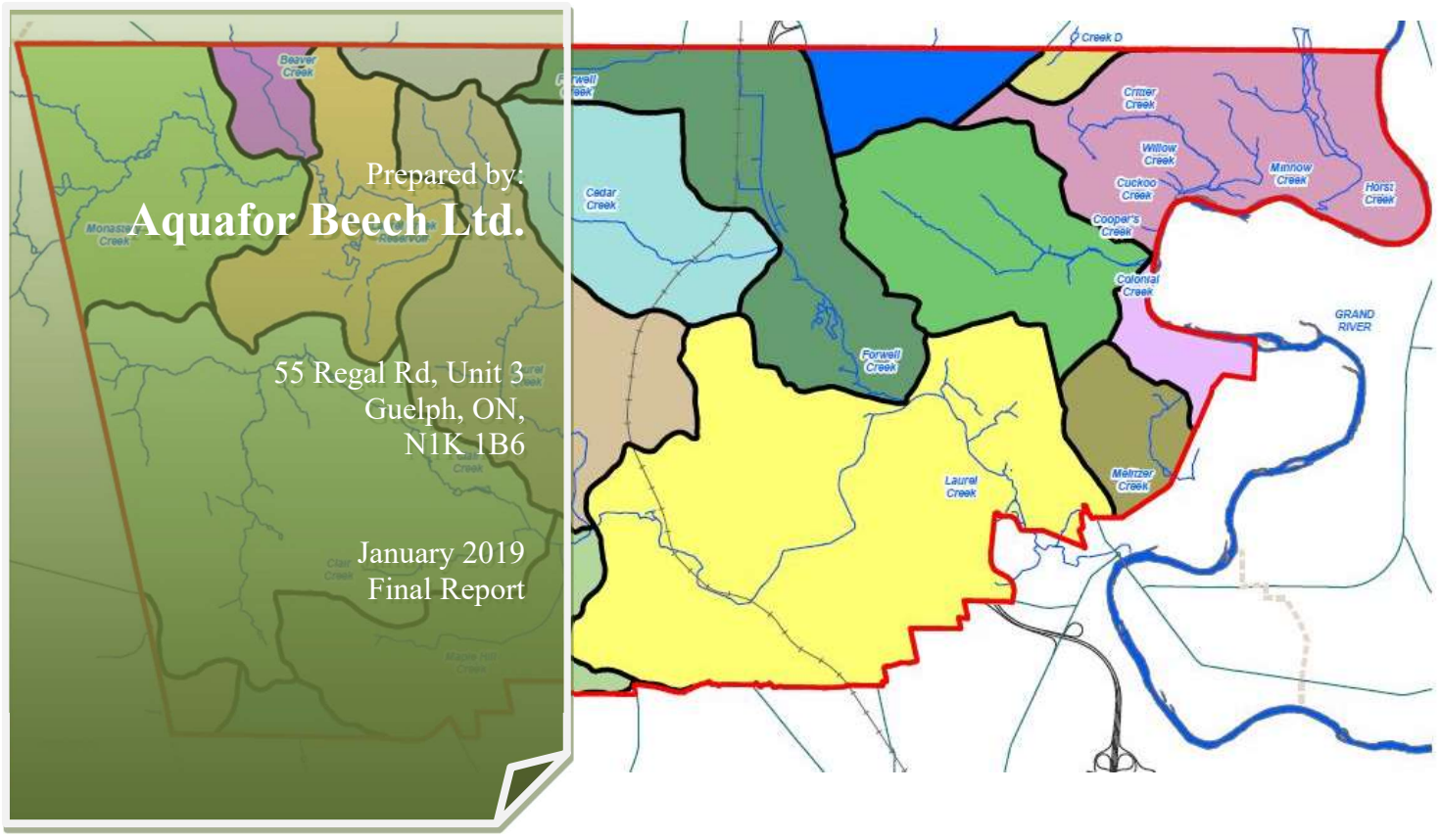
Prepared for:
City of Waterloo

STORMWATER MANAGEMENT MASTER PLAN:
MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

Existing Conditions Report



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January 2019
Final Report

Contents

List of Terms, Definitions and Acronyms

SWM-MP	Stormwater Master Plan
SWM	Stormwater Management
WRS	Water Resource Sustainability
GRWMP	Grand River Water Management Plan
WWTP	Wastewater Treatment Plant
WTP	Water Treatment Plant
WHPA	Well Head Protection Area
ICA	Issue Contributing Area
BMP	Best Management Practice
SARA	Species at Risk Act
ECA	Environmental Compliance Approval
CofA	Certificate of Authorization
MOECC	Ministry of the Environment and Climate Change
MNRF	Ministry of Natural Resources and Forestry
DFO	Department of Fisheries and Oceans
LID	Low Impact Development
GI	Green Infrastructure
OP	Official Plan
ROP	Regional Official Plan
RMOW	Regional Municipality of Waterloo
PPS	Provincial Policy Statement
SPP	Source Protection Plan
SWS	Subwatershed Study
EA	Environmental Assessment
MEA	Municipal Class Environmental Assessment
AMA	Adaptive Management Approach
AEM	Adaptive Environmental Management
OWRA	Ontario Water Resources Act
NPS	Urban Non-point Source
ERA	Ecological Restoration Areas
BMP	Best Management Practice
LOS	Level of Service
GRCA	Grand River Conservation Authority
Cms	Cubic Metres per Second
EMC	Event Mean Concentration
PWQO	Provincial Water Quality Objectives
NHS	Natural Heritage System
ESPA	Environmentally Sensitive Policy Area
ANSI	Area of Natural and Scientific Interest
OGS	Oil and Grit Seperator
GWCS	Ground Water Collection Systems
GIS	Geographical Information Systems
SFU	Single Family Unit
WEMP	Water Efficiency Master Plan

1.0 INTRODUCTION

The objective of the Stormwater Management Master Pan (SWM-MP) is to develop a preferred stormwater management strategy for the City of Waterloo. Within the City of Waterloo there are eighteen (18) distinct subwatersheds. Each of these areas has unique environmental and infrastructural conditions. In order to tailor an effective approach to all subwatersheds within the City of Waterloo, a comprehensive understanding of existing conditions is necessary.

2.0 PURPOSE

The purpose of this report is to provide a comprehensive technical understanding of the natural environment and infrastructure within the City of Waterloo in support of the completion of a municipal Stormwater Master Plan (SWM-MP), following a Master Planning approach in accordance with the *Environmental Assessment Act* as outlined by the Municipal Engineer's Association Municipal Class Environmental Assessment (MEA), October 2000, as amended in 2007 and 2011.

The findings of the Existing Conditions Report are used as a foundation for the SWM-MP and decisions regarding stormwater management (SWM) policy and priority projects for the next ten (10) to fifteen (15) years.

The Existing Conditions Report provides a thorough summary of the City of Waterloo's:

- Land-Use (Section 3.2)
- Physiography (Section 3.3)
- Geology (Section 3.4)
- Surficial Soils and Infiltration Potential (Section 3.5)
- Hydrogeology (Section 3.6)
- Hydrology (Section 3.7)
- Fluvial Geomorphology (Section 3.8)
- Aquatic Ecology (Section 3.9)
- Natural Heritage (Section 3.10)
- Stormwater Management Infrastructure (Section 3.11)
- Water Supply (Section 3.12)
- Wastewater (Section 3.13)

3.0 STUDY AREA DESCRIPTION

This chapter summarizes the existing environmental, surface and groundwater conditions as well as the relevant water, wastewater and stormwater conditions and assets within the City of Waterloo. The summary is based on available information extracted from background reports such as watershed studies and monitoring programs, GIS mapping and City databases.

In preparation of the existing conditions, the following background studies were reviewed and summarized wherever relevant information existed:

Region and Agency

1. Grand River Watershed Management Plan (GRCA, 2013)
2. Grand River Fisheries Management Plan (GRCA, 2005)
3. Grand River Watershed Characterization Report (2008)
4. Grand River Source Protection Area (Plan) – Approved Assessment Report (2012)
5. Grand River Source Protection Plan (SPP) (MOECC Approved 2015)
6. Water Quality Targets to Support Healthy and Resilient Aquatic Ecosystems in the Grand River Watershed (2013)
7. Nutrient and Sediment Sources in The Grand River Watershed (2013)
8. Assessment of Future Water Quality Conditions in the Grand and Speed Rivers (2012)
9. Water Quality in the Grand River Watershed: Current Conditions & Trends (2003-2008)

Subwatershed Studies and Master Drainage Plans

1. North Waterloo Scoped Subwatershed Study (2013)
2. Forwell Creek Functional Drainage Study Class EA (2001)
3. Laurel Creek Flood Control Project Class EA (1990)
4. Eastbridge District North Master Drainage Plan (1997)
5. Albert/MacGregor Drainage Study (2008)
6. Northland Creek Drainage Study (1985)
7. Colonial Creek Rehabilitation Plan Functional Design Study (1995)
8. Scoped Subwatershed Study – Portions of Subwatersheds 307 and 314 Laurel Creek Watershed (2004)
9. Laurel Creek Watershed Study (1992)
10. Requirements for Subwatershed Plans in the Laurel Creek Watershed (1994)
11. Clair Creek Subwatershed Study (1977)
12. Melitzer Creek Master Drainage Plan (1989)
13. Colonial Creek Watershed and Basin A and B Maser Drainage Plan (1990)
14. Clair Creek Subwatershed 317 Drainage Study (2003)
15. Subwatershed Management Plans #313 and #309 (1999)
16. Subwatershed 311 Subwatershed Plan (1995)
17. Subwatershed 314 Management Plan (1996)

City of Waterloo – Master Plans and Technical Documents

1. Park Strategy, City of Waterloo (Under Development)

2. Waterloo Park Master Plan, City of Waterloo (2009)
3. Transportation Master Plan, City of Waterloo (2011)
4. Asset Management Plan, City of Waterloo (2016)
5. Stormwater Utility and Credit Program By-Law, City of Waterloo (By-Law No. 2012-125)
6. Greenlands Network Implementation Guideline, Region of Waterloo (2016)
7. Grand River Water Management Plan – Stormwater, GRCA (2014)
8. Urban Design Manual, City of Waterloo (2010)

3.1 General

The City of Waterloo is located in the center of the Grand River Watershed, and is bounded by the middle reaches of the Grand River itself along a significant portion of the eastern municipal boundary. **Figure 3.1.1** shows the location of the study area in the context of the Grand River Watershed. **Figure 3.1.2** illustrates the municipal boundaries of the City of Waterloo and represents the SWM-MP study area.

As a whole, the Grand River extends 298 km from its headwaters north of Dundalk (40 km south of Georgian Bay) in Dufferin County to Port Maitland on Lake Erie. It is the largest inland river system in Southern Ontario (6500 km^2) (GRFM, 2005). Water falls 352 meters from the headwaters to the lake and takes 10 days to reach Lake Erie. The Grand River watershed is home to a growing population of close to one million people. There are five major urban areas - Kitchener, Waterloo, Cambridge, Guelph and Brantford – as well as many towns and villages such as Grand Valley, Drayton, Arthur, Elora, Fergus, Elmira, Paris, St George, Caledonia, Cayuga and Dunnville. The watershed is also home to some of the most intensively farmed lands in the province.

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.1.1
STUDY AREA CONTEXT

- Study Area
- Municipal Boundaries
- Watercourse
- Region of Waterloo
- GRCA Watershed

0 5 10 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.1.2
SUBWATERSHEDS

- Study Area
- Watercourse
- Subwatershed Boundary

Subwatersheds

- Alder Creek
- Beaver Creek
- Cedar Creek
- Clair Creek
- Colonial Creek
- Conestogo River - Lower
- Forwell Creek
- Grand River Tributaries North
- Grand River Tributaries South
- Laurel Creek Reservoir
- Lower Laurel Creek
- Maple Hill Creek
- Martin Creek East
- Martin Creek West
- Melitzer Creek
- Middle Laurel Creek
- Monastery reek
- Schneider Creek

0 0.5 1 Kilometers

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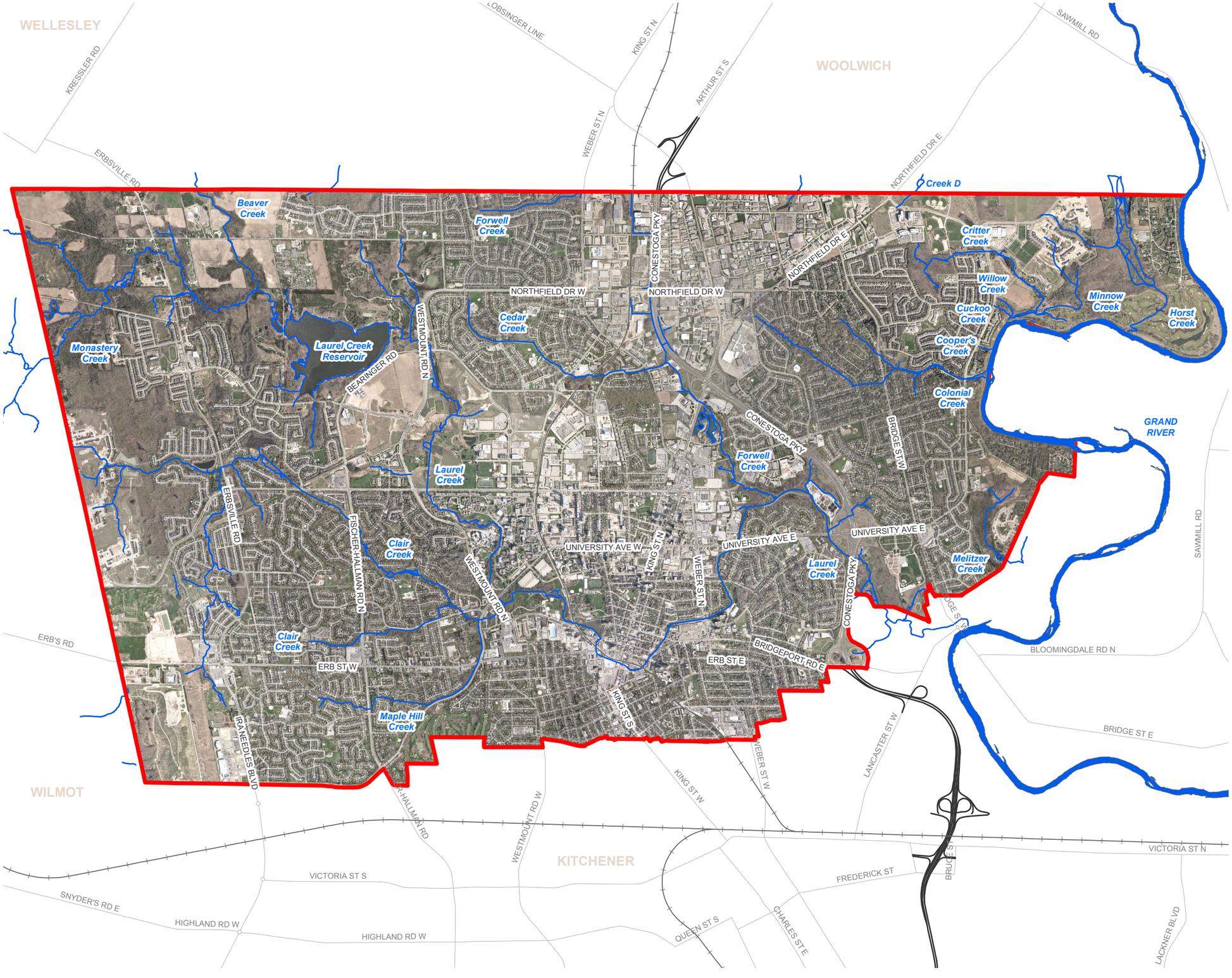
Base data provided by The City of Waterloo, 2017 and Grand River Conservation Authority, 2017.

Date: May 2017



MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.1.3
STUDY AREA

Study Area
Watercourse

0 0.5 1 Kilometers

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Base data provided by The City of Waterloo, 2017.

Date: May 2017

Located in the Region of Waterloo, the City of Waterloo is one municipality of the Tri-City area along with the City of Kitchener and the City of Cambridge, both located further south (**Figure 3.1.1**). The City of Waterloo covers approximately 65.2 km^2 of land. As of the 2016 Canadian census, the City of Waterloo 's population was of 134,600[1] with an expectation to increase by almost 40,000 residents by the year 2031[2], representing more than 19% of the total population of the Waterloo Region.

The City operates under a two-tier system of local government. As the upper tier, the Region of Waterloo operates region-wide water management services such as water supply and water services, in addition to waste management, planning, social services, public health, Emergency Medical Services/Land ambulance, Regional roads and Traffic signals and signs, public and specialized transit and the Region of Waterloo International Airport. Along with its municipal neighbors, the City makes up one of six (6) second tier municipalities in the Region. In that role, the City is responsible for water management services such as water distribution, sanitary and water connections and stormwater management among other services and programs specific to the City and its community.

The City is composed of 18 subwatersheds, with approximately 92 km of watercourses. Watersheds along with total catchment areas and stream length are listed in **Table 3.1.1** and shown on **Figure 3.1.3**.

Table 3.1.1: Watersheds in the City of Waterloo

Watershed	Drainage Area (ha) Within the Municipal Boundaries	Stream Length (km) Within the Municipal Boundaries
Alder Creek	46.1	0.1
Beaver Creek	85.8	1.6
Cedar Creek	356.9	2.9
Clair Creek	1013.0	17.8
Colonial Creek	436.7	5.2
Conestogo River - Lower	35.1	0.3
Forwell Creek	508.5	9.2
Grand River Tributaries North	540.9	12.9
Grand River Tributaries South	82.7	0.0
Laurel Creek Reservoir	358.2	7.8
Lower Laurel Creek	1212.0	10.6
Maple Hill Creek	346.8	3.3
Martin Creek East	142.0	0.1
Martin Creek West	74.3	0.2
Melitzer Creek	134.5	1.5
Middle Laurel Creek	609.7	8.9
Monastery Creek	488.8	9.7
Schneider Creek	51.1	0.0
TOTAL	**6,523.1**	**91.9**

[1] Region of Waterloo Estimate using 2016 Canadian Census data, includes students and other foreign/temporary residents.

[2] Region of Waterloo – Regional Official Plan, 2015.

3.2 Land-use

The following section describes the existing land-use with the City of Waterloo and the proposed development and intensification areas.

3.2.1 Existing Land-use

The City of Waterloo is characterized by a mixture of land-uses. Generally, agricultural lands remain only along the periphery of the City, both along the Grand River, in the northwest and in the southwest. Lands that are zoned industrial are clustered primarily in the north and central area of the City between Weber Street North and Northfield Drive East but smaller clusters can be found further south. Approximately, 34% of the City is occupied by private residential property (i.e. residential development areas excluding the municipal right-of-way).

The City is home to a large area of lands zoned as institutional, these are largely located east of Westmount Road North and South of Bearinger Road extending to University Avenue West in the South and the Laurie Trail in the East.

North of Columbia Street West the industrial lands extend west to Fischer-Hallman Road. The industrially zoned lands include the David Johnston Research & Technology Park, the University of Waterloo and Wilfred Laurier University. Waterloo's commercial lands are primarily located along King Street with other commercial hubs at major intersections and along major transitways.

Land use designations within the City of Waterloo per the City's Official Plan are summarized in **Figure 3.2.1** and illustrated in **Figure 3.2.2**.

Figure 3.2.1 - Existing City of Waterloo Land Use Designations Per Official Plan

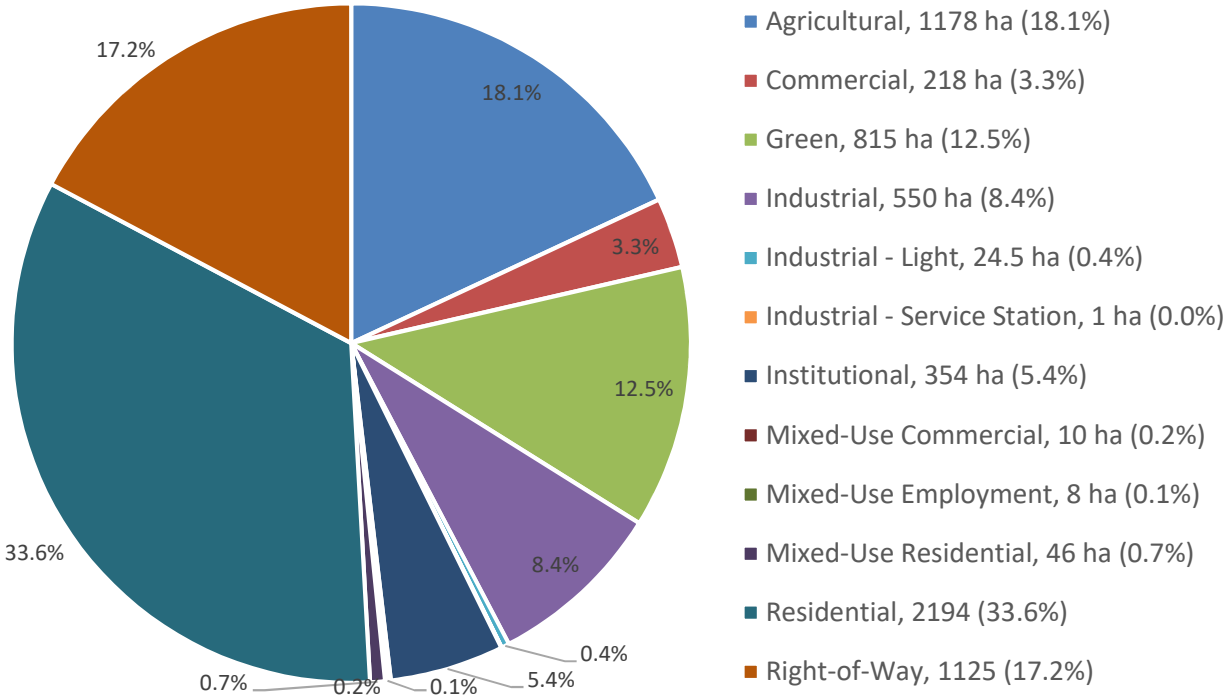

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Figure 3.2.2
LAND USE

Study Area
- Study Area
- Watercourse

Land Use
- Agricultural
- Commercial
- Green
- Industrial
- Industrial - Light
- Industrial - Service Station
- Institutional
- Mixed-Use Commercial
- Mixed-Use Employment
- Mixed-Use Residential
- Residential

0 0.5 1 Kilometers

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Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.2.2 Proposed Development and Intensification Areas

In accordance with Ontario legislation, the City of Waterloo, like all municipalities, is charged with ensuring that they direct proper and orderly development within their urban boundary. The City has many tools to achieve these requirements, including the Regional Official Plan and the City of Waterloo Official Plan.

The City's Growth Management Division (GMD) develops planning policies, including the City's Official Plan, to guide growth and change in the City. The GMD also develops district and neighbourhood plans and undertakes special studies including statistical analysis, environmental initiatives and heritage and community improvement planning.

Through the City's Official Plan, Designated Greenfield Areas are identified as growth areas however it is identified that as the supply of land within Designated Greenfield Areas diminishes, it is anticipated that a greater proportion of overall growth will be accommodated through intensification. Designated Greenfield Areas are identified in **Figure 3.2.3**.

Intensification will be concentrated in Built-Up Areas. The OP identifies a hierarchy of designated Nodes and Corridors that are anticipated to accommodate a significant proportion of the City's population and employment growth over the life of the OP. The hierarchy is:

1) **Uptown Waterloo Urban Growth Centre**
   The Uptown Waterloo Urban Growth Centre is the Primary Node within the City and will be planned to accommodate a wide range of commercial, employment, social, cultural, entertainment, accommodation, open space, recreational, institutional, as well as residential uses, facilities and spaces. The Uptown Waterloo Urban Growth Centre is intended to serve as a destination within the community as well as fulfilling a local service and administrative function for surrounding neighbourhoods. The Uptown Waterloo Urban Growth Centre is identified in **Figure 3.2.4**. The Uptown Waterloo Urban Growth Centre is also identified as the Primary Node in **Figure 3.2.5**.

2) **Major Nodes**
   According to the OP, Major Nodes are planned as medium high to high density mixed-use areas that accommodate a range of uses which may include residential, commercial, employment, social, cultural, recreational and institutional uses. Commercial uses that provide for the day-to-day and weekly shopping needs of several surrounding neighbourhoods will be encouraged and, where appropriate, Major Nodes shall be planned to accommodate small to medium-sized food stores, with the objective that all residents will have access to a food store within two kilometres of their residence. Employment areas that are located within Major Nodes will be planned to support Major Nodes as a destination, and in order to provide such support, are not contemplated to be converted to non-employment uses. Major Nodes are identified in **Figure 3.2.5**.

3) Major Corridors

According to the OP, Major Corridors generally connect a series of Major Nodes and/or the Primary Node and have the greatest capacity and potential to support higher frequency transit. As such, they will be planned to accommodate medium-high to high-density uses to provide for sufficient future population and employment growth to support planned transit service levels. Major Corridors are identified in **Figure 3.2.5**.

4) Minor Nodes

According to the OP, Minor Nodes are planned as medium to medium-high density mixed-use areas that accommodate a range of uses which may include residential, commercial, employment, social, cultural, recreational and institutional uses. Minor Nodes generally include neighbourhood-serving commercial centres that provide for the day to day and weekly shopping needs of the surrounding neighbourhood and, where appropriate, shall be planned to accommodate small to medium-sized food stores, with the objective that all residents will have access to a food store within two kilometers of their residence. Where lands within a Minor Node are adjacent to Low Density Residential areas, height and/or density will be limited as defined by this Plan and the Zoning By-Law. Minor Nodes are identified in **Figure 3.2.5**.

5) Minor Corridors

According to the OP, Minor Corridors connect a series of Major Nodes, Minor Nodes and/or the Primary Node. Planned land uses within Minor Corridors will be predominantly medium to medium high density residential with some limited areas having a planned function other than residential. A limited amount of commercial uses are permitted as set out in the applicable land use designations. Where lands within a Minor Corridor are adjacent to lands designated as Low Density Residential, height and/or density will be limited as defined by this Plan and the Zoning By-Law. Minor Corridors are identified in **Figure 3.2.5**.

6) Major Transit Station Areas

According to the OP, Major Transit Station Areas are the areas including and around proposed rapid transit stations within the City of Waterloo. Planned land use designations within Major Transit Station Areas, as shown in **Figure 3.2.6** will be selected to encourage transit ridership. In general, planned land use designations within these areas will include medium to high density residential, commercial and employment uses.

