Stantec

# INTEGRATED SANITARY MASTER PLAN

Municipal Class Environmental Assessment

May 2, 2024

Prepared for:
City of Kitchener

Prepared by:
Stantec Consulting Ltd.

Project Number: 165640334

| Revision | Description | Author | Quality Check |
|---|---|---|---|
| Draft | Draft MP | HB / SM | JP / DE |
| Final | Final MP | HB / SM | JP / DE |

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# Table of Contents

## LIST OF TABLES

## LIST OF FIGURES



## LIST OF APPENDICES

# Executive Summary

## Introduction

The City of Kitchener (City) has retained Stantec Consulting Ltd. (Stantec) to complete the Integrated Sanitary Master Plan (ISAN-MP). The purpose of the ISAN-MP is to develop a master plan to guide the future needs of the City. The ISAN-MP will account for growth, development, and asset renewal to the year 2051. The Plan will identify recommendations to support growth across the City.

This Master Plan is being completed under the Municipal Class Environmental Assessment (MCEA) (as amended in 2015). The Master Plan is following Approach #2 of the Master Planning Process. This report will meet the requirements of Schedule B projects, completing Phases 1 and 2 of the MCEA process.

## Consultation

Consultation is a vital part of the Class EA process. The project contact list includes agencies, stakeholders, the public and Indigenous Nations. Project notices include:

- Notice of Study Commencement (September 2021)
- Notice of Virtual Public Information Centre (PIC) 1 (July 2022)
- Notice of Virtual PIC 2 (December 2023)
- Notice of Completion (2024)

All notices were published in the Record newspaper, posted on the City’s Engage Kitchener website, and emailed to the project contact list.

Two Virtual PICs were hosted on the City’s website (engagewr.ca/sanitarymasterplan). The PICs gathered input from the public to assist with the development of a preferred plan. The first Virtual PIC provided background information on the study. The PIC was available on the City's website from July 8 to August 8, 2022. The second Virtual PIC discussed alternative solutions and presented the recommended solution. The PIC was available on the City's website from December 20, 2023, to January 7, 2024. Participants could submit comments through the City’s Online Forum Tool and Question Tool, or by emailing the project team. A copy of the comments and the City’s responses are in Appendix A.

## Problem and Opportunity Statement

At the start of the MCEA process, a problem and opportunity statement was developed. To support the development of the statement, a review of the existing system was completed.

This included a review of previous studies and state of repair of the existing sewer system. The project team collected rainfall data and sanitary pumping station data. Sanitary flows were updated, and rainfall events for 5-, 10-, and 25-year design storms were simulated.

The following problem and opportunity statement was developed for this study:

*The City of Kitchener has significant sanitary sewer infrastructure which needs to be managed to ensure it is resilient and sustainable for future generations. The growing population in the City, as identified in the Official Plan, will lead to an increase in the production of wastewater, causing additional strain on aging infrastructure and may require new infrastructure.*

*This sanitary servicing review will assess the current state of the City's sanitary sewers and pumping stations. Where issues are identified, the City will identify preferred solutions that will continue to service existing homes and businesses as well as provide the ability to service identified growth areas. The City is committed to providing a reliable and sustainable sanitary servicing system.*

## Alternative Solutions

Four alternative solutions considered for the ISAN-MP included:

- Alternative 1 – Do Nothing
- Alternative 2 – Shaping Community Growth
- Alternative 3 – Infrastructure Updates
    - Capacity-based Solutions
    - Condition-based Solutions
- Alternative 4 – Data Acquisition, Flow Monitoring, and I/I Mitigation Programs
    - Inflow & Infiltration Reduction Program
    - Rainfall, Flow & Thermal Monitoring Program
    - Computer Model Updates & Maintenance
    - Sanitary Trunk Sewer & Forcemain Investigation Program
    - Hydrogen Sulfide Monitoring and Dosing Program

## Recommended Solutions

Alternatives 2, 3 and 4 are recommended for this Master Plan.

- *Shaping Community Growth*

Community growth can lead to an increase in sanitary flows. It is important to plan growth where the system can handle it. The sewer system may need upgrades if they are cost-effective and beneficial.

Regular reviews of growth are essential to identify system constraints. It is important to conduct regular Master Plan updates to reduce these restrictions. It is recommended that Master Plan updates be conducted every 5 years to mitigate these limitations. However, the timing of these updates should be flexible and responsive to significant changes, such as major population shifts or adjustments to the capital plan.

- **Infrastructure Upgrades**

Upgrades are important to improve the capacity and condition of the existing system.

  - Capacity-Based Solutions

Capacity-based solutions increase the capacity in the system, improving sanitary flow. Identified solutions focus on immediate, medium-term (by 2031) and long-term (by 2051) needs.

  - Condition-Based Solutions

Condition-based solutions improve sewers and pumping stations in poor condition. Upgrades may include repair, rehabilitation, or replacement. The City will focus on renewal based on the condition of the existing sewer.

- **Data Acquisition, Flow Monitoring, and Inflow & Infiltration Mitigation Programs**

This solution refers to a broad collection of programs. The goal of the programs is to reduce flows in the sanitary sewer system and improve the City's understanding of the state of the system. This will allow the City to better assess the condition of the system.

  - Rainfall, Flow and Thermal Monitoring Program

This program will manage all rainfall and sewer flow monitoring equipment and contracts, providing valuable data to the City. The data will identify how the sanitary system responds to growth and storm events, allowing for operational tracking of system performance over time. This will allow the City to better target system improvements. Data collection should include sewer water depth and velocity (used to calculate flow rate), along with temperature for trunk sewers to provide input into future wastewater heat recovery planning.

  - Inflow and Infiltration Reduction Program

This involves the review and analysis of data collected as part of other programs. It would help determine specific areas where inflow and infiltration sources are entering the sanitary system and their relative amount. This strategic long-term assessment and planning program results in recommended short and long-term actions to investigate and remedy the sources of additional flows, and/or or mitigate their impact on system operation.

- Computer Model Updates & Maintenance

This program will provide further improvements to the existing computer model of the sanitary sewer system that was development for the ISAN-MP. It will continually keep the model up to date with the latest infrastructure, population, and flow data. The model is used for capital planning, operations, and infrastructure decision-making.

- Sanitary Trunk Sewer & Forcemain Investigation Program

This program enhances the City's existing program which inspects existing sewers. It will allow all larger sewers to be inspected by camera on a 10-year frequency to assess any issues in a timely manner.

- Hydrogen Sulfide Monitoring and Dosing Program

Hydrogen Sulfide occurs naturally in wastewater as it ages. It is an issue in sewer systems because it creates odors and has a corrosive effect on concrete pipe and concrete maintenance holes. Reducing Hydrogen Sulfide is an important goal for the City. This program involves the monitoring of hydrogen sulfide levels in key locations in the sanitary sewer system. It will identify areas of high hydrogen sulfide within the system. The program would then recommend actions to remedy the high hydrogen sulfide levels.

### Preliminary Cost Estimate

The Opinion of Probable Cost (OPC) is classified as Class D estimates, with a variance of +/- 25-30%, and is calculated in 2022 dollars using a 5% per year inflation factor. These costs have been approximated to the nearest thousand. The OPC for the Capital projects, spanning from 2024 to 2031, is estimated to be $64,578,000, while the data acquisition is estimated to cost $8,855,000 over the next four years. These OPCs serve as a valuable resource for the City's budgeting process which occurs on a four-year cycle. The implementation plan distributes the total cost across the years 2024 to 2031. The estimated cost is subject to change.

### Implementation and Timing

The Implementation Plan outlines the schedule of projects and data collection. Costs are adjusted for inflation based on the year of implementation. It also spreads out the capital works based on their importance to provide a yearly cost for the City. Table ES-1-1 gives a summary of the yearly costs for the short-term projects (2024 to 2027), the medium-term projects (2028 to 2031) and the long-term projects (2032 to 2051), with an annual inflation rate of 5%. Data acquisition costs are noted only in the initial four years of the plan. Data acquired during this time should be used to provide direction to the City about ongoing data acquisition in the next four-year cycle.

**Table ES-1-1: Summary of Budgetary Estimates**

| | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 - 2051 |
|---|---|---|---|---|---|---|---|---|---|
| Capital Projects | $14,678,853 | $13,131,983 | $15,463,550 | $14,252,365 | $3,446,899 | $1,511,408 | $1,629,825 | $462,497 | $1,722,408 |
| Data Acquisition | $2,098,132 | $2,160,322 | $2,277,252 | $2,319,098 | - | - | - | - | - |
| **Total** | **$16,776,985** | **$15,292,305** | **$17,740,802** | **$16,571,463** | **$3,446,899** | **$1,511,408** | **$1,629,825** | **$462,497** | **$1,722,408** |

## Closing

The Master Plan Report marks the end of Phase 1 and 2 of the MCEA planning process. None of the projects contemplated by this study require additional environmental assessment study work. If there are no Section 16 Order requests, the City may proceed 30 days following the completion of the public review period.

# Acronyms / Abbreviations

| | |
|---|---|
| ADWF | Average Dry Weather Flow |
| CoA | Certificate of Approval |
| CLI-ECA | Consolidated Linear Infrastructure Environmental Compliance Approval |
| DGSSMS | Design Guidelines and Supplemental Specifications for Municipal Services |
| DWF | Dry Weather Flow |
| EA | Environmental Assessment |
| ECA | Environmental Compliance Approval |
| FM | Flow Monitor |
| GIS | Geographic Information Systems |
| GWI | Groundwater Infiltration |
| HGL | Hydraulic Grade Line |
| ICI | Industrial-Commercial-Institutional (Land Use) |
| I/I | Infiltration and Inflow |
| ISAN-MP | Integrated Sanitary Master Plan |
| KDM | Kitchener Development Manual |
| LOS | Level of Service |
| MCEA | Municipal Class Environmental Assessment (Process) |
| MECP | Ministry of Environment, Conservation and Parks |
| MH | Maintenance Hole |
| OPC | Opinion of Probable Cost |
| PIC | Public Information Centre |
| PPJ | Parcel-People-Jobs Data |
| RDII | Rainfall-Derived Infiltration and Inflow |
| RG | Rain Gauge |
| SCADA | Supervisory Control and Data Acquisition |
| SPS | Sewage Pumping Station |
| SS | Surcharge State |
| TM | Technical Memorandum |
| WWF | Wet Weather Flow |
| WWTP | Wastewater Treatment Plant |

# 1 Introduction

The City of Kitchener (City) has retained Stantec Consulting Ltd. (Stantec) to complete the Integrated Sanitary Master Plan (ISAN-MP). The purpose of the ISAN-MP is to develop an overall master plan to guide the future needs of the City with respect to growth development and infrastructure renewal to account for updated population and employment growth projections to the 2051 planning horizon, building on the work/studies previously completed and integrating available information from ongoing studies/programs.

Priority and strategic projects will be evaluated to continue to efficiently and effectively operate the sanitary system, implement best management practices (including growth tracking and digital innovation), and sustainably stage and fund capital projects.

## 1.1 Study Area

The study area for the ISAN-MP is the City of Kitchener. A map of the City of Kitchener boundary is displayed in **Figure 1-1.**

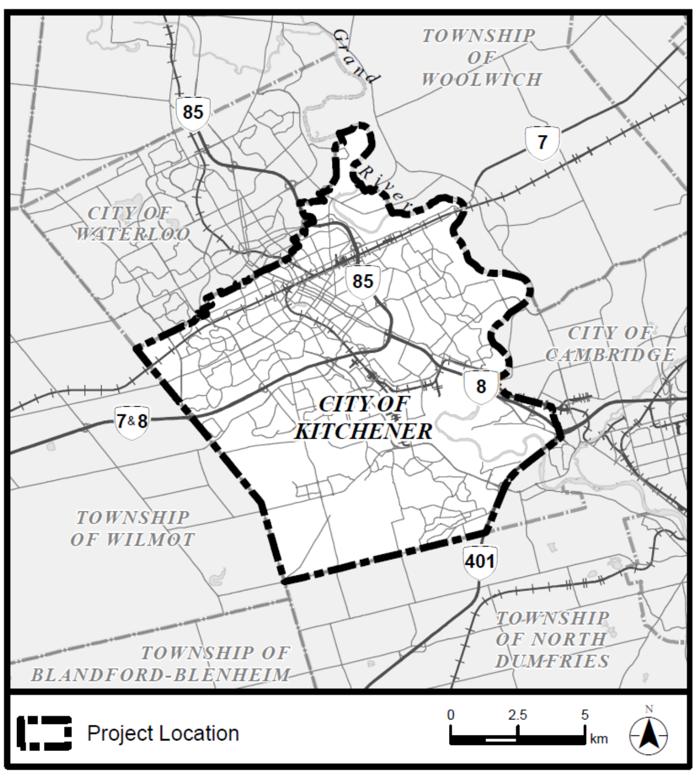



**Figure 1-1: Study Area**

## 1.2 Municipal Class Environmental Assessment Process

The Environmental Assessment Act of Ontario (EAA) provides for the protection, conservation, and management of the environment in Ontario. Activities with common characteristics and common potential effects may be assessed as part of a “class” and are therefore approved subject to compliance with the pre-approved Class EA process. The Ministry of the Environment, Conservation and Parks (MECP) is responsible for administration of the EA Act.

The Municipal Class Environmental Assessment (MCEA) is an approved Class EA process that applies to municipal infrastructure projects including roads, water, and wastewater. This process provides a comprehensive planning approach to consider alternative solutions and evaluate their impacts on a set of criteria (e.g., environmental, social, technical, and economic considerations) and determine mitigating measures to arrive at a preferred alternative for addressing the problem (or opportunity). The Class EA process involves a rigorous public consultation component that includes various provincial and municipal agencies, Indigenous Nations, and the public, at each of the project stages.

The MCEA process is undertaken prior to modifications or additions to municipal infrastructure, to ensure that potential impacts associated with all project aspects are considered. **Figure 1-2** illustrates the Class EA planning process and identifies the steps considered mandatory for compliance with the requirements of the EA Act. The following provides an overview of the five-phase planning process:

- Phase 1 – Identify the Problem and Opportunity statement
- Phase 2 – Identify and evaluate alternative solutions
- Phase 3 – Identify and evaluate alternative design concepts for the preferred solution
- Phase 4 – Prepare design plans and an Environmental Study Report (ESR) for a minimum 30-day public review period
- Phase 5 –This phase involves detailed design and the preparation of contract/tender documents followed by construction, operation, and monitoring.

The EA process adhered to for this study and shown in **Figure 1-2** follows the MCEA document amended in 2015.

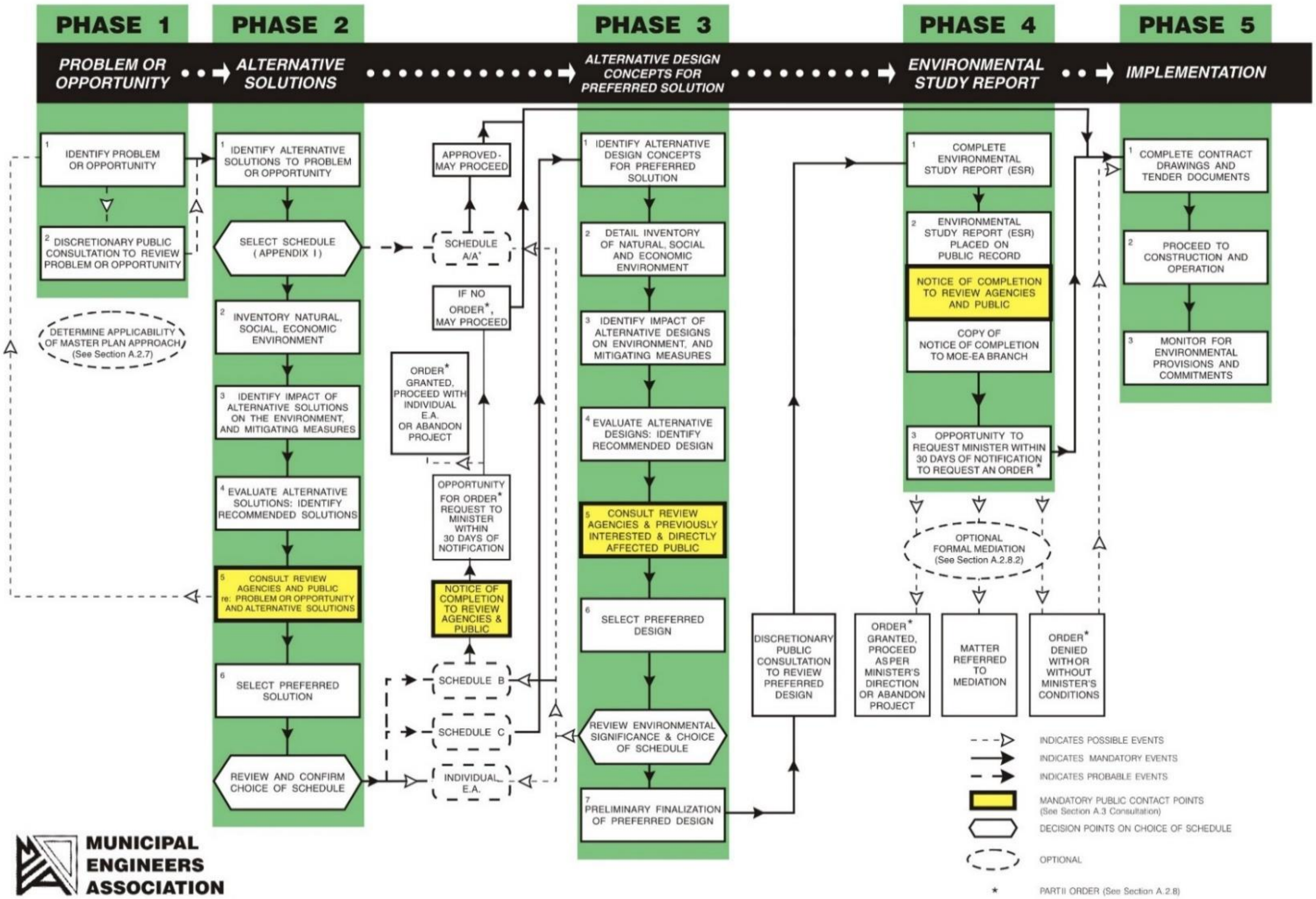



**Figure 1-2: Municipal Class Environmental Assessment Process**

Based on the nature and extent of the project, as well as its anticipated impacts to the surrounding environment, the MCEA document specifies different schedules under which projects may be planned, and the assessment process required for each:

**Schedule A/A+ projects** are pre-approved under the MCEA and can proceed directly to Phase 5 (implementation). Schedule A and A+ projects, include various municipal maintenance, operational activities, rehabilitation works, minor reconstruction or replacement of existing facilities, and new facilities that are limited in scale and have minimal adverse effects on the environment. These projects are exempt from the requirements of the *Environmental Assessment Act*.

**Schedule B projects** have potential for some adverse environmental impacts. These projects are required to proceed through the first two phases of the MCEA process, involving mandatory contact with directly affected public and relevant review agencies, to ensure that they are aware of the project and that their concerns are identified and considered. A Project File Report must be prepared and made available for review (30-day public review period) by any interested person or party. If there are no outstanding concerns or Section 16 Orders, then the proponent may proceed to implementation/detailed design (i.e., Phase 5) once the regulatory process has been completed. Schedule B projects generally include improvements and minor expansions to existing facilities or smaller new projects.

**Schedule C projects** have the potential for more significant environmental impacts. These projects are required to proceed through all five stages of the MCEA process. Schedule C projects require an Environmental Study Report be completed and filed for a 30-day public review period. If there are no outstanding concerns, the proponent may proceed to implementation once the regulatory process has been completed. These projects generally include the construction of new facilities, or major expansions to existing facilities.

The selection of the appropriate project schedule to be followed is dependent on the anticipated level of environmental impact, and at times the estimated construction costs.

The MEA Class EA document also identifies different approaches to completing Master Plans corresponding to different levels of assessment. Regardless of the approach selected, Master Plans must follow at least the first two phases of the MCEA process.

**Approach 1** is undertaken with a broad scope and level of assessment. This process follows Phases 1 and 2 as defined above, then uses the Master Plan as a basis for future investigations of site-specific Schedule ‘B’ and ‘C’ projects. Any Schedule ‘B’ and ‘C’ projects that need specific Phase 2 work and Phases 3 and 4 work, usually have this Phase 2, 3, and 4 deferred until the actual project is implemented.

**Approach 2** is undertaken to complete all work necessary for Schedule ‘B’ site-specific projects at the time they are identified. Using this approach, a municipality would identify everything it needed in the first five years and would complete all the site-specific work required, including public consultation to meet Class EA requirements.

The Master Plan in such cases must be completed with sufficient detail so that the public can be reasonably informed, and so that the approving government Agencies (Conservation Authorities, MECP, Ministry of Citizenship and Multiculturism, etc.) can be satisfied, in principle, that their concerns will be addressed before construction commences.

**Approach 3** is to complete the requirements of Schedule 'B' and Schedule 'C' at the Master Plan stage. The Master Plan would document Phases 1 to 4 of the Class EA process.

### 1.2.1 Class EA Project Classification

This Master Plan is being undertaken in accordance with Approach #2 of the Master Planning Process, as outlined in Appendix 4 of the Municipal Class EA document (2015). Master plans are long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system(s) or group of related projects to outline a framework for planning for subsequent projects and/or developments. This report is intended to fulfill the requirements of Schedule B projects which may be identified through the Master Planning process.

### 1.2.2 Section 16 Order Process

Interested persons may provide written comments to the City of Kitchener for a response using the following contact information:

Jean Hao
Design & Construction Project Manager
City of Kitchener
Jean.Hao@kitchener.ca
519-741-2200 ext. 4156

In addition, a request may be made to the Minister of the Environment, Conservation and Parks under Section 16 of the *Environmental Assessment Act* requiring a higher level of study (i.e., requiring an individual/comprehensive EA approval before being able to proceed), or that conditions be imposed (e.g., require further studies), only on the grounds that the requested order may prevent, mitigate, or remedy adverse impacts on constitutionally protected Aboriginal and treaty rights. Requests on other grounds will not be considered. Requests should include the full name and contact information of the person(s) making the request for the ministry.

Requests should specify what kind of order is being requested (request for additional conditions or a request for an individual/comprehensive environmental assessment), how an order may prevent, mitigate, or remedy those potential adverse impacts, and any information in support of the statements in the request. This will ensure that the ministry is able to efficiently begin reviewing the request.

The request should be sent in writing by mail or by email to:

Minister of the Environment, Conservation and Parks
Ministry of Environment, Conservation and Parks
777 Bay Street, 5th Floor.
Toronto ON M7A 2J3
minister.mecp@ontario.ca

and

Director, Environmental Assessment Branch
Ministry of Environment, Conservation and Parks
135 St. Clair Ave. W, 1st Floor.
Toronto ON, M4V 1P5
EABDirector@ontario.ca

Requests should also be sent to the City.

## 1.3 Consultation

Consultation is a vital part of the Class EA process. Active engagement with all potentially affected parties including government agencies, community members, special interest groups, and Indigenous Nations ensures a transparent and responsible planning process.

### 1.3.1 Project Contact List

A project contact list was created which includes multi-level government agencies and officials, City of Kitchener staff, committees, emergency service contacts, potentially interested Indigenous Nations, members of the public, utility services, and special interest groups. The list was regularly updated to include those who expressed interest in the study. A copy of the contact list is provided in Appendix A.

### 1.3.2 Project Notices

Notices were sent via mail or email (where requested) to property owners within the study area, the project contact list, and Indigenous Nations. Notices were published in the Kitchener Record newspaper and posted on the City's website (Link to Integrated Sanitary Master Plan site. https://www.engagewr.ca/sanitarymasterplan). The Public Information Centres (PICs) were also promoted through paid targeted advertisements on social media. The study notifications are provided in Appendix A, and include:

- Notice of Study Commencement – published in The Record newspaper on September 2 and September 9, 2021. Posted on the City's Engage Kitchener website on September 2, 2021. Mailed and emailed to the project contact list and Indigenous Nations on September 2, 2021.

- Notice of Public Information Centre 1 – published in The Record newspaper on July 8 and July 15, 2022. Posted on the City's Engage Kitchener website on July 8, 2022. Mailed and emailed to the project contact list and Indigenous Nations on July 8, 2022.
- Notice of Public Information Centre 2 – published in The Record newspaper on December 6 and 13, 2023. Posted on the City's Engage Kitchener website on December 6, 2023. Mailed and emailed to the project contact list and Indigenous Nations on December 6, 2023.
- Notice of Study Completion – the notice will be published in The Record newspaper, posted on the City's Engage Kitchener website, and mailed and emailed to the project contact list and Indigenous Nations.

### 1.3.3 Public Consultation

Two Virtual PICs were hosted on the City's website (Link to Integrated Sanitary Master Plan site. https://www.engagewr.ca/sanitarymasterplan) as a component of the consultation process for this study, to provide the public with an opportunity to ask questions, share feedback, and express concerns throughout the study process, while assisting the development of a preferred plan.

#### 1.3.3.1 Virtual Public Information Centre 1

The first Virtual PIC was hosted on the City's Engage website from July 8 to August 8, 2022. The purpose of the PIC was to present the study process, problems being addressed, and background information. A pre-recorded presentation was provided online. A copy of the presentation and transcript were made available online for download and were available to be mailed out upon request.

Interested persons were invited to submit comments through the City's Online Forum Tool, Online Question Tool, Online Quick Poll, and through the project team emails provided on the City's website. Six comments were received through the Forum Tool, one comment received through the Question Tool, three responses through the Quick Poll, and two emails were received by the project team. Common themes of the questions received included centralization of municipal sanitary systems, wastewater heat recovery, low impact development and stormwater management. A copy of the comments and the City's responses are provided in Appendix A.

#### 1.3.3.2 Virtual Public Information Centre 2

The second Virtual PIC was hosted on the City's Engage website from December 6, 2023, to January 7, 2024. The purpose of the PIC was to present the evaluation process, recommended solutions, and next steps. A pre-recorded presentation and interactive map were provided online. A copy of the presentation and transcript were made available online for download and were available to be mailed out upon request.

Interested persons were invited to submit comments through the City's Online Forum Tool, Online Question Tool, and through the project team emails provided on the City's website.

Five comments were received through the Forum Tool, no comments were received through the Question Tool, and two emails were received directly by the project team. Common themes of the questions received included potential to convert existing septic systems to municipal sanitary services, timing and format of the PIC, the quantity of inflow and infiltration flows into the sanitary system, inflow and infiltration data and monitoring, and using demand management to reduce water consumption to lessen sanitary sewer flows. A copy of the comments and the City's responses are provided in Appendix A.

### 1.3.4 Agency Stakeholder Consultation

The notices were sent to relevant agencies and stakeholders to solicit feedback on the project. A list of the agencies and stakeholders is provided below:

Provincial/Federal

- Ministry of Environment, Conservation and Parks
- Ministry of Citizenship and Multiculturalism
- Ministry of Agriculture, Food, and Rural Affairs
- Ministry of Indigenous Affairs
- Department of Fisheries and Oceans Canada
- Infrastructure Ontario

Municipal

- Region of Waterloo
- City of Waterloo
- City of Cambridge
- Township of Wilmot
- Township of Woolwich

Agencies

- Grand River Conservation Authority
- Waterloo Region Home Builders Association
- Greater Kitchener Waterloo Chamber of Commerce
- University of Waterloo Water Institute
- Allstream
- Bell Canada
- Enbridge
- Hydro One
- Enova Power Corp.
- Rogers
- Telus
- Waterloo-North Hydro
- Kitchener Utilities
- Waterloo Regional Police Services
- Region of Waterloo Paramedic Services
- City of Kitchener Fire

A copy of agency correspondence is provided in **Appendix A**.

### 1.3.5 Indigenous Consultation

The following Indigenous Nations and organizations were provided with a Notice of Study Commencement on September 2, 2021, and Notice of PIC 1 on July 8, 2022:

- Haudenosaunee Development Institute
- Huron-Wendat Nation
- Mississaugas of the Credit First Nation
- Six Nations of the Grand River Territory

The following Indigenous Nations and organizations were provided with a Notice of PIC 2 on December 6, 2023:

- Huron-Wendat Nation
- Mississaugas of the Credit First Nation
- Six Nations of the Grand River Territory

Further consultation meetings were held:

- Haudenosaunee Development Institute
    - 2021-11-16
- Mississaugas of the Credit First Nation
    - 2023-03-28
    - 2024-02-09
- Six Nations of the Grand River
    - 2023-02-28

Throughout the study, Notices and communications were sent by email.

## 1.4 Report Organization

This report is divided into 11 sections:

- Section 1.0 introduces the project, outlines the study area, details the study process, and provides an overview of the consultation undertaken throughout the study.
- Section 2.0 identifies the problem and opportunity statement, which guides the study as alternatives are developed.
- Section 3.0 outlines the planning documents and policies that are relevant to this study and have the potential to influence the decision-making process.
- Section 4.0 provides an overview of the existing conditions within the study area, including the social environment, existing sanitary sewer system, and the existing sanitary sewer system under future conditions.

- Section 5.0 presents the future population projections and updates to the sanitary system.
- Section 6.0 summarizes the design criteria and level of service metrics used to assess the sewer system performance and triggers for upgrades.
- Section 7.0 presents an assessment of the existing and future sanitary sewer system, opportunities and constraints identified in the review.
- Section 8.0 discusses the development and evaluation of alternative solutions, and the decision-making process to get to the recommended solution.
- Section 9.0 highlights the project implementation process, including a potential construction timeline for priority and strategic projects, and estimated project costs.
- Section 10.0 discusses innovation opportunities for the City of Kitchener to further consider.
- Section 11.0 summarizes the conclusions and recommendations of the Master Plan report.

### 1.4.1 Technical Memos

In the completion of the ISAN-MP, four (4) supporting Technical Memos (TM) were developed. Each memo is briefly described below. Note that TM4 was integrated with TM3.

- **Technical Memo 1** – Background Review
- **Technical Memo 2** – Hydraulic Analysis
    - Technical Memo 2a: Model Assessment and Software Recommendation
    - Technical Memo 2b: Model Plan
    - Technical Memo 2c: Calibration
    - Technical Memo 2d: Modelling Scenarios
- **Technical Memo 3 (including TM4)** – Sanitary Servicing Analysis & Capital Infrastructure Funding and Risk Analysis and Implementation Plan
- **Technical Memo 5** – Design Criteria & Level of Service

The TMs are referenced throughout this document and are provided under separate cover in Volume 2.

# 2 Problem Statement and Opportunity Identification

A problem and opportunity statement was developed at the onset of the study.

The City of Kitchener has significant sanitary sewer infrastructure which needs to be managed to ensure it is resilient and sustainable for future generations. The growing population in the City, as identified in the Official Plan, will lead to an increase in the production of wastewater, causing additional strain on aging infrastructure and may require new infrastructure. The potential impacts of climate change or other stressors to normal operation such as a global pandemic may further reduce sanitary service levels and drive the need for new infrastructure.

This sanitary servicing review will assess the current state of the City's sanitary sewers and pumping stations. Where issues are identified, the City will identify preferred solutions that will continue to service existing homes and businesses as well as provide the ability to service identified growth areas. The City is committed to providing a reliable and sustainable sanitary servicing system.

# 3 Planning & Policy Framework

A summary of the federal, provincial, and municipal planning and policy context is provided below as it relates to the Master Plan.

## 3.1 Federal Legislation

### 3.1.1 Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act* (2012) focuses federal environmental review on projects which have the potential to cause significant adverse environmental effects in areas of federal jurisdiction. For the *Act* to apply, the proposed project must be designated under the "Regulations Designating Physical Activities" and specifically be listed in the "Schedule for Physical Activities". Review of the Schedule for Physical Activities shows there is no physical activity that matches the work proposed. Therefore, meeting the requirements of the *Canadian Environmental Assessment Act* will not be necessary for this project.

### 3.1.2 Fisheries Act

The federal Fisheries Act (1985) is the primary legislation governing fish and fish habitat in Canada. The Fisheries Act defines fish habitat as "…waters frequented by fish and any other areas on which fish depend directly or indirectly in order to carry out their life processes including spawning grounds and nursery, rearing, food supply and migration areas." The fish and fish habitat protection provisions of the Fisheries Act apply to all fish and fish habitat in Canada. The Act prohibits activities that result in the death of fish or the harmful alteration, disruption, or destruction (HADD) of fish habitat unless authorized by the Minister of Fisheries, Oceans, and the Canadian Coast Guard. If it is determined that the death of fish or HADD of fish habitat is unavoidable as part of the Project, an authorization under the Fisheries Act may be required.

### 3.1.3 Species at Risk Act

The *Species at Risk Act* (SARA) identifies wildlife species considered to be at risk in Canada and designates them as threatened, endangered, extirpated or of special concern. Species at Risk (SAR) are identified and assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which is an independent committee of wildlife experts and scientists that makes recommendations to the federal government regarding the status of wildlife species in Canada.

The purpose of SARA is to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered, or threatened because of human activity and to manage species of special concern to prevent them from becoming endangered or threatened.

The protection and conservation measures afforded by SARA apply to those species identified on Schedule 1 of the *Act.* Other species identified by COSEWIC as SAR that required further assessment in accordance with current assessment criteria are identified on Schedule 2 (Endangered and Threatened) and Schedule 3 (Special Concern) of the *Act*. All listed (Schedule 1) aquatic species and migratory birds in Canada are protected by SARA. Remaining listed species (plants, mammals, reptiles, amphibians) are only protected where they occur on federal lands (i.e., National Parks, First Nations Reserves).

Any activity affecting a listed species, or its critical habitat requires the prior issuance of a permit from the applicable agency, either Environment and Climate Change Canada or Fisheries and Oceans Canada (DFO). Permits may only be issued for scientific research relating to the conservation of the species, where activities are required to benefit a species or to enhance its chances of survival or for incidental impacts. Efforts to avoid, reduce, or minimize impacts must first be employed and activities will not be permitted if they would jeopardize the survival or recovery of the species.

## 3.2 Provincial Policies and Legislation

### 3.2.1 The Planning Act

The *Planning Act, R.S.O. 1990, c.P13* sets the framework for land use planning in Ontario. According to the provisions within the Act, the Province of Ontario is the primary authority for planning matters in Ontario, and the *Act* enables the Province to delegate some of its planning authority to the upper-tier municipalities (i.e., counties and regional/district municipalities, and planning boards) while retaining control through the approval process. Municipalities must conform to approved policies of the Provincial government and its agencies. Provincial ministries, municipal councils, planners, and other stakeholders implement the *Act* when they undertake certain actions, including:

- Preparing Official Plans and planning policies that guide future development considering provincial interests, such as protecting and managing natural resources;
- Regulating and controlling land uses through zoning by-laws and minor variances; and
- Dividing land into separate lots for sale or development through Plans of Subdivision or a Land Severance.

This study considers development applications approved under the *Planning Act* and associated conditions of approval along with lands designated for future development within the City of Kitchener.

### 3.2.2 Provincial Policy Statement

The *Provincial Policy Statement* (PPS) (2020), issued under Section 3 of the *Planning Act*, sets a policy foundation for regulating the development and use of land. It provides direction on matters of provincial interest and supports the enhancement of the quality of life for all citizens of Ontario, while still maintaining environmental integrity. In accordance with Section 3 of the *Planning Act*, decisions affecting planning matters shall have regard for the PPS. The PPS establishes a framework to build strong communities while ensuring development patterns are efficient and optimize the use of land, resources, and public investment in infrastructure.

Policies relevant to water infrastructure include the requirement for infrastructure to be provided in a coordinated, efficient, and cost-effective manner that considers impacts from climate change while accommodating projected needs (Policy 1.6.1). These systems are meant to minimize erosion and changes in water balance and prepare for the impacts of a changing climate through the effective management of stormwater, including the use of green infrastructure (Policy 1.6.6). The service shall promote the efficient use and optimization of existing services, ensure the systems are reliable, promote efficiency, and integrate land use considerations throughout the process. The preferred alternatives and supporting recommendations will meet the objectives of the PPS by providing for infrastructure that is appropriate to address projected needs, protects the natural environment and protects public health and safety.

### 3.2.3 Endangered Species Act

The *Endangered Species Act* (ESA) (2007) identifies wildlife species considered to be at risk in Ontario and designates them as threatened, endangered, extirpated or of special concern. Provincial species at risk are identified and assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) which is a committee of wildlife experts and scientists, as well as those who provide Indigenous traditional knowledge, that classify species according to their degree of risk based on the best available scientific information, community knowledge and Indigenous traditional knowledge. When COSSARO classifies a species at risk, that classification applies throughout Ontario, unless otherwise noted.

The ESA protects species at risk and their habitats by prohibiting anyone from killing, harming, harassing, or possessing protected species, as well as prohibiting any damage or destruction to the habitat of species identified on the Species at Risk in Ontario (SARO) list. Species listed as threatened or endangered on the SARO list are provided with general habitat protections under the *ESA*, which protect areas that species depend on to carry out their life processes, such as reproduction, rearing, hibernation, migration, or feeding.

Activity that may impact a protected species or its habitat requires the prior issuance of a permit from the MECP. Such permits may only be issued under certain circumstances, which are limited to activities required to protect human health and safety, activities that will assist in the protection or recovery of the species, activities that will result in an overall benefit to the species or activities that may provide significant social or economic benefit without jeopardizing the survival or recovery of the species in Ontario.

A permit may be issued under Section 17(2) of the ESA or eligible activities can be registered under Ontario Regulation 242/08 to authorize work that is otherwise prohibited.

Consultation with the ministry is recommended early in detailed design and prior to the works starting to ensure compliance with the ESA.

### 3.2.4 Climate Change

The MECP's guide, *Consideration of Climate Change in the Environmental Assessment Process*, outlines two approaches for considering and addressing climate change in project planning, including:

- Reducing a project's impact on climate change (climate change mitigation measures).
- Increasing the projects and the local ecosystem's resilience to climate change (climate change adaptation).

As part of this study, the objectives of the climate change document have been considered and incorporated into the generation and evaluation of alternatives and mitigation measures.

### 3.2.5 Grand River Conservation Authority

The *Conservation Authorities Act* (CAA) was created with the purpose of conservation, restoration, development, and management of natural resources in watersheds in Ontario. The CAA is now administered by the Ministry of the Environment, Conservation and Parks (MECP). The Ministry of Natural Resources and Forestry (MNRF) is responsible for conservation authorities' activities related to natural hazard management. Conservation Authorities are enabled with regulatory responsibility within their respective jurisdictions. The Grand River Conservation Authority (GRCA) is the CAA regulatory agency for the study area.

Under Ontario Regulation 150/06, GRCA reviews projects and implements their permitting process to achieve the following under the CAA:

- Prevent the loss of life and property due to flooding and erosion.
- Prevent pollution.
- Conserve and enhance natural resources.

The regulation applied to fill placement and removal or site grading, flood prone areas, erosion prone areas, dynamic beach areas, alteration of watercourses, and interference with wetlands.

## 3.3 Municipal Planning Policies

### 3.3.1 Region of Waterloo Official Plan

The Region of Waterloo Official Plan (2015) directs growth and change towards a more balanced community structure. The Region of Waterloo is an upper tier municipal government, and includes the Cities of Cambridge, Kitchener, and Waterloo, and the Townships of North Dumfries, Wellesley, Wilmot, and Woolwich.

The Region is committed to a sustainable community, by providing infrastructure services that support a diverse and growing economy that develop the Region is a sustainable manner.

The Official Plan notes the Region will prepare and update a Regional Wastewater Treatment Master Plan (see **Section 3.3.2**) to provide direction for planning and staging of investments in the Region's wastewater treatment plants and facilities. The plan guides the operation of the Region's day-to-day wastewater treatment programs and protects human health and the natural environment.

### 3.3.2 Region of Waterloo Wastewater Treatment Master Plan

The Region of Waterloo Wastewater Treatment Master Plan (2018) provides strategic long-term planning for the Region's wastewater treatment services. The plan developed a comprehensive, cost-effective, and feasible strategy to address wastewater treatment needs for a 35-year horizon.

The Region owns wastewater treatment plants, wastewater residuals processing facilities, wastewater pumping stations, and wastewater collection systems, treating approximately 66 million cubic meters of wastewater annually. Most of the collection systems and pumping station infrastructure that conveys wastewater to the Region's treatment facilities are owned, managed, and operated by the area municipalities (Cities of Cambridge, Kitchener, Waterloo and Townships of Wilmot, Woolwich). The Wastewater Treatment Master Plan identifies projects, new technologies, and servicing strategies to meet long term needs of residents and businesses within the Region. The Kitchener plant rated capacity is cited as 122,745 $m^3$/d, with sufficient capacity for planned growth to 2051.

### 3.3.3 City of Kitchener Official Plan

The City of Kitchener Official Plan (2014) provides a framework for decision-making and plays several essential roles in the future planning of the City, through to the year 2031. The Official Plan supports new development and growth by optimizing the use of existing and new infrastructure and ensure that any growth will not overload the existing municipal sanitary and storm sewer systems. The City promotes the efficient use of the existing sanitary services and minimizing the number of pumping stations required. In addition, the City prepares and updates as appropriate, studies to assess capacity to meet requirements for upgrades and maintenance and plan for long-term sanitary sewer needs.

# 4 Existing Conditions

## 4.1 Natural, Social, and Economic Environment

As part of the study, the existing natural, social, and economic features were taken into consideration when evaluating the alternatives to identify preferred solutions. A desktop inventory was completed for natural, social features, and economic contributions.

### 4.1.1 Social Environment

Social features identified for consideration in the evaluation process included: regional cycling routes, historical streets, heritage buildings, heritage districts, cultural heritage landscapes, and significant buildings in the City. **Figure 4-1** provides a map of the social environment identified within the City. As the City progresses the improvements from this Master Plan, these social features will be considered.

### 4.1.2 Natural Environment

Natural features identified for consideration in the evaluation process included: waterbodies, watercourses, regional recharge areas, significant valleys, wetlands, regional forests, forest greater than 4 ha, and environmentally sensitive policy areas. **Figure 4-2** provides a map of the natural features identified within the City. As the City progresses the improvements from this Master Plan, these natural features will be considered.

### 4.1.3 Economic Contributions

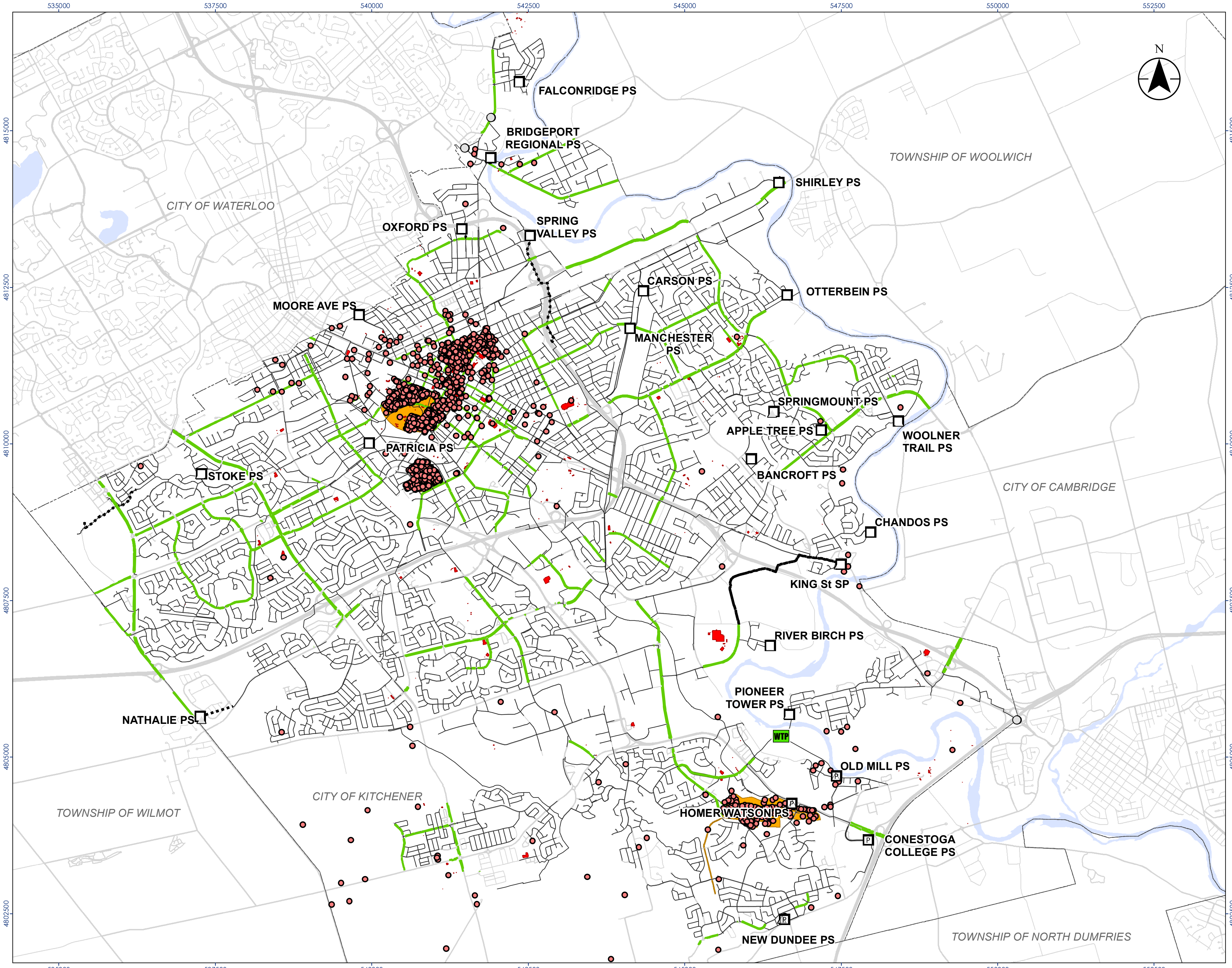
Economic features identified for consideration in the evaluation process included: land use, population distribution, primary nodes, major/minor nodes, major/minor corridors. **Figure 4-3** provides a map of the economic considerations identified within the City. As the City progresses the improvements from this Master Plan, these economic features will be considered.

