water | 200 | Fountain Street E | | $254,000 |
| W-15 | water | 200 | Surrey Street E | | $282,000 |
| W-16 | water | 200 | Surrey Street E | | $307,000 |
| W-18 | water | 300 | Wellington Street E | | $280,000 |
| W-19 | water | 300 | Gordon Street | | $1,371,000 |
| W-20 | water | 200 | Duke Street | ST-9 | $338,000 |

**Table ES.1 Consolidated Project List**

| Project | Type | Size (mm) | Location | Overlap | Cost |
|---|---|---|---|---|---|
| SAN-3 | sanitary | 450 | Wyndham Street | | $161,000 |
| SAN-4 | sanitary | 300 | Gordon Street/Wellington Street E | | $16,000 |
| ST-4 | storm | 900/525 | Macdonell Street | W-4 | $331,000 |
| ST-5 | storm | 600/675 | Carden Street | | $177,000 |
| ST-6 | storm | 450 | Yarmouth Street | W-7 | $205,000 |
| ST-7 | storm | 375/450 | Ontario Street | | $371,000 |
| ST-8 | storm | 375/450/525 | Manitoba St., Oliver St., Arthur St. | | $645,000 |
| ST-9 | storm | 600 | Duke Street | W-20 | $270,000 |
| ST-10 | storm | 375/450/675 | Elizabeth Street, Huron Street | | $597,000 |
| ST-11 | storm | 1200 (RR) | Between Huron Street and Duke Street, Arthur Street | | $2,221,000 |
| ST-12 | storm | 375 | Elizabeth Street | | $216,000 |
| **TOTAL (2023-2027)** | | | | | **$10,023,000** |
| **2027 - 2031** | | | | | |
| W-10 | water | 200 | Nottingham Street | | $201,000 |
| W-5 | water | 200 | Dublin Street | ST-13 | $400,000 |
| ST-13 | storm | 750 | Dublin Street | W-5 | $314,000 |
| **TOTAL (2028-2031)** | | | | | **$915,000** |
| **OGS Units (no defined timeline)** | | | | | |
| **Location** | | | **Unit Type / Footprint Area** | | |
| Gordon St | | | 2xEF12 (20m$^2$) | | $195,850 |
| Silvercreek 1 | | | EF10 (8m$^2$) | | $67,600 |
| Silvercreek 2 | | | EF8 (5m$^2$) | | $45,550 |
| **TOTAL (OGS)** | | | | | **$309,000** |

## Table ES.2 Consolidated Project List

| SUMMARY BY SYSTEM TYPE | |
|---|---|
| **TOTAL WATER** | $8,111,000 |
| **TOTAL WASTEWATER** | $2,437,000 |
| **TOTAL STORM** | $6,509,000 |
| GRAND TOTAL | $17,057,000 |

# 1 Introduction

The City of Guelph (the “City”) retained the services of Cole Engineering Group Ltd. (COLE) and C3 Water Inc. (C3W) to undertake the Downtown Servicing Study related to water, wastewater and stormwater services in the City’s downtown area. The City initiated this project to determine the water, wastewater and stormwater servicing needs in support of existing and future development as the City works to implement the Downtown Secondary Plan and the associated draft Downtown Zoning By-law.

This assignment assesses the performance of existing water, wastewater and stormwater systems and evaluates how revitalization of the Guelph downtown area will impact local systems and the need for local service improvements.

This report presents the findings with respect to water, wastewater and storm systems identifying capacity constraints as well as providing a long-term servicing strategy for water, wastewater and storm systems to support growth in the Downtown Secondary Plan area.

## 1.1 Background

The City of Guelph, as with other municipalities across Southern Ontario and in line with Provincial growth plans, is looking at the revitalization of the downtown area through redevelopment and intensification. The transformation of the existing Downtown core is defined in the City’s 2012 Downtown Secondary Plan (DSP) which outlines a clear vision of the area based on a set of eight principles with objectives to guide the revitalization of the Downtown core. Fundamentally, the DSP is based on intensification of residential and employment population, which translates into greater demands on existing municipal infrastructure. The challenge is to meet the demands by maximizing the use of existing infrastructure through strategic planning for improved services and to ensure servicing is timely, sustainable and cost effective for the City.

The City prepared the 2007 Water and Wastewater Master Plan and the 2012 Stormwater Management Plan, which informed the DSP with respect to water, wastewater and stormwater requirements at a macro level. Both the 2007 Water and Wastewater Master Plan and the 2012 Stormwater Management Plan identified system deficiencies. Through the Master Planning work and subsequent studies, system improvements were identified and, in some cases, acted on to support DSP servicing. For example, the York Trunk Sewer and Paisley-Clythe Feedermain Environmental Assessment, which have moved forward to construction, were projects required for the downtown area revitalization providing water security and critical capacity for wastewater from the downtown area.

This assignment builds on the Master Planning work and is focused on local Downtown servicing to assess current service capacity and identify timely system upgrades or improvement to support the DSP using the best available planning information for the area.

**Figure 1-1** shows the core downtown area under review.

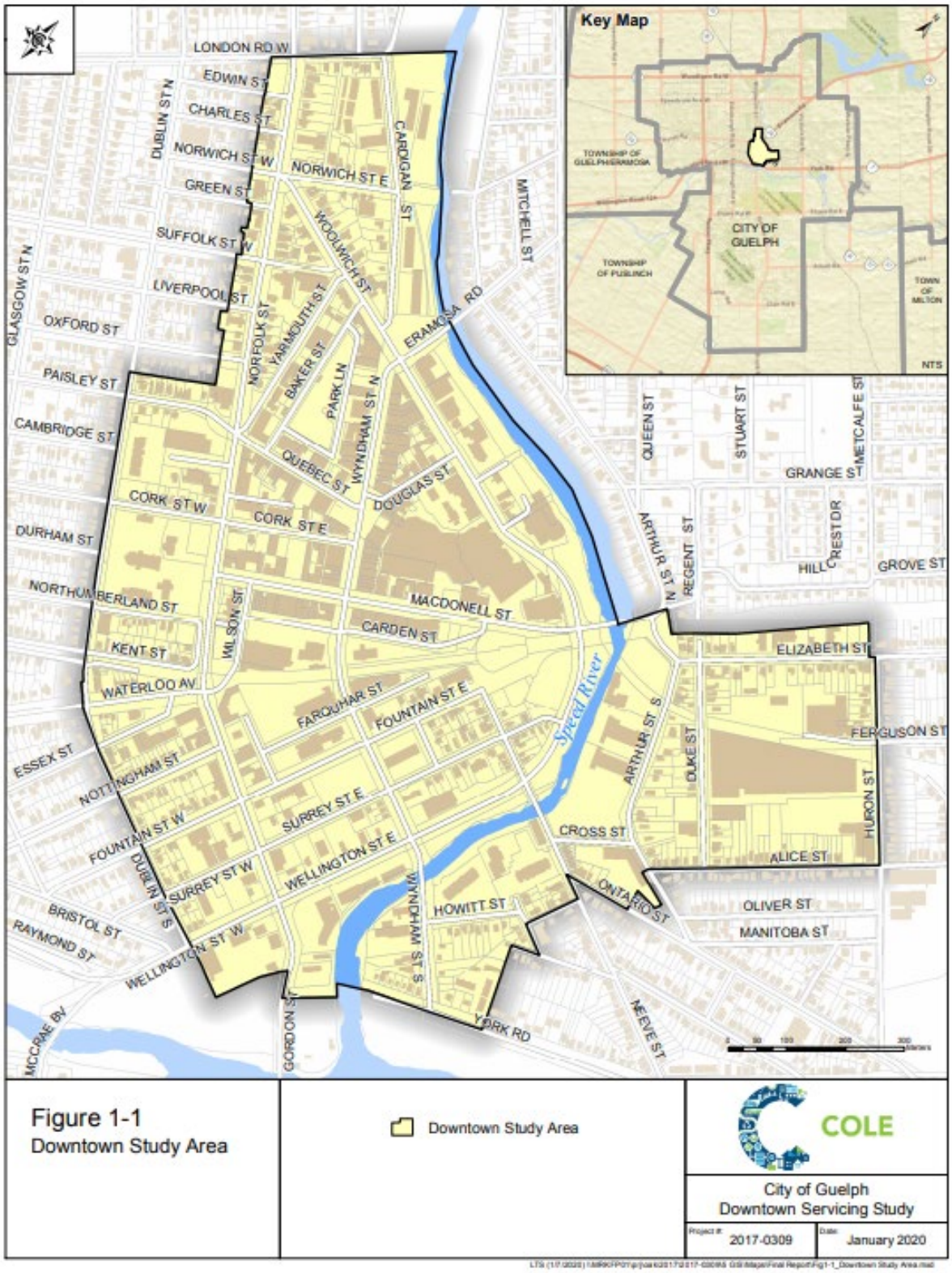


**Figure 1-1 Downtown Study Area**

## 1.2 Objectives

Project objectives include:

- Determine specific servicing needs for the downtown area with defined projects for water, wastewater and stormwater.
- Provide area and site-specific servicing recommendations based on a detailed assessment of current services and performance.
- Present timely and cost-effective projects that are environmental sound and provide the required servicing in an integrated and well-developed implementation plan.
- Through the process of developing servicing plans ensure capacity is available when it is required.

## 1.3 Project Overview

Regardless of the system type (water, wastewater, or storm) this assignment involved the following key activities.

### 1.3.1 Background Review

The background review involved the compilation of background information, documents and water, wastewater and stormwater hydraulic models. Relevant information was compiled and reviewed. The primary sources of information included the 2007 Water and Wastewater Master Plan, Downtown Secondary Plan, Development Charges Background Report, Council Reports regarding Downtown development zoning, York Trunk Sewer and Paisley-Clythe Feedermain Environmental Assessments, 2012 Stormwater Master Plan, operational records and technical reports provided by the City. The City also has available wastewater flow monitoring and rainfall data in the downtown area starting in late 2016, early 2017, which continues today. The background review led to updating modelling tools with updated or new infrastructure and additional local infrastructure detail in the downtown area.

An important part of the background data included a review of planned development in the downtown area. The review considered the type, location, size and planning horizon of development, which is critical to determining infrastructure needs. The planning in formation is based on the best available planning information at the time.

### 1.3.2 Existing System Assessment

The assessment of existing systems used available hydraulic models for the water, wastewater and stormwater systems provided by the City. Each of the models were review and updated as required with new, or modified infrastructure. Specifically, the wastewater model calibration was updated using recent 2017 and 2018 flow data collected at three locations in the downtown area. This was further refined using additional data collected in 2019. Beyond updating the models with current infrastructure, additional detail was added to models to improve the representation of the downtown area. The updated models were used to assess existing system

performance and identify servicing needs related to existing and future growth scenarios in the downtown area.

### 1.3.3 Servicing Needs

To assess servicing needs an expected level of service for each system type (water, wastewater and stormwater) was defined. System performance for existing conditions and future development scenarios were evaluated to identify infrastructure needs.

### 1.3.4 Recommendations

Recommended servicing strategies are provided for each system type to promote Downtown servicing that supports growth in the area.

## 1.4 Existing Conditions

The study area, as it exists today, encompasses an area of approximately 120ha comprised of 665 land parcels. Of these parcels, 326 are classified as residential with the remaining majority being commercial, along with a few industrial sites and vacant lots. It is also noted that due to the unique nature of the downtown area, many parcels are made up of a mix of commercial and residential space (i.e. ground floor commercial with residential units above).

**Figure 1-2**, **Figure 1-3**, and **Figure 1-4** presents the extent of the core Downtown study area and existing water, wastewater and storm networks, respectively.

Water servicing for the study area is provided through the integrated water distribution network consisting mainly of cast iron and plastic piping ranging in diameter from 25 to 400mm. There is a history of watermain breaks concentrated in the downtown, as many of the watermains and services were installed prior to 1930. **Appendix A** includes additional figures showing locations of watermain breaks centralized in the DSP area and the year of pipe installation.

Wastewater servicing is provided through a fully separated wastewater collection network consisting of mainly PVC pipes ranging in diameter from 225 to 825mm. The portion of the study area north of the Speed River discharges to the York Road trunk and the remainder of the study area discharges to twin trunk sewers on Bristol Street.

Stormwater services flow generally north to south discharging into the Speed River. The storm service area also includes an area east of the Speed River (The Ward). There are 23 outfalls from the downtown area into the Speed River. The storm system has storm sewers ranging in size from 200mm to greater than 1350mm and is generally shallow in depth at around 3m.

## 1.5 Downtown Secondary Plan

As part of the Ontario places to grow legislation, the City of Guelph and surrounding area is required to incorporate an additional population of 115,000. The downtown area was identified as one of two areas within the City to concentrate population growth through intensification.

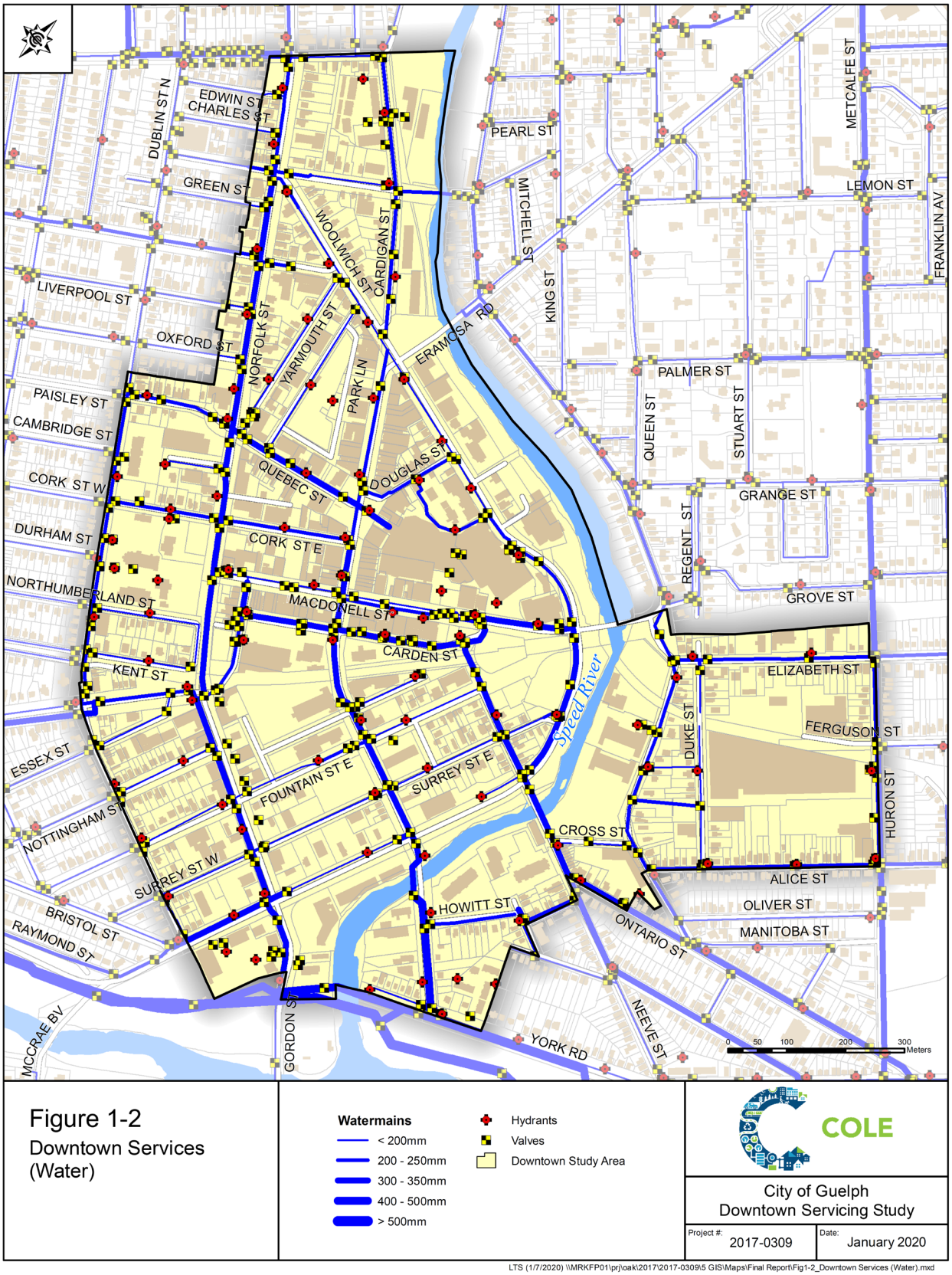


**Figure 1-2 Downtown Services (Water)**

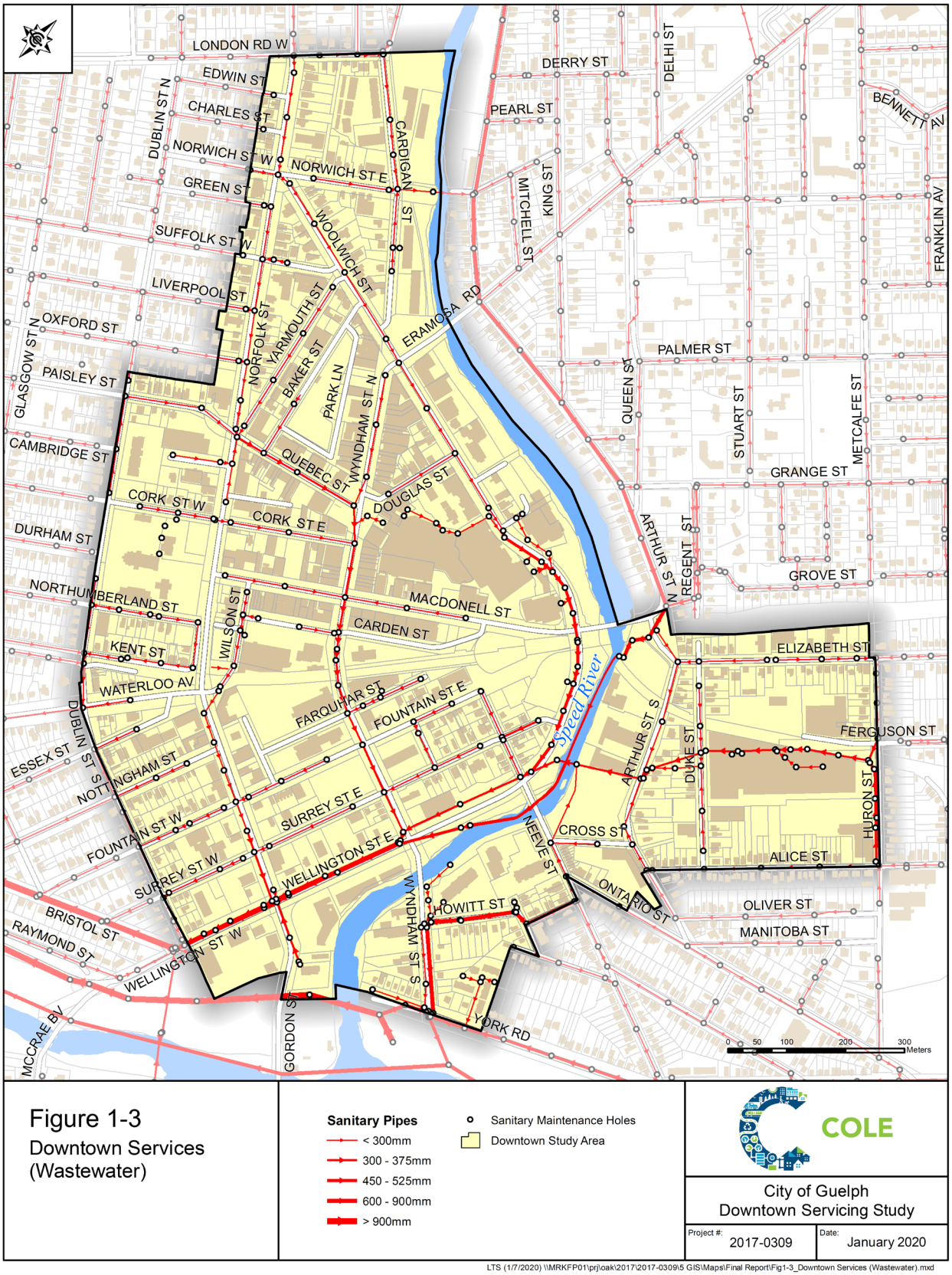


Figure 1-3
Downtown Services
(Wastewater)

**Sanitary Pipes**
- < 300mm
- 300 - 375mm
- 450 - 525mm
- 600 - 900mm
- > 900mm

Sanitary Maintenance Holes
Downtown Study Area

COLE

City of Guelph
Downtown Servicing Study

Project #: 2017-0309
Date: January 2020

LTS (1/7/2020) \\MRKFP01\prj\oak\2017\2017-0309\5 GIS\Maps\Final Report\Fig1-3_Downtown Services (Wastewater).mxd

**Figure 1-3 Downtown Services (Wastewater)**

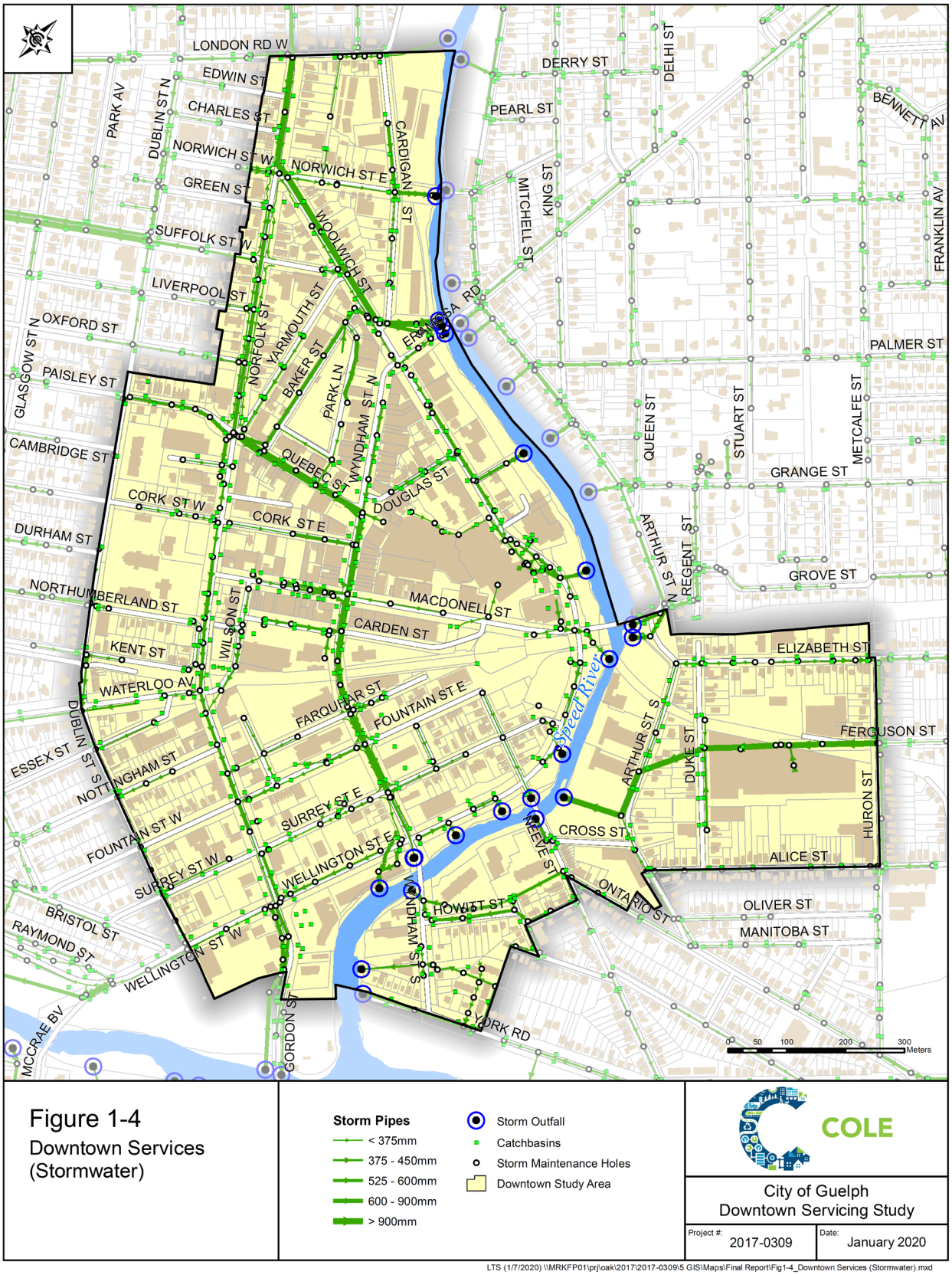


Figure 1-4
Downtown Services
(Stormwater)

**Storm Pipes**
- < 375mm
- 375 - 450mm
- 525 - 600mm
- 600 - 900mm
- > 900mm

- Storm Outfall
- Catchbasins
- Storm Maintenance Holes
- Downtown Study Area

COLE

City of Guelph
Downtown Servicing Study

Project #: 2017-0309
Date: January 2020

LTS (1/7/2020) \\MRKFP01\prj\oak\2017\2017-0309\5 GIS\Maps\Final Report\Fig1-4_Downtown Services (Stormwater).mxd

**Figure 1-4 Downtown Services (Stormwater)**

The Downtown Secondary Plan is an all-inclusive strategy for revitalizing downtown Guelph by means of re-development and intensification through to the year 2031. The rejuvenation of the Downtown core is defined in the City's 2012 Downtown Secondary Plan (DSP), which outlines a clear vision of the area based on a set of eight principles with objectives to guide the revitalization of the Downtown core.

The growth plan for the downtown area addresses both municipal and provincial growth objectives, by addressing the increased need for residential development to complement continued commercial and employment growth in the area.

## 1.6 Planned Development

Planning information provided by the City identified 53 developments in the DSP area with a mix of residential, commercial and institutional developments. **Table 1.1** presents population growth projections for the study area, categorized by type of development with anticipated phasing in 5-year increments based on the best available information.

**Figure 1-5** shows the location of all planned developments within the study area and the associated phasing.

**Table 1.1 Summary of Planned Development in the DSP Area**

| Planning Phase | Residential Population | Commercial Population | Office/ Institutional Population | Population Growth |
|---|---|---|---|---|
| **Pre-2018** | **2,762** | **168** | **48** | **2,978** |
| **2018-2022** | **2,325** | **281** | **343** | **2,949** |
| **2023-2027** | **6,419** | **592** | **68** | **7,079** |
| **2028-2031** | **1,777** | **307** | **790** | **2,874** |
| **Total** | **13,283** | **1,348** | **1,249** | **15,880** |

Notes:

1. Population is considered Growth Population and is in addition to existing population.

**Appendix B** contains planning information provided by the City. At the request of City staff, a conservative population value was carried forward in the analysis by selecting the higher of the two methodologies used in the planning information provided. The Floor Space Index (FSI) method was used for population estimates.

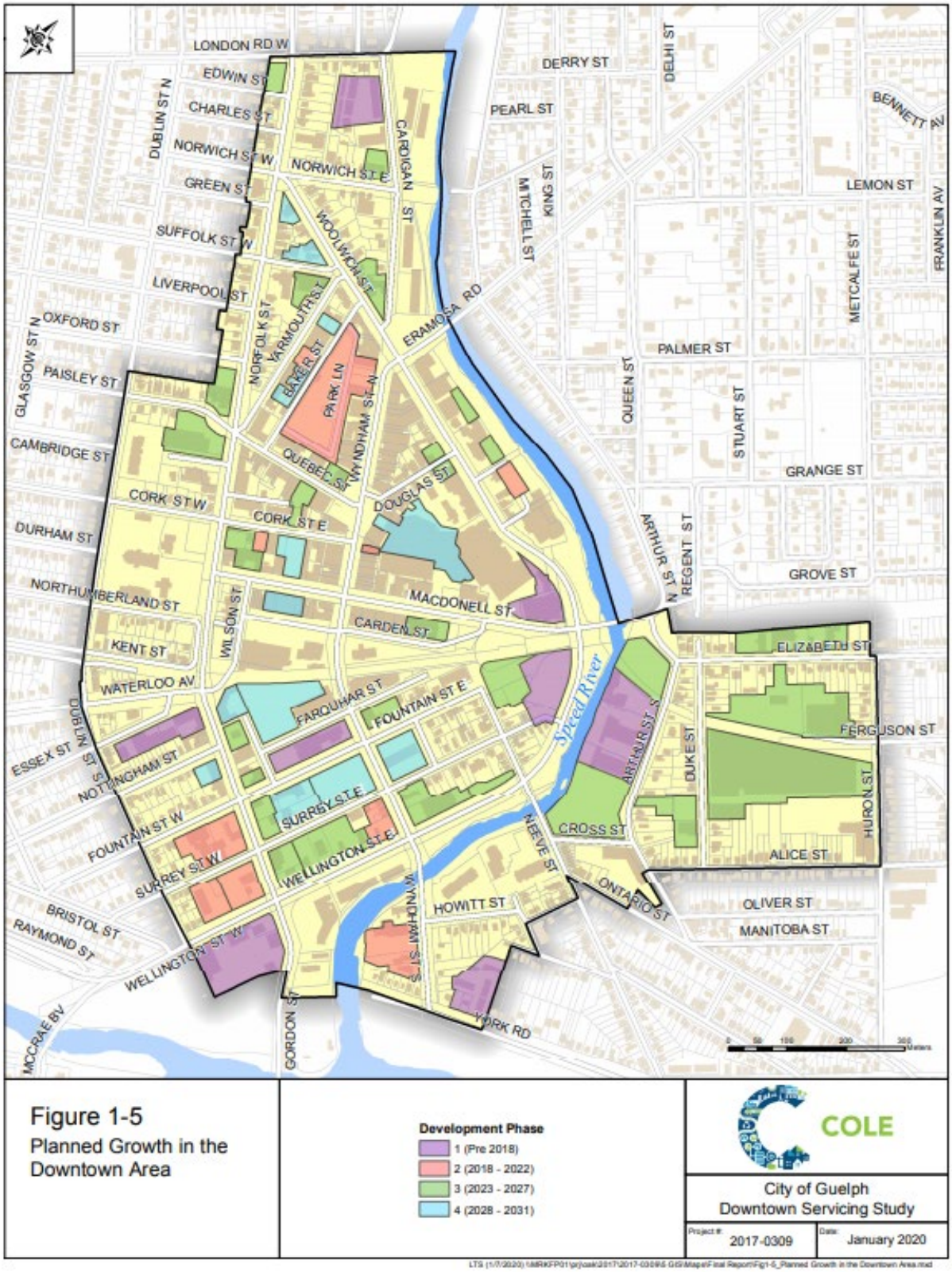


**Figure 1-5 Planned Growth in the Downtown Area**

# 2 Hydraulic Model Updates in the Downtown Area

The following sections provides an overview of the hydraulic models used and the updates made to assess the hydraulic capacity of the water, wastewater and stormwater systems in the downtown area.

## 2.1 Water Model Updates

The following sections describe updates to the existing City-wide water distribution system model for this assignment.