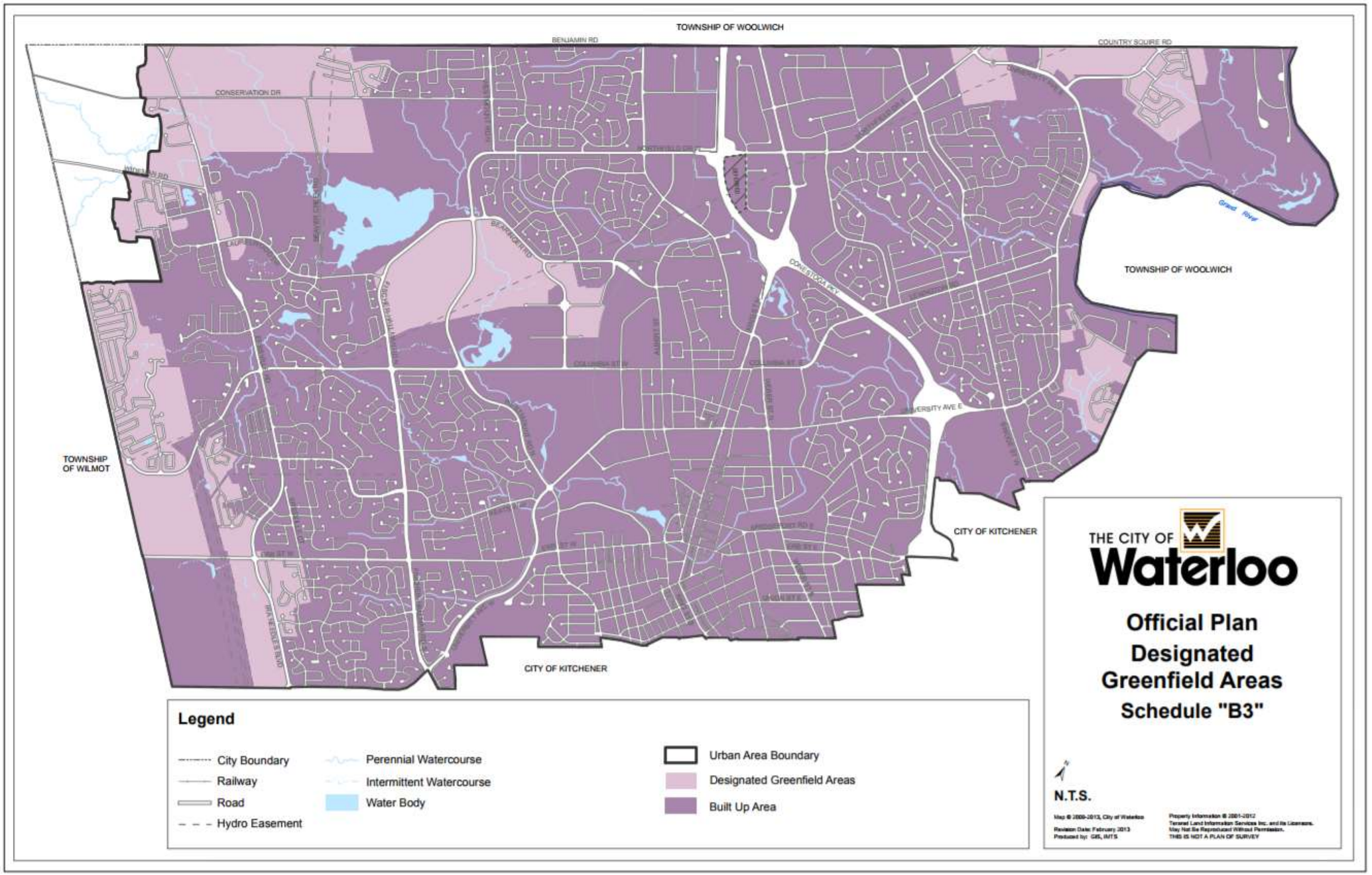

Figure 3.2.3 Designated Greenfield Areas per City of Waterloo Official Plan

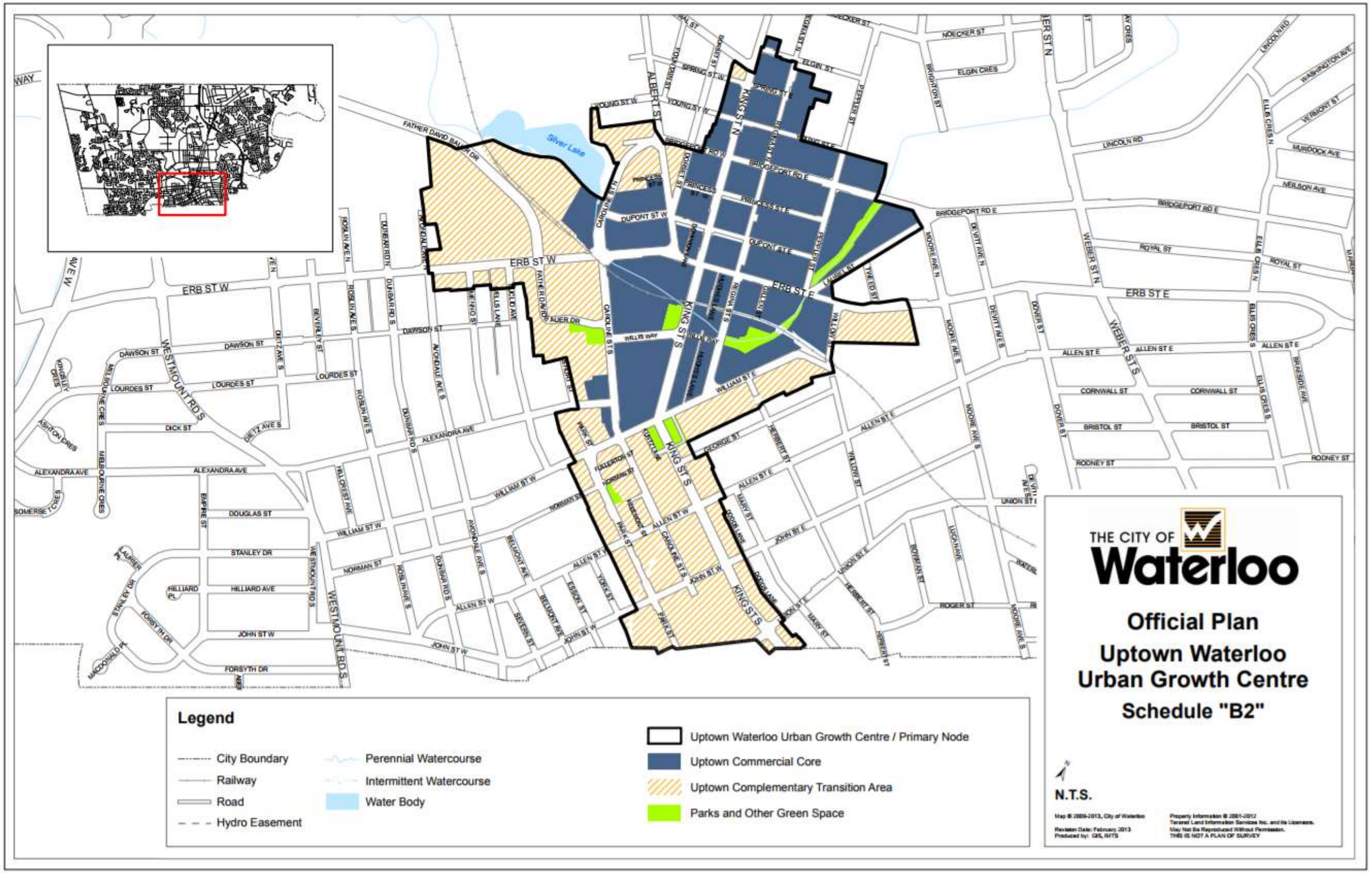

Figure 3.2.4 Uptown Waterloo Urban Growth Centre per City of Waterloo Official Plan

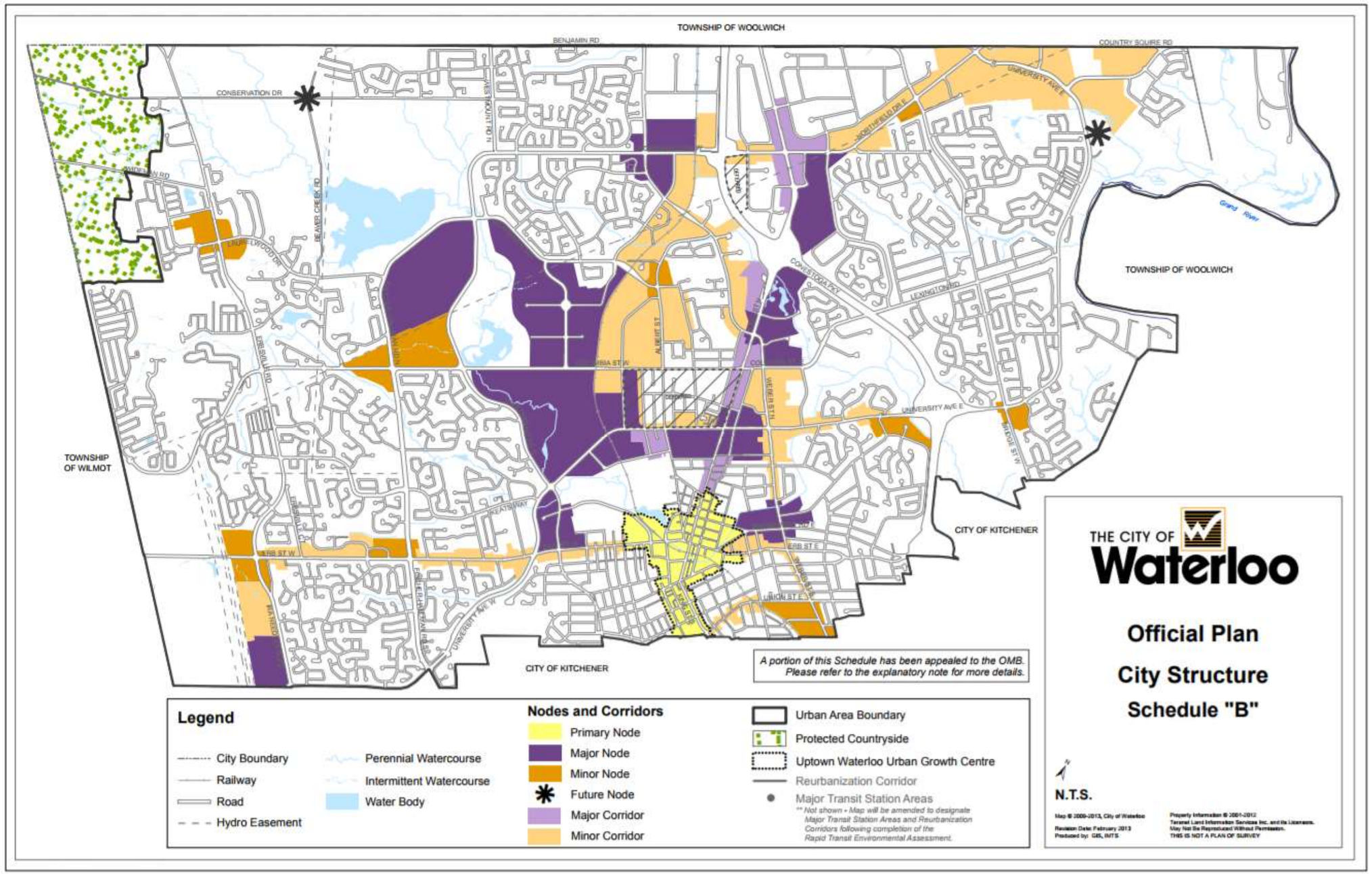

Figure 3.2.5 Nodes and Corridors for Intensification per City of Waterloo Official Plan

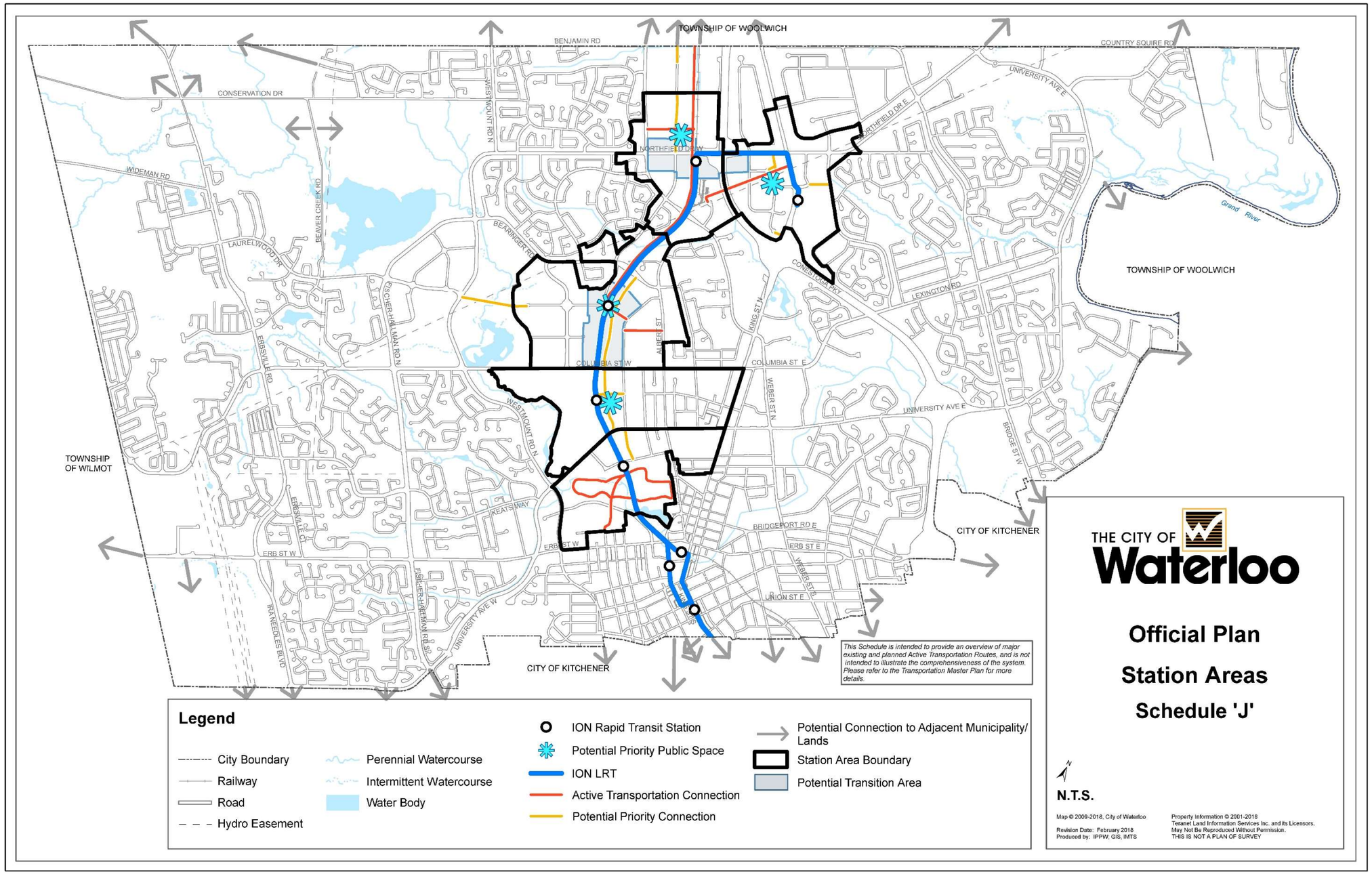

Figure 3.2.6 Major Transit Station Areas per City of Waterloo Official Plan

3.3 Physiography

Physiography, also commonly referred to as physical geography, is the study of the physical features of the earth's surface and the classification, mapping and grouping of landforms based on their geologic structures and age. The following information was extracted and summarized from existing sources including, but are not limited to those listed in **Section 3.0**.

There are three (3) dominant physiographic regions within the City's municipal boundary per the Grand River Source Protection Area Assessment Report (2015). The City is bisected from northwest to southeast by the transition between a large Oxford Till deposit extending northeast and a large Waterloo Hills deposit extending southwest. Along the Grand River, fluvial deposits on the western periphery of the Guelph Drumlin Field dominate the landscape.

Within the Oxford Till Plain, all of the blocks of natural habitat of any significant size are wetlands. Soils and drainage in this region are considered to be good.

The Waterloo Hills region is characterized by sand hills, gravel terraces, and many swampy valleys. The soils of the hilly areas are rich and well drained. Water from precipitation infiltrates in the sand hills and discharges as groundwater to the headwater wetlands and source areas of the streams, creating fens, bogs, kettle lakes, swamps, marshes, and baseflow in streams. Generally following the boundary of the Waterloo Hills Region within the City is a portion of the Waterloo Moraine. The Waterloo Moraine is located within the central area of the Grand River watershed and is approximately 400 km^2 in size. The Waterloo Moraine is the dominant topographic feature in the area, trending in a general northwest-southeast direction. The topography of the Waterloo Moraine consists of gently rolling to undulating hills, with local areas of pronounced relief in the central area of the moraine and flatter, less pronounced relief along its flanks.

The general landform pattern in the Guelph Drumlin Field consists of drumlins or groups of drumlins fringed by gravel terraces and separated by swampy valleys. Tributaries of the Grand River flow through these valleys. The dominant soil materials are the stony tills of the drumlins and deep gravel terraces. This region has the most extensive network of forest habitat in the watershed. Large forests typically cover the valleys between the numerous hills and drumlins. The areas of lowest elevation are swamp and floodplain.

3.4 Geology

3.4.1 Bedrock Geology

Beneath the Grand River Watershed, bedrock formations generally outcrop or subcrop in long parallel bands of varying width, aligned in a north-west to south-east direction. Bedrock outcrops are most commonly found in the central-eastern and southern areas of the watershed. Within the central-eastern area, outcrops, which are commonly found along river valleys, generally consist of the Guelph and Amabel Formations. Guelph Formation is one of the most important bedrock formations in terms of groundwater supply in the Grand River watershed. It is the uppermost bedrock layer over a large portion of the watershed, stretching in a 30 km wide swath from Dundalk to Carluke (east of Brantford). Several municipal wells for Regional Municipality of Waterloo extract water from this bedrock unit (Grand River Source Protection Area Assessment Report, 2015).

3.4.2 Quaternary Geology

The understanding and interpretation of the Quaternary geology of the Grand River watershed is largely confined to the Late Wisconsinan time period, which began around 25,000 years ago. During this period, numerous surficial landforms were deposited within the Grand River Watershed.

The primary moraine structure within the City of Waterloo is the Waterloo Moraine which is the largest moraine in the watershed, covering a majority of Kitchener, Waterloo and the four surrounding townships. It was formed by the separation of the Georgian Bay and Ontario ice lobes. It contains a series of large aquifers which discharge to and maintain the base flow for the Grand River, Nith River and many of their tributaries. These aquifers are also the source for approximately 50 percent of all the groundwater used within the Region of Waterloo water supply system. In some places, the deposits within the Waterloo Moraine are 120 metres thick.

Surficial Quaternary geology mapping (**Figure 3.4.1**) shows the presence of a wide range of glacial outwash within the City boundaries. Dominant deposits include Marryhill Till in the southwest, Ice-contact Sand generally in the south and central subwatersheds of Laurel Creek and Clair Creek, Tavistock Till in the Cedar Creek and north Laurel Creek subwatersheds, and Port Stanley Till dominant in subwatersheds with their headwaters closer to the Grand River including Colonial Creek, Criter Creek and other systems classified as part of the Grand River Tributaries North subwatershed. In **Figure 3.4.1**, beds of outwash are observed following the valley systems of the City's main creek systems.

THE CITY OF Waterloo

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Figure 3.4.1
SURFICIAL GEOLOGY

Study Area
- Study Area
- Watercourse

Geologic Deposit
- Bog and swamp deposits
- Catfish Creek Till
- Glaciofluvial sand
- Ice-contact gravel
- Ice-contact sand
- Kames and eskers
- Lacustrine deposits
- Lacustrine, kame, and outwash
- Maryhill Till
- Middle Till
- Modern alluvium
- Outwash
- Outwash gravel
- Outwash sand
- Peat and muck
- Port Stanley Till
- Stream alluvium
- Stream deposits
- Swamps and bogs
- Tavistock Till
- Wentworth Till

0 0.5 1 Kilometers

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Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.5 Surficial Soils & Infiltration Potential

It was noted in previous reports including the Grand River Characterization Report that the areas of highest recharge tend to coincide with the moraine features within the watershed. For the City of Waterloo, this primarily applies to the Waterloo Moraine in the central and western area of the City. This moraine is comprised of permeable, coarse-grained deposits and consist of areas of hummocky topography (disconnected drainage), allowing for extensive infiltration and recharge. The moraine includes significant recharge zones for the watershed's major aquifers. Infiltration recommendations put forward in the context of this SWM-MP will have to consider the protection of groundwater resources and Source Protection Plan (SPP) Policies including Issue Contributing Areas (ICAs).

Areas with relatively impervious material include areas with Port Stanley Till (**Figure 3.4.1**) in the east (Colonial Creek, Critter Creek and other systems classified as part of the Grand River Tributaries North subwatershed), and areas with Maryhill Till in the southwest (upper reaches of Clair Creek, headwaters to Schneider Creek and headwaters to Alder Creek).

3.6 Hydrogeology

Hydrogeology is the science that deals with the movement and distribution of groundwater. Geological materials make up the solid medium that controls the storage, movement and chemical evolution of groundwater. Groundwater interacts with surface water through recharge and discharge. In general, rainwater infiltrates and is stored underground in sand and gravel deposits, called aquifers, which may supply drinking water to local wells or supply baseflow to adjacent streams.

3.6.1 Groundwater Recharge

Groundwater recharge can potentially occur in any location where groundwater levels are below or have relief from surface water sources. Recharge areas, where water infiltrates into the groundwater system, are usually areas of highly permeable soils such as sands and gravels.

The central portion of the Grand River watershed (where the City is roughly located) contains the majority of the watershed's moraines and sand/gravel deposits left by glaciation. Because of the significant amount of pervious material as opposed to the northern and southern areas of the Grand River watershed, the City is generally characterized by high infiltration and relatively low surface runoff.

As noted earlier, the areas of highest recharge tend to coincide with the moraine features within the watershed. The Waterloo Moraine plays a major role in the recharge of the local and regional groundwater system, although the rate of recharge is highly variable, ranging from <120 mm to >500 mm/yr. Many of the water-related ecological features are found in and around the main recharge area in the core of the Waterloo Moraine this includes more than 70 Provincially Significant Wetlands (PSW's). The Waterloo Moraine is commonly comprised of permeable,

coarse-grained deposits and consist of areas of hummocky topography (disconnected drainage), allowing for extensive infiltration and recharge.

Although the Waterloo Moraine landform is often described as a major recharge area not all areas of the Waterloo Moraine will provide major recharge. The rate at which recharge occurs is dependent on the nature of the overburden material, where highest rates of recharge occur on coarse-grained moraine deposits with disconnected drainage. It is therefore important to note that the flanks of the Waterloo Moraine have low hydraulic conductivity tills at ground surface. Significant recharge areas classified as high, medium and low capacity are illustrated on **Figure 3.6.1.** Within the City, the largest concentration of significant recharge areas can be found in the northwest (around the Laurel Creek reservoir, in the Beaver Creek subwatershed and in the Monastery Creek subwatershed) and in the Northeast (around the Martin Creek East subwatershed as well as Minnow Creek and Horst Creek in the Grand River Tributaries North subwatershed). Small clusters of significant recharge areas can be fund along the municipal boundary to the southeast and in the southwest corner of the municipality.

3.6.2 Groundwater Discharge

Groundwater discharge can potentially occur anywhere the groundwater levels intersect ground surface. Springs and seepage areas, where groundwater exits the soils, are said to be discharge areas. These discharge zones supply streams with cold baseflows which benefits aquatic life.

Within the Grand River Watershed, there are several areas of groundwater discharge. In the Region of Waterloo most direct groundwater discharge to the Grand River occurs south of the Study Area. Within the City of Waterloo there are three (3) creeks that are classified as coldwater streams as a result of groundwater discharge (see **Figure 3.9.3**). These are Monastery Creek upstream of Wideman Road and Beaver Creek in the northwest corner of the City and Melitzer Creek in the southeast.

THE CITY OF Waterloo

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Figure 3.6.1
SIGNIFICANT RECHARGE AREAS

- Study Area
- Watercourse
- City of Waterloo Wells

Recharge Area

- High
- Medium
- Low

0 0.5 1 Kilometers

N

Aquafor Beech limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.7 Hydrology

Hydrology is the science which deals with the flow of water from precipitation events to the receiving watercourses and to the groundwater system. The most dramatic change brought about by forest clearing, improving drainage for agriculture and urbanization is the change in stream hydrology. For example, the replacement of vegetation and undisturbed terrain with impermeable surfaces (i.e. pavement, roof tops, graded surfaces and the provision of an underground storm drainage network) intercepts water that would naturally infiltrate into the ground, and provides a direct and rapid transport of surface runoff to streams. As a result, groundwater discharges diminish which in turn lowers or eliminates stream baseflows. A more rapid rate of stormwater runoff from rainfall events results in an increase in the total volume, peak flow and frequency of runoff occurrences. Uncontrolled, these hydrologic changes will result in increases in flooding, channel erosion, sediment transport, and pollutant loadings. These changes can also cause deterioration in natural channel morphology, fish and wildlife habitats, recreational opportunity and aesthetics.

3.7.1 Subwatersheds and Catchment Delineation

The City of Waterloo's surface water system consists of several watercourses discharging into the Grand River. The most prominent watercourse draining through the City to the Grand River is Laurel Creek. The Laurel Creek subwatershed is approximately 75 square kilometers and includes the following tributaries before discharging into the Grand river at Bridgeport:

- Forwell Creek;
- Cedar Creek;
- Clair Creek;
- Beaver Creek; and
- Monastery Creek.

Significant watercourse systems that are not tributary to Laurel Creek include Melitzer Creek and Colonial Creek, both located on the east side of the City. On the northeast side, several small watercourses flow directly into the Grand River. These include Copper's Creek, Cuckoo Creek, Willow Creek, Critter Creek, Minnow Creek and Horst Creek. Along the periphery of City, several headwater areas drain to Grand River tributaries that are external of the municipal boundary.

For the purposes of this study, the municipality has been broken down into 18 subwatersheds. Of these, the primary subwatersheds are:

- Alder Creek
- Beaver Creek
- Cedar Creek
- Clair Creek
- Colonial Creek
- Conestogo River- Lower
- Forwell Creek
- Laurel Creek

- Maple Hill Creek
- Martin Creek
- Militzer Creek
- Monastery Creek
- Schneider Creek

To allow for more detailed analysis, of some of the larger subwatershed were divided into distinct segments with more homogenous environmental conditions, including:

- the main branch of Laurel Creek was divided into Lower Laurel Creek, Middle Laurel Creek and the Laurel Creek Reservoir.
- Martin Creek was also divided into two smaller subwatersheds. Martin Creek East and Martin Creek West both flow north from the northern area of the City but are divided by the Forwell Creek subwatershed which drains south.
- The drainage areas of six small watercourses (Copper's Creek, Cuckoo Creek, Willow Creek, Critter Creek, Minnow Creek and Horst Creek) were combined to form Grand River North Tributaries subwatershed.
- The area of the City between the Melitzer Creek subwatershed and the Colonial Creek subwatershed that drains directly to the Grand River has been defined as the Grand River Tributaries South.

The subwatersheds defined in this study are identified in **Figure 3.7.1**.

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.7.1
SUBWATERSHEDS

- Study Area
- Watercourse
- Subwatershed Boundary

Subwatersheds

- Alder Creek
- Beaver Creek
- Cedar Creek
- Clair Creek
- Colonial Creek
- Conestogo River - Lower
- Forwell Creek
- Grand River Tributaries North
- Grand River Tributaries South
- Laurel Creek Reservoir
- Lower Laurel Creek
- Maple Hill Creek
- Martin Creek East
- Martin Creek West
- Melitzer Creek
- Middle Laurel Creek
- Monastery reek
- Schneider Creek

0 0.5 1 Kilometers

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Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017 and Grand River Conservation Authority, 2017.

Date: May 2017

WELLESLEY
WOOLWICH
WILMOT
KITCHENER
Beaver Creek
Forwell Creek
Creek D
Critter Creek
Willow Creek
Minnow Creek
Horst Creek
Cuckoo Creek
Cooper's Creek
Colonial Creek
Cedar Creek
Monastery Creek
Laurel Creek Reservoir
Laurel Creek
Clair Creek
Maple Hill Creek
Melitzer Creek
GRAND RIVER
ERBSVILLE RD
NORTHFIELD DR W
NORTHFIELD DR E
CONESTOGA PKY
BEARINGER RD
WESTMOUNT RD N
FISCHER-HALLMAN RD N
BRIDGE ST W
UNIVERSITY AVE W
UNIVERSITY AVE E
KING ST N
WEBER ST N
ERB ST W
ERB ST E
BRIDGEPORT RD E
KING ST S
WEBER ST S
IRA NEEDLES BLVD

3.7.2 Flow Monitoring

There are four (4) hydrometric gauges to measure flow on the Laurel Creek system. These are located at on Monastery Creek at Erbsville Road, at the Laurel Creek Dam, on Clair Creek at Westmount Road and on the main branch of Laurel Creek at Weber Street North. The gauge at Weber Street North is operated by the Water Survey of Canada (WSC ID 02GA024). The other three (3) gauges are operated by the GRCA. The GRCA also operates a gauge at Bridgeport on the Grand River. The hydrometric gauges along with precipitation gauges are shown on **Figure 3.7.2**.

3.7.3 Flow Control

Flow is regulated through the central portion of the Grand River from upstream reservoirs. Spring flows are greatly reduced by the reservoirs which capture the spring snow melt. In combination with local dyke systems, this has reduced average annual flood damages through the urban centers in Waterloo, Kitchener, and Cambridge by 75 percent. In addition, flow regulation provides for flow augmentation.

There are no flow control structures on the Grand River within the City of Waterloo However, multi-purpose dams and reservoirs upstream of the City provide flow control targets at streamflow gauges within the City. Specifically, Shand and Conestogo Dams are operated to maintain minimum summer flows. Downstream of the City, the minimum summer flow target is 9 m^3/s at the Doon gauge. According to the Grand River Characterization Report, this minimum flow (**Table 3.7.1**) is critical to ensure adequate water supply and dilution of wastewater effluent along the main Grand River.

Table 3.7.1: Grand River: Minimum Flow Requirements for Water Supply and Wastewater Dilution

Hydrological Metric	Grand River Minimum Summer Targets (May 1 to Oct 31) (m3/s)	Grand River Minimum Fall Targets (Nov 1 to Dec 31) (m3/s)	Grand River Minimum Winter Targets (Jan 1 to Apr 30) (m3/s)
Minimum Flow Target[1]	9.9	7.1	2.8
Reliability (occurrence)[2]	82.4%	88.2%	100%
Reliability (time)[3]	98.9%	94.5%	100%
Actual Min. Weekly Flow	8.5	5.5	3.9
Actual Min. Daily Flow	8.3 (Oct)	5.1	3.8

[1] Because of the 30 hour travel time from the reservoirs to Doon, the daily flows can vary approximately +/- 0.9 m^3/s from the target/ The travel time from the reservoirs to Brantford is 48 hours. The daily flows can vary +/- 1.4 m^3/s from the target.

[2] Reliability (occurrence) refers to the percentage of days target was met in 17 years of flow records.

[3] Reliability (time) refers to the percentage of days target was met within operating period for 17 years of flow records.