## 4.2 Existing Population

The City's Planning Department provided the Parcels-Persons-Jobs (PPJ) data which estimates the current population and job numbers per land use parcel across the City as presented in **Table 4-1**. **Figure 4-3** presents the population distribution, indicating the balance of greenfield development in the outskirts of the City and the intensification within major urban corridors. There is a mix of residential and Industrial/Commercial/Institutional (ICI), or employment, usage throughout.

**Table 4-1: Existing Population**

| Horizon | Residential | Employment | Total Equivalent Population |
|---|---|---|---|
| 2021 | 251,000 | 79,000 | 330,000 |




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WTP WWTP
- Heritage Properties
- Cycling Infrastructure
- Other Sewers
- Forcemain
- City Owned Buildings
- Heritage District

0 1 2 km

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**Notes**

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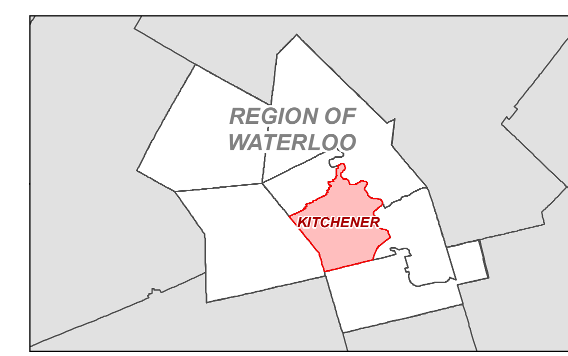


Project Location
City of Kitchener

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Prepared by EH on 2024-03-15

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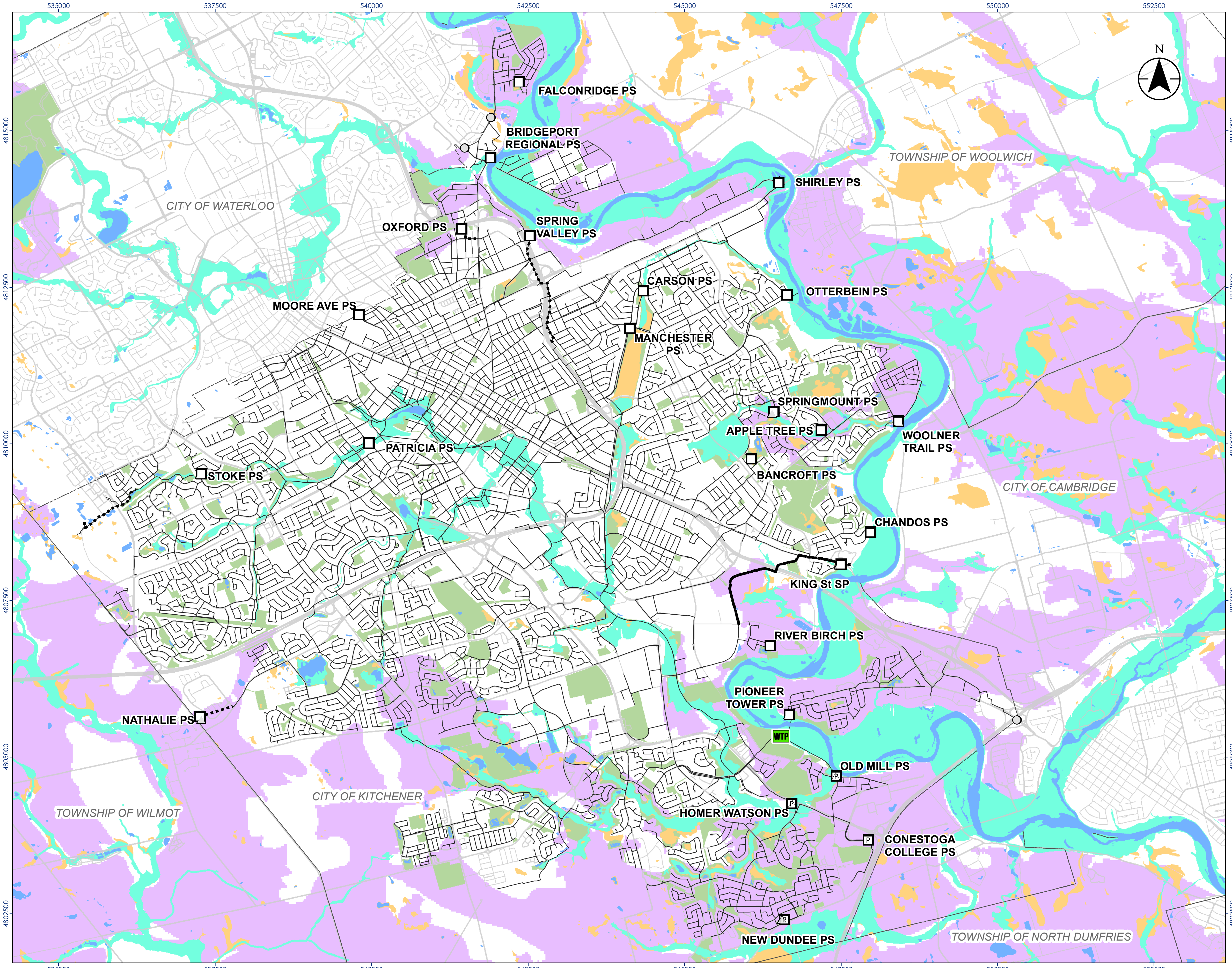
Figure No.
**4-1**

Title
**Social Environment**




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Other Sewers
- Forcemain
- Park Land
- Wetland
- Waterbody and Watercourse
- Regulatory Floodplain Limit
- Groundwater Recharge Area

0 1 2 km

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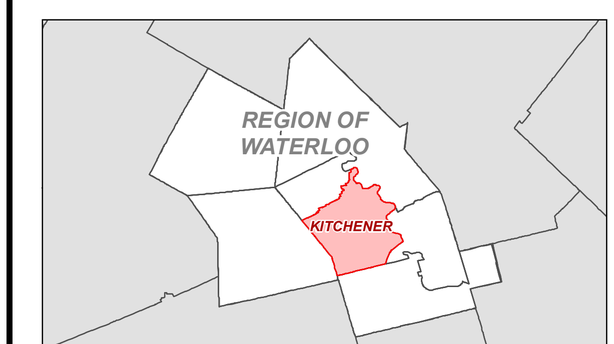


Project Location
City of Kitchener

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Figure No.
**4-2**

Title
**Natural Environment**

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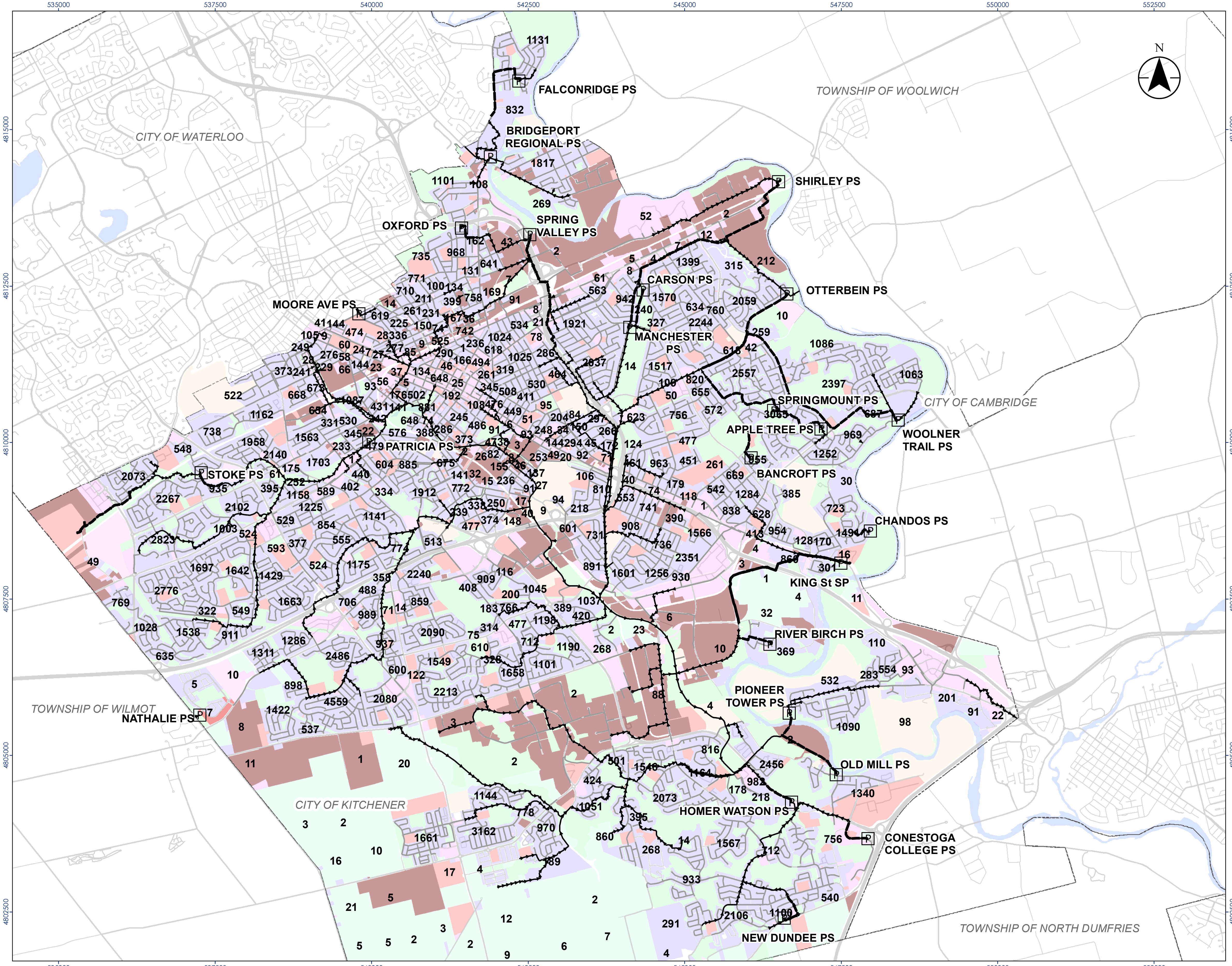


**Stantec**

**Legend**

- P Sanitary Pumping Stations
- Forcemain
- Sub-Trunk
- Trunk Sewer
- Local Sewer
- # Population

**Land Use**

- Agricultural
- Commercial
- Industrial
- Institutional
- Mixed Use
- Open Space
- Recreational
- Residential
- Utility

0 1 2 km

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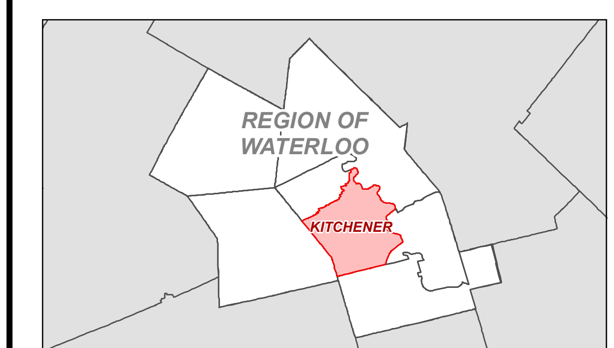


Project Location
City of Kitchener

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Figure No.
**4-3**

Title
**Economic Contributions**

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## 4.3 Existing Sanitary System

### 4.3.1 Background Reports

The City has undertaken various studies of portions of its sanitary sewer network to better understand functional capacity and overall performance in specific areas. As well, asset management plans for the Sanitary Utility were completed in both 2013 and most recently in 2019 outlining a detailed analysis of the current condition and forecast for sanitary infrastructure.

A selection of key documents to be relied upon for this ISAN-MP include:

- Sanitary System Asset Management Plan (2018)
- Region of Waterloo 2018 Wastewater Treatment Master Plan (2018)
- Kitchener Growth Management Plan (2019)
- Sanitary Sewer System Model Update (2019)
- Pumping Station Assessment Reports (2012 & 2020)
- 2020 Capital Budget & 10-Year Forecast (2019) + 2021 to 2030 Projects & Funding
- Design Criteria Guidelines/Specifications
- Cross-Border Agreements (Various)
- Region of Waterloo 2018 Wastewater Treatment Master Plan (2018)
- Water Consumption vs Processing Charges
- Kitchener Growth Management Plan (2019)
- Sanitary System Asset Management Plan (2018)

These sources were reviewed to gather an understanding of the existing sanitary sewer network.

### 4.3.2 Cross-Border Agreements

Multiple servicing agreements have been established with neighboring municipalities, as detailed in **Table 4-2.**

### Table 4-2: City of Kitchener Cross-Border Agreements

| ID | Municipality | Location | Discharge | Maximum Sewage Flow (L/s) | Notes |
|---|---|---|---|---|---|
| 1 | Township of Woolwich | Breslau | Inflow to Kitchener (Shirley PS) | 189 L/s | 2017 (update). Woolwich allocated 50% of Shirley PS flow capacity. |
| 2 | | Safety Kleen | Pumped Inflow to Kitchener | 38 L/s (2am to 5am) | 1991. Private industrial treated wastewater under Grand River to Otterbein (Forwell) PS (connects at JCT-88). Restricted discharge between 2am and 5am. Flow is measured. |
| 3 | City of Cambridge | Sportsworld | Outflow to Cambridge | None Reported | 2012. Payment to Cambridge based on water consumption. Drainage Area defined. Expires 2032. |
| 4 | | Conestoga College | Pumped Inflow to Kitchener WWTP | None Reported | 2011. Forcemain directly to WWTP. |
| 5 | Township of Wilmot | Mannheim Village Estates | Pumped Inflow to Kitchener | 7.05 L/s | 2015. Measured annually at pump station (max 77 units can be serviced). Discharge to MH311511 (Ottawa St). |
| 6 | Region of Waterloo | 925 Erb Street West Landfill | Pumped Inflow to Kitchener | 30 L/s | 2017. Leachate to MH310088. Region measures flow at the Landfill pumping stations. |
| 7 | City of Waterloo | Ira Needles (Boardwalk) | Inflow to Kitchener | None Reported | 2011. For water, stormwater management and sanitary services. |
| 8 | | Various Residential | Inflow to Kitchener and Outflow to Waterloo | None Reported | 1996. Sewage treatment paid based on water consumption. 34 Kitchener properties to Waterloo; 105 Waterloo properties to Kitchener. |
| 9 | | Bridgeport North (Falconridge) | Inflow to Kitchener and Pumped Outflow to Waterloo | None Reported | 2000. Falconridge PS to Bridgeport PS (Region) to Waterloo system. Kitchener pays for volume treated in Waterloo. |
| 10 | | Bridgeport PS | Pumped Outflow to Waterloo | None Reported | 1996. Kitchener pays servicing fee equal to Regional Treatment Rate for the portion of actual metered sewage flows based on water usage ratio between Waterloo and Kitchener to Bridgeport PS. |

The City of Kitchener Cross-Border Agreements necessitate regular updates to ensure their relevance and effectiveness. This is particularly crucial for older agreements, such as Safety Kleen, which was established in 1991.

Periodic reviews help align these agreements with current standards and practices. Terms within the agreements need to be clearly defined. Clear definitions will help avoid future disputes or misunderstandings.

The agreements also need to be flexible and adaptable to changing circumstances. For example, the allocation of 50% of Shirley PS flow capacity to the Township of Woolwich may need to be reviewed regularly to ensure its appropriateness based on current and projected future usage.

Environmental considerations are important, especially for agreements involving industrial waste like Safety Kleen. Regular environmental impact assessments should be incorporated into these agreements.

Planning for the future is another crucial aspect. Agreements nearing their expiration date, such as the City of Cambridge agreement expiring in 2032, require early planning for any necessary extensions or modifications.

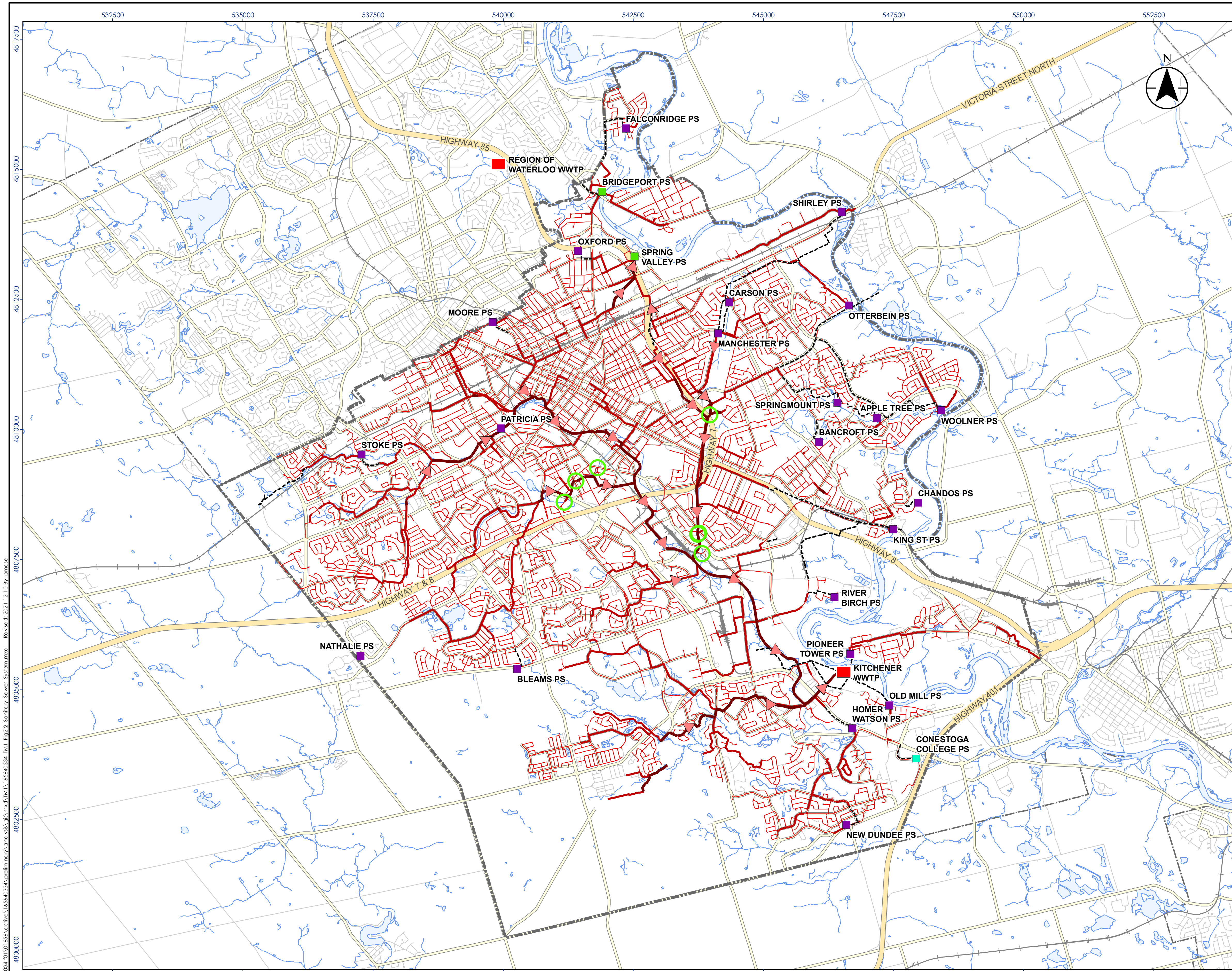
### 4.3.3 Existing Infrastructure and Inventory

#### 4.3.3.1 General Overview

The City operates the sanitary sewage collection system under the MECP-issued Consolidated Linear Infrastructure Environmental Compliance Approval (CLI-ECA) # 019-W601 (January 29, 2023), found on the City's website Link to Environmental compliance approval - https://www.kitchener.ca/en/resourcesGeneral/Documents/INS_SSU_ECA_019-W601.pdf.

**Figure 4-4** provides an overview of the sanitary sewer system within the City boundary, that consists of works for the collection and transmission of sewage including trunk sewers, local sewers, sewage pumping stations, and forcemains, with discharge into the City of Waterloo's sanitary system, City of Cambridge's sanitary system, and the Region of Waterloo's Kitchener Wastewater Treatment Plant (WWTP).

There is approximately 855 km of pipes and 22 sewage pumping stations owned by the City. The following subsections provide more information on the component parts of the sanitary collection and transmission system.




Legend

- Wastewater Treatment Plant
- Sanitary Pumping Station (City of Kitchener)
- Sanitary Pumping Station (Region of Waterloo)
- Sanitary Pumping Station (Other)
- Flow Direction
- Syphon Pipe
- Forcemain

**Sanitary Sewer (Diameter)**

- 825 - 2250 mm
- 375 - 750 mm
- 100 - 300 mm
- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Waterbody
- City of Kitchener Boundary
- Other Municipal Boundary

0 2 4 km

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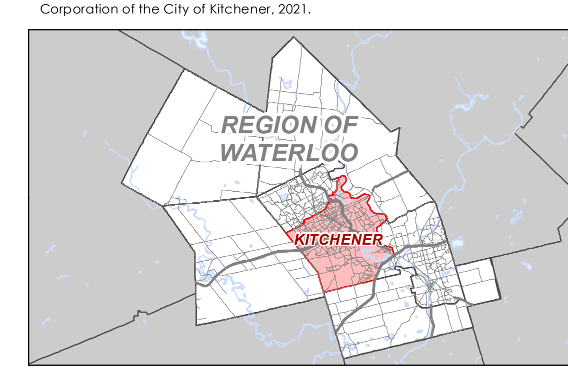


Project Location
City of Kitchener

165640334 REVA
Prepared by PRM on 2021-12-10
Technical Review by FB on 2021-12-10

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Figure No.
**4-4**

Title
**Sanitary Sewer System**

#### 4.3.3.2 Sewage Pumping Stations

The location and ownership of the sanitary pump stations (SPS) included within the City's collection system is shown in **Table 4-3**.

**Table 4-3: Sanitary Pump Station Information**

| PS No. | Name | Ownership | Assessment Report Year | Notes |
|---|---|---|---|---|
| 01 | Bleams | Kitchener | 2012 | Decommissioned |
| 02 | Nathalie | Kitchener | 2022 | Built |
| - | Manheim | Township of Wilmot | 2012 | |
| 03 | Stoke | Kitchener | 2020 | |
| 04 | Patricia | Kitchener | 2021 | |
| 05 | Moore | Kitchener | 2021 | Decommissioning |
| 06 | Oxford | Kitchener | 2020 | |
| 08 | Falconridge | Kitchener | 2020 | Formerly Melitzer |
| 09 | Shirley | Kitchener | 2012 | Includes Breslau SPS |
| 10 | Carson | Kitchener | 2021 | |
| 11 | Manchester | Kitchener | 2021 | |
| 12 | Otterbein | Kitchener | 2021 | |
| 13 | Springmount | Kitchener | 2021 | |
| 14 | Bancroft | Kitchener | 2020 | |
| 15 | Apple Tree | Kitchener | 2020 | |
| 16 | Woolner Trail | Kitchener | 2021 | Formerly Zeller and Grand River South |
| 17 | Chandos | Kitchener | 2021 | |
| 18 | King St | Kitchener | 2020 | Formerly Freeport |
| 19 | River Birch | Kitchener | 2021 | |
| 20 | Pioneer Tower | Kitchener | 2021 | Upgraded in 2022 |
| 21 | Old Mill | Kitchener | - | Rebuilt in 2021 |
| 22 | Homer Watson | Kitchener | 2021 | |
| 24 | New Dundee | Kitchener | 2021 | Formerly Doon South |
| - | Spring Valley | Region of Waterloo | 2013 | |
| - | Bridgeport | Region of Waterloo | 2013 | |
| PS No. carried forward from previous reports | | | | |

There are 22 City-owned SPS and two Regionally owned and operated stations in Bridgeport and Spring Valley. The CLI-ECA summarizes the specific station characteristics. Information from assessment reports completed between 2012 and 2021 included drawings, dimensions, rated capacity, condition, operational performance, and recommended upgrades.

#### 4.3.3.3 Sanitary Sewers, Siphons and Forcemains

The sanitary system primarily relies on gravity to transport wastewater to the Kitchener WWTP. The system comprises approximately 818 kilometers of gravity-based sewers, with pipe diameters varying from 100 mm to 2250 mm. The majority of the system (over 85%) consists of pipes that have diameters of 450 mm or smaller. There are short sections of siphons in the system that cross under other infrastructure or watercourses, and approximately 33 km of forcemains associated with pump stations. The age of pipe distribution indicates a relatively young system, with almost half of the sewers built in the last 30 years and only 3% in the ground for more than 70 years.

The sanitary sewer system has been grouped into sewersheds based on the location within the trunk sewer network. **Figure 4-5** presents the trunk sewer names and the associated sewershed.

#### 4.3.3.4 Maintenance Holes

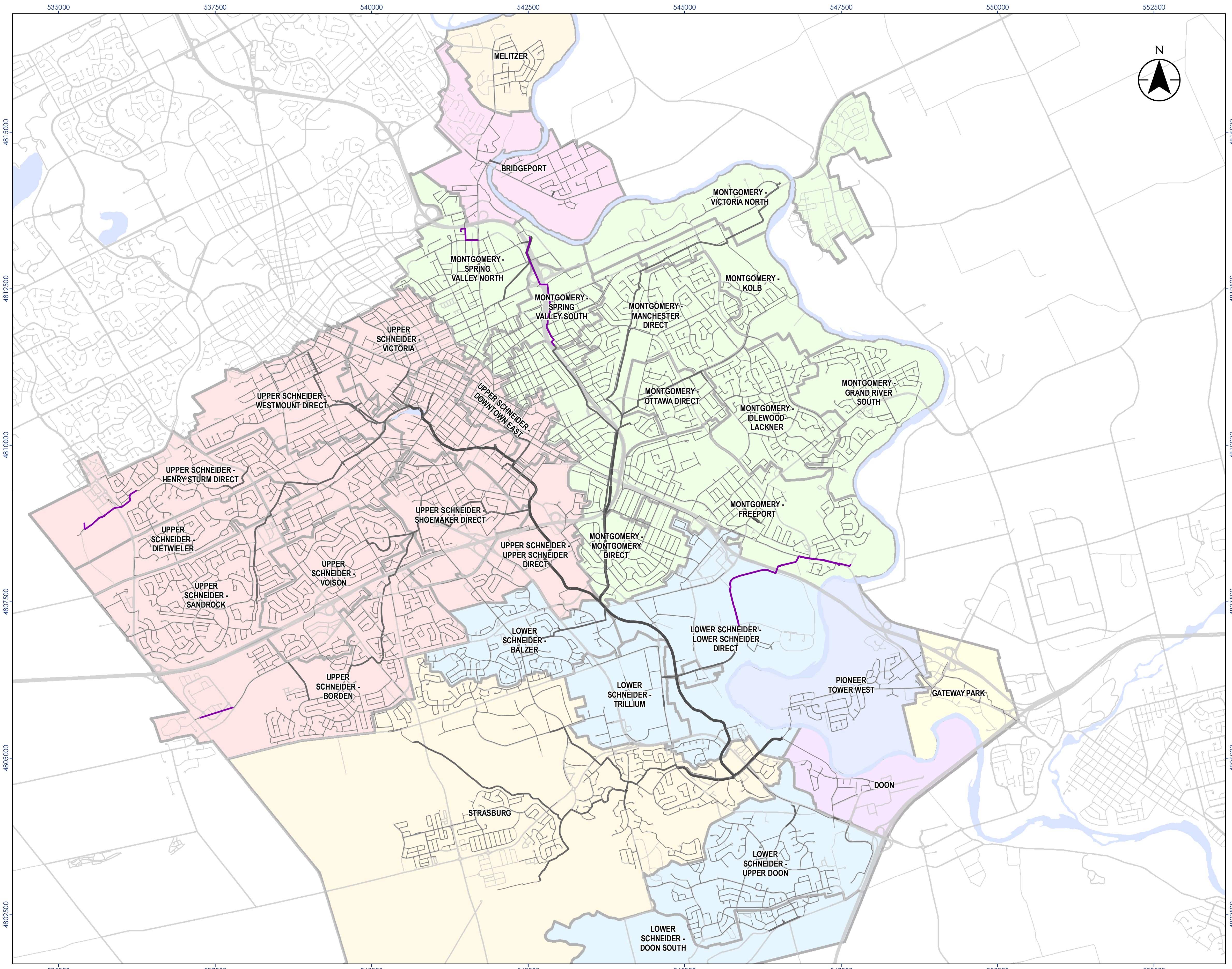
Kitchener has over 12,600 publicly owned maintenance holes (MH), acting as access points for inspection and maintenance activities. The majority of MHs are located within the municipal right-of-way; however, some exist within easements or along watercourses. Additionally, the collection system includes private MH connections from private property.

### 4.3.4 Monitored Flow

To support understanding of the sanitary sewer system performance over time, the City conducts temporary rainfall and flow monitoring programs throughout the collection system. For the ISAN-MP, a temporary flow monitoring program was conducted as discussed in **TM2** and summarized in the following sections.

#### 4.3.4.1 2021 Monitoring Program

20 flow meters were strategically installed from July 2021 through November 2021, mostly in local or sub-trunk sewers to maximize sewer system coverage, as shown in **Figure 4-6**. **Table 4-4** summarizes the location of the meters, the sizes of the pipes, and the characteristics of the areas that contribute to the flow.




Stantec

Legend

**Sanitary Sewer**

- 100 - 525 mm
- 600 - 1050 mm
- 1200 - 2500 mm
- Forcemain

**Sub Trunk**

- Bridgeport
- Doon
- Gateway Park
- Lower Schneider
- Melitzer
- Montgomery
- Pioneer Tower West
- Strasburg
- Upper Schneider

0 1 2 km

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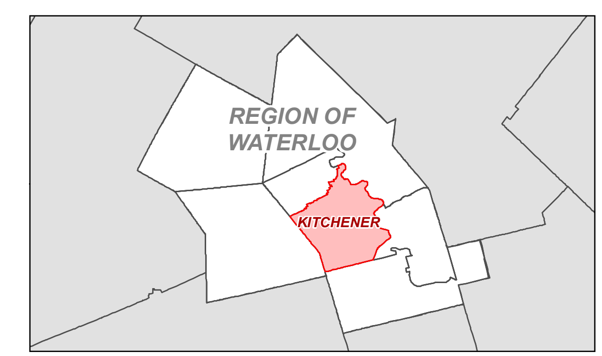


Project Location
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Figure No.
**4-5**

Title
**Trunk Sewer Network and Sewershed Classification**

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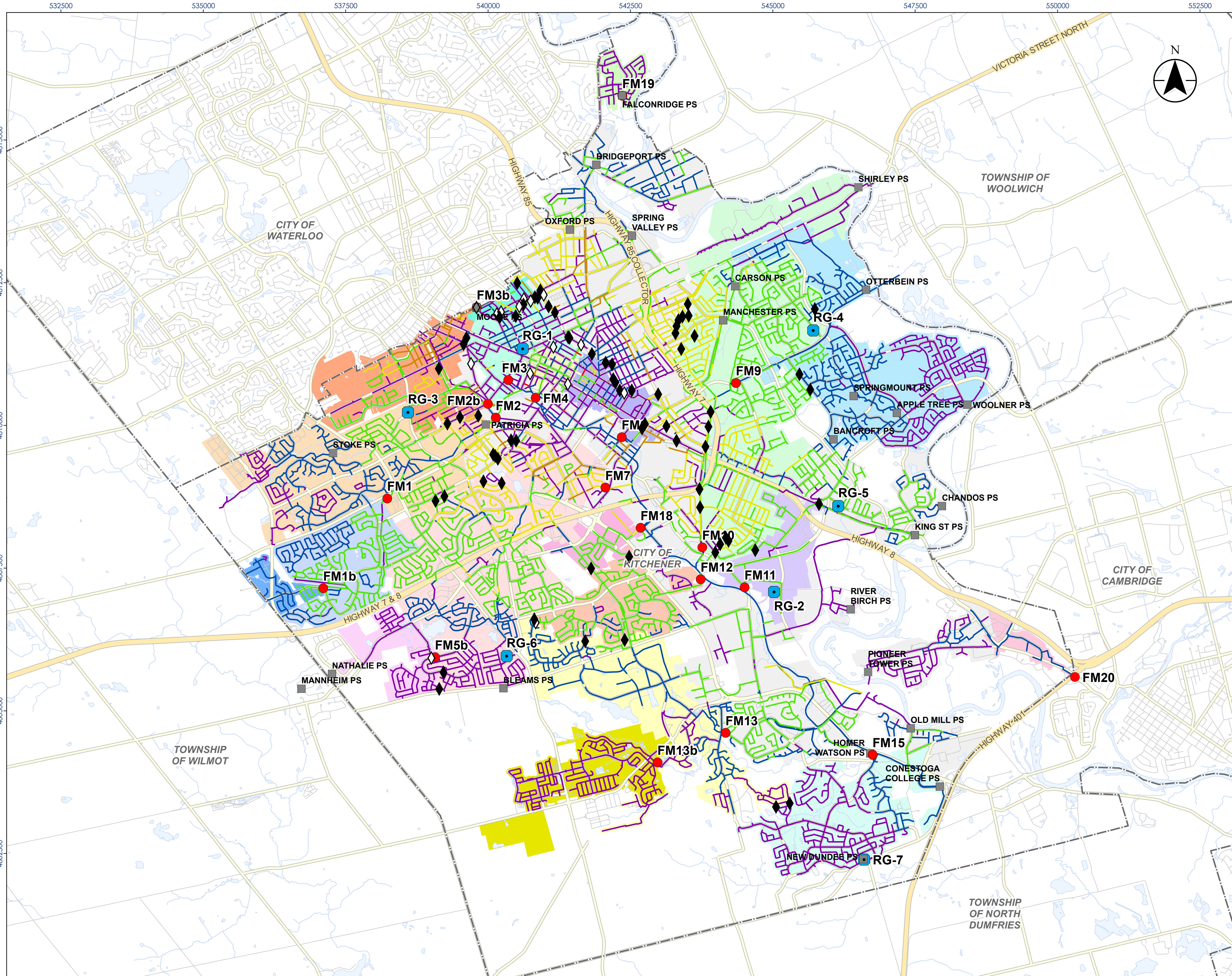


Stantec

Legend

- Flow Meter
- Rain Gauge
- Sanitary Pumping Station

**Metershed Spill Points**

- Major Flow Split
- Minor Flow Split

**Sanitary Sewer Installation**

- 2000 - 2021
- 1980 - 1999
- 1960 - 1979
- 1940 - 1959
- 1920 - 1939
- 1907 - 1919
- Not Stated

**Flow Metershed**

| | | |
|---|---|---|
| FM1 | FM5b | FM13 |
| FM1b | FM6 | FM13b |
| FM2 | FM7 | FM15 |
| FM2b | FM9 | FM18 |
| FM3 | FM10 | FM19 |
| FM3b | FM11 | FM20 |
| FM4 | FM12 | Unmonitored |

0 2 4 km

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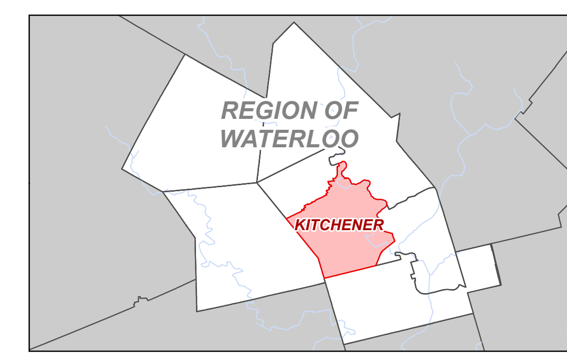



Project Location
City of Kitchener

165640334 REVA
Prepared by KB on 2022-10-05
Technical Review by AL on 2022-10-05

Client/Project
CITY OF KITCHENER
INTEGRATED SANITARY MASTER PLAN

Figure No.
**4-6**

Title
**2021 Flow Monitoring Program Meter & Rain Gauge Locations**

### Table 4-4: Flow Meter & Metershed Characteristics

| FM ID | FM Name and Location | Rain Gauge ID | Pipe Size (mm) | Total[1] Parcel-Based[2] Contributing Area (ha) | Incremental[3] Parcel-Based Contributing Area (ha) | Total[1] % RES[4] Population | Incremental[3] % RES[3] Population | Land Use Classification[5] |
|---|---|---|---|---|---|---|---|---|
| FM1 | 308300-KW-Highland Rd W* | RG3 | 675 | 246 | 206 | 94% | 93% | RES |
| FM1b | 309484-KW-Highview Dr | RG3 | 300 | 40 | 40 | 97% | 97% | RES |
| FM2 | 304470-KW-West Ave* | RG3 | 1050 | 655 | 409 | 89% | 87% | RES |
| FM2b | 304819-KW-Sandrock Creek | RG4 | 675 | 283 | 283 | 69% | 69% | Mixed |
| FM3 | 311165-KW-Victoria St S* | RG1 | 900 | 159 | 128 | 65% | 61% | Mixed |
| FM3b | 2091740-KW-Moore Ave PS | RG1 | 450 | 31 | 31 | 87% | 87% | RES |
| FM4 | 303786-KW-David St | RG1 | 600 | 32 | 32 | 28% | 28% | ICI |
| FM5b | 311440-KW-Activa Ave | RG6 | 525 | 115 | 115 | 99% | 99% | RES |
| FM6 | 301110-KW-Borden Ave S | RG1 | 600 | 87 | 87 | 52% | 52% | Mixed |
| FM7 | 306584-KW-Hoffman St* | RG1 | 900 | 727 | 612 | 91% | 90% | RES |
| FM9 | 301182-KW-Ottawa St N | RG4 | 675 | 420 | 420 | 90% | 90% | RES |
| FM10 | 300305-KW-Shelley Dr* | RG2 | 1200 | 1,213 | 794 | 85% | 81% | RES |
| FM11 | 302989-KW-Manitou Dr | RG2 | 450 | 165 | 165 | 35% | 35% | ICI |
| FM12 | 300575-KW-Balzer Creek Trail | RG2 | 750 | 165 | 165 | 95% | 95% | RES |
| FM13 | 303564-KW-Black Walnut Dr* | RG2 | 1050 | 559 | 346 | 74% | 55% | Mixed |
| FM13 b | 2001421-KW-Huron Rd | RG6 | 675 | 214 | 214 | 98% | 98% | RES |
| FM15 | 303238-KW-Homer Watson PS | RG7 | 600 | 249 | 249 | 95% | 95% | RES |
| FM18 | 306550-KW-Hanson Ave | RG2 | 300 | 71 | 71 | 52% | 52% | Mixed |
| FM19 | 311719-KW-Falconridge PS | RG1 | 450 | 46 | 46 | 98% | 98% | RES |

| FM ID | FM Name and Location | Rain Gauge ID | Pipe Size (mm) | Total[1] Parcel-Based[2] Contributing Area (ha) | Incremental[3] Parcel-Based Contributing Area (ha) | Total[1] % RES[4] Population | Incremental[3] % RES[3] Population | Land Use Classification[5] |
|---|---|---|---|---|---|---|---|---|
| FM20 | 303424-KW-King St E | RG7 | 375 | 40 | 40 | 1% | 1% | ICI |

Notes:

1. Total Contributing Area and % RES includes area/populations draining to upstream FMs (FM in series).
2. Parcel-Based area refers to the area of all parcels draining to each meter; includes non-effective areas like parking lots, parks, etc.
3. Incremental area and % RES refer to only the area between the upstream FM and the FM of focus.
4. Percent (%) RES Population is based on total population (RES population / Total population).
5. Land Use Classification is generalized based on % RES;
   - < 50% is considered ICI,
   - Between 50% and 70% is considered Mixed, and,
   - > 70% is considered Residential.

* FM is downstream of one or more other FMs (FM in series)

Each metershed is given a general land use classification based on how much of the population in the area lives in residential areas. Most of the metersheds are mostly residential. Only three metersheds have less than 50% residential population, so they are classified as Industrial/Commercial/Institutional (ICI). Five metersheds have 50% to 70% residential population, so they are considered mixed land use. This variation in land use was helpful in assessing the different flow generation rates and patterns across the City.

#### 4.3.4.1.1 Flow Meter Schematic and System Connectivity

A schematic illustrating the 2021 flow meters, their connectivity, and their Average Dry Weather Flow (ADWF) is shown in **Figure 4-7**. The sanitary sewer system generally flows to a single trunk or pump station on route to the WWTP; however, there are several overflow points where pipes can send flow to an adjacent subtrunk system should the water levels get high enough. The flow schematic indicates these locations in the context of the flow monitor metersheds, subtrunks and the ultimate receiving trunk sewer. Refer to TM2 for more details including monitoring data availability and data quality review.

The sanitary system is organized into three main components: local sewers, sub-trunk sewers, and trunk sewers. A local sewer collects sanitary discharge from properties. This sanitary flow is then directed to sub-trunk sewers, which are defined as gravity pipes with 375 mm diameters or larger, forcemains, and additional smaller pipes that connect these sewers to form the system's spinal network. The trunk sewer, consisting of larger pipes, receives this sanitary flow and transports it to either an intercepting sewer or directly to the WWTP.