### 2.1.1 2008 Water Model

The City's all-pipe hydraulic model utilizes Innoyvze's InfoWater software and was used. The model was fully calibrated in 2011 and has been updated periodically since 2011. The model's existing scenario is based on 2016 demands. Since this time, C3W has carried out updates through other projects including the Watermain Criticality Analysis, Linear Upgrade Prioritization, Zone 1 Study, and the Hydraulic Modelling Operational Support contract. These studies were undertaken to identify areas within the City's distribution system with existing concerns, potential for intensification and impacts of additional development.

### 2.1.2 Water Model Updates

Linear updates were applied to the City's model to confirm layout, diameter and material of water services in the downtown area to include recent construction. **Appendix A** contain thematic maps showing the size, material and age of existing watermains in the DSP area. Recent GIS data provided by the City was cross-referenced with the model to identify linear updates required. Results of this comparison were confirmed with City staff to identify areas with new or proposed watermain connections. Roughness C-Factors were also updated.

The future demands in the existing model were reviewed and compared to development data provided for this project. Future demands in the model were found to increase rapidly from existing conditions (2016) until 2018, and then slowly increase until 2031. Population data for proposed development projects from 2018 to 2031 were used in conjunction with meter records from 2016 to develop a more conservative and accurate demand increase reflecting existing conditions and future growth. The following baseline per capita water demands were applied from the 2014 Water Supply Master Plan. The Maximum Day Demand (MDD) factor was set as 1.35 to reflect trends in the City. **Figure 2-1** shows the previous model demands versus the updated demands.

- 180L/cap/d residential.
- 286L/cap/d employed
- 43L/cap/d non-revenue water

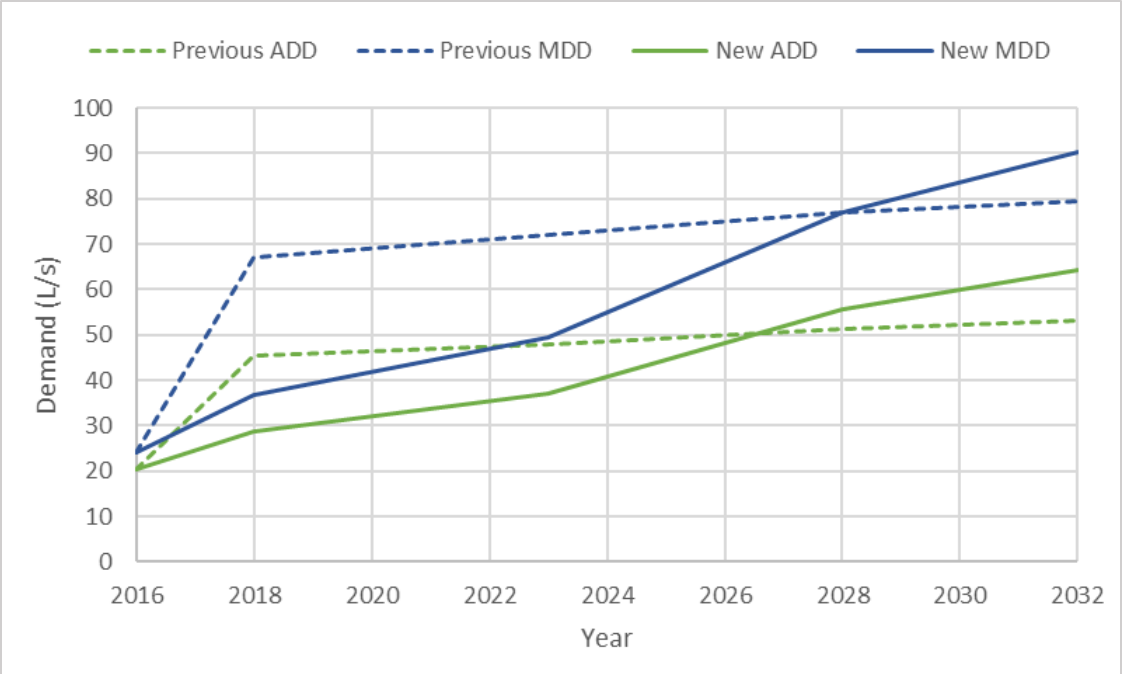


**Figure 2-1 Updated Demands for the Downtown Service Area**

## 2.2 Wastewater Model Updates

The following sections describe updates to the existing City-wide wastewater collection system model for this assignment.

### 2.2.1 2008 Master Plan Model

The City's existing wastewater collection system model was developed as part of the 2008 Water and Wastewater Servicing Master Plan Project. This model was developed for the purposes of assessing sanitary servicing requirements at a macro-level through to the year 2031.

The Master Plan model is an all pipes model, covering the extent of City limits, inclusive of Rockwood. This model includes a dynamic dry weather flow component as well as a representation of wet-weather inflows to the collection system. Wastewater loadings in the model were determined by intersecting water billing data with a Thiessen polygon layer generated for all maintenance holes in the system. Flows generated by the model were then calibrated to observed flow data collected in 2006 and 2007. Flow data used in the calibration process consisted of data from eight (8) flow monitors installed on sanitary trunk sewers and two (2) rainfall gauges.

### 2.2.2 Wastewater Model Updates

The refinement of the City-wide wastewater collected model was completed in consultation with City staff to ensure accurate representation of existing conditions in the study area. **Appendix C** contains a memorandum from COLE outlining the strategy used to update the wastewater collection system model in the study area.

#### 2.2.2.1 Model Conversion to PCSWMM

The City's model was provided in an InfoSWMM format. The City's model was first converted into a PCSWMM format for this assignment. Both modelling software packages use the same EPA SWMM5 engine, allowing for easy conversion of the model by importing the *.inp files. Following model conversion, model results generated by the converted model were compared to those generated by the City's model for a series of dry and wet-weather events. It was confirmed that the PCSWMM model generated identical results to the InfoSWMM model for the events reviewed.

#### 2.2.2.2 Sanitary System Network Data

In the time since the Master Plan model was developed, several infrastructure projects have been completed in the downtown area that have result in significant changes in the configuration of the wastewater collection system. To reflect these changes, the model pipe and maintenance hole network was replaced with the City's 2018 GIS data. The network was replaced only in areas that may affect modelling results in the downtown area, including any contributing pipes to the study area, within the study area, and downstream to the wastewater treatment plant. Once updated, sewer profiles were generated and reviewed to identify data anomalies for correction and to verify the physical system.

In addition to updating the network, City staff identified several recent projects had been completed or were close to completion that were not yet reflected in the City's GIS. These projects were incorporated into the updated model using engineering drawings. Specific projects that were added to the model from drawings include:

- Arthur Street reconstruction and disconnection of sewers below the Speed River; and,
- York Road/ Speed River sanitary trunk sewer.

#### 2.2.2.3 Sanitary System Flow Generation

The approach to sanitary flow generation in the model was updated to improve the level of detail in the downtown area. A first estimate of wastewater flows from each property in the study area was determined by intersecting 2016 water consumption records (tied to address points) with parcel fabric. Load points for each property were determined using the "Service Laterals" shapefile provided, to match parcels with the appropriate sewer. Flows in each section/reach of sewer were conservatively loaded to the upstream node.

A parcel-based approach to load wastewater flows in the model was used allowing existing flows to be replaced with design flows when individual parcels are redeveloped. As parcels are redeveloped, the load point into the network did not change. This parcel based approach was only used for the downtown area replaced the Thiessen polygon subcatchments in the original model.

To generate sanitary flows for redevelopment areas a similar approach to the 2008 Master Plan was used versus using the City's area based flow approach for new sanitary pipe design. The Master Plan used sanitary flow allowance of 300 Litre/capita/day (Lpcd) plus a Harmon Peaking Factor. Using the master plan approach

was determined more representative of the individual developments proposed in the Downtown Area.

As redevelopment occurred, the original sanitary inflow is replaced with a calculated design flow, although the amount of inflow and infiltration remains unchanged to be conservative.

#### 2.2.2.4 Assessment of 2017 Sewer Flow Data

To support modelling activities in the downtown area, the City installed three (3) sanitary sewer flow monitors and one (1) rainfall gauge in the study area. Sanitary flow monitors collect flow, depth and velocity measurements and the rainfall gauge collects total rainfall depths, both at 5-minute increments. **Figure 2-2** shows the monitoring locations and service areas. **Table 2.1** summarizes the sanitary flow monitoring locations. Data collected at these sites was used to check the model representation of wastewater flows during both dry and wet-weather periods.

During the 2019 flow monitoring period, the City installed additional flow meters in the downtown area to provide more resolution of flow contributions upstream of FM-06 and FM-07. These additional flow meters were installed following the initial model update and preliminary assessment of system capacity under existing and future conditions.

**Table 2.1 Details of Sanitary Flow Monitoring Locations**

| Site ID | Maintenance Hole ID | Pipe Diameter (mm) | Contributing Area (ha) | Installation Date | Removal Date |
|---|---|---|---|---|---|
| FM-06 | MH 8055 | 450 | 28.9 | January 9 and 19, 2017 | On-going |
| FM-07 | MH 7417 | 375 | 40.3 | January 19, 2017 | On-going |
| FM-08 | MH 1577 | 450 | 9.6 | December 21, 2016 | May 10, 2018 |
| Additional 2019 Flow Monitor | | | | | |
| FM-06A | MH 7537 | 250 | 14.7 | Jul 31, 2019 | On-going |
| FM-07A | MH 1337 | 300 | 24.0 | July 31, 2019 | On-going |

#### 2.2.2.5 Model Flow versus Flow Data

For each flow monitoring site, an updated diurnal flow pattern was developed to represent weekday and weekend dry-weather flow. Flow data over a number of dry weather flow days was averaged together to represent a typical diurnal flow pattern. A day is considered dry if there is no precipitation recorded on the day and 72 hours in advance.

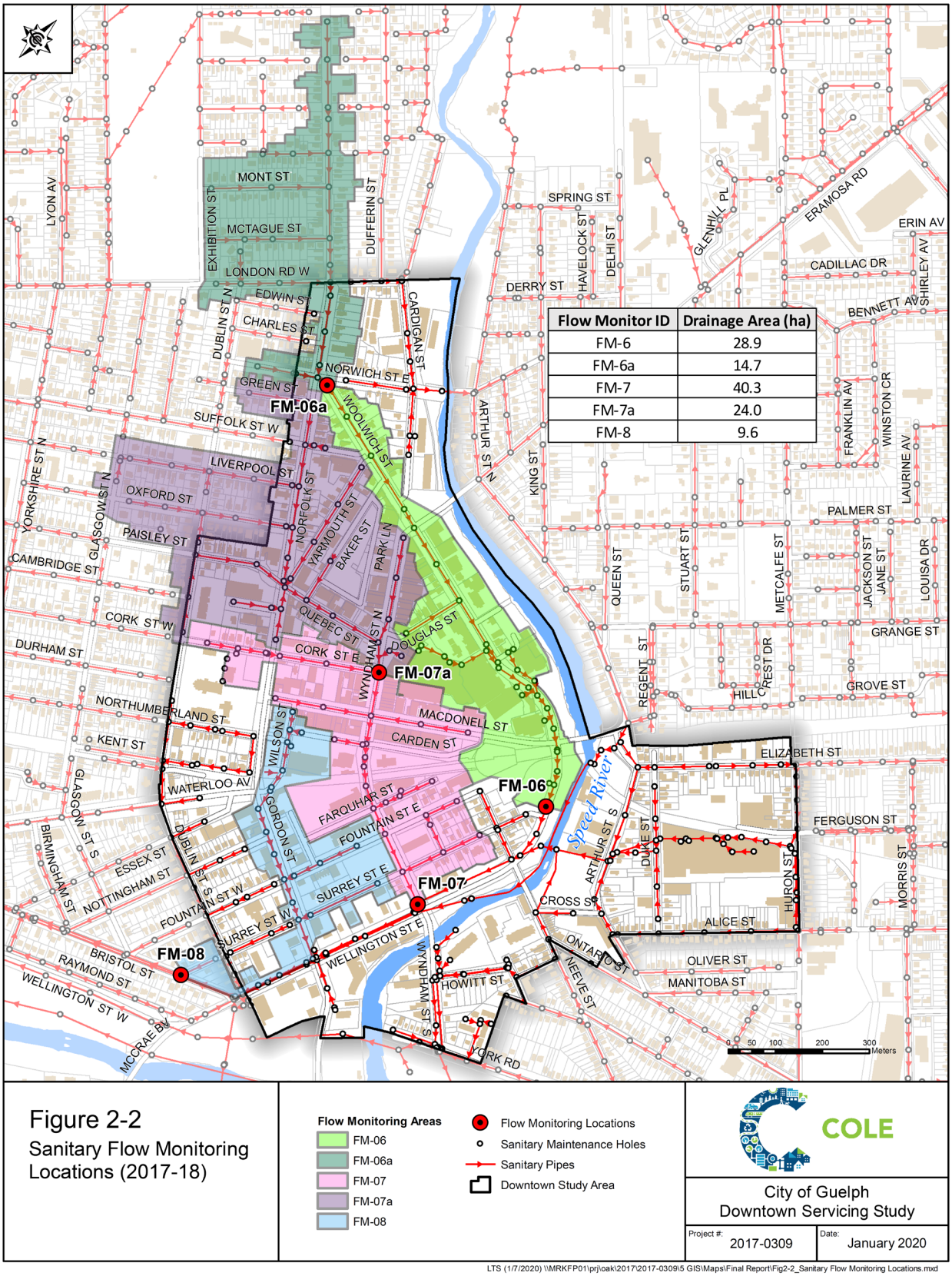


**Figure 2-2 Sanitary Flow Monitoring Locations (2017-2018)**

Model results were compared to observed flow data for a series of wet-weather events that occurred in 2017. Based on this review, minor adjustments were made to the model calibration to better represented wet-weather inflows. A similar process was followed with the additional 2019 data where the model parameters were adjusted at FM-06 and FM-07 because of the upstream flow data at sites FM-06a and FM-07a. **Appendix C** presents modelled versus flow data for select events.

## 2.3 Stormwater Model Updates

The following sections describe updates to the existing City stormwater model used for this assignment. **Figure 2-3** shows the updates made to the existing stormwater models.

### 2.3.1 2012 Stormwater Master Plan Model

The City, through the 2012 Stormwater Master Plan developed a PCSWMM model of the storm drainage system. The PCSWMM model includes larger diameter storm sewers, generally greater than 600mm. In total, 59 sewershed networks have model networks where networks US01, US02/07 and LS04 make up most of the downtown area.

In addition, information on the Speed River from Grand River Conservation Authority (GRCA) was also reviewed as part of the storm system review.

### 2.3.2 Stormwater Model Updates

The PCSWMM model was updated for the Downtown study area first by combining the three network models into one model. The following updates were made to the model:

- Storm sewers less than 600mm in diameter were added where there is planned redevelopment.
- The extent of the model was expanded into areas previously not modelled along Woolwich Street from Wyndham Street to Thorp Street.
- Storm sewer improvements on Wellington Street (March 2014) and Arthur Street (February 2017) were added.
- Inlet capture curves were updated to more accurately represent the relationship between inflow and head. The revised inlet curves are based on curves developed by the City of Ottawa to represent depth-flow relationships for four (4) common CB types: rectangular grate, fish type, fishbone, and curb inlet. The fish and fishbone types were assumed to have identical inlet properties. All of the curves were developed for road transects with a 2% cross slope and the curves were generalized from groups of curves for different longitudinal slopes and geometries, and as such are applicable to most locations. For all CB curves, a maximum flow rate of 50L/s was assumed. In the original model the maximum inlet flow was 48L/s, so comparable.

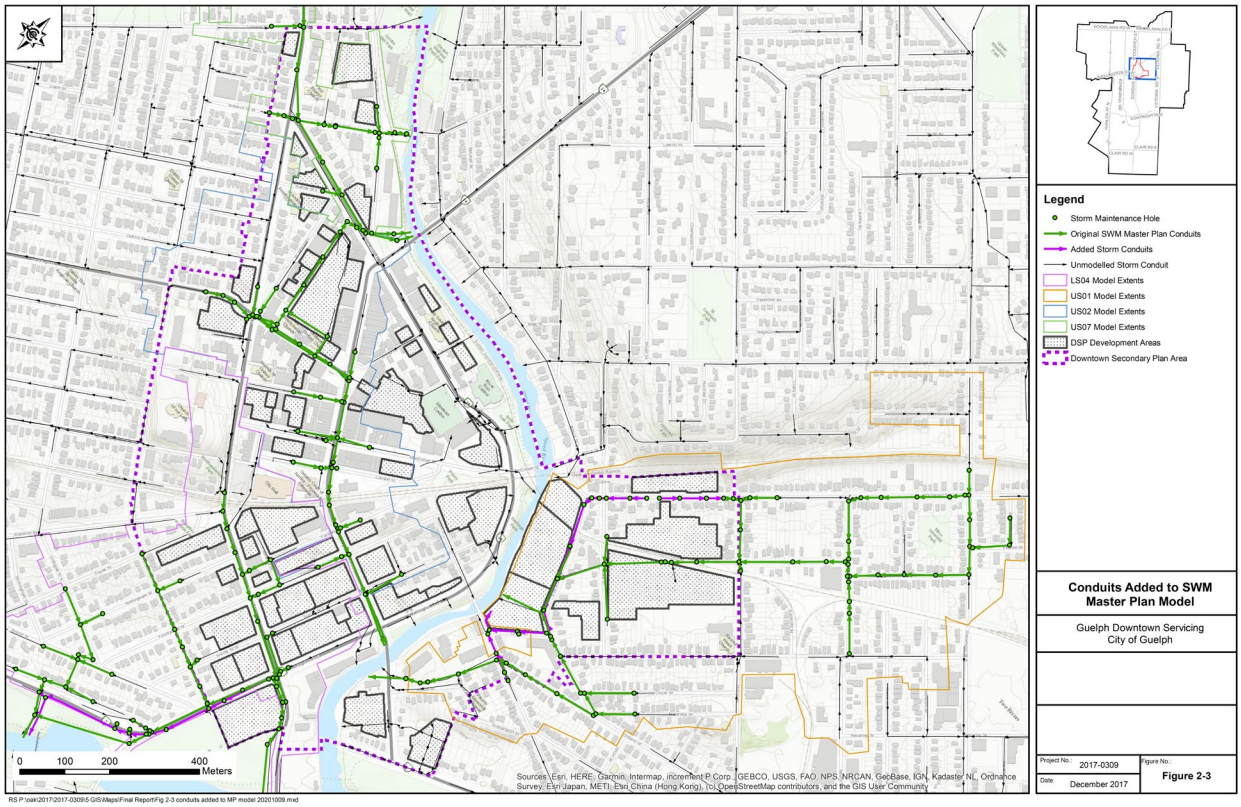


**Figure 2-3 Conduits Added to Stormwater Master Plan Model**

- Curves were assigned in a similar way to the original model. Inlets for a pipe reach were lumped at the upstream end. Composite inlet curves for groups of CBs were generated by summing the depth-flow tables for all inlets at a location. In development priority areas, or areas suspected to be sensitive to subcatchment loading, inlets were further discretized to provide a higher level of detail.

No changes were made to existing model hydrology as the majority of the Downtown Area is largely impervious and proposed development would be similar in nature. Consequently, modelled imperviousness was not adjusted. As well, not all downtown storm systems were modelled. The drainage area adjacent to the Speed River on Woolwich Street from Thorpe Street to Macdonell Street was not in the original model and were not added because of its proximity to the Speed River.

# 3 Water Distribution System Assessment

The following section presents an assessment of the existing water distribution system under baseline conditions and future planning horizons. **Appendix D** presents additional figure illustrating results.

## 3.1 Performance Criteria

Performance criteria for the water distribution system in the downtown area were developed in consultation with City staff, considering both Average Day Demand (ADD) and Maximum Day Demand (MDD) conditions. The criteria are based on municipal standards and typical guidelines applied in the City of Guelph. Criteria included the following:

- Pressure:
  - 50 – 80psi (ADD preferred)
  - 40psi (PHD minimum)
  - 100psi (Maximum)
- Head loss: < 3.0 metre per kilometre (m/km)
- Available fire flow:
  - Large commercial developments: 367 Litre per second (L/s)
  - MDD, 12:00pm for 5 hours
  - Maintain 20psi in the distribution system

Extended period simulations were run in the model to record minimum pressure under MDD conditions and Peak Hour Demand (PHD). Maximum pressure was also analyzed under ADD conditions and compared to the City's preferred pressure range of 50 to 80psi.

The head loss through a pipe network can be used as a measure of capacity as it accounts for flow, velocity, condition, pressure loss, and diameter. Head loss values of less than 3.0m/km of pipe length are preferred because as these indicate that the watermain is capable of transporting required flows without significant losses in pressure that might be found in smaller watermains or older infrastructure.

Available fire flow is an important gauge of the hydraulic capacity of water distribution infrastructure; it is essential that the watermains can deliver sufficient flows in the event of an emergency. The Quebec Street Mall represents the maximum fire flow requirement for the DSP area. A value of 367L/s for large commercial developments was set as a target in the City's 2007 Water and Wastewater Master Plan and was chosen as the design criteria upper limit. This fire flow demand does not represent the full study area; each demand is dependent on the specific land use type. It is recommended that developers build according to the available fire flows determined through hydraulic analysis and field testing. Modelling was conducted using steady-state analysis of available fire flows at a residual pressure of 20psi for a 5-hour fire flow scenario at 12:00pm under MDD conditions.

### 3.1.1 Thematic Mapping

To present the results of the water distribution system assessment, thematic maps were prepared to represent modelled hydraulic performance. The use of thematic maps allows for interpretation of modelling results and easy identification of areas where the City's design criteria are not met. Pipe and node themes were applied to all planning horizons, evaluated under ADD and MDD conditions. Head losses across a length of pipe are shown in terms of meters of head lost per kilometer. Pressures and fire flow results are represented with colour coded nodes according to the stated criteria.

## 3.2 Water System Capacity Assessment

The water system assessment has been completed for the four scenarios: Baseline/Pre-2018; 2022; 2027; and, 2031 development conditions.

### 3.2.1 Baseline/Pre-2018

The layout of the baseline model is representative of existing watermain infrastructure. Existing demands were maintained in the model and were based on the most recent model update with 2016 water billing data. The watermains near the F.M. Woods Water Treatment Plant (WTP) and in the DSP area were updated to include recent construction up to 2018 that would impact the study. The remaining watermains were consistent with 2016 infrastructure. Baseline hydraulic analysis was conducted to highlight weaknesses in the existing infrastructure before new demands were applied.

#### 3.2.1.1 Pressure

**Figure 3-1** and **Figure 3-2** presents the minimum and maximum pressures for baseline MDD and ADD conditions, respectively. The pressures were above 50psi in the DSP area with some areas greater than 80psi, but none exceeded 100psi. Higher pressures were seen in the southeast section of the DSP area, which were expected due to lower elevations along the Speed River and proximity to the F.M. Woods Water Treatment Plant (WTP). A few locations on Dublin Street North between Cambridge Street and Cork Street North showed pressures between 40 – 50psi due to high elevations, but the values meet the criterion for minimum pressure at PHD.

#### 3.2.1.2 Head Loss

**Figure 3-3** presents the water distribution system performance under peak head loss which was seen to occur in the downtown area around 9:00pm. Under baseline conditions, the head losses in the DSP area are mostly below 1m/km, showing adequate capacity and minimal stress in the distribution system. All locations were below 3.0m/km, meeting criteria under baseline conditions. A few small areas were found to have head loss over 1.0m/km and are addressed below:

- Area HL-1: Head loss above 2.0m/km was observed on London Road East and Norwich Street East near where the river crossing enters the DSP area from the north. This area is expected to be addressed in the future by the proposed feedermain and river crossing along Eramosa Road proposed as part of the 2014 DC Background Study.

- Area HL-2: A small section old 150mm cast iron pipe near the end of Macdonell Street was found to be over 2.0m/km of head loss where the 150mm watermain meets the 300mm pipe.
- Area HL-3: The Speed River crossing along Gordon Street was also seen to have slight restrictions and is a known area of limited flow into the Old University Area.

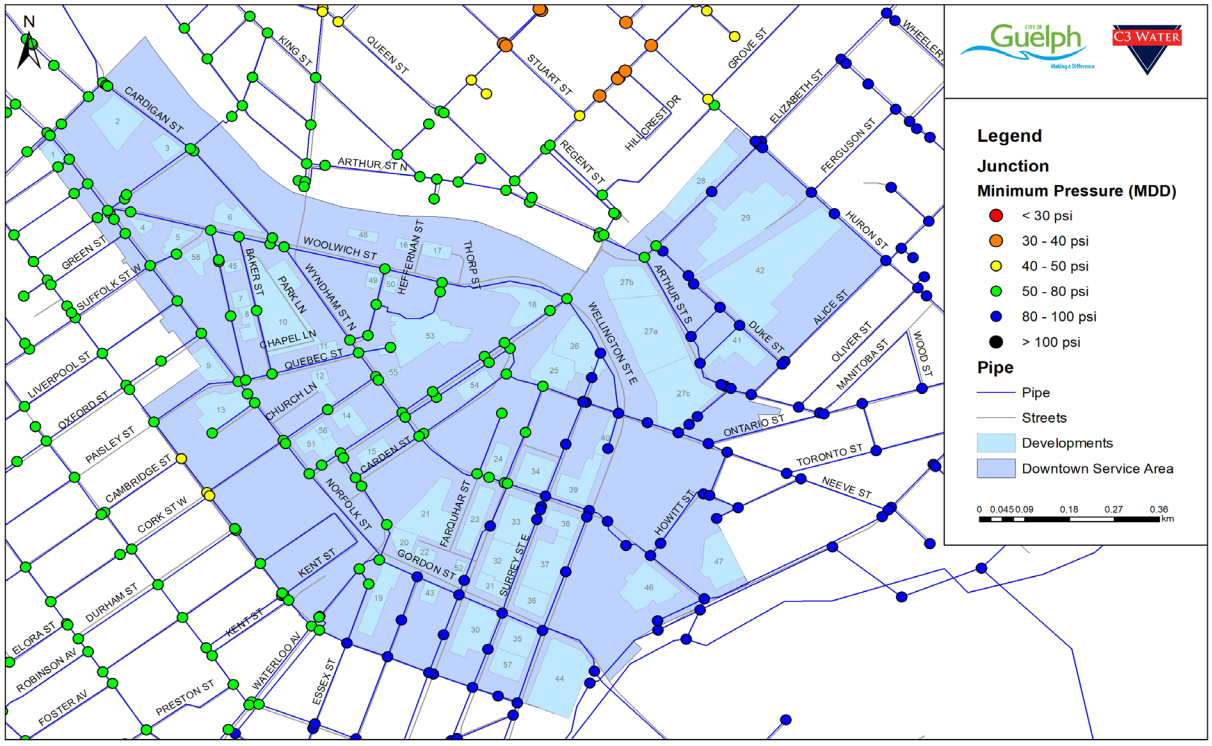


**Figure 3-1 Baseline Minimum Pressure Conditions - MDD 2016**

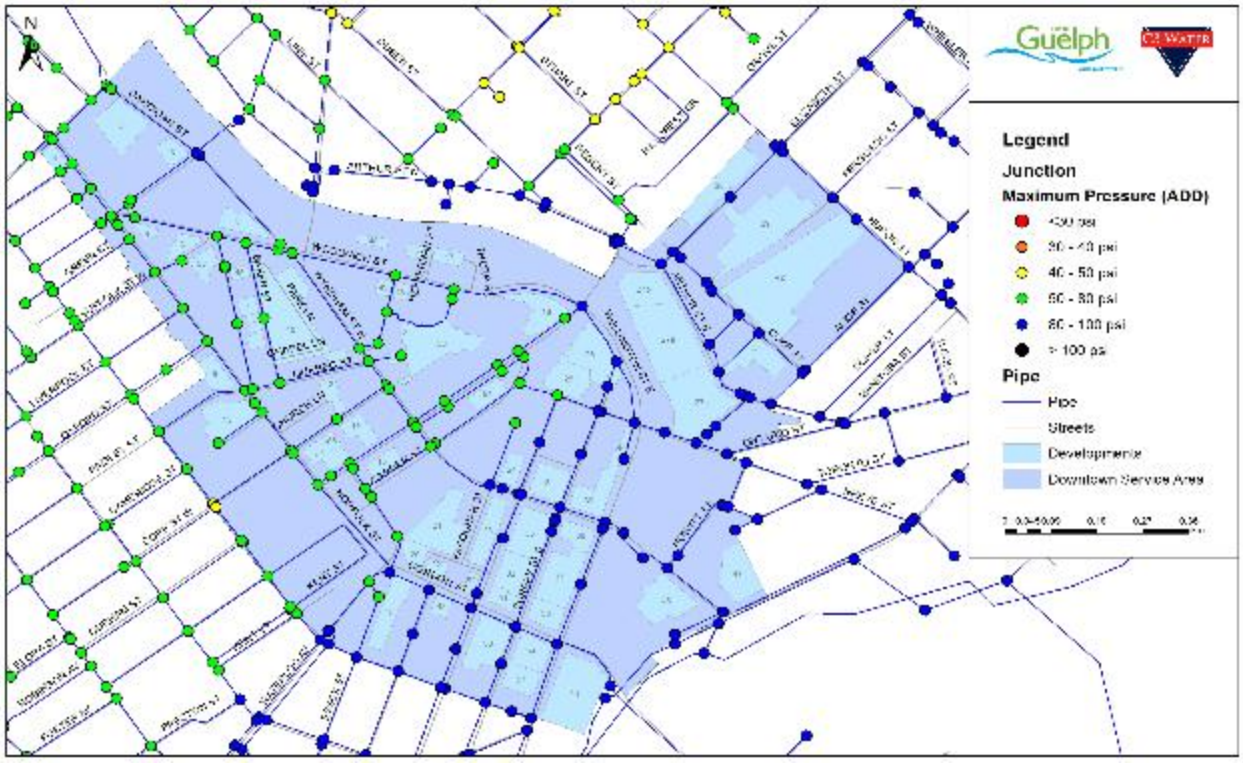


**Figure 3-2 Baseline Maximum Pressure Conditions - ADD 2016**

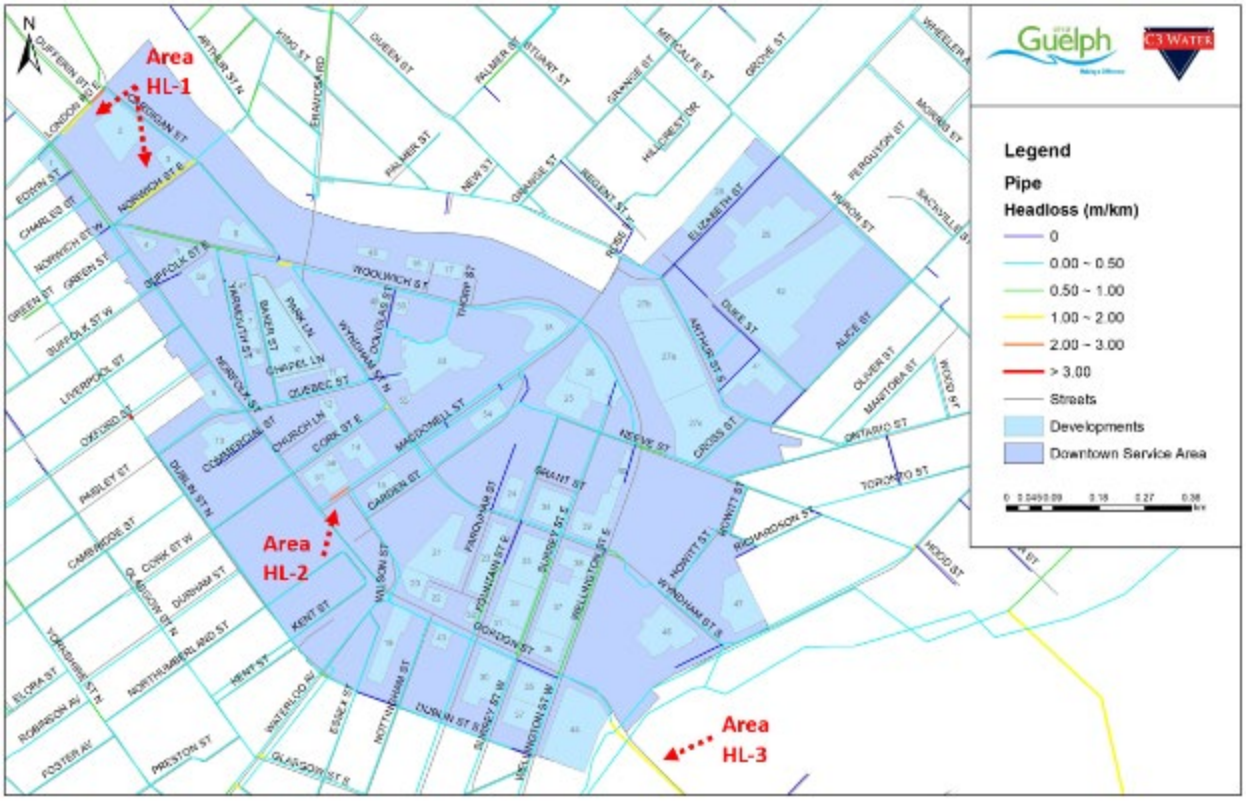


**Figure 3-3 Baseline Head Loss Conditions - MDD 2016**

### 3.2.1.3 Available Fire Flow

**Figure 3-4** presents the available fire flows in the DSP area. Many watermains surrounding the development areas can provide fire flows above 200L/s which can support future intensification. A few areas have fire flows below 80L/s due to prevalence of smaller, older cast-iron watermains. These locations are shown in the figure and described below.