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.7.2
MONITORING LOCATIONS

- Study Area
- Watercourse
- Flow Gauge
- Rain Gauge

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017 and Grand River Information Network, Grand River Conservation Authority, 2017.

Date: May 2017

3.7.4 Hydraulics

Hydraulics is the study of water conveyance through channels and pipes. Hydraulic studies are commonly undertaken to establish floodplain mapping along creeks and rivers. Mapping is undertaken for specific return periods (e.g. 1:2-year event, 1:5-year event, 1:10-year event 1:25-year event, 1:50-year, 1:100-year event) as well as the regional event which is Hurricane Hazel for this region of the province. Development is generally prohibited in floodplains resulting from the regulatory event through provincial policy as indicated in the Provincial Policy Statement. The City has policies in its Official Plan that outline what development can happen in the floodplain. Floodplains are also being incorporated into the new Zoning By-law.

The floodplain in the City is divided into three (3) categories. These are:

One Zone Policy Area: Development is generally prohibited in this area.

Two Zone Policy Area: This zone is more permissive to development than One Zone. In two zone areas the floodplain is classified as either "floodway" or "flood fringe". Some development, with conditions, is permitted in the flood fringe. The flood fringe is the outer portion of the floodplain where the depth and speed of flood water is less than the floodway, therefore posing less of a threat to people and property. New development is generally prohibited in the floodway.

Special Policy Area: This zone reflects an approach to floodplain management where the GRCA, municipality and Province agree to relax provincial flood proofing and technical standards and accept a higher level of risk than in the One Zone or Two Zone Policy Areas.

Floodplain mapping for the City of Waterloo is identified in **Figure 3.7.3.**

Data Gaps for Section 3.7

1. Current shape files or GIS geodatabase for floodplain policy areas (Two Zone and Special Policies Areas)
2. Most recent floodplain studies (reports) for watersheds within or partially within the City of Waterloo

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.7.3
FLOODPLAIN & LAND REGULATED BY ONTARIO REGULATION 150/06

- Study Area
- Watercourse
- Floodplain
- Regulation Limit

0 0.5 1 Kilometers

N

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Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.8 Fluvial Geomorphology

The fluvial geomorphology of creek systems, in a study such as a Master Plan, provides an understanding of the channel conditions and processes at a range of spatial scales, from:

> Watershed (Grand River) → subwatershed (Laurel Creek) → watercourse (Main Branch) → reach (LRL-R10) → site scale (University Avenue West crossing).

This spatial progression enables insight to be gained into the macro- (planform), meso- (channel cross-section level), and micro- (bed material level) scales of channel form within the study area and into the factors that influence them.

In the City of Waterloo, approximately 92 km of stream systems flow through 18 distinct subwatersheds or catchment areas, all of which all drain into the central segment of the Grand River watershed. This segment of the Grand River includes all stream systems within Waterloo, Kitchener, and Cambridge, and is the most urbanized section of the watershed. Associated with urbanization are both direct and indirect factors of human activity on stream morphology. Direct impacts include changes of channel form, alignment, bank and bed materials, and instream structures (weirs, culverts, and dams), whereas indirect impacts relate primarily to changes in adjacent land use which can significantly influence the rate and method of water and sediment routing to a creek or river.

When the modifying and controlling variables remain relatively constant, channel geomorphology may become 'balanced' or 'stable', referred to as being in quasi-equilibrium. The concept of an equilibrium channel form is often represented pictorially by a balance (**Figure 3.8.1**). Using this symbology, when sediment load or size are disrupted or a change in flow occurs, the balance is offset and the result may include an increase in erosion or channel activity, or excessive degradation or aggradation. For example, if flow increases, but the slope of the channel remains the same, then the size of material or quantity of material that can be moved will increase, and must increase, to enable a balance to be regained. As such, erosion and deposition are necessary and natural processes that occur in all watercourses, and these processes are exacerbated when the equilibrium shifts.

With regards to this study, the geomorphic analysis is intended to provide a context for erosion and channel adjustments within the City, with the primary deliverable being a comprehensive inventory of erosion where each segment or issue is well documented at both the site and reach context. As such, each site will be prioritized applying a transparent and reproducible ranking scheme consistent with a Master Planning approach. Prioritization of erosion sites that pose the greatest risk enables the City to prepare a temporal and financial strategy for undertaking restoration works. Once the comprehensive inventory is ranked in order of priority, conceptual alternatives for each of the top priority sites will be defined.

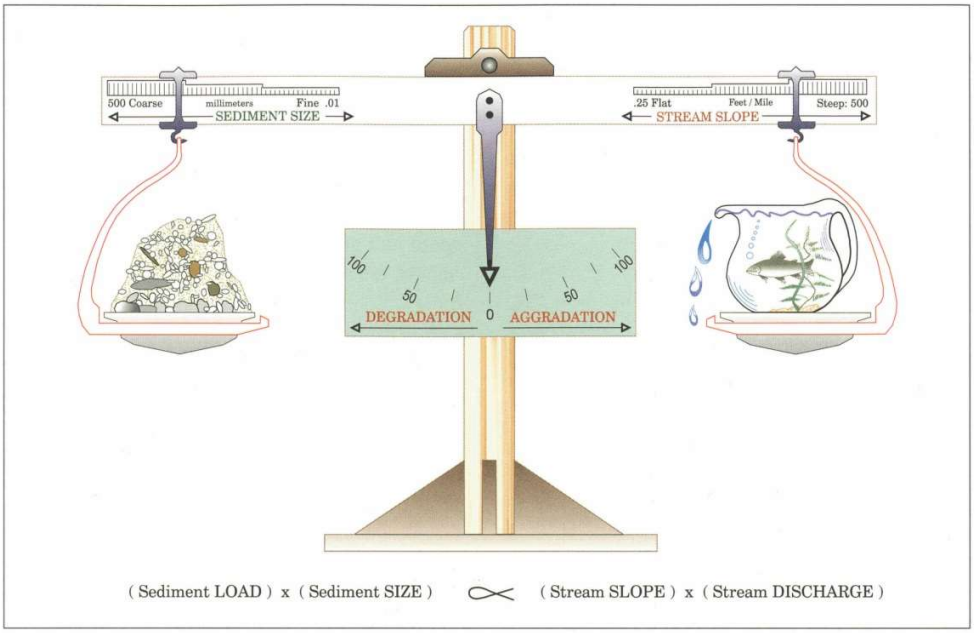

Figure 3.8.1: Lane's balance concept for channel equilibrium form (modified from Rosgen, 1996)

The City of Waterloo has previously undertaken inspections of municipal watercourses in 2002 (Parish Geomorphic Ltd. And Planning & Engineering Initiatives Ltd.) and 2013 (City of Waterloo). The 2013 report was provided to Aquafor at the onset of the current study and its methodology and findings are summarized below to provide a background to the current inspections.

Table 3.8.2 shows the extent of the watercourse assessments in the 2013 assessment. Six (6) parameters were assessed during the field walks:

- Channel/bank stability,
- Erosion/sediment deposition,
- Physical in-stream habitat,
- Water quality,
- Riparian habitat, and
- Integrity of support structures.

Each parameter was given a health ranking as follows:

- Poor (score of 1-2),
- Fair (score of 2.1-3),
- Good (score of 3.1-4), and
- Excellent (score of 4.1-5).

The overall health of the stream was summarized as a weighted average of the individual parameter scores. The results of 2013 assessments are summarized in **Table 3.8.1**. This assessment methodology is subjective to the individual assessors as no quantifiable metrics were used. As such, a second team assessing the watercourses at the same time could conceivably

score the watercourse differently. Although all assessments contain an element of subjectivity of the individual assessor, it is possible to add quantifiable metrics to assist in standardizing the evaluation. As such, a new methodology was proposed for the current assessments. As discussed with the City, reaches were characterized by channel dimensions, bed material sizes, bed and bank revetments, and dominant processes (as derived from the Rapid Geomorphic Assessments). Numerical assessments were applied at erosion sites and used parameters such as distance to risk, type of risk, extent of erosion to evaluate the site conditions.

Table 3.8.1: Summary of Stream Health Assessment Results in 2013

Watercourse	Health Rating
Beaver Creek	Good
Cedar Creek	Fair
Clair Creek	Good
Colonial Creek	Good
Forewell Creek	Good
Laurel Creek	Fair
Maple Hill Creek	Fair
Monastery Creek	Good
Other Creeks	Good
Tributaries to Clair Creek	Good
Tributaries to Forwell Creek	Good
Tributaries to Laurel Creek	Good
Tributaries to Lauren Reservoir	Excellent
Tributaries to Tributaries to Laurel Creek	Fair

In addition to the stream health assessments in 2013, photographs of points of disturbance were taken and the location was logged. The report summarized 11 areas at which it was recommended that follow-up investigations be undertaken to determine whether remediation was required. These sites are summarized in **Table 3.8.2.** with the geographic locations identified in **Figure 3.8.3**. Nine (9) additional sites were identified at which it was recommended that conditions continue to be monitored. These sites are summarized in Error! Reference source not found. with their geographic locations identified in **Figure 3.8.3**. All sites were re-evaluated during the current creek walks and ranked according to the new erosion site evaluation matrix.

Table 3.8.2 Areas identified in 2013 for Investigation and Possible Remediation

Watercourse	Reach	Issue
Clair Creek	CL18	Collapsing and/or damaged bank protection above and below crossing with Coleridge Drive
Clair Creek	CL20	Woody debris at culvert outfalls between University Avenue and Westmount Road
Colonial Creek	COL1	Large woody debris inhibiting flow of water near start of the reach.
Colonial Creek	CS1	Debris accumulation and encroachments from nearby properties, including a makeshift bridge, garbage and waste dumping.
Colonial Creek	CS2	Extensive erosion occurring along the edge of residence (510 Oxbow Road). Undermining of fence abutting creek.
Colonial Creek	CS3	Failed stormsewer outfall approximately 40-50m downstream from the creek access at Lee Avenue.
Forwell Creek	F2	Collapsing bank adjacent to industrial area near intersection of Weber Street North and Benjamin Road.
Forwell Creek	F4	Significant encroachment from Ferrell Builders Supply. Debris spilling and/or being dumped into riparian zone and creek.
Laurel Creek	L23	Collapsing support structures at the bottom of a property abutting the creek, just east of Weber Street.
Laurel Creek	L25	Excessive woody debris accumulation at University Avenue bridge.
Maple Hill Creek	MH3	Failing support structures along reach.

Table 3.8.3: Areas identified in 2013 for Investigation and Monitoring

Watercourse	Reach	Issue
Cedar Creek	C1	Gabion basket failure approximately midway between Rolling Hills Drive and Glenn Forest Boulevard. Stones spilling into creek.
Cedar Creek	C3	Gabion basket failure north of Cedarbrae Public School baseball diamond. Stones spilling into creek.
Cedar Creek	C6	Failing support structures, aggradation and vegetation in pool at intersection of Longwood Drive and Albert Street.
Clair Creek	CL9	Deeply incised banks and damaged outfall near intersection of Erbsville Road and Columbia Street.
Clair Creek	CL19	Significant erosion and sedimentation, undercutting and slumping of unprotected banks between Keats Way and University Avenue.
Colonial Creek	COL6	Extensive undercutting of banks near crossing at University Avenue
Forwell Creek	F10	Significant deadfall accumulation throughout reach with water becoming dammed in some cases
Colonial Creek	CN1	Extensive woody debris approximately 100m north of Sugarbush Drive
Laurel Creek	L29	Outfalls observed with strong smell and visual indicators of sewage effluent. Observed near Waterloo Wastewater Treatment Plant.

Data Gaps for Section 3.8

1. Current shape files or GIS geodatabase for watercourse channel types (e.g. concrete lined, restored, natural, etc.)

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.8.2
CREEKS REACHES WALKED IN 2013

- Study Area
- Reaches Walked in 2013
- Watercourse

0 0.5 1 Kilometers

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Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.8.3
2013 STREAM INSPECTION RESULTS

- Study Area
- Watercourse
- Potential Monitoring Areas
- Potential Remediation Areas

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by Stream Inspections 2013 Technical Report, The City of Waterloo, 2013 and the City of Waterloo, 2017.

Date: May 2017

3.9 Aquatic Ecology

Aquatic ecology is the science concerned with the study of aquatic ecosystems, including surface water quality, biodiversity (fisheries and benthic macroinvertebrates) and aquatic habitat. Benthic macroinvertebrates are commonly used to assess water quality, as well as the health and integrity of aquatic ecosystems.

The City of Waterloo is located within the Grand River Watershed. The Grand River watershed is the largest watershed in Southern Ontario and displays incredible diversity in regards to fish species. Eighty (80) confirmed, 12 probable, and a further 6 possible fish species are found within the Grand River watershed, which comprises 62% of all fish species found in Ontario. Six (6) fish species found within the watershed are classified as vulnerable or threatened in Canada (GRFMPIC, 2005). Main tributaries of the Grand River are the Speed, Eramosa, Nith, and Conestogo Rivers, and hundreds of smaller tributaries drain into the main channel. The Grand River Fisheries Management Plan (GRFMP) was initiated in 1994 by the MNRF and the GRCA, as well as many partners and the public. According to the GRFMP, the watercourses of the City of Waterloo are part of the Middle Grand River Reach.

The main branch of the Grand River within the City of Waterloo has a diverse warm water fish community dominated by top predators such as walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu*), and northern pike (*Esox Lucius*) (GRFMPIC, 2005). Adjacent landuse activities (excess nutrients, sediment inputs, water treatment plant effluents, and stormwater discharge) and a loss of natural habitat from stream hardening and channelization have had major impacts to fish habitat and water quality (GRFMPIC, 2005). Recreational fishing, particularly for smallmouth bass, is popular in this stretch of the river.

The City of Waterloo contains 18 subwatersheds. Fisheries records were requested for this report from the GRCA and MNRF with results identified in **Table 3.9.1.**

Table 3.9.1: Fish Species in City of Waterloo Creeks

Fish Species Name		General Abundance in Ontario	Thermal Regime	Tolerance	Creek															
Scientific Name	**Common Name**				**Cedar**	**Clair**	**Colonial**	**Critter**	**Cuckoo**	**Forwell**	**Laurel**	**Willow**	**Minnow**	**Creek D**	**Horst**	**Melitzer**	**Cooper's**	**Maple Hill**	**Monastery**	**Beaver**
Notropis heterolepis	Blacknose Shiner	Common	Coolwater	Intolerant							✓									
Pimephales notatus	Bluntnose Minnow	Common	Warmwater	Intermediate		x					✓		✓					✓	✓	✓
Hybognathus hankinsoni	Brassy Minnow	Common	Coolwater	Intermediate												✓				✓
Culaea inconstans	Brook Stickleback	Common	Coolwater	Intermediate	✓				✓							✓	✓		✓	✓
Salvelinus fontinalis	Brook Trout	Common	Coldwater	Intolerant												✓				
Ameiurus nebulosus	Brown Bullhead	Common	Warmwater	Intermediate							✓								✓	✓
Umbra limi	Central Mudminnow	Common	Coolwater	Tolerant				✓					✓			✓			✓	✓
Cyprinus carpio	Common Carp	Common	Warmwater	Tolerant	✓						✓									✓
Luxilus cornutus	Common Shiner	Common	Coolwater	Intermediate							✓								✓	✓
Semotilus atromaculatus	Creek Chub	Common	Coolwater	Intermediate		✓			✓		✓					✓	✓	✓	✓	✓
Rhinichthys atratulus	Eastern Blacknose Dace	Limited	Coolwater	Intermediate	✓	✓		✓			✓					✓		✓	✓	✓
Pimephales promelas	Fathead Minnow	Common	Warmwater	Tolerant	✓	✓												✓		✓
Etheostoma exile	Iowa Darter	Common	Coolwater	Intermediate															✓	✓
Etheostoma nigrum	Johnny Darter	Common	Coolwater	Tolerant				✓					✓							✓
Micropterus salmoides	Largemouth Bass	Common	Warmwater	Tolerant			No data			No data		No data (Similar to Cuckoo)		Limited Data. Creek Chub and Largemouth Bass.	Limited data. Possible Northern Pike migration corridor and/or spawning grounds.					
Rhinichthys cataractae	Longnose Dace	Common	Coolwater	Intermediate							✓									
Esoc lucius	Northern Pike	Common	Coolwater	Intermediate					✓ (potential spawning)		✓						✓ (Potential spawning)			
Phoxinus eos	Northern Redbelly Dace	Common	Coolwater	Intermediate																✓
Lepomis gibbosus	Pumpkinseed	Common	Warmwater	Intermediate	✓	✓			✓		✓						✓	✓		
Etheostoma caeruleum	Rainbow Darter	Common	Coolwater	Intolerant															✓	✓
Amphloplites rupestris	Rock Bass	Common	Coolwater	Intermediate							✓									
Noturusflavus	Stonecat	Common	Warmwater	Tolerant							✓									
Morone saxatilis	Striped Bass	*Likely a misidentification - Striped Bass are not known to exist in Ontario*														✓				
Cyprinus sp.	Unidentified YOY Minnow Sp.				✓															
Sander vitreus	Walleye	Common	Coolwater	Intermediate							✓ (potential spawning)									
Rhinichthys obtusus	Western Blacknose Dace	Common	Coolwater	Intermediate																
Catostomus commersonii	White Sucker	Common	Coolwater	Tolerant	✓	✓		✓			✓		✓			✓		✓	✓	✓
			Number of Species		**7**	**6**	**N/A**	**4**	**4**	**N/A**	**14**	**N/A**	**4**	**N/A**	**N/A**	**8**	**4**	**6**	**10**	**15**

3.9.1 Habitat & Fisheries

Current stream thermal regime classification (commonly referred to as stream classification) was provided by the MNRF for each watercourse within the City of Waterloo, and is illustrated in **Figure 3.9.3**. The stream classification shown on **Figure 3.9.3** represents current stream classification and does not reflect historic conditions.

Stream thermal regime classification is useful to identify what fish species may be present within a stream. Cold water streams are capable of supporting species such as brook trout (*Salvelinus fontanalis*) throughout the year, whereas warm water streams will not support cold water species through the warmer months, and instead provide habitat for species such as smallmouth bass and common carp (*Cyprinus carpio*) (**Figure 3.9.1**). Cold water streams tend to have groundwater inputs and provide more sensitive habitat than warm water streams. Although many streams that were historically classified as cold water and cool water are now classified as warm water which may indicate habitat degradation, there are other streams that have always been warm water and should not be considered degraded.

Figure 3.9.1: Common Carp Observed in Laurel Creek

Figure 3.9.2: Hardened Channel on Forwell Creek

The majority of the 92 km of streams in the City of Waterloo (not including the Grand River) are classified as warm water streams. Most watercourses in the City of Waterloo are highly urbanized with significant portions of them showing channelization and bank hardening. Channels lined with concrete, such as stretches of Forwell Creek (**Figure 3.9.2**), limit the burrowing depth of fish, having negative impacts on habitat, forage, and spawning. Three streams - Beaver Creek and Monastery Creek on the western edge of the City, and Melitzer Creek on the east, are classified as cold water streams. These streams tend to be in less urbanized areas.

Each stream classification is related to Ministry of Natural Resources and Forestry (MNRF) aquatics/ fisheries timing windows for in-water works and is detailed below:

- Warm Water Timing Window – no in-water works should occur between March 31 and June 30 of any given year.

- Cool Water Timing Window - no in-water works should occur between April 1 and June 30 of any given year.

- Cold Water Timing Window – no in-water works should occur between October 1 and June 30 of any given year.

In-water work includes but is not limited to the discharges of water from dewatering activities into the watercourse, as well as work conducted on the outlet structure of a pond and or storm sewer outlet at the receiving watercourse.

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.9.3
THERMAL REGIME

Study Area

Watercourse Thermal Regime

- Coldwater
- Warmwater

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.9.2 Water Quality

Surface water quality is monitored to observe impacts on fish and fish habitat by determining changes over time of contaminants, identifying emerging issues, and tracking the progress and results of remedial measures. Good water quality is very important to healthy fish habitat- places where fish can spawn, feed, grow, and live. As the Grand River flows through the Region of Waterloo, water quality is greatly influenced by five (5) wastewater treatment plants. Very high nitrogen and phosphorus concentrations cause growth of macro-algae and aquatic plants, which causes dissolved oxygen fluctuations. As a result of these factors, the Grand River has marginal to poor water quality within the Region of Waterloo. Water quality recovers to an exceptional level as it reaches Paris and Brantford (Loomer and Cooke, 2011). Major impacts to water quality and quantity are through urban land use practices including (GRFMPIC, 2005):

- Excess nutrients,
- Sediment inputs,
- Water treatment plan effluents, and
- Stormwater discharge

3.9.2.1 Provincial Water Quality Monitoring Network

The Provincial Water Quality Monitoring Network (PWQMN) is a partnership between the MOECC and other conservation partners to undertake surface water quality monitoring throughout Ontario. There are two existing monitoring stations in close proximity to the City of Waterloo. These are identified in **Table 3.9.2**.

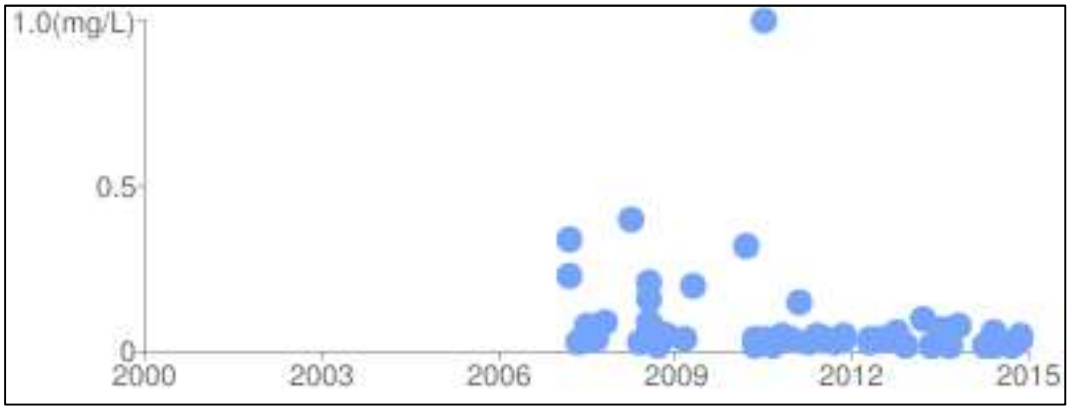
Table 3.9.2: PWQMN Sampling Locations within the City

Location	Site ID	Parameters Sampled	Sample Period
Laurel Creek (at Bridge St, W of Bridgeport)	**16018413002**	Phosphorus, Nitrates, TSS, Chloride	2007 to present
Grand River (at Bridge St)	**16018401502**	Phosphorus, Nitrates, TSS, Chloride	1964 to present

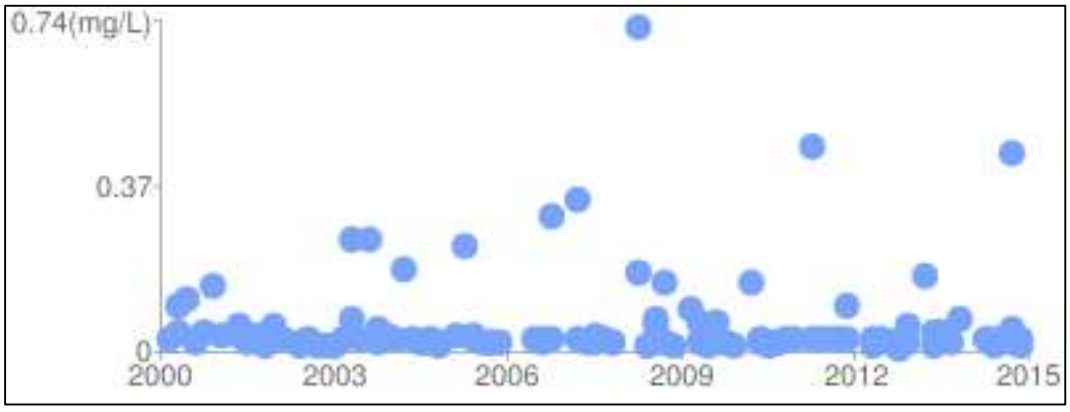
Total Phosphorus

Phosphorus is a nutrient that is essential for plant growth in aquatic environments. Excess phosphorus can lead to eutrophication and anoxia. The Provincial Water Quality Objective (PWQO) for Phosphorus is **0.03 mg/L** for streams in Ontario. **Figures 3.9.4a** and **3.9.4h** present recent Phosphorus concentrations as recorded by the PWQMN at Laurel Creek and the Grand River respectively.

Figures 3.9.4a – Phosphorus Concentrations at Laurel Creek



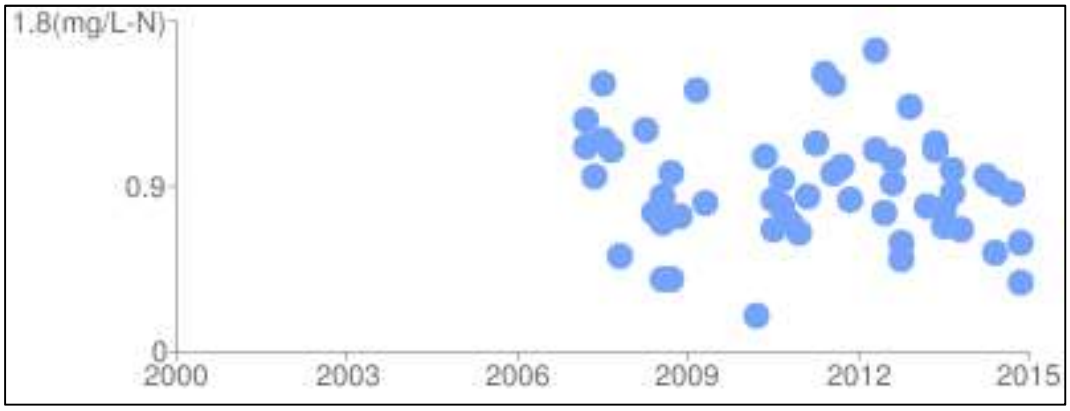
Figures 3.9.4b – Phosphorus Concentrations at the Grand River



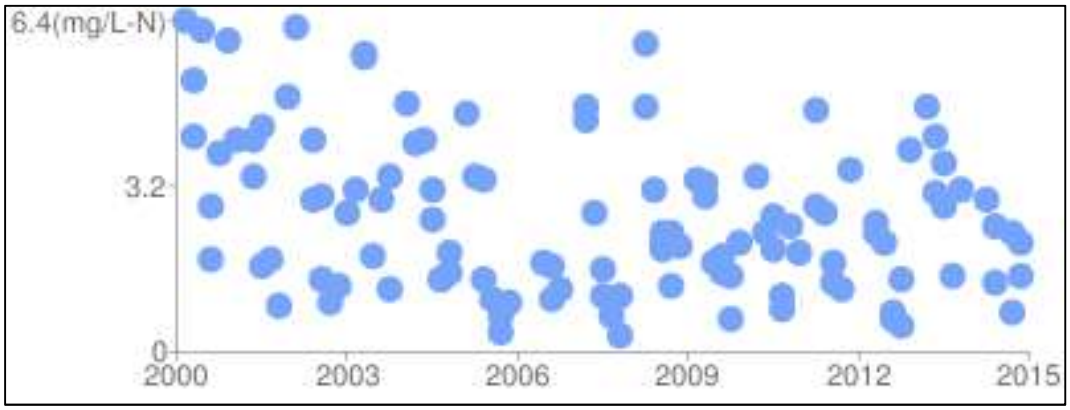
Nitrate

Like phosphorus, Nitrates are nutrients that are essential for plant growth in aquatic environments. Nitrates are found in several different forms in terrestrial and aquatic ecosystems. These forms of nitrogen include ammonia (NH3), nitrates (NO3), and nitrites (NO2). Excess nitrates can lead to eutrophication and anoxia. The Grand River Watershed Management Plan suggests a maximum guideline concentration of 3.0 mg/L. Figures **3.9.2.1c** and **3.9.2.1d** present resent Nitrate concentrations as recorded by the PWQMN at Laurel Creek and the Grand River respectively.