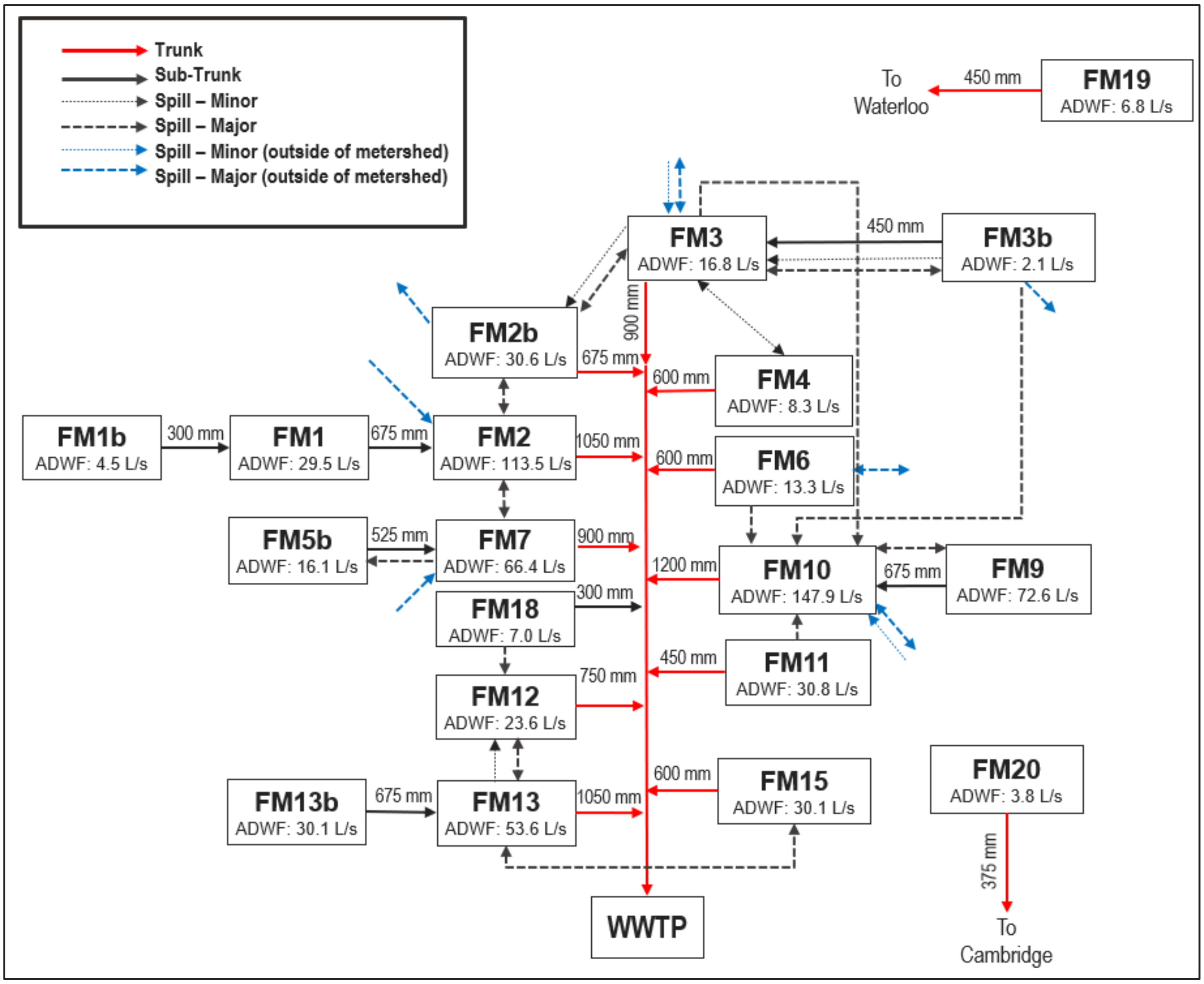



**Figure 4-7: 2021 Flow Meter Schematic**

### 4.3.4.1.2 Rain Gauge Locations

There are two (2) permanent rain gauges at City Hall and the Kitchener Operations Facility. Given the size of the City, five (5) additional temporary rain gauges were installed, to improve the understanding of rainfall patterns across the City, and their influence on the sanitary sewer system. Due to the location of these seven (7) rain gauges, six (6) were used for analysis. The coverage of RG5 is significantly smaller than the other rain gauges and was used for validation of the other gauges only. **Table 4-5** lists the available rain gauges, and **Figure 4-6** shows their location.

**Table 4-5: Available 2021 Rain Gauge Network**

| ID | Location | Notes |
|---|---|---|
| RG1 | City Hall | Existing Permanent Gauge |
| RG2 | Kitchener Operations Facility | Existing Permanent Gauge |
| RG3 | Victoria Hill Community Centre | Temporary Gauge |
| RG4 | Grand River Arena | Temporary Gauge |
| RG5 | Centreville Chicopee Community Centre | Temporary Gauge |
| RG6 | Williamsburg | Temporary Gauge |
| RG7 | New Dundee Pump Station | Temporary Gauge |

Refer to TM2 for more details on the rainfall data collection and analysis.

#### 4.3.4.2 Dry Weather Flows

The volume of wastewater that enters the sanitary sewer system is determined by the population in both residential and ICI areas within each section of the system. This calculation excludes groundwater infiltration (GWI). The average amount of wastewater produced by each person per day is calculated using data from the flow monitors during average dry weather conditions. This is known as sewage flow and is made up of normal daily activities such as washing, flushing, and other residential or business use that relies on plumbing connections to the sanitary sewer.

Sanitary flows are not steady and vary throughout the day. This variation is known as a daily, or diurnal, pattern that is unique for each monitored area (metershed). The combination of sewage flow and GWI generate Average Dry Weather Flow (ADWF). The maximum flow in a dry day resulting from the daily variation is called the Peak DWF.

#### 4.3.4.3 Wet Weather Flows

##### 4.3.4.3.1 Storm Events Summary

As outlined in **Section 4.3.4.1.2**, six (6) primary rain gauges were processed to identify storm events. A storm event was defined by a minimum duration of 6 hours and 15 mm of rainfall. Peak intensities were also factored into the identification of potential events for calibration. Between August 2021 and early October 2021, an average of 24 rainfall events were observed per rain gauge. **Table 4-6** provides a summary of the six most significant rainfall events that were common across multiple rain gauges.

**Table 4-6: Storm Event Characteristics**

| Start Time | End Time | Duration (hr) | Average Depth (mm) | Average Peak Intensity (mm/hr) |
|---|---|---|---|---|
| 8/21/2021 11:40 | 8/21/2021 20:55 | 9.2 | 10.99[1] | 25.70[1] |
| 8/29/2021 18:45 | 8/30/2021 1:10 | 6.4 | 16.11 | 64.96 |
| 9/7/2021 16:55 | 9/9/2021 01:35 | 32.6 | 39.11 | 63.21 |
| 9/14/2021 21:35 | 9/15/2021 23:55 | 26.3 | 20.93 | 56.13 |
| 9/21/2021 16:35 | 9/23/2021 20:45 | 52.2 | 95.76 | 41.76 |
| 10/3/2021 5:30 | 10/5/2021 11:50 | 54.3 | 26.41 | 16.38 |

Notes:

1. The August 21st rainfall event was not observed at RG6 or RG7 and thus, the average depth and peak intensity for this event is affected.

It should be noted that RG6 and RG7 did not experience the rainfall event on August 21st, thus reducing the average depth and peak intensity presented in the above table and resulting in the exclusion of this event for calibration.

## 4.4 Sanitary Hydraulic Model

### 4.4.1 Existing Hydraulic Model and Platform Review

To provide a Digital Twin representation of the sewer network and system performance, the City has invested in the development of an all-pipe, hydraulic computer model. A software selection review was undertaken as part of the 2009 Systemwide Capacity Study, which resulted in the selection of the InfoSWMM platform. Since that time, the City has also invested in the InfoWorks ICM platform for the Stormwater Utility.

As part of the ISAN-MP, the model platform was re-reviewed to confirm or recommend migration to another software platform. Details of the state of the industry review, criteria, and evaluation are provided in **TM2**, which recommended the City migrate the existing sanitary model to the InfoWorks ICM software. This recommendation considered that the City already owns and maintains the InfoWorks ICM product which is considered superior to those short-listed in many ways:

- Excellent data management / auditing data structure (one database) and strong documentation / flagging;
- Robust features including advanced query/geospatial/visualization tools;
- Does not require ArcGIS license (but is more powerful with ArcGIS v10.7 or earlier);
- Stable computational engine, advanced core computing options for improved processing speed; and,
- Powerful data sharing through compact transportable databases.

Additionally, the recommendation to abandon the existing InfoSWMM license reduces the annual maintenance fees with no cost to transition to ICM. Migrating to InfoWorks also allows alignment with the Stormwater Utility and provides a common asset/model management process to be established for both sanitary and storm utilities.

### 4.4.2 Model Updates

The last update before the ISAN-MP was based on 2016 flow data and infrastructure changes. Since that time, a detailed Asset Management Plan for the Sanitary Utility was completed in 2019 for the City's sanitary infrastructure, which was desired to be incorporated into the hydraulic model for continuity and future connectivity to the asset database.

#### 4.4.2.1 Network Updates

The original model was converted to InfoWorks ICM and updated with GIS data (as of July 2021), then an extensive data consistency review (called 'engineering validation') was completed to identify and rectify data gaps and sewer profile data inconsistencies through select record drawing review in areas of focus (trunks, pump stations) and engineering inference. A series of 'flags' were established and used to indicate what changes were required and made for each asset attribute, to assist with model interpretation and for incorporation back into the Asset Management system.

### 4.4.3 Flow Generation Updates

With the change to the new model platform, there was an opportunity to update the flow generation methodology that more directly links land use parcel fabric and population estimates to model subcatchment input. The City's Planning Department provided the Parcels-Persons-Jobs (PPJ) data which included current population and job numbers per parcel. The 2021 data was used for existing conditions. (See **Section 4.2)**.

Similarly, a more robust method for defining future growth was applied as separate subcatchments, to assist with growth management planning and tracking. The City's Planning Department provided projected residential and non-residential equivalent populations for future growth scenarios (see **Section 5.1**).

### 4.4.4 External Flow Input and Boundary Conditions

Boundary conditions help to define the operation of an area or feature that is decidedly excluded from the model for simplification or due to municipal boundaries. They are used at points where the model connects to other systems or watercourses, or where the model gets inflow from other areas. They can also be used to define the water level conditions in complex facilities like wastewater treatment plants (WWTPs).

In the Kitchener ISAN-MP model, there are several points where the model connects to other systems. The agreements for these connections were reviewed.

If the conditions of the other systems affect the Kitchener system, the water levels or inflows from those systems are used in the model. If the water levels of the other systems are not known, a conservative estimate is used and checked during calibration. If the inflows from the other systems are not available, estimates are used. If the water levels or inflows from the other systems are very small, they are not included in the model.

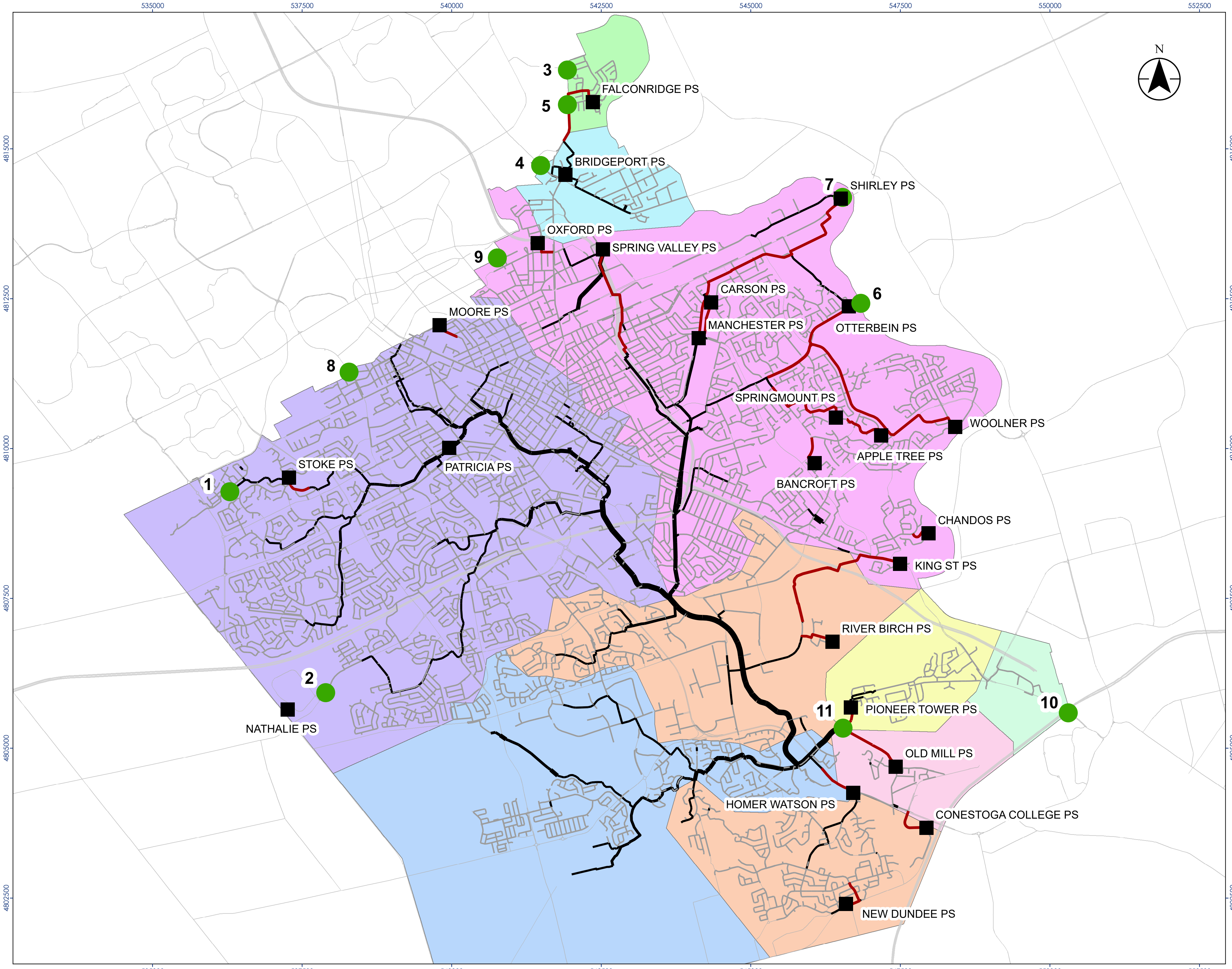
There are also 11 pump station overflows that go to nearby watercourses or storm systems. It's assumed that the water levels downstream do not affect these overflows. This assumption was checked during calibration. There is also one potential boundary condition at the WWTP. Based on a review of the WWTP drawings and discussions with the operators, the drop in water level between the sewer system and the WWTP is large and is not expected to cause backwater conditions in the system upstream. So, a free-flowing outfall is used at this location in the model (this means no water level boundary is applied).

**Table 4-7** documents the boundary conditions applied in the existing conditions assessments These boundary conditions are illustrated in **Figure 4-8**.

**Table 4-7: Existing Model Boundary Conditions**

| Location No. | Location (Sewershed) | MH/ Modelled Node ID | Second Party in Cross Border Agreement | Boundary Condition Type | FM Metershed | Value Applied |
|---|---|---|---|---|---|---|
| 1 | Upper Schneider - Henry Sturm Direct | 310088 | Waterloo | Inflow | FM2 | 30.00 L/s |
| 2 | Upper Schneider - Borden | 311511 | Wilmot | Inflow | FM5b | 7.05 L/s |
| 3 | Melitzer | 311933 | Waterloo | Inflow | FM19 | Accounted for in GWI Rate |
| 4 | Bridgeport | JCT-236 | Waterloo | Inflow | Unmonitored | Accounted for in GWI Rate |
| 5 | Melitzer | JCT-736 | Waterloo | Inflow | FM19 | Accounted for in GWI Rate |
| 6 | Montgomery - Kolb | JCT-88 | Safety Kleen | Inflow | FM9 | 38.00 L/s (2 am to 5 am) |
| 7 | Montgomery - Kolb | Shirley-Dummy-Inflow | Woolwich | Inflow | FM10 | 189.00 L/s |
| 8 | Upper Schneider Westmount Direct | 306155 | Waterloo | External Subcatchment | FM2b | 61 Units x 3.5 PPU |
| 9 | Montgomory – Spring Valley North | JCT-256 | Waterloo | External Subcatchment | Unmonitored | 38 Units x 3.5 PPU |
| 10 | Gateway Park | 303424 | Cambridge | Level | FM20 | 294.93 m (Pipe Obvert) |
| 11 | Lower Schneider – Direct | WWTP | N/A | Level | Unmonitored | Free Flowing |

The boundary conditions used may be conservative as the maximum allowable flow value is applied as a constant inflow and may result in overestimation of downstream flows. Additionally, for the other 3 locations where the inflow data was not provided, downstream modelled flows may be underestimated. This could include underestimations of GWI, per capita flow rates and RTK parameters, which may affect the calibration downstream of these locations.




Stantec

Legend

- Boundary Condition Location
- Sewage Pumping Station
- Sanitary Sewer
- ForceMain

**Sewershed**

- Bridgeport
- Gateway Park
- Lower Schneider
- Melitzer
- Montgomery
- New Dundee
- Pioneer Tower West
- Strasburg
- Upper Schneider

0 10 20 km

1:65,355 (At original document size of 11x17)

**Notes**

1. Coordinate System: NAD 1983 UTM Zone 17N
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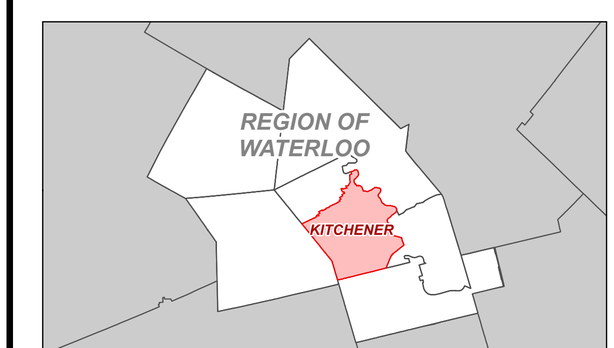



Project Location
City of Kitchener

165640334 REVA
Prepared by HB on 2022-10-05

Client/Project
CITY OF KITCHENER
INTEGRATED SANITARY MASTER PLAN

Figure No.
**4-8**

Title
**Boundary Condition Locations**

### 4.4.5 Hydraulic Model Calibration

Model calibration is the process of comparing simulated hydraulic results (flow, volume, depth, velocity) against actual measured flow monitoring data, and systematically adjusting model input parameters to achieve a best fit across several dry periods and rainfall events. TM2 outlines the calibration approach and provides in-depth detail on the selection of monitoring data periods / events along with presenting the results and final parameter selection. The following provides a high-level summary of the hydraulic model calibration.

#### 4.4.5.1 DWF Calibration Periods

DWF period were defined by no more than 1 mm of rain in the previous two days, no more than 2.5 mm of rain in the previous three days, and no more than 50 mm of rain in the previous 7 days, to isolate dry conditions as best as possible for at least five consecutive days. The selected periods are as follows:

- DWF Period 1: August 15th, 2021, to August 20th, 2021; and,
- DWF Period 2: September 28th, 2021, to October 3rd, 2021.

#### 4.4.5.2 DWF Calibration Results

**Table 4-8** presents the final DWF parameters derived through model calibration for each metershed.

**Table 4-8: Dry Weather Flow Parameters**

| Flow Monitor | | Metershed Characteristics | | | | Calibrated Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total[1] Area-Based[2] Tributary Area | Total[1] Existing Population | Water Consumption Rates[3] | | Average Dry Weather Flow | | Groundwater Infiltration | | Average Sewage Flow | |
| | | (ha) | | (L/s) | (L/c/d) | (L/s) | (L/c/d) | (L/s) | (L/s/ha) | (L/s) | (L/c/d) |
| FM1 | 308300-KW-Highland Rd W | 307 | 13,213 | 23.2 | 152 | 29.5 | 193 | 8.5 | 0.028 | 21.1 | 138 |
| FM1b | 309484-KW-Highview Dr | 48 | 1,984 | 4.2 | 183 | 4.5 | 196 | 1.0 | 0.021 | 3.4 | 147 |
| FM2 | 304470-KW-West Ave | 703 | 37,628 | 65.2 | 150 | 113.5 | 261 | 17.6 | 0.025 | 96.0 | 220 |
| FM2b | 304819-KW-Sandrock Creek | 217 | 15,073 | 32.1 | 184 | 30.6 | 175 | 12.8 | 0.059 | 17.8 | 102 |
| FM3 | 311165-KW-Victoria St S | 168 | 12,532 | 15.6 | 108 | 16.8 | 116 | 0.8 | 0.005 | 16.1 | 111 |
| FM3b | 2091740-KW-Moore Ave PS | 33 | 1,810 | 2.4 | 115 | 2.1 | 100 | 0.1 | 0.003 | 2.0 | 95 |

| Flow Monitor | | Metershed Characteristics | | | | Calibrated Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total[1] Area-Based[2] Tributary Area | Total[1] Existing Population | Water Consumption Rates[3] | | Average Dry Weather Flow | | Groundwater Infiltration | | Average Sewage Flow | |
| | | (ha) | | (L/s) | (L/c/d) | (L/s) | (L/c/d) | (L/s) | (L/s/ha) | (L/s) | (L/c/d) |
| FM4 | 303786-KW-David St | 44 | 6,663 | 9.3 | 121 | 8.4 | 109 | 2.2 | 0.050 | 6.3 | 82 |
| FM5b | 311440-KW-Activa Ave | 81 | 4,522 | 11.6 | 222 | 16.1 | 308 | 0.8 | 0.010 | 15.3 | 292 |
| FM6 | 301110-KW-Borden Ave S | 92 | 9,174 | 12.6 | 119 | 13.3 | 125 | 1.0 | 0.011 | 12.3 | 116 |
| FM7 | 306584-KW-Hoffman St | 780 | 40,466 | 73.1 | 156 | 66.4 | 142 | 9.3 | 0.012 | 57.1 | 122 |
| FM9 | 301182-KW-Ottawa St N | 486 | 18,841 | 45.2 | 207 | 72.6 | 333 | 20.4 | 0.042 | 52.2 | 239 |
| FM10 | 300305-KW-Shelley Dr | 1,210 | 51,964 | 80.8 | 134 | 147.9 | 246 | 35.3 | 0.029 | 112.6 | 187 |
| FM11 | 302989-KW-Manitou Dr | 62 | 9,802 | 18.7 | 165 | 30.8 | 271 | 5.2 | 0.084 | 25.5 | 225 |
| FM12 | 300575-KW-Balzer Creek Trail | 172 | 11,463 | 24.7 | 186 | 23.6 | 178 | 4.9 | 0.028 | 18.7 | 141 |
| FM13 | 303564-KW-Black Walnut Dr | 456 | 21,118 | 24.0 | 98 | 53.6 | 219 | 16.5 | 0.036 | 37.0 | 151 |
| FM13b | 2001421-KW-Huron Rd | 175 | 9,495 | 20.9 | 190 | 30.1 | 274 | 3.8 | 0.022 | 26.3 | 239 |
| FM15 | 303238-KW-Homer Watson PS | 289 | 10,340 | 30.6 | 256 | 30.1 | 252 | 8.7 | 0.030 | 21.4 | 179 |
| FM18 | 306550-KW-Hanson Ave | 51 | 3,220 | 5.2 | 140 | 7.0 | 188 | 1.0 | 0.020 | 6.0 | 161 |
| FM19 | 311719-KW-Falconridge PS | 60 | 1,960 | 5.5 | 242 | 6.8 | 300 | 1.7 | 0.028 | 5.2 | 229 |
| FM20 | 303424-KW-King St E | 26 | 1,159 | 1.9 | 142 | 3.8 | 283 | 0.7 | 0.027 | 3.1 | 231 |
| ***Average*** | | ***-*** | ***-*** | ***-*** | ***155*** | ***-*** | ***216*** | ***-*** | ***0.028*** | ***-*** | ***170*** |
| ***Total*** | | ***5,459*** | ***282,426*** | ***507*** | ***-*** | ***708*** | ***-*** | ***152*** | ***-*** | ***555*** | ***-*** |

Notes:

1. Total Area-Based Tributary Area and Total Existing Population includes all area/population draining to upstream FMs (FM in series).
2. Area-Based Tributary area refers to the area draining to each meter, based on the buffer-derived “SA” subcatchments only. “SA” subcatchments are defined by a 90 m buffer around all pipes and are meant to represent the effective area contributing groundwater and rainfall derived I/I to each sewer segment.
3. The Water Consumption Rates presented are based on 100% of the average water consumption rates for August, September, and October 2020.

GWI rates, indicating the volume of water seeping into the pipe system from the groundwater table, vary across different areas. Lower rates are associated with newer residential areas due to improved pipe seals, while higher rates are found in areas with older pipes. Per capita flow rates, representing the water usage per person, are generally lower than the design rate used for new developments, but is consistent with water usage rates and is reflective of advances in water conservation measures such as low flow toilets and more efficient laundry machines, along with the increasing awareness of the public and industry due to ongoing City and Region of Waterloo education campaigns.

In general, while there were some challenges due to data quality during dry weather, the calibration was sufficient in volume and peak flow representation to proceed to wet weather calibration.

#### 4.4.5.3 WWF Calibration Events

The goal was to select four WWF events where it rained at least 15 mm, to perform model calibration. Consequently, the following events were selected:

- WWF Event 1: September 7th, 2021, to September 9th, 2021
- WWF Event 2: September 14th, 2021, to September 15th, 2021
- WWF Event 3: September 21st, 2021, to September 23rd, 2021
- WWF Event 4: October 3rd, 2021, to October 5th, 2021

#### 4.4.5.4 WWF Calibration Results

When it rains, water can enter the sanitary system through direct connections like downspouts, sump pumps, and foundation drains (this is called inflow), or by seeping into the system from the surrounding soil through cracks in the pipes and MH structures (this is called infiltration). Together, this is known as rainfall-derived infiltration and inflow (RDII).

In a sanitary system, the RDII is often calculated using the RTK method which allows for the characterization of the theoretical fast, medium, and slow wet weather response in the sanitary sewer system. Details of this method are outlined in TM2. One parameter that provides an indication of magnitude of wet weather is the “Total R” factor, which is the percentage of rainfall that falls in the tributary area that ends up in the sanitary sewer. The Total R ranges from low to high depending on the metershed. Lower R values are found in areas that are characterized as newer (pipes from 1980 and later), where the pipes are still in good condition (less leaky) and where Building Code restrictions prevented extraneous water flows such as roof downspouts and foundation drain from being connected. The highest total R values are found in areas with older pipes (pre-1980) that may have remaining extraneous roof or foundation drains connected and are leakier. Overall, at the locations monitored, RDII values were not excessive City-wide. Additional flow monitoring data collection and analysis is recommended as part of an infiltration and inflow strategy to further isolate, quantify and rectify excessive RDII contributions that impact local, trunk and WWTP operation.

In general, the trunk-level WWF calibration achieved a good match to observed flow monitoring data with emphasis on the largest event recorded September 21st to 23rd, 2021. Refer to **TM2**, for a comprehensive understanding of the WWF calibration methodology, including the challenges, assumptions, and in-depth results. This calibration was deemed suitable to proceed with existing and future trunk system capacity analysis.

### 4.4.6 Hydraulic Model Validation

2021 SCADA data was obtained for the Kitchener WWTP, which is operated by the Region of Waterloo. This information consisted of influent flows measured every 5-minutes in $m^3/d$ from July 1st to November 30th, 2021. The results of this validation indicate that the model adequately replicates the flows at the WWTP when compared to observed data for all DWF periods and WWF events selected for calibration. **Figure 4-9** presents the WWF validation results.

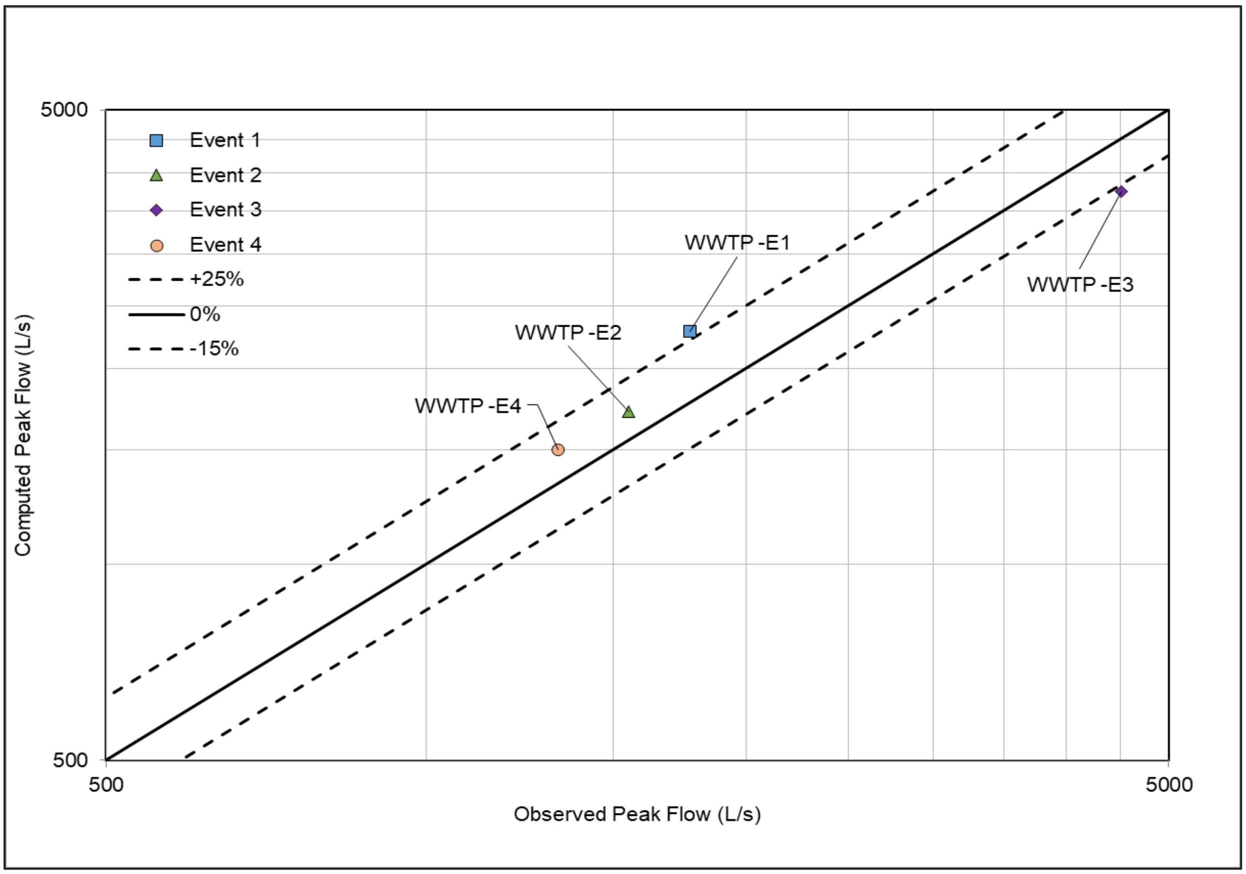



**Figure 4-9: Hydraulic Model Wet Weather Validation at the WWTP**

See **TM3** for more details.

# 5 Future Sanitary System Conditions

## 5.1 Population and Growth Projections

As one of the fastest growing municipalities in Ontario, the City recognizes that readily available sanitary infrastructure is essential to the viability of the growing community. The Province has identified the 2051 residential and employment projection for the City and the City Planning group has completed various distributions of the data. **Table 5-1** presents the population growth projections applied in the ISAN-MP.

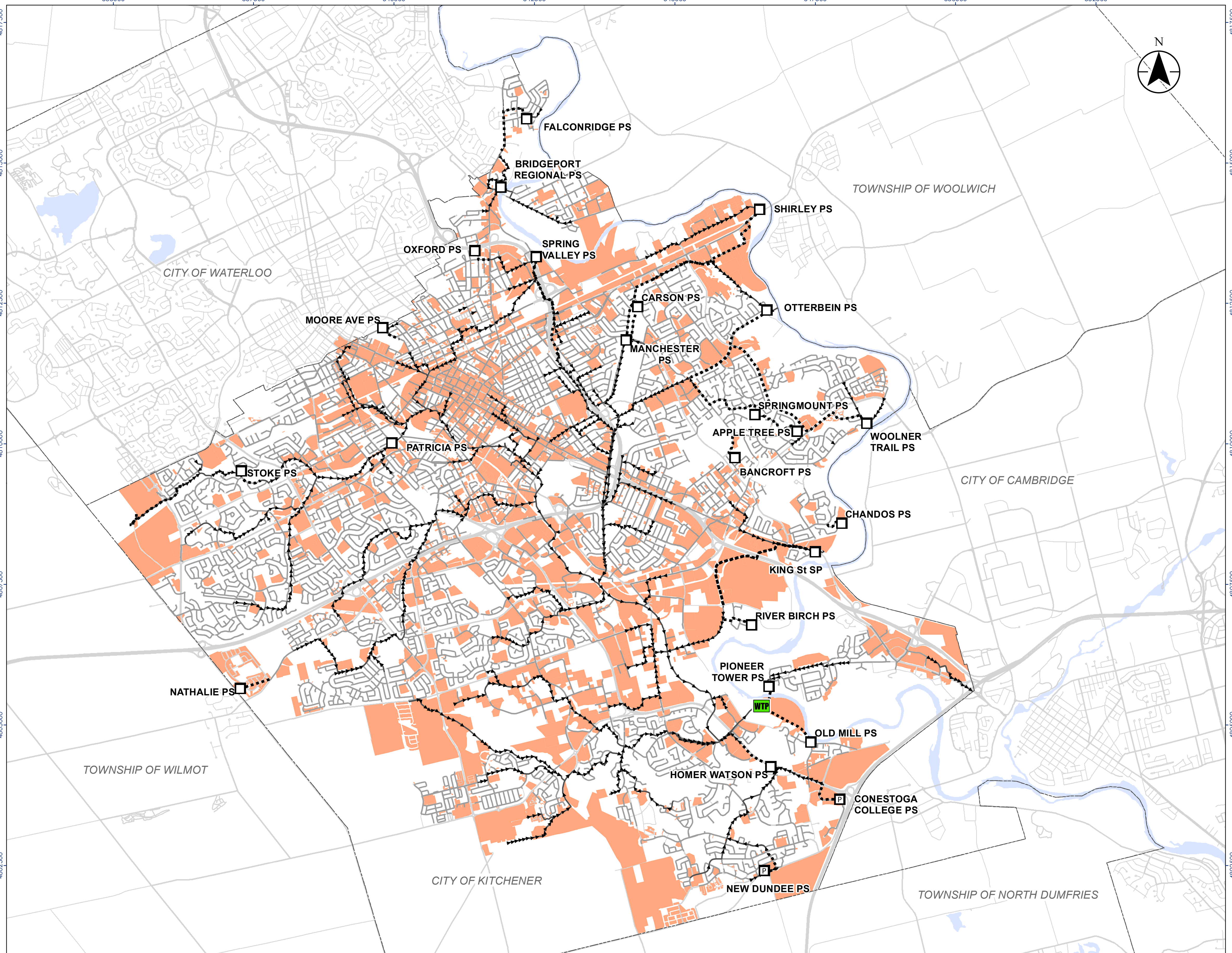
**Table 5-1: Population Projections**

| Horizon | Residential | Employment | Total Equivalent Population |
|---|---|---|---|
| 2021 | 251,000 | 79,000 | 330,000 |
| 2031 | 377,000 | 189,000 | 566,000 |
| 2051 | 475,000 | 279,000 | 754,000 |

The ISAN-MP plans for the City's growth up to 2051 are based on a growth management model that makes parcel-by-parcel assumptions regarding the distribution of growth. This model takes into account the City's PPJ information, which provides build-out populations. For instance, the 2031 projection carried forward 50% of the build-out populations, and the 2051 projection was based on 75% of the total possible population.

The City's development is an approximately equal mixture of new development in greenfield areas and as infill and intensification. Infill involves the redevelopment of land, often converting open space to new residential or ICI construction. Intensification, on the other hand, includes the redevelopment of properties to accommodate higher densities of populations. Greenfield development introduces new extensions to the sanitary infrastructure, while infill and intensification often introduce increased flow contributions over existing conditions. All these factors have potential impacts on the existing infrastructure. **Figure 5-1** illustrates the areas for these growth projections based on the City's PPJ information.

When aggregated, the growth model represents a population of 475,000 people and 279,000 jobs, which is higher than the approved Regional Growth Forecast for Kitchener of 409,200 people and 170,500 jobs by 2051. This discrepancy between the approved Regional forecast is justified as providing a margin of error to reflect uncertainty regarding where growth, and related impacts on the sanitary collection system, are forecast to occur. Nevertheless, the planned sanitary flow at the wastewater treatment plant is expected to correspond to the forecast of 409,200 people by 2051.




Stantec

**Legend**

- Sanitary Pumping Stations
- WWTP
- Local Sewer
- Trunk Sewer
- Forcemain
- Growth Areas*

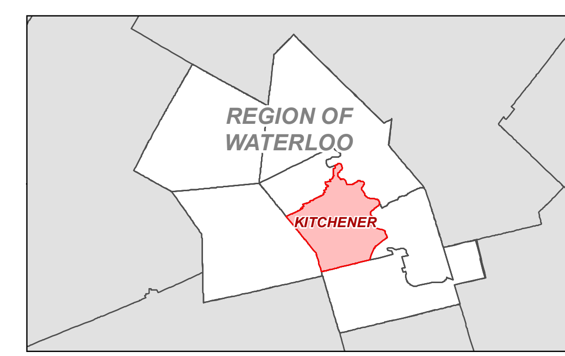
*Growth Areas taken from City of Kitchener's Growth Management Model

0 1 2 km

1:70,000 (At original document size of 11x17)

**Notes**

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.
3. Contains information licensed under the Open Government Licence - The Corporation of the City of Kitchener, 2021.




Project Location
City of Kitchener

165640334 REVA
Prepared by HB on 2024-04-18

Client/Project
CITY OF KITCHENER
INNOVATION PLAN AND GROWTH MANAGEMENT

Figure No.
**5-1**

Title
**Growth Projections**

## 5.2 Hydraulic Model Updates

### 5.2.1 Future Population

Two model scenarios were defined to represent the baselines 2031 and 2051 known infrastructure upgrades and population projections. Given there are differences in the flow contributions whether it is new development where none existed previously, versus infill and intensification where existing development is replaced with new development, different modelling methodologies were developed to account for the GWI and WWF generation. Population estimates are applied directly as new Future subcatchments.

### 5.2.2 Infrastructure Updates

The future scenarios incorporate the replacement of the Old Mill SPS with the New Old Mill SPS; the decommissioning of the Moore SPS and substitution for gravity conveyance to the Waterloo sewer system; as well as upgrades that are proposed at the Otterbein SPS and Spring Valley SPS.

The City has plans for growth in the Hidden Valley area and a possible extension of River Road. This growth is represented in the model by a steady flow into the Wabanaki Trunk Sewer.

Information about the proposed upgrades to the Wabanaki Trunk Sewer was provided, but they are not included in the 2031 and 2051 scenarios at this time. However, the 2051 scenario does not show any capacity issues with the existing Wabanaki trunk infrastructure.

The proposed East Side Lands development was also reviewed. The recommended plan includes installing a pumping station in the area that sends flows straight to the WWTP. This is not expected to affect the existing or proposed infrastructure capacity.

The Biehn Drive sanitary trunk sewer extension is not included in the future conditions modelling due to its limited impact. The growth in this area is accounted for in the provided PPJ file and allocated to the proposed trunk sewer extension connection point.

### 5.2.3 Pumping Stations

As noted in the preceding section, the New Old Mill SPS is included in the future model scenarios. Like the existing conditions pumping stations, it is modelled as ideal with the following firm and rated capacity constraints considered. The current Old Mill SPS is omitted from the 2031 model scenario, as it will be decommissioned during transition to the New Old Mill SPS.

Upgrades are proposed at the Otterbein SPS and Spring Valley SPS for the 2031 and 2051 scenarios. The EA was provided and used to obtain the future conditions' capacities. All other pumping station setups are maintained from the existing conditions scenario. **Table 5-2** outlines the pumping station updates made for the 2031 and 2051 scenario.

### Table 5-2: Updated Pumping Station Firm & Rated Capacities Based on Theoretical Operation

| Pumping Station | Horizon | Firm Capacity (L/s) | Rated Capacity (L/s) | Rated Capacity Pump Operation | ECA Firm Capacity (L/s) | Additional Notes |
|---|---|---|---|---|---|---|
| Old Mill SPS | 2031 & 2051 | N/A | N/A | N/A | N/A | • Decommissioned |
| New Old Mill SPS | 2031 & 2051 | 150.0 | 150.0 | 2 Duty ON;<br>1 Standby OFF | N/A | • The firm capacity and pump/system curves are not provided in the Process Control Narrative (PCN); assume equivalent to rated capacity denoted in PCN.<br>• ECA was not available at time of ISAN-MP analysis |
| Moore SPS | 2031 & 2051 | N/A | N/A | N/A | N/A | • To be decommissioned; Flows redirected via new gravity sewer north on Moore Ave to Waterloo sanitary sewer system |
| Otterbein SPS | 2031 & 2051 | 165.0 | 165.0 | Unknown | 165.0 | • EA for proposed upgrades provided; notes 165 L/s design capacity |
| Spring Valley SPS | 2031 | 350.0 | 350.0 | Unknown | 245.0 | • Currently in design process to provide a near-term upgrade to SPS, increasing capacity to 350 L/s<br>• ECA to be updated with upgrades; current ECA allows for 245 L/s |
| | 2051 | 470.0 | 470.0 | Unknown | 245.0 | • Currently in EA process to upgrade SPS to an ultimate buildout capacity of 470 L/s<br>• ECA to be updated with upgrades; current ECA allows for 245 L/s |

Provisional additions to the pumping stations noted in their ECAs are considered when evaluating solutions, if applicable.

# 6 Design Criteria & Level of Service

This section provides a summary of the data sources, design criteria for sanitary sewer/pump stations, and level-of-service (LOS) considerations used in the City and other Ontario municipalities. The information is compared with the Ministry of Environment (MECP) criteria, and suggestions for improvements are provided where necessary. A distinction is made between the design criteria used for new developments and pipe sizing (typical design sheet methodology), and the system-wide LOS performance and Master Planning triggers for infrastructure upgrades, which are evaluated using the City's dynamic hydraulic model.

**Section 6.1** discusses standard design sheet methodologies used for development applications, pipe sizing, and pump station capacity. **Section 6.2** focuses on the metrics used in this Master Plan for evaluating pipe and pump station performance and determining when upgrades are needed. More details can be found in **TM5**.

## 6.1 Sanitary Collection System Criteria

The criteria for sanitary sewer and pump station design, referencing several sources, including the Kitchener Development Manual (KDM), the Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS), and the Kitchener Standard Specifications, among others.

The KDM refers to the DGSSMS for all criteria, specifying values only when the City deviates from the DGSSMS. As discussed in Section 4.3.3.1, the MECP has adopted a Consolidated Linear Infrastructure permissions approach for low-risk projects related to sanitary collection and stormwater management, which replaces the previous Certificate of Authorization (CoA) approach. This allows municipalities to proceed with certain collection system alterations without obtaining individual Ministry permission, provided the work complies with the municipality's CLI-ECA, including meeting MECP design criteria (Version 2.0, dated May 31, 2023). The City of Kitchener's ECA number is 019-W601, granted on January 29, 2023.

### 6.1.1 Design Sewage Flows

#### 6.1.1.1 Local vs. Trunk System

The City of Kitchener designates trunk sewers as pipes with 375 mm diameter and larger. Therefore, local sewers are less than 375 mm diameter. The City's GIS Asset data provides an indication of the sub-drainage area related to the defined trunk sewersheds (e.g., Upper Schneider – Sandrock), which helps to communicate tributary connectivity and location within the trunk sewershed.

### 6.1.1.2 Drainage Area

The background documents have limited references for defining drainage areas, crucial for sanitary flow generation and infiltration assessments. Drainage areas, typically based on parcel fabric and extended across road rights-of-way, are now assessed with a new system-wide hydraulic model. This model uses Parcel-Based subcatchments for development and Buffer-Based subcatchments for rainfall-derived infiltration and inflow (RDII), promoting consistency in area extent applications. For development applications, Parcel-Based subcatchments are recommended for population and RDII calculations. However, for certain developments, a smaller area may be more suitable for RDII generation, and a Buffer-based approach using 45 m around gravity pipes should be used.

### 6.1.1.3 Domestic Sewage Flows

**Table 6-1** presents a comparison of the domestic (residential) sewage generation rate criteria within the reference documents, with section numbers indicated.

**Table 6-1: Domestic Sewage Generation Rates**

| Criterion | **MECP** (2023) | **DGSSMS** (B.3.1.2.1) | **KDM** (E.1.1) |
|---|---|---|---|
| Per Capita Rate (L/c/d) | 2.1.1: 225-450 | 275[1] | 305 |
| Population | Not referenced | Actual or Projected based on data (zoning or other) from City[1] | Table 4 by Zoning Category, in People/ha<br>Persons/unit densities are not to be used |
| Peaking Factor | 2.1.6: Harmon or Babbitt<br>Min. PF = 2 | Harmon | Harmon |

1. Kitchener Deferred to Chief Municipal Engineer (KDM)

Kitchener's selected value (305 L/c/d) is within MECP's acceptable range and higher than DGSSMS. The Region of Waterloo reports an average flow per capita of 250 L/c/d at the Kitchener WWTP, but this includes RDII and ICI contributions, making it incomparable to domestic sewage generation. Flow monitoring data reveals rates from 60 to 200 L/c/d, less than the design value. Despite the high KDM value, it's recommended to maintain 305 L/c/d for new designs for continuity and safety.