- Area FF-1: Old 150mm Cast Iron Pipes exist on Baker Street and Yarmouth Street, restricting fire flow and servicing to proposed developments.
- Area FF-2: The two dead-ends created by the train track crossing on Duke Street cause low fire flows. This is being addressed through the proposed upgrades as part of a separate assignment.
- Area FF-3: The dead end on Wellington Street East causes a disconnect in the downtown looping and results in low available fire flow between Wyndham Street South and Neeve Street.
- Area FF-4: The 50mm dead end on Richardson Street results in low fire flows. Improving fire flows at dead end hydrants is often not achievable but can be supplemented by other nearby hydrants. The proposed development #47 will also likely be serviced from York Road.
- Area FF-5: the 100mm old cast iron watermains on Nottingham Street and Surrey Street West cause fire flow restrictions below 50L/s.

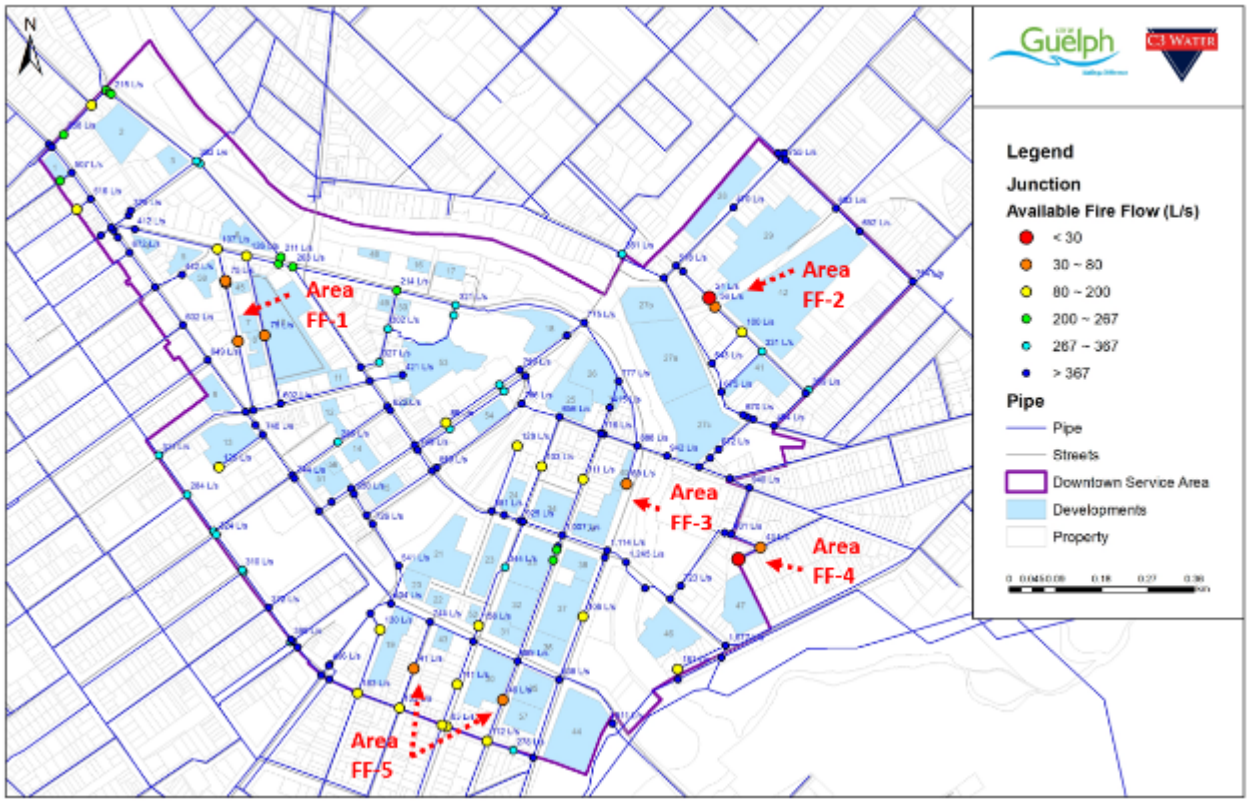


**Figure 3-4 Baseline Fire Flow Conditions - MDD 2016**

### 3.2.2 2022 Conditions

The impact of added water demands on existing infrastructure was modelled by applying 2022 development demands to the existing system. Pressure results for the Baseline through to the 2031 scenarios were all found to meet criteria, so intermediate pressure results are not presented for 2022, 2027 and 2031.

The head loss and available fire flows were observed under 2022 conditions and are summarized in the following sections.

#### 3.2.2.1 Head Loss

**Figure 3-5** shows the head loss results showing no significant changes from baseline conditions. Two additional areas within the DSP area showed head loss above 2.0m/km as noted below.

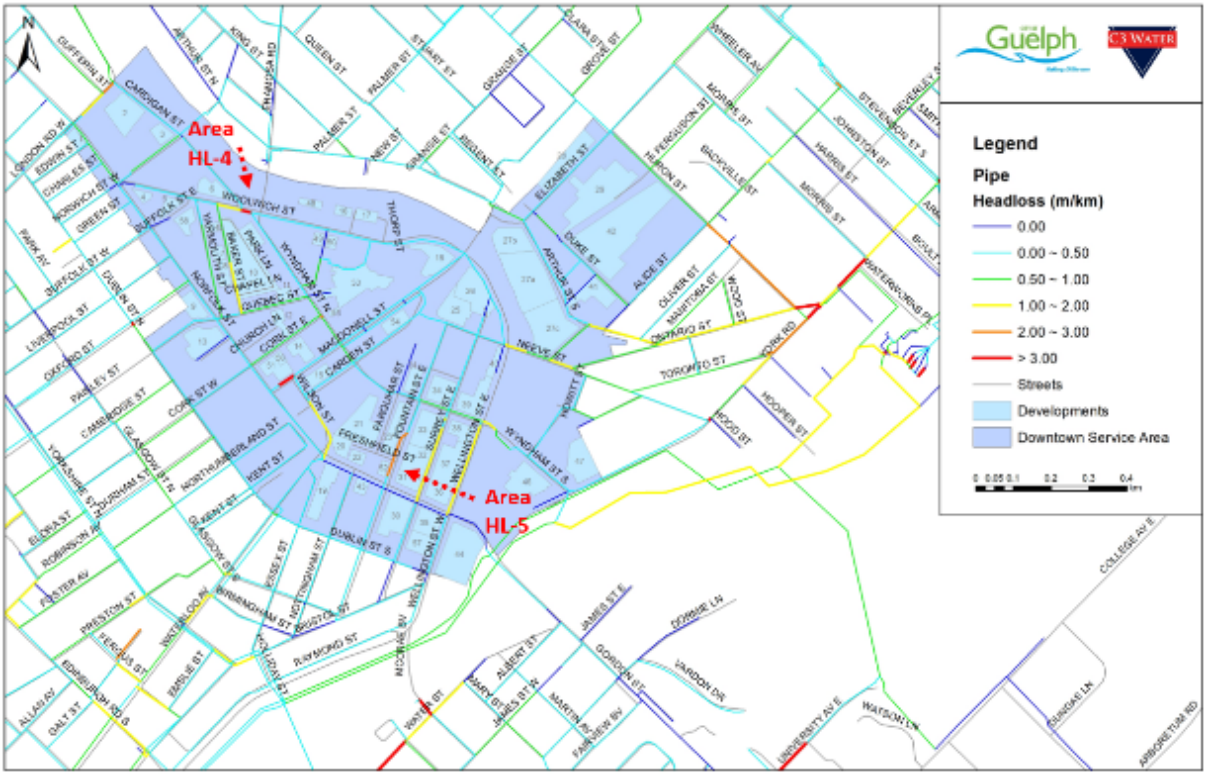


**Figure 3-5 Head Loss Conditions – MDD 2022**

- Area HL-4: The section of 100mm cast iron watermain on Fountain Street East experience head loss over 2.0m/km.
- Area HL-5: A small section of old 150mm cast iron pipe on Woolwich Street had head losses over 3.0m/km at the intersection with the 250mm pipe on Windham Street North.

#### 3.2.2.2 Available Fire Flow

Under 2022 conditions, the areas of low fire flow remained the same from baseline conditions as shown previously in **Figure 3-4**. Figure D.1 in **Appendix D** shows Fire Flow Conditions – MDD 2022.

### 3.2.3 2027 Conditions

The same process was conducted for 2027 demands to observe the impact of this phase of development on system performance. Areas of high head loss and low fire flow remained consistent with Baseline and 2022 conditions as shown in **Appendix D**, Figure D-2 and Figure D-3, respectively.

### 3.2.4 2031 Conditions

Proposed water demands were applied to the baseline model including all new developments that are proposed for construction by 2031. This analysis highlighted the deficiencies in the existing infrastructure when all proposed demands were applied to existing infrastructure.

#### 3.2.4.1 Pressure

**Appendix D**, Figure D-4 and Figure D-5 present the minimum and maximum pressures for 2031 MDD and ADD conditions, respectively. The results were consistent with Baseline conditions. The pressures in the DSP area remained above 50psi, with some areas greater than 80 psi, but none exceeding 100psi.

#### 3.2.4.2 Head Loss

**Figure 3-6** presents the water distribution system performance under peak head loss which was seen to occur in the DSP area around 9:00pm when the total demand was approximately 85L/s. Limited watermain capacity to supply new developments to 2031 was shown to increase head loss results in more locations from baseline conditions.

- Area HL-6: A portion of Baker Street showed head loss over 2.0m/km with development demands.
- Area HL-7: The newer 200mm PVC watermain on Wilson Street experienced head loss between 2.0 – 3.0m/km, likely due to the lack of large watermain looping around the DSP area.
- Area HL-8: The old 300mm and 350mm cast iron river crossings along Neeve Street and Wyndham Street had head losses over 3.0m/km. There are limited river crossing to bring water to the downtown from the WTP, the largest source of water.
- Area HL-9: The portion of old 150mm cast iron watermain on Wellington Street between Gordon Street and Wyndham Street showed increased head loss due to added development demands and lack of watermain looping.

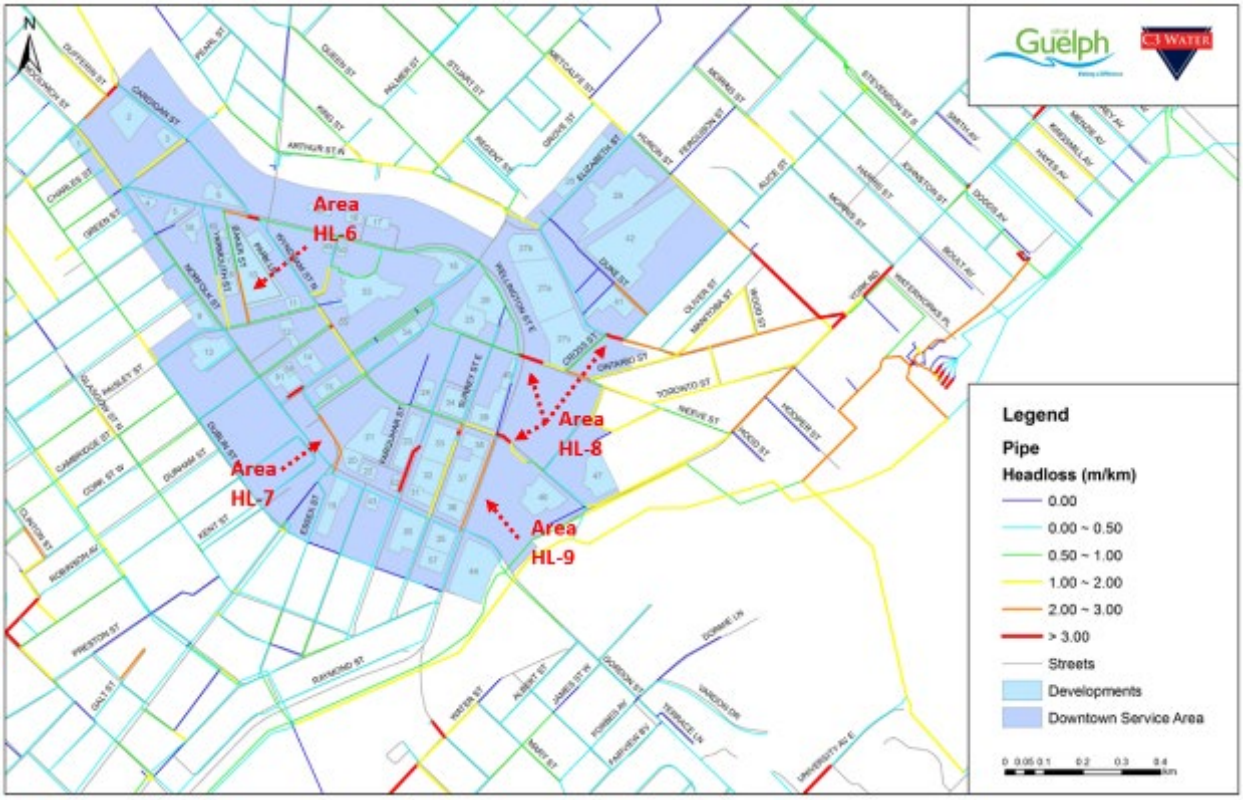


**Figure 3-6 Head Loss Conditions – MDD 2031**

### 3.2.4.3 Available Fire Flow

**Figure 3-7** presents the available fire flows in the DSP area under 2031 conditions. Areas of low fire flow availability remained mostly consistent with Baseline conditions. The fire flows on Duke Street were worsened with the intensification from developments.

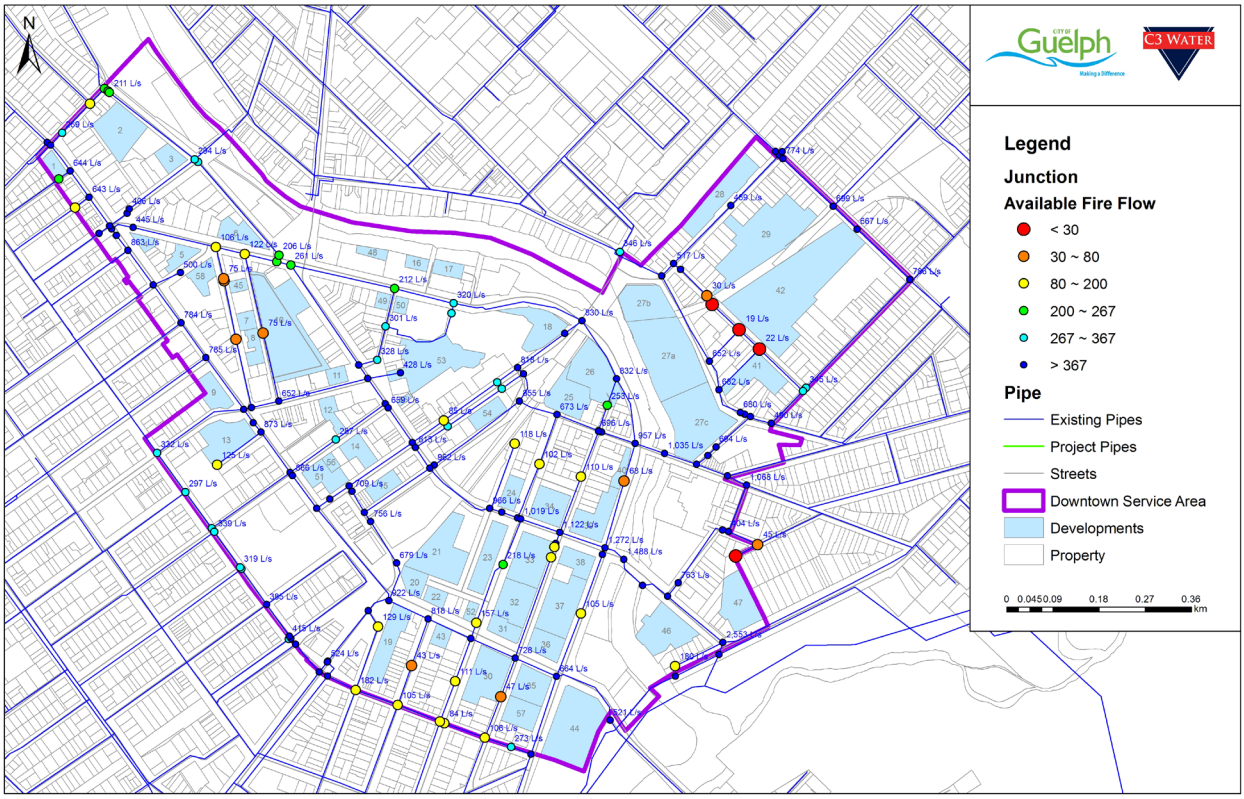


**Figure 3-7 Fire Flow Conditions – MDD 2031**

## 3.3 Summary

The assessment of the water distribution system was used to highlight existing areas in the DSP that did not meet pressure, head loss and fire flow criteria. Future demands from proposed developments were applied to see how these areas would perform under added stress, and identify new areas of concern through 2022, 2027 and 2031.

Based on model results, the pressures in the DSP area met minimum and maximum criteria under baseline and 2031 conditions.

Head losses under baseline conditions were found to meet criteria, with a few areas that could benefit from improvement (HL-1, HL-2, HL-3). Increased demands from 2022 and 2027 phases of development highlighted additional areas of concern (HL-4 and HL-5). By 2031, the DSP area experienced high head losses through prevalent small cast iron watermains, as well as through limited river crossings (HL-6, HL-7, HL-8, HL-9).

Fire flow availability is an existing concern in the downtown core with multiple areas below 80L/s (FF-1, FF-2, FF-3, FF-4, FF-5). Many areas with fire flows below 150L/s could also be improved to better service existing and future commercial land uses.

# 4 Wastewater Collection System Assessment

The following section presents an assessment of the existing wastewater collection system under baseline conditions and future planning horizons.

## 4.1 Performance Criteria

Performance criteria for the sanitary system in the downtown area were developed in consultation with City staff, considering both dry and wet-weather flows. The Development Engineering Manual (DEM), January 2019 criteria for new sewer design is 80% full flow design capacity of the pipe size. For this assignment and the evaluation of existing sanitary sewers the new sewer criteria is not the only metric to consider given the dynamic nature of sanitary systems. To evaluate existing sanitary system capacity, the following criteria are used:

- Under dry-weather flow conditions, the peak depth in sewers is not to exceed 85% of the total pipe depth (d/D < 0.85); and,
- Under wet-weather flow conditions, no pipe surcharge is to occur under peak flow conditions (d/D < 1). The City's wet-weather design event used in evaluation of sanitary sewer systems is the 25-year recurring 6-hour Chicago distribution storm. This is the same event that was used in evaluating the wastewater collection system in the City's 2007 Water and Wastewater Master Plan.

The criteria are applied using engineering judgement. There are conditions where surcharging under the 25-year event may occur because of the physical system without increasing the risk of flooding.

### 4.1.1 Thematic Mapping

To present the results of the wastewater collection system assessment, thematic maps were prepared representing modelled hydraulic performance. The use of thematic maps allows for interpretation of modelling results and easy identification of areas where the evaluation criteria are not met. Pipe themes were applied to all planning horizons for dry and wet weather conditions.

For dry-weather flows the maximum pipe full depth was identified for each section of sewer as follows:

- Green Line: Peak depth in pipe is less than 85% of pipe depth; and
- Red Line: Peak depth in pipe is greater than 85% of pipe depth.

For wet-weather flows the maximum pipe full depth was identified for each section of sewer as follows:

- Green Line: Pipe is not surcharged and the maximum HGL is below the obvert of the pipe; and
- Red Line: Pipe is surcharged and the maximum HGL is above the crown of the pipe.
- Green Node: The freeboard (Ground Elevation – Maximum Hydraulic Gradeline) is greater than 1.8m, a low risk of basement flooding from a surcharged system.
- Red Node: The Freeboard (Ground Elevation – Maximum Hydraulic Gradeline) is less than 1.8m, a higher risk of basement flooding from a surcharged system.

## 4.2 Sanitary System Capacity Assessment

The capacity assessment was completed for four scenarios: Baseline (Pre-2018); 2022; 2027; and, 2031 development conditions. The baseline condition is representative of existing conditions and calibrated to 2017 flow data.

The following is a summary of capacity conditions for each growth scenario. Thematic figures related to each scenario are found in **Appendix E** along with select maximum Hydraulic Grade Line Profiles for select pipe segments. Thematic maps are only presented in the main text for the Pre-2018 and 2031 scenarios.

### 4.2.1 Baseline and Pre-2018 Scenarios

**Figure 4-1** shows the Pre-2018 Peak Dry Weather Flow thematic map and **Figure 4-2** shows the Pre-2018 25-year thematic map. From reviewing the figures and modelling results the following observations are made:

- The Baseline and Pre-2018 conditions are the same in the downtown area.
- No capacity issues are identified under peak dry weather flow conditions.
- Under wet weather conditions, surcharging occurs in the following areas:
  - 380m of 225mm sewer on Woolwich Street, extending outside of the study area from Charles Street to Kerr Street.
  - Woolwich Street for 335m of 225mm sewer from Eramosa Road to the Sleeman Centre.
  - 120m of 300mm sewer on Quebec Street downstream of Yarmouth Street, past Baker Street.
  - 42m of a 300mm sewer on Wyndham Street between Carden Street and Macdonell Street. Backwater from Wyndham Street affects 103m of 225m pipe on Macdonell Street, west of Wyndham Street.
- The freeboard for all surcharged sewers is greater than 1.80m below the ground elevation.

### 4.2.2 2022 Scenario

- For 2022 peak dry-weather flow conditions no sewer capacity issues are identified.
- Under wet weather flow conditions, the extent of surcharging is similar to Pre-2018 conditions with surcharging extending upstream or downstream of previously surcharged segments.
  - On Woolwich Street, the amount of surcharge is similar, but marginally higher.
  - Norfolk Street (46m of 225mm), south of Quebec Street is surcharged because of backwater from Quebec Street.
  - Wyndham Street N, north of Macdonell Street is now showing surcharge.
- The freeboard for all surcharged sewers is greater than 1.80m below the ground elevation.


**Figure 4-1 Sanitary System Performance Pre-2018 Peak Dry Weather Flow**


**Figure 4-2 Sanitary System Performance Pre-2018 25-Year Maximum**

### 4.2.3 2027 Scenario

- For 2027 peak dry-weather flow conditions no sewer capacity issues are identified.
- Under wet weather flow conditions, the extent of surcharging is similar to 2022 conditions with surcharging extending upstream or downstream of previously surcharged segments.
  - On Woolwich Street, the amount of surcharge is similar to previous scenarios.
  - Surcharge continues to extend north on Norfolk Street, north of Quebec Street, while the level of surcharge on Quebec Street increases.
  - Surcharge continues to move north on Wyndham Street North, north of Cork Street East.
- The freeboard is greater than 1.8m below the ground elevation except for one location at Woolwich Street and Eramosa Road where the freeboard is 1.6m. In reviewing the locations this does not appear to be a risk of basement flooding.

### 4.2.4 2031 Scenario

**Figure 4-3** shows the 2031 Dry Weather Flow thematic map and **Figure 4-4** shows the 2031 25-year thematic map. From reviewing the figures and modelling results the following observations are made:

- For 2031 peak dry-weather flow conditions one (1) surcharge issue has been identified on Wellington Street between Gordon Street and Dublin Street. System inverts at this location are within 1.8 m of the ground surface, therefore any surcharging will result in the system being out-of-compliance with the defined criteria. This may be a consequence of how the model is loaded given the parallel pipes where there is capacity in the adjacent sanitary sewer.
- Under wet weather flow conditions, the extent of surcharging is similar to 2027 conditions with surcharging extending upstream or downstream of previously surcharged segments.
  - On Woolwich Street, the amount of surcharge is extended from previous scenarios.
  - The surcharging observed on Wyndham Street North has reached back to Quebec Street over to Norfolk Street.
- There is a new surcharge section on Wyndham Street North at Wellington Street East (95m of 375mm). As well, new surcharge sections appear on Wellington Street E from Dublin Street South to Gordon Street extending up Gordon Street (255m of 300mm)
- Freeboard at Woolwich Street and Eramosa Road, and Wyndham Street North at Wellington Street East is less than 1.8m. Similarly, on Gordon Street onto Wellington Street the freeboard is less than 1.8m, but the sanitary sewer in this location is relatively shallow with cover ranging from 1.6m to 2.0m.