Figures 3.9.4c – Nitrate Concentrations at Laurel Creek



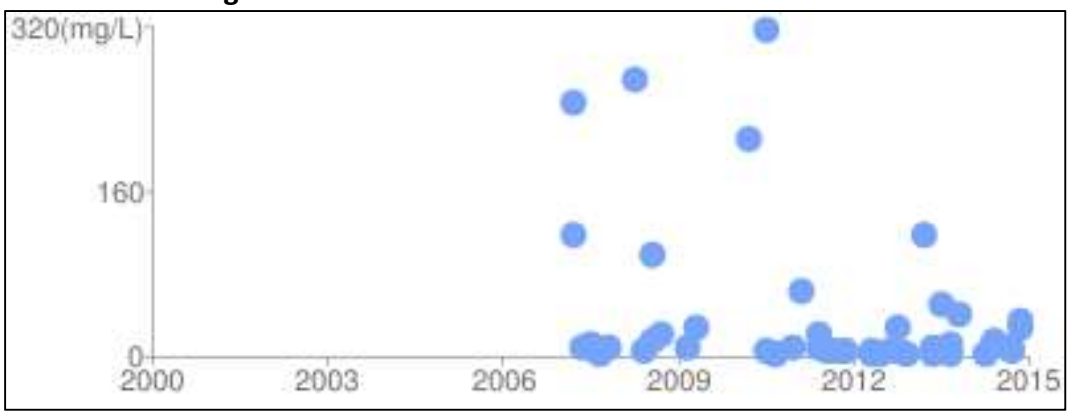
Figures 3.9.4d – Nitrate Concentrations at the Grand River



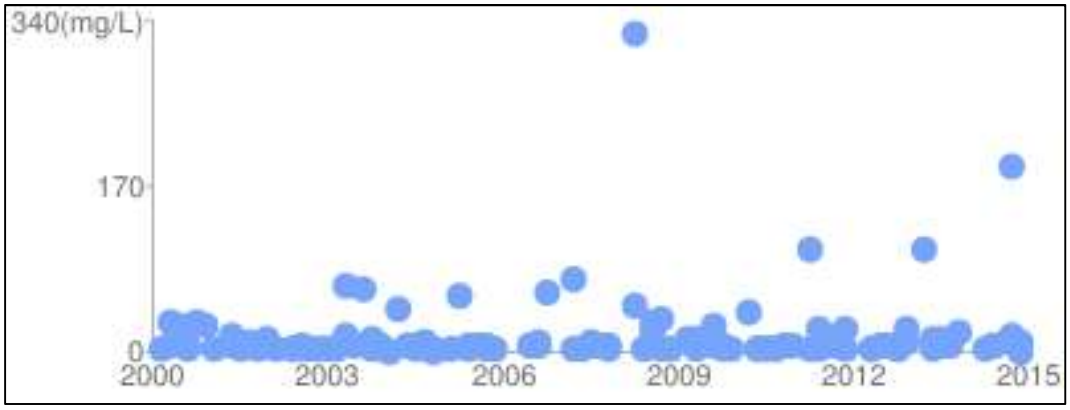
Total Suspended Solids

A total suspended solids (TSS) value represents the amount of particulate matter (e.g. silt, clay, organic and inorganic matter, soluble organic compounds, plankton, other microscopic organisms) suspended in water. Suspended sediments can act as a transport vector for a wide range of contaminants (e.g. metals are charged particles which can bind with sediment) and can affect aquatic organisms. Direct negative effects to fish include clogging and abrasion of gills, behavioral effects (e.g. movement and migration), blanketing of spawning gravels and other habitat changes, the formation of physical constraints disabling proper egg and fry development, and reduced feeding (CCME, 2002). The levels of TSS in a watershed vary significantly between reaches, flow conditions and seasons. **Figures 3.9.2.1e** and **3.9.2.1f** present resent TSS concentrations as recorded by the PWQMN at Laurel Creek and the Grand River respectively.

Figures 3.9.4e– TSS Concentrations at Laurel Creek



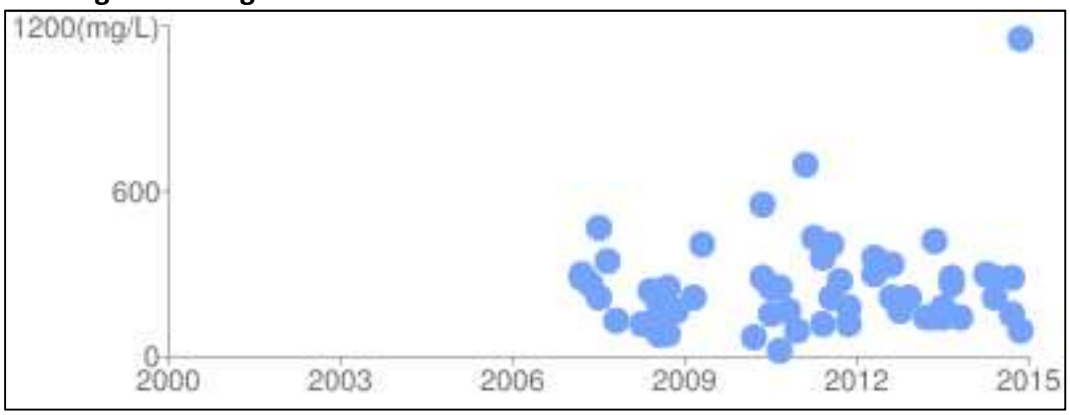
Figures 3.9.4 – Nitrate Concentrations at the Grand River



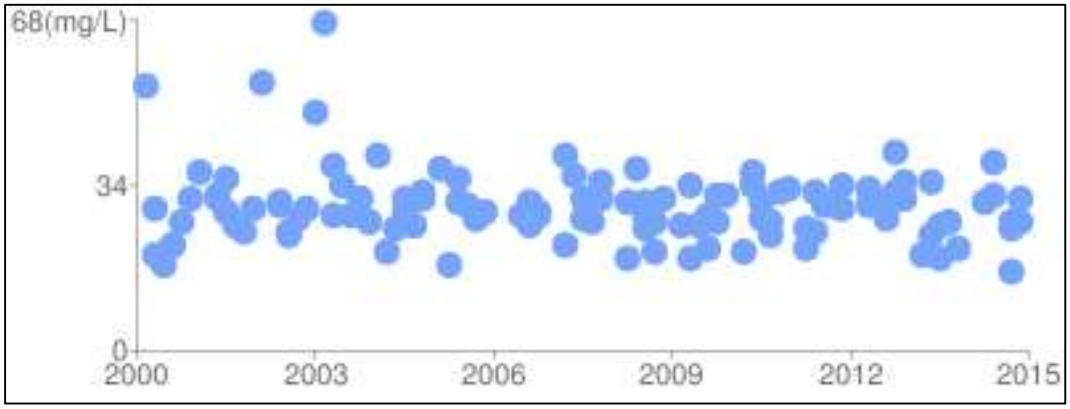
Dissolved Chloride

Chloride is a chemical that enters natural waterways via road runoff especially during the application of road salts during the winter season. Significant chloride loading also occurs during the spring freshet. Chloride that is dissolved in surface water can be toxic to aquatic life. 120 mg/L is the Canadian Water Quality Guideline (CWQG) for dissolved Chloride in surface waters. **Figures 3.9.2.1g** and **3.9.2.1h** present resent dissolved Chloride concentrations as recorded by the PWQMN at Laurel Creek and the Grand River respectively.

Figures 3.9.4g – Dissolved Chloride Concentrations at the Laurel Creek



Figures 3.9.4h – Dissolved Chloride Concentrations at the Grand River



3.9.2.2 Provincial Water Quality Monitoring Network

The GRCA operates automated water quality stations across the watershed to measure water temperature, pH level, dissolved oxygen and conductivity. The information from these stations is relayed back to the GRCA head office where it is uploaded to their website every hour, usually about 20 minutes after the hour.

This information provides an overview of current water quality conditions which is helpful to staff at the GRCA, municipalities and other agencies. The information is also useful in studying long-term water quality changes. One of the GRCA's water quality stations is located at Bridgeport. This station records conductivity, Dissolved Oxygen, Nitrate, pH level, Turbidity (which can be

used to approximate TSS), and Water Temperature. Less than one month of data is available on the GRCA's website; however larger data sets are available by request.

3.9.2.3 Laurel Creek Water Quality Monitoring Program (1996-2015)

The University of Waterloo Department of Geography and Resource Management undertook a long-term water quality study of Laurel Creek spanning a period of 1996 through 2015 (Stone, 2016). The program was implemented to measure the effects of urban development on water quality and water quantity. Standard methods were used to measure total phosphorus, suspended solids, pH, dissolved oxygen and water temperature at ten sites reflecting a range of land uses. Also included in this program is the monitoring and assessment of benthic macroinvertebrate communities, of which can help identify trends in water quality and aquatic habitat. Each monitoring site was sampled from the beginning of May through to the end of August consecutively for 20 years (1996 to 2015). **Figures 3.9.5a** through **3.9.5d** from the summary report of the study titled Laurel Creek Water Quality Monitoring Program (1996-2015) Summary of Hydrometric and Water Quality Data, identify monitoring locations and average water quality parameters as detected over the 20-year study.

Figure 3.9.5a Average TP concentrations in Laurel Creek (1996-2015)

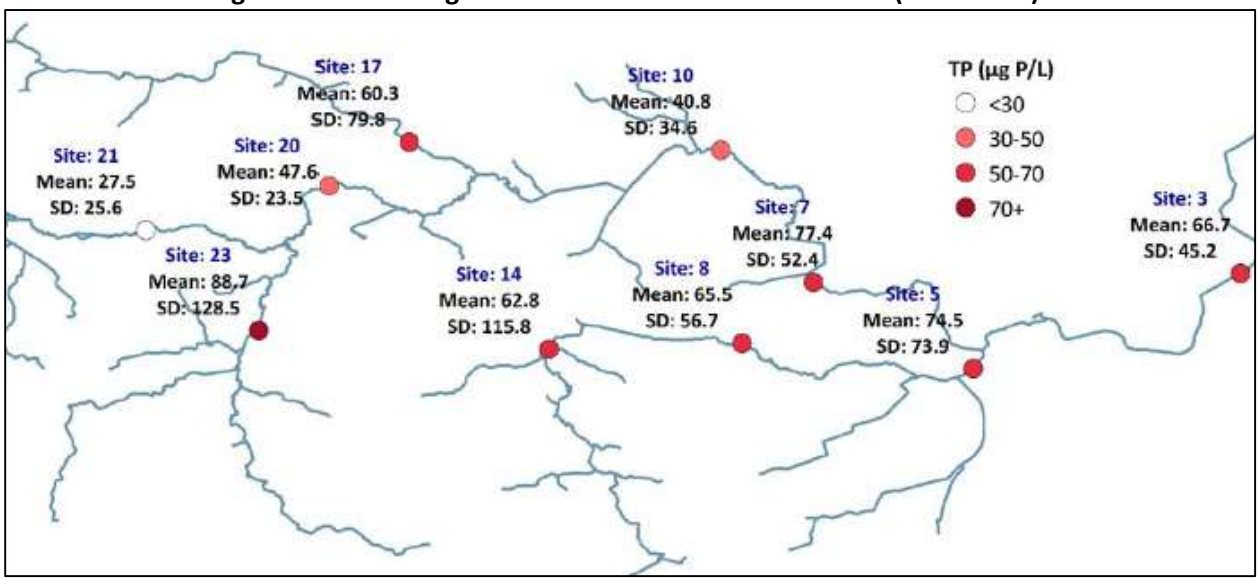


Figure 3.9.5b Average suspended sediment concentrations in Laurel Creek watershed (1996-2015)

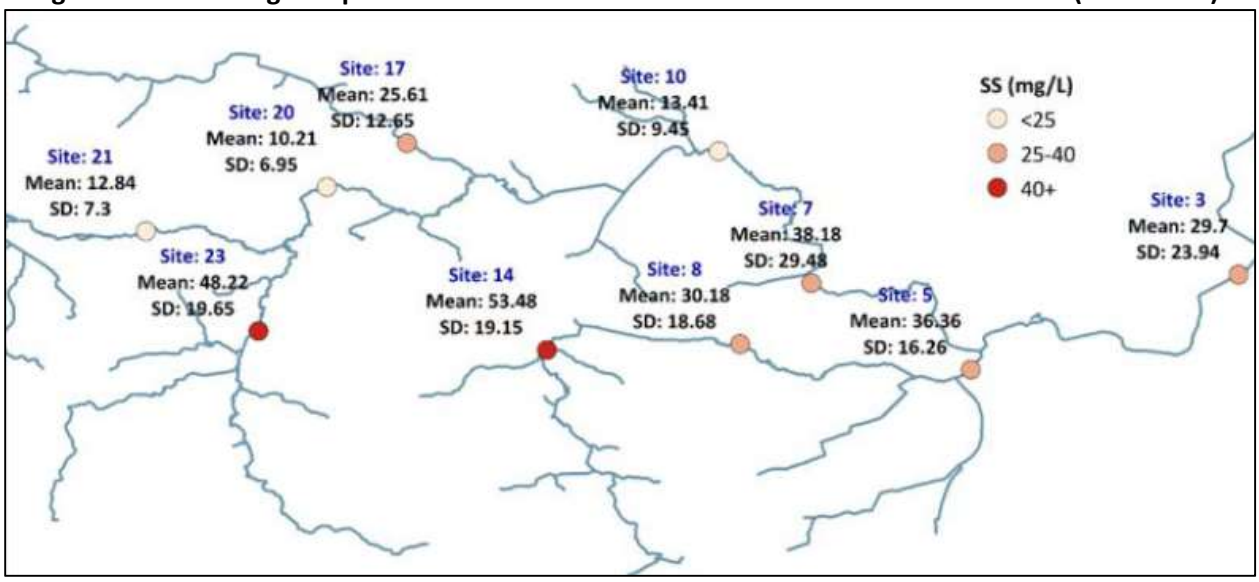


Figure 3.9.5c Average stream temperature in Laurel Creek (1996-2015)

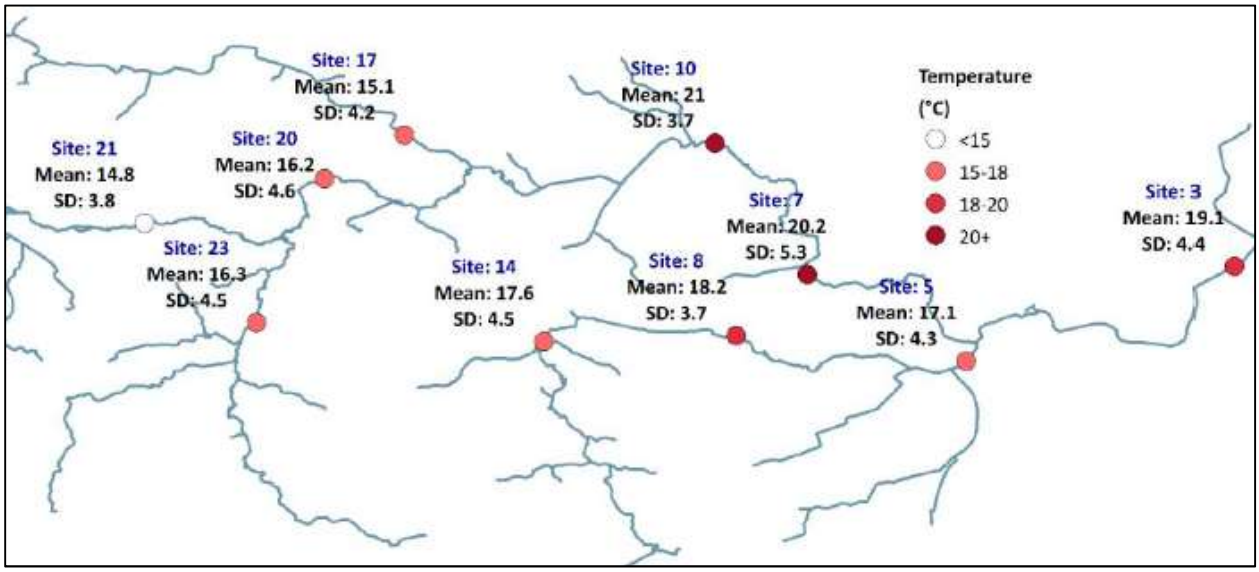
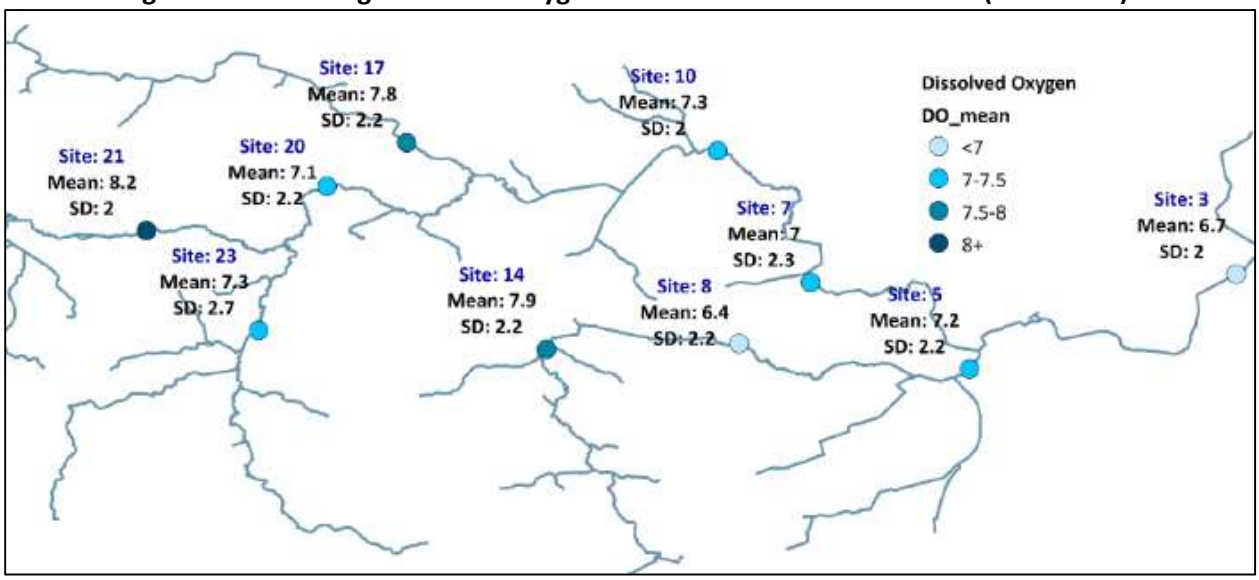


Figure 3.9.5d Average dissolved oxygen concentrations in Laurel Creek (1996-2015)



Summarized conclusions from the report are:

1. Water quality in the Laurel Creek watershed is comparable to that reported for many urbanizing watersheds. Water quality parameters (primarily suspended solids and total phosphorus concentrations) in Laurel Creek are also consistent with the levels reported in studies addressing the water quality impacts of urban development.
2. "Wet" vs "Dry" years can have a significant effect on the mobilization and subsequent transport of sediment and associated phosphorus. During wet years, TP concentrations and unit area loads are higher on average than levels measured during drier years because phosphorus transport is strongly related to sediment transport which mostly occurs during stormflow.
3. The drawdown of the Laurel Creek reservoir and Columbia Lake in the autumn is significant for the release of large quantities of sediment and associated phosphorus to downstream environments.
4. In the years immediately after residential development on Clair Creek above Site 14, sediment and phosphorus concentrations increased dramatically compared to predevelopment levels. However, over the past 10 years - the data show these levels have decreased to near predevelopment levels. However, despite the implementation of several Low Impact Development Best Management Practices (BMPs) during the development process, urban intensification in Clair Creek increased sediment availability and transfer to the creek during periods of wet weather. Accordingly, this sediment was then transported to downstream reaches in Laurel Creek where it has deposited in Silver Lake.
5. The data show that the PWQO for TP (30 µg L-1) was generally exceeded between 70 to 85% of the observations in the less urbanized headwater sites of the watershed (10, 14,

17, 20, 23); whereas, the TP PWQO was exceeded > 90% of all observations in the lower, more urbanized portion of the watershed (sites 3, 5, 7, 8).

6. Water quality at Site 23 on Monastery Creek was surprisingly poor over the period of record given that a wetland is located above the sample site. The data show that Monastery Creek is a significant headwater source of sediment and phosphorus to downstream reaches of Laurel Creek and should be a priority management area for the Regional Municipality of Waterloo.
7. The concentration of suspended sediment at sample locations in the watershed varied spatially and temporally in relation to precipitation, land use, development and river impoundments. At sites 23 and 7, the PWQO was exceeded ~35-55% of all observations. Historically, these two sites have produced high levels of sediment and illustrate the impacts of agriculture (site 23) and construction (site 7) on sediment mobilization and transfer to receiving waters.
8. The long-term data show that while the initial increase of sediment in streams impacted by residential development can be dramatic (i.e. site 14), there has been a subsequent reduction over time as sources of sediment and total phosphorus are minimized after construction activities have been finalized. The data suggest that BMPs implemented at this site have reduced the availability of sediment and phosphorus in the landscape thereby reducing its mobilization to streams.

Benthic macroinvertebrate community and aquatic habitat information from the monitoring program was provided as a separate report titled Laurel Creek Monitoring Program, Aquatic Habitat (Barton, 2016). This component of the Laurel Creek Monitoring Program uses Ontario Benthic Biodiversity Monitoring (OBBN) protocol to collect and process samples at each of the monitoring sites listed above. Invertebrate data were summarized over all sampling years using indices commonly found to express sensitivity to water and aquatic habitat quality.

In general, conclusions from this report support those from the Summary of Hydrometric and Water Quality Data (Stone, 2016). Over the 20 years of monitoring, little change to the overall quality of aquatic habitat has been observed in the Laurel Creek basin. Conditions generally deteriorate downstream, with good overall quality in the headwaters of both Laurel and Beaver Creek.

Low water and aquatic habitat is observed below impoundments as low index scores in May samples. This is consistent with low water quality identified by Stone (2016) as the annual autumnal drawdown of the Laurel Creek reservoir and Columbia Lake is significant for the release of large quantities of sediment. This sediment greatly influences habitat for invertebrates. As sediment erodes steadily throughout the summer months, habitat is restored which is reflected as higher index scores in the August samples.

In summary, the quality of water and aquatic habitat is more degraded in May than in August on parts of the Laurel Creek basin influenced by upstream reservoirs and areas with high imperviousness.

Data Gaps for Section 3.9

1. Water quality data at storm sewer outlets, SWM facilities and/or from storm sewers

3.10 Natural Heritage

While stormwater management (SWM) infrastructure is not intended to provide habitat for wildlife, there are often situations where the location and type of SWM infrastructure provides potentially suitable habitat for wildlife (i.e. a SWM pond adjacent to a natural area, online SWM ponds, etc.). As SWM ponds may represent wildlife "sinks", it is not generally recommended that traditional quantity control facilities be designed to expressly provide wildlife habitat. That being said, there are several cases where SWM infrastructure can serve to benefit the natural heritage system, either through mitigation of development impacts or enhancement of ecologic function. For example, Low Impact Development measures can ensure that water is infiltrating into the ground and recharging groundwater tables, wetlands, watercourses and even woodlands; and dry ponds could serve as linkages.

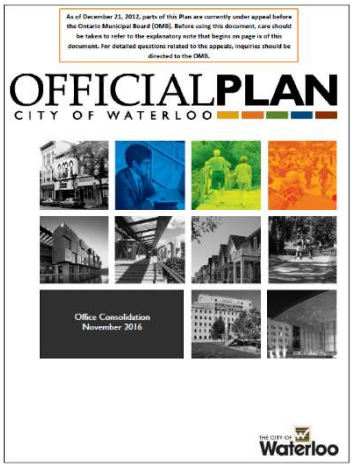
The first step in considering how SWM infrastructure could potentially impact, positively or negatively, the City of Waterloo's Natural System is to define the elements of the Natural System present in a given area. In addition, when evaluating the health of each subwatershed within the City of Waterloo, the extent and diversity of the natural heritage system is an important consideration. Accordingly, the proceeding text presents a framework for defining the elements of the City of Waterloo's Natural System.

Section 2.1.2 of the 2014 Provincial Policy Statement (PPS) states that:

> *the diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features* (Ministry of Municipal Affairs and Housing, 2014).

Accordingly, the key objectives of the City of Waterloo's Natural System are to:

a) Identify and protect elements of the Natural System through watershed-based analysis and planning.
b) Maintain, enhance, and restore *natural features* and functions.
c) Identify opportunities for ecological corridors and buffers.
d) Encourage community involvement in natural heritage maintenance, enhancement, and restoration.
e) Balance recreational opportunities and environmental protection.



The City of Waterloo's Official Plan (OP) provides a framework to guide the development of lands so that ecological processes, functions and significant natural features are protected, maintained, restored, and enhanced management, and stewardship of the environment. "This takes the form of maintaining, enhancing, and restoring the Natural System and our water resources, ensuring environmental health and safety, supporting the sustainable production and use of energy, improving air quality and reducing contributions to climate change, and encouraging sustainable

development practices. Such measures are fundamental to achieving environmental sustainability" (City of Waterloo, 2016).

The Province of Ontario provides technical guidance to implement the natural heritage policies of the PPS through the Natural Heritage Reference Manual (NHRM). The first edition of the NHRM, issued by the Ministry of Natural Resources and Forestry (MNRF) in 1999, recognizes the development of a natural heritage system (NHS) as a comprehensive approach to defining and protecting natural heritage features and areas. The most recent edition of the NHRM, issued in 2010, places greater emphasis on planning for natural heritage systems and providing connectivity among natural heritage features and areas (MNRF, 2010).

The PPS defines a Natural Heritage System as:

> *a system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional and site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored and areas with the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue*
>
> (Ministry of Municipal Affairs and Housing, 2014).

The NHS approach is a useful method for the protection of terrestrial and aquatic natural heritage features and areas because it reinforces an understanding that the elements of the system have strong ecological ties to each other, as well as to other physical features and areas in the overall landscape. The NHS approach also addresses a number of important land use planning concerns, including biodiversity decline, landscape fragmentation and the maintenance of ecosystem health. The NHRM describes these planning concerns in greater detail and outlines the potential benefits of a NHS (MNRF, 2010).

At the Regional level, the Region of Waterloo Official Plan (as approved June 2015) defines the regional NHS, or Greenlands Network. The Greenlands Network is a layered approach to environmental protection comprised of Landscape Level Systems, Core Environmental Features and Supporting Environmental Features. Each layer contains policies that provide appropriate protection to areas of environmental significance. Landscape Level Systems are recognized within the Greenlands Network as macro-scale environmental features or as concentrations of high quality Core and Supporting Environmental Features. Policies relating to Landscape Level Systems focus on protecting and enhancing the ecological integrity and functions of these landscapes (Region of Waterloo, 2015). All of the above elements of the Greenlands Network are

incorporated into the City of Waterloo's Natural System. Also included within the Waterloo Natural System are fish habitat, Restoration Areas, and Linkages (City of Waterloo, 2016).

Like the regional Greenlands Network, the City of Waterloo's Natural System is also a nested system. In summary, the City of Waterloo's NHS is comprised of:

- Landscape Level Systems;
- Core Natural Features;
- Supporting Natural Features;
- Fish Habitat;
- Ecological Restoration Areas; and,
- Linkages.

As shown in the diagram below (Error! Reference source not found.**Figure 3.10.1**), Natural Heritage Features are comprised of five (5) general natural heritage feature categories, as listed above, defined by a total of sixteen (16) specific natural heritage feature types.

City of Waterloo Natural Heritage System	Landscape Level Systems	Environmentally Sensitive Landscapes
		Significant Valleys
		Regional Recharge Areas
	Core Natural Features	Significant Habitat of Endangered or Threatened Species
		Provincially Significant Wetlands
		Environmentally Sensitive Policy Areas
		Regionally Significant Woodlands
		Environmentally Significant Valley Features
	Supporting Natural Features	Locally Significant Wetlands
		Locally Significant Woodlands
		Significant Wildlife Habitat
		Perennial Watercourses
		Intermittent Watercourses
		Other Wetlands
		Other Woodlands
		Environmentally Significant Discharge Areas and Environmentally Significant Recharge Areas
	Restoration Areas	-
	Linkages	-

Figure 3.10.1: City of Waterloo's Natural Heritage System Framework

Together, the above-mentioned Natural System components complement one another in the context of the City of Waterloo's NHS. Under the City's Official Plan, development and site alteration within the Natural System is generally prohibited; development and site alteration on adjacent lands is not permitted unless it is demonstrated that there will be no adverse environmental impacts to the natural heritage feature or its ecological function.

GIS data provided by the City of Waterloo was reviewed in the preparation of this report along with wetland GIS data from the MNRF. Schedule maps from the Region of Waterloo's Official Plan (Region of Waterloo, 2016) were also reviewed. The components of the City of Waterloo's Natural System are included in this report and are illustrated as follows:

- Environmentally Sensitive Policy Areas, **Figure 3.10.2**
- Wetlands, **Figure 3.10.3**
- Woodlands, **Figure 3.10.4**
- Watercourse Type (discussed in **Section 3.9**), **Figure 3.10.5**
- Valleylands, **Figure 3.10.6**
- Significant Recharge Areas (discussed in **Section 3.9**), **Figure 3.10.7**

The following pages of this report summarize known Landscape Level Systems, Core and Supporting Natural Heritage Features, Restoration Areas, and Linkages for each subwatershed within the City of Waterloo based upon data received from the City. As not all areas of the City have been comprehensively evaluated, the status of species-at-risk is subject to change, and ecosystems are dynamic; *not all extant NHS components are identified in this report; site-specific studies are required to accurately and comprehensively characterize the NHS for each subwatershed and/or site.* As stated in the City's OP, the Natural System is a "living system, involving plants, animals, and humans, and is therefore continually evolving".