### 6.1.1.4 ICI Sewage Flows

**Table 6-2** presents a comparison of industrial-commercial-institutional (ICI) generation rates.

**Table 6-2: ICI Sewage Generation Rates**

| Criterion | **MECP[1]** (2023) | **DGSSMS** (B.3.1.2) | KDM |
|---|---|---|---|
| Industrial | 2.1.4: Actual sanitary flow monitor data for min. 2-years; otherwise, average flow of 0.20 to 0.64 L/s/gross ha | 0.40 L/s/ha | Defers to DGSSMS |
| Commercial - Core | 2.1.2: Actual sanitary flow monitor data for min. 2-years; otherwise, minimum 28 $m^3$/gross ha/day | 0.95 L/s/ha | |
| Commercial – Mall | | 0.30 L/s/ha | |
| Commercial - General | | 0.50 L/s/ha | |
| Institutional | 2.1.3: Historical water use for min. 2-years of similar facility. Table 1 of MECP can be used. Designer to use professional judgment | 0.25 L/s/ha | |
| Institutional – Hospital Bed | | 0.015 L/s/bed | |

For design sheet analysis, use DGSSMS's area-based flow rates. However, if available, maintain the equivalent population approach for consistency with the hydraulic model. Exceptions may be needed for specific high-water users, depending on their location and the receiving sewer's sensitivity.

### 6.1.1.5 Extraneous Flow

Extraneous flow refers to storm or groundwater inputs into the sanitary sewer system. In design, it accounts for long-term leakage expected towards a pipe's end of service life, not immediate post-construction flow. New sewers should be free from major extraneous or illicit water sources common in pre-1980s construction. Connections from roof downspouts, private drains, and foundation drainage to the sanitary sewer system are prohibited. However, pre-1980s replacement sewers may still receive foundation drainage via sump pump discharge. **Table 6-3** presents the comparison of published values.

**Table 6-3: Extraneous Flow Generation Rates**

| Criterion | **MECP** (2023) | DGSSMS | KDM |
|---|---|---|---|
| Extraneous Flow | 2.1.5: up to 0.28 L/s/ha | B.3.1.2.5: 0.25 L/s/ha | E.1.2: 0.15 L/s/ha |
| Foundation Drainage | Foundation drains are not permitted to be connected to the sanitary sewer system | | |

Kitchener's allowance is lower than DGSSMS and MECP, but it's offset by a higher per capita flow generation rate. The hydraulic model, calibrated to flow monitoring data, reduces the allowance's impact on the system by directly capturing extraneous flow associated with rainfall. For design, if using the overall parcel for area calculation, it's recommended to retain the use of 0.15 L/s/ha.

### 6.1.2 Sewer Design

Sewer design generally follows MECP Guidelines, which set the minimum standard and are superseded by Regional and Municipal guidelines. The Mannings equation is universally used in Ontario for sewer sizing and capacity assessment.

#### 6.1.2.1 Pipe Criteria

**Table 6-4** compares the sanitary pipe design criteria from the reference documents. In general, the sewer design criteria are similar to the MECP Guidelines. The flow velocities comply with the MECP Guidelines, with additional considerations for subcritical flow.

**Table 6-4: Comparison of Sanitary Pipe Design Criteria**

| **Criterion** | **MECP** (2023) | **DGSSMS** | **KDM** |
|---|---|---|---|
| Min. Pipe Size | 2.3: 200 mm<br>(150 mm is acceptable if it is demonstrated in the design that there is no risk of clogging, and the design is accepted by the Owner) | B.3.1.4: Per MECP | Defer to DGSSMS |
| Min. Pipe Slope | - | B.3.1.6: 1st Reach: 1.0%<br>All Other Pipes: 0.5% | E.1.3: 1st Reach: per DGSSMS<br>All Other: As a function of flow velocity |
| Velocities | 2.4: Min: 0.6 m/s when flowing full<br>Max: 3.0 m/s | B.3.1.7: Per MECP | E.1.4: Min: 0.8 m/s when flowing full<br>Max: 3.0 m/s |
| Pipe Depth | 2.8: Installed at sufficient depth to prevent freezing, considering traffic load and manufacturer recommendations | B.3.1.10: Min. 2.8 m to Obvert<br>> 5.0 m may require secondary shallow sewer | E.1.5: Per DGSSMS |
| Capacity Ratio | - | - | E.1.2: Local: <95% Pipe Full Capacity<br>Trunk: <85% Pipe Full Capacity |
| Roughness | 2.2: 0.013 | B.3.1.5: 0.013 | Defer to DGSSMS |

#### 6.1.2.2 Maintenance Hole Criteria

**Table 6-5** presents a comparison of the maintenance hole (MH) criteria.

## Table 6-5: Comparison of Sanitary MH Design Criteria

| Criterion | **MECP** (2023) | DGSSMS | KDM |
|---|---|---|---|
| Minimum Invert Drops | 2.10.4: Based on bend angle:<br>0˚: 0.025 m<br>45˚ Turn: 0.03 m<br>90˚ Turn: 0.05 m<br>Sewer grade may be maintained across maintenance holes provided minimum required flow velocity is maintained | B.3.2.6:<br>0˚ – 45˚: 0.030 m<br>45˚ – 90˚: 0.060 m | Defer to DGSSMS |
| Change in Flow Direction | - | B.3.2.9: Must be less than 90˚<br>Pipes 675mm or greater must be less than 45˚ | Defer to DGSSMS |
| Benching | - | D.3.3.4: All sanitary MHs benched to springline<br>Slope: 8% | Defer to DGSSMS |
| Drop Structures | 2.10.6: Drop should be provided for sewer entering ≥610mm above MH invert.<br>External drop connection preferred; internal drops if necessary to be secured to interior wall of MH for access and cleaning.<br>Where drop not feasible, alternative methods of energy dissipation and minimizing air entrainment and odour problems to be specified | B.3.2.4: Defers to MECP<br>Only external drops allowed | Only external drops allowed |
| Change in Pipe Size | 2.10.5: When smaller sewer joins larger one, invert of larger sewer should be lowered sufficiently to maintain the same energy gradient, or pipe obverts are matched | - | - |
| Minimum Diameter | 2.10.11: 1200mm<br>Maintenance holes shall be designed based on the pipe size, alignment, and inspection and maintenance needs; minimum access diameter of 610mm required | B.3.2.3: 1200mm | Defer to DGSSMS |
| Maximum Spacing | 2.10.1:<br>400mm = <120 m<br>450mm-750mm = <150m | B.3.2.2:<br>200mm – 450mm = 90 m<br>>450mm – 900mm = 120 m<br>>900mm = at approval of Chief Municipal Engineer | Defer to DGSSMS |
| Lids | 2.10.7: Located away from any route or ponding area. Grading around MH to shed water away from lids | B.3.2.8: Where there is a possibility of surface flood water ingress, watertight lids shall be installed | - |

### 6.1.3 Design of Pump Stations

There are many facets to pump station design criteria as outlined in the KPF. Select criteria relative to this Master Plan are presented in **Table 6-6**.

**Table 6-6: Pump Station Criteria**

| **Criterion** | **MECP** (7.2.3) (2008) | **KPF** |
|---|---|---|
| Design Flow | Multiple pumps should be provided. Where only two pumps, they should be of equal size and provide a Firm Capacity (one pump out of service) to handle at least the 10-yr peak hourly flow | 2.1: Pumping Facilities should be able to pump 10-yr peak flows with the largest capacity pump out of operation. For a two-pump station, each pump should have sufficient capacity to handle the peak flows. For three-pump stations or larger, with the largest pump out of operation, the remaining pumps operating in parallel should convey the peak flows. |
| Pump Sizing | Min. Dia. = 80 mm<br>Min. Dia. Suction & Discharge Opening=100 mm | 2.7.1: Min. Dia. = 75 mm |
| Hazen-Williams C-Factor | Low Sewage Level: C = 120<br>Median Sewage Level: C = 130<br>Overflow Sewage Level: C = 140 | Same as MECPP |
| Protection | Pumps receiving flow from >= 750 mm pipes to be protected by bar racks<br>Pumps receiving flow from smaller pipes to be protected from clogging | 2.7.10: Grinders to be installed to protect pumps from clogging or damage.<br>Where size warrants, a mechanically cleaned bar screen with grinder or compaction device is recommended. |
| Forcemain Sizing | Firm design capacity should be based on design peak instantaneous flow and should be adequate to maintain a minimum velocity of 0.6 m/s in the forcemain | 2.6.5: ≥ 100 mm<br>2.6.1: Velocities should be in the range of 0.8 to 2.5 m/s, with the lower limit preferred for the initial phase |
| Emergency Storage | 7.7.3: Controlled, high-level wet well overflow to be provided for use during possible periods of extensive power outage or uncontrollable emergency conditions | 2.2.3: Storage to be provided for 1-hr time to overflow, calculated under peak flow (10-yr) conditions |

## 6.2 Sanitary Collection System Level of Service

The design criteria guide new or infill development infrastructure and assess how increased flows affect existing infrastructure, a process known as Level of Service (LOS) analysis. LOS, defined by the USEPA, describes service performance characteristics, and is tied to Asset Management, a data-driven approach to manage assets sustainably.

Ontario’s Asset Management legislation, O. Reg. 588/17, defines Community and Technical LOS for core assets. Community LOS includes qualitative descriptions of the end-user experience, while Technical LOS provides quantitative metrics of municipal services.

In sanitary servicing, Community LOS includes drainage area mapping, educational materials on system operation, and service reliability information. Technical LOS, as per ISAN-MP, establishes metrics for capital planning, considering resiliency to aging infrastructure, infiltration and inflow effects, and climate change impacts.

The City's Corporate Asset Management Policy emphasizes correlating operational activities to infrastructure for effective LOS, balancing asset maintenance with service provision, and implementing a LOS framework that supports city-wide sustainability and resiliency targets.

The City's Sanitary Asset Management Plan (2018) categorizes LOS into customer expectations, legislated obligations, and technical standards. The document focuses on Technical Standards. Since 2017, the Sanitary Utility provides annual Key Result Indicators, including metrics like percentage of sewer pipes flushed and inspected, kilometers of pipe replaced, blockages per 100 km, and environmental spills. These metrics measure long-term system performance. Legislated obligations, based on Provincial guidelines, emphasize environmental protection and regulatory compliance. Kitchener maintains a copy of the MECP's Grand River Watershed Sewage Discharge Notification Form for Spills and Bypasses. Sanitary network modeling is a key metric for LOS assessment, comparing project model results to design criteria.

### 6.2.1 Sanitary Sewers

A LOS analysis offers insights into the resilience of the collection system and helps determine if infrastructure modifications are needed. It starts by evaluating the system's performance under dry weather conditions, then assesses its capacity to handle increasingly rare wet weather events.

#### 6.2.1.1 Difference Between Design and Existing System Performance

Municipalities maintaining hydraulic models face challenges in assessing development applications. The models, based on macro-level population distributions and calibrated to trunk-level flow monitoring data, differ fundamentally from the methods used in new sewer design. This difference can cause confusion when assessing applications. One major difference is that design sheets are simplified static representations of the dynamic flow routing that occurs in a sewer system. The use of the Harmon Peaking factor is a means of accounting for flow attenuation and dampening of the peak as it travels through the pipe (i.e., peak flows are not directly additive as you move downstream). Dynamic hydraulic models simulate the full process of flow travel over time, using actual diurnal patterns and dry weather groundwater infiltration rates, rather than the Harmon formula or direct extraneous flow allowances.

Peak flow rates derived by designers often result in conservative values beneficial for new sewer sizing but less suitable for downstream impact assessment. With the ISAN-MP update, the application assessment process should continue to evolve to better integrate these methodologies, using the system model to evaluate system-wide impacts of proposed developments.

#### 6.2.1.2 LOS Capacity-Based Metrics

For assessing sanitary sewer system capacity performance and triggers for upgrades, there are three main metrics typically used in the industry:

- Depth to Diameter or Height (d/D) ratio
- Peak Flow to Pipe Full Capacity (q/Q) ratio
- Hydraulic Grade Line (HGL) Freeboard

These can be assessed at the pipe level using the asset geodatabase and Manning's formula. The updated hydraulic model is the tool for extracting this information, where it also provides a Surcharge State (SS) metric, a ratio of the HGL slope to the pipe slope, indicating surcharge conditions and pipe capacity. Using the HGL Freeboard and SS can provide insights into system-wide performance. Coupling these metrics with design storm simulations in the calibrated hydraulic model allows for LOS quantification based on design storm return frequency using the City's Intensity-Duration-Frequency data.

Another metric is peak velocity in m/s, indicating adequacy for conveying solids, potential for deposition leading to blockages and odour concerns, and risks of increased headlosses or long-term pipe shifting.

#### 6.2.1.3 Dry Weather Flow Performance

Under dry weather flow (DWF) conditions, the collection system's performance should account for daily flow variations using a diurnal pattern based on dry period sewer flow monitoring data. The pipe should not exceed 80% d/D to allow air movement, and peak DWF velocity should be ≥ 0.8 m/s for sufficient scour velocity and system operation.

#### 6.2.1.4 Wet Weather Flow Performance

Collection system performance under wet weather flow (WWF) conditions provides insights into LOS and flood risk. WWF analysis uses synthetic design storm distributions or historic events to establish upgrade triggers.

Kitchener uses the 25-yr, 12-hr AES Distribution design storm for its sanitary collection system assessment, which is more reasonable for its size than the peaky Chicago Distribution, suitable for storm drainage systems.

For sanitary collection system LOS analysis, HGL elevations at model nodes are the main indicators of system issues. Elevated HGLs indicate capacity constraints. Basement flooding risk in the 25-yr AES, 12-hr design event is considered if HGLs are within 1.8 m from the surface elevation, consistent with other Ontario municipalities.

Sewer performance is reviewed alongside elevated HGLs to identify issues and solutions. Upgrades may be warranted if surcharging is observed in smaller events like the 5-yr AES, 12-

hr storm. In the hydraulic model, the Surcharge State (SS) indicates performance. Pipes are considered free flowing when SS is less than 1, under backwater when SS is 1, and bottlenecked/undersized when SS is 2.

For shallow sewers within 1.8 m from the surface, if the water level remains within the pipe and the pipe is under free-flowing conditions, it is proposed not to trigger the need for upgrades.

### 6.2.2 Pump Stations

LOS for pump stations is expressed as a Design Period, unrelated to rainstorm return frequency. MECP guidelines suggest that each pump in a two-pump station should handle the peak hourly flow of the 10-year Design Period. Kitchener's Condition Assessment reports the highest 1-hr flow in a 10-year timeframe as the peak wet weather flow. The KPF specifies a minimum design period of 50 years for ultimate conditions and 10 years for initial installation.

MECP doesn't specify wet weather response as a LOS item or define an emergency overflow. KPF's Section 2.1 identifies peak hourly flow as the peak wet weather hourly flow. Section 2.2.3 states the emergency overflow response time is 1-hr, without relating it to a design storm threshold. Once operational, actual peak wet weather flow can be derived from averaged SCADA measurements, providing a baseline for comparison over time.

For LOS assessment in ISAN-MP, the 10-yr AES, 12-hr storm event is recommended. Pump stations should be designed to pump the 10-yr peak flow with the largest pump offline. Stations receiving 10-yr peak flows exceeding their firm capacity are considered capacity-constrained. The 10-yr modelled peak flow is compared to the ECA's firm capacity to assess if it's adequate for existing and future flows or needs amendment. Pump station performance is also evaluated for overflows, which shouldn't occur in events smaller than the 25-yr AES storm.

### 6.2.3 Sensitivity Testing

To ensure system resilience under climate change impacts, additional simulations are suggested for assessing system sensitivity and considering enlargement of planned upgrades. The IDF_CC Web-based Tool (ver. 6.5) from Western University was used to define factors to increase the 25-yr AES, 12-hr storm rainfall intensities. A 20% increase to the design storm time series, termed the 25-yr + CC event, was applied for testing sensitivity.

This event is applied to LOS and capital project sizing to understand capacity constraints and prioritization, which is incorporated into capital planning decisions, potentially leading to solution expansion or priority advancement.

The City's condition-based system assessment is also utilized in identifying and prioritizing LOS and capital upgrade triggers, using available metrics like condition-based scores from CCTV and the Total Wastewater Priority Assessment Score (TWPAS).

# 7 Assessment of Existing and Future Sanitary Infrastructure

## 7.1 Design Criteria

Both the DWF and WWF conditions are reviewed as part of the sanitary sewer system performance assessment.

The Hydraulic Grade Line (HGL) elevation at nodes is used to identify issues in the sewer system. The system is evaluated for HGL issues in DWF conditions and during the 1:25-year AES, 12-hour storm event. Risk of basement flooding (or HGL issues) in this design event is considered if the HGLs are higher than 1.8 m below the surface elevation, which coincides with the assumed basement elevation for homes with direct or indirect basement connections to the sewer.

For sewers that are shallow (within 1.8 m from the surface), HGL issues might be observed in the hydraulic model. However, if the water level stays within the pipe and the pipe is free flowing, it is not considered for upgrades.

The pumping stations are assessed using a 1:10-year AES, 12-hour storm event. The peak flow carried through the pump station during the 10-year event is compared to the pumping station's firm capacity. If the 10-year peak flow exceeds the station's firm capacity, it indicates capacity constraints.

Moreover, overflows should not occur in events smaller than the 25-year. If an overflow occurs, it indicates inadequate pumping station capacity. No physical damage to the pumping station should occur due to flooding during stress test events, which is evaluated as part of the climate change analysis.

In later stages of this project, solutions to the identified capacity constraints can be sized based on the following criteria, where feasible, as per the City of Kitchener Development Manual (Summer 2021) and discussed with the City:

- Depth of flow to diameter (d/D) ratio is no higher than 80% in DWF conditions (lower d/D ratios may be considered in trunks to facilitate maintenance activities);
- Full flow velocity is appropriate to provide scour and peak flow velocity is less than the maximum allowable (0.8 m/s > v > 3 m/s);
- No HGL issues observed due to capacity constraints in the 25-year AES design event;
- No surface flooding observed during stress test events; and,
- Pumping stations have adequate firm capacity to convey the 10-year AES peak flows, and do not experience overflows in events smaller than the 25-year AES storm event or endure physical damage to the pumping station due to flooding during stress test events.

## 7.2 Climate Change

Ontario cities are learning to handle climate change. Places like Peel Region, York Region, and Toronto are using a plan for a big storm that happens once every 25 years. They're also making their storm drains better and using green ways to manage water. They use a model to predict rain and then make plans.

The IDF CC Tool helps cities understand the potential impact of climate change on rainfalls. It looks at past weather and uses models to guess how much intense a 25-year storm could get with climate change. The Master Plan utilized the amount of rain we observe currently in a 25-year storm, plus 20%. This 'stress test' helps decide which projects are most important, how to allocate funds, and what other programs can help with the design stages.

## 7.3 Critical Failure Analysis

If key parts of the sewer system break, it could lead to significant flooding. This critical failure analysis aims in comprehending potential responses of the system under such circumstances.

Four locations were chosen because they are important to the sanitary system, and the pipes are in poor condition. The pipes are rated from 1 to 5, with 1 being good and 5 being bad. Refer to **Table 7-1** for a list of the critical failure analysis locations and rationale.

All pump stations are also tested to see how the system might react if all the pumps break. This is done by setting a flow limit of 0 L/s to the pumps in the model.

These scenarios could indicate conditions of flooding. The outcomes can be utilized to strategize on incorporating redundancy into the sanitary system, thereby mitigating severe flooding or property damage.

**Table 7-1: Selected Critical Trunk Sewers for Failure Analysis**

| Trunk Sewer Name | Suggested Link ID for Failure Analysis | Rationale |
|---|---|---|
| Ottawa Direct | 301192.1 | Known sewer collapse; CCTV score of 5 |
| Montgomery Direct | 300583.1 | Concern for sewer collapse noted by City; significant drainage area |
| Upper Schneider Direct | 300579.1 | Significant drainage area |
| Strasburg Direct | 303094.1 | Significant drainage area |

## 7.4 Modelling & Analysis

### 7.4.1 Assessment Approach

The sewer system's performance is reviewed under two conditions, DWF and WWF. The Hydraulic Grade Line (HGL) elevations at nodes are used as the main indicator of issues within the collection system. If the HGLs are less than 1.8 m from the ground level, there's a risk of basement flooding. The system is evaluated for HGL issues in DWF conditions and during the 1:25-year AES, 12-hour storm event.

The sewer's capacity constraints are reviewed alongside the HGLs to determine the cause of the HGL issues observed and determine possible solutions. Usually, the sewer's capacity alone does not decide if upgrades are needed. But if the sewer gets too full during smaller events like a 5-year storm, upgrades might be needed. The sewer's capacity is measured by looking at how full the pipe is and how much water it can carry. If the pipe is less than full, it's considered free flowing. If it is full or more than full, it is considered under backwater or bottlenecked.

For shallow sewers that are less than 1.8 m from the surface, HGL issues might be shown. But if the water level stays within the pipe and the pipe is free flowing, it is not considered for upgrades.

For pump stations, a 10-year storm is used to review performance. All sewage pump stations should be designed to pump the peak flow of a 10-year storm with the biggest pump offline. This is called 'firm capacity'. The peak flow during a 10-year storm is compared to the pump station's firm capacity. If the 10-year peak flow is more than the firm capacity, the pump station is considered to have capacity constraints. The 10-year peak flow is also compared to the firm capacity from the ECA to see if the current ECA is enough for now and the future, or if it needs to be changed.

Pump station performance is also reviewed for overflows. Overflows should not happen in storms smaller than the 25-year storm. The pump station's rated capacity (the most it can pump) is used to limit outflow from the station in the model. If an overflow happens in storms smaller than the 25-year storm, it means the pump station does not have enough capacity.

### 7.4.2 Assessment Results

The model was reviewed under DWF conditions and during 5-year, 10-year, and 25-year storms to look at the HGL and surcharge results for the sewer. Figures were generated of each scenario to represent the system results using the following rendering:

- MH HGL (freeboard):
  - **Black:** HGL is more than 1.8 m below ground surface (i.e., low risk of basement flooding);
  - **Yellow:** HGL is within 1.8 m of ground surface (i.e., potential for basement flooding); and,

    - **Red:** HGL is above ground surface (i.e., potential for basement and surface flooding).
- Pipe surcharge state:
    - **Black:** free flow within sewer;
    - **Yellow:** sewer surcharged, peak flow within free-flow capacity of the sewer (i.e., under backwater conditions);
    - **Red:** sewer surcharged, peak flow greater than free-flow capacity of the sewer (i.e., sewer is undersized and causing bottleneck); and,
    - **Purple** halo: shallow sewers with less than 1.8 m between the sewer obvert and the ground surface.

#### 7.4.2.1 Existing Capacity-Based System Performance

The model results show no issues with capacity causing HGL problems under DWF conditions. There are two locations where the pipes are 85% full or more, but these are not a concern for the system's capacity and do not cause HGL problems in a 25-year storm. These locations are:

- **One 200 mm pipe at the Bancroft SPS (Asset ID 118789)**, which is 85% full or more because of the water levels downstream and the connecting invert.
- **One 250 mm pipe that connects the local system on Park St to the Westmount trunk sewer (Asset ID CDT-35)**, because of the water levels downstream in the trunk and the connecting inverts.

There are 13,825 pipes in the system. Most of these pipes (about 11,850 or 85.7%) have maximum velocity less than 0.6 m/s under normal conditions. There are 2,088 trunk sewers in the system, and about half of these (around 1,075 or 51.5%) have maximum velocity speeds less than 0.6 m/s under normal conditions.

Trunk sewers are defined as gravity pipes with 375 mm diameters or larger, forcemains, and additional smaller pipes that connect these sewers to form the system's spinal network, as per consultations with the City. There is less confidence with the local system pipes in the model due to identified engineering validation errors. These issues were resolved only where needed, as local sewers are not considered the focus of this MP.

Like DWF conditions, there are no capacity issues causing HGL problems in a 5-year storm, except for the area upstream of the Old Mill SPS, which is being replaced by a new, bigger pump station across the road (included in 2031 and 2051 conditions); and the area upstream of Shirley SPS, which is discussed further below. Excluding the area upstream of the Old Mill SPS, there are seven (7) locations that experience pipes 85% full or greater during this event due to sewer capacity constraints (including the area upstream of Shirley SPS); two (2) of which have HGL issues in the 25-year event and are described below. The remaining five (5) locations are not considered a concern as HGL issues are not generated by these capacity constraints in the 25-year design event.

- **Dalewood**, 250 mm sewers experience backwater during the 5-year event and surcharging and HGL issues in the 25-year event. This location is defined as an existing conditions problem area (SA-2); and,
- **Upstream of Shirley SPS**, HGL and surcharge issues are experienced in the 525 mm sewers in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-8).

In the 25-year design event, seven (7) Problem Areas (areas of observed sewer capacity constraints) are identified within the existing conditions system. These areas are highlighted in **Figure 7-4** and described in **Table 7-2** by Problem Area ID, where "SA" refers to Sanitary Area. All other areas with HGL issues are representative of shallow sewers, or inconsistent profiles in local areas deemed to have minimal impact to the Master Plan and thus were not updated in the model validation stages due to magnitude of profile issues observed.

**Table 7-2: Existing Conditions Sanitary Sewer Problem Areas**

| No. | Problem Area ID | Location | Capacity Constraint Description |
|---|---|---|---|
| 1 | SA-1<br>Upstream of King St SPS | King St, east of River Rd E | HGLs within 1.8 m of surface due to undersized pipes. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| 2 | SA-2<br>Dalewood | Dalewood Dr and Penrose Ave | Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes along Dalewood Dr. |
| 3 | SA-3<br>Upstream of Spring Valley SPS | Spring Valley SPS off of Riverbend Dr | HGLs within 1.8 m of surface due to downstream capacity constraints at the Spring Valley SPS. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| 4 | SA-6<br>Homer Watson | Homer Watson Blvd | Risk of basement flooding along Kingswood Dr and Flint Dr due to undersized pipes within the private ICI property and on Homer Watson Blvd. HGLs within 1.8 m of surface on Alpine Rd and Homer Watson Blvd with low risk of basement flooding as no building connections are anticipated along these sewers. |
| 5 | SA-7<br>Sandrock Trunk | Highland Rd W and Fischer-Hallman Rd | HGLs within 1.8 m of surface due to undersized pipes along Highland Rd W. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| 6 | SA-8<br>Upstream of Shirley SPS | Shirley Dr and Victoria St N | Risk of basement flooding and surface flooding along Shirley Dr due to downstream capacity constraints at the Shirley SPS. HGLs within 1.8 m of surface on Victoria St N with low risk of basement flooding as no building connections are anticipated along these sewers. |
| 7 | SA-10<br>Upstream of Bridgeport SPS | Bridge St E between Bloomingdale Rd and Grand Ave | Risk of basement flooding on Bridge St E due to downstream capacity constraints at the Bridgeport SPS. Risk of PS flooding. |

Additionally, the 10-year incoming peak flows are compared to the pumping station's firm, rated and ECA capacities to determine performance or approval issues. The following **Table 7-3** presents these results, along with the 25-year peak incoming flows for reference. The ECA, firm and rated capacities surpassed by the 10-year incoming flow are noted in **red**, illustrating the pump stations that do not meet criteria. The 10-year flows draining to the Bridgeport SPS, Pioneer Tower SPS, Shirley SPS and Spring Valley SPS exceed their firm and rated capacities. However, it is noted that Pioneer Tower SPS capacity was upgraded by the City during the ISAN-MP which is not reflected in the table, and sufficient capacity (estimated capacity of 125.1 L/s) has been allocated to 2051. The 10-year incoming flows to Bridgeport SPS and Spring Valley SPS also exceed their current ECA approved rates. Note that the Bridgeport SPS and Spring Valley SPS are owned by the Region of Waterloo and not the City of Kitchener.

**Table 7-3: Existing Conditions Pumping Station Performance**

| Pumping Station | Incoming 10-Year Peak Flow (L/s) | Incoming 25-Year Peak Flow (L/s) | ECA Capacity (L/s) | Firm Capacity (L/s) | Rated Capacity (L/s) | Notes |
|---|---|---|---|---|---|---|
| Apple Tree SPS | 38.4 | 47.6 | 50.0 | 66.0 | 66.0 | |
| Bancroft SPS | 4.6 | 5.7 | 7.7 | 7.7 | 7.7 | |
| Bridgeport SPS[1] | 175.2 | 211.9 | **136.0** | **136.0** | **136.0** | |
| Carson SPS | 37.5 | 49.5 | N/A | 66.9 | 66.9 | No ECA available |
| Chandos SPS | 7.1 | 9.2 | 30.0 | 27.0 | 27.0 | |
| Conestoga College SPS | 2.9 | 3.6 | 50.0 | 47.5 | 47.5 | |
| Falconridge SPS | 15.2 | 17.7 | 118.0 | 45.5 | 45.5 | |
| Homer Watson SPS | 73.2 | 86.9 | 310.0 | 314.0 | 314.0 | |
| King St SPS | 136.0 | 171.6 | 290.0 | 176.0 | 176.0 | |
| Manchester SPS | 158.9 | 207.6 | 240.0 | 240.0 | 240.0 | |
| Moore SPS | 11.9 | 15.3 | N/A | 21.5 | 23.5 | No ECA available |
| New Dundee SPS | 7.4 | 9.3 | 56.0 | 56.0 | 56.0 | |
| Old Mill SPS | 70.6 | 81.8 | N/A | N/A | N/A | To be replaced by New Old Mill SPS |
| Otterbein SPS | 54.0 | 57.3 | 126.0 | 88.7 | 88.7 | EA for proposed upgrades provided; notes future 165 L/s design capacity |
| Oxford SPS | 31.2 | 41.0 | N/A | 49.0 | 49.0 | No ECA available |
| Patricia SPS | 3.9 | 4.8 | N/A | 23.5 | 23.5 | No ECA available |
| Pioneer Tower SPS | 77.7 | 90.1 | 125.1 | **70.0**[3] | **70.0**[3] | Upgrade completed during study |

| Pumping Station | Incoming 10-Year Peak Flow (L/s) | Incoming 25-Year Peak Flow (L/s) | ECA Capacity (L/s) | Firm Capacity (L/s) | Rated Capacity (L/s) | Notes |
|---|---|---|---|---|---|---|
| River Birch SPS | 9.6 | 12.8 | 17.3 | 19.0 | 19.0 | |
| Shirley SPS | 222.5 | 231.3 | 378.0 | **207.0** | **207.0** | |
| Spring Valley SPS[1] | 252.9 | 319.6 | **245.0** | **245.0** | **245.0** | Currently in design process for SPS upgrades |
| Springmount SPS | 98.8 | 122.6 | 205.5 | 162.0 | 162.0 | |
| Stoke SPS | 62.4 | 69.2 | 473.0 | 196.0 | 196.0 | |
| Woolner SPS | 80.1 | 97.7 | 115.2 | 136.0 | 136.0 | |
| Nathalie SPS[2] | 0.0 | 0.0 | 148.0 | 98.0 | 98.0 | |

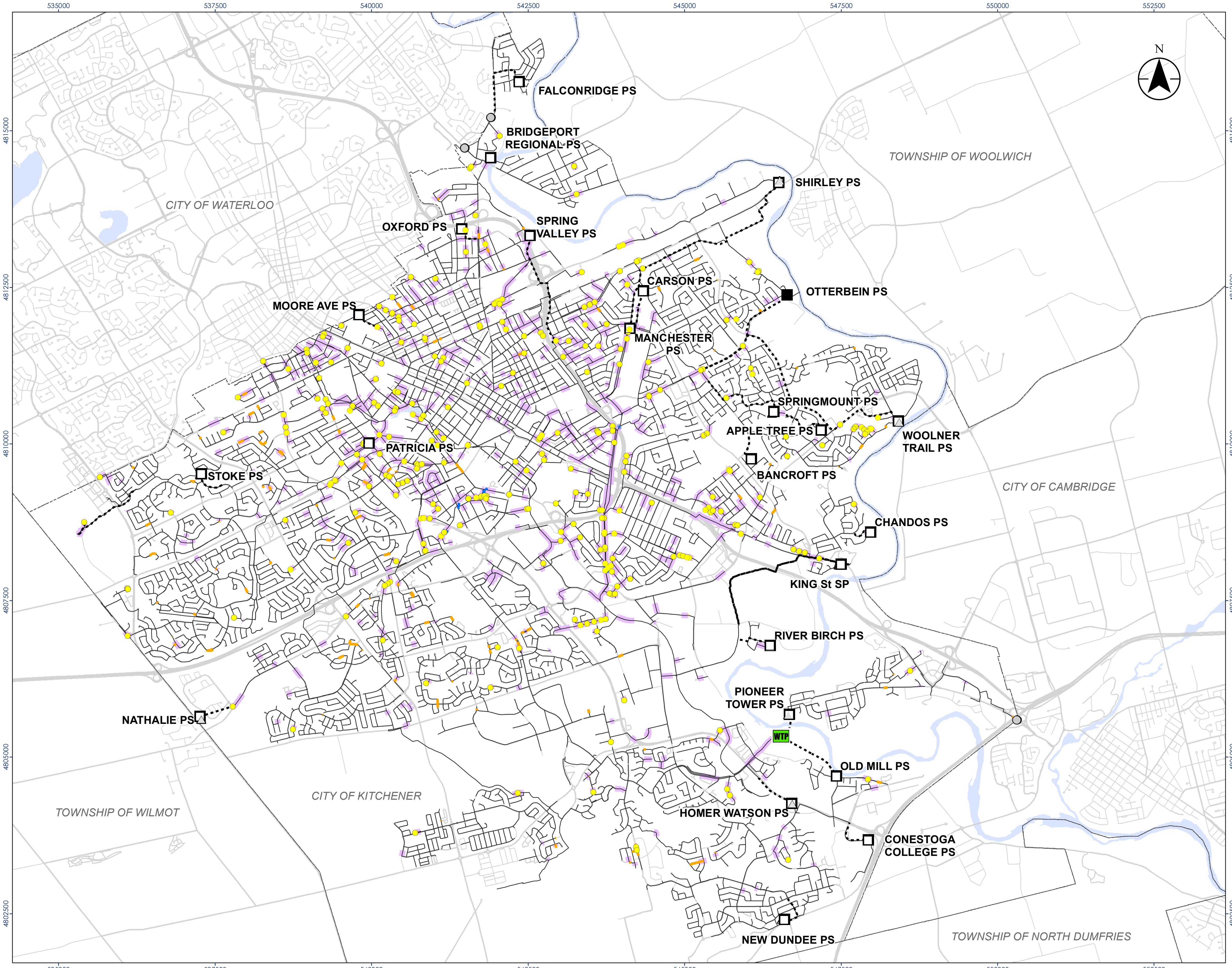
**Notes:**

1 Bridgeport SPS and Spring Valley SPS are owned by the Region of Waterloo.

2 Nathalie SPS sees no incoming flows in existing conditions as the area draining to this station has no population attributed to it for this scenario (still under development).

3 Pioneer Tower SPS was upgraded after technical analysis was completed for the ISAN-MP. The SPS has sufficient firm capacity (125 L/s) for existing and future conditions.

In **Figure 7-3** and **Figure 7-4**, the pumping stations are rendered based on the whether the 10-year and 25-year flows, respectively, exceed the pumping station's ECA, firm or rated capacities in existing conditions. See figure legends for details.




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**HGL Freeboard**

- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

1:62,500 (At original document size of 11x17)

**Notes**

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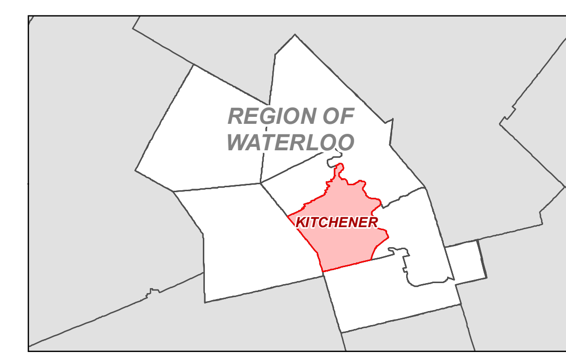


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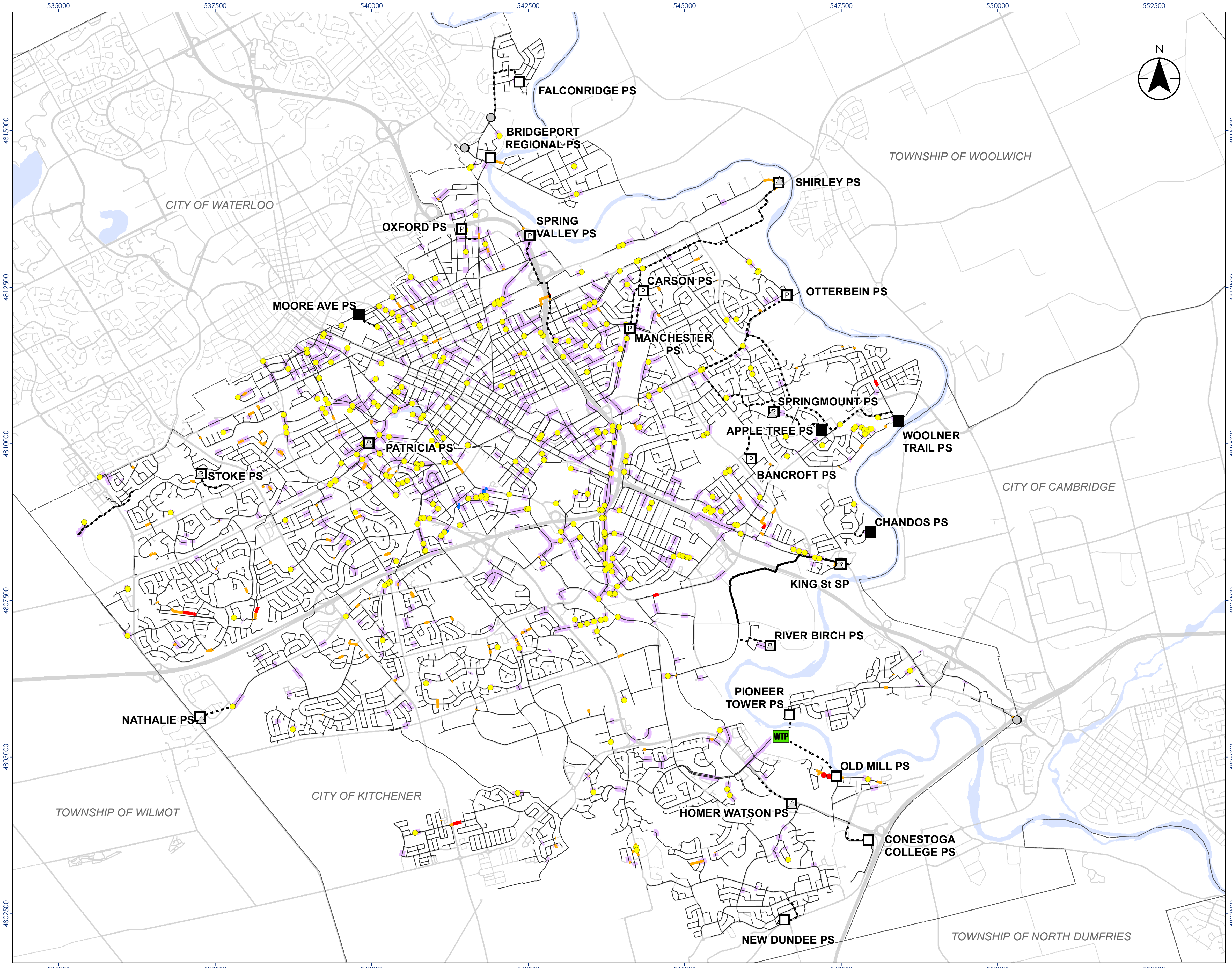
Figure No.
**7-1**

Title
**Existing Conditions Sanitary Sewer System Dry Weather Flow HGL & Surcharge Results**




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WTP WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**HGL Freeboard**

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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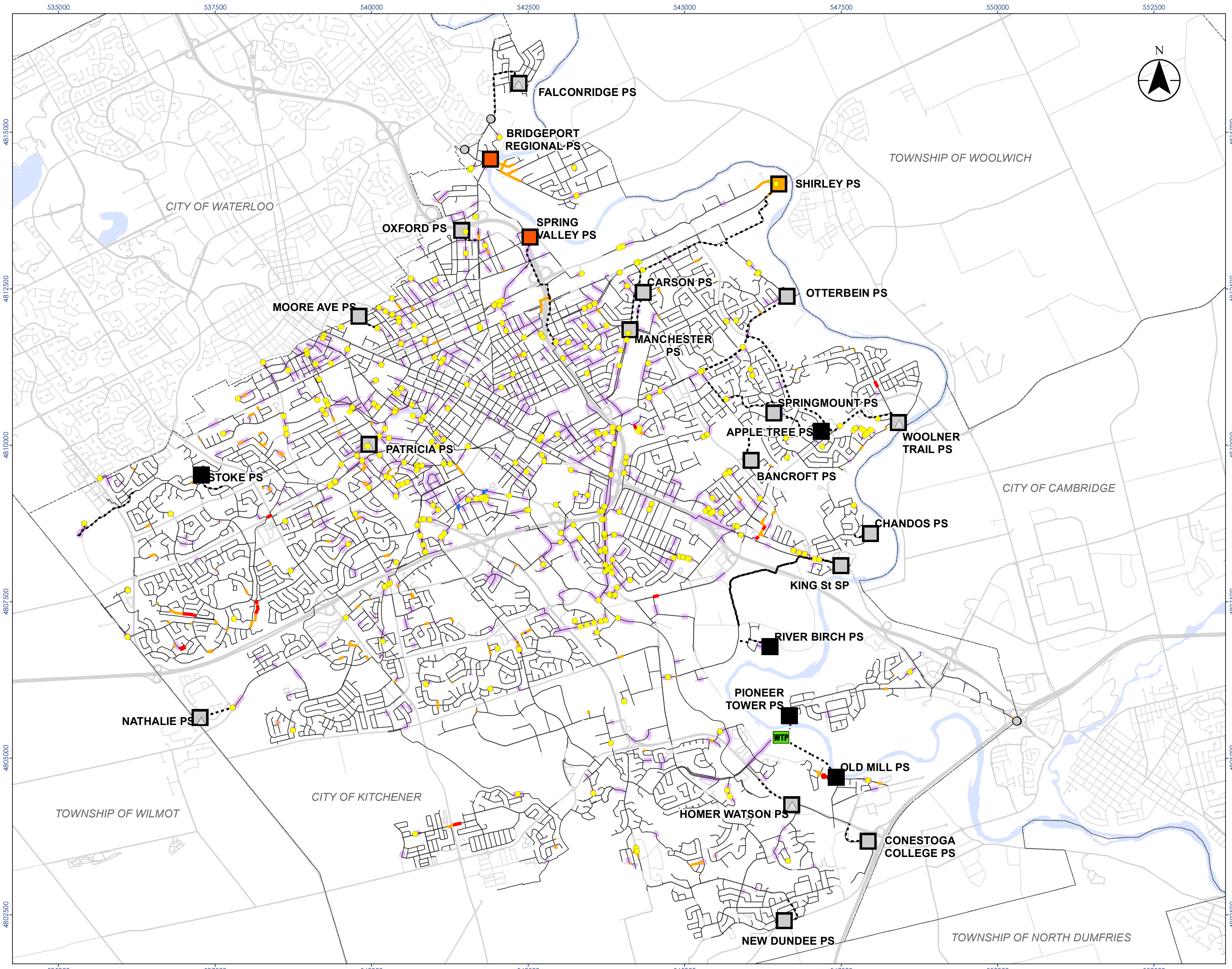
Figure No.
7-2

Title
**Existing Conditions Sanitary Sewer System**
**5-Year HGL & Surcharge Results**




Stantec

Legend

- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**Pumping Station 10yr Flow Results**

- PS ECA Exceeded by 10yr Flow
- PS Firm & Rated Capacities Exceeded by 10yr Flow
- PS ECA, Firm & Rated Capacities Exceeded by 10yr Flow
- All Other PSs

**HGL Freeboard**

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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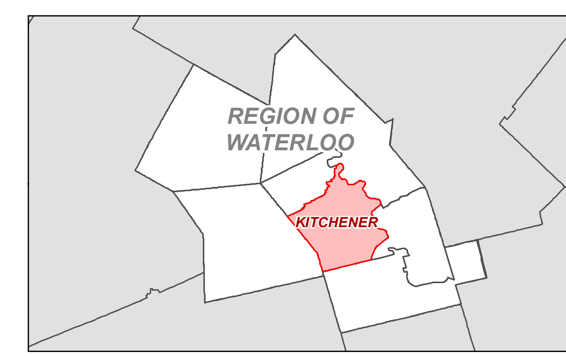


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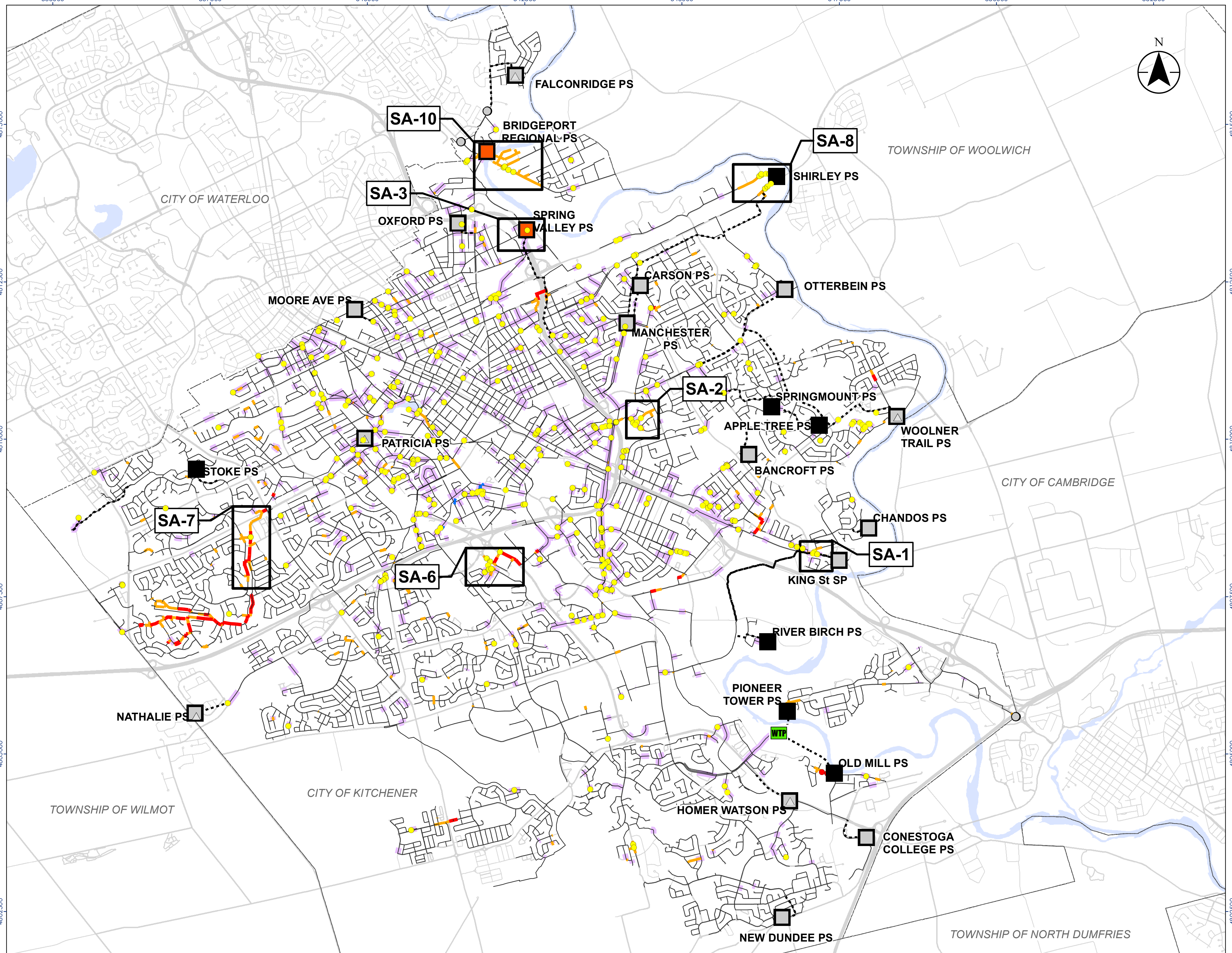
Figure No.
**7-3**

Title
**Existing Conditions Sanitary Sewer System 10-Year HGL & Surcharge Results**




Stantec

Legend

- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**Pumping Station 25yr Flow Results**

- PS ECA Exceeded by 25yr Flow
- PS Firm & Rated Capacities Exceeded by 25yr Flow
- PS ECA, Firm & Rated Capacities Exceeded by 25yr Flow
- All Other PSs

**HGL Freeboard**

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

1:62,500 (At original document size of 11x17)

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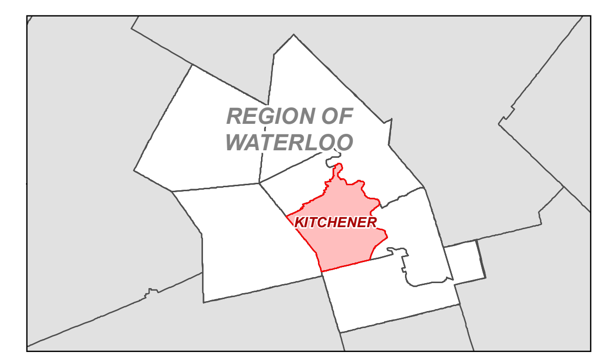


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Figure No.
**7-4**

Title
**Existing Conditions Sanitary Sewer System 25-Year HGL & Surcharge Results**

#### 7.4.2.2 2031 Capacity-Based System Performance

The approach to the future conditions system assessment and criteria is consistent with that of the existing conditions system assessment, as described in **Section 7.4.1**. **Figure 7-6**, **Figure 7-7**, and **Figure 7-8** illustrate the modelled 2031 scenario HGL and surcharge results for the DWF, 5-year, 10-year, and 25-year events, respectively, and are presented with rendering as discussed in **Section 7.4.1**.