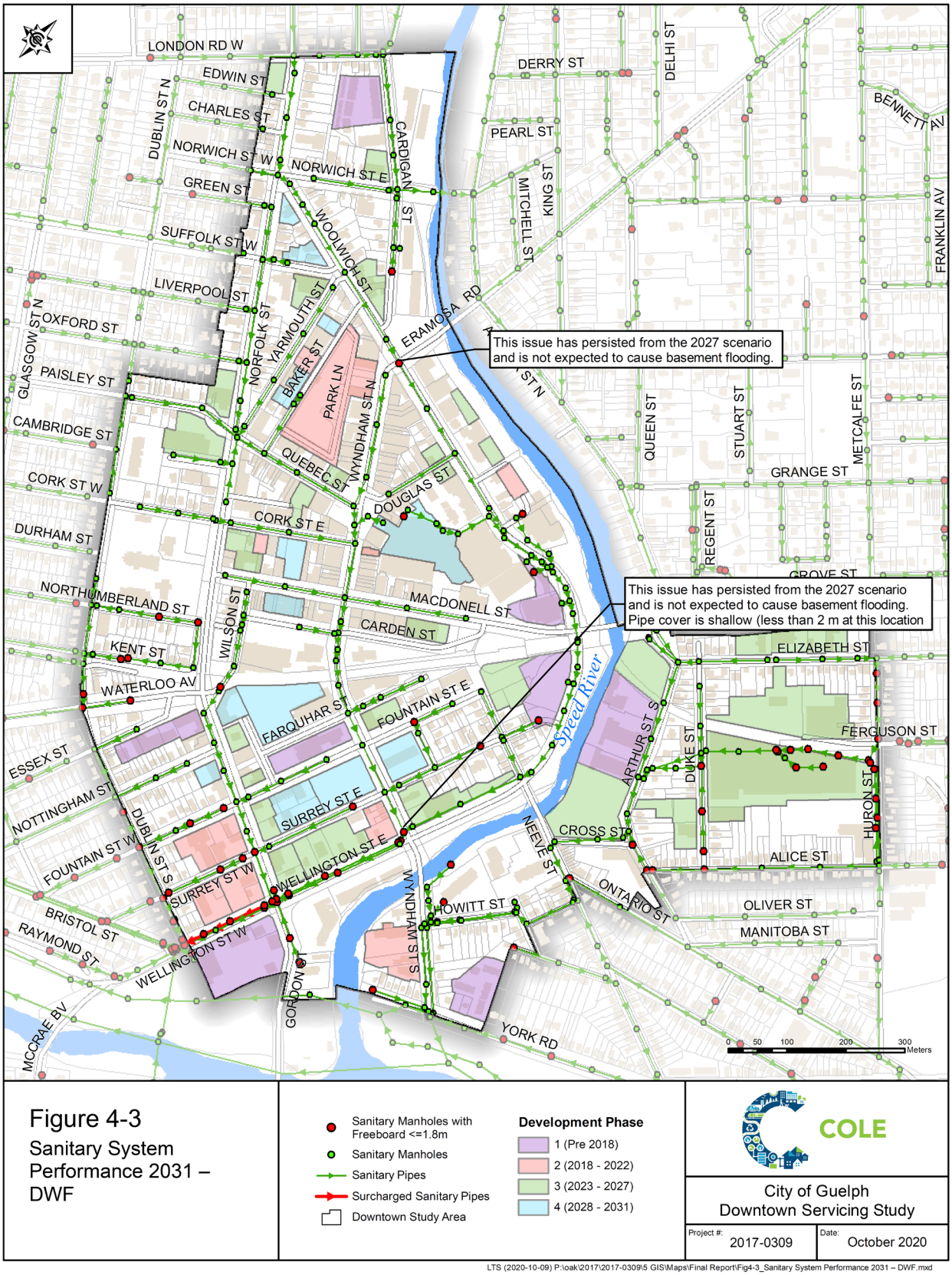


**Figure 4-3 Sanitary System Performance 2031 Peak Dry Weather Flow**

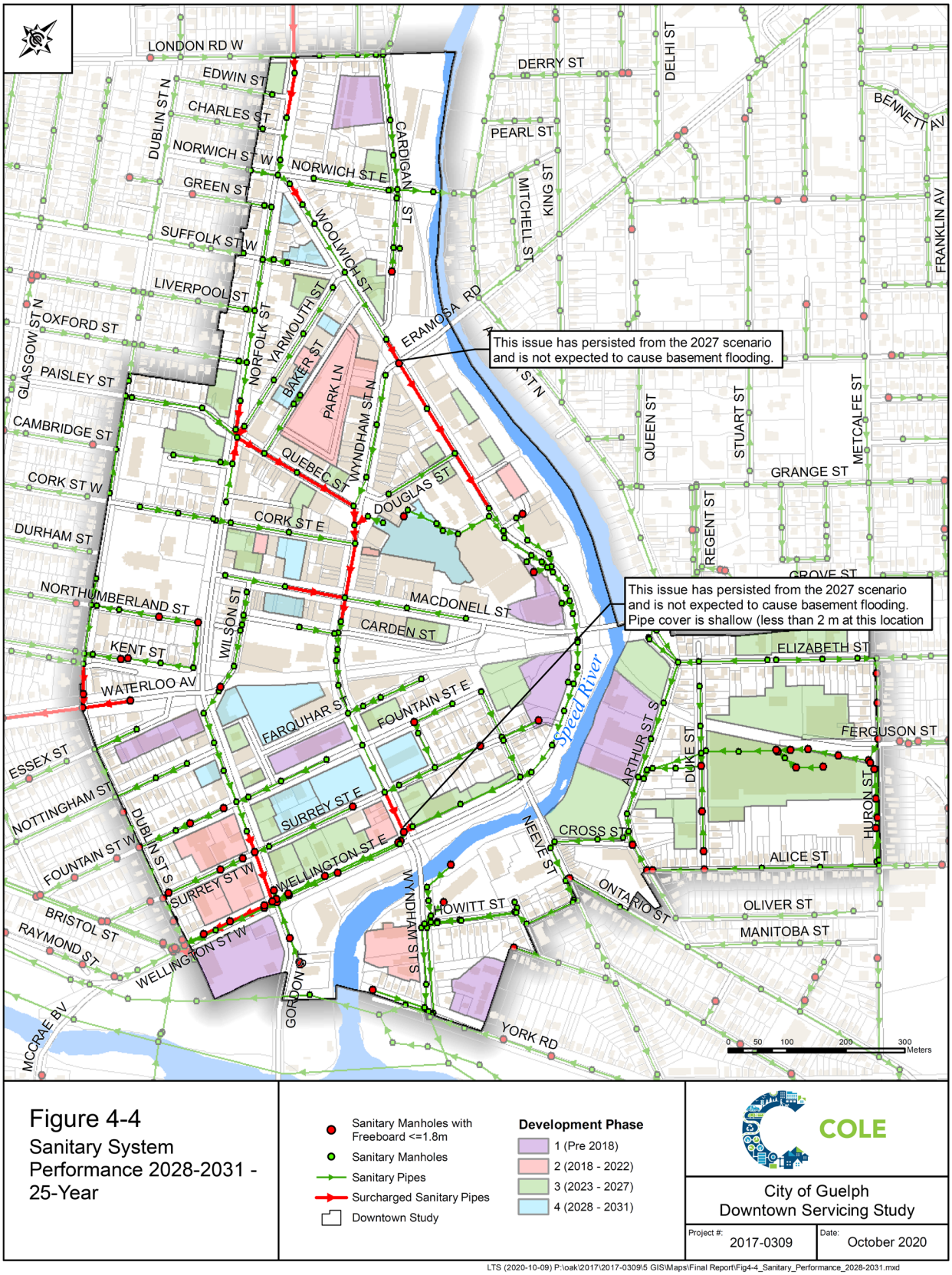


**Figure 4-4 Sanitary System Performance 2031 25-Year Maximum**

## 4.3 Wastewater Summary

In reviewing the wastewater capacity assessment for each scenario, the existing sanitary sewers in the downtown area operate well under dry weather conditions where the flow depth in existing sewers does not exceed 85% full for any of the growth scenarios. The one exception is on Wellington Street where the system is shallow and there is more capacity in the parallel system in the area. This assessment takes into consideration existing flows plus design flows associated with redevelopment.

Under wet weather conditions (25-year), the existing sanitary system receives Rainfall Derived Inflow and Infiltration (RDII). RDII flows in the existing system result in surcharging in approximately four areas of Downtown. With redevelopment, the surcharging extends to other segments as design flows are added to the system. The surcharge levels are not considered critical as the freeboard is greater than 1.8m below the ground surface. However, by 2031 the surcharge levels are elevated, and the freeboard is less than 1.8m below the ground in several locations, as shown on **Figure 4-3** and **Figure 4-4**.

Through redevelopment, it is expected the amount of RDII will decline as service laterals are replaced and onsite servicing is brought up to current drainage standards. This could result in the removal of roof drainage, foundation drains and other historical cross connections that contribute storm drainage to the sanitary system. The reduction in RDII is not taken into consideration in the capacity assessment as the sources of RDII are not known.

Based on the capacity assessment, there are sanitary system improvements that need to be considered to ensure reliable and timely servicing for growth. Given the outcome of the capacity assessment for each scenario, there is no immediate capacity issue identified in the short term (2018 to 2022). Beyond 2022 sanitary system improvements need to be considered.

The capacity assessment and conclusions are premised on available information and potential redevelopment scenarios. As well, sanitary system model is limited to available data used for calibration and assumes that existing system is in good operating condition.

# 5 Stormwater System Assessment

Current practice for stormwater management system design requires the design of a major-minor drainage system (overland and subsurface networks). Stormwater infrastructure, particularly in the downtown area pre-dates the application of major-minor drainage systems, especially the need for positive overland flow routes. In the downtown area, the design standards at the time the storm infrastructure was constructed is generally unknown and is sub-standard to current standards which apply to new design. Consequently, the evaluation of existing system performance is based primarily in hydraulic performance for different design storm events versus the evaluation of stormwater quantity and quality control against current standards.

In considering growth in the downtown area, stormwater is based on today's standards and the principle of controlling post-development flow quantity to pre-development flow quantity. The downtown area is largely impervious; therefore, any additional controls would be beneficial to stormwater management. The following section provides an overview of existing system performance. Given the City's requirement to control post-development flows to match pre-development conditions, the hydrologic analysis for existing conditions (pre-development) is the same as for 2021, 2027 and 2031 conditions (post-development). As well, as there are no significant changes in land use (i.e. the study area is expected to undergo urban intensification and remain highly impervious), no changes were made to modelled imperviousness.

## 5.1 Performance Criteria

The hydraulic model prepared through the 2012 Stormwater Master Plan and updated for this assignment was used to analyze the hydraulic performance of the minor and major systems. Criteria used to assess the stormwater system are consistent with the 2012 Master Plan. To evaluate existing storm system, the following criteria are used:

- Under 5-year Chicago design storm no pipe surcharge (d/D < 1.0);
- Under 100-year Chicago design storm pipe surcharge is acceptable with freeboard greater than 1.8m (Freeboard>1.8m); and
- Under 100-year Chicago design storm overland flow depths are to be less than 300mm in the overland system (Overland depth<300mm).

The criteria are applied using engineering judgement. There are conditions where surcharging under the 5- or 100-year events may occur because of the physical system without increasing the risk of flooding. Similarly, the 300mm overland flow depth criteria is used to identify potential locations where the overland flow may go beyond the public right-of way.

### 5.1.1 Thematic Mapping

To present the results of the stormwater system assessment, thematic maps were prepared representing modelled hydraulic performance. The use of thematic maps allows for interpretation of modelling results and easy identification of areas where the evaluation criteria are not met.

For the stormwater thematic maps two types of maps are prepared, the first is for pipe hydraulic performance and the second is for the overland system.

For the 5-year and 100-year events, thematic maps show the following performance information:

- Green Line: Pipe is not surcharged and the maximum HGL is below the crown of the pipe
- Red Line: Pipe is surcharged and the maximum HGL is above the crown of the pipe
- Green Node: The Freeboard (Ground Elevation – Maximum Hydraulic Gradeline) is greater than 1.8m, a low risk of flooding from a surcharged system
- Red Node: The Freeboard (Ground Elevation – Maximum Hydraulic Gradeline) is less than 1.8m, a higher risk of flooding from a surcharged system.

For Overland flow the thematic map shows the following performance information:

- Green Line: Overland flow link is less than 300mm in depth
- Red Line: Overland flow link is greater than 300mm in depth.

## 5.2 Stormwater System Assessment

Current practice for stormwater management system design requires the design of a major-minor drainage system (overland and subsurface networks). Stormwater infrastructure, particularly in the downtown area pre-dates the application of major-minor drainage, especially the need for positive overland flow routes. The stormwater system, although compliant with the standards at the time of installation, would be considered sub-standard compared to current day standards for new design.

Consequently, the assessment of stormwater drainage is undertaken using event based approach using the City's standard 5 and 100-years design storms using a 4-hour Chicago distribution using the updated PCSWMM dual drainage model. This approach is consistent with the City's 2012 Stormwater Master Plan and considered the quantity of stormwater. In addition, design events using the 2-, 10-, 25- and 50-year design storms were also used to determine the level of service and the need for controls.

### 5.2.1 Baseline/Pre-2018

**Figure 5-1** and **Figure 5-2** show the 5-year performance for the minor and major system respectively, and **Figure 5-3** and **Figure 5-4** show the minor and major system performance for the 100-year design storm condition.

In reviewing the 5-year stormwater system assessment the following is revealed:

- Overall, the local storm system provides a 5-year level of service except for some locations:
    - In The Ward area (east side of Speed River) bounded by Ontario Street in the south and Elizabeth Street to the north there is surcharging conditions to surface. The level of service is generally less than 2-year. Overland flow is not an issue in this area for the 5-year event. However, there are several locations on Elizabeth Street and one location on Duke Street where the minor system surcharges to the surface where the overland depth is not identified as an issue.

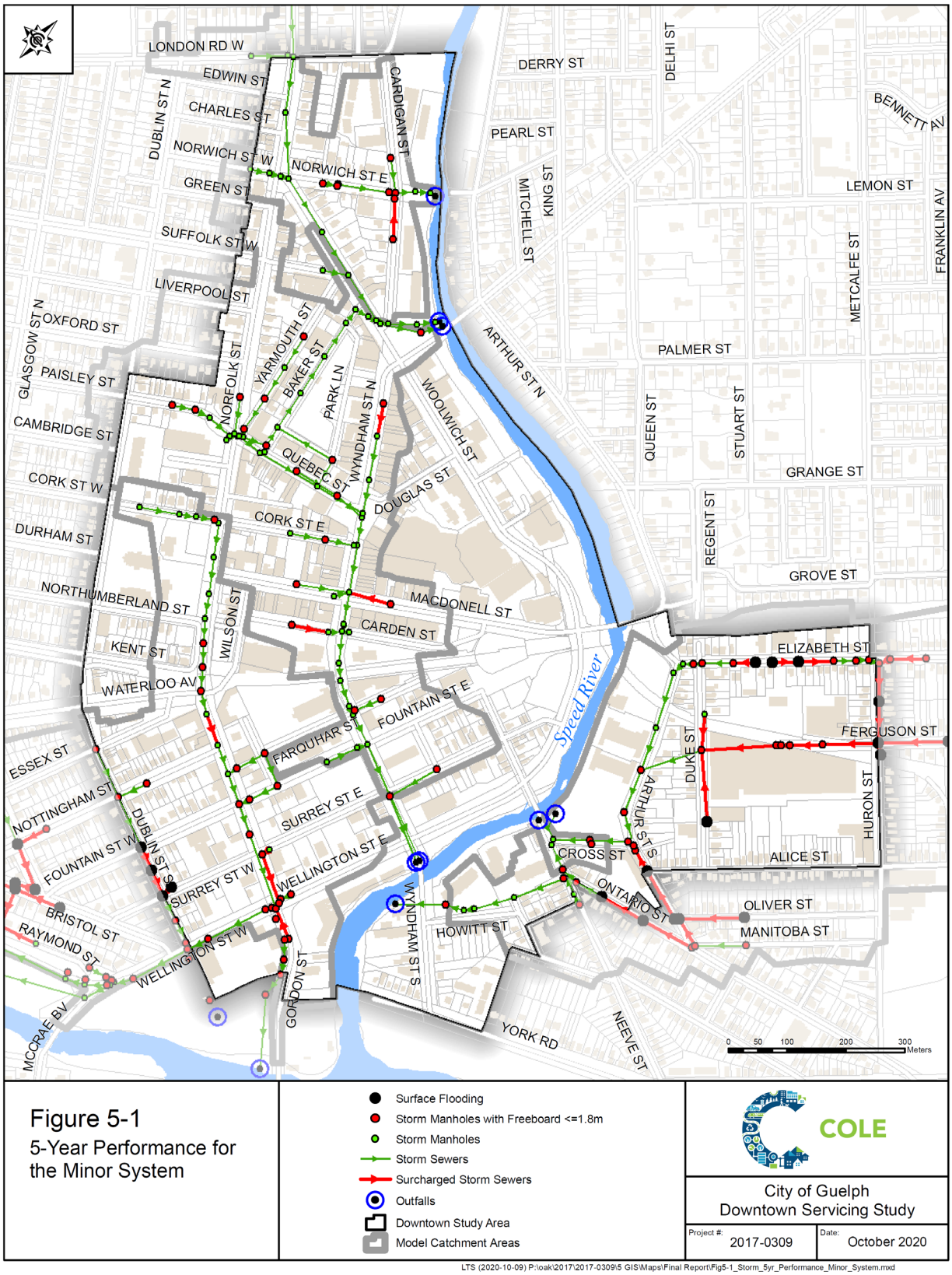


**Figure 5-1 5-Year Performance for the Minor System**

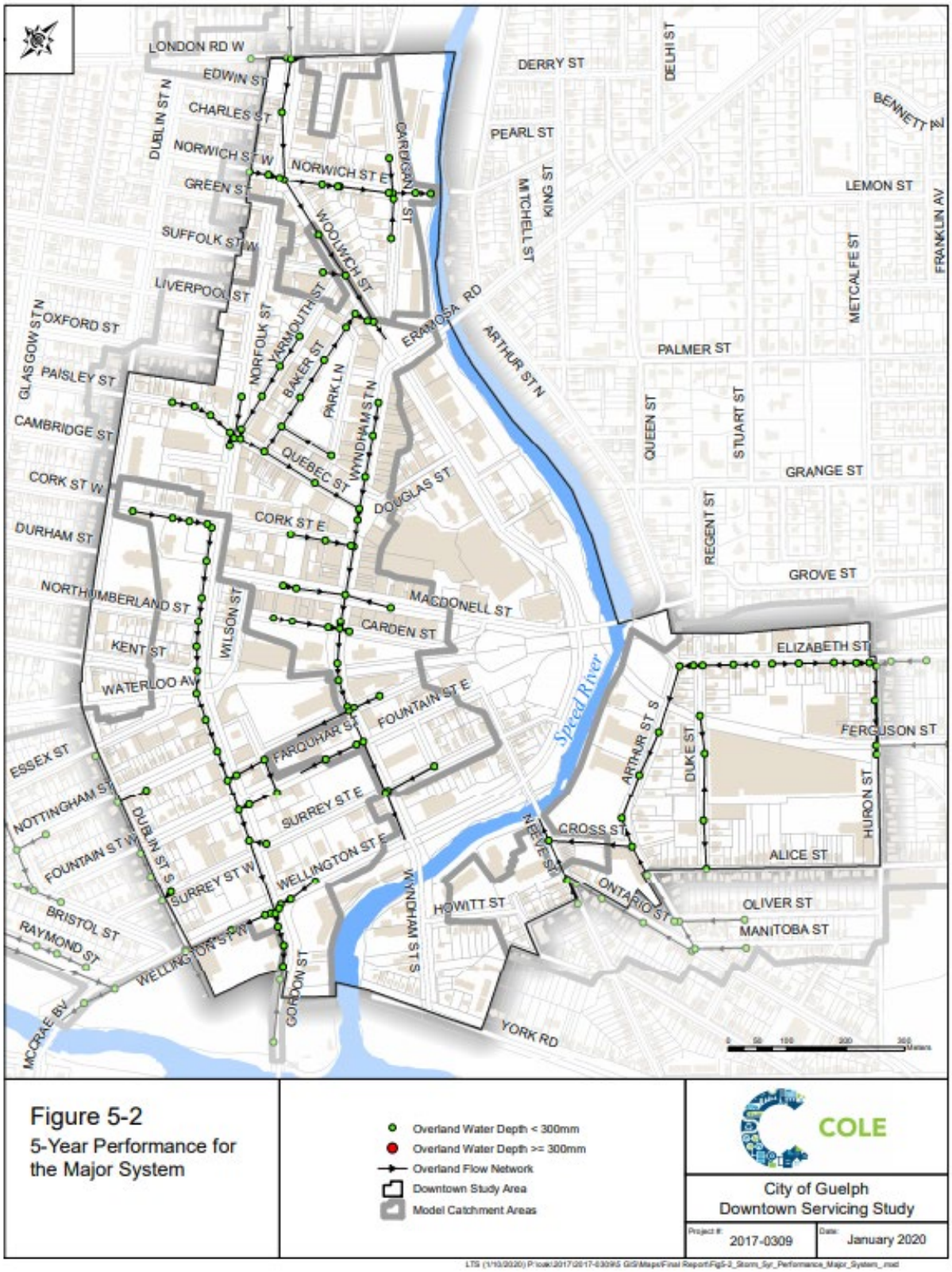


**Figure 5-2 5-Year Performance for the Major System**

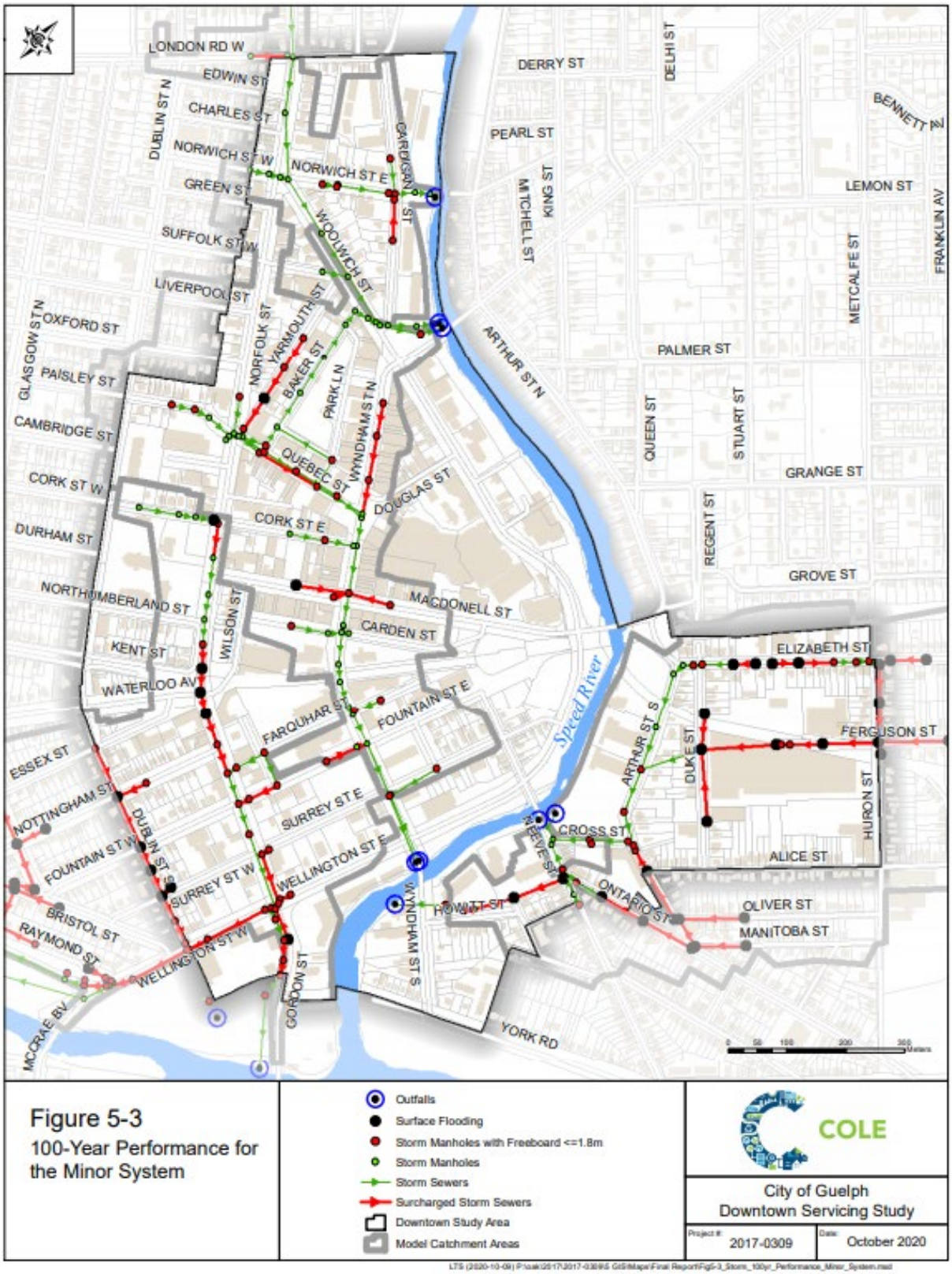


**Figure 5-3 100-Year Performance for Minor System**

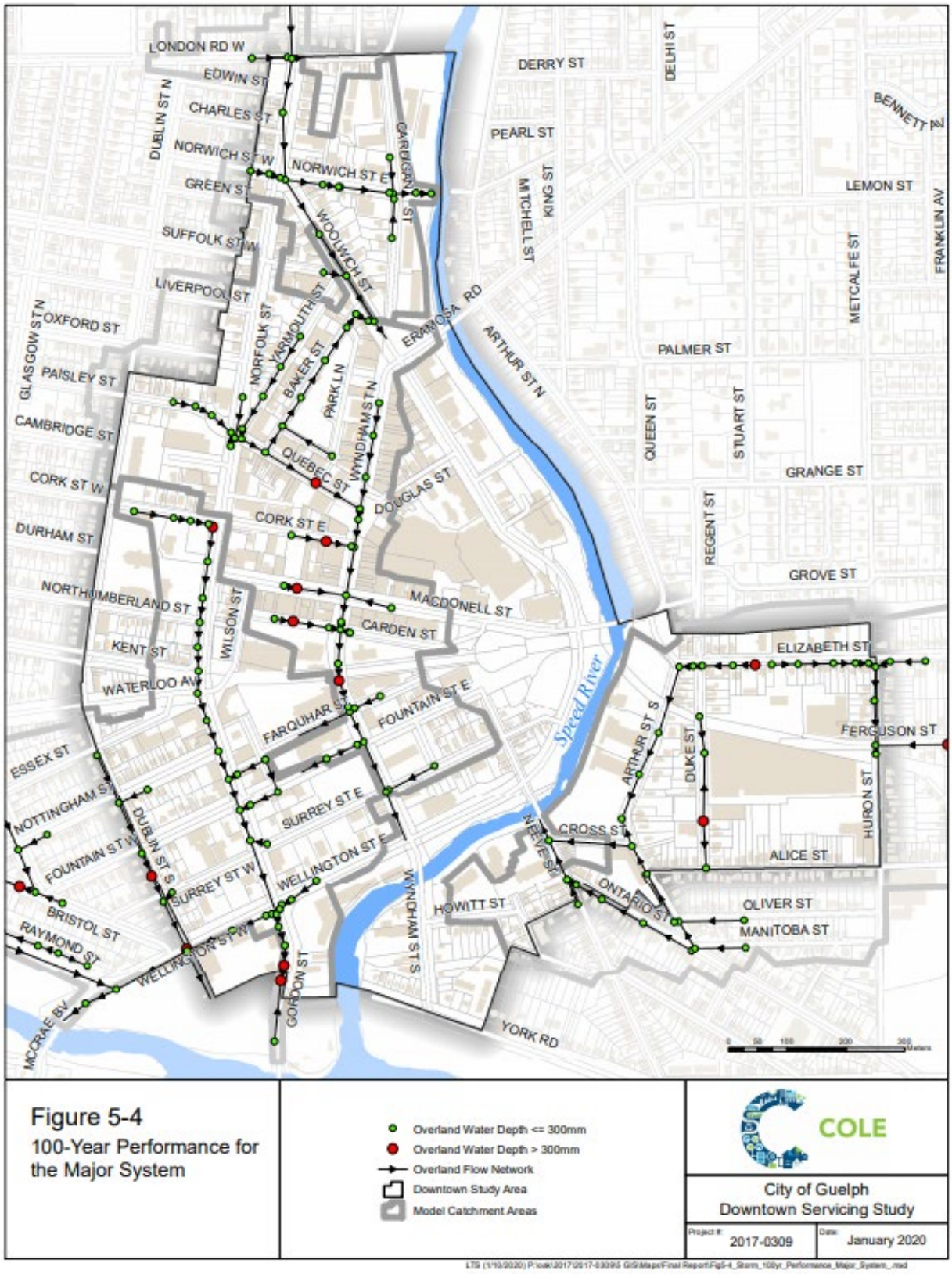


**Figure 5-4 100-Year Performance for Major System**

  - The storm sewer is surcharged on Dublin Street from Fountain Street West, south towards Wellington Street West. The surcharge is likely related to a combination of the steep contributing storm sewers into a flat section on Dublin Street and restrictions from other contributing storm sewers on Wellington Street West. Surcharge levels are to surface. It should be noted that Dublin Street is on the boundary of the Downtown study area and there are no development proposals associated with this storm system.
  - There is minor modelled surcharge on Macdonell Street, Carden Street and at the top end of Wyndham Street N.
  - There is a cluster of maintenance holes with low freeboard (<1.8m)at the intersection of Gordon and Wellington Streets. The storm sewers are not surcharged indicating a shallow system. Where there is a surcharged storm sewer on the east side of Gordon Street it is not considered critical as it is likely not connected to local buildings.
- In **Figure 5-1**, the freeboard for the 5-year event shows a number of locations where the HGL is within 1.8m of the surface. However, in the majority of these locations the attached pipes are not surcharged, indicating a shallow maintenance hole and system versus a hydraulic issue. Thematically, this is shown as a RED node, with a GREEN conduit.
- There are no locations where the depth of water in the right-of-way exceeds 300 mm, as shown in **Figure 5-2**.

In reviewing the 100-year stormwater system assessment the following is observed:

- The extent of hydraulic issues extends beyond the issues identified in the 5-year assessment.
- In The Ward area, modelled surcharging is seen on Ontario Street, Arthur Street South, Elizabeth Street and between Huron Street and Duke Street through an easement, as seen in the 5-year event.
- The surcharge on Dublin Street increases to contribute to overland.
- There is hydraulic surcharging on Gordon Street around Waterloo Avenue. South of this location the system operated without surcharge.
- Surcharge appears on Quebec Street, while surcharging in Macdonell Street increases.
- The overland depth of flow exceeds 300mm in the following locations:
  - Dublin Street, north of Wellington Street West; and, Gordon Street south of Wellington Street West.
  - Quebec Street (east for Norfolk Street); and Cork Street East, Macdonell Street, Carden Street all west of Wyndham Street North.
  - Elizabeth Street East of Duke Street.

In reviewing the results and system connectivity, stormwater issues in the downtown area can be grouped into three areas as shown in **Figure 5-5**. The three areas are identified as Dublin Street/Gordon Street, Macdonell/Quebec Streets, and The Ward.

### 5.2.2 2022 through 2031 Scenario

Given the need to control post-development flows to pre-development conditions, the hydraulic analysis for existing conditions (pre-development) is the same hydraulic analysis for 2021, 2027 and 2031 conditions (post-development).

## 5.3 Stormwater Summary

In reviewing the stormwater system performance in the downtown area there are three primary areas of the City where the existing system is showing hydraulic and overland flow issues which may result in flooding. The three areas include:

- Dublin Street, Wellington Street West and Gordon Street.
- Quebec Street, Macdonell Street and Yarmouth Street.
- The Ward (Elizabeth Street, Arthur Street and Ontario Street).

The Dublin Street and Gordon Street/Waterloo Avenue areas have a 5-year level of service before surcharging starts to occur in select storm systems, which only becomes worse under a 100-year condition. In The Ward area, storm sewers become surcharged for a 2-year design storm and severely overloaded under a 100-year conditions. In the Quebec Street and core downtown area, the storm system generally provides a 25-year level of service with some localized issues related to overland flow depth. Under the 100-year event there are surcharged areas with locations where the overland flow depth is greater than 300mm.

There are other minor performance issues identified in the Downtown Area that our outside the three primary areas. These are considered in the subsequent discussion on controls.

The storm services in the downtown area were never designed using current standards (i.e. dual drainage design, which was adopted in the early 2000s) and therefore should not be expected to meet current stormwater guidelines. However, through redevelopment the post-redevelopment flows must not worsen pre-redevelopment conditions and if possible, improve quantity control and look at opportunities to introduce quality control where feasible.

Based on the capacity assessment, there are storm system issues where system improvements need to be considered to improve the current level of service while striving to achieve a higher standard of quantity control. In considering potential improvements a combination of infrastructure improvement, and potential stormwater controls will need to be considered. The system improvement required for the current system will be applicable to future conditions considering the need to control to pre-redevelopment flows.

Beyond the hydraulic performance and quantity control, quality control, erosion control and water balance need to be taken into consideration as part of a Downtown stormwater strategy.