While fish habitat is an (unmapped) element of the City of Waterloo's NHS, it is included under the heading "Aquatic Ecology", in **Section 3.9** and illustrated in **Figure 3.9.3**. For ease of reference, a table summarizing the components of the City of Waterloo's Natural System within each subwatershed is provided below (**Table 3.10.1**). Information received from the City with regards to Woodlands did distinguish Regionally Significant Woodlands. As such, Regionally Significant Woodland data is represented in **Table 3.10.1** as Core Natural Features, defined by the City's OP**.** However, it did not distinguish between Locally Significant Woodlands and Other Woodlands; this data was not available from other publicly available sources. Both features, as defined by the City's OP are considered Supporting Natural Features and are considered equal under the OP. As such, Locally Significant Woodlands and Other Woodland data is represented together in **Table 3.10.1.**

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure3.10.2
ENVIRONMENTALLY SENSITIVE POLICY AREAS

- Study Area
- Watercourse
- Environmentally Sensitive Landscapes (Laurel Creek Headwaters)
- Environmentally Sensitive Policy Area (ESPA)

ESPA Name

- Forested Hills
- Laurel Creek Conservation Area
- Laurel Creek Forest
- Optimist Swamp and Forest
- Rosendale Woods
- Schaefer`s Woods
- Schneider Woods
- St. Agatha Forest
- Stanley Park Conservation Area
- Sunfish Lake

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017 and The Ministry of Natural Resources and Forestry, 2013.

Date: May 2017

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.10.3
WETLANDS

- Study Area
- Watercourse
- Wetland (GRCA)
- Provincially Significant Wetland (Waterloo OP)

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017 and The Ministry of Natural Resources and Forestry, 2013.

Date: May 2017

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.10.4
WOODLANDS

Study Area Watercourse

OPSIG

Locally Significant and Other Woodlands

Regionally Significant Woodland

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.10.5
WATERCOURSE TYPE

Study Area

Watercourse

- Unknown
- Intermittent
- Perennial

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.10.6
VALLEYLANDS

Study Area
Watercourse
Valleylands

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

Table 3.10.1: Natural Heritage System Summary

Subwatershed	City of Waterloo Natural Heritage System																	
	Landscape Level Systems			Core Natural Features					Supporting Natural Features							Restoration Areas [1]	Linkages [1]
	Environmentally Sensitive Landscapes	Significant Valleys	Regional Recharge Areas	Significant Habitat of Endangered or Threatened Species	Provincially Significant Wetlands	Environmentally Sensitive Policy Areas	Regionally Significant Woodlands	Environmentally Significant Valley Features [1]	Locally Significant Wetlands	Significant Wildlife Habitat [1]	Perennial Watercourses	Intermittent Watercourses	Other Wetlands	Locally Significant and Other Woodlands	Environmentally Significant Discharge Areas & Environmentally Significant Recharge Areas [1]		
Alder Creek	N/A	N/A	N/A	Not a mappable feature	N/A	St. Agatha Forest		N/A	Walden West Wetland Complex	DD	✓	N/A	N/A	✓	ESDA: DD ESRA: High	DD	DD
Beaver Creek	N/A	N/A	N/A		Sunfish Lake – Laurel Creek Complex	Forested Hills	✓	N/A	N/A		✓	N/A	N/A	✓	ESDA: DD ESRA: High; Med.; Low		
Cedar Creek	N/A	N/A	N/A		N/A	N/A	✓	N/A	Walden West Wetland Complex		✓	N/A	✓	✓	ESDA: DD ESRA: N/A		
Clair Creek	N/A	N/A	✓		Sunfish Lake – Laurel Creek Complex	Forested Hills; St. Agatha Forest	✓	N/A	N/A		✓	✓	✓	✓	ESDA: DD ESRA: High; Med.; Low		
Colonial Creek	N/A	N/A	N/A		N/A	N/A	✓	✓	N/A		✓	N/A	✓	✓	ESDA: DD ESRA: Low		
Conestogo River - Lower	N/A	N/A	N/A		N/A	N/A		N/A	N/A		✓	N/A	N/A	✓	ESDA: DD ESRA: High; Med.; Low		
Forwell Creek	N/A	N/A	N/A		N/A	N/A	✓	N/A	N/A		✓	✓	✓	✓	ESDA: DD ESRA: High		
Grand River Tributaries North	N/A	✓	N/A		Waterloo Rural East Wetland	N/A	✓	✓	N/A		✓	✓	✓	✓	ESDA: DD ESRA: High; Med.; Low		
Grand River Tributaries South	N/A	✓	N/A		N/A	N/A	✓	✓	N/A		✓	N/A	N/A	✓	ESDA: DD ESRA: High; Med.		

Subwatershed	City of Waterloo Natural Heritage System																
	Landscape Level Systems			Core Natural Features					Supporting Natural Features							Restoration Areas [1]	Linkages [1]
	Environmentally Sensitive Landscapes	Significant Valleys	Regional Recharge Areas	Significant Habitat of Endangered or Threatened Species	Provincially Significant Wetlands	Environmentally Sensitive Policy Areas	Regionally Significant Woodlands	Environmentally Significant Valley Features [1]	Locally Significant Wetlands	Significant Wildlife Habitat [1]	Perennial Watercourses	Intermittent Watercourses	Other Wetlands	Locally Significant and Other Woodlands	Environmentally Significant Discharge Areas & Environmentally Significant Recharge Areas [1]		
Laurel Creek Reservoir	N/A	N/A	N/A		Sunfish Lake – Laurel Creek Complex	Forested Hills; Laurel Creek Cons. Area	✓	N/A	N/A		✓	N/A	✓	✓	ESDA: DD ESRA: High; Med.; Low		
Lower Laurel Creek	N/A	N/A	N/A	Not a mappable feature	N/A	N/A	✓	N/A	Bechtel Park Wetland	DD	✓	N/A	✓	✓	ESDA: DD ESRA: High; Med.	DD	DD
Maple Hill Creek	N/A	N/A	N/A		N/A	N/A	✓	N/A	N/A		✓	N/A	✓	✓	ESDA: DD ESRA: N/A		
Martin Creek East	N/A	N/A	N/A		N/A	N/A		N/A	N/A		✓	N/A	✓		ESDA: DD ESRA: High; Med.; Low		
Martin Creek West	N/A	N/A	N/A		N/A	N/A		N/A	N/A		✓	N/A	N/A	✓	ESDA: DD ESRA: High; Med.; Low		
Melitzer Creek	N/A	N/A	N/A		Melitzer Creek Wetland Complex	N/A	✓	N/A	N/A		✓	N/A	N/A	✓	ESDA: DD ESRA: High; Med.; Low		
Middle Laurel Creek	N/A	N/A	N/A		Sunfish Lake – Laurel Creek Complex	N/A	✓	N/A	N/A		✓	✓	✓	✓	ESDA: DD ESRA: High; Med.		
Monastery Creek	Laurel Creek Headwaters	N/A	✓		Sunfish Lake – Laurel Creek Complex	Forested Hills; Schaefer's Woods; Laurel Creek Forest	✓	N/A	N/A		✓	✓	✓	✓	ESDA: DD ESRA: High; Med.; Low		
Schneider Creek	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	✓		ESDA: DD ESRA: N/A		

3.10.1 Species at Risk

As mentioned above, species-at-risk (SAR) in Ontario are protected by the Endangered Species Act; harm to species and their habitat is prohibited under the Act and the PPS. Aquatic SAR are also protected under the federal Species at Risk Act, as aquatic species are on Federal lands/waters. The City of Waterloo's Natural System includes the Significant Habitat for Endangered and Threatened Species as well as Significant Wildlife Habitat, which affords protection to species listed as Endangered, Threatened, or of Special Concern Nationally, of Special Concern nationally and provincially, and provincially rare species (i.e. those with provincial ranks of S1-S3).

Aquafor Beech Limited contacted the Guelph District MNRF for updated information on provincially listed SAR known or suspected to occur within the City of Waterloo. The list is presented below in **Table 3.10.2**. The list of Species at Risk in Ontario and Canada are periodically updated as new information is available and species statuses change; as such it is critical to have the most up-to-date SAR information available.

Note that the absence of records for a SAR does not preclude its presence. Thus, it is important for adequate ecological surveys to be conducted in order to account for the possibility that SAR, and other species of conservation concern, may be present.

Table 3.10.2: Species at Risk Known or Suspected to Occur Within the City of Waterloo

Date Generated: September-21-17

Amphibian	SARO	Protection	Habitat Information	Timing Windows	Survey Protocol
Jefferson Salamander *Ambystoma jeffersonianum*	END	Species Protection and Habitat Regulation	Inhabits deciduous and mixed deciduous forests with suitable breeding areas which generally consist of ephemeral (temporary) bodies of water that are fed by spring runoff, groundwater, or springs.	Active: March – October Hibernates: October – March Breeding: Late March - Mid April	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Unisexual Ambystoma - Jefferson-dominated *Ambystoma laterale - jeffersonianum*	END	Species Protection and General Habitat Protection	Inhabits deciduous and mixed deciduous forests with suitable breeding areas which generally consist of ephemeral (temporary) bodies of water that are fed by spring runoff, groundwater, or springs.	Active: March – October Hibernates: October – March Breeding: Late March - Mid April	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Bird	**SARO**	**Protection**	**Habitat Information**	**Timing Windows**	**Survey Protocol**
Acadian Flycatcher *Empidonax virescens*	END	Species Protection and General Habitat Protection	Generally requires large areas of mature, undisturbed forest; avoids the forest edge; often found in well wooded swamps and ravines.	Migrate South before Winter	Follow Breeding Bird Survey Protocol
Bald Eagle *Haliaeetus leucocephalus*	SC	N/A	Prefers deciduous and mixed-deciduous forest; and habitat close to water bodies such as lakes and rivers. They roost in super canopy trees such as Pine.	Breed and Nest - April or May Some Migrate South when waterbodies freeze over	Follow Breeding Bird Survey Protocol
Bank Swallow *Riparia riparia*	THR	Species Protection and General Habitat Protection	It nests in a wide variety of naturally and anthropogenically created vertical banks, which often erode and change over time including aggregate pits and the shores of large lakes and rivers.	Migrate South before Winter	Follow Breeding Bird Survey Protocol. Colony and Roost information should be recorded and submitted using Bird Studies Canada's Ontario Bank Swallow Project data forms (2010).
Barn Swallow *Hirundo rustica*	THR	Species Protection and General Habitat Protection	Prefers farmland; lake/river shorelines; wooded clearings; urban populated areas; rocky cliffs; and wetlands. They nest inside or outside buildings; under bridges and in road culverts; on rock faces and in caves etc.	Migrate South before Winter	Follow Breeding Bird Survey Protocol

Black Tern *Chlidonias niger*	SC	N/A	Generally prefer freshwater marshes and wetlands; nest either on floating material in a marsh or on the ground very close to water	Migrate South for the Winter	Follow Breeding Bird Survey Protocol
Bobolink *Dolichonyx oryzivorus*	THR	Species Protection and General Habitat Protection	Generally prefers open grasslands and hay fields. In migration and in winter uses freshwater marshes and grasslands	Migrate South for the Winter	Contact MNR Guelph District Management Biologist to obtain a copy of the protocol
Canada Warbler *Cardellina canadensis*	SC	N/A	Generally prefers wet coniferous, decidiuous and mixed forest types, with a dense shrub layer. Nests on the ground, on logs or hummocks, and uses dense shrub layer to conceal the nest.	Arrive in Early May Migrate South for the Winter	Follow Breeding Bird Survey Protocol
Cerulean Warbler *Setophaga cerulea*	THR	Species Protection and General Habitat Protection	Generally found in mature deciduous forests with an open understorey; also nests in older, second-growth deciduous forests.	Migrate South for the Winter	Follow Breeding Bird Survey Protocol
Chimney Swift *Chaetura pelagica*	THR	Species Protection and General Habitat Protection	Historically found in deciduous and coniferous, usually wet forest types, all with a well developed, dense shrub layer; now most are found in urban areas in large uncapped chimneys	Nesting - Late April to Mid-May Migrate South in September or Early October	Chimney Swift Monitoring Protocol. Bird Studies Canada, March 2009
Common Nighthawk *Chordeiles minor*	SC	N/A	Generally prefer open, vegetation-free habitats, including dunes, beaches, recently harvested forests, burnt-over areas, logged areas, rocky outcrops, rocky barrens, grasslands, pastures, peat bogs, marshes, lakeshores, and river banks. This species also inhabits mixed and coniferous forests. Can also be found in urban areas (nest on flat roof-tops).	Migrate South for the Winter	Contact MNR Guelph District Management Biologist to obtain a copy of the protocol

Eastern Meadowlark *Sturnella magna*	THR	Species Protection and General Habitat Protection	Generally prefers grassy pastures, meadows and hay fields. Nests are always on the ground and usually hidden in or under grass clumps.	Migrate South for the Winter	Contact MNR Guelph District Management Biologist to obtain a copy of the protocol
Eastern Wood-Pewee *Contopus virens*	SC	N/A	Associated with deciduous and mixed forests. Within mature and intermediate age stands it prefers areas with little understory vegetation as well as forest clearings and edges.	Migrate South for the Winter	Follow Breeding Bird Survey Protocol
Least Bittern *Ixobrychus exilis*	THR	Species Protection and General Habitat Protection	Generally located near pools of open water in relatively large marshes and swamps that are dominated by cattail and other robust emergent plants	Migrate South for the Winter	Follow Marsh Monitoring Protocol; 10 day window of male calling (variable timing). Does not respond well to playback. Very difficult to detect.
Louisiana Waterthrush *Seiurus motacilla*	THR	Species Protection and General Habitat Protection	Generally inhabits mature forests along steeply sloped ravines adjacent to running water. It prefers clear, cold streams and densely wooded swamps	Migrate South for the Winter	Follow Breeding Bird Survey Protocol or Marsh Monitoring Protocol
Peregrine Falcon *Falco peregrinus*	SC	N/A	Generally nest on tall, steep cliff ledges adjacent to large waterbodies; some birds adapt to urban environments and nest on ledges of tall buildings, even in densely populated downtown areas.	Active Year Round - Lay Eggs around Easter Hatching occurs around Mother's Day Young fledge around Father's	Visit ideal habitat locations and listen/look for individuals in the vicinity.
Red-Headed Woodpecker *Melanerpes erythrocephalus*	SC	N/A	Generally prefer open oak and beech forests, grasslands, forest edges, orchards, pastures, riparian forests, roadsides, urban parks, golf courses, cemeteries, as well as along beaver ponds and brooks	Active from May to September	Follow Breeding Bird Survey Protocol
Wood Thrush *Hylocichla mustelina*	SC	N/A	Nests mainly in second-growth and mature deciduous and mixed forests, with saplings and well-developed understory layers. Prefers large forest mosaics, but may also nest in small forest fragments.	Migrate South for the Winter Arrive in Ontario in mid to late spring	Follow Breeding Bird Survey Protocol

Fish	SARO	Protection	Habitat Information	Timing Windows	Survey Protocol
Black Redhorse *Moxostoma duquesnei*	THR	Species Protection and General Habitat Protection	Generally lives in moderately sized rivers and streams, with generally moderate to fast currents	Active Year Round	For information please contact your local MNRF office, CA or DFO
Silver Shiner *Notropis photogenis*	THR	Species Protection and General Habitat Protection	Generally prefer moderate to large, deep, relatively clear streams with swift currents, and moderate to high gradients	Spawning occurs in May and June	For information please contact your local MNRF office, CA and/or DFO
Insect	**SARO**	**Protection**	**Habitat Information**	**Timing Windows**	**Survey Protocol**
Monarch Butterfly *Danaus plexippus*	SC	N/A	Exist primarily wherever milkweed and wildflowers exist; abandoned farmland, along roadsides, and other open spaces	Usually migrate south in late September and October	Watch for adults along roadsides and in open fields. Caterpillars feed on milkweeds: Common milkweed grows in open disturbed habitats (fields, roadsides, etc) and swamp milkweed grows in wet habitats (along streams, lakes, marshes) Adults can be spotted from a distance; caterpillars must be looked for carefully on the host plant.
Rusty-patched Bumble Bee *Bombus affinis*	END	Species Protection and General Habitat Protection	Generally inhabits a range of diverse habitats including mixed farmland, sand dunes, marshes, urban and wooded areas. It usually nests underground in abandoned rodent burrows	Active from early Spring to late Fall	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
West Virginia White *Pieris virginiensis*	SC	N/A	Generally prefer moist, deciduous woodlands. The larvae feed only on the leaves of the two-leaved toothwort (Cardamine diphylla), which is a small, spring-blooming plant of the forest floor.	Adult butterfly emerges from pupa in late March; flies only in April and May	Watch for adults within moist, deciduous woodlands Caterpillars feed on the two-leaved toothwort: Toothwort grows in damp, open, rich hardwood woodlands and blooms from April to June. Adults can be spotted from a distance; caterpillars must be searched for carefully by checking host plant
Mammal	**SARO**	**Protection**	**Habitat Information**	**Timing Windows**	**Survey Protocol**

Eastern Small-footed Myotis *Myotis leibii*	END	Species Protection and General Habitat Protection	Overwintering habitat: Caves and mines that remain above 0 degrees Celsius Maternal Roosts: primarily under loose rocks on exposed rock outcrops, crevices and cliffs, and occasionally in buildings, under bridges and highway overpasses and under tree bark.	Hibernates in caves and mines during winter	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Little Brown Myotis *Myotis lucifugus*	END	Species Protection and General Habitat Protection	Overwintering habitat: Caves and mines that remain above 0 degrees Celsius Maternal Roosts: Often associated with buildings (attics, barns etc.). Occasionally found in trees (25-44 cm dbh).	Hibernates during winter	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Northern Myotis *Myotis septentrionalis*	END	Species Protection and General Habitat Protection	Overwintering habitat: Caves and mines that remain above 0 degrees Celsius Maternal Roosts: Often asssociated with cavities of large diameter trees (25-44 cm dbh). Occasionally found in structures (attics, barns etc.)	Hibernates during winter	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Tri-colored Bat *Perimyotis subflavus*	END	Species Protection and General Habitat Protection	Overwintering habitat: Caves and mines that remain above 0 degrees Celsius Maternal Roosts: Can be in trees or dead clusters of leaves or arboreal lichens on trees. May also use barns or similar structures.	Hibernates during winter	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Mollusc	**SARO**	**Protection**	**Habitat Information**	**Timing Windows**	**Survey Protocol**
Rainbow *Villosa iris*	SC	N/A	Most abundant in shallow, welloxygenated reaches of small- to medium-sized rivers and sometimes lakes, on substrates of cobble, gravel, sand and occasionally mud.	Active Year Round	Please reference: Mackie, G, T.J Morris, and D Ming. "Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area (OGLA)." Fisheries and Oceans Canada. (2008): Print.

Wavy-rayed Lampmussel *Lampsilis fasciola*	THR	Species Protection and Habitat Regulation	Generally inhabit clear rivers and streams of a variety of sizes, where the water flow is steady and the substrate is stable	Active Year Round	Please reference: Mackie, G, T.J Morris, and D Ming. "Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area (OGLA)." Fisheries and Oceans Canada. (2008): Print.
Plant	**SARO**	**Protection**	**Habitat Information**	**Timing Windows**	**Survey Protocol**
American Ginseng *Panax quinquefolius*	END	Species Protection and General Habitat Protection	Grows in rich, moist, undisturbed and relatively mature deciduous woods in areas of neutral soil (such as over limestone or marble bedrock).	Flowering begins in June and continues until August The fruit develop from July to August and ripen in August and September	Walk slowly and systematically in grid fashion, pausing to scan for plants every 5 meters Use a plant field guide to distinguish from similar species
Butternut *Juglans cinerea*	END	Species Protection and General Habitat Protection	Generally grows in rich, moist, and well-drained soils often found along streams. It may also be found on well-drained gravel sites, especially those made up of limestone. It is also found, though seldomly, on dry, rocky and sterile soils. In Ontario, the Butternut generally grows alone or in small groups in deciduous forests as well as in hedgerows	Flowers from April to June. Fruits reach maturity during the month of September or October	Walk slowly and systematically in grid fashion through suitable habitat pausing every 30 meters for a detailed scan of trees within sight. Areas with dense foliage or many saplings will require a more intensive survey to detect sapling butternut. Use Butternut Health Assessment Protocol if planning on removing trees.
Reptile	**SARO**	**Protection**	**Habitat Information**	**Timing Windows**	**Survey Protocol**
Blanding's Turtle *Emydoidea blandingii*	THR	Species Protection and General Habitat Protection	Generally occur in freshwater lakes, permanent or temporary pools, slow-flowing streams, marshes and swamps. They prefer shallow water that is rich in nutrients, organic soil and dense vegetation. Adults are generally found in open or partially vegetated sites, and juveniles prefer areas that contain thick aquatic vegetation including sphagnum, water lilies and algae. They dig their nest in a variety of loose substrates, including sand, organic soil, gravel and cobblestone. Overwintering occurs in permanent pools that average about one metre in depth, or in slow-flowing streams.	Eggs are laid in June, with hatchlings emerging in late September and early October.	Contact MNR Guelph District Management Biologist to obtain a copy of the protocol

Eastern Ribbonsnake *Thamnophis sauritus*	SC	N/A	Generally occur along the edges of shallow ponds, streams, marshes, swamps, or bogs bordered by dense vegetation that provides cover. Abundant exposure to sunlight is also required, and adjacent upland areas may be used for nesting.	Hibernate: October - April Mating: Early Spring Hatching: Early Fall (September)	Contact MNRF Guelph District Management Biologist to obtain a copy of the protocol
Northern Map Turtle *Graptemys geographica*	SC	N/A	Generally inhabits both lakes and rivers, showing a preference for slow moving currents, muddy bottoms, and abundant aquatic vegetation. These turtles need suitable basking sites (such as rocks and logs) and exposure to the sun for at least part of the day.	Active: At night Hibernate: October - April Hatching: Late August - Early September	Scan shoreline in spring and partially submerged logs/rocks in summer for basking turtles Be aware that map turtles do not allow as close of approach as other turtles before leaving a basking site Snorkel in desired aquatic habitat
Snapping Turtle *Chelydra serpentina*	SC	N/A	Generally inhabit shallow waters where they can hide under the soft mud and leaf litter. Nesting sites usually occur on gravely or sandy areas along streams. Snapping Turtles often take advantage of man-made structures for nest sites, including roads (especially gravel shoulders), dams and aggregate pits.	Nesting: Late May and June Hibernate: October - April	Scan offshore rocks and logs for basking turtles (10am-2pm) Snorkel in desired aquatic habitat Nesting Season: Search known or preferred nesting habitat areas for females

ONTARIO MINISTRY of NATURAL RESOURCES and FORESTRY | GUELPH DISTRICT OFFICE
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3.11 Stormwater Management Infrastructure

Municipal stormwater management (SWM) infrastructure includes all SWM facilities (dry ponds, wet ponds, wetlands, and hybrid facilities), oil & grit separators and holding tanks, exfiltration systems, and storm pipe networks and associated appurtenances, such as manholes, catch basins, leads, and outfalls responsible for the capture, convey, and control (water quality and quantity) of stormwater runoff. Stream reaches are also highly important elements of a stormwater management system; however, such features will be discussed under separate sections.

The following discussions of stormwater management infrastructure within the City of Waterloo will summarize the following:

1. Existing stormwater management infrastructure within the City of Waterloo and its status.
2. Planned stormwater management infrastructure identified in existing plans but not yet constructed.
3. The progress of the City's recently established Stormwater Credit program including the number and type of credits as well as their distribution.
4. Identify data gaps to be fulfilled as part of the Stormwater Management Master Plan.

3.11.1 Existing SWM Infrastructure

The following section describes and summarizes the individual elements of the existing stormwater infrastructure within the City. Individual sections have been prepared for existing stormwater management facilities and maintenance, Oil and Grit Separators (OGS), the existing storm sewer network and associated outfall locations.

3.11.1.1 Stormwater Management (SWM) Facilities

According to the City's GIS database, there are a total of 81 active SWM facilities within the City of Waterloo. Of these facilities, 59 are owned by the City, while the remainder are private or owned by the Region of Waterloo.

Using the City's GIS data to classify the 81 SWM facilities:

- 61 of these facilities are classified as providing both quality and quantity control, and
- 20 were found to provide only quantity control.

Table 3.11.1 provides a breakdown of control areas for stormwater management facilities in the City using design drawings, design reports and Environmental Compliance Approvals as the primary source of data.

Where possible, the City's GIS data was only used to fill in gaps were other data could not classify the facility type or did not identify a total catchment area.

Table 3.11.1: Stormwater Type and Catchment Areas for City of Waterloo

Type of SWM Facility	Number of Facilities in City	Total Catchment Area (ha)	% of City Controlled
Quality Only	0	-	-
Quantity Only	20	375.9	5.8
Quality and Quality	61	1,718.1	26.3
No Stormwater Control	-	4,429.1	67.9

The 81 SWM facilities provide some level of control to 2,049.0 ha (28.8%) of the City. Of this area, approximately 1,718.1 ha (26.3%) are controlled for both water quality and water quantity, and 375.9 ha (5.8%) are controlled for water quantity only.

Accordingly, there is approximately 4,429.1 ha of the City that does not have water quality or quantity control provided by SWM facilities such as wet ponds, dry ponds, or engineered wetlands. This however includes areas of the City that are not expected to have stormwater management controls due to their impervious nature. Agricultural lands and green spaces (including municipal parks and natural features such as floodplain and woodlands) account for 1,178 ha, and 815 ha respectively. When these areas are removed from the analysis we are left with 4,530.1 ha of urban area of which a total of 46.2% is provided with some level of stormwater control. **Table 3.11.2** provides a breakdown of stormwater management facilities in the urban area.

Table 3.11.2: Stormwater Type and Catchment Areas for Urban Area of City of Waterloo

Type of SWM Facility	Number of Facilities in City	Total Catchment Area (ha)	% of Urban Controlled
Quality Only	0	-	-
Quantity Only	20	375.9	8.3
Quality and Quality	61	1,718.1	37.9
No Stormwater Control	-	2,436.1	53.8

Figure 3.11.1 shows the location of the existing stormwater management facilities within the City of Waterloo. **Figure 3.11.2** shows the location and facility type (quantity/quality) for each of the existing facilities as permitted by available background information. **Table 3.11.3** summarizes the existing SWM facilities including their type, drainage areas, installation year and basic design features.