Based on the presented modelling results, no capacity constraints resulting in HGL issues are observed in the DWF conditions. Excluding siphons, forcemains or the remaining inconsistent profiles, there are now five (5) locations where the pipes were found to be 85% full or greater in DWF conditions. Two (2) of these locations are consistent with those observed in existing conditions (as described in **Section 7.4.2**), while the remaining three (3) are described below. All five locations are not considered concerns with respect to capacity constraints in the system and do not result in HGL issues in the 25-year event.

- **Three pipes (1x 300 mm diameter, 2x 200 mm diameter) along Seabrook Dr at Fischer Hallman Rd.** Pipe running 85% full or greater due to a drop in pipe sizes from the 300 mm to 200 mm pipes. The next downstream pipe is a 300 mm diameter. Asset IDs include 2098781, 121209, and 121212;
- **One twinned 200 mm pipe (Asset ID 2083719) along Robert Ferrie Dr just east of Southridge Dr.** Due to a drop in pipe size from 375 mm to 200 mm on the main line (immediately draining to a single 375 mm pipe); and,
- **One 600 mm pipe (Asset ID 103273) that connects the Manitou Dr sewers to the Lower Schneider trunk via Wabanaki Dr.** Due to downstream trunk water level and connecting invert.

In the model, there are a total of 13,825 pipes. Among these, 2,088 pipes are classified as trunk sewers. These trunk sewers are defined as gravity pipes with diameters of 375 mm or larger, forcemains, and additional smaller pipes that connect these sewers to form the system's spinal network, as per consultations with the City. Approximately 81.2% (11,232 pipes), experience maximum velocities less than 0.6 m/s under DWF conditions. When examining solely the trunk sewers under DWF conditions, approximately 40.1% experience maximum velocities less than 0.6 m/s.

Like DWF conditions, no capacity constraints resulting in HGL issues are observed in the 5-year storm event, other than the area upstream of the Shirley SPS and Dalewood Dr, which are discussed further below. There are nine (9) locations that experience pipes 85% full or greater during this event due to sewer capacity constraints (including the area upstream of Shirley SPS and on Dalewood Dr); three (3) of which see HGL issues in the 25-year event and are described below. The remaining six (6) locations are not considered a concern as HGL issues are not generated by these capacity constraints in the 25-year design event.

- **Dalewood**, 250 mm sewers experience backwater during the 5-year event and surcharging and HGL issues in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-2);
- **Upstream of Shirley SPS**, HGL and surcharge issues are experienced in the 525 mm sewers in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-8);
- **Upstream of Bridgeport SPS**, 450 mm, and 525 mm sewers experience backwater during the 5-year. HGL and surcharge issues are experienced in the 450 mm sewers in the 25-year events. This location is defined as an existing conditions problem area (SA-10).

In the 25-year design event, one additional Problem Area (areas of observed sewer capacity constraints) is identified within the 2031 future conditions system. This area, in addition to those identified in existing conditions, is highlighted in **Figure 7-8** and described (**bolded**) in **Table 7-4**. Note that while this new problem area (SA-16) is identified in the figure, there are no HGL issues shown. This is because this problem area arises only when the upstream New Dundee SPS capacity is increased as part of solution development.

**Figure 7-8** only shows the modelled results excluding solutions and thus, this is not evident. This area is however, accounted for in the problem area list, as it does require solutions. All other areas with HGL issues observed are representative of shallow sewers, or inconsistent profiles in local areas deemed to have minimal impact to the Master Plan.

**Table 7-4: 2031 Future Conditions Sanitary Sewer Problem Areas**

| No. | Problem Area ID | Applicable Scenario(s) | Location | Capacity Constraint Description |
|---|---|---|---|---|
| 1 | SA-1<br>Upstream of King St SPS | Existing<br>2031 | King St, east of River Rd E | HGLs within 1.8 m of surface due to undersized pipes. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| 2 | SA-2<br>Dalewood | Existing<br>2031 | Dalewood Dr and Penrose Ave | Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes along Dalewood Dr. |
| 3 | SA-3<br>Upstream of Spring Valley SPS | Existing<br>2031 | Spring Valley SPS off of Riverbend Dr | HGLs within 1.8 m of surface due to downstream capacity constraints at the Spring Valley SPS. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| 4 | SA-6<br>Homer Watson | Existing<br>2031 | Homer Watson Blvd | Risk of basement flooding along Kingswood Dr and Flint Dr due to undersized pipes within the private ICI property and on Homer Watson Blvd. HGLs within 1.8 m of surface on Alpine Rd and Homer Watson Blvd with low risk of basement flooding as no building connections are anticipated along these sewers. |

| No. | Problem Area ID | Applicable Scenario(s) | Location | Capacity Constraint Description |
|---|---|---|---|---|
| 5 | SA-7<br>Sandrock Trunk | Existing<br>2031 | Highland Rd W and Fischer-Hallman Rd | HGLs within 1.8 m of surface due to undersized pipes along Highland Rd W. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| 6 | SA-8<br>Upstream of Shirley SPS | Existing<br>2031 | Shirley Dr and Victoria St N | Risk of basement flooding and surface flooding along Shirley Dr due to downstream capacity constraints at the Shirley SPS. HGLs within 1.8 m of surface on Victoria St N with low risk of basement flooding as no building connections are anticipated along these sewers. |
| 7 | SA-10<br>Upstream of Bridgeport SPS | Existing<br>2031 | Bridge St E between Bloomingdale Rd and Grand Ave | Risk of basement flooding on Bridge St E due to downstream capacity constraints at the Bridgeport SPS. Risk of PS flooding. |
| **8** | **SA-16**<br>**Downstream of New Dundee SPS** | **2031** | **Robert Ferrie Dr** | **Risk of basement flooding along Mossgrove Dr and Monarch Woods Dr due to undersized pipes on Robert Ferrie Dr.** |

Additionally, the 10-year incoming peak flows are compared to the pumping station's firm, rated and ECA capacities to determine performance or approval issues. The following **Table 7-5** presents these results, along with the 25-year peak incoming flows for reference. The ECA, firm and rated capacities surpassed by the 10-year incoming flow are rendered in **red**, illustrating the pump stations that do not meet criteria in this scenario. The 10-year flows draining to the Bridgeport SPS, New Dundee SPS, and Shirley SPS in the 2031 future conditions scenario exceed their firm and rated capacities. The 10-year incoming flow to Bridgeport SPS, New Dundee SPS, and Spring Valley SPS also exceed their current ECA approved rates. Note that the Bridgeport SPS and Spring Valley SPS are owned by the Region of Waterloo and not the City of Kitchener.

Similarly to existing conditions, the pumping stations are rendered in **Figure 7-7** and **Figure 7-8** based on the whether the 10-year and 25-year flows, respectively, exceed the pumping station's ECA, firm or rated capacities in 2031 conditions. See figure legends for details.

**Table 7-5: 2031 Future Conditions Pumping Station Performance**

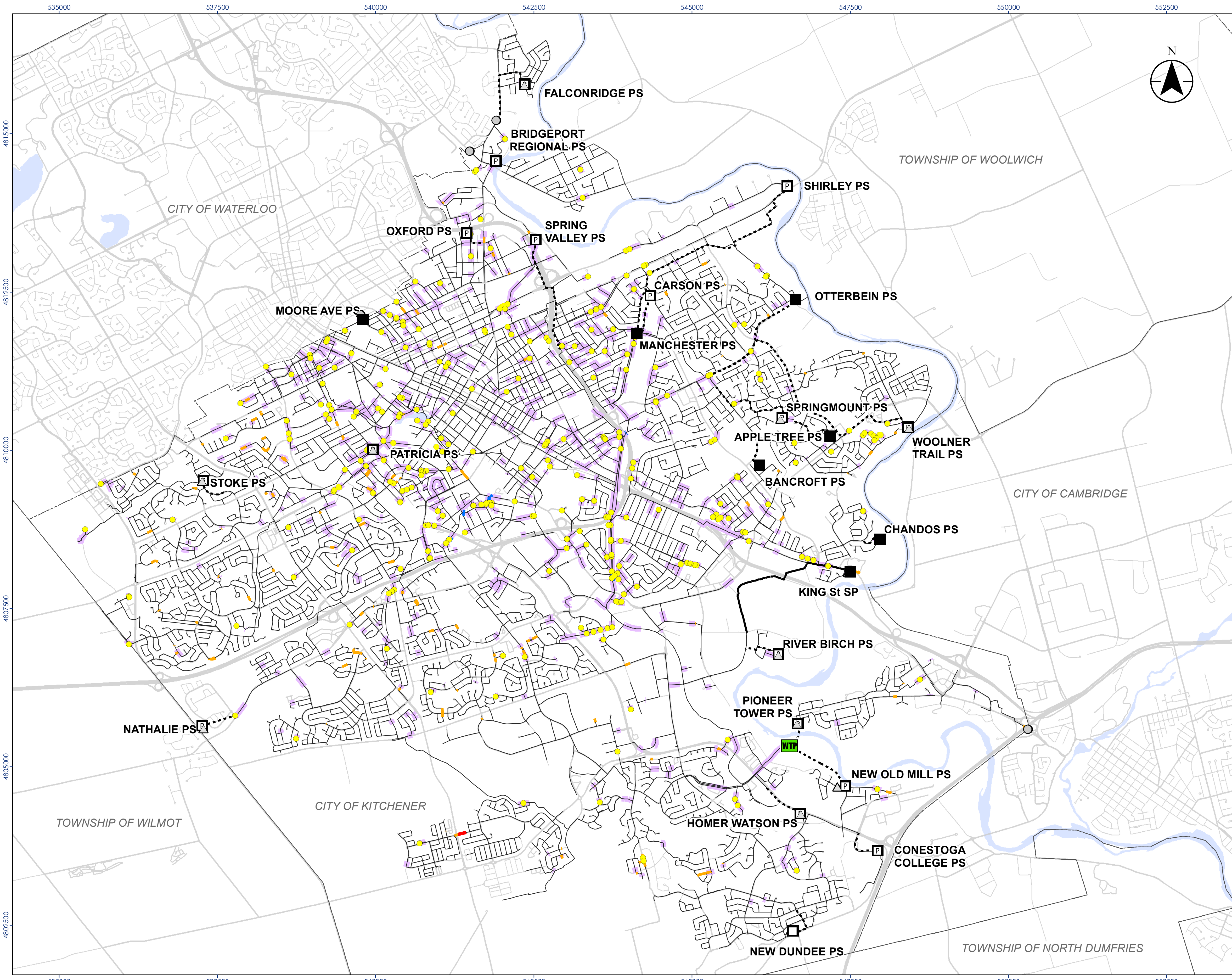
| Pumping Station | 10-Year Peak Flow (L/s) | 25-Year Peak Flow (L/s) | ECA Capacity (L/s) | Firm Capacity (L/s) | Rated Capacity (L/s) | Notes |
|---|---|---|---|---|---|---|
| Apple Tree SPS | 47.2 | 56.3 | **50.0** | 66.0 | 66.0 | |
| Bancroft SPS | 4.6 | 5.7 | 7.7 | 7.7 | 7.7 | |
| Bridgeport SPS[1] | 176.7 | 216.4 | **136.0** | **136.0** | **136.0** | |
| Carson SPS | 38.7 | 53.8 | N/A | 66.9 | 66.9 | No ECA available |
| Chandos SPS | 7.4 | 9.6 | 30.0 | 27.0 | 27.0 | |

| Pumping Station | 10-Year Peak Flow (L/s) | 25-Year Peak Flow (L/s) | ECA Capacity (L/s) | Firm Capacity (L/s) | Rated Capacity (L/s) | Notes |
|---|---|---|---|---|---|---|
| Conestoga College SPS | 4.5 | 5.2 | 50.0 | 47.5 | 47.5 | |
| Falconridge SPS | 16.0 | 18.5 | 118.0 | 45.5 | 45.5 | |
| Homer Watson SPS | 133.5 | 145.9 | 310.0 | 314.0 | 314.0 | |
| King St SPS | 150.6 | 185.4 | 290.0 | 176.0 | 176.0 | |
| Manchester SPS | 168.7 | 217.7 | 240.0 | 240.0 | 240.0 | |
| Moore SPS | N/A | N/A | N/A | N/A | N/A | Decommissioned in 2031 scenario |
| New Dundee SPS | 70.6 | 89.1 | **56.0** | **56.0** | **56.0** | |
| Old Mill SPS | N/A | N/A | N/A | N/A | N/A | Decommissioned and replaced by New Old Mill SPS in 2031 scenario |
| Otterbein SPS | 61.0 | 72.8 | 165.0 | 165.0 | 165.0 | EA for proposed upgrades provided; notes 165 L/s design capacity |
| Oxford SPS | 31.5 | 41.4 | N/A | 49.0 | 49.0 | No ECA available |
| Patricia SPS | 3.7 | 4.6 | N/A | 23.5 | 23.5 | No ECA available |
| Pioneer Tower SPS | 84.4 | 94.5 | 125.1 | **70.0**[2] | **70.0**[2] | Upgrade completed during study |
| River Birch SPS | 9.3 | 12.5 | 17.3 | 19.0 | 19.0 | |
| Shirley SPS | 223.3 | 231.7 | 378.0 | **207.0** | **207.0** | |
| Spring Valley SPS[1] | 264.7 | 331.9 | **245.0** | 350.0 | 350.0 | ECA to be updated with upgrades; current ECA allows for 245 L/s |
| Springmount SPS | 113.0 | 136.8 | 205.5 | 162.0 | 162.0 | |
| Stoke SPS | 70.4 | 77.1 | 473.0 | 196.0 | 196.0 | |
| Woolner SPS | 90.3 | 109.1 | 115.2 | 136.0 | 136.0 | |
| Nathalie SPS | 15.5 | 17.9 | 148.0 | 98.0 | 98.0 | |
| New Old Mill SPS | 62.2 | 71.5 | N/A | 150.0 | 150.0 | No ECA available |

**Notes:**

1 Bridgeport SPS and Spring Valley SPS are owned by the Region of Waterloo

2 Pioneer Tower SPS was upgraded after technical analysis was completed for the ISAN-MP. The SPS has sufficient firm capacity (125 L/s) for existing and future conditions.




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**HGL Freeboard**

- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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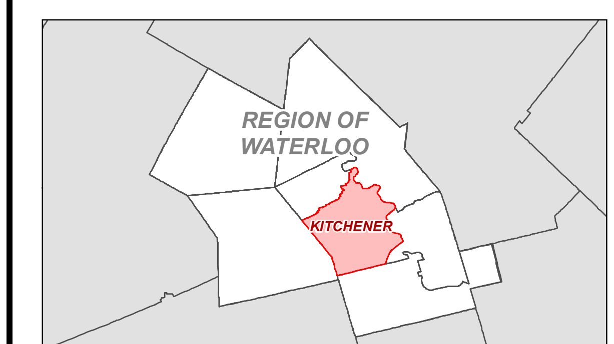


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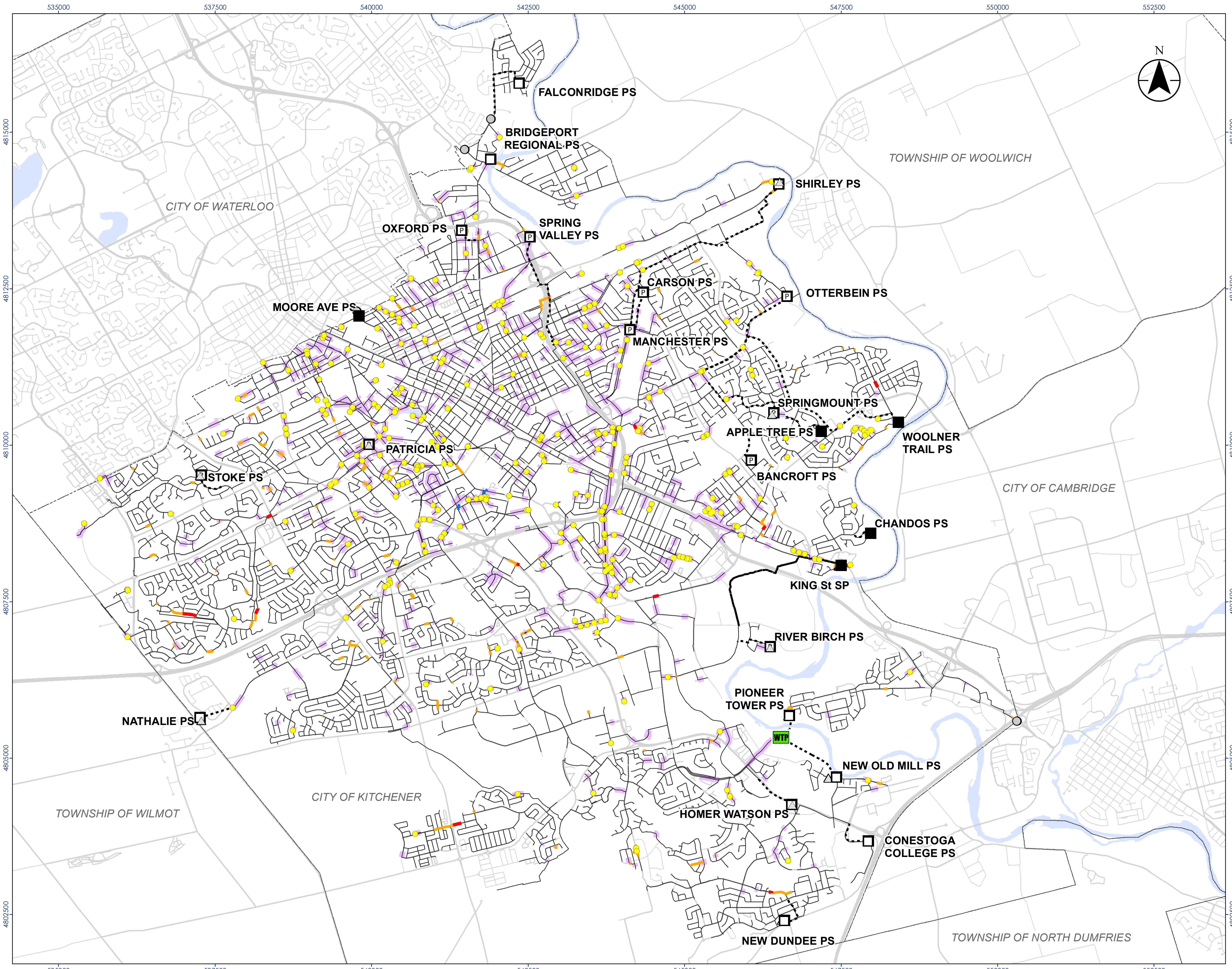
Figure No.
**7-5**

Title
**2031 Future Conditions Sanitary Sewer System Dry Weather Flow HGL & Surcharge Results**




Stantec

Legend
- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WTP WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**HGL Freeboard**
- Within Basement Level (Within 1.8m of Surface)

**Pipe Surcharge State**
- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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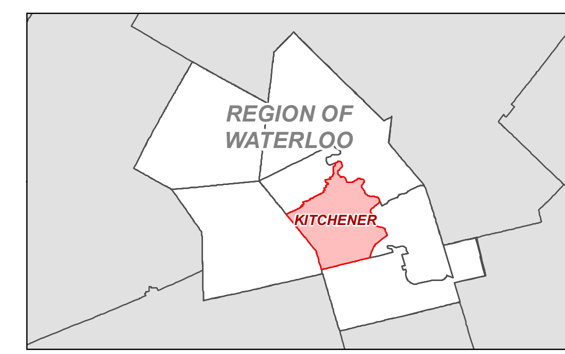


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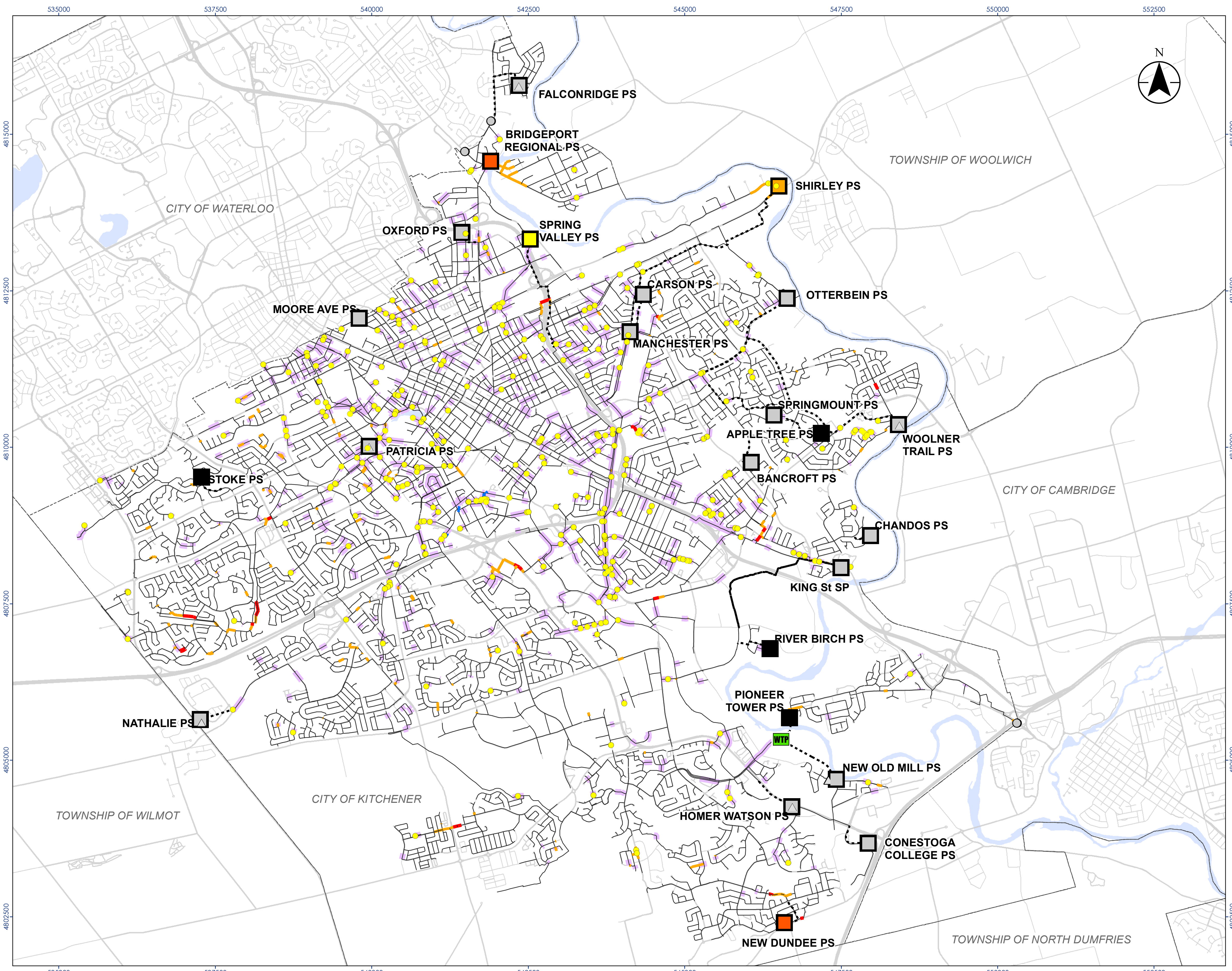
Figure No.
**7-6**

Title
**2031 Future Conditions Sanitary Sewer System 5-Year HGL & Surcharge Results**




Stantec

Legend

- Outflow to Adjacent System
- PS Overflow
- WTP WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**Pumping Station 10yr Flow Results**

- PS ECA Exceeded by 10yr Flow
- P PS Firm & Rated Capacities Exceeded by 10yr Flow
- P PS ECA, Firm & Rated Capacities Exceeded by 10yr Flow
- P All Other PSs

**HGL Freeboard**

- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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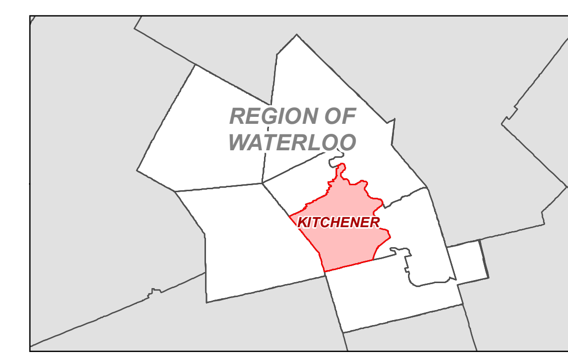


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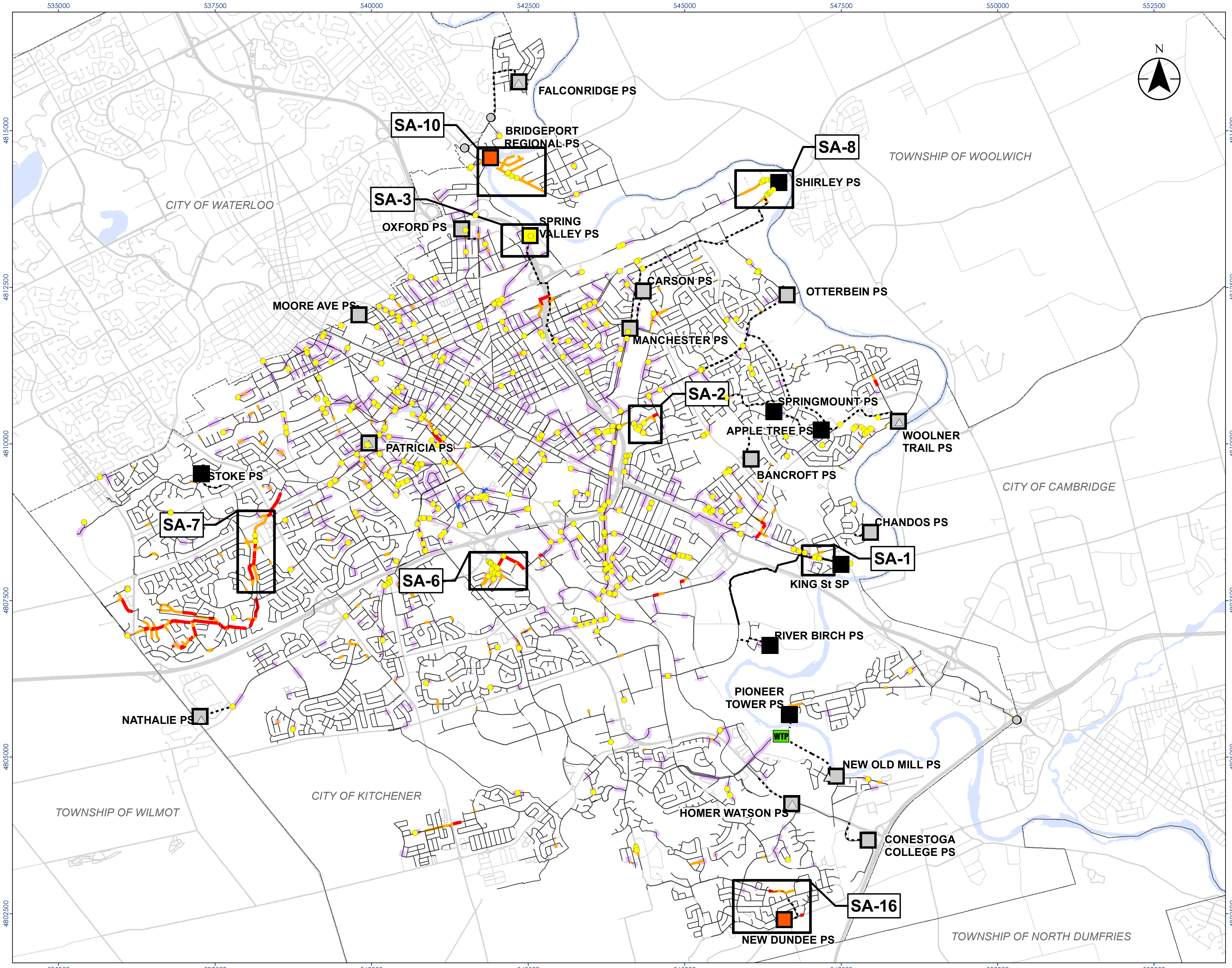
Figure No.
7-7

Title
**2031 Future Conditions Sanitary Sewer System 10-Year HGL & Surcharge Results**




**Stantec**

Legend

- Outflow to Adjacent System
- PS Overflow
- WWTP
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**Pumping Station 25yr Flow Results**

- PS ECA Exceeded by 25yr Flow
- PS Firm & Rated Capacities Exceeded by 25yr Flow
- PS ECA, Firm & Rated Capacities Exceeded by 25yr Flow
- All Other PSs

**HGL Freeboard**

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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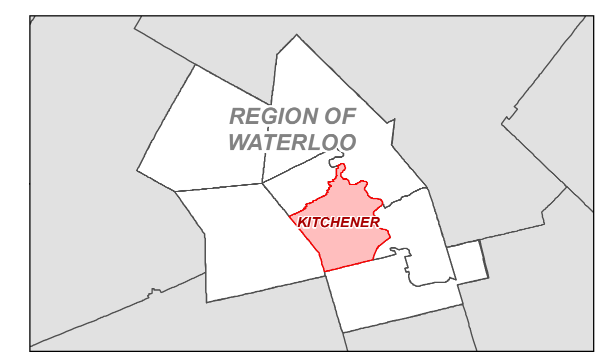


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Figure No.
**7-8**

Title
**2031 Future Conditions Sanitary Sewer System 25-Year HGL & Surcharge Results**



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#### 7.4.2.3 2051 Capacity-Based System Performance

The approach to the future conditions system assessment and criteria is consistent with that of the existing conditions system assessment, as described in **Section 7.4.1**. **Figure 7-9**, **Figure 7-10**, **Figure 7-11**, and **Figure 7-12** illustrate the modelled 2051 scenario HGL and surcharge results for the DWF, 5-year, 10-year, and 25-year events, respectively, and are presented with rendering as discussed in **Section 7.4.2**.

Based on the presented modelling results, no capacity constraints resulting in HGL issues are observed in the DWF conditions. Excluding siphons, forcemains or remaining inconsistent profiles, there are now seven (7) locations where the pipes were found to be 85% full or greater in DWF conditions. Five (5) of these locations are consistent with those observed in the 2031 scenario conditions (as described in **Section 7.4.2.2**), while the remaining two (2) are described below. All seven locations are not considered concerns with respect to capacity constraints in the system and do not result in HGL issues in the 25-year event.

- **One 300 mm diameter pipe (Asset ID 101338) that connects the Dreger Ave sewers to the Ottawa trunk via Graber Pl.** Pipe running 85% full or greater due to downstream trunk water level and connecting invert; and,
- **One 300 mm pipe (Asset ID 100033) along Fairway Rd S just upstream of the sewer that conveys flow through a private ICI property.** Due to a drop in pipe size from 375 mm to 300 mm and a flat slope of 0.03%.

The model comprises a total of 13,825 pipes, with 2,088 of these classified as trunk sewers. Under DWF conditions, around 79.2% (10,950 pipes) have maximum velocities less than 0.6 m/s. Focusing on the trunk sewers under DWF conditions, we find that about 36.1% experience maximum velocities less than 0.6 m/s.

Similar to DWF conditions, no capacity constraints resulting in HGL issues are observed in the 5-year storm event, other than the area upstream of the Shirley SPS, Dalewood Dr, King St, and Homer Watson Blvd, which are discussed further below. There are nine (11) locations that experience pipes 85% full or greater during this event due to sewer capacity constraints; five (5) of which see HGL issues in the 25-year event and are described below. The remaining seven (7) locations are not considered a concern as HGL issues are not generated by these capacity constraints in the 25-year design event.

- **Dalewood**, 250 mm sewers experience backwater during the 5-year event and surcharging and HGL issues in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-2);
- **Upstream of Shirley SPS**, HGL and surcharge issues are experienced in the 525 mm sewers in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-8);
- **Upstream of Bridgeport SPS**, 450 mm, and 525 mm sewers experience backwater during the 5-year. HGL and surcharge issues are experienced in the 450 mm sewers in

the 25-year events. This location is defined as an existing conditions problem area (SA-10);

- **King St**, HGL and surcharge issues are experienced in the 300 mm sewers in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-1)
- **Homer Watson Blvd**, 250 mm sewers experience backwater during the 5-year event and surcharging and HGL issues in the 5- and 25-year events. This location is defined as an existing conditions problem area (SA-6).

In the 25-year design event, one additional Problem Area (areas of observed sewer capacity constraints) is identified within the 2051 future conditions system. This area, in addition to those identified in existing conditions, are highlighted in **Figure 7-12** and described (bolded) in **Table 7-6**. Similarly, to SA-16 identified in 2031 conditions, while this new problem area (SA-9) is identified in the figure, there are no HGL, or surcharge issues shown. This is because this problem area arises only when the upstream Shirley SPS capacity is increased as part of solution development. **Figure 7-12** only shows the modelled results excluding solutions and thus, this is not evident. This area is however, accounted for in the problem area list, as it does require solutions. All other areas with HGL issues observed are representative of shallow sewers, or inconsistent profiles in local areas deemed to have minimal impact to the Master Plan.

**Table 7-6: 2051 Future Conditions Sanitary Sewer Problem Areas**

| Problem Area ID | Applicable Scenario(s) | Location | Capacity Constraint Description |
|---|---|---|---|
| SA-1<br>Upstream of King St SPS | **Existing**<br>**2031**<br>**2051** | King St, east of River Rd E | HGLs within 1.8 m of surface due to undersized pipes. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| SA-2<br>Dalewood | **Existing**<br>**2031**<br>**2051** | Dalewood Dr and Penrose Ave | Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes along Dalewood Dr. |
| SA-3<br>Upstream of Spring Valley SPS | **Existing**<br>**2031**<br>**2051** | Spring Valley SPS off of Riverbend Dr | HGLs within 1.8 m of surface due to downstream capacity constraints at the Spring Valley SPS. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| SA-6<br>Homer Watson | **Existing**<br>**2031**<br>**2051** | Homer Watson Blvd | Risk of basement flooding along Kingswood Dr and Flint Dr due to undersized pipes within the private ICI property and on Homer Watson Blvd. HGLs within 1.8 m of surface on Alpine Rd and Homer Watson Blvd with low risk of basement flooding as no building connections are anticipated along these sewers. |

| Problem Area ID | Applicable Scenario(s) | Location | Capacity Constraint Description |
|---|---|---|---|
| SA-7<br>Sandrock Trunk | **Existing**<br>**2031**<br>**2051** | Highland Rd W and Fischer-Hallman Rd | HGLs within 1.8 m of surface due to undersized pipes along Highland Rd W. Low risk of basement flooding as no building connections are anticipated along these sewers. |
| SA-8<br>Upstream of Shirley SPS | **Existing**<br>**2031**<br>**2051** | Shirley Dr and Victoria St N | Risk of basement flooding and surface flooding along Shirley Dr due to downstream capacity constraints at the Shirley SPS. HGLs within 1.8 m of surface on Victoria St N with low risk of basement flooding as no building connections are anticipated along these sewers. |
| SA-10<br>Upstream of Bridgeport SPS | **Existing**<br>**2031** | Bridge St E between Bloomingdale Rd and Grand Ave | Risk of basement flooding on Bridge St E due to downstream capacity constraints at the Bridgeport SPS. Risk of PS flooding. |
| SA-16<br>Downstream of New Dundee SPS | **2031**<br>**2051** | Robert Ferrie Dr | Risk of basement flooding along Mossgrove Dr and Monarch Woods Dr due to undersized pipes on Robert Ferrie Dr. |
| **SA-9**<br>**Downstream of Manchester SPS** | **2051** | **Southeast of Manchester Dr/ River Rd E Intersection** | **HGLs within 1.8 m of surface due to undersized pipes downstream of the Manchester SPS. Low risk of basement flooding as no building connections are anticipated along these sewers.** |

Additionally, the 10-year incoming peak flows are compared to the pumping station's firm, rated and ECA capacities to determine performance or approval issues. The following **Table 7-7** presents these results, along with the 25-year peak incoming flows for reference. The ECA, firm and rated capacities surpassed by the 10-year incoming flow are rendered in **red**, illustrating the pump stations that do not meet criteria in this scenario. The 10-year flows draining to the Bridgeport SPS, New Dundee SPS, and Shirley SPS in the 2051 future conditions scenario exceed their firm and rated capacities. The 10-year incoming flow to Apple Tree SPS, Bridgeport SPS, New Dundee SPS, and Spring Valley SPS also exceed their current ECA approved rates. Note that the Bridgeport SPS and Spring Valley SPS are owned by the Region of Waterloo and not the City of Kitchener.