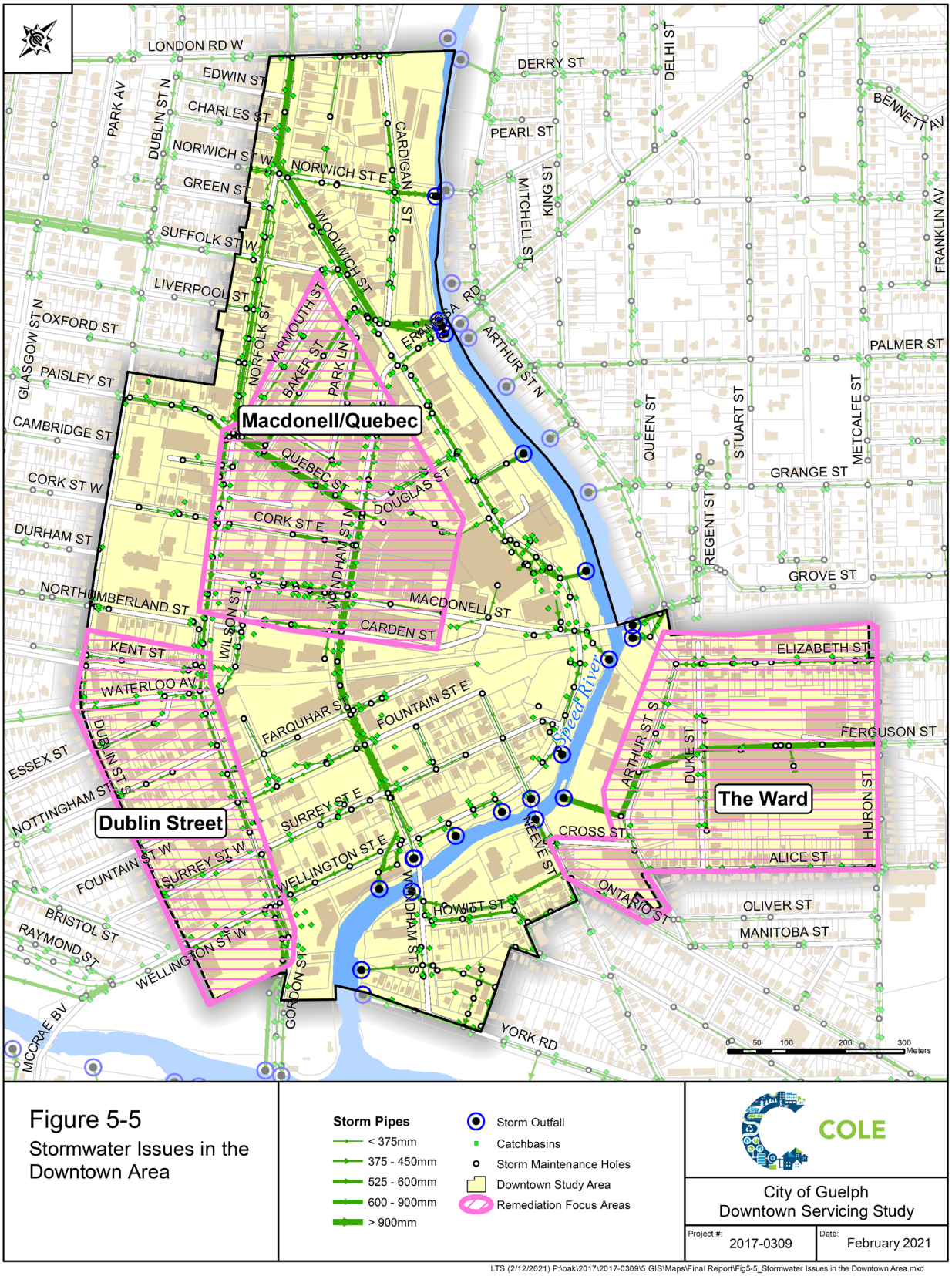


Figure 5-5
Stormwater Issues in the Downtown Area

**Storm Pipes**
- < 375mm
- 375 - 450mm
- 525 - 600mm
- 600 - 900mm
- > 900mm

- Storm Outfall
- Catchbasins
- Storm Maintenance Holes
- Downtown Study Area
- Remediation Focus Areas

City of Guelph
Downtown Servicing Study

Project #: 2017-0309
Date: February 2021

LTS (2/12/2021) P:\oak\2017\2017-0309\5 GIS\Maps\Final Report\Fig5-5_Stormwater Issues in the Downtown Area.mxd

**Figure 5-5 Stormwater Issues in the Downtown Area**

# 6 Downtown Servicing Alternatives

Through the assessment of water, wastewater and stormwater services under existing and future growth conditions, it is evident system improvements are required to support growth and provide a suitable level of service. The following section looks at water, wastewater and stormwater servicing alternatives to meet the servicing needs related to growth and ensure municipal services are in place when redevelopment occurs. The recommendations are based on performance needs and do not take into consideration infrastructure condition. Overall, the condition of most water and sewer infrastructure in the downtown area is fair to poor.

## 6.1 Overview

In developing servicing alternatives for all systems current City and Ministry Guidelines for water, wastewater and stormwater systems were used. Initially, alternatives were developed to meet servicing needs by upsizing existing infrastructure as a majority of capacity issues are related to undersized system for both existing and projected growth in the downtown area. As growth occurs it provides the opportunity to upgrade the level of service to todays' standards and provide resilience through asset renewal.

The following sections present water, wastewater and stormwater system improvements highlighting alternatives where one may exist. In most cases for water and wastewater systems, there is only a single alternative involving system upgrades to consider. For stormwater servicing alternatives, it is a more involved process when considering alternatives as original storm systems were not designed using current stormwater practices (i.e. dual drainage) and it is a retrofit situation.

The development of servicing alternatives were based first on 2031 planning conditions and system deficiencies observed in the water, wastewater, and stormwater systems. With the 2031 improvement identified for each system, the staging is based on the incremental needs associated with development timing in the downtown area.

## 6.2 Water Projects

Water servicing alternatives were developed to address downtown areas that did not meet criteria when future demands were applied to the existing infrastructure. Areas of high head loss and low fire flow were the main concerns, while pressures were not greatly impacted. The prevalence of small diameter, old, cast iron watermains in the Downtown core is the main cause of high head loss and low flows, therefore several linear pipe upgrades were proposed to improve servicing for future developments to 2031. Other projects were proposed to replace old cast iron watermains with 200mm pipes for servicing existing commercial land use and future developments. In total there are 7 of 20 projects that are based on existing system resilience and growth needs, while the balance of projects is driven by growth alone.

The goal of the proposed upgrades was also to improve overall connectivity by creating strong looping around and throughout the downtown area by connecting sections of existing 300mm watermain. These projects were planned in consideration of future feedermain infrastructure scheduled as part of the 2013 DC Background Study and Zone 1 Infrastructure Study.

**Figure 6-1** shows the proposed water projects. **Figure 6-2** and **Figure 6-3** show the existing and proposed watermain diameters in the downtown area, respectively, to display the enhanced connectivity and looping. A summary of the project phasing, costing, and rational are described in **Section 6.2.4** and included in a summary table. Detailed project sheets for each location are provided in the **Appendix F**. The following sections describe the impact of the proposed projects on the hydraulic performance of the water distribution system.

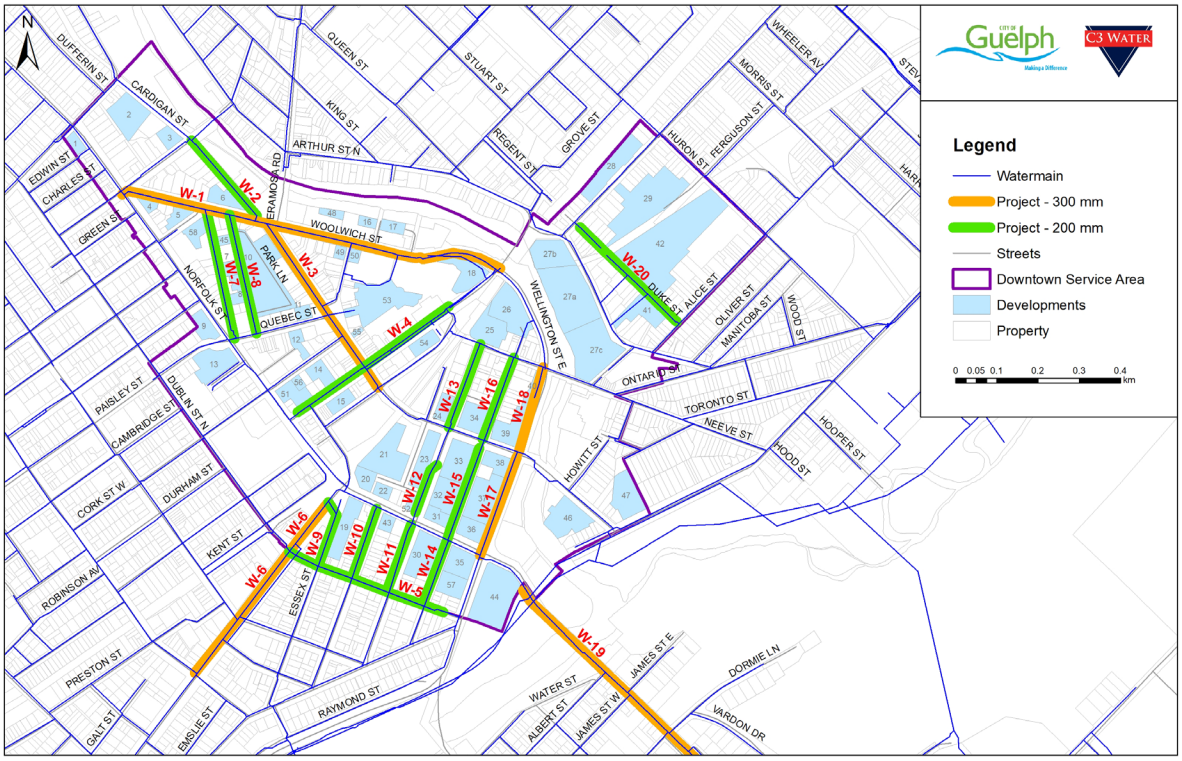


**Figure 6-1 Proposed Water Project Locations 2031**

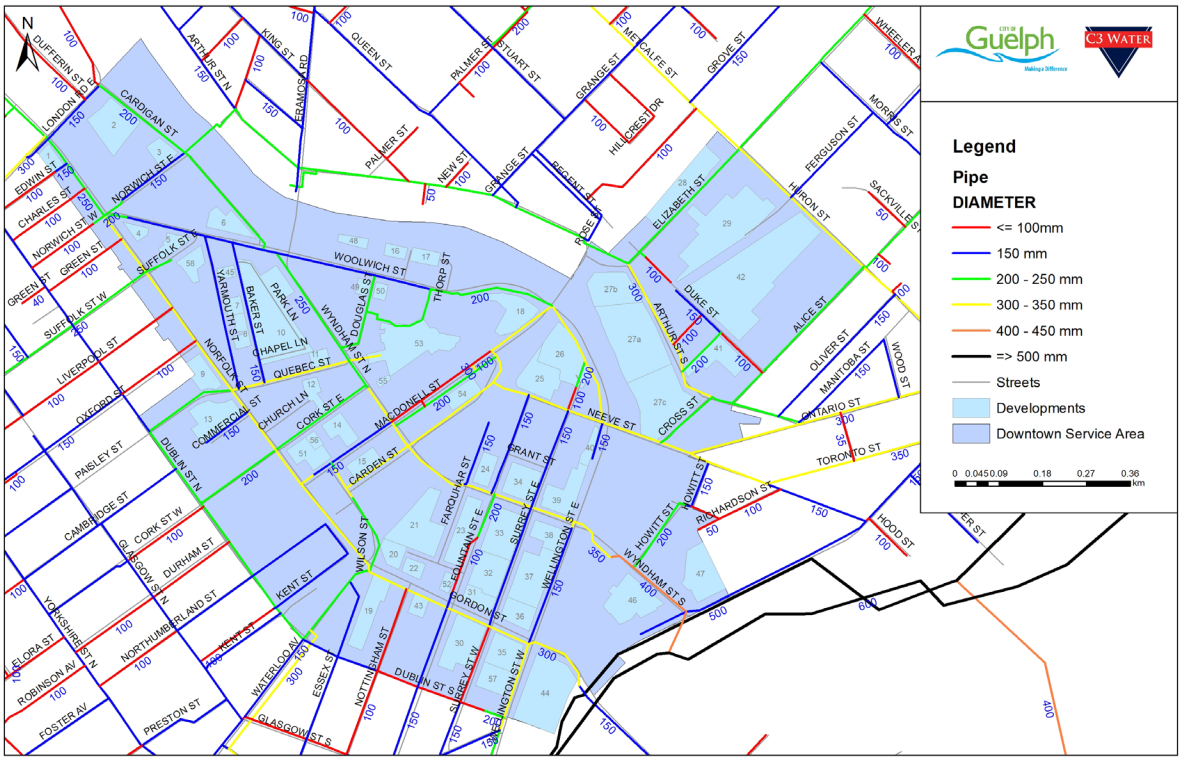


**Figure 6-2 Existing Watermain Diameters – 2018**

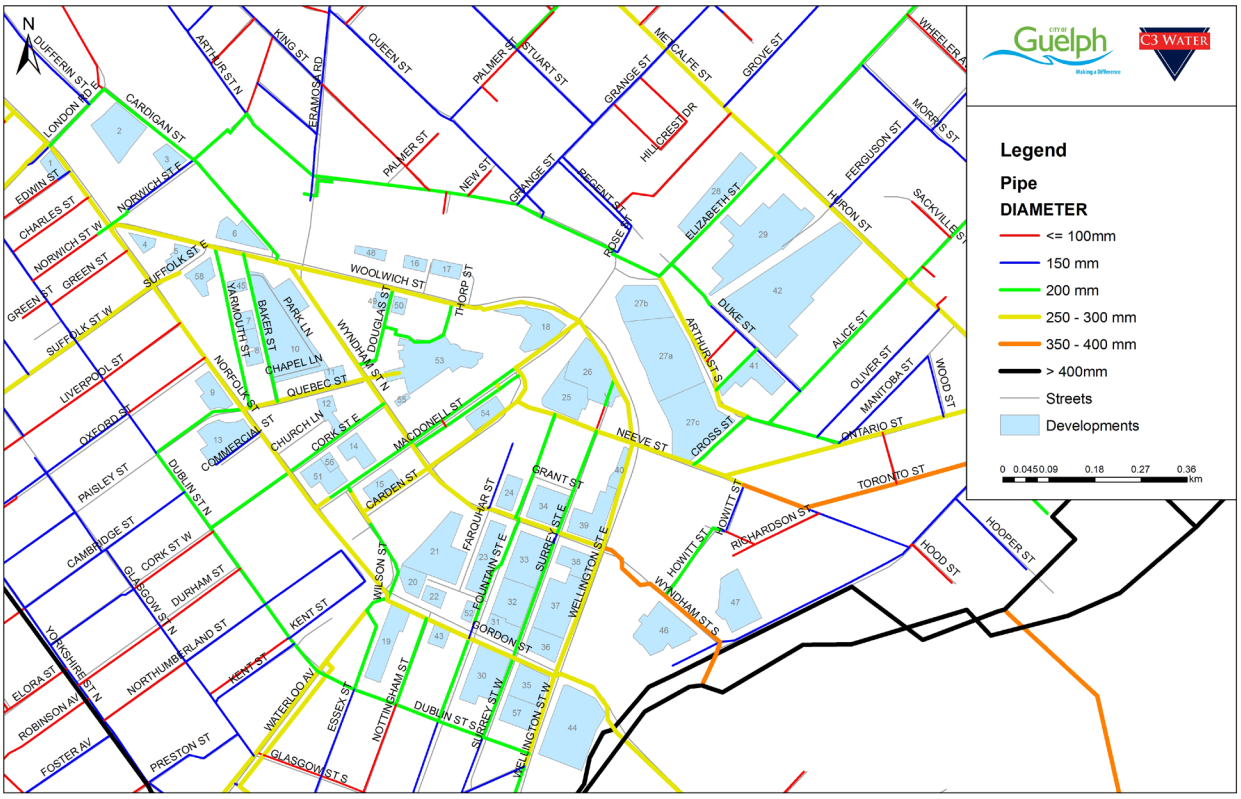


**Figure 6-3 Watermain Diameters with Proposed Projects - 2031**

### 6.2.1 Hydraulic Assessment – Proposed Project Conditions

Proposed projects were developed to address deficiencies in existing infrastructure observed in the baseline scenario and when 2031 demands were applied in the DSP area. Proposed projects were then added to the 2031 scenario model to test if proposed watermain upgrades allowed the system to meet criteria under future conditions. The following results show the expected pressure, head loss, and fire flows with upgraded watermains.

#### 6.2.1.1 Pressure

**Figure 6-4** presents minimum pressures under PHD for 2031 MDD conditions and **Figure 6-5** presents maximum pressures under ADD 2031 MDD conditions. The pressure results did not change significantly from the baseline conditions. Minimum and maximum pressures were still found to be within the City's criteria with the addition of proposed projects to the DSP area. Pressures do not exceed 100 psi, at which point a

#### 6.2.1.2 Head Loss

**Figure 6-6** presents head losses across pipe sections under PHD for 2031 MDD conditions. The proposed water distribution system upgrades are expected to mitigate baseline head loss concerns. Existing small, old, cast iron watermains were addressed as well as a strong loop of 300mm connections through the centre of the DSP area and around the core. All new commercial developments are proposed to have 200mm watermains.

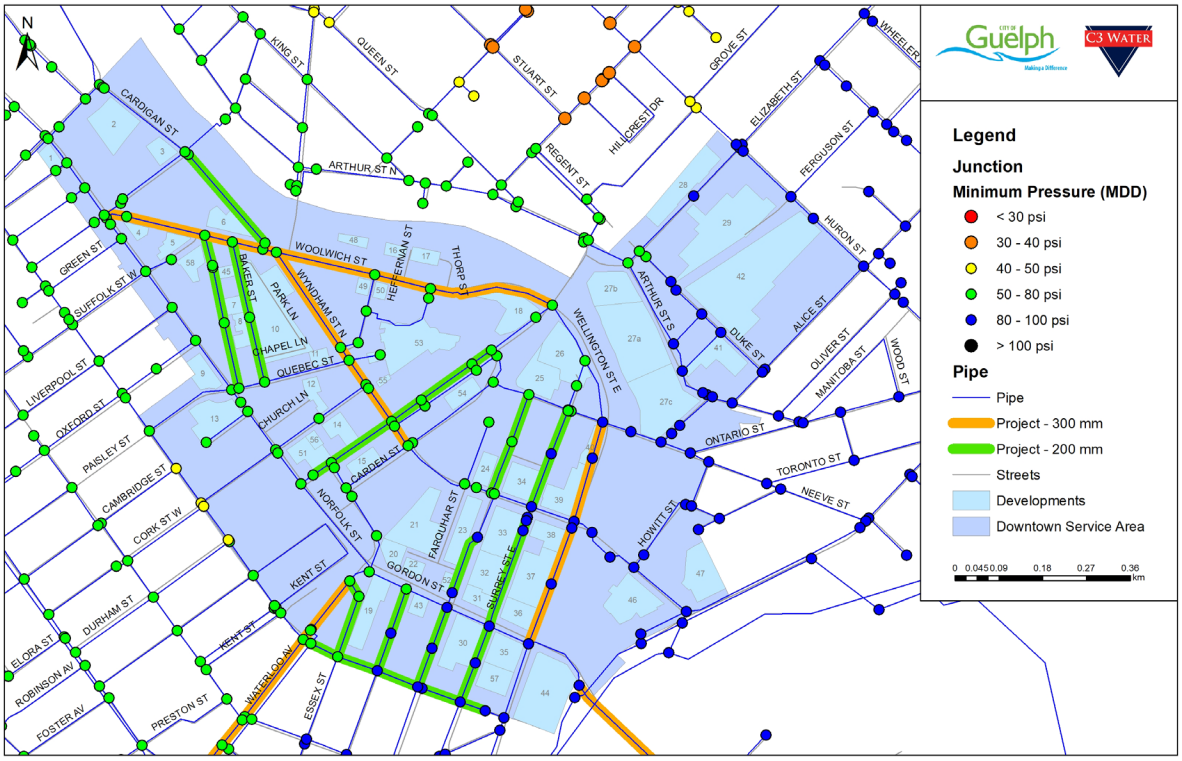


**Figure 6-4 Proposed Minimum Pressure Conditions - MDD 2031**

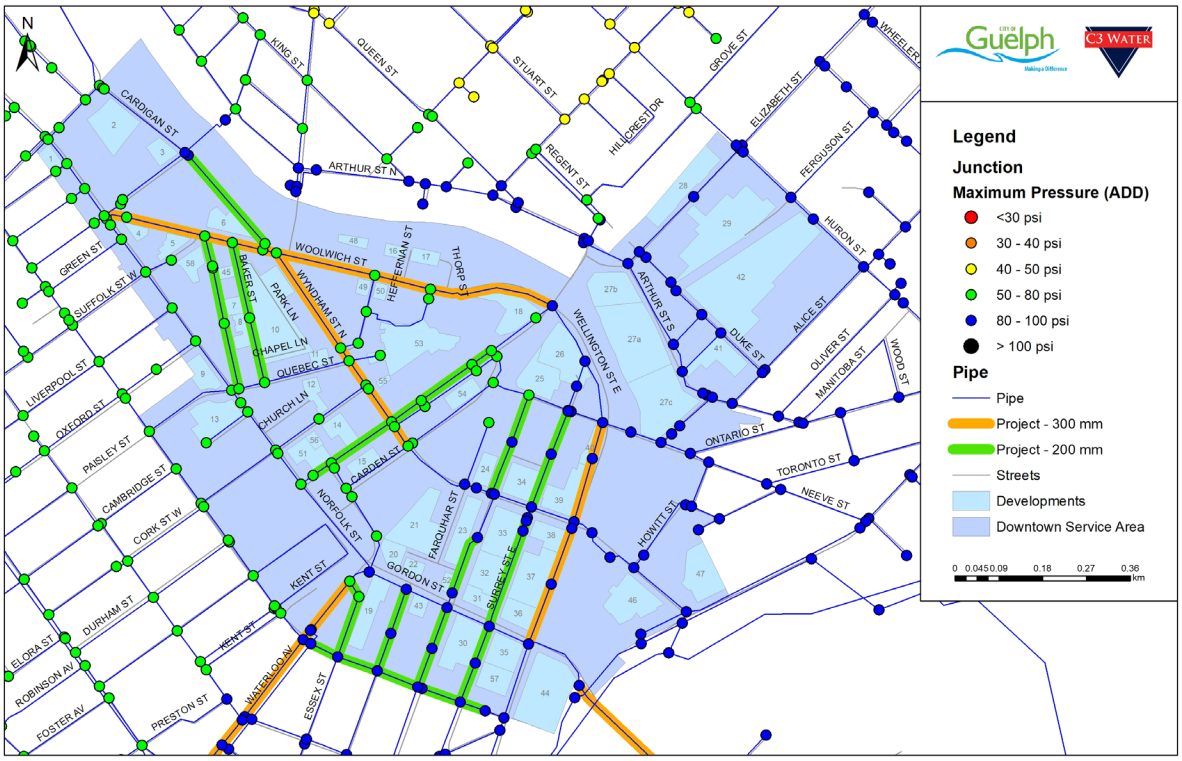


**Figure 6-5 Proposed Maximum Pressure Conditions - ADD 2031**

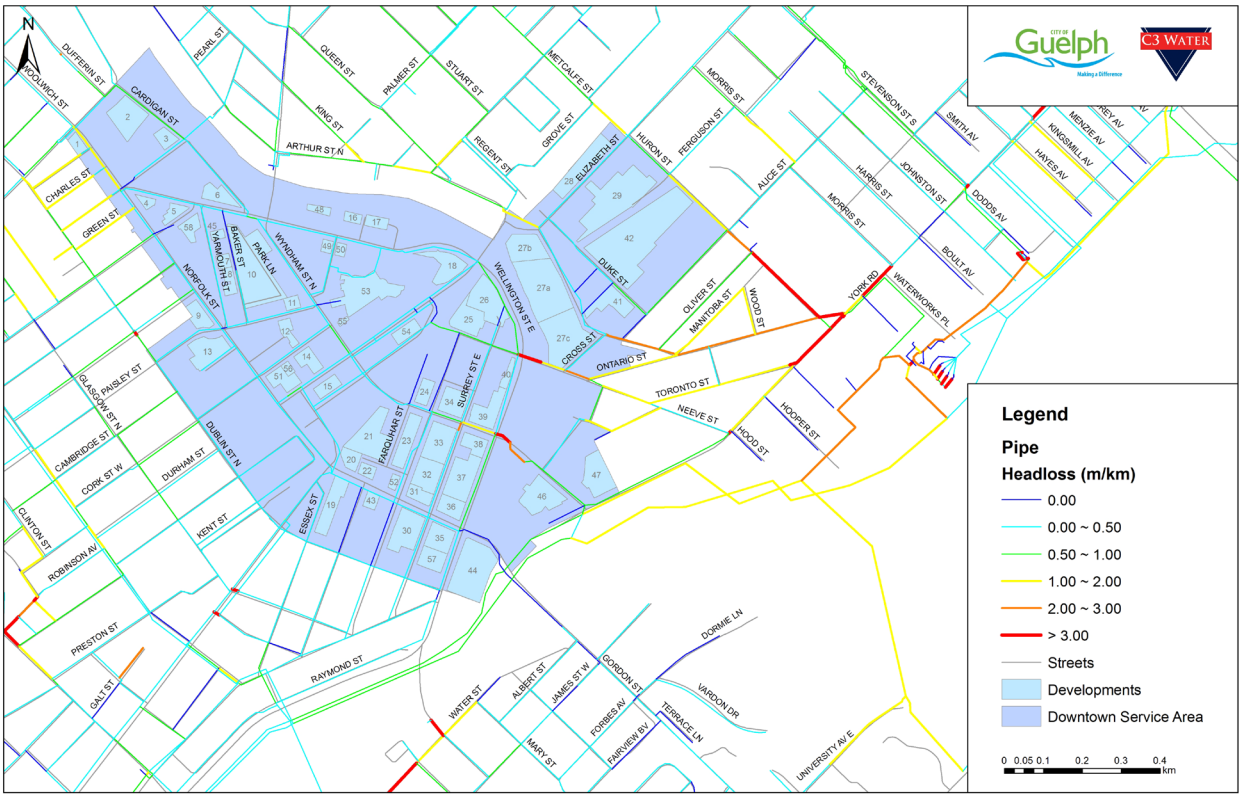


**Figure 6-6 Proposed Head Loss Conditions - MDD 2031**

### 6.2.1.3 Available Fire Flow

**Figure 6-7** presents the available fire flows under 2031 conditions. Fire flows are expected to improve from baseline conditions, with all locations having 200L/s or greater, excluding dead-ends.

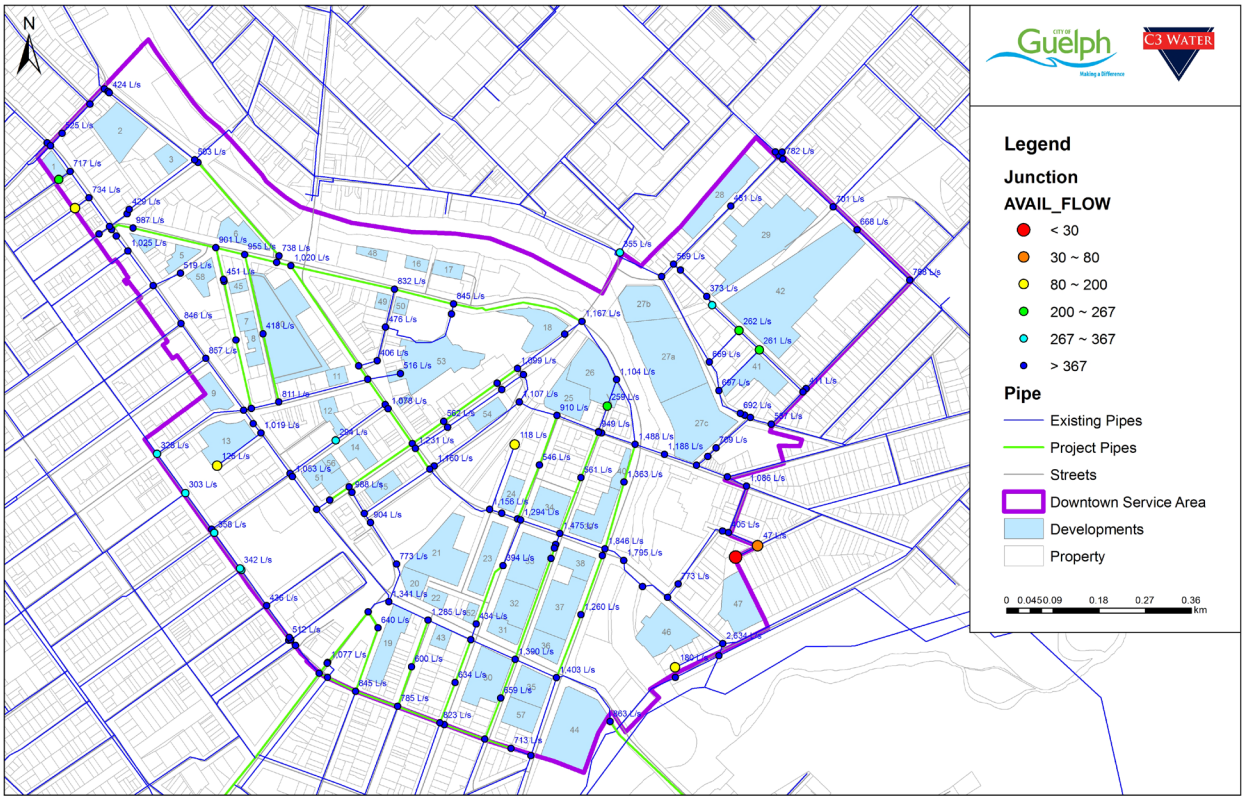


**Figure 6-7 Proposed Fire Flow Conditions - MDD 2031**

### 6.2.2 Downtown Water Supply Resilience

Since the DSP area is bordered by the Speed River and Eramosa River, there are limited watermain crossing that connect downtown to the Woods WTP. There are two existing connections from the DSP area to the 600mm trunk main from F.M. Woods; one via Neeve Street and Ontario Street, and the other on Wyndham Street South. The 300mm watermain on Gordon Street does not currently connect to the 600mm watermain where they meet between Water St and Wellington St. Up-sizing this connection through project W-19 is proposed to improve water flow across the Speed River and to add redundancy. It is recommended that connecting W-19 to the Wellington Road feedermains should be investigated. This connection would further enhance the watermain supply capacity to the DSP, although it is understood that this connection may not be feasible. Additional capacity into the DSP area is also anticipated through proposed master plan feedermains along Yorkshire Street North and Holiday Street (W-I-18, 2023) and Eramosa Road (W-I-18, post-2031). The timing and sections of these projects reflect the Zone 1 Infrastructure Implementation Plan (2018).

### 6.2.3 Water Improvements Summary

The water system improvements first and foremost address existing and 2031 deficiencies. In doing so the improved overall connectivity and system resilience. As well, the water system upgrades are replacing old, small diameter cast iron mains providing more capacity and asset renewal. Furthermore, the proposed improvements consider long term feedermain improvements to serve the area.

### 6.2.4 Water Opinion of Probable Cost and Phasing

The timing of proposed pipe upgrades was aligned with the phasing of adjacent developments. Opinion of probable cost (OPC) were developed based on watermain construction costs prepared by COLE/C3W using tender values from the Greater Toronto Area (GTA) and approved by the City of Guelph. Unit costs for watermains, valves, services and hydrants were applied based on length and diameter. The unit costs were classified as being either independent or in conjunction with road programs to account for the added cost of road removals and restoration efforts. Where water projects overlapped with wastewater projects, unit costs for watermains upgrade in conjunction with road programs were applied so that road works were not double counted. Estimating percentages were applied to account for contingency (25%), engineering (15%) and other general items (5%). **Table 6-1** summarizes the project details and OPCs for all water servicing alternatives.