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.11.1
STORMWATER FACILITIES

Study Area
Watercourse

SWM Pond Type
Dry Pond
Wet Pond

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

Table 3.11.3: Existing Stormwater Management Facilities

POND ID	TYPE	Year Constructed	Water Quantity Control	Design Level of Water Quality Protection	Catchment Area (ha)	CofA / ECA Available
1	Dry Pond	1990	Yes	No Data	22.5	Yes
2	Dry Pond[A]	No Data	Yes	No Data	37.9[A]	No
3	Wet Pond[A]	No Data	No Data	No Data	69.8[A]	No
4	Dry Pond[A]	No Data	Yes	No Data	142.9[A]	No
5	Hybrid	2006	Yes	Level 2 (Normal)	80.2	Yes
6	Wetland	2015	Yes	Level 1 (Enhanced)	34.5	Yes
7	Wet Pond	1989/2004	Yes	Level 3 (Basic)	20.9	Yes
8	Dry Pond[A]	No Data	Yes	No Data	78.4[A]	No
9	Dry Pond[A]	No Data	Yes	No Data	No Data	No
10	Wet Pond	1990	No Data	Level 3 (Basic)	No Data	Yes
11	Wet Pond	1992	No Data	No Data	16.5[A]	No
12	Wet Pond	1995	No Data	Level 2 (Normal)	19.3	No
13	Dry Pond	No Data	Yes	Level 1 (Enhanced)	5.5	Yes
14	Wetland	1996/2002	Yes	Level 2 (Normal)	10.2	Yes
15	Wet Pond	1996	Yes	Level 2 (Normal)	41.3	No
16	Dry Pond	1994	Yes	Level 1 (Enhanced)	5.4	Yes
17	Hybrid	1986/2011	Yes	Level 2 (Normal)	8.4	Yes
18	Dry Pond[A]	No Data	Yes	No Data	84[A]	No
19	Wet Pond	1988	Yes	No Data	36.6	No
20	Wet Pond[A]	1985	No Data	No Data	75[A]	Yes
21	Wet Pond[A]	No Data	No Data	No Data	No Data	No
22	Wet Pond	1993	No Data	No Data	1.3	Yes
23	Dry Pond[A]	No Data	Yes	No Data	No Data	No
24	Wet Pond	1994	Yes	Level 3 (Basic)	80.0	Yes
25	Wet Pond	No Data	Yes	No Data	3.2	No
26	Wet Pond	1989	Yes	No Data	17.9	Yes
27	Wet Pond	2000	Yes	Level 2 (Normal)	45.7	Yes
28	Wet Pond[A]	No Data	No Data	No Data	4[A]	No
29	Hybrid	2000	Yes	Level 2 (Normal)	8.2	Yes
30	Wet Pond	1996	Yes	Level 1 (Enhanced)	44.0	Yes
31	Dry Pond	1994	Yes	Level 2 (Normal)	50.7	Yes
32	Dry Pond[A]	No Data	Yes	No Data	4.3[A]	No
33	Wet Pond	1997	Yes	Level 3 (Basic)	80.0	No
34	Dry Pond	1990	Yes	No Data	22.2	Yes
35	Wetland	2002	Yes	Level 2 (Normal)	4.8	Yes
36	Dry Pond	1987	Yes	No Data	12.7	No
37	Wet Pond[A]	No Data	No Data	No Data	4.8[A]	No
38	Wetland	1999/2008	Yes	Level 2 (Normal)	55.9	Yes
39	Wetland	1998	Yes	Level 2 (Normal)	30.4	Yes
40	Wetland	1998	Yes	Level 2 (Normal)	19.6[A]	Yes
41	Wetland	1998	Yes	Level 2 (Normal)	18.1	Yes

POND ID	TYPE	Year Constructed	Water Quantity Control	Design Level of Water Quality Protection	Catchment Area (ha)	CofA / ECA Available
42	Dry Pond	1998	Yes	Level 2 (Normal)	34.9	Yes
43	Wetland	2001	Yes	Level 2 (Normal)	56.4	Yes
45	Wet Pond	1997	Yes	Level 2 (Normal)	29.4	No
46	Hybrid	2013	Yes	Level 1 (Enhanced)	4.6	No
47	Wet Pond[A]	No Data	No Data	No Data	No Data	No
48	Wet Pond[A]	1989	Yes	No Data	76.7[A]	Yes
49	Dry Pond	1983	Yes	No Data	10.0	No
50	Wet Pond[A]	No Data	No Data	No Data	76.7[A]	No
51	Wetland	2000	Yes	Level 2 (Normal)	17.4	Yes
52	Wet Pond	2000	Yes	Level 1 (Enhanced)	6.1	Yes
53	Wet Pond	2000	Yes	Level 1 (Enhanced)	19.4	Yes
54	Wet Pond	2001	No Data	Level 2 (Normal)	8.1	Yes
55	Wet Pond	1999	Yes	Level 3 (Basic)	5.2	No
56	Wet Pond	1999	Yes	Level 2 (Normal)	25.6	Yes
57	Wet Pond	1999	Yes	Level 2 (Normal)	5.2	Yes
58	Wet Pond	2003	Yes	Level 1 (Enhanced)	5.9	Yes
59	Wet Pond	2002/2008	Yes	Level 1 (Enhanced)	60.9	Yes
62	Dry Pond	2000	Yes	Level 3 (Basic)	8.2	Yes
64	Wet Pond[A]	No Data	No Data	No Data	No Data	No
65	Wetland	2005	Yes	Level 2 (Normal)	23.7	Yes
71	Wetland	2010	Yes	Level 2 (Normal)	29.7	No
72	Wet Pond[A]	No Data	No Data	No Data	4.8[A]	No
77	Wet Pond[A]	No Data	No Data	No Data	No Data	No
78	Wetland	2010	Yes	Level 2 (Normal)	11.8	No
79	Dry Pond[A]	No Data	Yes	No Data	No Data	No
80	Wetland	2010	Yes	Level 2 (Normal)	56.8	No
84	Wet Pond[A]	No Data	No Data	No Data	11.2[A]	No
86	Wet Pond	2005	Yes	Level 2 (Normal)	No Data	Yes
87	Wet Pond	2005	Yes	Level 2 (Normal)	No Data	Yes
88	Dry Pond	2005	Yes	No Data	No Data	Yes
89	Wetland	2011	Yes	Level 1 (Enhanced)	26.6	Yes
91	Wetland	2011	Yes	Level 1 (Enhanced)	48.8	Yes
93	Wetland	2012	Yes	Level 1 (Enhanced)	12.4	Yes
60	Wet Pond	2005	Yes	Level 1 (Enhanced)	7.3	Yes
61	Wetland	2005	Yes	Level 1 (Enhanced)	17.0	Yes
63	Wet Pond	2004	Yes	Level 1 (Enhanced)	8.2	Yes
70	Wet Pond	2004	Yes	No Data	No Data	No
75	Wet Pond	2012	Yes	Level 2 (Normal)	44.1	Yes
76	Wet Pond	2012	Yes	Level 2 (Normal)	44.1	Yes

-Levels 1, 2, & 3 shown in **Table 3.11.3** are based on MOECC (1994 & 2003) definition which translates into “enhanced”, “normal” and “basic”

-[A] indicates that City of Waterloo GIS Data was used to fill data gap

3.11.1.2 Stormwater Management (SWM) Facilities Maintenance

To maintain water quality performance and ensure sufficient detention volume is maintained for flood control, periodic sediment removal is necessary. More specifically, the Ministry of Environment (2003) Stormwater Management Planning and Design Manual (SWMPDM) outlines that a SWM facility is due to be cleaned out once its target sediment removal efficiency has decreased to 5% below design level due to sediment accumulation. Other maintenance that can be expected at most SWM facilities includes outlet repairs, erosion repairs, debris removal and brush clearing.

To prioritize maintenance issues at SWM facilities it is necessary to know the approximate period since last sediment removal. The last year of sediment removal (dredging) is indicated in **Table 3.11.4**. Sediment removal data was only available for 18 SWM facilities.

Table 3.11.4: Sediment Removal Years for SWM Facilities

POND ID	Last Sediment Removal year
1	2000[A,B]
7	2004 [A,B]
12	2000 [A,B]
13	2000[A]
14	2003[B]
17	2011 [A]
19	2000 [A,B]
20	2000 [A,B]
21	2002[B]
24	2010 [A,B]
28	2002 [A,B]
31	2010 [A,B]
33	2003 [A,B]
42	2002 [A,B]
49	2002 [A]
51	2005 [A,B]
54	2007 [A,B]
63	2004 [A]

[A] Data from City of Waterloo GIS

[B] Data from 2015 City of Waterloo Stormwater facility Assessment (Ecosystem Recovery)

In 2015, a Stormwater Management Facility Assessment was conducted for the City by Ecosystem Recovery Inc. As part of the assessments, bathymetric surveys were completed and compared for design drawings to determine estimated annual loading rates and remaining capacity of each facilities permanent pool volumes. The results of this analysis are summarized in **Table 3.11.5**.

Table 3.11.5: Sediment Accumulation Summary from 2015 SWMF Assessment Report

POND ID	Years of Operation since Construction or Sediment Removal[1]	Percent of Permanent Pool filled with Sediment (%)	Estimated Annual Loading (m^3/ha/year)
21	13	85	5.1
3	23	85	0.3
53	23	71	12.9
28	13	75	1.1
20	15	73	0.4
21	13	71	0.1
62	15	84	2.0
10	22	62	0.9
52	13	61	8.8
14	12	59	3.1
12	15	58	4.7
64	9	54	No Data
33	12	54	4.6
30	19	40	3.9
54	8	39	2.3
58	12	35	4.1
29	15	33	2.5
55	15	30	2.6
50	No Data	27	No Data
7	11	25	4.9
42	13	25	3.2
15	20	25	1.2
34	18	24	1.6
38	16	24	2.8
64 (Rideau pond north)	9	24	4.8
64 (Rideau pond north A)	9	23	4.8
1	15	23	2.8
27	15	23	2.4
19	15	22	0.9
31	5	21	1.8
5	9	20	1.1
25	29	18	0.8
51	10	17	3.0
57	14	17	1.3
64 (Rideau pond east)	9	15	2.4
64 (Rideau pond east A)	9	15	2.4
45	16	14	2.2

POND ID	Years of Operation since Construction or Sediment Removal[1]	Percent of Permanent Pool filled with Sediment (%)	Estimated Annual Loading (m^3/ha/year)
41	16	12	0.6
56	16	7	0.4
24	5	7	0.6
11	23	0	0.0

[1]Updated to reflect years since report published

3.11.1.3 Oil Grit Separators (OGS)

Oil Grit Separators (OGSs) are priority water quality treatment devices that can provide long-term sediment removal using hydrodynamic separation. These devices are commonly installed on sites that have size constraints that limit the feasibility of SWM facilities such as ponds and wetlands.

According to the City's GIS database, there are a total of 235 OGS units in the City of Waterloo. Of these units 59 are owned and operated by the City, 7 are owned and operated by the Region of Waterloo and 156 are privately owned and operated. There are 13 OGS units for which ownership cannot be classified with existing data. The geographical disbursement and ownership of the OGS units is shown in **Figure 3.11.1.3.**

The City of Waterloo maintains an extensive database of OGS data. Included in the database are installation dates, site addresses, ownership, maintenance responsibilities, inverts, and access port diameters. At this time, determining the total area of the City and within each catchment that is controlled by OGS units is not feasible as catchment area delineations for each OGS unit are not available. **Table 3.11.6** presents OGS install dates, ownership, maintenance responsibilities, model numbers and allowable sediment depths for OGS units within the City. Although inspection dates are recorded in the database, they are not available for every OGS. Table **3.11.7** identifies inspection and clean out dates for 50 of the 59 OGS units that are owned and operated by the City.

Table 3.11.6: OGS Data for City, Regional and Private OGS Units within the City

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080562	August 25, 2005	Private	Vortechnics	Private	No Data
10080552	September 4, 2009	Private	STC-750	Private	230 mm
10080604	November 2, 2011	Private	STC-750	Private	230 mm
10080528	September 26, 2006	Private	STC-2000	Private	350 mm
10080566	July 15, 2010	City	STC-750	City	230 mm
10080532	September 26, 2002	Private	STC-750	City	230 mm
10080606	January 11, 2012	Private	STC-750	Private	230 mm
10131820	May 20, 2014	Private	STC-300	Private	225 mm
10080715	March 14, 2007	Private	STC-300i	Private	225 mm
10080714	May 26, 2008	Private	STC-300i	Private	225 mm
10080615	February 22, 2010	Private	STC-750	Private	230 mm
10080607	January 1, 1994	City	STC-1000	City	275 mm
10080668	August 2, 2001	City	STC-1000	City	275 mm
10080686	June 7, 2010	Private	STC-750	Private	230 mm
10080536	October 19, 1998	City	STC-3000	City	375mm
10080535	October 19, 1998	City	STC-3000	City	375mm
10080640	June 15, 2006	Private	STC-1000	Private	275 mm
10080540	May 20, 2014	Private	STC-300	Private	225 mm
10080587	May 26, 2011	Private	STC-300	Private	225 mm
10080517	March 29, 2012	Private	STC-750	Private	230 mm
10080695	January 1, 1999	City	STC-1500	City	400 mm
10080708	July 12, 2010	Private	STC-300i	Private	225 mm
10080678	November 29, 2007	Private	STC-300	Private	225 mm
10080647	January 1, 1999	City	STC-1500	City	400 mm
10080687	October 7, 2010	Private	STC-300i	Private	225 mm
10080569	January 1, 1999	City	STC-1500	City	400 mm
10080713	December 3, 2009	Private	STC-300	Private	225 mm
10080664	January 1, 1998	Private	STC-1500	Private	400 mm
10080546	June 1, 2001	Private	STC-750	Private	230 mm
10080605	September 8, 1999	Private	STC-750	City	230 mm

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080570	July 21, 2000	City	STC-750	City	200 mm
10080601	September 8, 1999	Private	STC-3000	City	475 mm
10080700	January 1, 2000	Private	STC 1500	City	400 mm
10080597	January 9, 2006	Private	STC-300	Private	225 mm
10080560	August 1, 1996	Private	STC-2000	Private	350 mm
10080618	September 9, 2005	City	STC-1500	City	400 mm
10080639	September 3, 1998	City	STC-4000	City	375 mm
10080680	May 13, 1999	Private	STC-1500	Private	400 mm
10143778	July 20, 2001	Private	No Data	No Data	No Data
10080683	July 6, 2006	Region	STC-2000	Region	350 mm
10080712	December 1, 2015	Private	STC 300	Private	225 mm
10131827	July 14, 2014	Private	STC-750	Private	230 mm
10080707	March 1, 2010	Private	STC-750	Private	230 mm
10131819	July 14, 2014	Private	STC-300	Private	225 mm
10080616	October 19, 2009	Private	STC-2000	Private	350 mm
10080595	May 12, 1998	Private	STC-1000	No Data	275 mm
10080646	September 3, 1998	City	STC-1500	City	400 mm
10080679	October 2, 2002	Private	STC-750	Private	230 mm
10080516	November 6, 1998	Private	STC-3000	Private	475 mm
10080697	May 14, 2003	City	STC-1500	City	400 mm
10080701	May 26, 2000	Private	STC-750	Private	230 mm
10131823	July 14, 2014	Private	STC-300	Private	225 mm
10080596	August 4, 2006	Region	STC-2000	Region	350 mm
10080602	November 12, 2009	Private	STC-300i	Private	225 mm
10080511	October 16, 2002	City	STC-2000	Private	350 mm
10131825	July 14, 2014	Private	STC-2000 MOD	Private	350 mm
10080603	November 12, 2009	Private	STC-300i	Private	225 mm
10080655	September 10, 2002	Private	STC-1000	Private	275 mm
10080693	January 6, 2004	Private	STC-750	Private	230 mm
10080649	December 10, 2002	City	STC-1000	City	275 mm
10080539	October 18, 2011	Private	STC-300i	Private	225 mm

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10143777	July 1, 1999	Private	No Data	No Data	No Data
10080652	August 27, 2010	Private	STC-300i	Private	225 mm
10131818	January 1, 2014	Private	STC 300	Private	225 mm
10080501	June 20, 2000	City	STC-1500	City	375mm
10080576	August 10, 1999	Private	STC-5000	Private	500 mm
10080670	01/01/1850 0:00:00	Private	No Data	Private	No Data
10080706	October 14, 1999	Private	STC-750	Private	230 mm
10080508	September 19, 2000	City	STC-3000	City	475 mm
10080593	February 27, 2003	Private	STC-300i	Private	225 mm
10080509	May 27, 2011	Private	STC-300	Private	225 mm
10080507	April 26, 2004	Region	STC-750	City	230 mm
10080524	July 13, 2004	City	STC-2000	City	350 mm
10080648	November 20, 2002	City	STC-6000	City	425 mm
10080557	November 7, 1997	Private	STC-3000	Private	475 mm
10080660	November 20, 2002	City	STC-6000	City	425 mm
10080520	July 24, 1998	Private	STC-3000	Private	475 mm
10080512	August 12, 2004	Private	STC-300	Private	225 mm
10080574	December 14, 2011	Private	STC-300i	Private	225 mm
10080599	May 19, 2004	Private	STC-5000	Private	500 mm
10080688	December 8, 2004	Private	STC-300	Private	225 mm
10080584	April 14, 2000	UofW	STC-750	Private	230 mm
10080696	February 19, 2014	Private	STC 300i	Private	225 mm
10080677	August 26, 2013	Private	STC-300i	Private	225 mm
10080645	July 29, 2004	Private	STC-4000	City	375 mm
10080567	June 15, 2011	City	STC-9000-IN	City	375mm
10147141	June 15, 2011	City	STC-9000-OUT	City	375mm
10080614	July 27, 2010	Private	STC-750	Private	230 mm
10080705	April 30, 2008	Private	STC-750	Private	230 mm
10080609	October 23, 2000	WCDSB	STC-2000	Private	350 mm
10143955	January 1, 2006	Private	STC-750	No Data	230 mm
10080515	June 13, 2005	City	STC-2000	City	350 mm

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080710	July 13, 2006	Private	STC-750	Private	230 mm
10080617	March 2, 2001	Private	STC-300	Private	225 mm
10080559	August 7, 2002	Private	STC-750	Private	230 mm
10080510	January 1, 2014	Private	STC-300i	Private	225 mm
10080514	June 13, 2005	City	STC-1000	City	275 mm
10080650	July 20, 2011	City	STC-6000	City	425 mm
10080554	May 18, 2004	Private	STC-300	Private	225 mm
10080608	January 1, 1998	City	STC-1500	City	375mm
10080719	October 23, 2009	City	STC-4000	City	375 mm
10080624	January 30, 2014	Private	STC-2000	Private	350 mm
10080594	March 1, 2010	Private	STC-300i	Private	225 mm
10080661	May 2, 2005	City	STC-750	City	200 mm
10149252	June 1, 2016	Private	STC 300	Private	225 mm
10080634	May 6, 2003	Private	STC-3000	Private	475 mm
10146773	October 21, 2015	Private	STC 300	Private	225 mm
10143312	October 1, 2015	Private	STC 300	Private	225 mm
10080626	January 29, 2014	Private	STC-300	Private	225 mm
10080653	April 26, 2004	Region	STC-750	City	230 mm
10080538	August 16, 2002	Private	STC-2000	Private	350 mm
10080534	January 5, 2001	Private	STC-1500	Private	400 mm
10080643	August 31, 2010	UofW	STC-750	Private	230 mm
10080676	October 21, 2015	Private	STC-750	Private	230 mm
10131764	July 1, 2015	Private	STC-300i	Private	225 mm
10131824	December 8, 2014	City	STC-2000	City	350 mm
10080622	March 31, 2015	City	STC6000	City	425 mm
10080675	November 26, 2015	Private	STC-750	Private	230 mm
10080658	April 2, 2012	Private	STC-300	Private	225 mm
10080662	September 1, 2004	Private	STC-2000	Private	350 mm
10080583	September 11, 2003	Private	STC-1000	Private	275 mm
10139366	January 1, 2013	Private	STC-750	Private	230 mm
10080556	October 30, 2008	Private	STC-750	Private	230 mm

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080541	October 13, 2010	Private	STC-300	Private	225 mm
10080620	February 21, 2012	Private	STC-300i	Private	225 mm
10170887	January 1, 2015	Private	STC 300	Private	225 mm
10080621	August 19, 2011	Private	STC-300	Private	225 mm
10080612	June 4, 1998	Private	STC-750	Private	230 mm
10080698	March 21, 2012	City	STC-4000	City	375 mm
10080563	March 21, 2012	City	STC-3000	City	475 mm
10080641	March 25, 2010	Private	STC 300i	Private	225 mm
10080673	July 14, 2011	Private	STC-300	Private	225 mm
10132494	May 15, 2013	Private	STC-300	No Data	225 mm
10080611	December 5, 1995	Private	STC-750	Private	230 mm
10080703	August 13, 2008	Private	STC-300	Private	225 mm
10080533	April 26, 2004	Region	STC-1500	City	400 mm
10080542	December 4, 2007	Private	STC-750	Private	230 mm
10131829	June 13, 2014	Private	STC-300	Private	225 mm
10080580	April 26, 2004	Region	STC-750	City	230 mm
10080589	November 2, 1999	Private	STC-4000	Private	400 mm
10080633	January 7, 2013	Private	STC-2000	Private	350 mm
10080610	July 9, 2001	Private	STC-750	Private	230 mm
10080590	November 2, 1999	Private	STC-1500	Private	400 mm
10080506	September 30, 2005	Private	STC-1000	Private	275 mm
10080718	October 30, 2009	Private	STC-750	Private	230 mm
10080694	January 1, 2012	Private	No Data	Private	No Data
10080579	March 21, 2012	City	STC-4000	City	400 mm
10080636	April 15, 2010	Private	STC-750	Private	230 mm
10080717	May 27, 2004	Region	STC-4000	Region	400 mm
10080654	March 12, 2012	City	STC-4000	City	400 mm
10080531	July 9, 2001	Private	STC-1000	Private	275 mm
10080619	May 27, 2004	City	STC-4000	City	400 mm
10080571	January 1, 2012	Private	No Data	Private	No Data
10080547	December 8, 2004	Region	STC-4000	Region	400 mm

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080555	January 1, 2012	Private	No Data	Private	No Data
10080625	July 9, 2010	Private	STC-4000	Private	400 mm
10080627	November 28, 1996	Private	STC-4000	Private	400 mm
10080523	December 2, 1997	Private	STC-6000	Private	425 mm
10080709	June 13, 2006	Private	STC-750	Private	230 mm
10080551	September 29, 1999	City	STC-6000	City	425 mm
10143088	May 22, 2001	Private	No Data	No Data	No Data
10143085	May 22, 2001	Private	No Data	No Data	No Data
10143087	May 22, 2001	Private	No Data	No Data	No Data
10080651	September 29, 1999	City	STC-6000	City	425 mm
10080550	September 25, 2003	City	STC-1500	City	400 mm
10080561	September 6, 2000	City	STC-2000	City	350 mm
10080519	October 21, 1997	Private	STC-2000	Private	350 mm
10080545	November 10, 1995	WCDSB	STC-1500	Private	400 mm
10080691	March 30, 2011	Private	STC-300	Private	225 mm
10080689	September 24, 2004	Private	STC-750	Private	230 mm
10146775	July 1, 2015	Region	STC-750	Region	230 mm
10080513	July 31, 2000	Private	STC-1500	Private	400 mm
10080565	March 22, 1999	Private	STC-750	Private	230 mm
10146971	No Data	No Data	No Data	No Data	No Data
10146774	July 1, 2015	Region	STC-300	Region	225 mm
10080503	September 1, 2004	Private	STC-750	Private	230 mm
10146777	July 22, 2015	Private	STC-750	Private	230
10080553	01/01/1850 0:00:00	Private	STC-1000	Private	275 mm
10080665	November 1, 1995	WRDSB	STC-1500	Private	400 mm
10080504	April 16, 2002	Private	STC-2000	Private	350 mm
10131822	May 20, 2014	Private	STC 6000	No Data	425 mm
10080711	January 9, 2013	Private	STC 2000	Private	350 mm
10080672	November 2, 1999	Private	STC-750	Private	230 mm
10132496	May 1, 2015	Private	STC 3000	No Data	475 mm
10080637	October 12, 2000	City	STC-4000	City	375mm/15in

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080635	July 28, 2003	City	STC-1500	City	400 mm
10080572	September 1, 1998	City	STC-1000	City	275 mm
10080684	June 23, 1998	Private	STC-2000	Private	350 mm
10147140	May 16, 2011	Private	STC-750	Private	230 mm
10080702	October 17, 2000	Private	STC-3000	Private	475 mm
10080549	June 16, 2000	Private	STC-4000	Private	400 mm
10080682	July 8, 1999	Private	STC-4000	Private	400 mm
10080657	February 22, 2001	Private	STC-750	Private	230 mm
10144553	March 1, 2006	Private	No Data	No Data	No Data
10080502	October 2, 2000	Private	STC-1500	Private	400 mm
10080505	July 8, 1999	Private	STC-1500	Private	400 mm
10080518	June 10, 1998	Private	STC-1000	Private	275 mm
10080592	April 1, 1998	Private	STC-3000	Private	475 mm
10080716	July 18, 2008	Private	STC-1500	Private	400 mm
10080600	June 22, 2004	Private	STC-300i	Private	225 mm
10080544	August 19, 1997	Private	STC-750	Private	230 mm
10080588	October 10, 2003	Private	STC-750	Private	230 mm
10080613	May 7, 2002	Private	STC-750	Private	230 mm
10080720	April 20, 2012	Private	STC-9000	Private	425 mm
10080598	August 17, 2005	Private	STC-1000	Private	275 mm
10080674	April 1, 1998	Private	STC-5000	Private	500 mm
10080681	July 25, 2007	Region	STC-4000	Region	400 mm
10080530	March 6, 2000	Private	STC-4000	Private	400 mm
10080663	April 21, 1998	Private	STC-3000	Private	475 mm
10080644	June 1, 1999	City	STC-1000	City	275 mm
10080699	October 27, 2000	City	STC-2000	City	350 mm
10080527	September 29, 2014	Private	STC 2000	Private	350 mm
10080577	November 30, 2001	Private	STC-750	Private	230 mm
10141897	June 27, 2016	Private	No Data	No Data	225 mm
10132495	August 26, 2013	Private	STC-750	Private	230 mm
10080671	October 15, 2007	Private	STC-300i	Private	225 mm

Asset ID	Date Installed	Owner	Model	Maintenance Provider	Allowable Sediment Depth
10080558	July 6, 2006	Private	STC-750	Private	230 mm
10080690	June 30, 2005	Private	STC-750	Private	230 mm
10080522	May 26, 1999	City	STC-3000	City	475 mm
10080529	May 23, 2007	Private	STC-2000	Private	350 mm
10080548	May 1, 2003	Private	STC-750	Private	230 mm
10080591	June 19, 2006	Private	STC-750	Private	230 mm
10080656	August 2, 2000	Private	STC-1000	Private	275 mm
10080704	September 1, 2005	Private	STC-750	Private	230 mm
10080543	February 10, 2004	Private	STC-750	Private	230 mm
10080575	July 12, 2000	City	STC-3000	City	475 mm
10080685	March 19, 2010	Private	STC-1000	Private	275 mm
10080568	September 21, 2009	City	STC-1500	City	400 mm
10080564	August 1, 2002	Private	STC-750	Private	230 mm
10080667	October 1, 1998	Private	STC-4000	Private	400 mm
10080666	September 25, 1998	Private	STC-4000	Private	400 mm
10080573	July 12, 2000	City	STC-3000	City	475 mm
10080521	April 24, 2001	City	STC-2000	City	350 mm
10080578	September 15, 2000	City	STC-4000	City	400 mm
10080585	September 15, 2000	City	STC-2000	City	350 mm

Table 3.11.7: OGS Data for City, Regional and Private OGS Units within the City

Asset ID	Model	Cleanout Depth (mm)	Sediment Depth (mm) *Indicates cleanout after sediment depth measurement			
			2007	2011	2015	2016
10080501	STC-1500	400			1016	1066.8*
10080508	STC-3000	475			457.2	
10080514	STC-1500	275				76.2
10080515	STC-2000	350				304.8
10080521	STC-2000	350	Cleaned		304.8	406.4
10080522	STC-3000	475	Cleaned		965.2*	0
10080524	STC-2000	350			254	101.6
10080535	STC-3000	475	Cleaned		1498.6	1320.8*
10080536	STC-3000	475	Cleaned		1549.4	762*
10080550	STC-1500	400	Cleaned	Cleaned	660.4	787.4*
10080551	STC-6000	425			330.2	228.6
10080561	STC-2000	350			482.6	254
10080563	STC-3000	475			609.6	762
10080566	STC-750	230			203.2	25.4
10080567	STC-9000	400			0	0
10147141	STC-9000	400				
10080568	STC-1500	400			76.2	304.8
10080569	STC-1500	400			711.2	609.6
10080570	STC-750	230			673.1	609.6*
10080572	STC-1000	275	Cleaned		635*	0
10080573	STC-3000	475			914.4*	0
10080575	STC-3000	475	Cleaned	Cleaned	1079.5*	0
10080578	STC-4000	400			431.8	254
10080579	STC-4000	400			381	101.6
10080585	STC-2000	350			330.2	254
10080607	STC-1000	275			0	0
10080608	STC-1500	400	Cleaned		685.8	711.2*
10080618	STC-1500	400		Cleaned	457.2	431.8
10080619	STC-4000	400			406.4	76.2
10080622	STC-6000	425				1016

Asset ID	Model	Cleanout Depth (mm)	Sediment Depth (mm) *Indicates cleanout after sediment depth measurement			
			2007	2011	2015	2016
10080635	STC-1500	400			1231.9*	0
10080637	STC-4000	400		Cleaned	1219.2	1244.6*
10080639	STC-4000	400			889	711.2*
10080644	STC-1000	275			2616.2*	0
10080645	STC-4000	400		Cleaned	1016	990.6*
10080646	STC-1500	400			228.6	228.6
10080647	STC-1500	400			762	889
10080648	STC-6000	425			0	50.8
10080649	STC-1000	275	Cleaned		190.5	304.8
10080650	STC-6000	425			508	
10080651	STC-6000	425			762	381
10080654	STC-4000	400			406.4	457.2*
10080660	STC-6000	425			0	50.8
10080661	STC-750	230			812.8	838.2*
10080668	STC-1000	275			0	0
10080695	STC-1500	400			1143	1168.4
10080697	STC-1500	400			330.2	
10080698	STC-4000	400			838.2	838.2*
10080699	STC-2000	350			1397	0
10131824	STC-2000	350			0	50.8

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.11.2
EXISTING OGS

Study Area
Watercourse

Existing OGS Ownership

- Unknown
- City of Waterloo
- Private
- Region of Waterloo

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.11.1.4 Storm Sewer Network

The stormwater conveyance network within the City includes storm sewers that are owned by the City and the Region as well as those on MTO or private property. The network is comprised of approximately 524 km of storm sewer of varying sizes. **Table 3.11.8** identifies the ownership, size and installed quantities of all storm sewers within the City. The table shows that pipes of sizes less than 600 mm diameter represent the bulk of the storm sewer within the City.