**Table 7-7: 2051 Future Conditions Pumping Station Performance**

| Pumping Station | 10-Year Peak Flow (L/s) | 25-Year Peak Flow (L/s) | ECA Capacity (L/s) | Firm Capacity (L/s) | Rated Capacity (L/s) | Notes |
|---|---|---|---|---|---|---|
| Apple Tree SPS | 51.8 | 60.9 | **50.0** | 66.0 | 66.0 | |
| Bancroft SPS | 4.6 | 5.7 | 7.7 | 7.7 | 7.7 | |
| Bridgeport SPS[1] | 179.0 | 224.4 | **136.0** | **136.0** | **136.0** | |
| Carson SPS | 39.7 | 59.1 | N/A | 66.9 | 66.9 | No ECA available |

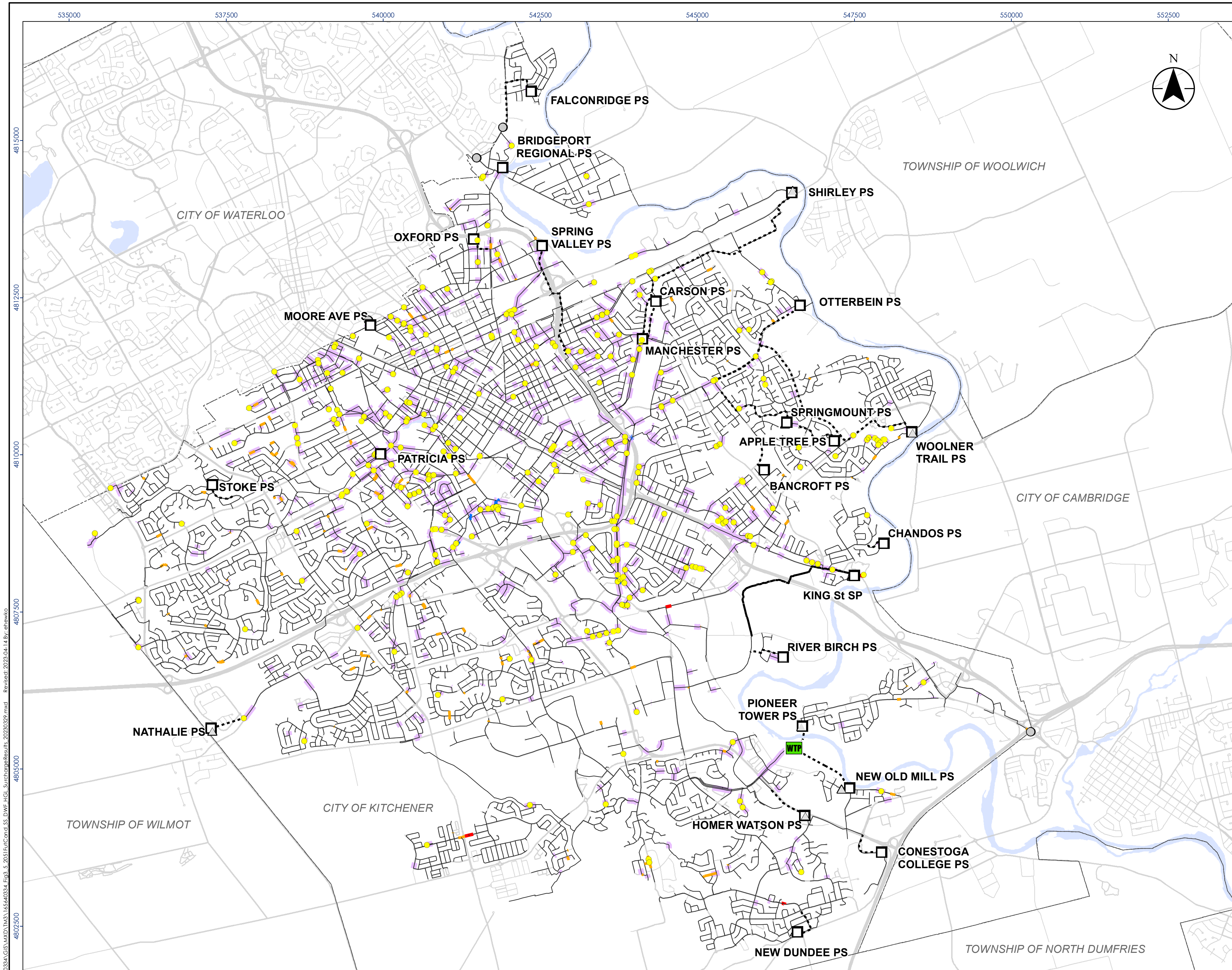
| Pumping Station | 10-Year Peak Flow (L/s) | 25-Year Peak Flow (L/s) | ECA Capacity (L/s) | Firm Capacity (L/s) | Rated Capacity (L/s) | Notes |
|---|---|---|---|---|---|---|
| Chandos SPS | 7.7 | 9.9 | 30.0 | 27.0 | 27.0 | |
| Conestoga College SPS | 5.7 | 6.4 | 50.0 | 47.5 | 47.5 | |
| Falconridge SPS | 16.4 | 18.9 | 118.0 | 45.5 | 45.5 | |
| Homer Watson SPS | 139.1 | 151.4 | 310.0 | 314.0 | 314.0 | |
| King St SPS | 161.8 | 195.2 | 290.0 | 176.0 | 176.0 | |
| Manchester SPS | 176.9 | 225.9 | 240.0 | 240.0 | 240.0 | |
| Moore SPS | N/A | N/A | N/A | N/A | N/A | To be decommissioned |
| New Dundee SPS | 75.4 | 93.9 | **56.0** | **56.0** | **56.0** | |
| Old Mill SPS | N/A | N/A | N/A | N/A | N/A | Previously decommissioned |
| Otterbein SPS | 69.0 | 80.7 | 165.0 | 165.0 | 165.0 | EA for proposed upgrades provided; notes 165 L/s design capacity |
| Oxford SPS | 32.0 | 41.9 | N/A | 49.0 | 49.0 | No ECA available |
| Patricia SPS | 3.7 | 4.6 | N/A | 23.5 | 23.5 | No ECA available |
| Pioneer Tower SPS | 86.7 | 95.8 | 125.1 | 70.0[2] | 70.0[2] | Upgrade completed during study |
| River Birch SPS | 9.3 | 12.5 | 17.3 | 19.0 | 19.0 | |
| Shirley SPS | 225.1 | 232.6 | 378.0 | **207.0** | **207.0** | |
| Spring Valley SPS[1] | 279.2 | 345.3 | **245.0** | 470.0 | 470.0 | ECA to be updated with upgrades; current ECA allows for 245 L/s |
| Springmount SPS | 121.4 | 145.1 | 205.5 | 162.0 | 162.0 | |
| Stoke SPS | 75.4 | 82.0 | 473.0 | 196.0 | 196.0 | |
| Woolner SPS | 91.7 | 110.6 | 115.2 | 136.0 | 136.0 | |
| Nathalie SPS | 17.9 | 20.2 | 148.0 | 98.0 | 98.0 | |
| New Old Mill SPS | 62.8 | 72.1 | N/A | 150.0 | 150.0 | No ECA available |

**Notes:**

1 Bridgeport SPS and Spring Valley SPS are owned by the Region of Waterloo

2 Pioneer Tower SPS was upgraded after technical analysis was completed for the ISAN-MP. The SPS has sufficient firm capacity (125 L/s) for existing and future conditions.

Similarly to existing and 2031 conditions, the pumping stations are rendered in **Figure 7-9** and **Figure 7-10** based on the whether the 10-year and 25-year flows, respectively, exceed the pumping station's ECA, firm or rated capacities in 2051 conditions. See figure legends for details.




**Stantec**

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**HGL Freeboard**

- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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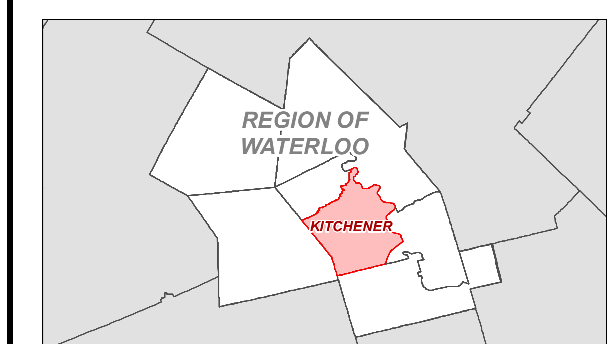


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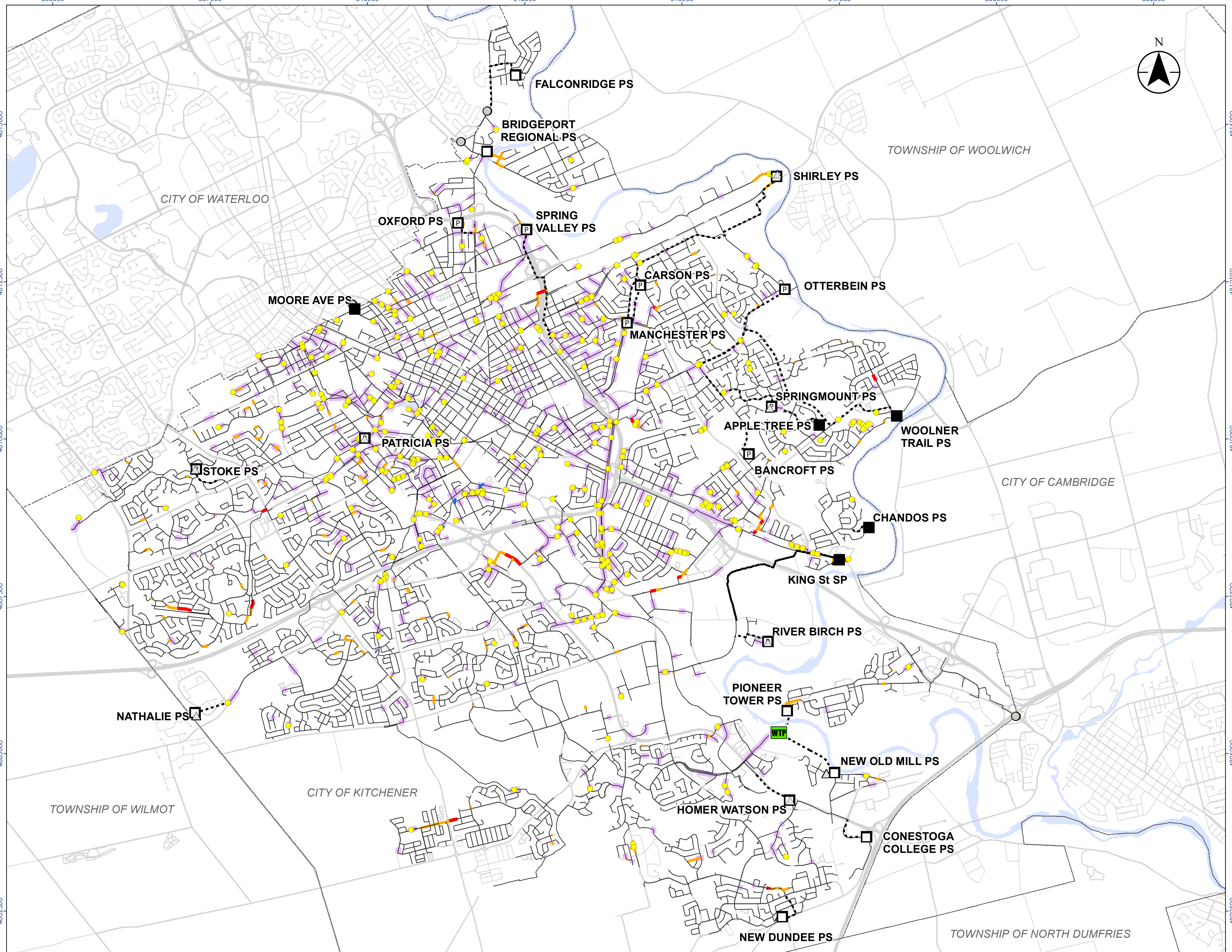
Figure No.
**7-9**

Title
**2051 Future Conditions Sanitary Sewer System Dry Weather Flow HGL & Surcharge Results**




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**HGL Freeboard**

- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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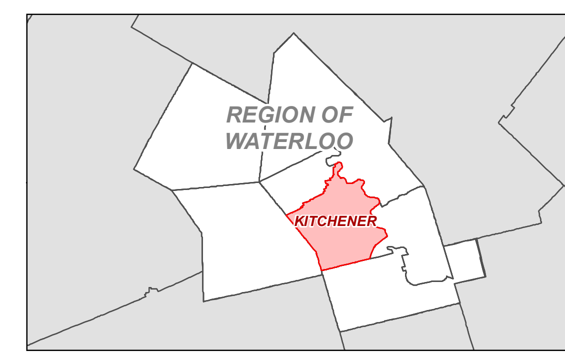


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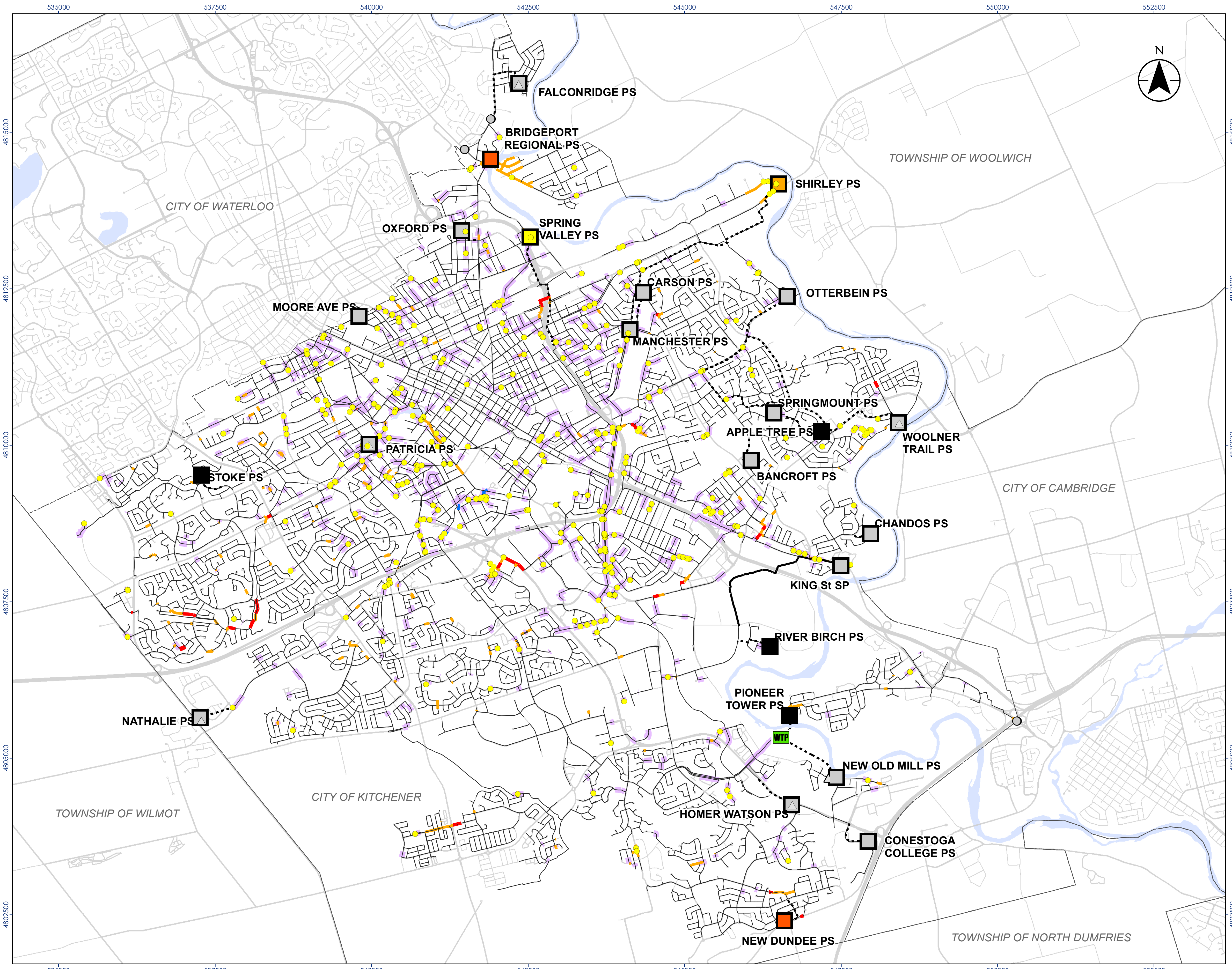
Figure No.
**7-10**

Title
**2051 Future Conditions Sanitary Sewer System 5-Year HGL & Surcharge Results**




Stantec

**Legend**

- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**Pumping Station 10yr Flow Results**

- PS ECA Exceeded by 10yr Flow
- PS Firm & Rated Capacities Exceeded by 10yr Flow
- PS ECA, Firm & Rated Capacities Exceeded by 10yr Flow
- All Other PSs

**HGL Freeboard**

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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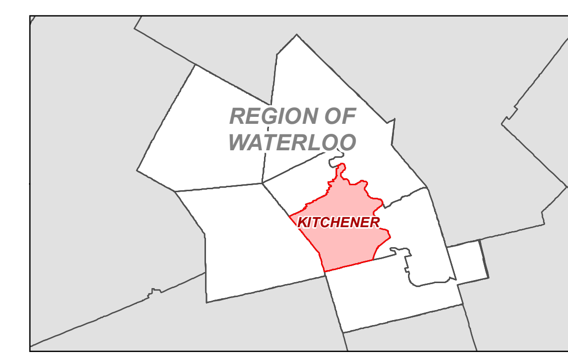


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Figure No.
**7-11**

Title
**2051 Future Conditions Sanitary Sewer System 10-Year HGL & Surcharge Results**



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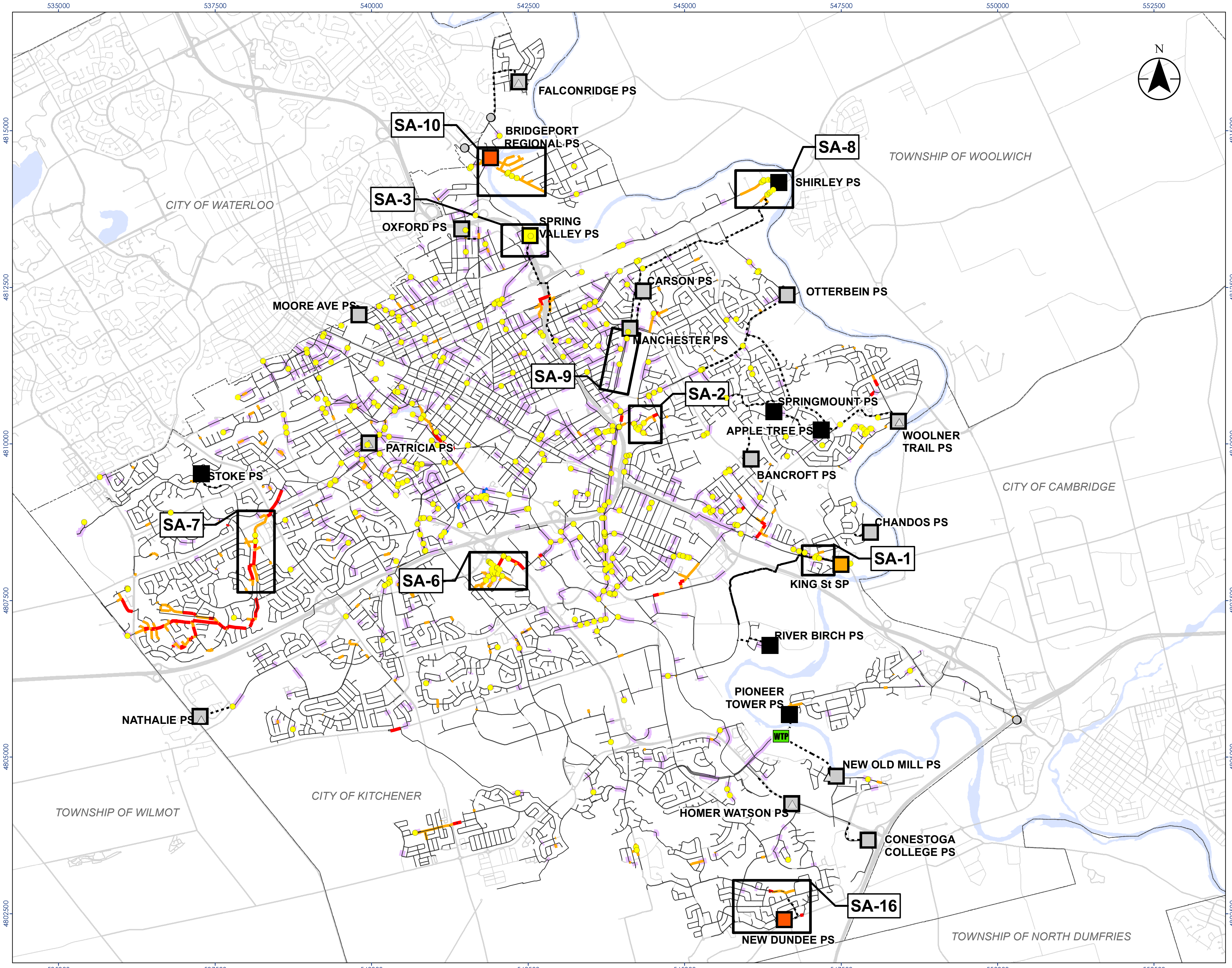


Stantec

Legend

- Outflow to Adjacent System
- PS Overflow
- WWTP
- Forcemain
- Siphon
- Shallow Pipes (Obvert <= 1.8m of Surface)

**Sanitary Pumping Stations**

- PS ECA Exceeded by 25yr Flow
- PS Firm & Rated Capacities Exceeded by 25yr Flow
- PS ECA, Firm & Rated Capacities Exceeded by 25yr Flow
- All Other PSs

**HGL Freeboard**

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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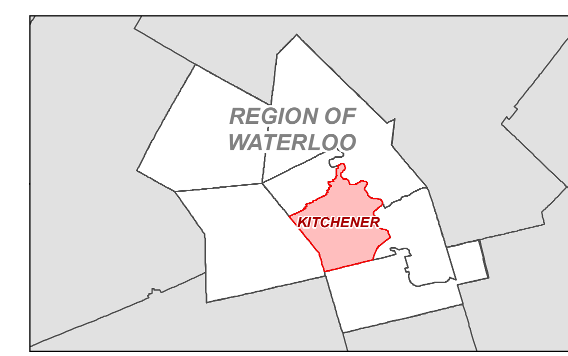



Project Location
City of Kitchener

165640334 REVA
Prepared by EH on 2023-09-20

Client/Project
CITY OF KITCHENER
INTEGRATED SANITARY MASTER PLAN

Figure No.
**7-12**

Title
**2051 Future Conditions Sanitary Sewer System**
**25-Year HGL & Surcharge Results**

## 7.5 Condition-Based System Assessment

The City's 2022 asset management data was provided per sewer on December 8th, 2022, in shapefile format (file name: "condition_score_2022.shp") and consisted of Pipe Asset IDs, road segments IDs, install years, material, ownership, age-based scores per sewer, the most recent CCTV inspection year, and condition-based scores per sewer. Additionally, the *Ottawa Street Sanitary Trunk Sewer Condition Assessment and Rehabilitation Recommendation Final Report* by Andrews Engineer (dated December 2022), was provided on December 21st, 2022, and used to extract up-to-date condition grades for the Ottawa St trunk sewers. This assessment was recently completed due to concerning conditions and hydrogen sulfide levels within the Ottawa St trunk sewer and had not yet been integrated into the City's asset management database. The City also assesses sanitary sewer risk based on sewer condition and criticality, which is defined by a Total Wastewater Priority Assessment Score (TWPAS), ranging from 0 (no data or low risk and consequence of failure) to 100 (high risk and consequence of failure). Based on the review of this dataset however, it was determined that the most up-to-date CCTV scoring, and criticality assessments had not yet been integrated into the file provided. This process is ongoing but was not anticipated for completion in time for this condition-based system assessment and thus, only the CCTV scoring was compiled and reviewed to determine the need for condition-based asset renewal projects based on existing pipe conditions. The following sub-sections discuss the approach and criteria used to define sewers in poor condition, and the subsequent list of sewers currently in need of asset renewal.

### 7.5.1 Assessment Approach

The CCTV scores provided in the City's asset management data were used to define sewers in poor condition and thus identify those considered for asset renewal. The following criteria was used to establish this list.

- Provided CCTV score or condition grade (if included in the Ottawa St trunk sewer assessment) of 4 or greater, regardless of when the most recent CCTV assessment was conducted;
- Owned by City of Kitchener, or dually owned by both the City of Kitchener and the Region of Waterloo;
- Not already identified for potential upgrades due to poor capacity-based performance, as per **Table 7-2** of **Section 7.4.2** above; and,
- Not already included in near-term (2029 or sooner) trenchless relining projects or share road segment IDs with proposed roadway reconstruction projects, as per the following files provided by the City on December 7th, 2022:
    - "Sanitary trenchless lining 2022.xlsx";
    - "Sanitary trenchless lining 2023.xlsx"; and,
    - "Reconstructions_plan.xlsx".

### 7.5.2 Assessment Results

The criteria outlined in **Section 7.5.1** was used to establish an inventory of trunk sewers within the City of Kitchener sanitary sewer network currently considered in poor condition based on the provided CCTV scoring and structural grades. A total of 108 gravity sewers were found to fall within these criteria, equating to 7.1 km of sewer length. These sewers are documented in **Table 7-8** by Problem Area, where "AC" refers to Asset Condition. Their general locations within the City are illustrated in **Figure 7-13**.

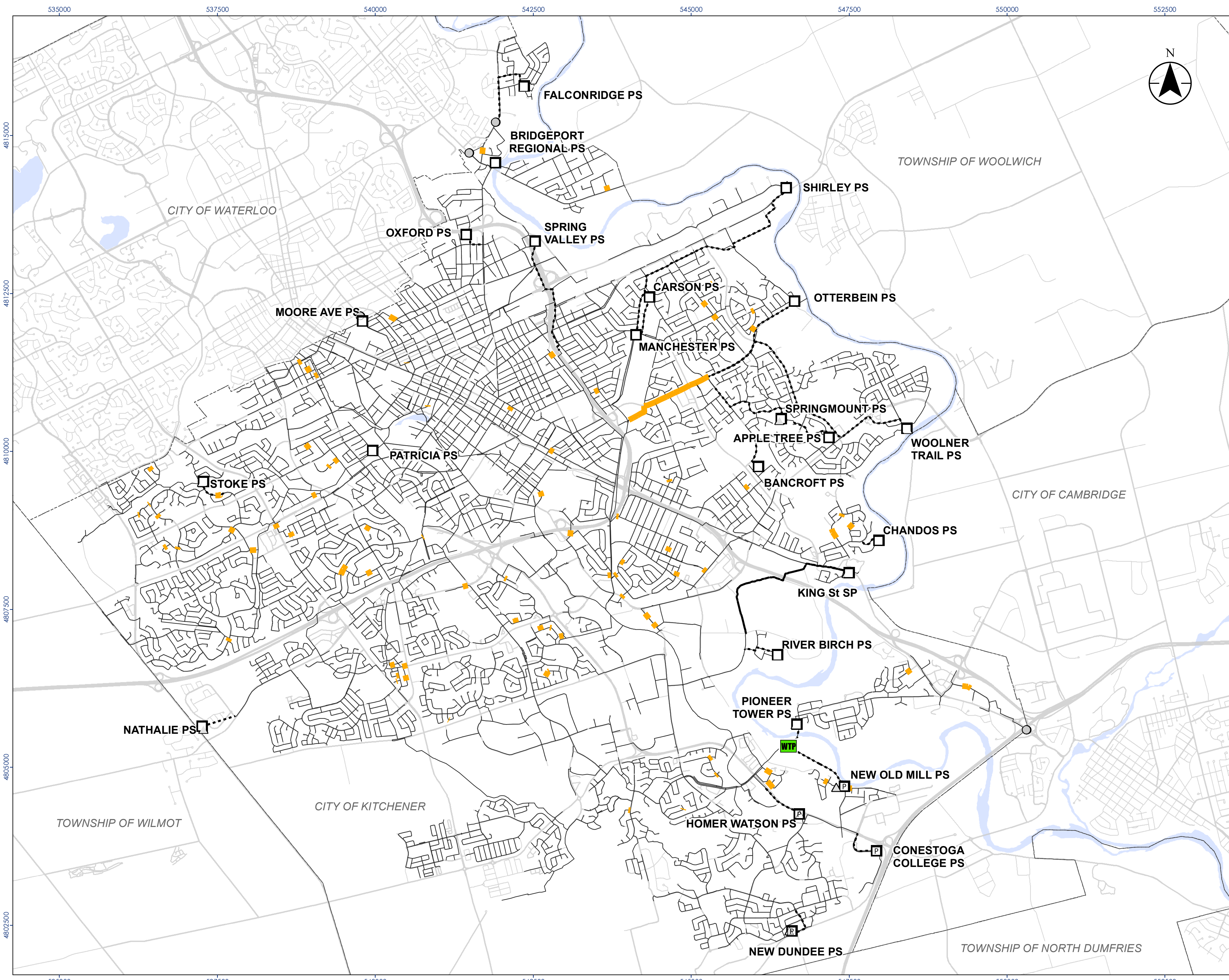
**Table 7-8: Gravity Sewers Currently in Poor Condition**

| Asset Condition ID | Street Name | Location Description | Pipe Asset IDs |
|---|---|---|---|
| AC-1 | Vanier Dr | 1x 375 mm sewer through easement between Vanier Dr and Clark Ave | 118182 |
| AC-2 | Westforest Trl | 1x 375 mm sewer between Westmeadow Dr and Hidden Creek Dr | 110504 |
| AC-3 | Bankside Dr | 1x 450 mm sewer between Golden Terrace Crt and Eastforest Trl | 109989 |
| AC-4 | Ottawa St N, Dreger Ave, Graber Pl | 19x 675 mm sewers from Old Chicopee Dr to just upstream of Conestoga Pkwy | 101611, 101612, 101613, 101365, 101366, 101367, 101368, 101335, 101339, 101340, 101341, 101342, 101350, 101351, 101352, 101849, 101850, 101851, 101852 |
| AC-5 | Greenbrook Dr | 2x 375 mm sewers between Birchcliffe Ave to just north of Stonybrook Dr | 108404, 108513 |
| AC-6 | Greenbrook Dr | Downstream of AC-8; 1x 900 mm sewer within Stirling Ave S intersection | 107730 |
| AC-7 | Rock Ave | 1x 525 mm sewer at the end of Rock Ave through private ICI property located between Belmont Ave W and the throughway behind the ICI buildings | 105256 |
| AC-8 | West of Connaught Pl | 1x 400 mm sewer in easement between Connaught Pl and Conestoga Pkwy | 100263 |
| AC-9 | Richmond Avenue | 1 x 250 mm sewer between Water St S and David St | 2002189 |
| AC-10 | Huck Crescent | 1 x 200 mm sewer between Udvari Crescent and Keller Crescent | 119495 |
| AC-11 | Highbrook Ct | 1 x 200 mm between Fisher-Hallman Rd and Highbrook St | 119059 |
| AC-12 | Deep Ridge Dr | 1 x 200 mm between Candle Crescent and Grand Hill Dr | 118447 |
| AC-13 | Woolwich St | 1 x 200 mm between Hillcrest Ln and Bridle Trail | 110889 |

| Asset Condition ID | Street Name | Location Description | Pipe Asset IDs |
|---|---|---|---|
| AC-14 | Northmanor Crescent | 1 x 200 mm between Resurrection Dr and University Ave W | 110709 |
| AC-15 | Windward Pl | 1 x 250 mm between Keller Crescent and Westforest Trail | 110658 |
| AC-16 | Westforest Trail | 1 x 200 mm between Shadyridge Pl and Beechcroft Pl | 110528 |
| AC-17 | Dawn Ridge Dr | 1 x 200 mm between Westmeadow Dr and Westforest Trail | 110522 |
| AC-18 | Marlis Crescent | 1 x 200 mm between Bleams Rd and Erinbrook Dr | 108258 |
| AC-19 | Highbrook St | 2 x 200 mm on Highbrook St | 108216, 108203 |
| AC-20 | Block Line Rd | 1 x 250 mm between Highbrook St and Westmount Rd E | 108196 |
| AC-21 | Ristau Crescent | 1 x 200 mm between Highbrook Crescent and Dinison Crescent | 108056 |
| AC-22 | Ottawa St S | 1 x 200 mm between McLennan Park Gate and Strasburg Rd | 107118 |
| AC-23 | Conestoga Pkwy Onramp | 1 x 200 mm between Courtland Ave E and Conestoga Pkwy | 107094 |
| AC-24 | Bedford Rd | 2 x 200 mm between Sydney St S and Schneider Creek | 106954, 106955 |
| AC-25 | Riverbend Dr | 1 x 250 mm incoming pipe North of Spring Valley SPS | 105863 |
| AC-26 | Cameron St N | 1 x 200 mm between Duke St E and Weber St E | 104745 |
| AC-27 | Breithaupt St | 1 x 200 mm between Moore Ave and Waterloo St | 104435 |
| AC-28 | McLeod Ct | 1 x 200 mm at the intersection of McLeod Ct and Biehn Dr | 103960 |
| AC-29 | Gateway Park Dr | 3 x 300 mm between Sportsworld Dr and Tu-Lane St | 103769, 103770, 103771 |
| AC-30 | Brembel St | 1 x 200 mm sewer through private residential complex located between Brembel St and Ottawa St N | 102507 |
| AC-31 | Denlow St | 1 x 200 mm between Brembel St and Rose Garden St | 102499 |
| AC-32 | Alpine Rd | 1 x 250 mm between Kingswood Dr and Homer Watson Blvd | 118286 |
| AC-33 | Hollinger Crescent | 1 x 250 mm between Bridge St E and Dumart Pl | 111001 |
| AC-34 | Stoke Dr | 1 x 200 mm between Wexford Crescent and Monarch Woods | 110577 |
| AC-35 | Driftwood Dr | 1 x 200 mm between Parkland Crescent and Toynbee Crescent | 109901 |

| Asset Condition ID | Street Name | Location Description | Pipe Asset IDs |
|---|---|---|---|
| AC-36 | Fisher-Hallman Rd | 1 x 250 mm between Highland Rd W and Queen's Blvd | 108906 |
| AC-37 | Westheights Dr | 1 x 300 mm sewer through private property located on Westheights Dr | 108878 |
| AC-38 | Overlea Dr | 1 x 250 mm sewer at the intersection of Overlea Dr and Overlea Crescent | 108477 |
| AC-39 | Stonybrook Dr | 1 x 225 mm sewer between Village Crescent and Sweetbriar Dr | 108398 |
| AC-40 | Barberry Pl | 1 x 225 mm sewer between Westmount Rd and Forest Hill Dr | 108347 |
| AC-41 | Sandsprings Crescent | 2 x 200 mm sewer between Devonglen Dr and Sandsprings Ct | 107604, 107656 |
| AC-42 | Cherry Hill Dr | 1 x 250 mm sewer between Coach Hill Dr and Murrayhill Ct | 107321 |
| AC-43 | Coach Hill Dr | 1 x 250 mm sewer between Cherry Hill Dr and Block Line Rd | 107318 |
| AC-44 | Coach Hill Dr | 1 x 250 mm sewer between Cherry Hill Dr and Homer Watson Blvd | 107306 |
| AC-45 | Selkirk Ct | 1 x 200 mm sewer between Selkirk Dr and Geneva Crescent | 107224 |
| AC-46 | Highland Crescent | 1 x 250 mm sewer between Highland Rd and Westmount Rd | 106442 |
| AC-47 | Paulander Dr | 2 x 250 mm sewer between Victoria St S and Lawrence Ave | 106329, 106334 |
| AC-48 | Weichel St | 1 x 250 mm sewer between Belton Dr and Karn St | 106299 |
| AC-49 | Belmont Ln W | 1 x 250 mm sewer between Claremont Ave and Argyle St | 106083 |
| AC-50 | Union Blvd | 1 x 250 mm sewer between Earl St and Severn Ave | 106063 |
| AC-51 | Guelph St | 1 x 250 mm sewer parallel to the Spur Line Trail and connect to Guelph St sewer | 105106 |
| AC-52 | Wheatfield Crescent | 1 x 200 mm sewer between Pathfinder Crescent and Bechtel Dr | 103885 |
| AC-53 | Manitou Dr | 2 x 250 mm sewer between Fairway Rd S and Webster Rd | 103436, 100040 |
| AC-54 | Upper Canada Dr | 1 x 250 mm sewer through private residential property located between Farrier Dr and Upper Canada Dr | 103415 |
| AC-55 | Old Mill Rd | 1 x 300 mm sewer between Sydenham St and Pinnacle Dr | 103117 |
| AC-56 | Old Mill Rd | 1 x 200 mm sewer between Mill Park Dr and Rose St | 103108 |

| Asset Condition ID | Street Name | Location Description | Pipe Asset IDs |
|---|---|---|---|
| AC-57 | Arrowhead Crescent | 2 x 250 mm sewer between Homer Watson Blvd and Green Valley Dr | 103052, 103053 |
| AC-58 | Green Valley Dr | 1 x 250 mm sewer between Pioneer Dr and Arrowhead Crescent | 103041 |
| AC-59 | Lower Canada Crescent | 1 x 250 mm sewer at the intersection of Lower Canada Crescent and Upper Canada Dr | 102928 |
| AC-60 | Dumfries Ave | 1 x 225 mm sewer between Chapel St and Krug St | 102355 |
| AC-61 | Heritage Dr | 1 x 200 mm sewer between Lorraine Ave and Oakhurst Crescent | 102231 |
| AC-62 | Heritage Dr | 1 x 250 mm sewer between Keewatin Ave and Lorraine Ave | 102226 |
| AC-63 | Nipigon St | 1 x 250 mm sewer between Nipigon Pl and Georgian St | 102207 |
| AC-64 | Burbank Rd | 1 x 200 mm sewer between Conestoga Pkwy and Ada St | 101738 |
| AC-65 | King St E | 1 x 200 mm sewer between Sydney St S and Ottawa St S | 101278 |
| AC-66 | Wyandotte Ct | 1 x 250 mm sewer in Morrison Park between Wyandotte Ct and Oneida Pl | 100995 |
| AC-67 | Morrison Road | 1 x 250 mm sewer between Quinte Crescent and Grand River Blvd | 100981 |
| AC-68 | Morrison Road | 2 x 200 mm sewer between mm sewer between Quinte Crescent and Grand River Blvd | 100972, 100973 |
| AC-69 | Burgetz Ave | 1 x 250 mm sewer between River Rd E and Thaler Ave | 100921 |
| AC-70 | Broadview Ave | 1 x 250 mm sewer between Broadview Ct and Shuh Ave | 100776 |
| AC-71 | Siebert Ave / Courtland Ave E | 1 x 250 mm sewer at the intersection of Siebert Ave and Courtland Ave E | 100628 |
| AC-72 | Greenfield Ave | 1 x 250 mm sewer at the intersection of Greenfield Ave and Kingsway Dr | 100602 |
| AC-73 | Broadmoor Ave | 1 x 200 mm sewer at the intersection of Broadmoor Ave and Clark Ave | 100324 |
| AC-74 | Hillmount St | 1 x 250 mm sewer at the intersection of Hillmount St and Shelley Dr | 100304 |
| AC-75 | Carrol St | 1 x 250 mm sewer between Connaught St and Greenfield Ave | 100146 |
| AC-76 | Traynor Ave | 1 x 250 mm sewer at the intersection of Wilson Ave and Traynor Ave | 100075 |
| AC-77 | Hazen Glen Dr / Ingleside Dr | 2 x 250 mm sewer on Hazen Glen Dr and Ingleside Dr | 110736, 110759 |
| AC-78 | Union St | 2 x 225 mm sewer on Union St | 104911, 106005 |




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Other Sewers
- Forcemain
- Gravity Sewers Currently in Poor Condition

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**Notes**

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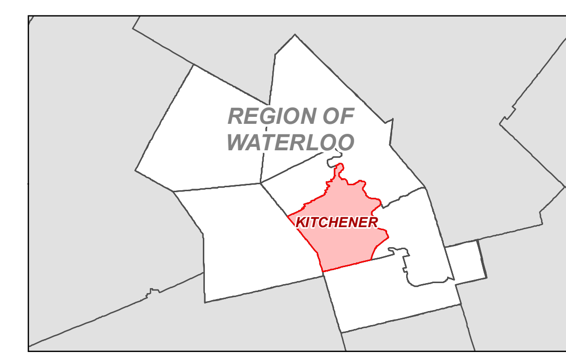


Project Location
City of Kitchener

165640334 REVA
Prepared by EH on 2023-09-20

Client/Project
CITY OF KITCHENER
INTEGRATED SANITARY MASTER PLAN

Figure No.
**7-13**

Title
**Gravity Sewers Currently in Poor Condition**

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# 8 Development & Evaluation of Servicing Strategy Alternatives

Alternative solutions were developed to provide overall solutions to resolve the problem and opportunities statement, as identified in Section 2. The alternative solutions are not only intended to resolve capacity-based and condition-based concerns within the sanitary sewer system, but also provide the City with recommendations to improve their data collection and mitigation programs, delivering a holistic approach to the Master Plan.

## 8.1 Evaluation Criteria

Alternative solutions were assessed using the factors and criteria in **Table 8-1**. Depending on comments received from agencies, Indigenous Nations, stakeholders and members of the public, criteria may be added or refined:

**Table 8-1: Evaluation Criteria**

| Category | Description |
|---|---|
| Socio-Economic Environment | • Potential to impact existing residences, businesses (e.g., agricultural operations) and community features<br>• Potential effect on approved/planned land uses<br>• Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features<br>• Potential to accommodate planned significant population and job growth in strategic growth areas |
| Natural Environment | • Potential to impact fish and fish habitat<br>• Potential to impact water resources including surface water (i.e., rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas<br>• Potential to impact significant natural heritage features<br>• Potential to impact significant wildlife habitat and species at risk |
| Technical Considerations | • Potential land requirements including land purchase and temporary/permanent easements<br>• Constructability<br>• Effect on existing utilities and infrastructure (number and type of potential conflicts)<br>• Ability to coordinate with existing and planned infrastructure improvements<br>• System resiliency and system suitability |
| Financial | • Lifecycle operations and maintenance costs<br>• Estimated capital cost |

## 8.2 Alternative Servicing Solutions

Four alternative solutions were developed, which can be combined to provide an overall solution for the City. These following four alternatives are described in detail in **Sections 8.2.1** to **8.2.4**:

- Alternative 1 – Do Nothing
- Alternative 2 – Shaping Community Growth
- Alternative 3 – Infrastructure Updates
- Alternative 4 – Data Acquisition, Flow Monitoring, and I/I Mitigation Programs

### 8.2.1 Alternative 1 – Do Nothing

The Do Nothing alternative maintains the status quo. It involves no changes to the existing system. This alternative does not align with the City's strategy, and is not feasible, and therefore has been screened out from the EA process.

However, the Do Nothing Alternative was not feasible for the City to carry forward for further consideration for reasons listed below:

- Does not support future growth within the City of Kitchener.
- Does not upgrade aging infrastructure, increasing the possibility of infrastructure failure.
- Failing infrastructure poses risks to the environment, and public health (i.e., contamination).
- Failing infrastructure has the potential to impact private property (i.e., flooding).

### 8.2.2 Alternative 2 – Shaping Community Growth

Community growth results in an increase in sanitary flows in the downstream system and can lead to sanitary sewer capacity constraints. Community growth can be shaped to limit negative impacts to the downstream system by encouraging growth in available areas that drain to portions of the system that can handle the additional flows without restriction. Sewer upgrades can be implemented if needed to allow for the upstream growth to occur, if the required upgrades are reasonable in cost, benefit, and extent. This review is most valuable on a trunk level, as local pipe restrictions can be resolved relatively easily. Based on existing conditions, 2031 and 2051 system assessment results, there are no significant concerns with trunk sewer capacity within the sanitary system, other than the Sandrock trunk and some of the larger pumping stations (Shirley SPS and New Dundee SPS) which can be resolved with relatively minor upgrade requirements.

Growth reviews should occur regularly to confirm that no major restrictions arise in the future. The best approach to accomplish this is to continue to regularly engage in Master Planning updates every 5 years where infrastructure upgrades are incorporated along with potential growth predictions.

### 8.2.3 Alternative 3 – Infrastructure Updates

Infrastructure update alternatives consist of both capacity and condition-based upgrades and are recommended to resolve system capacity restrictions and degrading sewer conditions.

#### 8.2.3.1 Capacity-Based Solutions

Capacity-based solutions increase the capacity in the sanitary sewer system. These replacements improve flows within the system and meet the needs of projected growth. Various capacity-based solutions were identified based on a high-level assessment of priority, focusing on solutions required in the near-term to resolve issues experienced in existing conditions, medium term issues triggered under 2031 conditions, and long-term issues triggered under 2051 conditions.

#### 8.2.3.2 Condition-Based Solutions

Condition-based solutions improve sewers and pumping stations that are in poor condition. The exact scope of work will require further investigation, but may include repair, rehabilitation, or replacement. The City's asset management data identified sewers in poor condition, and prioritizes renewal based on the condition.

### 8.2.4 Alternative 4 – Data Acquisition, Flow Monitoring and Inflow and Infiltration Mitigation Programs

This alternative involves the implementation of programs to reduce water inflow and infiltration into the sanitary sewer system as well as obtain additional data to assess the condition of the system. Through these programs, data will be collected about the existing system and will improve data accuracy to inform the City of future project needs. Programs include:

- **Rainfall & Flow Monitoring Program**
    - This program will manage all rainfall and sewer flow monitoring equipment and contracts, providing valuable real-time operational data to the City. The data will identify how the sanitary system operates over time including response to population/industry growth, storm events, and emergency conditions such as blockages, changing climate, and pandemics. Data collection includes rainfall across the City, sewer water depth and velocity (to calculate flow), pump station flows, levels, and energy consumption, along with sewer temperature in trunks to provide input to Regional initiatives for energy optimization, wastewater heat recovery and district energy developments.
- **Computer Model Updates & Maintenance**
    - This program will provide further improvements to the computer model. It will simulate the operation of the sanitary sewer system and work to keep the model up to date with the latest infrastructure, population, and other inflow data. The model is used for capital planning and operational assessment and decision-making.

- **Sanitary Trunk Sewer & Forcemain Investigation Program**
    - This program enhances the City's existing program which inspects existing sewers. It will allow all larger sewers to be inspected by camera on a 10-year frequency to assess any issues in a timely manner.

Data collection will allow the City to better assess inflow and infiltration into the sanitary system. This alternative recommends programs to remove sources of strain on the system caused by:

- The inflow of excess water into sewer pipes. Inflow water comes from yards, roofs, drains, downspouts, and manhole covers.
- The infiltration of excess water from the groundwater system. The water then enters the sewers. Infiltration occurs following large storm events that can trigger a rise in groundwater levels.

The following programs will be implemented for inflow and infiltration:

- **Inflow and Infiltration Reduction Program**
    - This involves the review of data collected as part of other programs. It would determine specific areas where inflow and infiltration is entering the sanitary system. The program would then recommend actions to remedy the source of additional flows.
- **Hydrogen Sulfide Monitoring and Dosing Program**
    - This involves the monitoring of hydrogen sulfide levels in key locations in the sanitary sewer system. It will identify areas of high hydrogen sulfide within the system. The program would then recommend actions to remedy the high hydrogen sulfide levels.