**Table 6.1 Water Summary of OPCs**

| Project | Phase | Length (m) | Size (mm) | Length of Directional Drilling (m) | Overlap | Trigger | Rational | Areas of Concern Addressed | *Unit Cost ($/m) | Total OPC (incl. valves, hydrants, services, estimating %) |
|---|---|---|---|---|---|---|---|---|---|---|
| W-1 | 2018 | 950 | 300 | | SAN-1 | Growth / Non-Growth | System Resilience | HL-1, HL-4 | $921 | $875,000 |
| W-2 | 2023 | 260 | 200 | | | Growth | Servicing | HL-1 | $1,123 | $292,000 |
| W-3-N | 2018 | 245 | 300 | | ST-1 | Growth / Non-Growth | System Resilience | | $1,343 | $329,000 |
| W-3-S | 2018 | 245 | 300 | | SAN-2 ST-2, ST-3 | Growth / Non-Growth | System Resilience | | $1,020 | $250,000 |
| W-4 | 2023 | 450 | 200 | | ST-4 | Growth | Servicing | HL-2, HL-7 | $1,213 | $546,000 |
| W-5 | 2028 | 450 | 200 | | ST-13 | Growth | Servicing | | $889 | $400,000 |
| W-6 | 2023 | 530 | 300 | | | Growth / Non-Growth | System Resilience | HL-8 | $1,232 | $653,000 |
| W-7 | 2023 | 330 | 200 | | ST-6 | Growth | Servicing | FF-1 | $903 | $298,000 |
| W-8 | 2018 | 300 | 200 | | | Growth | Servicing | HL-6, FF-1 | $1,103 | $331,000 |
| W-9 | 2023 | 170 | 200 | | | Growth | Servicing | | $1,129 | $192,000 |

**Table 6.1 Water Summary of OPCs**

| Project | Phase | Length (m) | Size (mm) | Length of Directional Drilling (m) | Overlap | Trigger | Rational | Areas of Concern Addressed | *Unit Cost ($/m) | Total OPC (incl. valves, hydrants, services, estimating %) |
|---|---|---|---|---|---|---|---|---|---|---|
| W-10 | 2028 | 180 | 200 | | | Growth | Servicing | FF-5 | $1,117 | $201,000 |
| W-11 | 2018 | 180 | 200 | | | Growth | Servicing | | $1,117 | $201,000 |
| W-12 | 2018 | 165 | 200 | | | Growth | Servicing | HL-5 | $1,133 | $187,000 |
| W-13 | 2023 | 220 | 200 | | | Growth | Servicing | | $1,155 | $254,000 |
| W-14 | 2018 | 181 | 200 | | | Growth | Servicing | FF-5 | $1,122 | $203,000 |
| W-15 | 2023 | 250 | 200 | | | Growth | Servicing | | $1,128 | $282,000 |
| W-16 | 2023 | 275 | 200 | | | Growth | Servicing | | $1,116 | $307,000 |
| W-17 | 2018 | 260 | 300 | | | Growth / Non-Growth | System Resilience | HL-7, HL-9 | $1,235 | $321,000 |
| W-18 | 2023 | 220 | 300 | | | Growth / Non-Growth | System Resilience | HL-7, FF-3 | $1,273 | $280,000 |
| W-19 | 2023 | 770 | 300 | 200 | | Growth / Non-Growth | System Resilience | HL-3, HL-8 | $1,781 | $1,371,000 |
| W-20 | 2023 | 325 | 200 | 20 | ST-9 | Growth | Servicing | FF-2 | $1,040 | $338,000 |
| **TOTAL** | | | | | | | | | | **$8,111,000** |

*The unit costs are based on open cut construction.

## 6.3 Wastewater Projects

With the planned development to 2031 there are no system improvements required under dry weather flow conditions, which include the existing dry weather flow plus peak design flow associated with development. However, improvements are required because of existing wet weather flow related to RDII to reduce the risk of system surcharge and flooding, which is aggravated by growth. Currently, the sources of RDII that drives the peak wet weather response is unknown in the downtown area. As such, wastewater system improvements do not take into consideration RDII reduction that may be possible through an inflow/infiltration (I/I) Program. The City is committed to undertaking an I/I Program and the outcome could change the recommended improvement or defer the need for improvement to a later date. As well, it is expected RDII flows will reduce as parcels are redeveloped and site servicing is updated and storm flows from potential sources such as roof drains or foundation drains may be removed from the wastewater system no longer contributing to wet weather flows. As the City completes their I/I Program, the recommended improvements can be revisited in light of the results.

The following wastewater system improvements are sized to eliminate surcharge in the wastewater under a 25-year design storm event for the 2031 growth scenario. **Figure 6-8** shows the proposed wastewater system improvements. In total, there are four improvement projects identified. A summary of the project phasing, costing, and rational is provided **Section 6.3.6** and included in a final summary table. Detailed project sheets for each location are provided in **Appendix F**.

### 6.3.1 San-01 – Woolwich Street

This improvement to existing wastewater services is a replacement of an existing sanitary sewer with a larger pipe. The pipe replacement starts at McTague Street on Woolwich Street and runs south Thorp Street. The improvement is approximately 1,030m of 300mm pipe. The improvement is identified as an existing hydraulic constraint and required after 2022. The pipe upgrade will meet 2031 capacity requirements under peak dry weather conditions and the 25-year design storm event.

### 6.3.2 San-02 – Quebec Street/Wyndham Street

This improvement to existing wastewater services is a replacement of an existing sanitary sewer with a larger pipe. The pipe replacement starts at Norfolk Street and extends along Quebec Street to Wyndham Street, then turning south on Wyndham Street to just south of Carden Street. The improvement is approximately 495m of 300/375mm pipe. The improvement is identified as an existing hydraulic constraint and required after 2022. The pipe upgrade will meet 2031 capacity requirements under peak dry weather conditions and the 25-year design storm event.

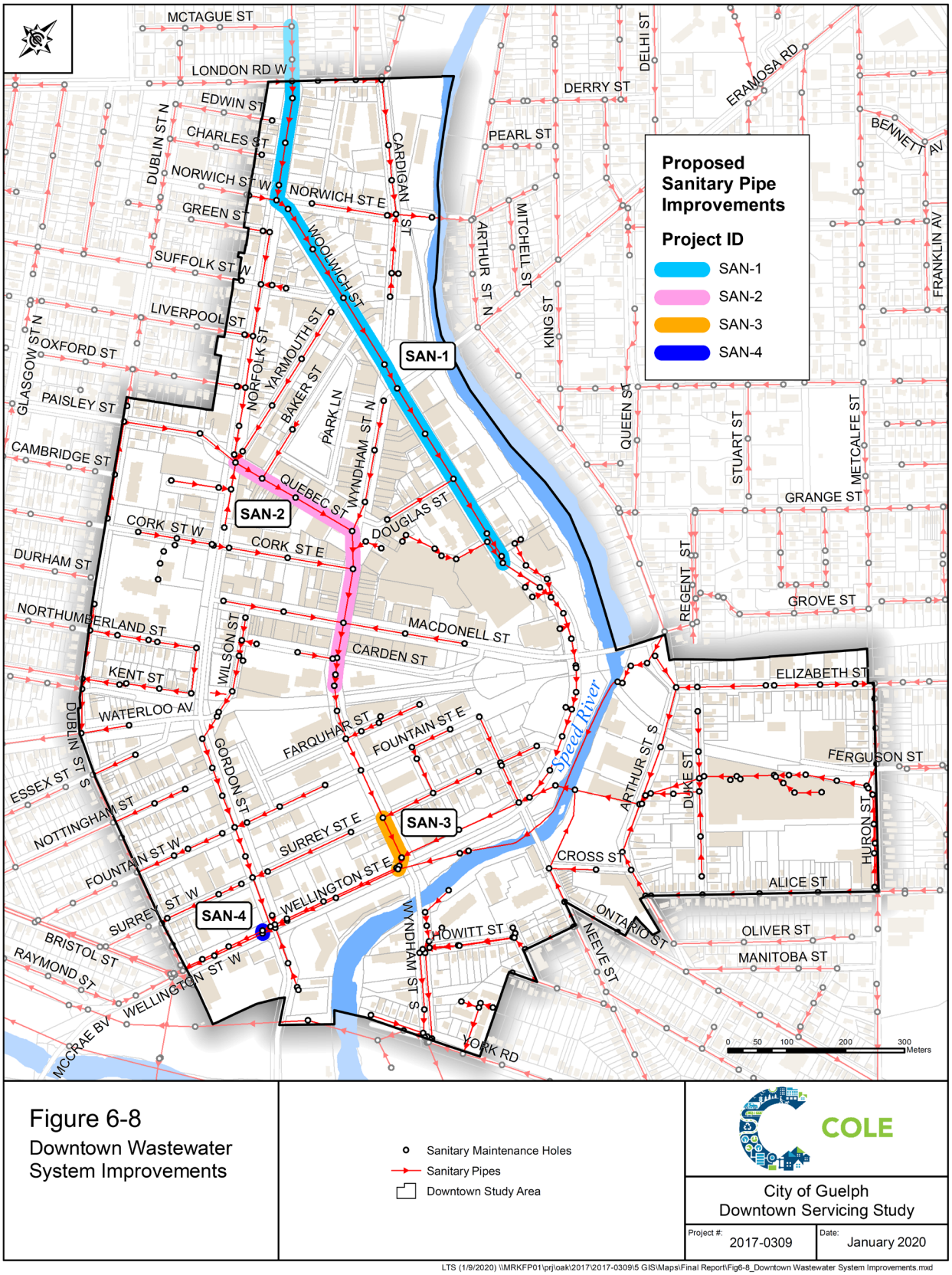


Figure 6-8
Downtown Wastewater System Improvements

Sanitary Maintenance Holes
Sanitary Pipes
Downtown Study Area

City of Guelph
Downtown Servicing Study

Project #: 2017-0309
Date: January 2020

LTS (1/9/2020) \\MRKFP01\prj\oak\2017\2017-0309\5 GIS\Maps\Final Report\Fig6-8_Downtown Wastewater System Improvements.mxd

**Figure 6-8 Downtown Wastewater System Improvements**

### 6.3.3 San-03 – Wyndham Street South

This improvement to existing wastewater services is a replacement of an existing sanitary sewer with a larger pipe. The pipe replacement starts at Surrey Street East and extends south on Wyndham Street approximately 75m to Wellington Street East to the south side sewer (currently, the existing sanitary pipe is connected to the north side sewer). The upgraded pipe is 450mm. The improvement is identified as an existing hydraulic constraint and required after 2022. The pipe upgrade will meet 2031 capacity requirements under peak dry weather conditions and the 25-year design storm event.

### 6.3.4 San-04 – Gordon Street

This improvement to existing wastewater services interconnects two wastewater systems on Wellington Street West at Gordon Street. The interconnection is between two sanitary sewers (300mm and 600mm). The 600mm sanitary pipe has capacity available and a 300mm interconnection will allow flows to be better distributed in the existing system. The need for this improvement is required by 2023. The interconnection will meet 2031 capacity requirements under peak dry weather conditions and the 25-year design storm event.

### 6.3.5 Wastewater Improvements Summary

**Figure 6-9** shows the hydraulic performance for 2031 conditions with improvements under a 25-year wet weather condition. The four recommended projects provide capacity to meet future servicing needs. **Appendix G** shows HGL profiles in the affected areas for the existing system for baseline and 2031 scenarios as well as 2031 with improvement all for the 25-year design storm. There still remains some maintenance holes that have a water elevation within 1.8m of the ground surface. These maintenance holes are connected to sanitary sewer that are not surcharge, therefore are shallow, not surcharged.

The proposed wastewater improvements are largely related to existing hydraulic issues and are not driven by new wastewater flows related to growth in the downtown area. Given this condition, and in reviewing the HGL profiles, it is arguable that the improvements are not critical and could be deferred or coordinated with other area improvements (water, stormwater and/or transportation).

### 6.3.6 Wastewater Opinion of Probable Cost and Phasing

An Opinion of Probable Cost (OPC) were developed based on sanitary pipe construction costs prepared by COLE using tender values from the Greater Toronto Area (GTA) and approved by the City of Guelph. Unit costs for sanitary sewers, maintenance hole, and services were applied based on length, depth and diameter. The unit costs were classified as being either independent or in conjunction with road programs to account for the added cost of road removals and restoration efforts. If there is another system improvement (water) along the same road segment, the unit cost for the water or stormwater project would be reduced to be in conjunction with a road program to avoid duplication of costs. Estimating percentages were applied to account for contingency (25%), engineering (15%) and other general items (5%). **Table 6.2** summarizes the project details and OPCs for all wastewater servicing alternatives.

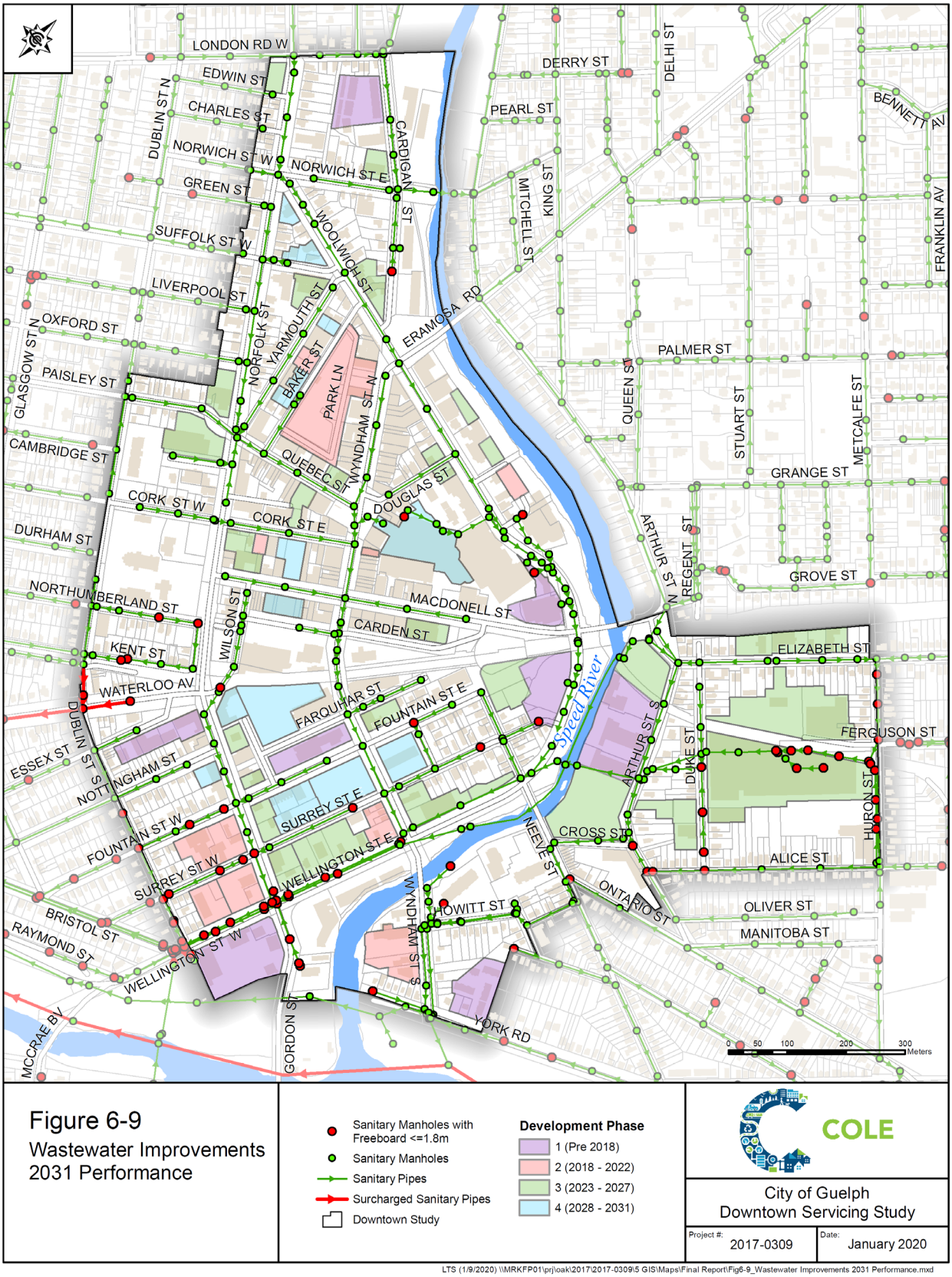


Figure 6-9
Wastewater Improvements
2031 Performance

Sanitary Manholes with Freeboard <=1.8m
Sanitary Manholes
Sanitary Pipes
Surcharged Sanitary Pipes
Downtown Study

**Development Phase**
1 (Pre 2018)
2 (2018 - 2022)
3 (2023 - 2027)
4 (2028 - 2031)

COLE
City of Guelph
Downtown Servicing Study
Project #: 2017-0309
Date: January 2020

LTS (1/9/2020) \\MRKFP01\prj\oak\2017\2017-0309\5 GIS\Maps\Final Report\Fig6-9_Wastewater Improvements 2031 Performance.mxd

**Figure 6-9 Wastewater Improvements 2031 Performance (25-Year)**

**Table 6.2 Wastewater Summary of OPCs**

| Project | Phase | Length (m) | Size (mm) | Average Depth (m) | Overlap | Trigger | Rational | *Unit Cost ($/m) | Wastewater Cost |
|---|---|---|---|---|---|---|---|---|---|
| SAN-1 | 2023 | 1028 | 300 | 3.2 | W-1 | Non-Growth | Existing wet-weather issue | $1,354 | $1,392,000 |
| SAN-2 | 2023 | 496 | 375 | 4.6 | ST-2, ST-3, ST-4 | Both | Existing wet-weather issue, aggravated by development | $1,750 | $868,000 |
| SAN-3 | 2023 | 96 | 450 | 2.6 | | Non-Growth | Existing wet-weather issue | $1,677 | $161,000 |
| SAN-4 | 2023 | 5 | 300 | 1.8 | | Growth | Servicing | $3,200 | $16,000 |
| **TOTAL** | | | | | | | | | **$2,437,000** |

*The unit costs are based on open cut construction.

## 6.4 Stormwater Projects and Criteria

The storm services in the downtown area were never designed using current standards and therefore should not be expected to meet current stormwater guidelines. However, through redevelopment the post-redevelopment flows must not worsen pre-redevelopment conditions and if possible, improve quantity control and look at opportunities to introduce quality control where feasible.

Stormwater system improvements are not characterized in the same way as wastewater or water systems. For stormwater systems quantity and quality are taken into consideration in the design of new services. In the context of the downtown area, the development of stormwater system improvements starts with the 2012 Stormwater Master Plan.

The development of alternatives involved reviewing projects recommended in the Master Plan and in reviewing the updated performance assessment of storm systems in the downtown area (Section 5.0). In considering alternatives the following objectives were used:

- Mitigate surcharge and flooding conditions in the minor system during the 5-year storm event and,
- Alleviate the depth of flooding during the 100-year storm event.

Furthermore, opportunities in the downtown area to incorporate Low Impact Development and water quality controls are investigated.

Finally, local stormwater criteria or controls are discussed in combination with system improvements recognizing it is generally difficult to effectively retrofit/implement traditional stormwater management techniques for quantity and/or quality control as part of infill/intensification involving individual land parcels in an established downtown area.

### 6.4.1 Stormwater Infrastructure Improvements

Infrastructure improvements are proposed to mitigate surcharge and flooding conditions in the minor system during the 5-year storm event, as well as to manage the maximum hydraulic grade line and overland flow depth during the 100-year storm event. From the PCSWMM assessment of the existing system hydraulic issues were identified in three areas of Downtown:

- Dublin Street, Wellington Street West and Gordon Street/Waterloo Avenue.
- Quebec Street, Macdonell Street and Yarmouth Street.
- The Ward (Elizabeth Street, Arthur Street and Ontario Street).

The 2012 Master Plan identified a short list of alternatives to alleviate minor system flooding where increasing the affected storm pipe size was generally considered the simplest and most cost effective solution. This approach combined with looking at opportunities to divert flow to under-utilized systems (minor or major) was used to identify the following improvements in the existing storm system to mitigate surcharge and flooding conditions during the 5- and 100-year storm events while managing overland flow depths in the three areas of concern.

**Figure 6-10** shows proposed storms system alternatives for the downtown area that are discussed below.

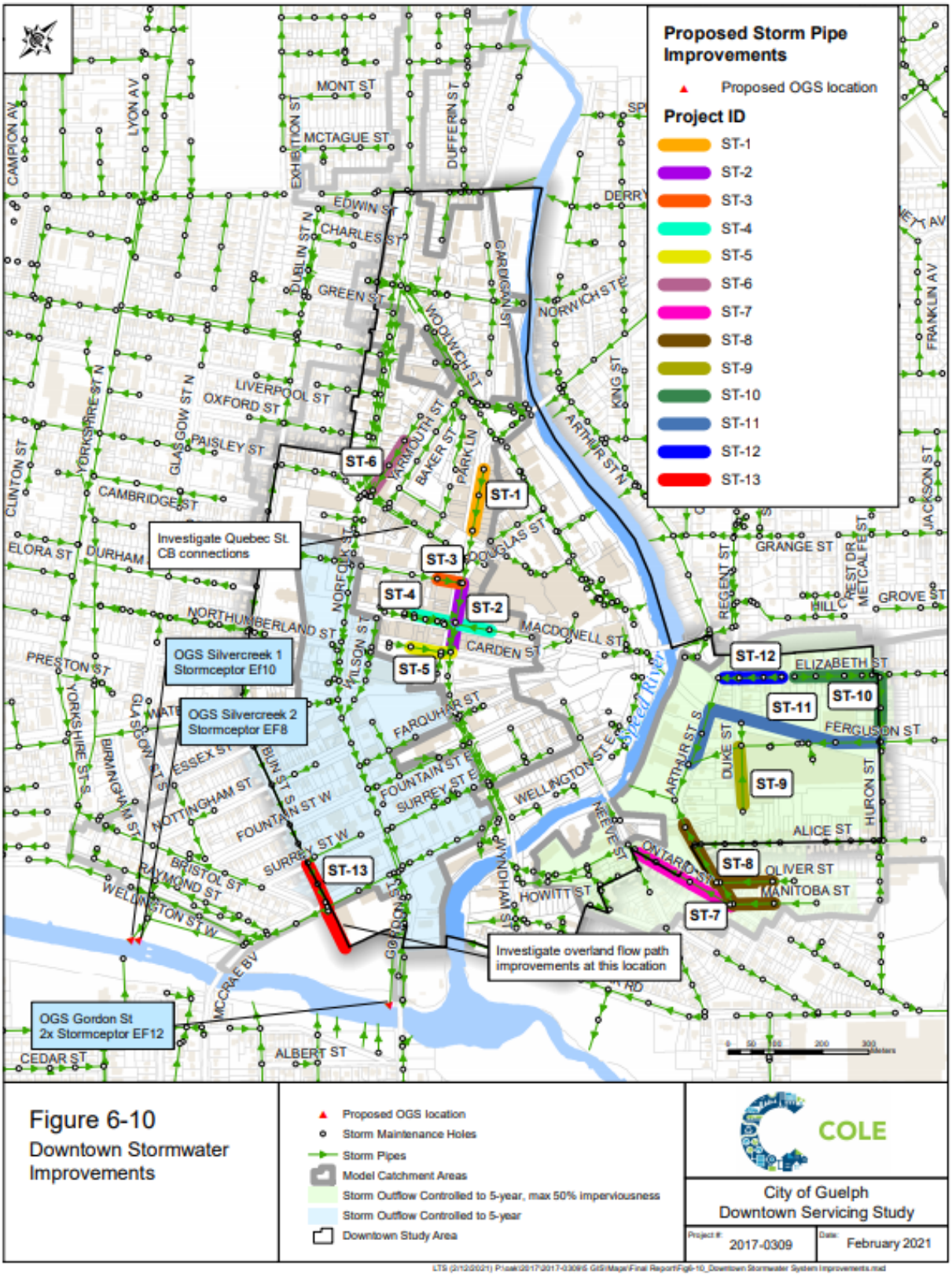


**Figure 6-10 Downtown Stormwater Improvements**

#### 6.4.1.1 Dublin Street / Gordon Street

The City recently improved the storm drainage system in this area, in particular along Wellington Street West. Further improvements have been identified to reduce the level of surcharge under the 5-year storm event and promote positive overland flow. A storm sewer upgrade on Dublin Street, from Fountain Street West to south of Surrey Street West and north of Wellington Street West is recommended (137m of 750mm) to provide a 5-year level of service for the minor system. The upgraded storm sewer would connect to an improved storm system on Wellington Street West.

Under the 100-year storm event there is surface flooding at Dublin Street and Wellington Street West. To minimize surface flooding at this intersection a positive overland flow route through the adjacent park should be considered. Under extreme conditions, there does appear to be an opportunity for overland flow to enter the plaza driveway and spill into the park, but this is no formal overland flow path. A detailed topographic survey of the area may provide better information to establish an overland outlet.

The hydraulic issues shown in the model on Gordon Street at Waterloo Avenue are associated more with the physical system configuration and the shallowness of the system combined with a steeper pipe slope going into a shallower sloped pipe. Therefore, upgrading the local infrastructure will not greatly affect system performance. The best protection for the Gordon Street/Waterloo Avenue system is to overcontrol stormwater to a 5-year predevelopment conditions for major and minor flows. This control also benefits the downstream systems including Dublin Street. The recent Wellington Street West improvements combined with the 5-year control have a positive influence on the level of service in the area.

For the Dublin / Gordon area, the following is recommended:

- Investigate potential overland flow drainage at Dublin Street and Wellington Street West.
- Upgrade the local storm sewer on Dublin Street from Fountain Street to Wellington Street (ST-13: 137m of 750mm). This improvement is not considered critical as there is no planned development contributing to this storm sewer directly. For the purpose implementation this project should be coordinated with water system improvement or future road work. Prior to implementation it is recommended that the City undertake some flow monitoring in the Dublin Street storm sewer pipe to validate the modelling results and determine the need for the upgrade. As part of this work, the City should confirm local storm connections to the Dublin Street storm sewer to determine if the local properties are at risk of flooding if the pipe surcharges.
- To control the stormwater and minimize the risk of system surcharge, development in the area should be required to control stormwater discharge to the minor system to the 5-year pre-development condition in conjunction with the proposed improvements. A 5-year limit will reduce inflow to the minor system providing needed control for the Gordon Street/Waterloo Avenue area while reducing the inflow overall thereby freeing up capacity for Dublin Street flows.

#### 6.4.1.2 Quebec Street and Macdonell Street

Alternative 1: The Quebec Street / Macdonell Street area includes a number of local improvements that reduces the overland flow depth for the 100-year design storm to less than 300mm, eliminates surcharge under the 5-year event, and maintains a freeboard of greater than 1.8m under the 100-year event, improvements include:

- On Quebec Street, investigate catchbasin connections. There are two storm sewers on Quebec Street and the local catchbasins may not be distributing the flow evenly between the two pipes.
- Improve the storm sewer on Yarmouth Street (ST-6: 122m of 450mm) to improve hydraulic performance.
- Increased inlet capacity on Cork Street East (west of Wyndham Street North) will reduce overland flow depth to below 300mm for the 100-year condition. Introduction of additional inlet capacity requires the minor system to be upgraded to prevent surcharge during the 5-year storm event and control surcharging in the 100-year storm event (ST-3: 47m of 825mm).
- Increased inlet capacity on Macdonell Street (west and east of Wyndham Street North) will reduce overland flow depth to below 300mm for the 100-year condition. Introduction of additional inlet capacity will require the minor system to be upgraded to prevent surcharge during the 5-year storm event and control surcharging in the 100-year storm event (ST-4: 90m of 900mm; 80m of 525mm).
- On Carden Street, storm sewer improvements are required to control surcharging for the 100-year condition (ST-5: 86m of 825mm).
- With the additional inlet capacity to control surface flooding, and the local storm sewer improvements, the storm sewer on Wyndham Street North will need to be upgraded between Cork Street East and Carden Street (ST-2: 145m of 1350mm). Downstream of Carden Street the existing storm sewer has adequate capacity.
- Improvement to the storm sewer on Wyndham Street North (ST-1: 133m of 525mm) will increase the level of service to 100-year.

Alternative 2: This alternative does not include local improvements and is based on over controlling storm drainage in this area. Analysis was undertaken for various design storms from 5-year up to the 100-year storm (5-, 10-, 25-, 50- and 100-year). Both the minor and major system performance were assessed to determine that both systems operate well for up to the 25-year design storm. Therefore, limiting post-development peak runoff to the 25-year pre-development peak flow will not require system improvements.

For the Quebec Street and Macdonell Street area, the following is recommended:

- **Alternative 1** improvements are recommended. The local improvements will control the overland flow depth for the 5- through 100-year event, eliminate system surcharge for the 5-year event and provide a 100-year level of service for the minor system with a freeboard of greater than 1.8m.

- Given the timeline of development contributing to this system, it is recommended that improvements be considered for implementation between 2022 and 2027.
- **Alternative 2**, limiting post development flow to a 25-year pre-development level, can be considered as an interim measure if pipe improvements are deferred.

#### 6.4.1.3 The Ward (Elizabeth Street, Arthur Street and Ontario Street) (US01)

As shown in the Master Plan and confirmed in the baseline modelling, the storm services in this area are undersized and are generally less than a 2-year level of service. There have been recent improvements to storm service on Arthur Street South from Elizabeth Street to Cross Street and the outfall which provides much needed outlet capacity. Proposed works to improve the service level to at least a 5-year level of service, include:

- Upgrade the storm sewer on Manitoba Street, Oliver Street and Arthur Street South to Cross Street (ST-8: 52m of 600mm; 120m of 450mm; 54m of 375, and 142m of 525m).
- Upgrade the storm sewer on Ontario Street (ST-7: 98m of 375mm and 135m of 450mm).
- Upgrade the storm sewer on Elizabeth Street (E) (ST-10: 165m of 375; 20m of 450m) and Huron Street (138m of 675m).
- Upgrade the storm sewer on Elizabeth Street (W) (ST-12: 123m of 375mm).
- Upgrading the storm sewer on Duke Street (ST-9: 140m of 600mm).

Beyond these local upgrades, storm servicing in this area is challenging given the current alignment of the main storm pipe through two large parcels which also passes under the railway line. In developing servicing alternatives to address 5-year storm event hydraulic issues, two alternatives were considered:

Alternative 1: Maintaining the existing pipe storm drainage system will require the two parcels adjacent to the main storm sewer to control the peak runoff rate to the 2-year peak flow. Upgrading the existing pipe through the two parcels, under the rail line and then from Duke Street to Arthur Street South is not feasible. For Alternative 1, onsite stormwater storage would be required as part of site redevelopment. The amount of storage required for both sites would be on the order of 3,500$m^3$ based on controlling the site to 2-year pre-development level. This alternative requires post development flows be controlled to the 2-year pre-development level based on 50% impervious.