Table 3.11.8: Storm Sewer Data for City, Regional and Private Pipes

Pipe Sizes (mm)	City of Waterloo		Region of Waterloo		Other[1]	
	km	%	km	%	km	%
Unknown size	33.3	8.1	10.2	15.7	7.5	16.7
Less than 450	195.6	47.3	24.2	37.2	30.6	68.0
450 - 525	67.1	16.2	11.4	17.5	1.7	3.8
600 - 750	55.9	13.5	8.2	12.6	3.0	6.7
800 - 1000	23.8	5.8	5.6	8.6	0.8	1.8
1050 - 1200	18.2	4.4	4.1	6.3	1.1	2.4
Greater than 1200	19.7	4.8	1.3	2.0	0.3	0.7
Total	**413.6**	**79.0**	**65.0**	**12.4**	**45.0**	**100.0**

[1] Includes 146 m on MTO Property, 4,308 m on University of Waterloo Property and 43,153 m on private property

The City's 2016 Asset Management Plan identifies that approximately 48% of the storm collection assets are in poor or very poor condition. The average annual budgeted capital expenditures of approximately $2.0 million will result in a decline in the condition profile of the storm collection assets over the next 25 years to a level which is anticipated to not be acceptable to most stakeholders. It is estimated that an annual expenditure of approximately $5.2 million per year over the next 25 years is required to achieve the target condition profile of the storm collection assets. The geographic distribution of storm sewer pipe is shown in **Figure 3.11.3**.

3.11.1.5 Outfall Network

The City of Waterloos GIS database identifies 338 storm sewer outfalls which discharge to watercourses, SWM facilities, or other drainage networks.

Table 3.11.1.5 identifies that the number of stormwater outfalls in each subwatershed within the City. The geographic location of each outfalls is shown on **Figure 3.11.9**.

Table 3.11.9: Stormwater Outfalls by Subwatershed

Subwatershed	# Outfalls
Alder Creek	0
Beaver Creek	0
Cedar Creek	10
Clair Creek	78
Colonial Creek	28
Conestogo River - Lower	1
Forwell Creek	35
Grand River Tributaries North	12
Grand River Tributaries South	2
Laurel Creek Reservoir	17
Lower Laurel Creek	54
Maple Hill Creek	27
Martin Creek East	3
Martin Creek West	13
Melitzer Creek	5
Middle Laurel Creek	47
Monastery Creek	4
Schneider Creek	2

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.11.3
STORMWATER SEWER SYSTEM & OUTFALLS

- Study Area
- Watercourse
- Stormwater Outfall
- Stormwater Pipe

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.11.2 SWM Planning

3.11.2.1 Identified Stormwater Management Projects

The City of Waterloo has identified and has allocated budget for several stormwater management projects that are slated to start between 2017 and 2025. These projects include technical studies, infrastructure improvements, large scale infrastructure maintenance and creek rehabilitations. The projects are summarized below. All costs stated include contingency, HST and inflation.

Correction of Lot Drainage Problems

These projects are undertaken to correct drainage problems in areas where third party actions have created a need for grading rectification. (i.e. catch basin installation or revised grading of overland flow routes). Annual budget of approximately $60,000 has been allocated from funding sources through 2025 for these projects.

Creek Bank Stabilization

Urban creek environments are prone to erosion and structural failure due to changes in the hydrologic cycle causing flashier flood events and flows from storm sewer outfalls causing stress on the banks. The purpose of these funds is to provide the ability to undertake spot repairs to creek banks where required. Annual budget of approximately $60,000 has been allocated from funding sources through 2025 for these projects.

SWM Pond Sediment Removal

Stormwater Management Facilities require sediment removal to ensure water quality function and storm detention is maintained. Several SWM facilities are reaching their sediment accumulation limit. The MOECC's Environmental Compliance Approval (ECA) for stormwater management facilities identify the requirements to remove excessive sediment and ensure that the pond is operating as per the approved design. Failure to follow these requirements will result in ECA non-compliance and could result in penalties under the Federal Fisheries Act, Ontario Water Resources Act, and the Environmental Protection Act. The City has allocated budget (approximately $1.1 million/year) for an average of three (3) sediment removal and disposal projects a year through 2025.

Clair Creek North Reach 1 Rehabilitation

A detailed design for this approximately 765 metre section of Clair Creek from south of Columbia Street to the Stormwater Management (SWM) pond in Leighland Park is required to identify measures that would be required to rehabilitate and protect this section. Based on recommendations in the Clair Creek EA, the final design will be prepared and the work implemented. It is the intention of this Council that the project be funded, to the extent permitted under the Development Charges Act, 1997, from development charges and that any excess capacity arising from this project be paid for by development charges. The project is slated to be implemented in 2019 after the completion of detailed design in 2018 and will cost approximately $1.3 million.

Core Area Development Driven Upgrades-Stormwater

The Uptown Core Area Infrastructure Study identified deficiencies with the Sanitary sewers & Watermains. Most of the issues are with capacity for future growth. This project sheet provides the City funds for watermain and sewer upgrades to accommodate development in designated growth nodes. Generally, the Developer is responsible for any upgrades on the city block of the proposed development. The City, through Development Charge Funding, is responsible for the reconnection of services from

adjacent properties and the new mains. Approximately $780,000 annually has been allocated for this project through 2025.

Development Driven Storm Sewer Upgrades - City Wide

Older portions of the City are serviced with pipes designed for a 1:2-year storm event. Infill and intensification in the nodes and corridor will require storm sewers to be replaced. It is assumed approximately 25% of existing Storm sewers will need to be replaced over the next 10 years. These funds are for storm sewer upgrades to accommodate development in designated growth nodes. Generally, the Developer is responsible for any storm sewer upgrades on the city block of the proposed development. The City, through Development Charge Funding, is responsible for the reconnection of Storm services from adjacent properties and the new storm connection to the existing Storm system. Approximately $1 million from funding sources has been allocated for this project.

Forwell Creek Industrial Lands

A Functional Study is scheduled to occur in 2018. Specific recommendations will identify flood control measures along 3,500 meter stretch of Forwell Creek to protect the industrial lands adjacent to Forwell Creek. It is anticipated that property acquisition will be required to provide lands for storm water management facilities to slow flood waters down before reaching the creek and to provide water quality improvement to the runoff. An education program will be required to accompany these measures. The design phase of this project is scheduled to occur in 2023 with implementation spanning 2024 and 225. In total, the project requires a budget of approximately $3 million.

Laurel Creek Channel Around Columbia Lake

The R&T Park Environmental Reserve Class EA and Functional Study are complete and approved. The study recommends that Columbia Lake be reconfigured and a new Laurel Creek channel be built around the lake. By doing this, Columbia Lake will be essentially "off-line" and there will be improvements to the water quality and aquatic habitat to the downstream watershed. In 2005, the reconfiguration of the lake was constructed however additional funds are required to build the creek channel. The project has been forecast for 2025 with an expected budget of approximately $1.5 million.

Laurel Creek Rehabilitation - Reservoir to Erbsville Rd

A Class EA for this approximately 1,050 metre section of Laurel Creek from the Reservoir to Erbsville Road is required to identify measures that would be required to rehabilitate and protect this section. Based on recommendations in the Class EA (2022) the final design will be prepared (2024) and the work implemented (2025). Approximately $2 million has been allocated through funding sources for all phases of this project.

Laurel Creek Functional Study & Implementation - Regina to Weber

Laurel Creek from Regina to Weber Street flows through a highly urbanized area of the City of Waterloo. The Creek has historically been straightened and subject to intense uncontrolled storm flows. Due to these impacts Laurel Creek is experiencing bank erosion and downcutting which is placing structures at risk. The purpose of this study is to identify remediation measures for the stream environment. The project is slated to include a functional study EA (2018), detailed design (2019), implementation from Erb to Bridgeport (2020), and Implementation from Bridgeport to Weber (2021). Approximately $2.3 million has been allocated through funding sources for all phases of this project.

Laurel Creek Study Implementation - Hillside Park to HWY 85
The Laurel Trunk Sewer and Creek EA (completing fall 2010) identified several enhancements/restorations to the natural environment and creek along the Hillside Park corridor. This project allots funds for those enhancements not related to the Sanitary sewer construction. The project has been scheduled for 2020 and 2021. The budget is expected to be approximately $750,000.

Laurel Creek Study Implementation - Hillside Park to HWY 85
Maple Hill Creek is a highly impacted creek system. Previous development with outdated stormwater practices have caused the stream to be channelized and hardened with gabion baskets. These structures are beginning to fail and residents have raised concerns regarding potential property loss. In addition, the Ontario government has legislated the mandatory inspection of bridges every two calendar years. The bridge inspection report identified that the culvert running through Maple Creek starting from Thorndale Dr. East of Fischer-Hallman Rd. to Westvale Drive West of Fischer-Hallman Road needs to be replaced. A systematic watershed scale approach is necessary for a 1.1 km section of the creek to address these issues. The project is slated to include a functional study EA (2016/2017), detailed design (2018), implementation (2018-2019). Approximately $2.8 million has been allocated through funding sources for all phases of this project.

Sediment Removal Creeks - City Wide
Urbanized streams experience excessive sediment loading from storm water washing off of roads, driveways, gardens, construction sites, etc. The sediment settles out in the creek environment smothering and raising the stream bed. This reduces the conveyance capacity of the stream and related structures (i.e. culverts) and buries outlet structures causing flooding onto adjacent properties. It also impacts on the aquatic health and water quality of the stream environment. Routine sediment removal is required to remediate this problem. From 2019 through 2025, approximately $60,000 has been allocated annually from municipal funding sources.

Silver Lake Study - EA Addendum
To identify a preferred remediation option for Silver Lake, an addendum to the 1996 Environmental Assessment (EA) study will be completed. Laurel Creek upstream of the Lake will also be rehabilitated to improve water quality, reduce erosion, create habitat and replace deteriorating structures. This is integral to the completion of the Silver Lake Rehabilitation because it will help to reduce sediment and pollutants entering Silver Lake. The project will include an EA Addendum and EIS (2017), detailed design (2017/2018), implementation of creek improvements (2018) and implementation of lake improvements (2019). The approximate cost of all phases of the project is expected to be $7.3 million.

Waterloo Spurline Storm Sewer Upgrades
Through the corridor, the City's storm sewer system requires repair and upgrading to extend the functional lifespan and mitigate urban flooding. This project is scheduled to be completed in 2017 with a total budget of approximately $1 million.

3.11.2.2 Stormwater Management Facilities – Retrofits and Sediment Removal

As discussed in **Section 3.11.1.2**, sediment removal is required to ensure SWM facilities maintain their design permanent pool and extended detention volume required for water quality and water quantity control respectively. Even with sediment removal, some facilities cannot meet contemporary stormwater objectives because of outdated designs or facility degradation. In some instances, a retrofit can be completed to enhance water quality, water quantity and/or water balance performance. Retrofits projects often include some of the following design modifications:

- Addition of or expansion of permanent pool volume
- Modification of outlet structure
- Extension of flow path / reduction of flow velocities
- Addition of forebay
- Addition of pretreatment
- Addition of infiltration facility
- Addition of cooling trench

Using facility maintenance priorities as identified in the 2015 Stormwater Management Facility and internal operational observations and input, the City of Waterloo has developed a schedule for SWM facility retrofits and sediment removals. **Table 3.11.9** identifies proposed retrofits and sediment removals through 2019.

Table 3.11.9: Scheduled Stormwater Management Facility Sediment Removal and Retrofits

Facility ID	Year	Type of Retrofit
53	2017	Sediment removal & re-use study
41	2017	Retrofit (cooling trench repair)
28	2018	Retrofit and Sediment Removal
10	2018	Retrofit and Sediment Removal
48	2018	Retrofit and Sediment Removal
62	2018	Retrofit and Sediment Removal
7	2018	Sediment Removal
55	2018	Sediment Removal
52	2018	Sediment Removal
14	2018	Sediment Removal
12	2018	Sediment Removal
20	2019	Retrofit and Sediment Removal
30	2019	Retrofit and Sediment Removal
33	2019	Retrofit and Sediment Removal
38	2019	Retrofit and Sediment Removal
3	2019	Retrofit and Sediment Removal
4	2019	Retrofit and Sediment Removal

3.11.2 Source Controls and SWM Credits

The City of Waterloo created a separate storm water utility to fund operation, maintenance and capital projects pertaining to stormwater management through the establishment of a stormwater charge on property owners based. A complimentary element establishes a stormwater charge credit awarded to landowners that demonstrate to the City that user`s stormwater facilities or best management practices provide the City with cost savings that the City would otherwise incurs as part of its efforts to manage storm water. Best management practices may include, but are not limited to the use of rain barrels, cisterns, rain gardens, permeable pavers and other practices promoting the infiltration and control of stormwater runoff.

Since its establishment in 2013, the City of Waterloo has issued over 2,300 credits as part of its credit program. The distribution of these credits amongst residential and non-residential properties is illustrated in **Figure 3.11.4**.

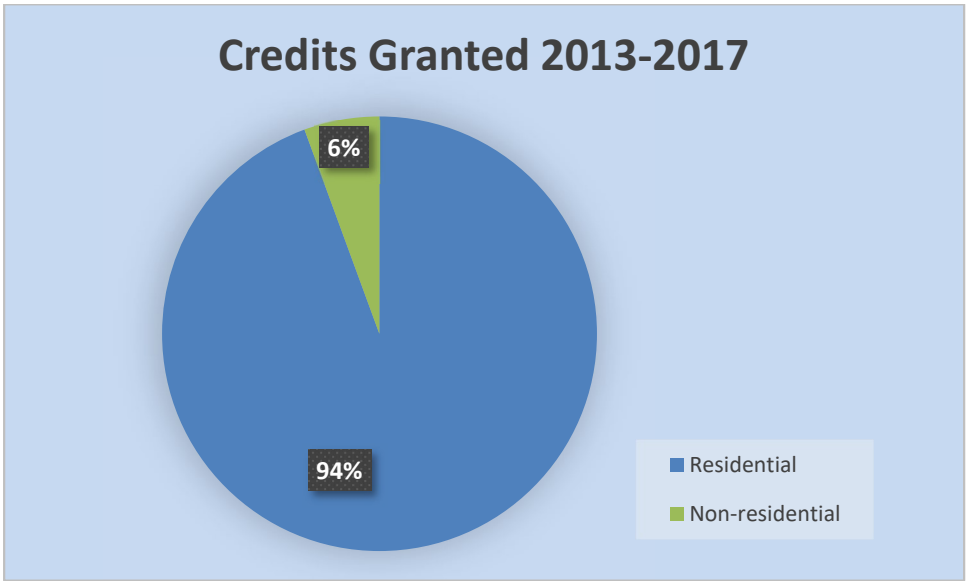

Figure 3.11.4: SWM Credits Granted – Residential vs. Non-Residential

Table 3.11.10 summarizes the number of credits per year granted since 2013 to 2017 and **Table 3.11.11** summarizes the credits granted per property type.

Table 3.11.10: SWM Credits Granted from 2013-2017

Year	Number of Credits Granted
2013	837
2014	407
2015	388
2016	432
2017	260
Total Credits Granted	**2324**

Table 3.11.11: SWM Credits Granted from 2013-2017 by Property Type

Property Type Breakdown	Credits Granted per Property Type	Percentage Uptake of Total Available Grants per Property Type
Single Family Residential	2194	7.76%
Non-residential	130	46.75%
Multi-residential	37	6.03%
Institutional	60	32.78%
Industrial	13	3.97%
Commercial	20	3.97%

Data Gaps for Section 3.11

1. Current shape files or GIS geodatabase for Stormwater Management Facility Catchment Areas
2. Current shape files or GIS geodatabase of Stormwater Credits applied for and/or successfully granted by the City
3. Information on any groundwater collection systems maintained by the City
4. Current shape files or GIS geodatabase and any design reports associated with stormwater infiltration facilities and other Stormwater LIDs maintained by the City
5. A list of stormwater management facilities, OGS, and stormwater LIDs that are planned or under construction but not in the provided datasets used for existing conditions
6. Any shape files or GIS geodatabase associated with "Identified Stormwater Management Projects" in Section 3.11.2.1.

3.12 Water Supply

Municipal potable water is the supply of water provided through a central distribution system operated by a municipality. Municipal water use includes urban domestic use, whether indoor or outdoor, and also includes uses for industrial, commercial, institutional or other uses that rely on municipalities for their water supply.

3.12.1 Watershed Context

The Grand River system is highly valued by watershed residents. The people of the Grand River watershed depend on the river to serve several essential functions, including in the context of domestic water supply, as it provides a raw water source for drinking water supplies for municipal water systems serving about 600,000 people.

There are 47 municipal groundwater supply systems within the Grand River watershed that rely on groundwater as a drinking water source. This includes twenty-four (24) in the Regional Municipality of Waterloo.

The Grand River Watershed Characterization Report (2008) identified the following proportions of Municipal Water use by source for the 41 municipal systems within the 11 municipalities within the watershed:

- Deep Overburden (groundwater- bedrock) – 39%
- Overburden (groundwater) – 30%
- Grand River (surface water) – 28%
- Great Lakes – 3%

A 2005 study entitled *Water Use in the Grand River Watershed* (Bellamy and Boyd, 2005) identified the following top 15 water uses within the Grand River watershed.

1. Municipal Water Supply
2. Dewatering
3. Aggregate Washing
4. Aquaculture
5. Remediation
6. Golf Courses
7. Agriculture
8. Agricultural Irrigation
9. Other – Industrial
10. Miscellaneous
11. Manufacturing
12. Food Processing
13. Rural Domestic
14. Cooling Water
15. Recreational

3.12.2 Regional Context

The Regional Municipality of Waterloo (RMOW) operates a total of eighteen (18) municipal drinking water systems that serve a population of approximately 500,000 through the Urban System (IUS). The IUS is a complex network of wells, reservoirs, pumping stations and trunk water mains which supplies water to people living in Cambridge, Kitchener, Waterloo, Elmira, and St. Jacobs. Seventeen (17) smaller water supply systems provide water to some settlement areas in the four townships. In all, groundwater is extracted from 115 wells throughout the Region and

surface water is obtained from an intake at the Grand River (Hidden Valley Intake) in Kitchener. Together these sources of water supply approximately 260,000 cubic metres of water a day.

The RMOW is responsible for water supply, storage and the operation of the trunk distribution system (including maintenance of pressure zones), while the lower tier municipalities are responsible for local distribution and customer billing.

Water Efficiency

In 1998, the Regional Council approved a Water Efficiency Master Plan (WEMP) that established a goal of reducing water consumption by 6.8 ML/d (1.5 MIgd) by 2009. As part of the WEMP, the Region endorsed an "enhanced water efficiency program" that included:

- subsidized rain barrel distribution,
- an Ayr Water Efficiency Program,
- a new Outdoor Water Use Bylaw and
- an increased public education program.

The 1998 WEMP and its enhancements formed an effective strategy to achieve water savings.

An updated WEMP was accepted by Regional Council in July 2006 to replace the 1998 Master Plan. The updated WEMP establishes the plan for water conservation in the Region from 2007 to 2015. This nine-year program focuses on the following areas:

- General Public Education;
- Outdoor Water Use Reduction;
- Efficient Toilet Replacement;
- Industrial, Commercial and Institutional Efficiencies;
- Municipal Leak Reduction; and,
- Research and Development.

The 2007-2015 plan targets a water savings of more than 8,146 m^3/d (1.8 MIgd) over the nine-year period. The estimated annual average budget (operating and capital) is $1.1 million per year.

3.12.3 City of Waterloo Context

The City of Waterloo is served by a combination of 5 Waterloo and 4 Wilmot groundwater wells drawing from the Waterloo moraine along with water production from the Manheim recharge facility. The central Waterloo land uses include several known historically contaminated sites, existing small industries, and commercial establishments. Waterloo Well W10 on the west side of the City is classified as a GUDI (groundwater under direct influence of surface water) in a predominantly residential area (Grand River Watershed Characterization Report, 2008).

Within the City of Waterloo are six (6) Regional wells within the Waterloo moraine. The wells are grouped according into two (2) Well Fields. These are identified in **Table 3.12.1**. and shown in **Figure 3.12.1**.

Table 3.12.1: Regional Wells within City of Waterloo

Well Field	Wells	Details	Identified Issue & Associated Threat
William Street Wellfield	W01B, W01C, W02, & W03	Screened from 20 to 34 m below ground surface	Chloride Issue Contributing Area
Waterloo North Wellfield	W05 & W10	W05 screened at 33 to 37 m below ground surface W10 is screened at 9 m to 18 m below ground surface	W05 ceased full-time production in the late 70s due to elevated TDS, hardness, iron and sulphate W10 is a GUDI and within a Chloride Issue Contributing Area

3.12.4 Well Head Protection Areas (WHPA) & Intake Protection Zones (IPZ)

As required under the Clean Water Act (2006), the Grand River Source Protection Area (Plan) – Approved Assessment Report (2012) sets forth policies that prevent activities from becoming a significant drinking water threat to surface and groundwater drinking supplies. This includes threatened areas highly vulnerable aquifers, significant groundwater recharge areas (SGRA), wellhead protection areas (WHPA), and surface water intake protection zones (IPZ).

In 2000, the WHPAs were incorporated in the Regional Official Policies Plan (ROPP) and were delineated using a multiple-component process including: undertaking three-dimension computer modeling for specific geographic areas, delineating well capture zones (land area contributing water supplies to the wells), creating capture zone envelopes or WHPAs, and developing a semi-quantitative indexing method to classify these areas into sensitivity categories. With the exception of the ASR wells, WHPA-B, WHPA-C and WHPA-D steady-state capture zones for Municipal Wells found in the Region of Waterloo were delineated with the Regional FEFLOW model. Well Head Protection Area (WHPA) pumping rates were prescribed by the Region. Pumping rates used for the delineation of the capture zones represent either the maximum safe yield of the production well (in urban areas), or the rate that would be required to meet predicted demand at the end of the current planning cycle (in rural areas). WHPA-E capture zones were delineated and scored for wells classified as groundwater under the direct influence of surface water (GUDI) in the Region of Waterloo.

Well Head Protection Areas (WHPAs) A to E which are relevant to the City of Waterloo are illustrated on **Figure3.12.1.**

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.12.1
WELLHEAD PROTECTION AREAS (WHPA)

- Study Area
- Watercourse
- City of Waterloo Wells

Wellfield

- Erb Street
- Greenbrook
- Lancaster
- Mannheim
- Mannheim West
- Pompeii Forwell
- Strange Street
- Waterloo North W05
- Waterloo North W10
- William Street
- Woolner

Wellhead Protection Areas

Wellhead Travel Zones

- A (0 to 2 years)
- B (2 to 5 years)
- C (5 to 10 years)
- D (10 to 25 years)
- E (25+ years)

0 0.5 1 Kilometers

N

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Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.12.5 Intake Protection Zones (IPZ)

The Region of Waterloo's Hidden Valley intake is located in the City of Kitchener in the Grand River downstream of the City of Waterloo. It consists of a small overflow weir located on the Grand River immediately downstream of the outlet from the Hidden Valley ESPA (see **Figure 3.12.2**). While the intake is outside of the City of Waterloo, watercourses - such as Laurel Creek - within the City boundaries that drain into the Grand River have the potential to impact the Hidden Valley intake.

Three (3) levels of IPZ's were delineated for the Hidden Valley Surface Water Intake, IPZ-1, IPZ-2 and IPZ-3. Within the City of Waterloo, there are no IPZ-1, however IPZ-2 and IPZ-3 do exist within the City boundaries. The three levels of IPZ's are discussed below:

- IPZ-1 – an area consisting of a 200 m radius semicircle in the upstream direction and extending an additional 10 m downstream which represents the most vulnerable areas adjacent to the intake;
- IPZ-2 – 2-hour in river flow time to the intake that represents the contributing area found upstream of the intake. Plant operators have minimal time to respond to spills in this zone; and
- IPZ-3 – the area found upstream of the IPZ-2 that represents the contributing water courses and adjacent lands, using an on-land setback based on the GRCA Regulation Limit, or 120 m, whichever was greater. The majority of the IPZ-3 delineation follows established GRCA watershed and subcatchment boundaries.

The Intake Protection Zone areas that are relevant to the City of Waterloo is illustrated on **Figure 3.12.2.**

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.12.2
INTAKE PROTECTION ZONES

- Study Area
- Watercourse
- City of Waterloo Wells
- Intake Protection Zones

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.12.6 Threats and Issue Contributing Areas (ICAs)

The Ontario Clean Water Act, 2006, defines a Drinking Water Threat as "an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and includes an activity or condition that is prescribed by the regulation as a drinking water threat."

If an Issue is identified for a well, all threats within the Issue Contributing Area that can potentially release the same chemical are automatically considered significant threats, regardless of the vulnerability. The Issue Contributing Area was selected on a case-by-case basis taking into account the following considerations:

- potential for multiple sources of contamination to complicate or prevent adequate management/mitigation of the contamination at the intake/well,
- potential for natural attenuation of the specific contaminant within the aquifer,
- potential effectiveness of mitigation/prevention programs over the Issue Contributing Area,
- the contaminant distribution in the aquifer, and
- the specifics of the well field hydrogeological system including groundwater-surface water interaction.

Issues relating to high concentration of chloride in well water were identified for the William Street Wellfield and wellhead W10 in the Waterloo North Wellfield.

Issue Contributing Area (ICA) has been developed in response to the identified issues for each of the aforementioned wells and well fields. Additional detail in regards to the delineation of each ICA is detailed below according to the relevant wells and/or well field. The corresponding ICAs are illustrated on **Figure 3.12.3.**

It is important to note that it is the activities not the land-use that relate to the ICA. The ICAs are a 'risk-based' approach which is intended to eliminate the threats that could contribute to an identified issue.

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.12.3
ISSUE CONTRIBUTING AREAS

- Study Area
- Watercourse
- Issue Contributing Area (ica) - CHL & TCE

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

3.13 Wastewater

Municipal wastewater is one of the largest sources of pollution, by volume, to surface water in Canada[3]. Municipal wastewater normally receives treatment before being released into the environment. The higher the level of treatment provided by a wastewater treatment plant, the cleaner the effluent and the smaller the impact on the environment.

The following section summarizes the watershed based, regional and local wastewater systems, approaches and demands placed on the area water resources.

3.13.1 Watershed Context

There are 30 municipal wastewater treatment plants discharging to the Grand River and its tributaries. The municipal wastewater treatment plants vary in size. Treatment level varies, and includes lagoon systems, as well as secondary and tertiary treatment systems. Secondary treatment refers to biological and chemical removal of organic matter from sewage. In tertiary wastewater treatment plants, advanced treatment processes are used to remove other constituents such as ammonia and phosphorus. There are no primary treatment systems or combined sewer overflows located in the Grand River watershed.

Approximately 85 percent of the total population of the watershed is serviced through municipal wastewater treatment plants. The remaining people have on-site septic or sewage systems. About two thirds of the serviced population is serviced by secondary treatment, while the remaining third have tertiary treatment, which includes advanced wastewater treatment such as the reduction of ammonia.

In the Grand River Watershed, there are a total of ten (10) wastewater treatment plants which discharge directly into the Grand River or the Speed River – including Fergus, Elora, Waterloo, Kitchener, Guelph, Hespeler, Preston, Galt, Paris and Brantford.

3.13.2 Regional and Local Context

The Region of Waterloo is responsible for treating all wastewater in the Region and operates 13 treatment plants. The three (3) largest waste water treatment plants (WWTP) in the Region of Waterloo are Waterloo, Kitchener and Hespeler.

As the Grand River flows through the Region of Waterloo, water quality is greatly influenced by the five (5) upstream wastewater treatment plants – Elmira, Alt-Heidelberg, St. Jacobs, and Conestogo.

Within the City of Waterloo is the Waterloo Wastewater Treatment Plant (WWTP) located at 340 University Avenue East immediately west of Highway 85. The plant is a conventional activated sludge plant that is designed to provide carbonaceous BOD removal, chemical phosphorus removal, disinfection (sodium hypochlorite) and anaerobic digestion. The Waterloo WWTP has a

[3] Government of Canada (2010) Proposed Wastewater Systems Effluent Regulations. Canada Gazette, Part I, 144(12), March 20, 2010.

hydraulic capacity of 72,730 m^3/d (Wastewater Treatment Master Plan, 2007). Treated wastewater is discharged into the Grand River. Based on the MOECC Certificate of Approval as updated in 2002, **Table 3.13.1** identifies effluent non-compliance limits (as average concentration over a 6-week period).

Table 3.13.1: Effluent Quality Parameters for non-Exceedance as Outlined in COA

Effluent Parameters	Average Concentration (< 54,600 m^3/d)	Average Concentration (> 54,600 m^3/d)
BOD_5	15.0 mg/L	15.0 mg/L
Suspended Solids	15.0 mg/L	15.0 mg/L
Total Phosphorus	0.8 mg/L	0.6 mg/L
Ammonia + Ammonium Nitrogen	-	1.8 mg/L
Fecal Coliform	200/100 mL	200/100 mL

Due difficulty meeting the more stringent water quality criteria associated with flows greater than 54,600 m^3/d, the Region has operated the facility at a self-imposed operational capacity of 54,600 m^3/d. Plans to provide the capability of nitrification and allow for release of the full hydraulic capacity are in the works. The design basis for proposed upgrades is a twenty-year timeframe (to 2031). The City's Wastewater Collection Network is identified in **Figure 3.13.1**.

THE CITY OF Waterloo

MUNICIPAL CLASS EA STORMWATER MANAGMENT MASTER PLAN

Figure 3.13.1
SANITARY NETWORK

- Study Area
- Watercourse
- Sanitary Network

0 0.5 1 Kilometers

N

Aquafor Beech Limited

Base data provided by The City of Waterloo, 2017.