Best in Class municipalities follow the best practices recently outlined in the Guideline to Developing an Efficient and Cost-Effective Inflow and Infiltration (I/I) Reduction Program: A Foundational Document (Robinson, B., and Sandink, D. 2021) as available on the Standards Council of Canada website: https://www.scc.ca/en/system/files/publications/Norton-ICLR-SCC_-_Efficient_and_Cost_Effective_I-I_Reduction_Programs_-_2021_EN.pdf.

The program aims to identify specific areas where inflow and infiltration sources are entering the sanitary system. Once these sources are identified, the program recommends short and long-term actions to address the source of additional flows. These actions are also guided by the principles outlined in the foundational document, ensuring that the approach to remedying these issues is in line with recognized best practices.

## 8.3 Alternative Infrastructure Update Solutions

### 8.3.1 Capacity-Based Solutions

Solutions to the identified capacity constraints are sized based on the following criteria, where feasible, as per the City of Kitchener Development Manual (Summer 2021), the Region of

Waterloo and Area Municipalities Design Guidelines for Supplemental Specifications for Municipal Sewers (DGSSMS; January 2021) and were discussed with the City:

- Depth of flow to diameter (d/D) ratio is no higher than 80% in DWF conditions (lower d/D ratios may be considered in trunks to facilitate maintenance activities)
- Full flow velocity is appropriate to provide scour and peak flow velocity is less than the maximum allowable (0.8 m/s > v > 3 m/s)
- No HGL issues observed due to capacity constraints in the 25-year AES design event; and,
- Pumping stations have adequate firm capacity to convey the 10-year AES peak flows, and do not experience overflows in events smaller than the 25-year AES storm event.

The proposed solutions are designed based on the criteria outlined below, as per the Development Manual and DGSSMS, as referenced above.

**Table 8-2: Sewer Design Criteria**

| Parameter | Design Value |
|---|---|
| Minimum Sewer Size (mm) | 200 |
| Minimum Flow Velocity (m/s) | 0.8 based on the City of Kitchener Development Manual (2021) |
| Minimum Sewer Slope (%) | Based on MECP Guidelines to achieve minimum flow velocity of 0.8 m/s |
| Minimum Drop Across Maintenance Holes (cm) | 3 - 6 |
| Minimum Cover (m) | 2.8 |
| Minimum Vertical Clearance at Sewer Crossings (m) | 0.5 |

The proposed solutions are presented in **Table 8-3** below, along with the estimated Opinion of Probable Cost (OPC) per solution. Solutions include both linear infrastructure upgrades and pumping station upgrades and are listed by their Project ID (CB-#, where CB refers to Capacity-Based solutions).

Solutions are ranked based on when they are needed: near-term for existing issues, medium-term for 2031 issues, and long-term for 2051 issues. All solutions within each time frame are equally important.

The OPCs are considered Class D estimates (+/- 25-30%) and are provided based on 2022 dollars. These costs and have been rounded to the nearest thousand. These OPCs can be used to help inform the City's budgeting process that occurs every 4 years. Thus, all near-term projects should be included within this year's budget, while all 2031 and 2051 solutions should be accounted for in future budgets, if still found to be required based on forthcoming Master Plan updates.

In most cases, the required solutions are simple in nature, in that only a few pipe segment upgrades within City-owned Right-of-Way (ROW) or existing easements to reduce HGLs below 1.8 m from surface. Pumping station capacity constraints are typically resolved by replacing an existing pump or adding pump(s) where provisional allowances already exist.

Thus, alternative solutions are not explored for most areas as limited variations of these solutions exist and would only be less cost effective. There are however, two (2) locations where alternative infrastructure upgrade solutions are explored due to property ownership restrictions. These include Dalewood (CB-2) and Homer Watson (CB-3). Their alternatives are presented in the following table.

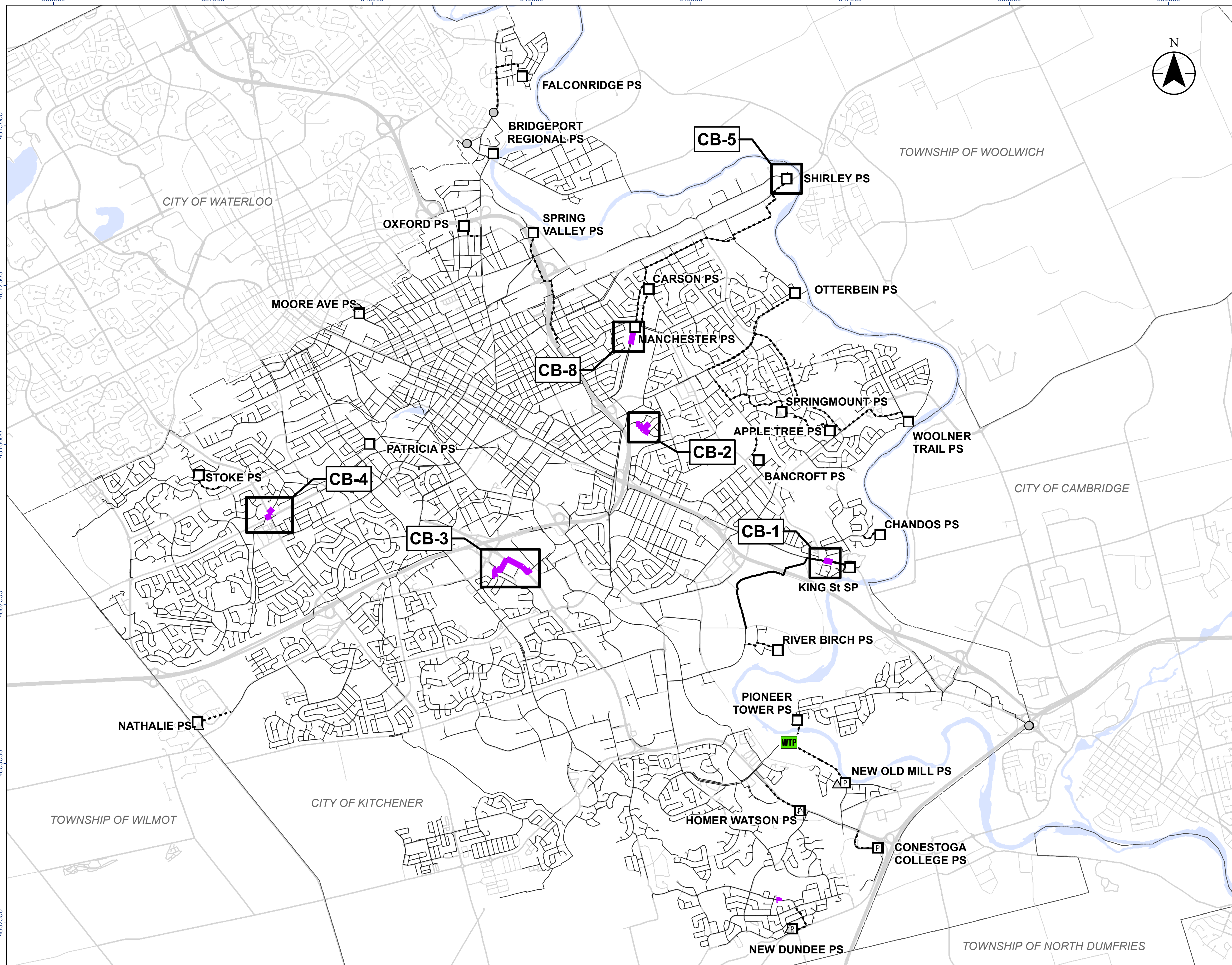
Three (3) sewer and pumping station capacity-based problem areas are not addressed with proposed solutions as their capacity concerns are generated by restrictions at either the Spring Valley SPS or the Bridgeport SPS. Both pumping stations are owned and operated by the Region of Waterloo and not the City of Kitchener and are thus not included in the following project list. A solution for problem area SA-10 defined in **Section 7.4.2** is also not proposed, as it is a result of the capacity constraints at the Bridgeport SPS.

The following **Figure 8-1** illustrates the locations of these proposed solution pipes and pump station upgrades. The 2051 future conditions 25-year HGL and surcharge results with solutions implemented are illustrated in **Figure 8-2**. Refer to **TM3** for further solution details, including close-up plan views and profiles of each of the proposed solutions.

### Table 8-3: Existing and Future Conditions Capacity-Based Sewer Solutions

| Project ID | Relevant Problem Area ID | Scenario Triggered | Solution Description | Estimated Opinion of Probable Cost | Contingency Allowance (30%) | Engineering Allowance (20%) | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|
| CB-1: Upstream of King St SPS | **SA-1** | **Existing** (Near-Term Priority) | Replacement of 2 lengths of sewer - upsize from 300 mm diameter to 375 mm diameter sewer | $499,000 | $149,700 | $129,740 | $32,435 | $810,875 | $811,000 |
| CB-2: Dalewood | **SA-2** | **Existing** (Near-Term Priority) | Alternative A - Replacement of 3 lengths of sewer on Dalewood one upgrade to 300 mm and two upgrade to 375 mm, and 2 lengths of sewer on Penrose upgraded to 300 mm diameter | $765,920 | $229,776 | $199,139 | $49,784 | $1,244,620 | $1,245,000 |
| | | | Alternative B - Replacement of 3 lengths of sewer on Dalewood, 2 lengths of sewer on Penrose and one length of sewer through the easement - all pipes upgraded to 300 mm diameter | $900,000 | $270,000 | $234,000 | $58,500 | $1,462,500 | $1,463,000 |
| CB-3: Homer Watson | **SA-6** | **Existing** (Near-Term Priority) | Alternative A – Replacement of 7 lengths of sewer on Homer Watson due to capacity, replacement of 2 lengths of sewer on comm. property due to capacity/condition, replacement of 7 lengths of sewer on Alpine due to capacity/condition, replacement of 2 lengths of sewer on Flint due to capacity, replacement of 1 length of sewer on Kingswood due to condition. | $2,445,443 | $733,633 | $635,815 | $158,954 | $3,973,845 | $3,974,000 |
| | | | Alternative B - Replacement of 5 lengths of sewer upstream of commercial property with 675 mm diameter sewer and replacement of 7 lengths of sewer downstream of commercial property with 300 mm diameter sewer | $2,306,418 | $691,925 | $599,669 | $149,917 | $3,747,929 | $3,748,000 |

| Project ID | Relevant Problem Area ID | Scenario Triggered | Solution Description | Estimated Opinion of Probable Cost | Contingency Allowance (30%) | Engineering Allowance (20%) | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|
| CB-4: Sandrock Trunk | **SA-7** | **Existing** (Near-Term Priority) | Replacement of 3 lengths of sewer - upsizing from 675 mm diameter to 750 mm diameter sewer | $1,448,000 | $434,400 | $376,480 | $94,120 | $2,353,000 | $2,353,000 |
| CB-5: Shirley SPS | **SA-8** | **Existing** (Near-Term Priority) | Increase PS capacity to 378 L/s firm capacity - project involves addition of pumps to accommodate higher flows<br><br>ECA update not required | $285,760 | $85,728 | $74,298 | $18,574 | $464,360 | $-<br>*(Upgrade to be paid for by Development Charges (DC) funds)* |
| CB-6: New Dundee SPS | **New Dundee SPS - Capacity Constraint (Table 2-4)** | **2031** (Medium-Term Priority) | Increase PS capacity to 75 L/s firm capacity – project involves addition of pumps to accommodate higher flows.<br><br>ECA update required | $477,336 | $143,201 | $124,107 | $31,027 | $775,671 | $776,000 |
| CB-7: Robert Ferrie | **Downstream of New Dundee SPS** | **2031** (Medium-Term Priority) | Replacement of 1 length of sewer downstream of New Dundee FM discharge to 375mm diameter | $495,550 | $148,665 | $128,843 | $32,211 | $805,269 | $805,000 |
| CB-8: Manchester | **SA-9** | **2051** (Long-Term Priority) | Replacement of 2 lengths of sewer to 825mm diameter downstream of Shirley and Manchester SPS discharge | $693,015 | $207,905 | $180,184 | $45,046 | $1,126,149 | $1,126,000 |
| | | | **Totals** | **$10,316,442** | **$3,094,933** | **$2,682,275** | **$670,568** | **$16,764,218** | **$16,301,000** |




Stantec

Legend
- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Other Sewers
- Forcemain
- Capacity-Based Solution

0 1 2 km

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**Notes**
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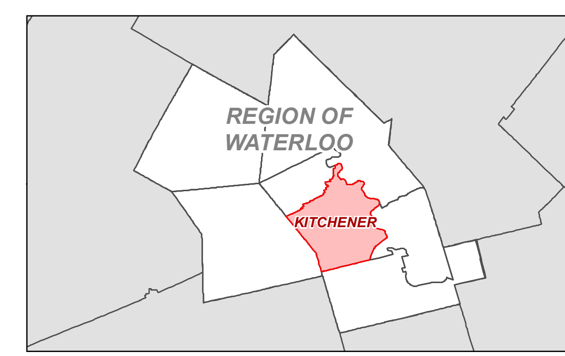


Project Location
City of Kitchener

165640334 REVA
Prepared by EH on 2023-09-20

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CITY OF KITCHENER
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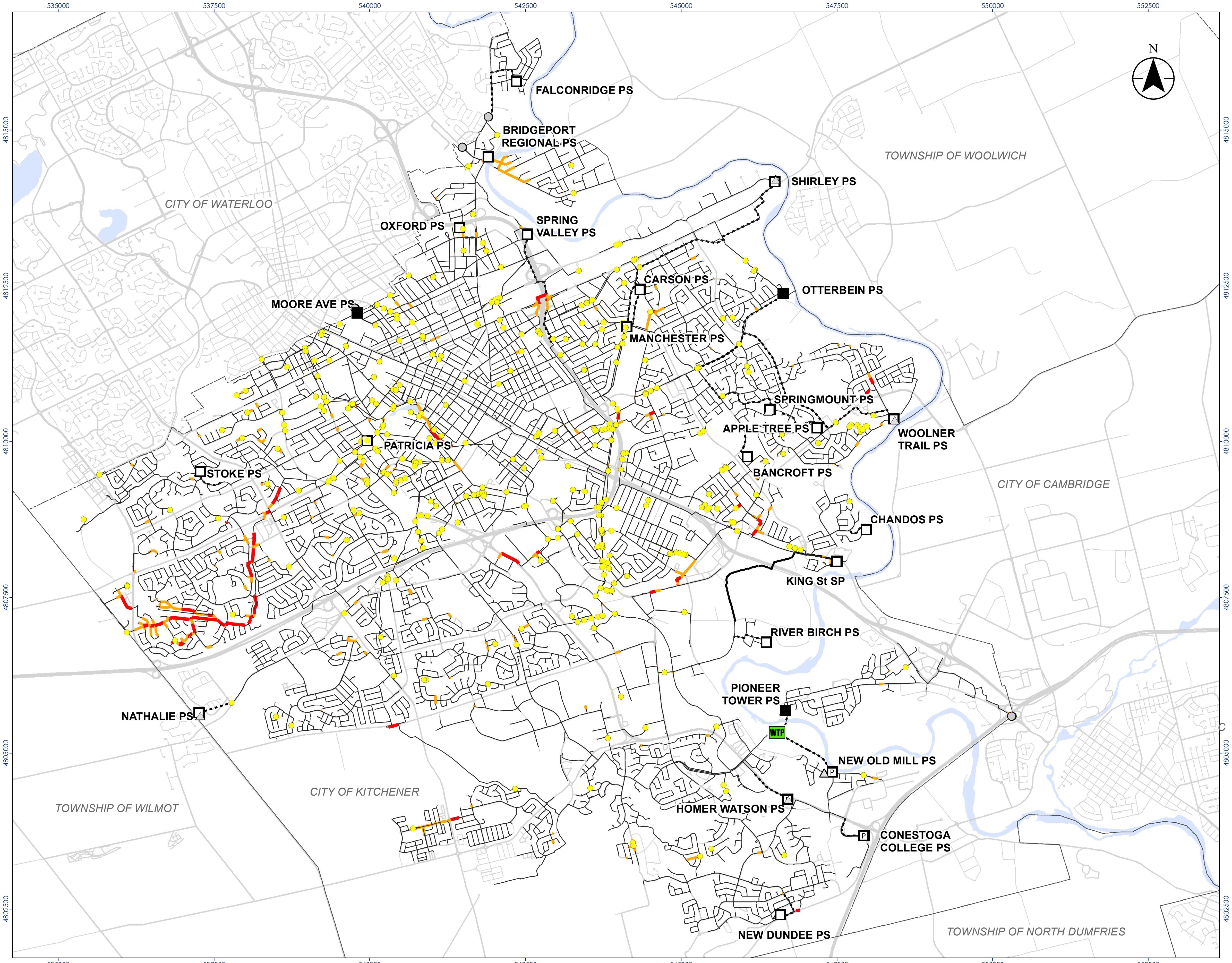
Figure No.
**8-1**

Title
**Proposed Capacity-Based Solutions**




Stantec

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Other Sewers
- Forcemain

**HGL Freeboard**

- Within Basement Level (Within 1.8 m or Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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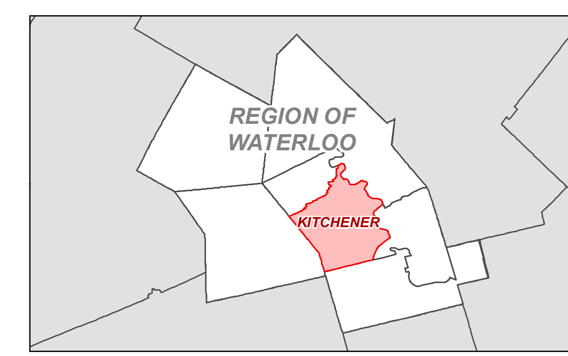



Project Location
City of
Kitchener

165640334 REVA
Prepared by EH on 2023-09-20

Client/Project
CITY OF KITCHENER
INTEGRATED SANITARY MASTER PLAN

Figure No.
**8-2**

Title
**2051 Future Conditions Sanitary Sewer System 25-Year HGL & Surcharge Results with Proposed Capacity-Based Solutions**

#### 8.3.1.1 Alternatives Review

As mentioned in **Section 8.3.1**, alternative solutions are not explored for most problem areas as limited variations of these simpler solutions exist. There are however, two (2) locations where alternative infrastructure upgrade solutions are explored due to property ownership restrictions. These include Dalewood (CB-2) and Homer Watson (CB-3). Their alternatives are detailed and evaluated in the following **Table 8-4**.

**Table 8-4: Alternatives Evaluation**

| Evaluation Element | Alternative A | Alternative B |
|---|---|---|
| **Dalewood** | | |
| **Project ID** | CB-2 | |
| **Location** | Dalewood Dr, Penrose Ave | |
| **Description** | Capacity upgrades (1 x 300 mm pipes, and 2 x 375 mm) on Dalewood Dr and (2 x 300 mm) on Penrose Ave. Avoids upgrade through pathway between Dalewood Dr and GRCA lands. | Capacity upgrade (6 x 300 mm pipe) on Dalewood Dr, on Penrose Ave, and through pathway between Dalewood Dr and GRCA lands. Majority of segment is within City-owned easement with 3.5 m of sewer in GRCA lands. |
| **Opinion of Probable Cost[1]** | $1,245,000 | $1,463,000 |
| **Pros** | • Avoids easement/private property upgrades resulting in fewer permitting requirements.<br>• Schedule A/A+<br>• Reduces HGL concerns in Dalewood area | • Eliminates HGL concerns throughout the area.<br>• Easement pipe upgrade can be done simultaneously to scheduled adjacent storm pipe upgrade.<br>• Meets cover, drop across MHs and velocity requirements.<br>• Schedule A/A+ |
| **Cons** | • Does not eliminate HGL concern at corner of Dalewood and pathway easement due to shallow downstream pipe<br>• Does not meet cover, drops across MHs or velocity requirements due to shallow downstream pipe | • Requires pipe construction through easement. |
| **Recommendation** | Alternative B – Due to the scheduled adjacent storm pipe upgrade through this easement, the ability to meet the design criteria, and the resulting hydraulic performance in the sanitary system, Alternative B is recommended, as per the City's preference. | |
| **Homer Watson** | | |
| **Project ID** | CB-3 | |
| **Location** | Homer Watson Blvd, Flint Dr, Alpine Rd, Hanson Ave | |

| Evaluation Element | Alternative A | Alternative B |
|---|---|---|
| **Description** | Replacement of 7 lengths of sewer on Homer Watson due to capacity, replacement of 2 lengths of sewer in City easement on commercial property due to capacity/condition, replacement of 7 lengths of sewer on Alpine due to capacity/condition, replacement of 2 lengths of sewer on Flint due to capacity, replacement of 1 length of sewer on Kingswood due to condition. | Inline storage (3 x 675 mm pipes) on Flint Dr and Alpine Rd to avoid pipe upgrades through City easement on private commercial property. Capacity upgrades (7 x 300 mm pipes) on Homer Watson Blvd and Hanson Ave downstream of private property |
| **Opinion of Probable Cost[1]** | $3,974,000 | $3,748,000 |
| **Pros** | • Smaller pipe sizes required<br>• Achieves requirements for cover, drops across MHs and velocity, except at upstream-most and downstream-most solution pipes<br>• Schedule A/A+ | • Avoids working adjacent to private property<br>• Achieves requirements for drops across MHs and velocity |
| **Cons** | • Requires upgrades within City-owned easement | • Does not achieve cover requirements due to inverts of private property pipes, however, cover is > 1.8 m, which at least does not result in 'shallow' sewers, as defined in **Section 7.4.2,** where HGLs are always within typical basement depths |
| **Recommendation** | Alternative A – Due to condition of the sewers in the easement, Alternative A is preferred, which also achieves the minimum cover requirement as per the Design Guidelines (2.8 m). | |
| 1. As per Opinion of Probable Cost discussed in **Section 8.3.1**. | | |

As the table above indicates, Alternative B is recommended for Dalewood problem area and Alternative A is recommended for Homer Watson problem area. The total recommended budgetary estimate for all proposed solutions, including only the recommended alternatives for CB-2 and CB-3, is $16,301,000, as per **Table 8-3** of **Section 8.3.1**.

Another mitigation measure that should be considered involves reviewing building permits in the problem areas. This would generally apply to areas that are industrial or commercial in nature as these structures generally do not have basements. Review of these areas would identify if there were any existing basements and, if the area lacks any basements, the City may consider prohibiting the construction of basements on new structures. This may eliminate the need for upgrades which are triggered by surcharging at less than 1.8 meters from the surface.

#### 8.3.1.2 Capacity-Based Solutions Sensitivity

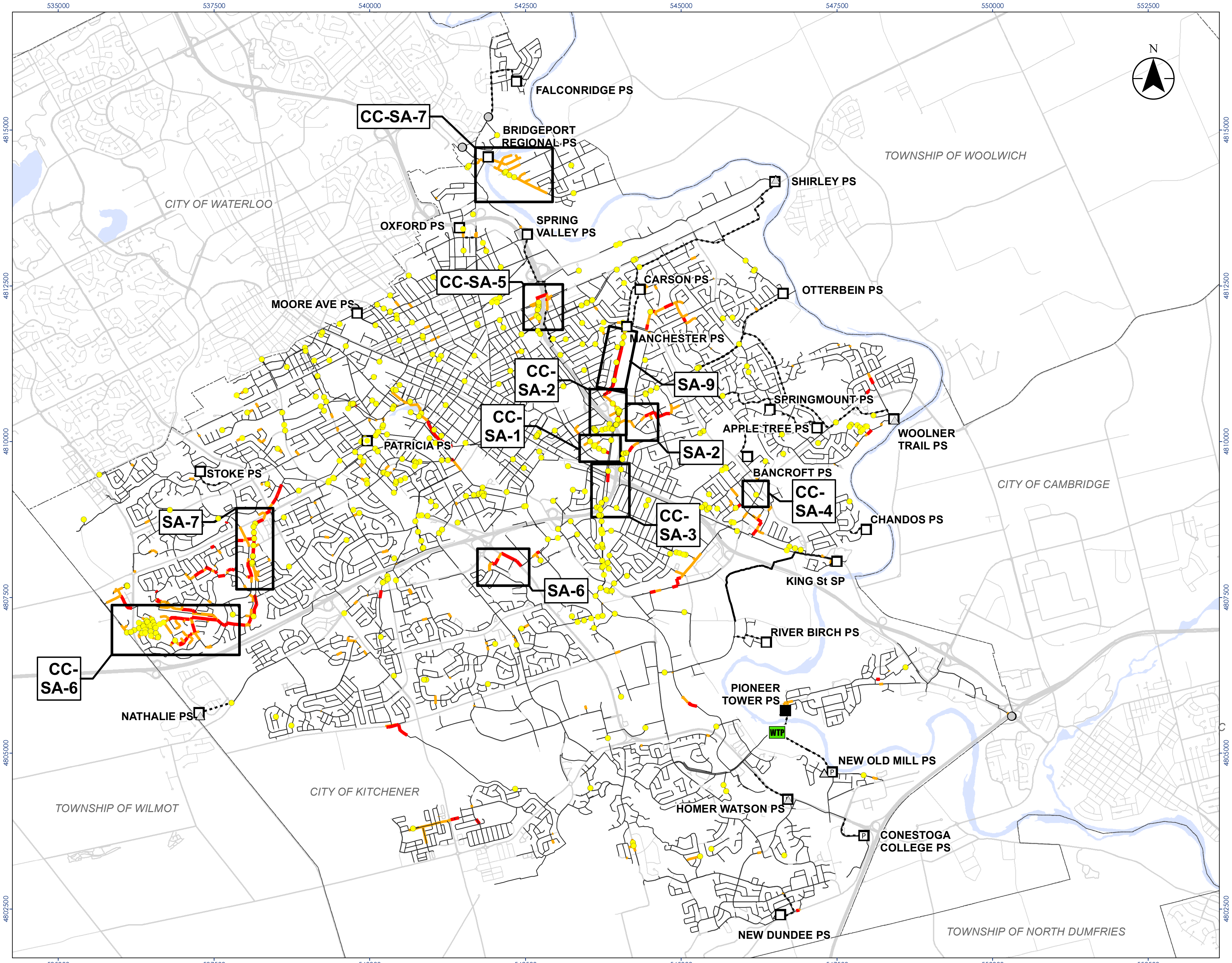
As discussed in **Section 7.2**, a 20% increase to the 25-year AES, 12-hour design storm event rainfall is used to generate the climate change/stress-test event (herein referred to as CC). This event was then used to test the sensitivity of proposed capacity-based solutions as defined in **Section 8.3.1** under the 2051 growth scenario. As anticipated, the higher intensity/volume rainfall results in the expansion of some (5) existing problem areas and the development of several (7) new problem areas. The sensitivity of the proposed solutions for each problem area is documented in the following **Table 8-5** which also includes the list of new problem areas and the estimated magnitude of solution required to solve the HGL concerns observed in the climate change event. Sensitivities are presented in red font and categorized by Minor Sensitivity and **Significant Sensitivity**, where minor sensitivities would require minor, simple upgrades to resolve, while significant sensitivities would require major, more complex upgrades. The climate change results are illustrated in **Figure 8-3**.

**Table 8-5: Climate Change Impacts to Proposed Solutions**

| Problem Area | Existing vs. New Problem Area | Solutions Sensitivity in Climate Change Event | Trunk vs. Local | Comments |
|---|---|---|---|---|
| SA-1 Upstream of King St SPS | Existing | Not sensitive | Local | |
| SA-2 – Alt B Dalewood | Existing | Minor Sensitivity | Local | Capacity constraint and upstream backwater (300 mm pipe D/S of Dalewood Dr in easement & GRCA property) |
| SA-3 Upstream of Spring Valley SPS | Existing | Not sensitive | Trunk | |
| SA-6 – Alt A Homer Watson | Existing | Minor Sensitivity | Local | Capacity constraint and backwater on sewers, including pipes on private property |
| SA-7 Sandrock Trunk | Existing | **Significant Sensitivity** | Trunk | Backwater and HGL issues on trunk & local sewers requiring significant additional upgrade(s), including pipes on private properties |
| SA-8 Upstream of Shirley SPS | Existing | Not sensitive | Trunk | |
| SA-16 Downstream of New Dundee SPS | Existing | Not sensitive | Local | |
| SA-9 Downstream of Manchester SPS | Existing | **Significant Sensitivity** | Trunk | Shallow & flat pipes restrict current solution; would require several additional upgraded and dropped sewer lengths |
| CC-SA-1 Brentwood Ave | New | Minor Sensitivity | Local | Backwater and HGL issues on local sewers requiring minor upgrades |
| CC-SA-2 Upstream of Conestoga Siphon | New | **Significant Sensitivity** | Trunk | Significant upgrades required along trunk (includes PKWY crossing); tied with solutions required downstream of Conestoga Siphon (CC-SA-3) |

| | | | | |
|---|---|---|---|---|
| CC-SA-3 Downstream of Conestoga Siphon | New | Minor Sensitivity | Trunk | Significant upgrades required along trunk; tied with solutions required upstream of Conestoga Siphon (CC-SA-2) |
| CC-SA-4 Guerin/Jansen | New | Minor Sensitivity | Local | Backwater and HGL issues on local sewers requiring minor upgrades |
| CC-SA-5 Conestoga PKWY | New | **Significant Sensitivity** | Trunk | Significant upgrades required to reduce backwater and HGL issues on trunk & local sewers; includes PKWY crossing. Separate (upstream) from CC-SA-2 & CC-SA-3 |
| CC-SA-6 Highview Dr | New | **Significant Sensitivity** | Local | Significant upgrades required to reduce backwater and HGL issues on local sewers upstream of Sandrock (SA-7), including pipes on private properties |
| CC-SA-7 Upstream of Bridgeport SPS | New | **Significant Sensitivity** | Trunk | SPS upgrades required to eliminate SPS flooding and resulting upstream backwater and HGL issues |
| **Note:** "CC-SA-#" refers to new sanitary problem areas observed due to climate change ("CC") impacts only, i.e., in addition to the previously identified capacity-based "SA" solutions. | | | | |

While some sensitivities are observed, no changes or additional proposed solutions are recommended at this time considering the uncertainty involved with not only climate change predictions, but also accurate growth predictions for the 2051 horizon. Alternatives regarding additional/continual data acquisitions, flow monitoring and I/I mitigation programs can help reduce sensitivities in these areas instead. See **TM3** for further discussions on Alternative 4.




**Stantec**

Legend

- Sanitary Pumping Stations
- Outflow to Adjacent System
- PS Overflow
- WWTP
- Other Sewers
- Forcemain

**HGL Freeboard**

- Within Basement Level (Within 1.8 m or Surface)

**Pipe Surcharge State**

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 1 2 km

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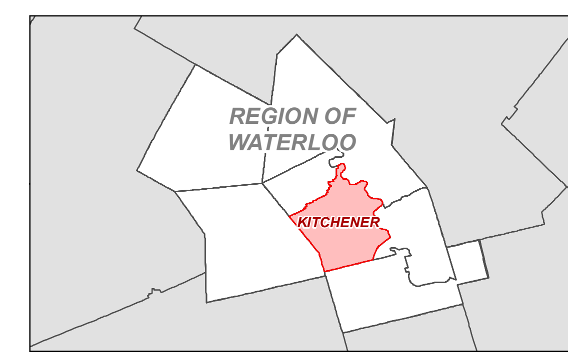


Project Location
City of Kitchener

165640334 REVA
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Figure No.
**8-3**

Title
**Capacity-Based Solutions Sensitivity – 25-Year Climate Change HGL & Surcharge Results**

#### 8.3.1.3 Condition-Based Solutions

As discussed in **Section 7.5**, the CCTV scores provided in the City's asset management data were used to define sewers in poor condition and thus identify those considered for asset renewal. A total of 108 gravity sewers were found to have CCTV scores of 4 or greater and fall within the other defined criteria (see **Section 7.5.1**), equating to 7.1 km of sewer length. These sewers are compiled into 78 renewal projects based on proximity and are documented in **Table 8-6** by Project ID, where "AR" refers to Asset Renewal. Their relevant Problem Area IDs are also included in the table for easy reference to **Table 7-8** in **Section 7.5.2**, along with the estimated Opinion of Probable Cost per project.

The solution projects are ordered based on the criticality associated with the current CCTV score (higher scores warrant higher prioritization). If CCTV scores are equal, the prioritization is assumed equal. The solution projects are also ordered from trunk to local sewer. All sewer asset renewal projects are identified for near-term solution development (2024 - 2027). For the condition-based sewer projects, the repair required is uncertain as the work is solely based on a CCTV score. Hence, the corrective action could be a simple spot repair on one section of pipe, relining of the pipe, or it could be a full pipe replacement. Therefore, the cost estimates were calculated for all three scenarios with a suggested budget amount between the high and low amounts based on 75% of the cost range. Ongoing data acquisition programs will be used to continually update this list for medium- and long-term asset renewal scheduling.

In addition to the recommended sewer asset renewal projects, the proposed sanitary pumping station asset renewals from RJ Burnside's Conditions Assessment Reports have been incorporated, along with updated OPCs for the City's budgeting purposes, compiled in **Table 8-7**. The budget for the sanitary pumping station asset renewals was adjusted by the City, thus the adjusted budget per City direction is also presented in the table. Moreover, SCADA systems upgrades due to National Fire Protection Association (NFPA) requirements was needed for some of the sanitary pumping station as part of the capital projects. Table 8-8 compiles the SPS with SCADA systems upgrades along with updated OPCs for the City's budgeting purposes.

The OPCs are considered Class D estimates (+/- 25-30%) and are provided based on 2022 dollars, with a 5% inflation adjustment factor applied for projects after 2022. These OPCs can be used to help inform the City's budgeting process that occurs every 4 years. Thus, all near-term projects should be included within this year's budget. The total recommended budgetary estimates for sewer asset renewals totals approximately $38,033,200, while the pumping station asset renewals adjusted per City direction equates to roughly $2,233,300, and the pumping station SCADA system update totals approximately $1,678,000; the overall total is $48,547,200.

## Table 8-6: Sewer Asset Renewal Projects (Near-Term)

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-1 | AC-4 | Ottawa St N, Dreger Ave, Graber Pl | 19x 675 mm sewers on Ottawa St N, Dreger Ave, and Graber Pl between Old Chicopee Dr and just upstream of Conestoga Pkwy | 101611, 101612, 101613, 101365, 101366, 101367, 101368, 101335, 101339, 101340, 101341, 101342, 101350, 101351, 101352, 101849, 101850, 101851, 101852 | Trunk | 5 | $2,747,000 | $137,350 | $2,884,350 | $2,884,400 |
| AR-2 | AC-7 | Rock Ave | 1x 525 mm sewer at the end of Rock Ave through private ICI property located between Belmont Ave W and the throughway behind the ICI buildings | 105256 | Trunk | 5 | $395,000 | $19,750 | $414,750 | $414,800 |
| AR-3 | AC-5 | Greenbrook Dr | 2x 375 mm sewers on Greenbrook Dr between Birchcliffe Ave to just north of Stonybrook Dr | 108513, 108404 | Trunk | 4.5 | $595,000 | $29,750 | $624,750 | $624,800 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-4 | AC-1 | Vanier Dr | 1x 375 mm sewer through easement between Vanier Dr and Clark Ave | 118182 | Trunk | 4.1 | $267,000 | $13,350 | $280,350 | $280,400 |
| AR-5 | AC-6 | Greenbrook Dr | Downstream of AC-8; 1x 900 mm sewer on Greenbrook Dr within Stirling Ave S intersection | 107730 | Trunk | 4.1 | $336,000 | $16,800 | 352800 | $352,800 |
| AR-6 | AC-2 | Westforest Trl | 1x 375 mm sewer on Westforest Trl between Westmeadow Dr and Hidden Creek Dr | 110504 | Trunk | 4 | $322,000 | $16,100 | 338100 | $338,100 |
| AR-7 | AC-3 | Bankside Dr | 1x 450 mm sewer on Bankside Dr between Golden Terrace Crt and Eastforest Trl | 109989 | Trunk | 4 | $279,000 | $13,950 | $292,950 | $293,000 |
| AR-8 | AC-8 | West of Connaught Pl | 1x 400 mm sewer in easement between Connaught Pl and Conestoga Pkwy | 100263 | Trunk | 4 | $646,000 | $32,300 | $678,300 | $678,300 |
| AR-9 | AC-11 | Highbrook Ct | 1 x 200 mm sewer on Highbrook Ct between Fisher-Hallman Rd and Highbrook St | 119059 | Local | 5 | $303,000 | $15,150 | $318,150 | $318,200 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-10 | AC-13 | Woolwich St | 1 x 200 mm sewer on Woolwich St between Hillcrest Ln and Bridle Trail | 110889 | Local | 5 | $486,000 | $24,300 | $510,300 | $510,300 |
| AR-11 | AC-38 | Overlea Dr | 1 x 250 mm sewer at the intersection of Overlea Dr and Overlea Crescent | 108477 | Local | 5 | $391,000 | $19,550 | $410,550 | $410,600 |
| AR-12 | AC-20 | Block Line Rd | 1 x 200 mm sewer on Northmanor Crescent between Resurrection Dr and University Ave W | 108196 | Local | 5 | $418,000 | $20,900 | $438,900 | $438,900 |
| AR-13 | AC-23 | Conestoga Pkwy Onramp | 1 x 200 mm sewer on Conestoga Pkwy Onramp between Courtland Ave E and Conestoga Pkwy | 107094 | Local | 5 | $781,000 | $39,050 | $820,050 | $820,100 |
| AR-14 | AC-46 | Highland Crescent | 1 x 250 mm sewer on Highland Crescent between Highland Rd and Westmount Rd | 106442 | Local | 5 | $361,000 | $18,050 | $379,050 | $379,100 |
| AR-15 | AC-25 | Spring Valley SPS | 1 x 250 mm incoming pipe North of Spring Valley SPS | 105863 | Local | 5 | $322,000 | $16,100 | $338,100 | $338,100 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-16 | AC-26 | Cameron St N | 1 x 200 mm sewer on Cameron St N between Duke St E and Weber St E | 104745 | Local | 5 | $491,000 | $24,550 | $515,550 | $515,600 |
| AR-17 | AC-28 | McLeod Ct | 1 x 200 mm sewer at the intersection of McLeod Ct and Biehn Dr | 103960 | Local | 5 | $241,000 | $12,050 | $253,050 | $253,100 |
| AR-18 | AC-29 | Gateway Park Dr | 3 x 300 mm sewer on Gateway Park Dr between Sportsworld Dr and Tu-Lane St | 103769, 103770, 103771 | Local | 5 | $1,462,000 | $73,100 | $1,535,100 | $1,535,100 |
| AR-19 | AC-55 | Old Mill Rd | 1 x 300 mm sewer on Old Mill Rd between Sydenham St and Pinnacle Dr | 103117 | Local | 5 | $486,000 | $24,300 | $510,300 | $510,300 |
| AR-20 | AC-59 | Lower Canada Crescent | 1 x 250 mm sewer at the intersection of Lower Canada Crescent and Upper Canada Dr | 102928 | Local | 5 | $180,000 | $9,000 | $189,000 | $189,000 |
| AR-21 | AC-62 | Heritage Dr | 1 x 250 mm sewer on Heritage Dr between Keewatin Ave and Lorraine Ave | 102226 | Local | 5 | $437,000 | $21,850 | $458,850 | $458,900 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-22 | AC-65 | King St E | 1 x 200 mm sewer on King St E between Sydney St S and Ottawa St S | 101278 | Local | 5 | $527,000 | $26,350 | $553,350 | $553,400 |
| AR-23 | AC-70 | Broadview Ave | 1 x 250 mm sewer on Broadview Ave between Broadview Ct and Shuh Ave | 100776 | Local | 5 | $352,000 | $17,600 | $369,600 | $369,600 |
| AR-24 | AC-72 | Greenfield Ave | 1 x 250 mm sewer at the intersection of Greenfield Ave and Kingsway Dr | 100602 | Local | 5 | $451,000 | $22,550 | $473,550 | $473,600 |
| AR-25 | AC-76 | Traynor Ave | 1 x 250 mm sewer at the intersection of Wilson Ave and Traynor Ave | 100075 | Local | 5 | $399,000 | $19,950 | $418,950 | $419,000 |
| AR-26 | AC-53 | Manitou Dr | 2 x 250 mm sewer on Manitou Dr between Fairway Rd S and Webster Rd | 103436, 100040 | Local | 5, 4 | $997,000 | $49,850 | $1,046,850 | $1,046,900 |
| AR-27 | AC-35 | Driftwood Dr | 1 x 200 mm sewer on Driftwood Dr between Parkland Crescent and Toynbee Crescent | 109901 | Local | 4.5 | $442,000 | $22,100 | $464,100 | $464,100 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-28 | AC-39 | Stonybrook Dr | 1 x 225 mm sewer on Stonybrook Dr between Village Crescent and Sweetbriar Dr | 108398 | Local | 4.5 | $441,000 | $22,050 | $463,050 | $463,100 |
| AR-29 | AC-45 | Selkirk Ct | 1 x 200 mm sewer on Selkirk Ct between Selkirk Dr and Geneva Crescent | 107224 | Local | 4.5 | $395,000 | $19,750 | $414,750 | $414,800 |
| AR-30 | AC-9 | Richmond Avenue | 1 x 250 mm sewer on Richmond Avenue between Water St S and David St | 2002189 | Local | 4 | $247,000 | $12,350 | $259,350 | $259,400 |
| AR-31 | AC-10 | Huck Crescent | 1 x 200 mm sewer on Huck Crescent between Udvari Crescent and Keller Crescent | 119495 | Local | 4 | $297,000 | $14,850 | $311,850 | $311,900 |
| AR-32 | AC-12 | Deep Ridge Dr | 1 x 200 mm sewer on Deep Ridge Dr between Candle Crescent and Grand Hill Dr | 118447 | Local | 4 | $579,000 | $28,950 | $607,950 | $608,000 |
| AR-33 | AC-32 | Alpine Rd | 1 x 250 mm sewer on Alpine Rd between Kingswood Dr and Homer Watson Blvd | 118286 | Local | 4 | $369,000 | $18,450 | $387,450 | $387,500 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-34 | AC-33 | Hollinger Crescent | 1 x 250 mm sewer on Hollinger Crescent between Bridge St E and Dumart Pl | 111001 | Local | 4 | $423,000 | $21,150 | $444,150 | $444,200 |
| AR-35 | AC-14 | Northmanor Crescent | 1 x 200 mm sewer on Northmanor Crescent between Resurrection Dr and University Ave W | 110709 | Local | 4 | $336,000 | $16,800 | $352,800 | $352,800 |
| AR-36 | AC-15 | Windward Pl | 1 x 250 mm sewer on Windward Pl between Keller Crescent and Westforest Trail | 110658 | Local | 4 | $425,000 | $21,250 | $446,250 | $446,300 |
| AR-37 | AC-34 | Stoke Dr | 1 x 200 mm sewer on Stoke Dr between Wexford Crescent and Monarch Woods | 110577 | Local | 4 | $444,000 | $22,200 | $466,200 | $466,200 |
| AR-38 | AC-16 | Westforest Trail | 1 x 200 mm sewer on Westforest Trail between Shadyridge Pl and Beechcroft Pl | 110528 | Local | 4 | $461,000 | $23,050 | $484,050 | $484,100 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-39 | AC-17 | Dawn Ridge Dr | 1 x 200 mm sewer Dawn Ridge Dr on between Westmeadow Dr and Westforest Trail | 110522 | Local | 4 | $406,000 | $20,300 | $426,300 | $426,300 |
| AR-40 | AC-36 | Fisher-Hallman Rd | 1 x 250 mm sewer on Fisher-Hallman Rd between Highland Rd W and Queen's Blvd | 108906 | Local | 4 | $544,000 | $27,200 | $571,200 | $571,200 |
| AR-41 | AC-37 | Westheights Dr | 1 x 300 mm sewer through private property located on Westheights Dr | 108878 | Local | 4 | $654,000 | $32,700 | $686,700 | $686,700 |
| AR-42 | AC-40 | Barberry Pl | 1 x 225 mm sewer on Barberry Pl between Westmount Rd and Forest Hill Dr | 108347 | Local | 4 | $412,000 | $20,600 | $432,600 | $432,600 |
| AR-43 | AC-18 | Marlis Crescent | 1 x 200 mm sewer on Marlis Crescent between Bleams Rd and Erinbrook Dr | 108258 | Local | 4 | $216,000 | $10,800 | $226,800 | $226,800 |
| AR-44 | AC-19 | Highbrook St | 1 x 200 mm sewer on Highbrook St between Highbrook St and Westmount Rd E | 108216, 108203 | Local | 4 | $679,000 | $33,950 | $712,950 | $713,000 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-45 | AC-21 | Ristau Crescent | 1 x 200 mm sewer on Ristau Crescent between Highbrook Crescent and Dinison Crescent | 108056 | Local | 4 | $557,000 | $27,850 | $584,850 | $584,900 |
| AR-46 | AC-41 | Sandsprings Crescent | 2 x 200 mm sewer on Sandsprings Crescent between Devonglen Dr and Sandsprings Ct | 107604, 107656 | Local | 4 | $503,000 | $25,150 | $528,150 | $528,200 |
| AR-47 | AC-42 | Cherry Hill Dr | 1 x 250 mm sewer on Cherry Hill Dr between Coach Hill Dr and Murrayhill Ct | 107321 | Local | 4 | $232,000 | $11,600 | $243,600 | $243,600 |
| AR-48 | AC-43 | Coach Hill Dr | 1 x 250 mm sewer on Coach Hill Drbetween Cherry Hill Dr and Block Line Rd | 107318 | Local | 4 | $607,000 | $30,350 | $637,350 | $637,400 |
| AR-49 | AC-44 | Coach Hill Dr | 1 x 250 mm sewer on Coach Hill Dr between Cherry Hill Dr and Homer Watson Blvd | 107306 | Local | 4 | $371,000 | $18,550 | $389,550 | $389,600 |
| AR-50 | AC-22 | Ottawa St S | 1 x 200 mm sewer on Ottawa St S between McLennan Park Gate and Strasburg Rd | 107118 | Local | 4 | $406,000 | $20,300 | $426,300 | $426,300 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-51 | AC-24 | Bedford Rd | 2 x 200 mm sewer on Bedford Rd between Sydney St S and Schneider Creek | 106954, 106955 | Local | 4 | $341,000 | $17,050 | $358,050 | $358,100 |
| AR-52 | AC-47 | Paulander Dr | 2 x 250 mm sewer on Paulander Dr between Victoria St S and Lawrence Ave | 106329, 106334 | Local | 4 | $552,000 | $27,600 | $579,600 | $579,600 |
| AR-53 | AC-48 | Weichel St | 1 x 250 mm sewer on Weichel St between Belton Dr and Karn St | 106299 | Local | 4 | $444,000 | $22,200 | $466,200 | $466,200 |
| AR-54 | AC-49 | Belmont Ln W | 1 x 250 mm sewer on Belmont Ln W between Claremont Ave and Argyle St | 106083 | Local | 4 | $458,000 | $22,900 | $480,900 | $480,900 |
| AR-55 | AC-50 | Union Blvd | 1 x 250 mm sewer on Union Blvd between Earl St and Severn Ave | 106063 | Local | 4 | $319,000 | $15,950 | $334,950 | $335,000 |
| AR-56 | AC-51 | Guelph St | 1 x 250 mm sewer parallel to the Spur Line Trail and connect to Guelph St sewer | 105106 | Local | 4 | $409,000 | $20,450 | $429,450 | $429,500 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-57 | AC-27 | Breithaupt St | 1 x 200 mm sewer on Breithaupt St between Moore Ave and Waterloo St | 104435 | Local | 4 | $252,000 | $12,600 | $264,600 | $264,600 |
| AR-58 | AC-52 | Wheatfield Crescent | 1 x 200 mm sewer on Wheatfield Crescent between Pathfinder Crescent and Bechtel Dr | 103885 | Local | 4 | $226,000 | $11,300 | $237,300 | $237,300 |
| AR-59 | AC-54 | Upper Canada Dr | 1 x 250 mm sewer through private residential property located between Farrier Dr and Upper Canada Dr | 103415 | Local | 4 | $405,000 | $20,250 | $425,250 | $425,300 |
| AR-60 | AC-56 | Old Mill Rd | 1 x 200 mm sewer on Old Mill Rd between Mill Park Dr and Rose St | 103108 | Local | 4 | $346,000 | $17,300 | $363,300 | $363,300 |
| AR-61 | AC-57 | Arrowhead Crescent | 2 x 250 mm sewer on Arrowhead Crescent between Homer Watson Blvd and Green Valley Dr | 103052, 103053 | Local | 4 | $508,000 | $25,400 | $533,400 | $533,400 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-62 | AC-58 | Green Valley Dr | 1 x 250 mm sewer on Green Valley Dr between Pioneer Dr and Arrowhead Crescent | 103041 | Local | 4 | $401,000 | $20,050 | $421,050 | $421,100 |
| AR-63 | AC-30 | Brembel St | 1 x 200 mm sewer through private residential complex located between Brembel St and Ottawa St N | 102507 | Local | 4 | $308,000 | $15,400 | $323,400 | $323,400 |
| AR-64 | AC-31 | Denlow St | 1 x 200 mm sewer on Denlow St between Brembel St and Rose Garden St | 102499 | Local | 4 | $301,000 | $15,050 | $316,050 | $316,100 |
| AR-65 | AC-60 | Dumfries Ave | 1 x 225 mm sewer on Dumfries Ave between Chapel St and Krug St | 102355 | Local | 4 | $479,000 | $23,950 | $502,950 | $503,000 |
| AR-66 | AC-61 | Heritage Dr | 1 x 200 mm sewer on Heritage Dr between Lorraine Ave and Oakhurst Crescent | 102231 | Local | 4 | $574,000 | $28,700 | $602,700 | $602,700 |
| AR-67 | AC-63 | Nipigon St | 1 x 250 mm sewer on Nipigon St between Nipigon Pl and Georgian St | 102207 | Local | 4 | $576,000 | $28,800 | $604,800 | $604,800 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-68 | AC-64 | Burbank Rd | 1 x 200 mm sewer on Burbank Rd between Conestoga Pkwy and Ada St | 101738 | Local | 4 | $295,000 | $14,750 | $309,750 | $309,800 |
| AR-69 | AC-66 | Wyandotte Ct | 1 x 250 mm sewer in Morrison Park between Wyandotte Ct and Oneida Pl | 100995 | Local | 4 | $499,000 | $24,950 | $523,950 | $524,000 |
| AR-70 | AC-67 | Morrison Road | 1 x 250 mm sewer on Morrison Road between Quinte Crescent and Grand River Blvd | 100981 | Local | 4 | $204,000 | $10,200 | $214,200 | $214,200 |
| AR-71 | AC-68 | Morrison Road | 2 x 200 mm sewer on Morrison Road between mm sewer between Quinte Crescent and Grand River Blvd | 100972, 100973 | Local | 4 | $699,000 | $34,950 | $733,950 | $734,000 |
| AR-72 | AC-69 | Burgetz Ave | 1 x 250 mm sewer on Burgetz Ave between River Rd E and Thaler Ave | 100921 | Local | 4 | $343,000 | $17,150 | $360,150 | $360,200 |
| AR-73 | AC-71 | Siebert Ave / Courtland Ave E | 1 x 250 mm sewer at the intersection of Siebert Ave and Courtland Ave E | 100628 | Local | 4 | $283,000 | $14,150 | $297,150 | $297,200 |