Alternative 2: Realign services through the two parcels. For the northern parcel (Elizabeth Street) a new storm sewer would be taken down to Arthur Street South. A parallel storm sewer on Arthur Street South would be needed until it intercepts the existing storm sewer that runs from Duke Street to Arthur Street South (ST11- 493m of 1200mm). At this point the new storm sewer would connect into the previously upgraded Arthur Street South sewer. It should be noted that Arthur Street was recently reconstructed, and this may make this alternative difficult to implement. For the parcel south of the rail line, the stormwater would discharge into the existing storm sewer on Duke Street as it does now. The existing pipe would be virtually empty because of the new storm sewer on the north side of the railway. This alternative improves the level of

service to 5-year and will require post development flows to be controlled to the 5-year pre-development level based on 50% impervious.

With either alternative, the stormwater servicing will be driven by the development and timing.

For The Ward area, the following is recommended:

- Implement the local improvements on Ontario Street, Manitoba Street, Oliver Street, Arthur Street S, Elizabeth Street and Huron Street to improve the basic level of service to 5-year.
- Alternative 2 is preferred over Alternative 1 as Alternative 2 provides the greatest flexibility for servicing the area and minimizes storage needs. Alternative 2 also provides a uniform level of service in the area.
- Given the uncertainty on redevelopment and timing, the preferred alternative should be determined when redevelopment is brought forward on either of the large parcels.
- Upstream storm flows contribute to existing issues. As such, more restrictive stormwater controls should be considered for the upstream area outside of the downtown area (i.e. the remainder of the Stormwater Master Plan US01 area, from Huron St. east to Stevenson St).

With the implementation of local improvements (projects ST-7, ST-8, ST-9, ST-10, ST-12) and Alternative 2 (ST-10), the level of service is 5-year.

Given the projected timeline of redevelopment in this area is between 2023-2027, improvements are not immediately required. Improvements on Ontario Street, Manitoba Street, Oliver Street, and Arthur Street are to improve the current level of service and are not driven by redevelopment.

### 6.4.2 Low Impact Development Opportunities

Low impact development (LID) opportunities were investigated. Infiltration is one type of LID that was considered in the downtown area. To assess infiltration opportunities, it is important to understand where infiltration is possible.

As the City of Guelph relies on groundwater as the primary source of drinking water, source water protection is paramount. **Figure 6-11** shows the downtown area is in a wellhead protection zone area with a vulnerability score of 10 given the proximity of the Water Street well to the area. Consequently, infiltration based LIDs are not recommended because of source water protection restrictions. However, non-infiltration LIDs, such as green roofs, rainwater harvesting may be viable in the downtown area and should be promoted as part of redevelopment.


**Figure 6-11 Downtown Area Wellhead Protection Zones**

To understand the influence of LID on the water balance and infrastructure upgrades various scenarios were modelled adjusting the amount of depression storage (15mm to 30mm) to replicate retention to assess the need for infrastructure upgrades. Applying 30mm of retention, as a reasonable maximum level, did not alter the need for infrastructure upgrades. In general, LIDs provide some benefit for 2-year events, but have limited if any benefit during larger events. Given the land use is highly impervious in the downtown area, it is not feasible to retain up to 30mm of stormwater on site without infiltration.

### 6.4.3 Stormwater Quality Opportunities

The City's expectation for new developments is an enhanced level of treatment in accordance with MECP where there is 80% removal of Total Suspended Solids (TSS). This expectation, in a Downtown retrofit situation will be difficult to achieve. In the downtown area, there are 23 outfalls into the Speed River varying in size.

There are only three (3) outfalls that have greenspace in and around their outfall, they include: Gordon Street in the Royal City Park; and two outfalls off Wellington Street West by Silver Creek Park. For quality control a wet pond facility would provide the enhanced level of treatment required. When considering wet pond facilities in the available greenspaces there are issues that prevent this type of control, namely:

- The facilities would be located in a floodplain area;
- The storm pipe elevations are not favourable for a pond facility; and
- Gaining public and stakeholder support in a mature park area for such facilities would be difficult.

For the above reasons, a stormwater wet pond is not feasible to implement for the downtown area outfalls.

To provide some level of water quality treatment it may be desirable to consider Oil-Grit-Separators (OGS). OGS units can be installed as part of redevelopment up in the local system on a site by site basis or as a more central end-of-pipe facility. The 2012 SWM Master Plan recommends a number of OGS units throughout the City. **Table 6.3** identifies three additional locations with estimated OGS unit sizes and costs based on treating the first 25mm of an event.

At the three identified outfalls, OGS units can be sized for more frequent events (i.e. less than 5-year), while for larger events flow would by-pass. The OGS facilities would be underground concrete units located in the greenspaces by the three outfalls. With respect to the Gordon Street outfall, consideration will need to be given to minimizing the impact on the park and mature trees. To advance such a retrofit facility will require going through the Environmental Assessment process working with Grand River Conservation Authority (GRCA) and other agencies.

**Table 6.3 OGS Sizing and Costs**

| Outfall | Drainage Area (ha) | C | I (mm/hr) | Q ($m^3/s$) | Unit Type / Footprint Area[2] | Cost ($)[3] |
|---|---|---|---|---|---|---|
| Gordon St | 15.8 | 0.679 | 35.10 | 105 | 2xEF12 (20$m^2$) | $195,850 |
| Silvercreek 1 | 11.9 | 0.364 | 21.55 | 26 | EF10 (8$m^2$) | $67,600 |
| Silvercreek 2 | 8.9 | 0.355 | 21.17 | 19 | EF8 (5$m^2$) | $45,550 |
| **TOTAL** | | | | | | **$309,000** |

**Notes:**

- Conceptual sizing assuming only the 25 mm 4-hour Chicago storm will be routed to OGS unit.
- Unit type based on Imbrium's Stormceptor® EF, approximate footprint area.
- Capital costs only, does not include design, construction or contingency.

As part of the Environmental Assessment process, preliminary stormwater retrofits would need to be reviewed and modified based on existing servicing conflicts as well as social considerations such as park lands, trail use and others. Through the 2012 Stormwater Master Plan process, input from GRCA indicated that stormwater retrofits could be located within GRCA's regulatory limits.

For other downtown area outfalls, where there is no opportunity for stormwater quality retrofits, the City should consider a cash-in-lieu of on-site stormwater quality management. Through such a funding program, monies can be collected to implement stormwater quality retrofit projects to provide quality control elsewhere.

Another stormwater quality aspect recommended is to require a Salt Management Plan as part of the site plan application process given the proximity of the downtown area to the Speed River.

### 6.4.4 Stormwater Quantity Opportunities

Given the retrofit conditions, there are no centralized opportunities to provide stormwater quantity control in the form of end-of- pipe type facilities.

In the 2012 Stormwater Master Plan an assessment of storage requirements was undertaken for the downtown area (US01, US02/07 and LS04) to approximate the storage needed to control peak flow to pre-development conditions. The assessment is based on assumptions on the amount of infill and intensification potential in each network area. The assumptions are documented in the 2012 Stormwater Master Plan and are assumed to be valid today in the downtown area considering the high level of imperviousness that currently exists. From this previous analysis for storm networks in the downtown area (US01, US02/07 and LS04) it was estimated that across the downtown area the average storage requirement is on the order of

160m$^3$/impervious ha, 245m$^3$/impervious ha, and 313m$^3$/impervious ha for the 5-, 25- and 100-year return period (Reference: 2012 Stormwater Management Master Plan, Table 5.19 and Table 5.20). Given the overall storage requirements there is no opportunity for central quantity facilities, therefore quantity controls will need to be evaluated at the site level.

### 6.4.5 Downtown Stormwater Criteria

As redevelopment progresses in the downtown area there is an opportunity to introduce stormwater management features and controls consistent with today's standards. The following section discusses the approach to stormwater quantity management, quality management, erosion control and water balance in the downtown area.

**Water Quantity:**

Water quantity control will be required at the site level as there is no identifiable opportunities for centralized water quantity controls in the downtown area.

Water quantity control will be based on post-development flows not exceeding existing pre-development flows for storm events from 2-year to the 100-year. This is consistent with the City Development Engineering Manual (January 2019).

For existing systems, the following peak flow criteria are recommended for quantity control in the existing downtown area:

- Stormwater discharge from new developments must improve downstream surcharge conditions, or at least maintain existing conditions;
- No surcharge during the 5-year design storm event;
- Maintain a freeboard of greater than 1.8m during the 100-year design storm
  - If there are no local storm service connection, more surcharging may be permissible.
  - The presence of downstream service connections should be evaluated on an individual site bases to determine freeboard requirements.
- Overland flows must be contained within the municipal Right-of-Way for all events (flow depth less than 300mm).

From the storm system assessment, achieving the above criteria is not possible in all areas. The following is a summary of post-development flow controls assuming local improvements are completed:

- Dublin Street/Gordon Street: 5-year pre-development flow control to bring HGL below grade.
- Quebec Street: Post-development not to exceed pre-development for 2- through 100-year.
- The Ward: 5-year pre-development flow control.

If the improvements are not implemented over-control will be required to the 5-year pre-development level in the Dublin Street area; 25-year in the Quebec Street area; and 2-year in The Ward all based on 50% imperviousness.

**Water Quality:**

Water quality control to current stormwater standards is not practical in the downtown area. Improving stormwater quality by installing OGS on site or part of a central OGS facility is recommended as a means to improve water quality supported by best practices, such as regular street cleaning and catchbasin cleaning.

It is recommended that OGS specifications and salt management plans be part of all site plan applications.

**LID:**

LID features, such as green roofs, rainwater harvesting, and rain gardens integrated into redevelopments present an opportunity to reduce the stormwater quantity as well as providing some water quality benefits.

As discussed previously, infiltration LIDs should be avoided because of wellhead protection.

**Other Criteria (Erosion Control, Water Balance):**

Other stormwater criteria contained in the City Development Engineering Manual (January 2019) will need to be followed for any new development in the downtown area related to erosion control and water balance where practical. Applicants will need to demonstrate they have addressed City requirements and if they cannot be met, applicants need to ensure they have not worsened conditions.

### 6.4.6 Stormwater Improvements Summary

The storm services in the downtown area were never designed using current standards and therefore should not be expected to meet current stormwater guidelines. However, through redevelopment the post-redevelopment flows must not worsen pre-redevelopment conditions and if possible, improve quantity control and look at opportunities to introduce quality control where feasible.

In the context of the downtown area, the development of stormwater system improvements started with the 2012 Stormwater Master Plan. The development of projects for this report involved reviewing projects recommended in the Master Plan with the following objectives:

- Mitigate surcharge and flooding conditions in the minor system during the 5-year storm event;
- Alleviate the depth of flooding during the 100-year storm event; and
- Control the 100-year freeboard to greater than 1.8m, where feasible.

Furthermore, opportunities in the downtown area to incorporate LID and water quality controls were investigated. Finally, stormwater criteria are discussed recognizing it is generally difficult to effectively retrofit/implement traditional stormwater management techniques for quantity and/or quality control as part of infill/intensification involving individual land parcels in an established downtown area.

The following summarizes the stormwater recommendations:

- **Dublin Street / Gordon Street**
  - Investigate overland flow drainage at Dublin Street and Wellington Street West.

- Upgrade the local storm sewer on Dublin Street from Fountain Street to Wellington Street (ST-13: 137m of 750mm). This improvement is not considered critical and should be coordinated with other water or road improvements.
- In the Dublin Street /Gordon Street area, limit post-development flows to a 5-year pre-development flow levels to improve hydraulic performance and minimize surcharge.

- **Quebec Street / Macdonell Street**
  - Implement local upgrades to provide a consistent level of performance with no surcharging under the 5-year event; freeboard greater than 1.8m for the 100-year event; and, ponding less than 300mm for the 100-year event in the downtown area.
  - Alternatively, without improvements, limit post-development flow to 25-year pre-development level.
- **The Ward**
  - The Ward currently has a <2-year level of service. Two alternatives are available, to control post development flow to 2-year level, or, implement improvements which will allow post development control to increase to 5-year.
  - It is recommended the City consider the local improvements (Alternative 2) and implement a 5-year control.
  - Upstream storm flows contribute to existing issues. As such, more restrictive stormwater controls should be considered for the upstream area outside of the downtown area.
- **LID-Controls -** Non-infiltration LIDs, such as green roofs, rainwater harvesting may be viable in the downtown area and should be promoted as part of redevelopment. Infiltration type LIDs are not recommended because of source water protection.
- **Water Quality -** There are limited opportunities to retrofit water quality controls. OGS located at three locations should be investigated as centralized facilities for the downtown area. LIDs will also contribute to improving water quality.
- **Stormwater Criteria -** Criteria have been proposed to guide the City in the process of reviewing proposals as they come forward. The criteria vary for different downtown areas given current performance.

### 6.4.7 Stormwater Opinion of Probable Cost and Phasing

**Figure 6-10** previoulsy showed the proposed stormwater system improvements (ST-1 through ST-13). In total, there are 13 improvement projects identified. A summary of the project phasing, costing, and rational is provided **Table 6.4**. Detailed project sheets for each location are provided in **Appendix F**.

**Figure 6-12** and **Figure 6-13** show the hydraulic performance (minor system) for 2031 conditions under the 5-year and 100-year events, respectively, with stormwater infrastructure improvements only.

Similarly, **Figure 6-14** and **Figure 6-15** show the same hydraulic performance for the 5- and 100-year events with peak flow control criteria: Dublin Street, 25-year; Quebec Street, 100-Year; and, The Ward, 5-year.

**Figure 6-16** shows the 100-year overland performance with improvements and stormwater criteria.

An Opinion of Probable Cost (OPC) were developed based on storm pipe construction costs prepared by COLE using tender values from the Greater Toronto Area (GTA) and approved by the City of Guelph. Unit costs for storm sewers, maintenance hole, and services were applied based on length, depth and diameter. The unit costs were classified as being either independent or in conjunction with road programs to account for the added cost of road removals and restoration efforts. If there is another system improvement (water or wastewater) along the same road segment, the unit cost for the stormwater project would be reduced to be in conjunction with a road program to avoid duplication of costs.

Estimating percentages were applied to account for contingency (25%), engineering (15%) and other general items (5%). **Table 6.4** summarizes the project details and OPCs for all stormwater servicing alternatives.

**Table 6.4 Stormwater Summary of OPCs**

| Project | Phase[3] | Length (m) | Size (mm) | Average Depth (m) | Overlap | Trigger[1] | Rational[2] | [5]Unit Cost ($/m) | Stormwater Cost |
|---|---|---|---|---|---|---|---|---|---|
| Dublin | | | | | | | | | |
| ST-13 | 2023 | 137 | 750 | 3 | | Exist | 25-yr | $2,432 | $314,000 |
| **TOTAL** | | | | | | | | | **$314,000** |
| **Quebec / Macdonell** | | | | | | | | | |
| ST-1 | 2023 | 133 | 525 | 3 | | Both | 100-yr | $1,781 | $237,000 |
| ST-2 | 2023 | 144 | 1350 | 3.3 | | Both | 100-yr | $3,434 | $494,000 |
| ST-3 | 2023 | 48 | 825 | 3 | | Both | 100-yr | $2,550 | $122,000 |
| ST-4 | 2023 | 170 | 900/525 | 3 | | Both | 100-yr | $2,335 | $331,000 |
| ST-5 | 2023 | 87 | 600/675 | 3 | | Both | 100-yr | $2,046 | $177,000 |
| ST-6 | 2023 | 122 | 450 | 3 | | Both | 100-yr | $1,678 | $205,000 |
| **TOTAL** | | | | | | | | | **$1,566,000** |
| **The Ward** | | | | | | | | | |
| ST-7 | 2023 | 234 | 375/450 | 3 | | Both | 5-yr | $1,586 | $371,000 |
| ST-8 | 2023 | 401 | 375/450 /525 | 3 | | Both | 5-yr | $1,607 | $645,000 |
| ST-9 | 2023 | 140 | 600 | 3 | | Both | 5-yr | $1,930 | $270,000 |
| ST-10 | 2023 | 320 | 375/450 /675 | 3 | | Both | 5-yr | $1,864 | $597,000 |
| ST-11 | 2023 | 494 | 1200 (RR) | 3 | | Both | 5-yr | $4,493 | $2,221,000 |
| ST-12 | 2023 | 123 | 375 | 3 | | Both | 100-yr | $1,762 | $216,000 |
| **TOTAL** | | | | | | | | | **$4,320,000** |
| **OGS** | | | | | | | | | |

| Outfall | Drainage Area (ha) | Q ($m^3/s$) | Cost ($)[4] |
|---|---|---|---|
| Gordon St | 15.8 | 105 | $195,750 |
| Silvercreek 1 | 11.9 | 26 | $67,600 |
| Silvercreek 2 | 8.9 | 19 | $45,450 |
| **TOTAL** | | | **$308,800** |

Notes:

- Trigger – BOTH means that existing performance and growth trigger the need for the improvement
- Rational – In all cases improving PERFORMANCE is the goal of the improvement to a minimum of 5-year with no surcharge and not overland ponding greater than 300mm for the 100-year event.
- Phase – When improvement should be considered.
- Capital costs only, does not include design, construction or contingency.
- Unit Costs based on open cut construction

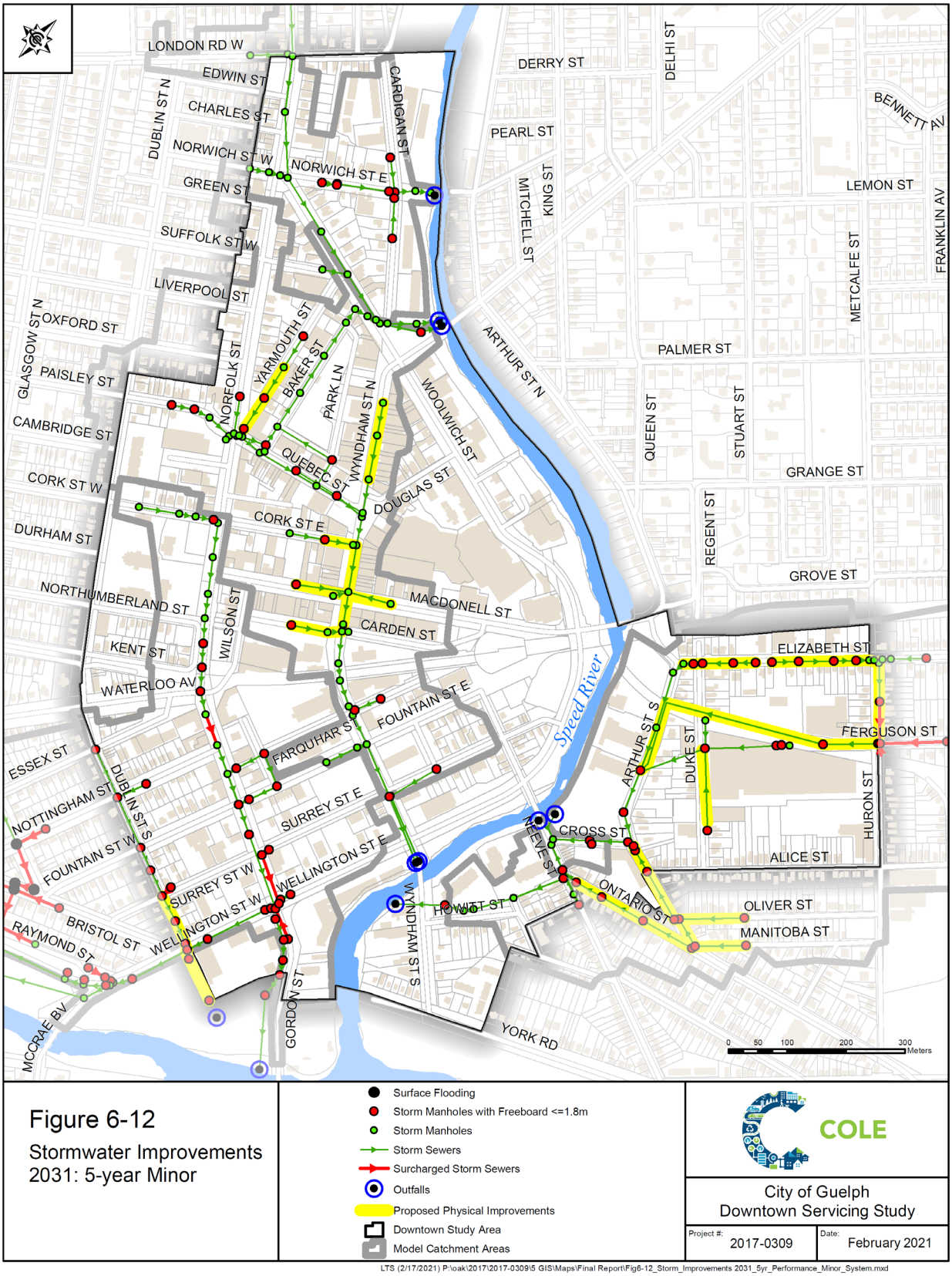


**Figure 6-12 Stormwater Improvements 2031: 5-Year Minor**

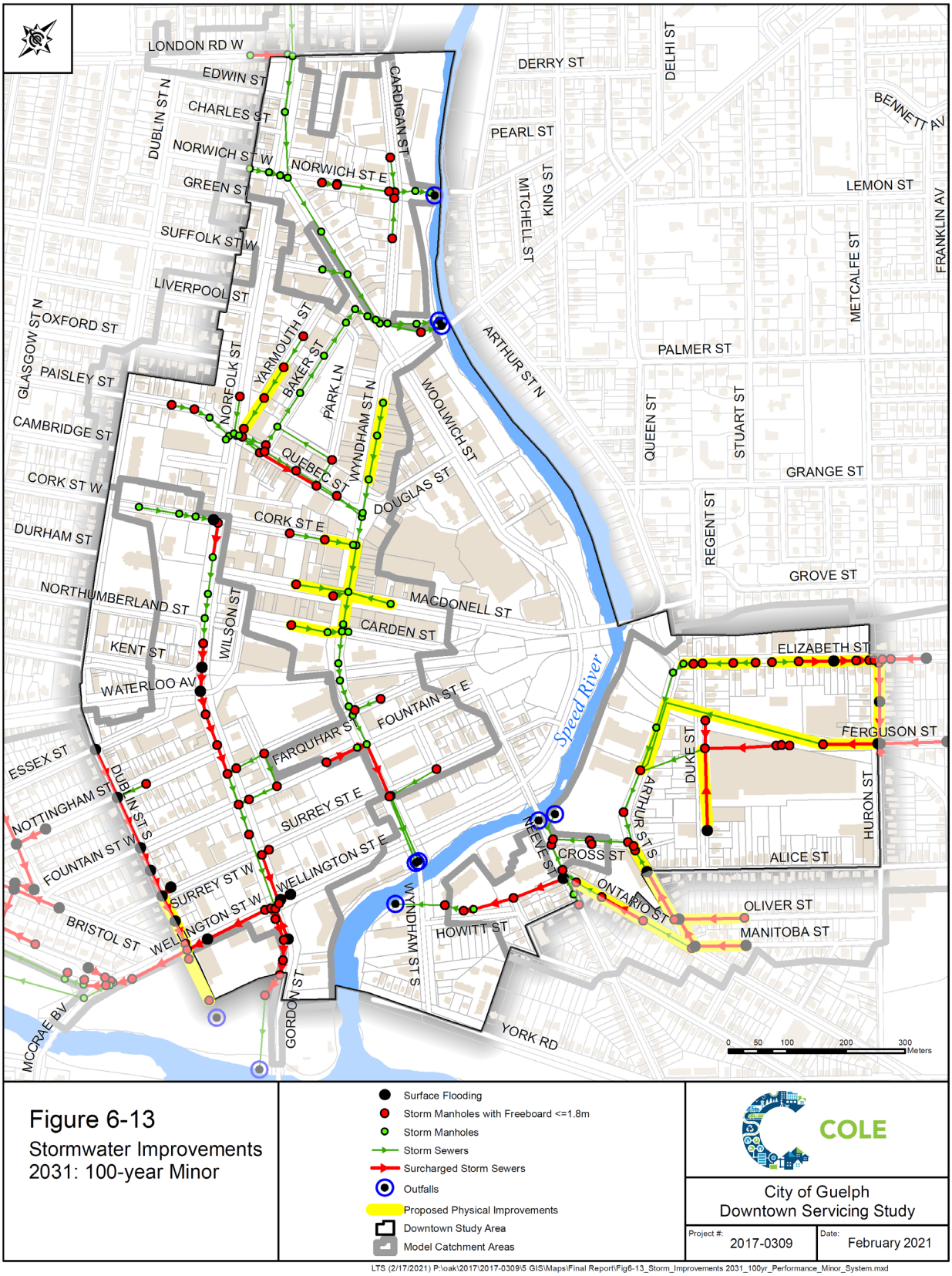


**Figure 6-13 Stormwater Improvements 2031: 100-Year Minor**

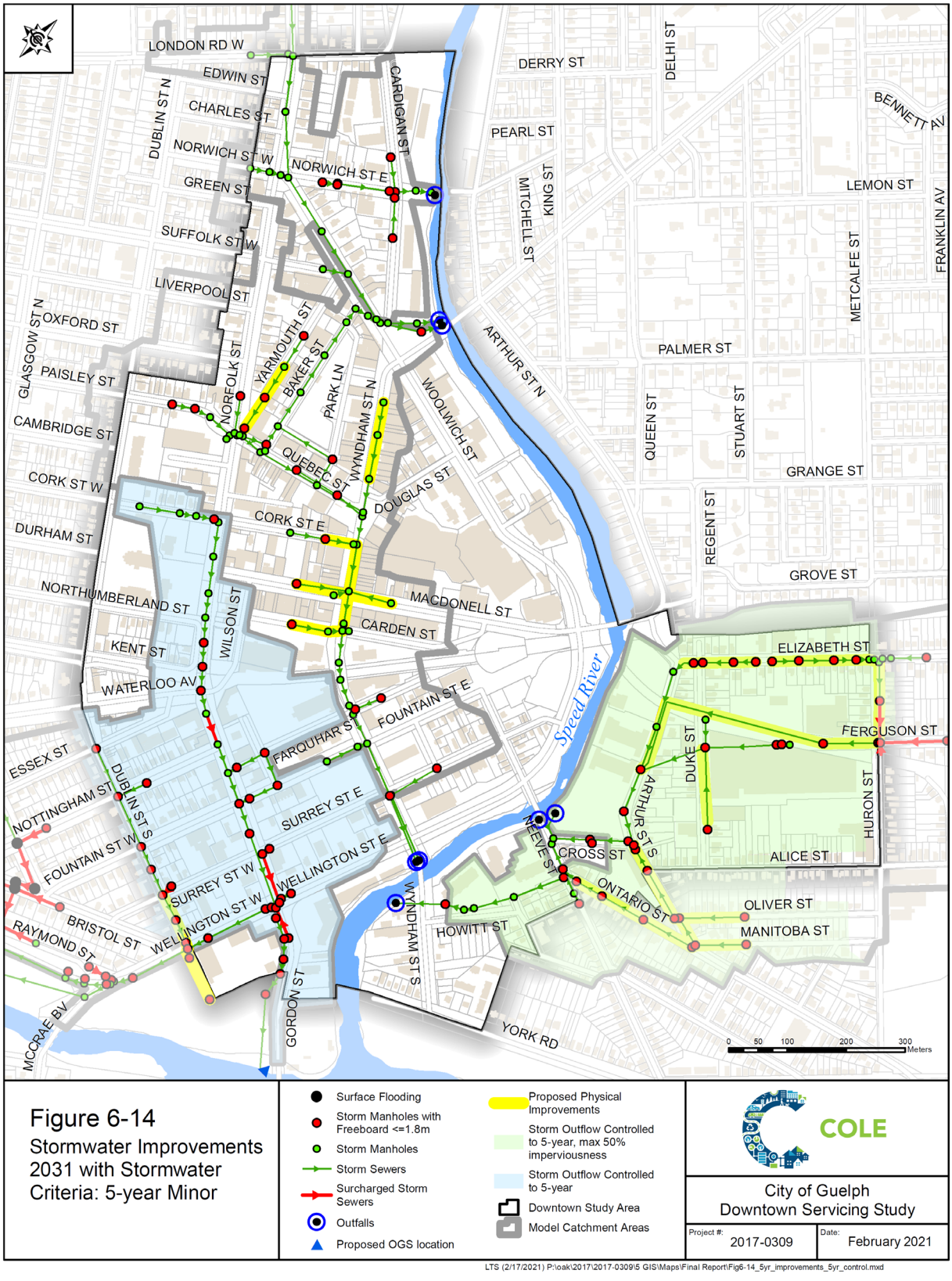


**Figure 6-14 Stormwater Improvements 2031 with Stormwater Criteria: 5-Year Minor**

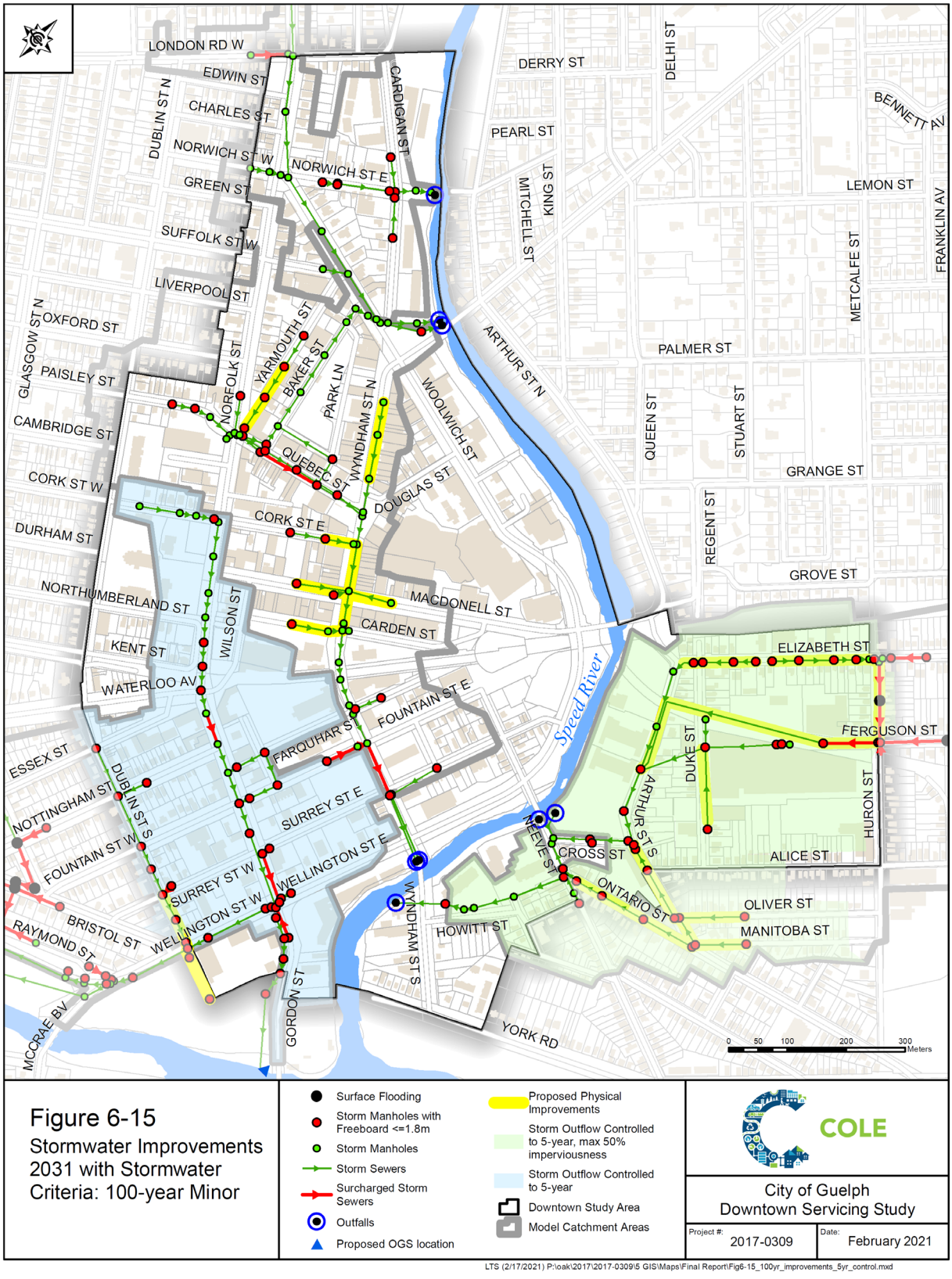


**Figure 6-15 Stormwater Improvements 2031 with Stormwater Criteria: 100-Year Minor**

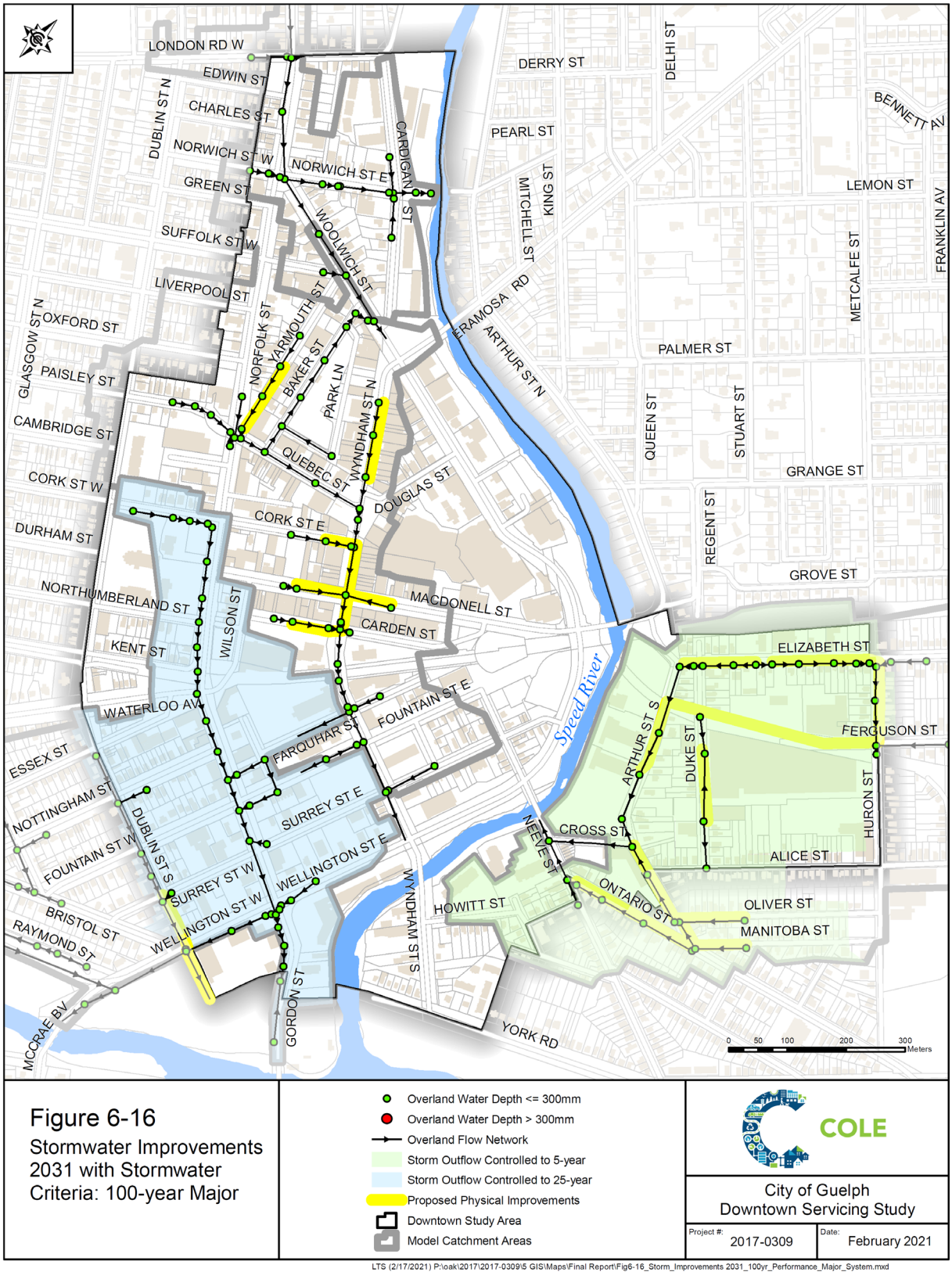


**Figure 6-16 Stormwater Improvements 2031 with Stormwater Criteria: 100-Year Major**

# 7 Conclusion

**Figure 7-1** shows the combination of water, wastewater and stormwater improvements for the downtown area. In reviewing the need and phasing of the various projects **Table 7-1** presents a consolidated list of infrastructure projects with proposed phasing taking into consideration where projects overlap. **Figures 7-2**, **7-3** and **7-4** show the implementation timelines.

## 7.1 Water

Water servicing alternatives were developed to address downtown areas that did not meet criteria when future demands were applied to the existing infrastructure. Areas of high head loss and low fire flow were the main concerns, while pressures were not greatly impacted. The prevalence of small diameter, old, cast iron watermains in the Downtown core is the main cause of high head loss and low flows, therefore several linear pipe upgrades are recommended to improve servicing for future developments to 2031.

Other projects were proposed to replace old cast iron watermains with 200mm pipes for servicing existing commercial land use and future developments. In total there are 7 of 20 projects that are based on existing system resilience and growth needs, while the balance of projects are driven by growth alone.

The recommended upgrades also improve overall connectivity by creating strong looping around and throughout the downtown area by connecting sections of existing 300mm watermain. These projects were planned in consideration of future feedermain infrastructure scheduled as part of the 2013 DC Background Study and Zone 1 Infrastructure Study.

The water system improvements first and foremost address existing and 2031 deficiencies. In doing so the improved overall connectivity and system resilience. As well, the water system upgrades are replacing old, small diameter cast iron mains providing more capacity and asset renewal. Furthermore, the proposed improvements consider long term feedermain improvements.

## 7.2 Wastewater

With the planned development to 2031 there are no system improvements required under dry weather flow conditions, which include the existing dry weather flow plus peak design flow associated with development. However, improvements are required because of existing wet weather flow related to RDII to reduce the risk of system surcharge and flooding, which is aggravated by growth.

Currently, the sources of RDII that drives the peak wet weather response is unknown in the downtown area. As such, wastewater system improvements do not take into consideration RDII reduction that may be possible through an inflow/infiltration (I/I) Program.

The recommended wastewater improvements are largely related to existing hydraulic issues and are not driven by new wastewater flows related to growth in the downtown area. Given this condition, and in reviewing the HGL profiles, it is arguable that the

improvements are not critical and could be deferred or coordinated with other area improvements (water, stormwater and/or transportation).

Through redevelopment of the downtown area, RDII in sanitary sewers are expected to decline. Similarly, with the recommended improvements, RDII related to system deficiencies will also decline. In addition to the recommended improvements, it is recommended the City advance their commitment to undertaking an I/I Reduction Program in the downtown area. By undertaking the needed investigations related to an I/I program the City will gain an understanding of potential source of I/I. In doing so, the City will also collect valuable structural and condition information on infrastructure through CCTV inspection, flow data characterizing actual flows, and identifying potential sources that can be removed or would be eliminated through redevelopment. The outcome of this work could change the recommended improvement or defer the need for improvement to a later date.

## 7.3 Stormwater

Storm services in the downtown area were never designed using current standards and therefore should not be expected to meet current stormwater guidelines. However, through redevelopment the post-redevelopment flows must not worsen pre-redevelopment conditions and if possible, improve quantity control and look at opportunities to introduce quality control where feasible.

The recommended improvements are designed to improve the level of service to mitigate surcharge and flooding conditions during the 5-year event as a minimum. Secondly, improvements were considered to improve the level of control so the freeboard of greater than 1.8m is maintained during the 100-year event and the overland flow depth does not exceed 300mm in the right-of-way.

In preparing recommendations, local stormwater criteria or controls were considered in combination with system improvements (public realm) recognizing it is generally difficult to effectively retrofit/implement traditional stormwater management techniques for quantity and/or quality control as part of infill/intensification (private realm) involving individual land parcels in an established downtown area.

The outcome of the stormwater system assessment led to a combination of system improvements (public realm) and stormwater criteria to maximize the level of service and protect against flooding. The following summarizes the stormwater recommendations:

- **Dublin Street / Gordon Street**
  - Investigate overland flow drainage at Dublin Street and Wellington Street West.
  - Upgrade the local storm sewer on Dublin Street from Fountain Street to Wellington Street (ST-13: 137m of 750mm). This improvement is not considered critical and should be coordinated with other water or road improvements.
  - In the Dublin Street /Gordon Street area, limit post-development flows to a 5-year pre-development flow levels to improve hydraulic performance and minimize surcharge.

- **Quebec Street / Macdonell Street**
  - Implement local upgrades to provide a consistent level of performance with no surcharging under the 5-year event; freeboard greater than 1.8m for the 100-year event; and, ponding less than 300mm for the 100-year event in the downtown area.
  - Alternatively, without improvements, limit post-development flow to 25-year pre-development level.
- **The Ward**
  - The Ward currently has a <2-year level of service. Two alternatives are available, to control post development flow to 2-year level, or, implement improvements which will allow post development control to increase to 5-year.
  - It is recommended the City consider the local improvements (Alternative 2) and implement a 5-year control.
  - Upstream storm flows contribute to existing issues. As such, more restrictive stormwater controls should be considered for the upstream area outside of the downtown area.
- **LID-Controls -** Non-infiltration LIDs, such as green roofs, rainwater harvesting may be viable in the downtown area and should be promoted as part of redevelopment. Infiltration type LIDs are not recommended because of source water protection.
- **Water Quality -** There are limited opportunities to retrofit water quality controls. OGS located at three locations should be investigated as centralized facilities for the downtown area. LID controls will also provide a level of water quality control.
- **Stormwater Criteria -** Criteria have been proposed to guide the City in the process of reviewing proposals as they come forward. The criteria vary for different downtown areas given current performance.

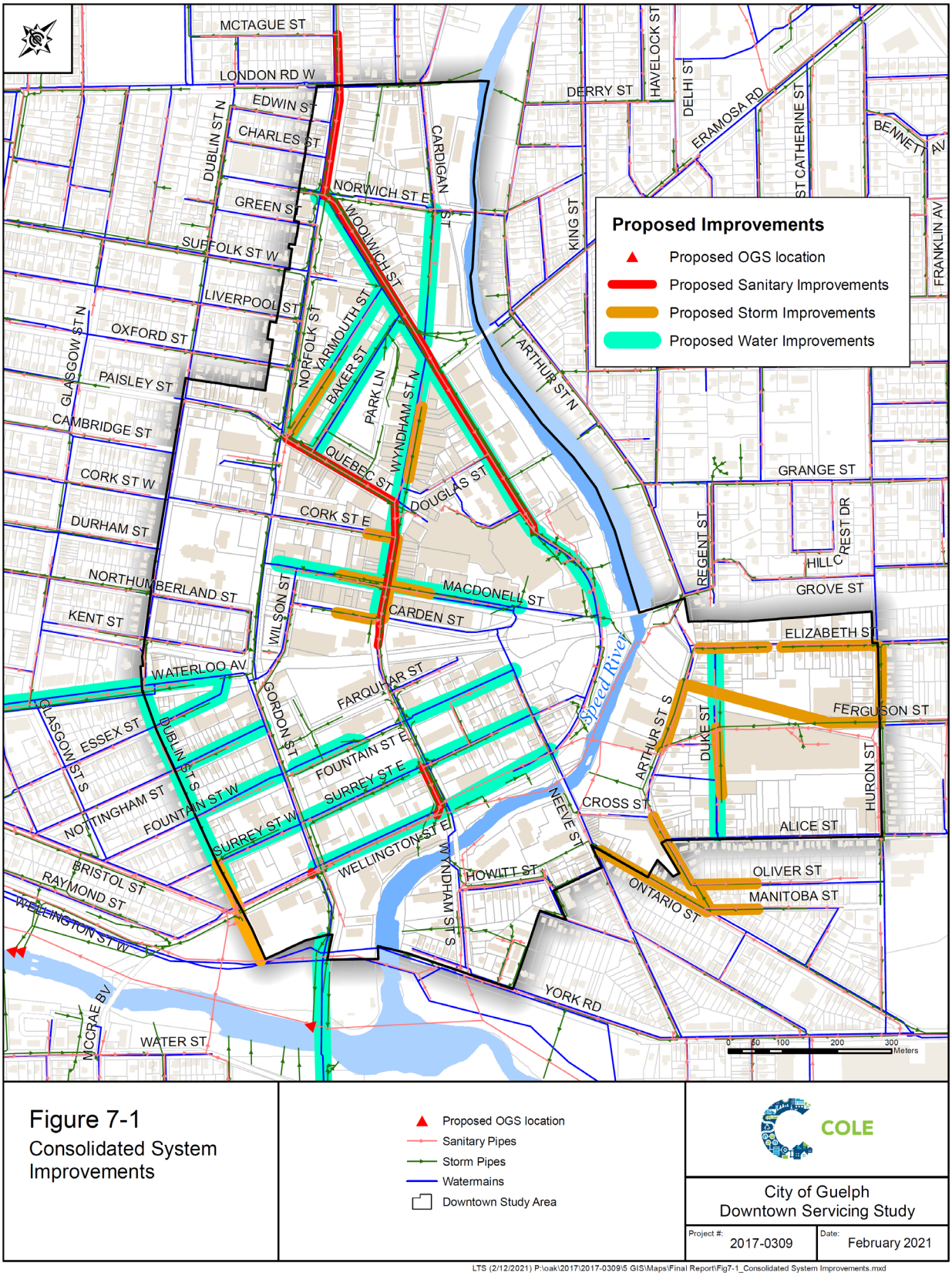


**Figure 7-1 Consolidated System Improvement**

**Table 7.1 Consolidated Project List**

| Project | Type | Size (mm) | Location | Overlap | Cost |
|---|---|---|---|---|---|
| **2018 - 2022** | | | | | |
| W-1 | water | 300 | Woolwich Street | SAN-1 | $875,000 |
| W-3-N | water | 300 | Wyndham Street N | ST-1 | $329,000 |
| W-3-S | water | 300 | Wyndham Street N | SAN-2, ST-2, ST-3 | $250,000 |
| W-11 | water | 200 | Fountain Street | | $201,000 |
| W-12 | water | 200 | Fountain Street | | $187,000 |
| W-14 | water | 200 | Surrey Street E | | $203,000 |
| W-17 | water | 300 | Wellington Street E | | $321,000 |
| W-8 | water | 200 | Baker Street | | $331,000 |
| SAN-1 | sanitary | 300 | Norfolk Street / Woolwich Street | W-1 | $1,392,000 |
| SAN-2 | sanitary | 375 | Quebec Street / Wyndham Street | W-3, ST-2, ST-3 | $868,000 |
| ST-1 | storm | 525 | Wyndham Street | W-3-N | $237,000 |
| ST-2 | storm | 1350 | Wyndham Street | SAN-2, W-3-S | $494,000 |
| ST-3 | storm | 825 | Cork Street E | | $122,000 |
| **TOTAL (2018-2022)** | | | | | **$5,810,000** |
| **2023 - 2027** | | | | | |
| W-2 | water | 200 | Cardigan Street | | $292,000 |
| W-4 | water | 200 | Macdonell Street | ST-4 | $546,000 |
| W-6 | water | 300 | Waterloo Avenue | | $653,000 |
| W-7 | water | 200 | Yarmouth Street | ST-6 | $298,000 |
| W-9 | water | 200 | Essex Street | | $192,000 |
| W-13 | water | 200 | Fountain Street E | | $254,000 |
| W-15 | water | 200 | Surrey Street E | | $282,000 |
| W-16 | water | 200 | Surrey Street E | | $307,000 |

**Table 7.1 Consolidated Project List**

| Project | Type | Size (mm) | Location | Overlap | Cost |
|---|---|---|---|---|---|
| W-18 | water | 300 | Wellington Street E | | $280,000 |
| W-19 | water | 300 | Gordon Street | | $1,371,000 |
| W-20 | water | 200 | Duke Street | ST-9 | $338,000 |
| SAN-3 | sanitary | 450 | Wyndham Street | | $161,000 |
| SAN-4 | sanitary | 300 | Gordon Street/Wellington Street E | | $16,000 |
| ST-4 | storm | 900/525 | Macdonell Street | W-4 | $331,000 |
| ST-5 | storm | 600/675 | Carden Street | | $177,000 |
| ST-6 | storm | 450 | Yarmouth Street | W-7 | $205,000 |
| ST-7 | storm | 375/450 | Ontario Street | | $371,000 |
| ST-8 | storm | 375/450/525 | Manitoba St., Oliver St., Arthur St. | | $645,000 |
| ST-9 | storm | 600 | Duke Street | W-20 | $270,000 |
| ST-10 | storm | 375/450/675 | Elizabeth Street, Huron Street | | $597,000 |
| ST-11 | storm | 1200 (RR) | Between Huron Street and Duke Street, Arthur Street | | $2,221,000 |
| ST-12 | storm | 375 | Elizabeth Street | | $216,000 |
| **TOTAL (2023-2027)** | | | | | **$10,023,000** |
| **2027 - 2031** | | | | | |
| W-10 | water | 200 | Nottingham Street | | $201,000 |
| W-5 | water | 200 | Dublin Street | ST-13 | $400,000 |
| ST-13 | storm | 750 | Dublin Street | W-5 | $314,000 |
| **TOTAL (2028-2031)** | | | | | **$915,000** |

**Table 7.1 Consolidated Project List**

| OGS Units (no defined timeline) | | |
|---|---|---|
| **Location** | **Unit Type / Footprint Area** | |
| Gordon St | 2xEF12 (20m$^2$) | $195,850 |
| Silvercreek 1 | EF10 (8m$^2$) | $67,600 |
| Silvercreek 2 | EF8 (5m$^2$) | $45,550 |
| **TOTAL (OGS)** | | **$309,000** |
| SUMMARY BY SYSTEM TYPE | | |
| TOTAL WATER | | $8,111,000 |
| TOTAL WASTEWATER | | $2,437,000 |
| TOTAL STORM | | $6,509,000 |
| GRAND TOTAL | | **$17,057,000** |

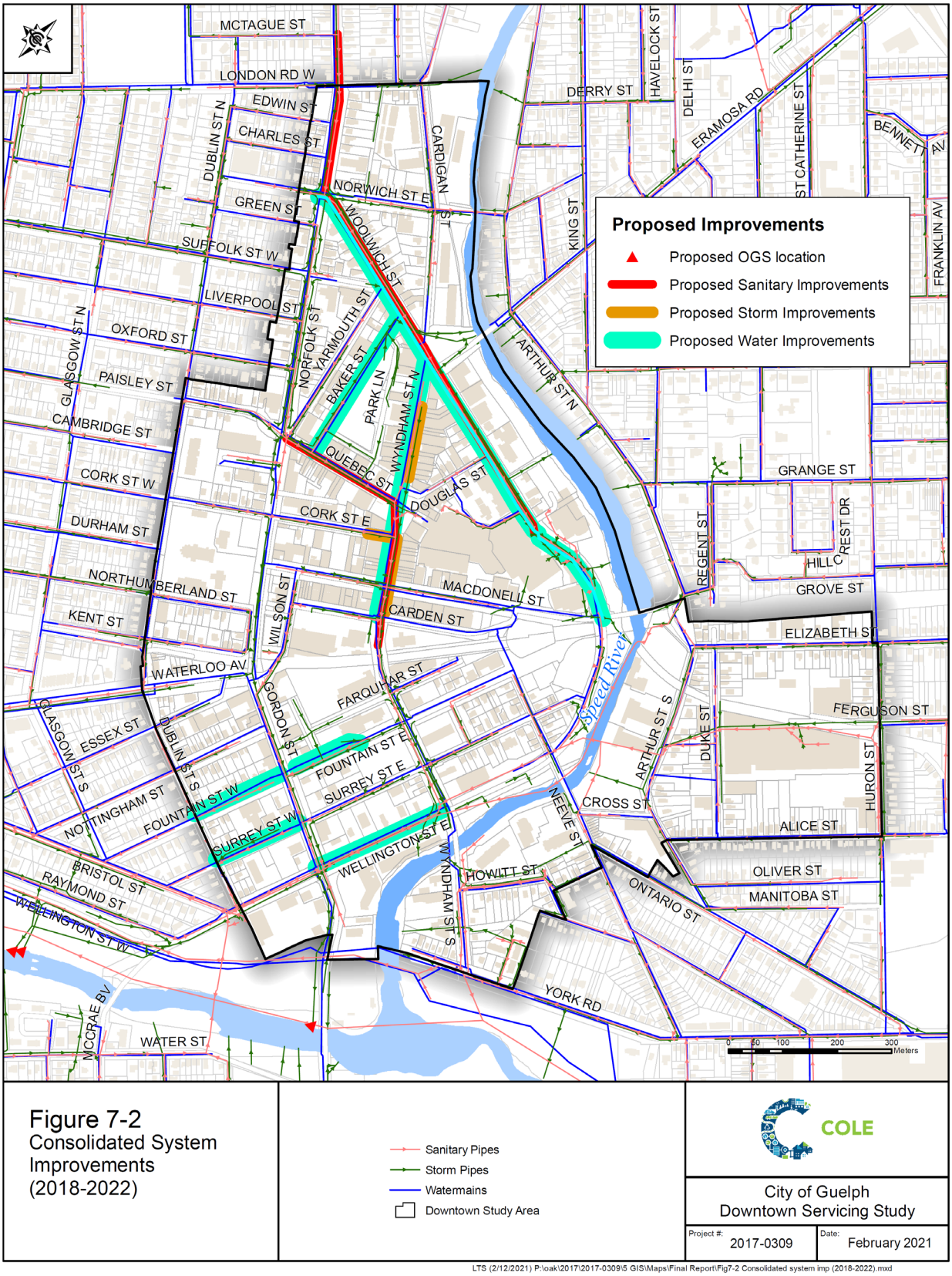


**Figure 7-2 Consolidated System Improvement (2018-2022)**

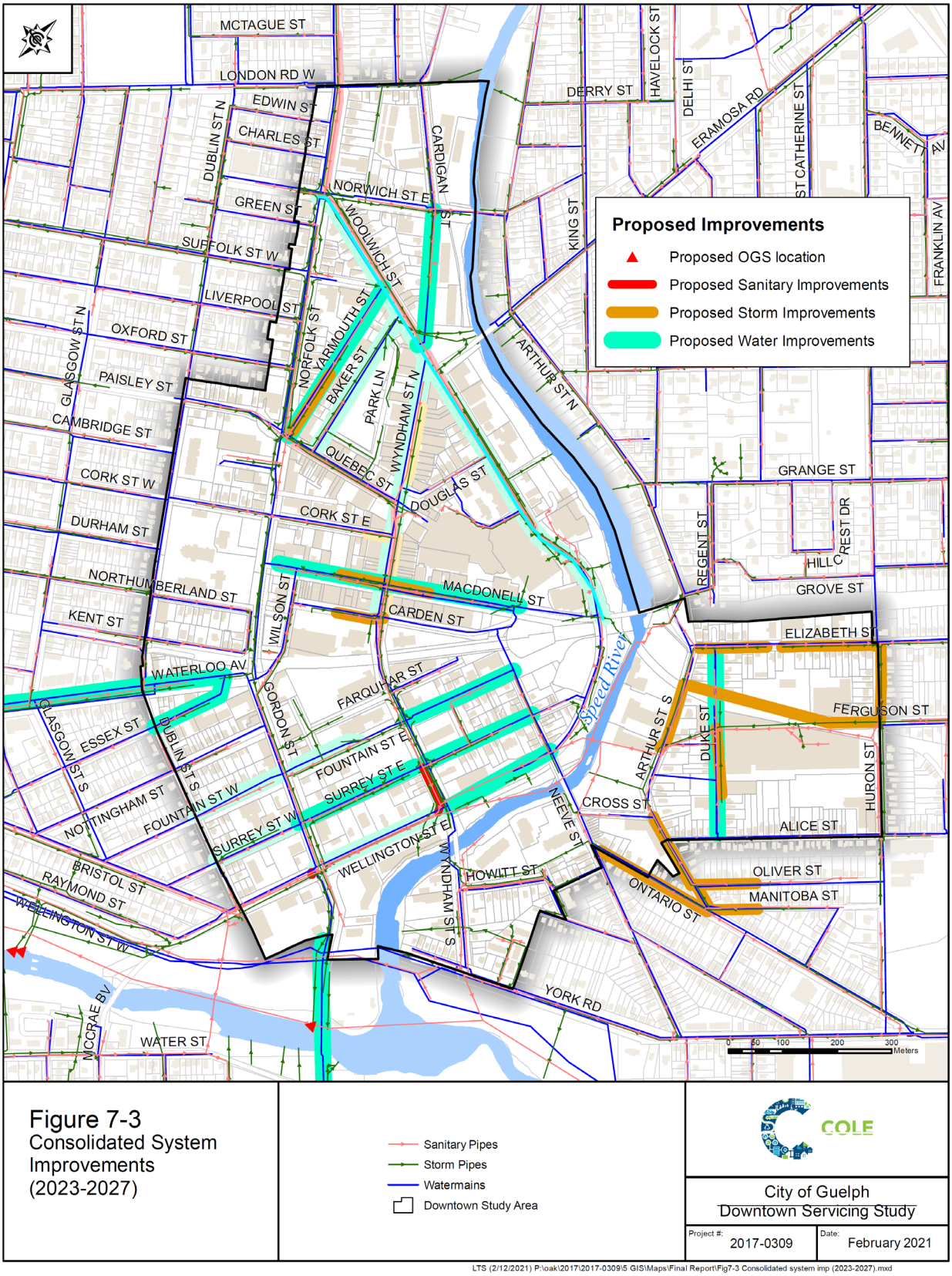


**Figure 7-3 Consolidated System Improvement (2023-2027)**

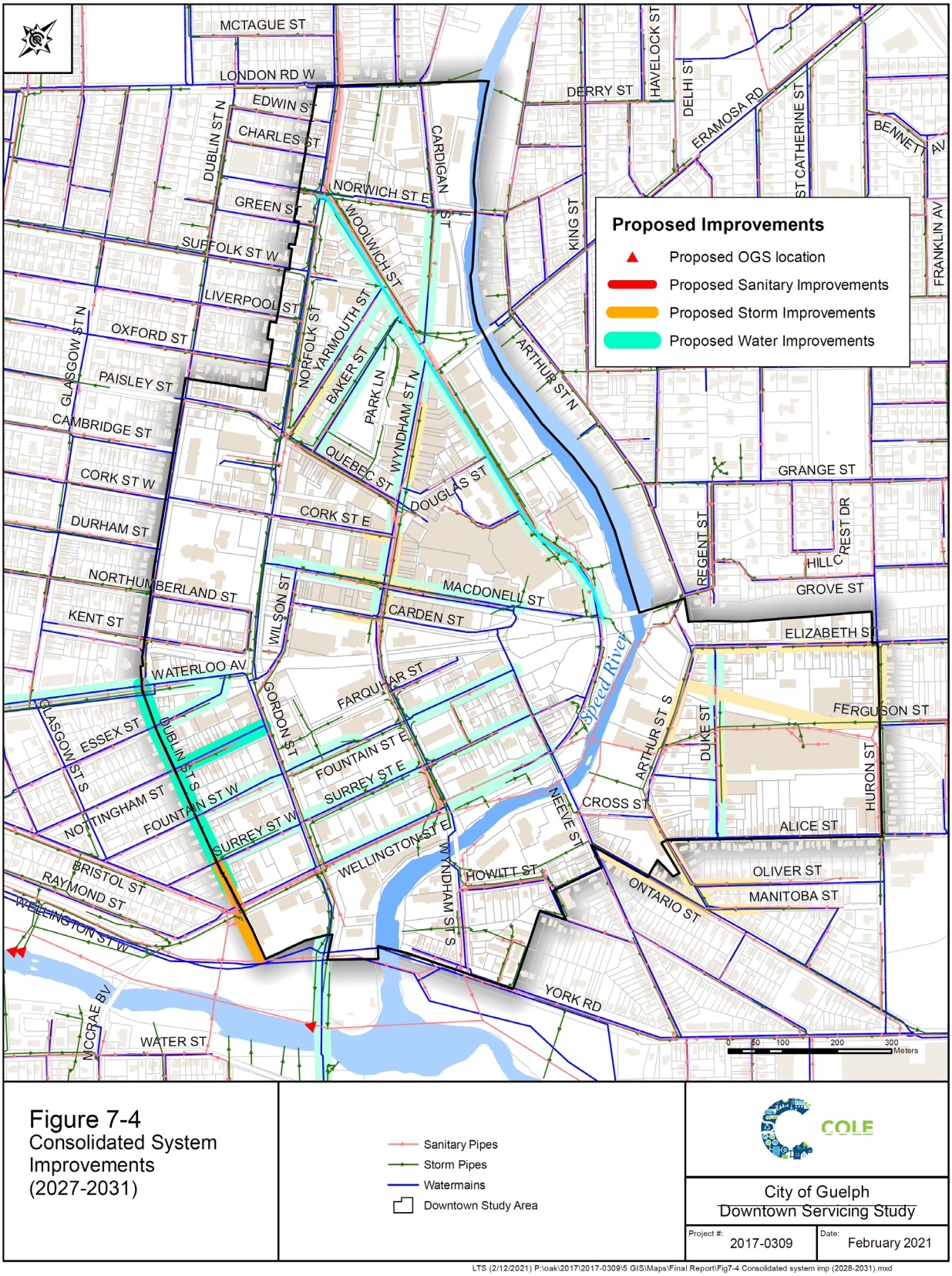


**Figure 7-4 Consolidated System Improvement (2027-2031)**