| Project ID | Asset Condition ID | Project Name | Project Description | Pipe Asset IDs | Sewer | Average CCTV Score | Estimated Opinion of Probable Cost | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|---|---|---|---|---|---|
| AR-74 | AC-73 | Broadmoor Ave | 1 x 200 mm sewer at the intersection of Broadmoor Ave and Clark Ave | 100324 | Local | 4 | $340,000 | $17,000 | $357,000 | $357,000 |
| AR-75 | AC-74 | Hillmount St | 1 x 250 mm sewer at the intersection of Hillmount St and Shelley Dr | 100304 | Local | 4 | $226,000 | $11,300 | $237,300 | $237,300 |
| AR-76 | AC-75 | Carrol St | 1 x 250 mm sewer on Carrol St between Connaught St and Greenfield Ave | 100146 | Local | 4 | $304,000 | $15,200 | $319,200 | $319,200 |
| AR-77 | AC-77 | Hazen Glen Dr / Ingleside Dr | 2 x 250 mm sewer on Hazen Glen Dr and Ingleside Dr | 110736, 110759 | Local | 4, 5 | $311,000 | $15,550 | $326,550 | $326,600 |
| AR-78 | AC-78 | Union St | 2 x 225 mm sewer on Union St | 104911, 106005 | Local | 4 | $699,000 | $34,950 | $733,950 | $734,000 |
| | | | | | | **Sub-Totals** | **$36,220,000** | **$1,811,000** | **$38,031,000** | **$38,033,200** |
| | | | | | | **Total** | **$38,033,200** | | | |

### Table 8-7: Sanitary Pumping Station Asset Renewal Projects

| Horizon | Budget from the RJ Burnside's Conditions Assessment Reports | Budget Adjusted per City Direction |
|---|---|---|
| Short Term Projects (2024 - 2027) | $3,902,008 | $444,000 |
| Medium Term Projects (2028 - 2031) | $5,390,522 | $1,193,000 |
| Long Term Projects (2032 - 2051) | - | $596,259 |
| **Total** | **$9,292,600** | **$2,233,300** |

### Table 8-8: Sanitary Pumping Station Scada System Upgrades

| Pumping Station | Estimated Opinion of Probable Construction Cost (Base Year 2022) | City Staff Time Allowance (5%) | Total Cost | Recommended Budgetary Estimate |
|---|---|---|---|---|
| Apple Tree SPS | $157,985 | $7,899 | $165,884 | $166,000 |
| Bancroft SPS | $11,673 | $584 | $12,257 | $12,000 |
| Carson SPS | $11,673 | $584 | $12,257 | $12,000 |
| Chandos SPS | $283,778 | $14,189 | $297,967 | $298,000 |
| Conestoga College SPS | $157,985 | $7,899 | $165,884 | $166,000 |
| Falconridge SPS | $299,308 | $14,965 | $314,273 | $314,000 |
| King Street SPS | $88,203 | $4,410 | $92,614 | $93,000 |
| New Dundee SPS | $11,673 | $584 | $12,257 | $12,000 |
| Oxford SPS | $124,839 | $6,242 | $131,081 | $131,000 |
| Patricia SPS | $72,332 | $3,617 | $75,948 | $76,000 |
| River Birch SPS | $157,985 | $7,899 | $165,884 | $166,000 |
| Springmount SPS | $11,673 | $584 | $12,257 | $12,000 |
| Stoke SPS | $33,801 | $1,690 | $35,491 | $35,000 |
| Shirley SPS | $11,673 | $584 | $12,257 | $12,000 |
| Woolner SPS | $164,684 | $8,234 | $172,918 | $173,000 |
| | | | **Total** | **$1,678,000** |

## 8.4 Recommended Servicing Solutions

In summary, the following alternatives are recommended as part of this Master Plan:

- **Alternative 2 – Shaping Community Growth**
- **Alternative 3 – Infrastructure Updates**
  - Capacity-based Solutions
  - Condition-based Solutions
- **Alternative 4 – Data Acquisition & Flow Monitoring**
  - Rainfall and Flow Monitoring Program
  - Sanitary Hydraulic Model Updates & Maintenance
  - Sanitary Sewer & Forcemain Investigation Program
  - Inflow and Infiltration Program
  - Hydrogen Sulfide Monitoring and Dosing Program

## 8.5 Municipal Class Environmental Assessment Project Schedule Classification

The projects recommended in this Master Plan fall under the 2015 MCEA Project Schedule Classifications listed in **Table 8-9**.

**Table 8-9: MCEA Project Schedule Classifications**

| Project | Project Description | MCEA Schedule |
|---|---|---|
| **Alternative 2** – Shaping Community Growth | The City will continue to monitor growth to ensure consistency with anticipated growth. Updates to the sewer model will be necessary when significant growth projection deviations occur. | N/A |
| **Alternative 3** – Infrastructure Updates | Capacity-based and condition-based infrastructure updates. The improvements identified are all in existing municipally owned lands and existing easements, and/or will include updates to existing systems. No property acquisition is required for any of the improvements. | Schedule A/A+ |
| **Alternative 4** – Data Acquisition & Flow Monitoring | The City will implement several programs to reduce flows in the sanitary sewer system and improve the City's understanding of the state of the system. | N/A |

# 9 Project Implementation

## 9.1 Capital Projects

The implementation plan consists of the timing of projects and data acquisition that was present in the previous sections with the costing adjusted using an annual inflation rate of 5%. Moreover, the implementation plan spreads the capital works based on criticality to provide an annualized cost for the City's consideration. **Table 9-1** presents the prioritization (with 1 indicating highest priority) and annual costing for the short-term Capital Projects, **Table 9-2** presents the prioritization and annual costing for the medium-term Capital Projects, and **Table 9-3** presents the costing for the Data Acquisition and Management Programs. Additionally, **Table 9-4** presents a summary of the annual costing from 2024 to 2031.

## Table 9-1: Short Term Projects (2024 - 2027) Prioritization & Annual Costing

| Short Term Project ID | Project Name | Project Type | Recommended Budgetary Estimate | Priority | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|
| ST1 | Homer Watson | Capacity / Condition | $3,974,000 | 3 | $- | $- | $4,830,422 | $- |
| ST2 | Upper Schneider - Sandrock | Capacity | $2,353,000 | 4 | $- | $- | $- | $3,003,091 |
| ST3 | Shirley SPS | Capacity | $0 | Upgrade to be paid for by Development Charges (DC) funds ($450,000) | | | | |
| ST4 | Moore Ave SPS Decommissioning | Condition | $2,065,000 | 1 | $2,276,663 | $- | $- | $- |
| ST5 | Apple Tree SPS | Condition | $166,000 | 2 | $- | $192,166 | $- | $- |
| ST6 | Bancroft SPS | Condition | $12,000 | 2 | $- | $13,892 | $- | $- |
| ST7 | Carson SPS | Condition | $12,000 | 2 | $- | $13,892 | $- | $- |
| ST8 | Chandos SPS | Condition | $298,000 | 3 | $- | $- | $362,221 | $- |
| ST9 | Conestoga College SPS | Condition | $166,000 | 2 | $- | $192,166 | $- | $- |
| ST10 | Falconridge SPS | Condition | $314,000 | 3 | $- | $- | $381,669 | $- |
| ST11 | King Street SPS | Condition | $93,000 | 1 | $102,533 | $- | $- | $- |
| ST12 | New Dundee SPS | Condition | $12,000 | 2 | $- | $13,892 | $- | $- |
| ST13 | Oxford SPS | Condition | $131,000 | 2 | $- | $151,649 | $- | $- |
| ST14 | Patricia SPS | Condition | $76,000 | 3 | $- | $- | $92,378 | $- |
| ST15 | River Birch SPS | Condition | $166,000 | 4 | $- | $- | $- | $211,863 |
| ST16 | Springmount SPS | Condition | $12,000 | 2 | $- | $13,892 | $- | $- |
| ST17 | Stoke SPS | Condition | $35,000 | 4 | $- | $- | $- | $44,670 |
| ST18 | Shirley SPS | Condition | $12,000 | 1 | $13,230 | $- | $- | $- |
| ST19 | Woolner SPS | Condition | $173,000 | 2 | $- | $200,269 | $- | $- |
| ST20 | All Pumping Stations[1] | Condition | $444,000 | | $18,690 | $164,731 | $172,968 | $181,616 |
| ST21 | Vanier | Condition | $280,400 | 2 | $- | $324,598 | $- | $- |
| ST22 | Westcrest | Condition | $338,100 | 2 | $- | $391,393 | $- | $- |
| ST23 | Bankside | Condition | $293,000 | 2 | $- | $339,184 | $- | $- |

| Short Term Project ID | Project Name | Project Type | Recommended Budgetary Estimate | Priority | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|
| ST24 | Ottawa | Condition | $2,884,400 | 1 | $3,180,051 | $- | $- | $- |
| ST25 | Greenbrook Drive | Condition | $624,800 | 1 | $688,842 | $- | $- | $- |
| ST26 | Greenbrook Drive | Condition | $352,800 | 1 | $388,962 | $- | $- | $- |
| ST27 | Belmont | Condition | $414,800 | 1 | $457,317 | $- | $- | $- |
| ST28 | Connaught | Condition | $678,300 | 2 | $- | $785,217 | $- | $- |
| ST29 | Richmond | Condition | $259,400 | 3 | $- | $- | $315,302 | $- |
| ST30 | Huck | Condition | $311,900 | 4 | $- | $- | $- | $398,072 |
| ST31 | Highbrook | Condition | $318,200 | 2 | $- | $368,356 | $- | $- |
| ST32 | Deer Ridge | Condition | $608,000 | 4 | $- | $- | $- | $775,979 |
| ST33 | Woolwich | Condition | $510,300 | 2 | $- | $590,736 | $- | $- |
| ST34 | Northmanor | Condition | $352,800 | 4 | $- | $- | $- | $450,272 |
| ST35 | Windward | Condition | $446,300 | 3 | $- | $- | $542,480 | $- |
| ST36 | Westforest | Condition | $484,100 | 4 | $- | $- | $- | $617,848 |
| ST37 | Dawn Ridge | Condition | $426,300 | 4 | $- | $- | $- | $544,079 |
| ST38 | Marius | Condition | $226,800 | 4 | $- | $- | $- | $289,461 |
| ST39 | Highbrook | Condition | $713,000 | 4 | $- | $- | $- | $909,989 |
| ST40 | Block Line | Condition | $438,900 | 2 | $- | $508,082 | $- | $- |
| ST41 | Ristau | Condition | $584,900 | 2 | $- | $677,095 | $- | $- |
| ST42 | Ottawa St | Condition | $426,300 | 4 | $- | $- | $- | $544,079 |
| ST43 | Conestoga Parkway | Condition | $820,100 | 4 | $- | $- | $- | $1,046,679 |
| ST44 | Bedford | Condition | $358,100 | 1 | $394,805 | $- | $- | $- |
| ST45 | Spring Valley SPS | Condition | $338,100 | 2 | $- | $391,393 | $- | $- |
| ST46 | Cameron | Condition | $515,600 | 2 | $- | $596,871 | $- | $- |
| ST47 | Breithaupt | Condition | $264,600 | 4 | $- | $- | $- | $337,704 |
| ST48 | Mcleod | Condition | $253,100 | 2 | $- | $292,995 | $- | $- |
| ST49 | Gateway Park | Condition | $1,535,100 | 1 | $1,692,448 | $- | $- | $- |
| ST50 | Brembel | Condition | $323,400 | 4 | $- | $- | $- | $412,749 |
| ST51 | Denlow | Condition | $316,100 | 4 | $- | $- | $- | $403,433 |

| Short Term Project ID | Project Name | Project Type | Recommended Budgetary Estimate | Priority | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|
| ST52 | Alpine | Condition | $387,500 | 3 | $- | $- | $471,009 | $- |
| ST53 | Hollinger | Condition | $444,200 | 1 | $489,731 | $- | $- | $- |
| ST54 | Hazel Glen | Condition | $326,600 | 2 | $- | $378,080 | $- | $- |
| ST55 | Stoke | Condition | $466,200 | 4 | $- | $- | $- | $595,002 |
| ST56 | Driftwood | Condition | $464,100 | 2 | $- | $537,254 | $- | $- |
| ST57 | Fisher Hallman | Condition | $571,200 | 3 | $- | $- | $694,297 | $- |
| ST58 | West Heights | Condition | $686,700 | 3 | $- | $- | $834,688 | $- |
| ST59 | Overlea | Condition | $410,600 | 2 | $- | $475,321 | $- | $- |
| ST60 | Stoneybrook | Condition | $463,100 | 2 | $- | $536,096 | $- | $- |
| ST61 | Barberry | Condition | $432,600 | 4 | $- | $- | $- | $552,119 |
| ST62 | Sandsprings | Condition | $528,200 | 4 | $- | $- | $- | $674,132 |
| ST63 | Cherry Hill | Condition | $243,600 | 3 | $- | $- | $296,097 | $- |
| ST64 | Coach Hill | Condition | $637,400 | 3 | $- | $- | $774,764 | $- |
| ST65 | Coach Hill | Condition | $389,600 | 3 | $- | $- | $473,561 | $- |
| ST66 | Selkirk | Condition | $414,800 | 2 | $- | $480,183 | $- | $- |
| ST67 | Highland | Condition | $379,100 | 2 | $- | $438,856 | $- | $- |
| ST68 | Paulander | Condition | $579,600 | 1 | $639,009 | $- | $- | $- |
| ST69 | Weichel | Condition | $466,200 | 3 | $- | $- | $566,669 | $- |
| ST70 | Belmont | Condition | $480,900 | 3 | $- | $- | $584,537 | $- |
| ST71 | Union | Condition | $335,000 | 3 | $- | $- | $407,195 | $- |
| ST72 | Union | Condition | $734,000 | 1 | $809,235 | $- | $- | $- |
| ST73 | Guelph | Condition | $429,500 | 3 | $- | $- | $522,060 | $- |
| ST74 | Wheatfield | Condition | $237,300 | 4 | $- | $- | $- | $302,862 |
| ST75 | Manitou | Condition | $1,046,900 | 2 | $- | $1,211,918 | $- | $- |
| ST76 | Upper Canada | Condition | $425,300 | 3 | $- | $- | $516,955 | $- |
| ST77 | Old Mill | Condition | $510,300 | 1 | $562,606 | $- | $- | $- |
| ST78 | Old Mill | Condition | $363,300 | 4 | $- | $- | $- | $463,673 |
| ST79 | Arrowhead | Condition | $533,400 | 1 | $588,074 | $- | $- | $- |

| Short Term Project ID | Project Name | Project Type | Recommended Budgetary Estimate | Priority | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|---|
| ST80 | Green Valley | Condition | $421,100 | 3 | $- | $- | $511,850 | $- |
| ST81 | Lower Canada | Condition | $189,000 | 2 | $- | $218,791 | $- | $- |
| ST82 | Dumfries | Condition | $503,000 | 4 | $- | $- | $- | $641,970 |
| ST83 | Heritage | Condition | $602,700 | 1 | $664,477 | $- | $- | $- |
| ST84 | Heritage | Condition | $458,900 | 2 | $- | $531,234 | $- | $- |
| ST85 | Nipigon | Condition | $604,800 | 1 | $666,792 | $- | $- | $- |
| ST86 | Burbank | Condition | $309,800 | 4 | $- | $- | $- | $395,392 |
| ST87 | King | Condition | $553,400 | 2 | $- | $640,630 | $- | $- |
| ST88 | Wyandotte | Condition | $524,000 | 3 | $- | $- | $636,925 | $- |
| ST89 | Morrison | Condition | $214,200 | 1 | $236,156 | $- | $- | $- |
| ST90 | Morrison | Condition | $734,000 | 1 | $809,235 | $- | $- | $- |
| ST91 | Burgetz | Condition | $360,200 | 3 | $- | $- | $437,825 | $- |
| ST92 | Broadview | Condition | $369,600 | 2 | $- | $427,858 | $- | $- |
| ST93 | Siebert | Condition | $297,200 | 3 | $- | $- | $361,248 | $- |
| ST94 | Greenfield | Condition | $473,600 | 2 | $- | $548,251 | $- | $- |
| ST95 | Broadmoor | Condition | $357,000 | 4 | $- | $- | $- | $455,633 |
| ST96 | Hillmount | Condition | $237,300 | 3 | $- | $- | $288,440 | $- |
| ST97 | Carrol | Condition | $319,200 | 3 | $- | $- | $387,990 | $- |
| ST98 | Traynor | Condition | $419,000 | 2 | $- | $485,045 | $- | $- |
| **Sub-Total Short-Term Projects** | | | **$48,547,200** | | **$14,678,853** | **$13,131,983** | **$15,463,550** | **$14,252,365** |

**Notes:**
1- Budget adjusted from Condition Assessment Reports per City direction

### Table 9-2: Medium Term Projects (2028 – 2031) Prioritization & Annual Costing

| Medium Term Project ID | Project Name | Project Type | Recommended Budgetary Estimate | Priority | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|
| MT1 | Dalewood | Capacity | $1,463,000 | 1 | $1,960,560 | | | |
| MT2 | Upstream of King St SPS | Capacity | $811,000 | 1 | $1,086,818 | | | |
| MT3 | New Dundee PS | Capacity | $776,000 | 2 | | $1,091,910 | | |
| MT4 | Robert Ferrie | Capacity | $805,000 | 3 | | | $1,189,352 | |
| MT5 | All Pumping Stations | Condition | $1,193,000 | - | $399,522 | $419,498 | $440,473 | $462,497 |
| **Sub-Total Medium-Term Projects** | | | **$5,048,000** | | **$3,446,899** | **$1,511,408** | **$1,629,825** | **$462,497** |

**Table 9-3: Data Acquisition & Management Programs Annual Costing**

| Data Acquisition Project ID | Project Name | Project Type | Recommended Budgetary Estimate | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|
| DA 1[1] | Trunk Sewer Condition Assessment | Data Acquisition | $540,270 | $148,912 | $156,358 | $164,175 | $172,384 |
| DA 2 | Forcemain Condition Assessment | Data Acquisition | $776,000 | $213,885 | $224,579 | $235,808 | $247,599 |
| DA 3 | I/I Reduction and Mitigation Program | Data Acquisition | $3,174,358 | $782,775 | $944,159 | $998,402 | $1,055,958 |
| DA 4 | Rainfall and Flow Monitoring Program | Data Acquisition | $1,849,181 | $275,625 | $615,278 | $647,920 | $682,347 |
| DA 5 | Sanitary Hydraulic Model Updates & Maintenance Program | Data Acquisition | $804,000 | $469,665 | $145,861 | $153,154 | $160,811 |
| DA 6 | Hydrogen Sulfide Monitoring Program | Data Acquisition | $316,000 | $207,270 | $74,088 | $77,792 | - |
| **Total Data Acquisition and Management Programs** | | | **$7,459,810** | **$2,098,132** | **$2,160,322** | **$2,277,252** | **$2,319,098** |

**Note:**
1 - Does not include current budget for hot spot flushing

**Table 9-4: Summary of Annual Costing for 2024 - 2031**

| | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|
| **Capital Projects** | $14,678,853 | $13,131,983 | $15,463,550 | $14,252,365 | $3,446,899 | $1,511,408 | $1,629,825 | $462,497 |
| **Data Acquisition** | $2,098,132 | $2,160,322 | $2,277,252 | $2,319,098 | - | - | - | - |
| **Total** | **$16,776,985** | **$15,292,305** | **$17,740,802** | **$16,571,463** | **$3,446,899** | **$1,511,408** | **$1,629,825** | **$462,497** |

In addition of the annual costing from 2024 to 2031, there is long-term projects (2032 – 2051) with the recommended budgetary estimate presented in **Table 9-5**.

**Table 9-5: Long-Term Projects (2032 - 2051)**

| Long Term Project ID | Project Name | Project Type | Recommended Budgetary Estimate |
|---|---|---|---|
| **LT1** | Manchester | Capacity | $1,126,149 |
| **LT2** | All Pumping Stations | Condition | $596,259 |
| **Sub-Total Long-Term Projects** | | | **$1,722,408** |

Note that the condition-based project the repair required is uncertain as the work is solely based on a CCTV score, as mentioned in **Section 7.5.** Therefore, to implement the condition-based projects, further review of existing CCTV videos should be undertaken and/or additional CCTV investigation completed to ascertain the precise nature of the required repair.

Moreover, with existing aging and outdated CCTV data, there is the expectation that increased CCTV work will populate projects in the medium-term category, thus it is recommended that the City budget accordingly for projects which have yet to be identified.

# 10 Innovation

The City of Kitchener is a progressive entity that has a rich history of innovation and technology, largely due to the presence of institutions like the University of Waterloo, Wilfrid Laurier University, and Conestoga College, and companies like Google, Communitech, Catalyst, Velocity Garage, and N Plus Networks. In 2019, the City was recognized with the Municipal World Innovation Award for its 2019-2022 Strategic Plan, and the 2023-2026 plan continues to outline its commitment to fostering a culture of innovation. The City's vision, "building a city for everyone where, together, we take care of the world around us – and each other.", serves as a guiding principle for its strategic initiatives.

One of the goals of the ISAN-MP is to continue in the spirit of the Smart Cities Challenge to pursue innovative, progressive, and emerging ideas that touch on the economy, environment, governance, and people to achieve a high quality of life for all the citizens and businesses of Kitchener. Building on the Corporate Asset Management Strategy (2016) and the Sanitary System Asset Management Plan (2018), a vision for advancing innovation for wastewater service delivery as part of a Smart Utility is discussed herein.

## 10.1 What is a Smart City and Smart Utility?

Internet of Things (IoT) devices and sensors, big data, artificial intelligence, and 5G are key components of a Smart City, but it's not the technology alone that makes a community more intelligent - it's how it is used to improve the lives of people. Whether seen or unseen, these applications are making communities safe, inclusive, sustainable, and resilient, while developing a smarter economy. Smart solutions can enhance performance within a singular system, such a sanitary utility infrastructure, but the goal is when those systems are planned and designed to securely work together.

A Smart Utility is the extension of the Smart City principles to the day-to-day operations and needs of the service utility, in this case the water, sanitary and stormwater utilities.

## 10.2 Foundation of a Smart Utility: Digital Transformation

As part of the Digital Kitchener Strategy (Link to www.kitchener.ca/en/strategic-plans-and-projects/digital-kitchener.aspx), investment is being made in innovative technologies and processes that support the goals of creating an inclusive, on-demand, connected, and innovative Smart City. Partnerships are being fostered that strengthen and sustain these initiatives, and progress is being actively communicated to bring the vision of a Digital Kitchener to life for every resident. For example, the Digital Kitchener Innovation Lab, located in the Communitech Hub, is a testament to the commitment to innovation.

The team explores how emerging technologies can improve city services like climate and air quality monitoring, multimodal traffic counting, and asset tracking. New ways to deliver great service are being experimented with and data-informed decision-making is being empowered.

Therefore, the City is already transitioning towards becoming a Smart Utility. Through the Sanitary System Asset Management Plan, data management through GIS inventory has been established, and initiatives such as rainfall and sewer flow monitoring and SCADA integration of pump stations and the treatment plant, alongside the development and maintenance of a Digital Twin computer model of the sewer system, form the initial backbone of the Smart Utility foundation.

Additionally, the City has a vision for aligning its Master Plan program towards a "One Water" Approach, where programs relating to water, wastewater and stormwater will be managed in an integrated manner to realize enhanced performance and efficiencies in program delivery. It also provides the ability to consider how the water systems can be managed within the context of the Circular Economy – a concept that focuses on conserving, reusing and repurposing resources, not just extracting, using, and disposing of them. This vision is consistent with the commonly used term "Utility of the Future" (UOTF) - defined by the World Bank as "*a future-focused utility that provides reliable, safe, inclusive, transparent, and responsive water and wastewater services through best-fit practices that allow it to operate in an efficient, resilient, innovative and sustainable manner*". **Figure 10-1** presents the intersection of the UOTF and the desired outcomes.

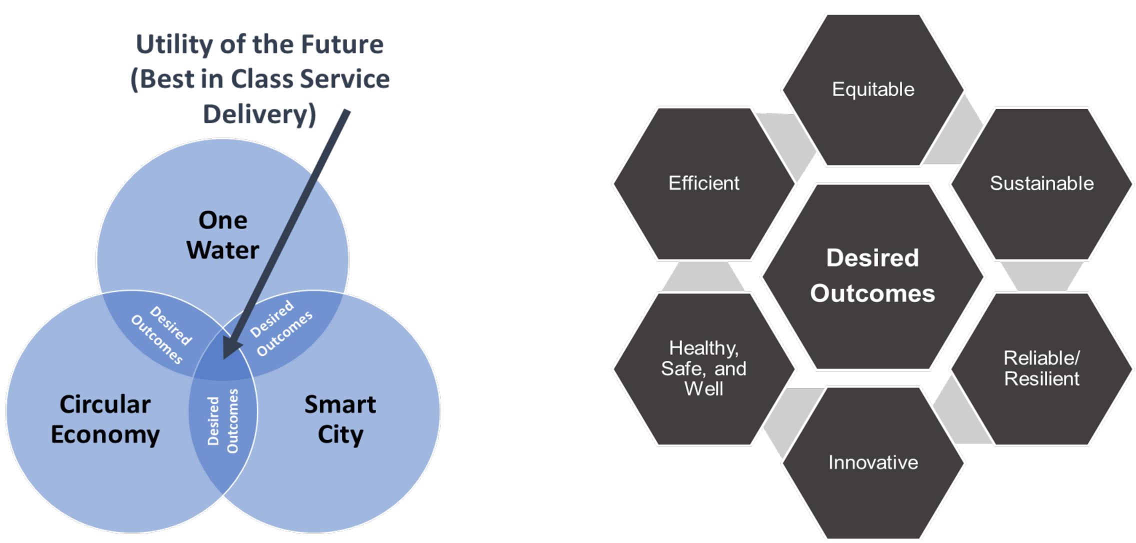


**Figure 10-1: Utility of the Future Components and Desired Outcomes**

The goal is to establish directions that will enable the City to evolve into a more modern and effective organization, with a focus on improving sustainability across various sectors - the economy, the environment, transportation, community development, and the overall organization - while striving towards enhanced community well-being. This goal is realized through the fortification of essential processes needed to address current challenges, while also developing forward-looking capabilities to stay ahead in a rapidly changing environment. This forms the foundation of the Utility of the Future.

## 10.3 The Smart Utility as the Digital Utility of the Future

The UOTF must be able to deliver better outcomes in a timely manner through better decision-making processes that are informed by better access to better data. Therefore, an emerging component within the UOTF arena is the growing reliance on data-driven decision-making and a move towards becoming a Digital Utility of the Future (Digital-UOTF). It must adapt its business operations to continually improve operations and capital efficiencies with innovative practices, technologies, and data-driven solutions.

The technological advances in cloud computing and communications, coupled with analytic capabilities, are enabling water utilities to better use the data they already have as well as plan and execute new ways of collecting data that lead to improving the efficiency of their operations. Through these data-driven approaches, the Digital-UOTF is reducing costs, mitigating risks, enhancing the customer experience, optimizing performance, and gaining efficiencies, all while improving level of service to the community, water quality (supply and receiving waters), and the benefiting environment more broadly.

Within the industry, more and more utilities are starting to adopt remote monitoring and system automation to achieve these objectives. Typically, installations commence with the trialing and adoption of smart metering and using sensors and monitors on watermains to manage leakage, water loss and pressure as well as metering of both flows and levels on collection systems to characterize trends in wet weather flow responses, monitor growth impacts, detect issues that necessitate operational and maintenance interventions, and/or generate alarms that indicate possible system failures and enaction of emergency response procedures. Technologies, such as drones are starting to be used for high-risk or hazardous tasks. Further opportunities exist with smart controls, where data management systems ingest SCADA, sensor and monitoring data in real time and incorporate analytics to then develop and automatically implement operational actions with decision support systems that require little human interaction other than operator oversight. The use of systems optimization and self-learning algorithms to enhance performance are also gaining favour amongst some, especially with energy and cost optimization programs.

With the above, and through the establishment of an enterprise data management and analytics platform as depicted in **Figure 10-2**, broader business insights beyond just system operations can now be generated in real time through computer assisted analytics, including machine learning and artificial intelligence, that can be applied to multiple and disparate data sets.

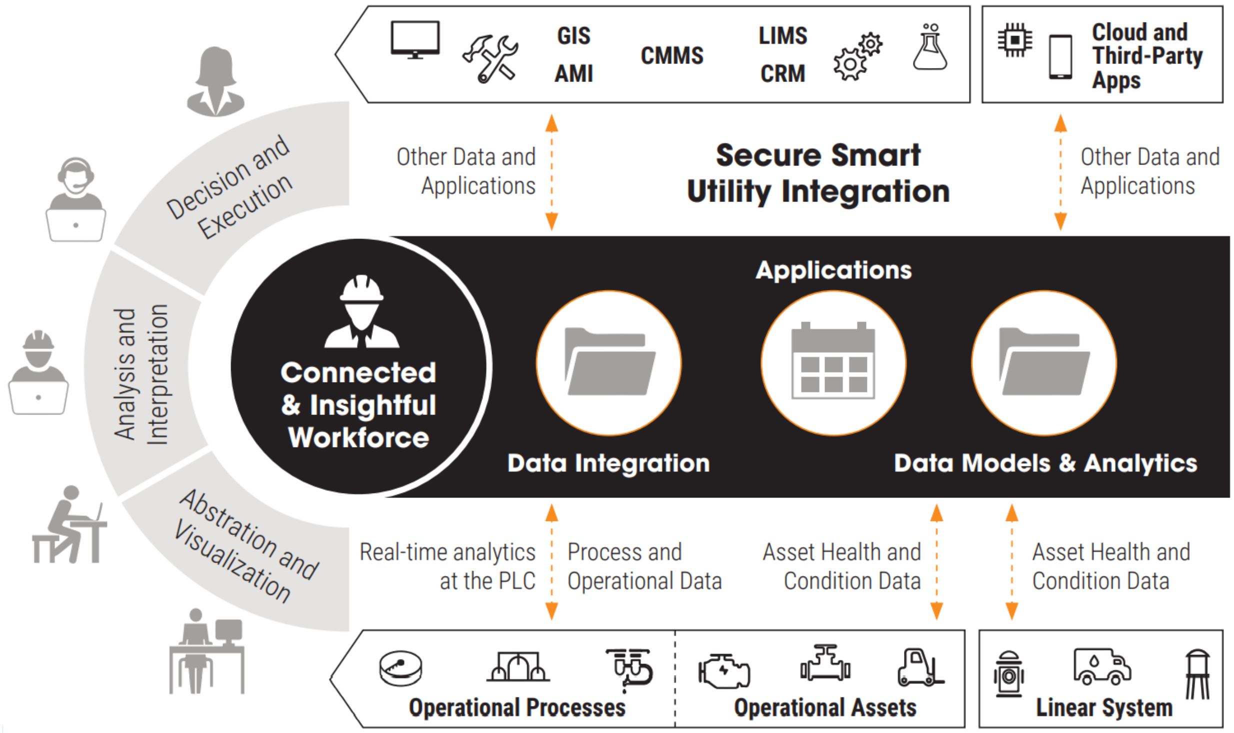


**Figure 10-2: Digital UOTF Integration with Enterprise Data Management and Analytics Platform**

Such systems enable the integration of data source and interoperability of applications for near-real-time decision-making. This includes integrating business (GIS, Computerized Maintenance Management System [CMMS], Customer Relationship Management [CRM], Advanced Metering Infrastructure [AMI], Laboratory Information Management [LIMS]) and operational (SCADA) technologies for application use cases that are needed for effective business process execution, data and information needs, and the functional needs of the organization. This provides for the following key benefits:

- Enables a connected & insightful workforce
- Enhances the ability to abstract, share, and visualize information
- Enhances the ability to analyze and interpret data
- Provides for better informed decision making and program/project execution

## 10.4 Energy Optimization and Renewable Energy

The City of Kitchener recognizes the critical role of sustainable energy sources for a prosperous future. Drawing inspiration from the momentum of the Smart Cities Challenge, the City is harnessing innovative technologies and practices to enhance energy efficiency across all its operations. This includes the integration of energy-saving technologies in municipal buildings, the optimization of energy use in water and wastewater facilities, and the deployment of energy management systems to monitor and control energy consumption.

In the realm of renewable energy, the City's commitment goes beyond mere optimization. It is actively exploring and implementing solutions involving solar, wind, and geothermal energy. Furthermore, the City is investigating the potential for energy recovery from wastewater conveyance and treatment processes, thereby transforming a waste product into a valuable energy resource.

The City of Kitchener should continue efforts to invest in energy-saving technologies and optimize energy use across all operations, including collection systems. Pumping wastewater is among the highest energy users in the City. Energy usage and performance of energy intensive equipment should be monitored over time, with research conducted into ways of optimizing and reducing energy use, such as identifying energy-saving opportunities during design of capital improvement projects. Opportunities for heat recovery in wastewater systems should continue to be explored, with consideration of concurrent District Energy initiatives such as the WR Community Energy evaluation of Downtown Kitchener. The WR Community Energy 2021 report "Wastewater Heat Recovery in Waterloo Region", identified three potential wastewater heat recovery opportunities in the trunk sewers of Kitchener where dry weather flow rates are greater than 100 L/s, offering significant natural gas offset potential with the associated benefit to greenhouse gas emission reduction.

The City should consider the policy recommendations of the WR Community Energy 2021 report including, **Increase Staff Awareness and Knowledge** of the energy potential in the system and the emerging technologies, **Develop a Thermal Database** of trunk sewer temperatures collected via the proposed Data Acquisition and Flow Monitoring Programs, and **Coordination** with area and regional municipalities to regulate the withdrawal of thermal energy from the sewer systems and to work in tandem to optimize the resource and protect downstream treatment process requirements. This should extend to other leading municipalities in Ontario, such as the Region of Peel and City of Toronto, to share lessons-learned of implementing new heat recovery technologies. Furthermore, collaboration with local institutions and businesses can drive innovation and sustainability, maintaining transparency and progress towards sustainability goals.

## 10.5 Recommendations

The following section presents a set of recommendations, derived from this review of the City of Kitchener's ongoing initiatives, strategies, and digital transformation efforts. These suggestions aim to further propel the City's journey towards becoming a Smart Utility:

- Continue Investing in Digital Transformation: The City should continue its investment in digital technologies and processes that support the goals of creating an inclusive, on-demand, connected, and innovative Smart City. This includes further development of the Digital Kitchener Innovation Lab and the exploration of emerging technologies related to wastewater collection systems.
- Develop a Comprehensive Smart Utility Strategy: As the City transitions towards becoming a Smart Utility, it should develop a comprehensive strategy that outlines its goals and objectives. This strategy should address the challenges faced by the organization and provide a roadmap for advancing the Utility of the Future vision. This should include identification of data management and analytics structure that integrates and supports the existing Corporate Asset Management Strategy and Sanitary System Asset Management Plan, that strives for consistency and transparency in digital data acquisition, hosting, organization, interpretation, and computation of decision-making metrics, that remains secure and flexible for adapting to future inputs and innovations. Key component elements that are inputs into the Strategy include the recommended Data Acquisition, Flow and Thermal Monitoring, Infiltration and Inflow Mitigation, Computer Model Maintenance, Trunk/Forcemain Investigation, and Hydrogen Sulfide Monitoring and Dosing Programs, alongside existing Asset / Operational and Energy Management initiatives (GIS, SCADA, CCTV, flushing etc.). Additionally, the recommendations from the WR Community Energy 2021 report on the burgeoning practice of heat recovery from sanitary sewers as a source of energy should be considered as a pilot program as part of the strategy, building off the foundational work of the report and other municipalities such as the Region of Peel and City of Toronto. The addition of thermal sensors is readily available as part of the sewer flow monitoring program to provide initial input to future program potential.
- Promote a Data-Informed Culture: The City should promote a culture of data-informed decision making. This includes training staff to use data effectively across departments and investing in tools that facilitate data acquisition, management, analysis, and visualization.
- Evaluate and Adapt: The City should regularly evaluate its progress and adapt the Innovation Strategy as needed. This includes monitoring key performance indicators, soliciting feedback from staff and residents, and staying abreast of emerging technologies and best practices, while maintaining IT security protocols.

These recommendations aim to support the City of Kitchener in its journey towards becoming a digitally advanced and interconnected urban environment. They align with the overarching goal of becoming a future-ready Smart Utility.

# 11 Closing

In conclusion, the Integrated Sanitary Master Plan (ISAN-MP) developed for the City of Kitchener is a comprehensive guide for the City's future sanitary infrastructure needs up to 2051.

The consultation process was vital in ensuring the plan's success, involving agencies, stakeholders, the public, and Indigenous Nations. Regular reviews of growth are essential to identify system constraints and to conduct regular Master Plan updates.

The problem and opportunity statement identified the need for managing the city's significant sanitary sewer infrastructure to ensure its resilience and sustainability for future generations.

The alternative solutions considered included doing nothing, shaping community growth, infrastructure updates, and data acquisition, flow monitoring, and inflow & infiltration mitigation programs.

The recommended solutions prioritized community growth, infrastructure upgrades, and data acquisition programs. These solutions were ranked based on their urgency and included cost estimates for budgeting purposes.

The cost estimate provided a Class D estimate of the probable costs, calculated in 2022 dollars. These estimates can help the City plan its budget, which is updated every four years.

The implementation and timing plan outlined the schedule of projects and data collection, with costs adjusted for inflation based on the year of implementation. It also spread out the capital works based on their importance to provide a yearly cost for the City.

This Master Plan is a crucial step towards a resilient and sustainable future for the City of Kitchener, underscoring the importance of proactive planning and regular review in managing significant sanitary sewer infrastructure.

This Master Plan summarizes Phase 1 and Phase 2 of the MCEA planning process, as outlined in the 2015 MCEA Document. Provided that no Section 16 Order requests are received, the City may proceed 30 days following the completion of the public review period.

# APPENDICES

# Appendix A Consultation