Date: May 2017

13.13.3 Wastewater and Stormwater Integration

As part of the Assessment of Future Water Quality Conditions in the Grand and Speed Rivers (2012), a number of water management scenarios were developed which incorporated wastewater treatment plant upgrades in current municipal wastewater master plans, wastewater treatment plant optimized performance targets and, most relevant to the City of Waterloo SWM-MP, are rural / agricultural and urban non-point source load reductions. Key questions that were addressed in the study included:

- Will the planned upgrades to wastewater treatment result in improved river water quality in future?
- What additional actions may be required to improve water quality, e.g. optimization of wastewater treatment processes, reducing nutrient inputs to the river from agricultural or urban non-point sources?

The study utilized the Grand River Simulation Model (GRSM) which enables watershed municipalities and partners to evaluate the cumulative effects of point and non-point source management approaches for the Grand and Speed Rivers for the purposes of strategic wastewater management planning. The GRSM simulates treated effluent from 10 wastewater treatment plants (WWTPs): Fergus, Elora, Waterloo, Kitchener, Guelph, Hespeler, Preston, Galt, Paris and Brantford. Seven (7) scenarios were developed to investigate future water quality impacts to the Grand River, of which two (2) scenarios represented future effluent flow with the inclusion of:

- Reduction in Urban Non-point Source Concentrations by 20%
- Reduce Urban Non-point Source Concentrations by 40%

The report notes the following, which relate to future SWM approaches in the City of Waterloo, and the need for integration of watershed resources as it relates to wastewater and stormwater:

1. Urban non-point source impacts on the river's ability to assimilate nutrients (i.e. waste assimilation) are not well quantified or characterized and are poorly understood.
2. The mechanisms or processes involved in urban non-point source delivery and the impact of urban stormwater on the river requires additional analysis and study
3. The concentration reductions chosen for the Urban Non-point scenarios were arbitrary and there is insufficient information available to determine how these reductions would be realized or if they are achievable.

The Grand River Watershed Management Plan, further acknowledge the need to quantify urban non-point pollution sources collaboratively by the City of Waterloo, the GRCA and the Region of Waterloo.

3.13 Cultural Heritage

It is appropriate at this high level of planning for a SWM-MP to perform an appropriately high level of screening for known or identified potential archeological and Cultural resources. Heritage screenings or technical studies as are required can be applied in the final selection of preferred undertakings. Doing so includes cultural heritage resources in the evaluation of alternatives at this preliminary stage. At later stages of the SWM-MP, and/or subsequent EAs to the plan, the more detailed processes stipulated by the archaeology and cultural heritage landscape can be applied to the individual projects.

Cultural heritage information was not provided to the project team as part of the SWM-MP in preparation of this report and has been identified as a data gap to be resolved for subsequent submission.

Data Gaps for Section 3.13

1. Reports and current shape files or GIS geodatabase for known Cultural Resources within the City of Waterloo.

3.14 Summary of Data Gaps

The following section summarizes the identified data gaps for the respective disciplines as described in the previous sections.

Land-Use:

1. Shape files or GIS geodatabase associated with schedules B, B2 and B3 from the City's Official Plan
2. Shape files or GIS geodatabase for existing land use parcels

Hydrology

1. Current shape files or GIS geodatabase for floodplain policy areas (Two Zone and Special Policies Areas)
2. Most recent floodplain studies (reports) for watersheds within or partially within the City of Waterloo

Fluvial Geomorphology

1. Current shape files or GIS geodatabase for watercourse channel types (e.g. concrete lined, restored, natural, etc.)

Water Quality

1. Water quality data at storm sewer outlets, SWM facilities and/or from storm sewers

Stormwater Management Infrastructure

1. Current shape files or GIS geodatabase for Stormwater Management Facility Catchment Areas

2. Current shape files or GIS geodatabase of Stormwater Credits applied for and/or successfully granted by the City
3. Information on any groundwater collection systems maintained by the City
4. Current shape files or GIS geodatabase and any design reports associated with stormwater infiltration facilities and other Stormwater LIDs maintained by the City
5. A list of stormwater management facilities, OGS, and stormwater LIDs that are planned or under construction but not in the provided datasets used for existing conditions
6. Any shape files or GIS geodatabase associated with "Identified Stormwater Management Projects" in Section 3.11.2.1.
7. Missing stormsewer information (inverts, lengths etc, per **Table 3.11.8.** Note: a separate tabular summary has been provided.

Cultural Heritage

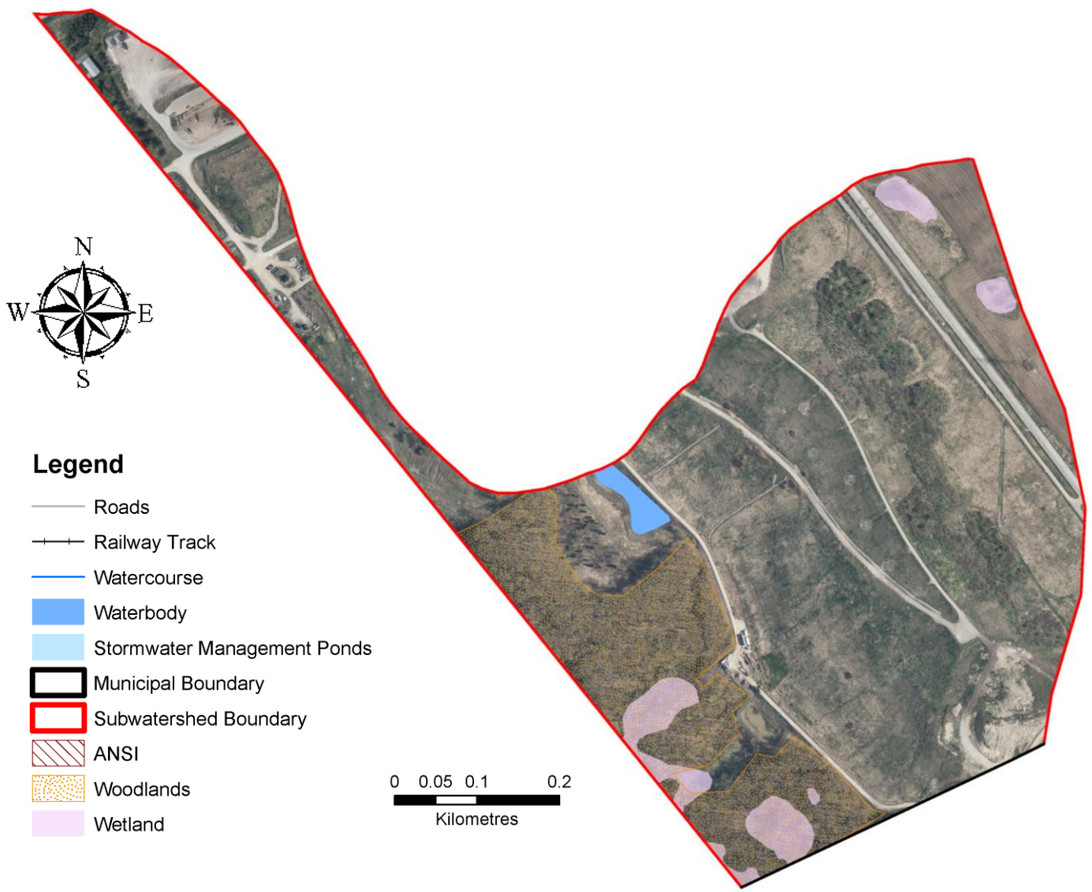
1. Reports and current shape files or GIS geodatabase for known Cultural Resources within the City of Waterloo.

Appendix A – Subwatershed Summaries

Alder Creek Subwatershed

Alder Creek Overview

Alder Creek is within the Lower Nith River sub-basin (GRFMPIC, 2005). The headwaters of this watercourse originate on the southwestern border of the City of Waterloo. Very little of the watershed is within the City of Waterloo; most is in the City of Kitchener and the Township of Wilmot. Alder Creek is a tributary of the Nith River, which is, in turn, a tributary of the Grand River. The Alder Creek watershed drains 81.2 km^2 of mixed forest, agricultural land, and small urban areas (Alder Creek Watershed Study and Upper Strasburg Creek Subwatershed Plan Update, CH2MHILL 2008). Within the City of Waterloo, the Alder Creek subwatershed has a drainage area of approximately 46.06 ha, and is located within a high recharge area. Alder Creek is categorized as a warm water stream. The dominant land use within the subwatershed is agricultural (99.8%).



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
46.06	0.15	0	3.28	82

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Insufficient data	Insufficient data	Insufficient data	Fair

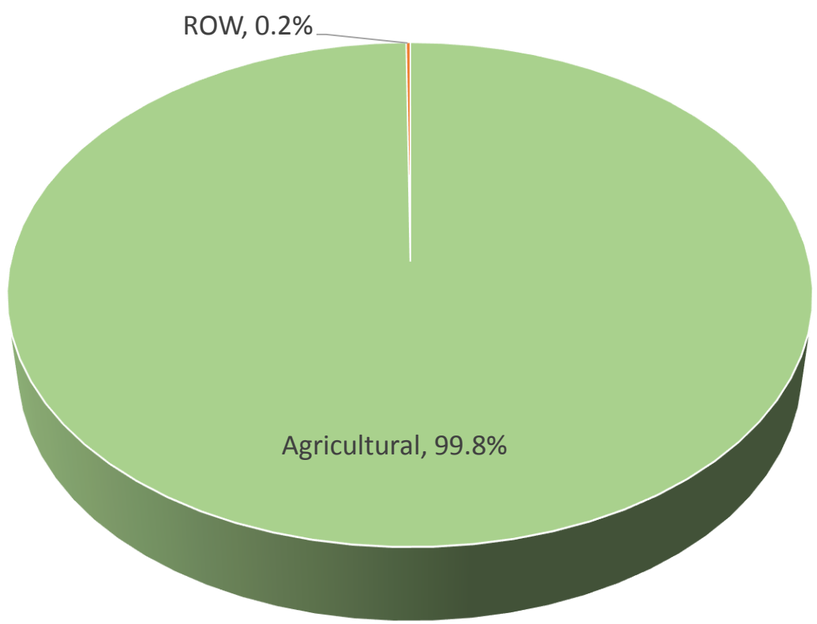
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
0	8.49	8.49	0

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Environmentally Sensitive Policy Areas: *St. Agatha Forest*
Supporting Natural Features	Locally Significant Wetland Complex: *Walden West Wetland Complex* Locally Significant and Other Woodlands

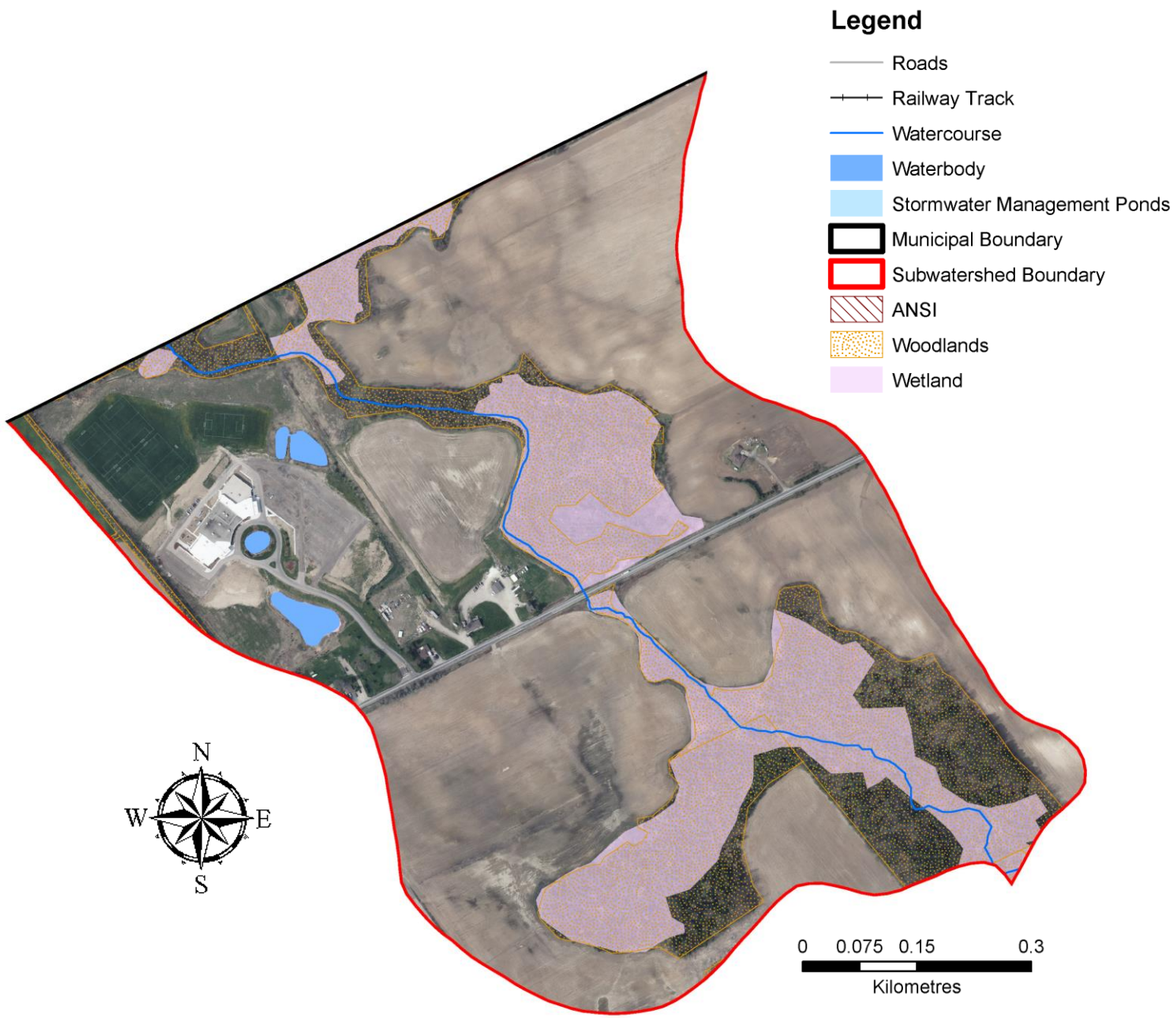
Land Use



Beaver Creek Subwatershed

Beaver Creek Overview

Beaver Creek is a tributary of Laurel Creek, upstream of Laurel Creek Reservoir. The headwaters of this watercourse originate in Wellesley Township. Within the City of Waterloo, the Beaver Creek subwatershed has a drainage area of approximately 85.8 ha, and is located within a high capacity significant recharge area. Much of the watershed is located in a Designated Greenfield Area by the Official Plan. The dominant land use within the watershed is agricultural (98.9%). The subwatershed has retained many of its wetlands, as nearly 18% of the watershed is classified as a wetland. Beaver Creek is categorized as a cold water stream, as only 2% of the channel is classified as warm water.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
85.81	0.86	19.61	17.93	1,576

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Excellent	Fair	Insufficient data	Fair	Good

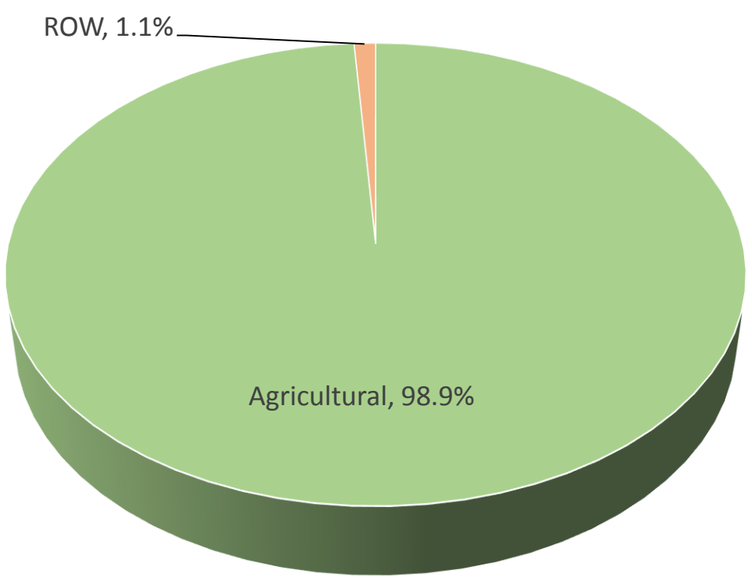
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
0	60.18	60.18	0

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Provincially Significant Wetland: *Sunfish Lake – Laurel Creek Complex* Environmentally Sensitive Policy Areas: *Forested Hills* *Regionally Significant Woodlands*
Supporting Natural Features	Locally Significant and Other Woodlands

Land Use



Cedar Creek Subwatershed

Cedar Creek Overview

Cedar Creek is a tributary of Forwell Creek, which in turn, is a tributary to Laurel Creek. The entirety of Cedar Creek's 356.9 ha watershed is within the City of Waterloo. The primary land use within the area is residential (52.9%) followed by ROW (22.5%). Approximately 56.4% of the catchment area is impervious. As a result of the age of the residential development there are few stormwater management facilities in the subwatershed. Of the 6 OGS units in the subwatershed, none are owned by the City. The entire channel is considered a warm water fishery.

General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
356.90	56.41	5.75	0.93	2,892

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Poor	Poor	Marginal	Marginal	Marginal

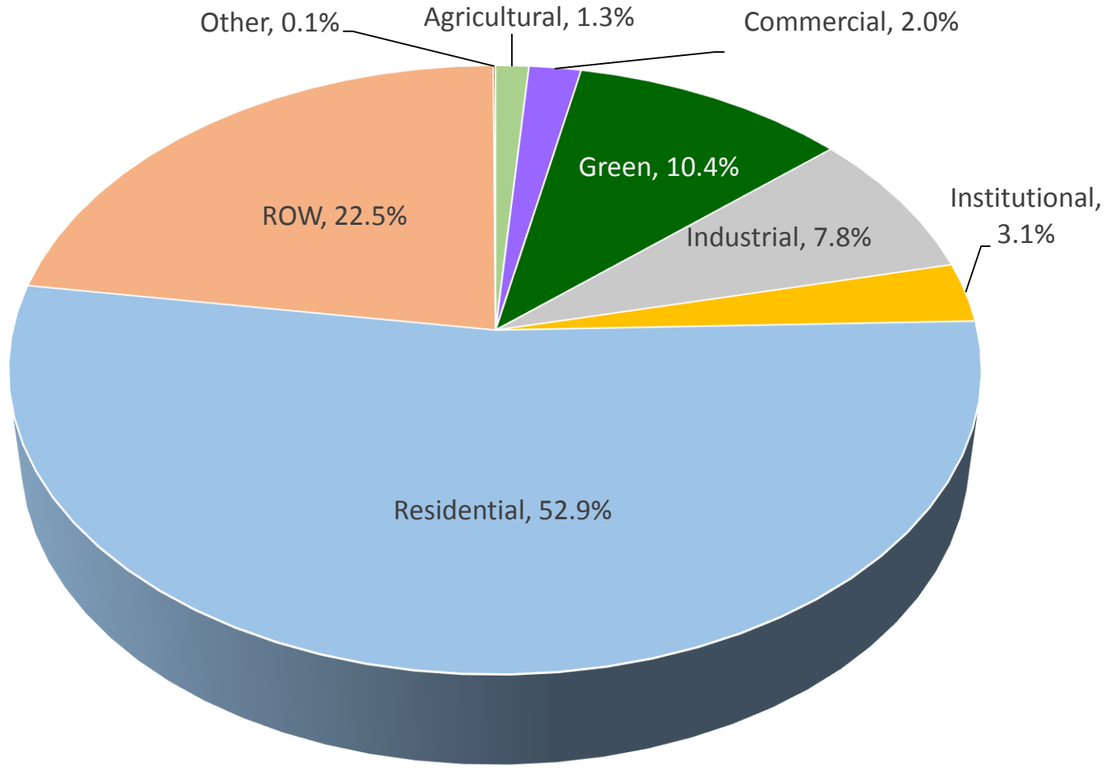
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
6	45.7	50.98	10

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Regionally Significant Woodlands
Supporting Natural Features	Locally Significant Wetlands: *Walden West Wetland Complex* Other Wetlands; Locally Significant and Other Woodlands

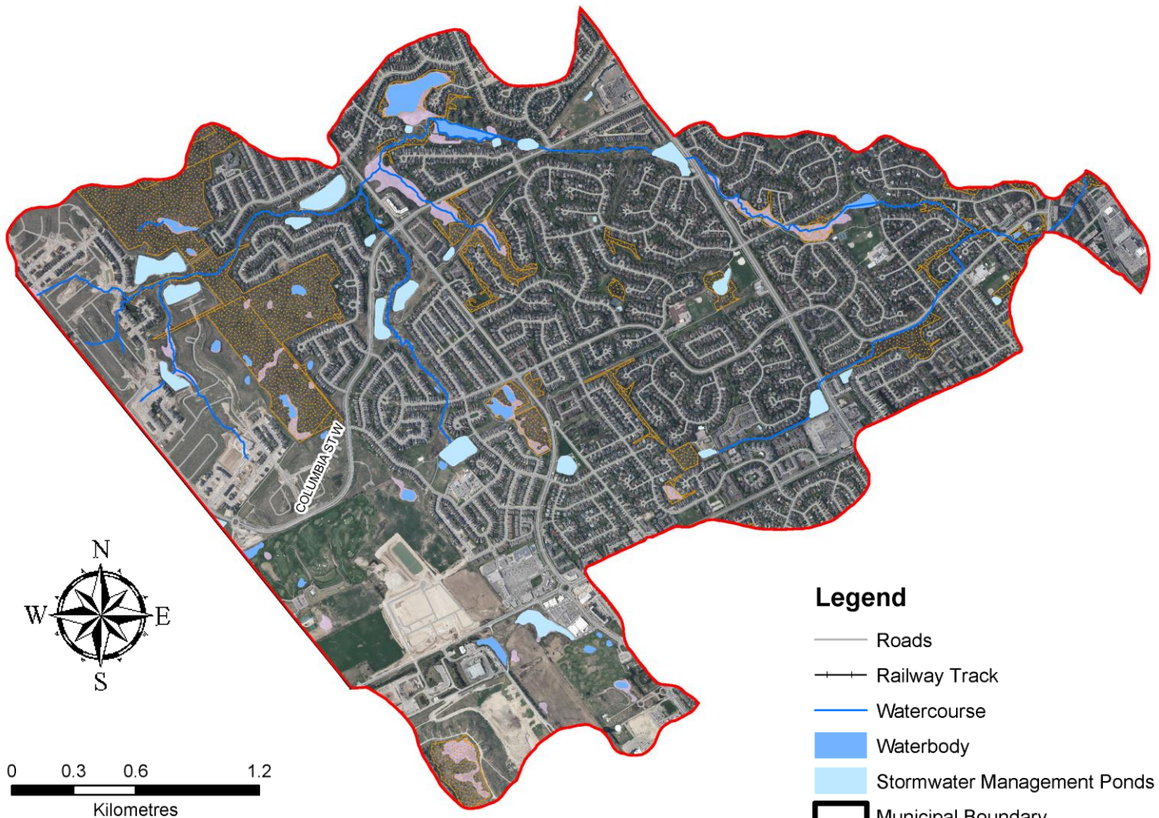
Land Use



Clair Creek Subwatershed

Clair Creek Overview

Clair Creek is a tributary of Laurel Creek. The catchment area within the City of Waterloo is 1013 ha, but the headwaters are west of the City, within Wilmot Township. The primary land use within the area is residential (45.6%), followed by agricultural (17.3%). Approximately 42% of the catchment area is impervious. Of the 28 OGS units in the subwatershed, 9 are owned by the City. A high capacity significant recharge area is located within the watershed. Municipal Well Waterloo North W10 is located along Clair Creek. Approximately 33% of the subwatershed is within a chloride/sodium/TCE Issue Contributing Area. The entire channel is considered a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
1013.11	42.44	7.10	3.39	17,803

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Marginal	Marginal	Marginal	Marginal

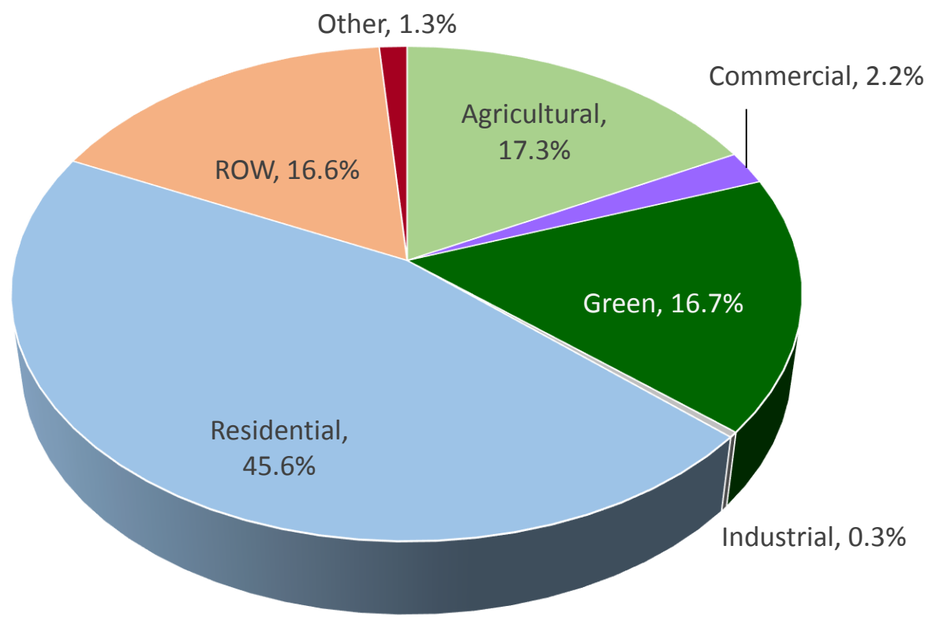
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
28	577.02	607.72	78

Natural Heritage

Landscape Level Systems	Regional Recharge Areas
Core Natural Features	Provincially Significant Wetlands: *Sunfish Lake – Laurel Creek Complex* Environmentally Sensitive Policy Areas: *Forested Hills; St. Agatha Forest* Regionally Significant Woodlands
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

Land Use



Colonial Creek Subwatershed

Colonial Creek Overview

Colonial Creek is a tributary of the Grand River. Its catchment area is 436.9 ha, and is entirely located within the City of Waterloo. The primary land use is residential (60.6%), followed by ROW (20.7%). Approximately 56% of the catchment is impervious. Of the 8 OGS units in the subwatershed, 2 are owned by the City. The entire channel is classified as a warm water fishery.

General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
436.90	55.81	4.04	1.21	5,200

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Marginal	Insufficient data	Marginal	Insufficient data	Poor

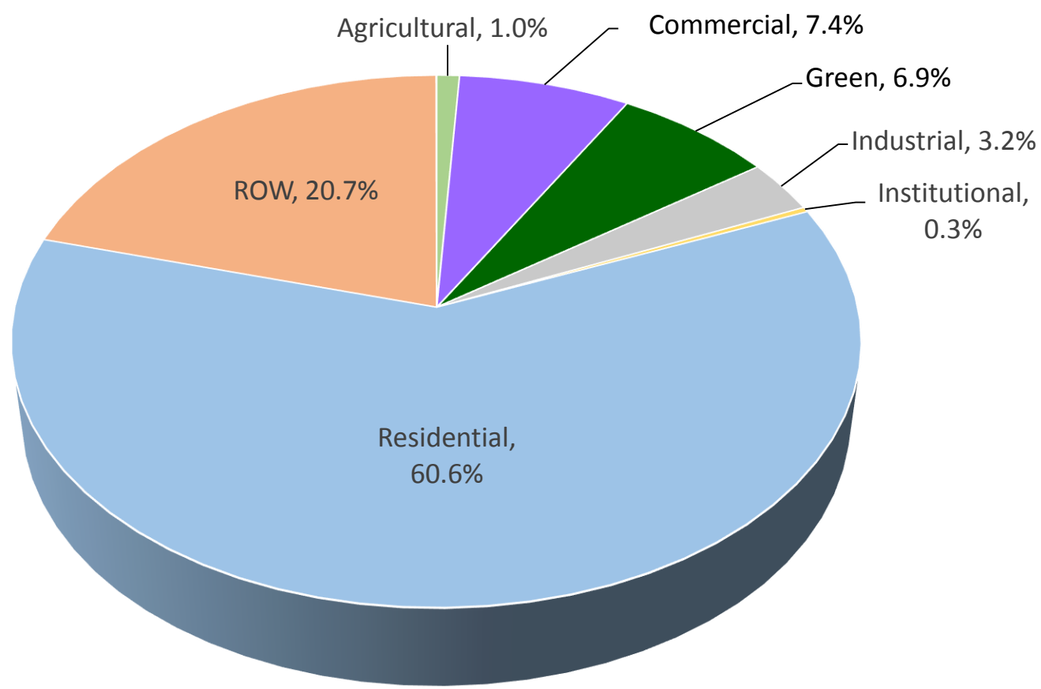
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
8	123.96	198.97	28

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Regionally Significant Woodlands; Environmentally Significant Valley Features
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

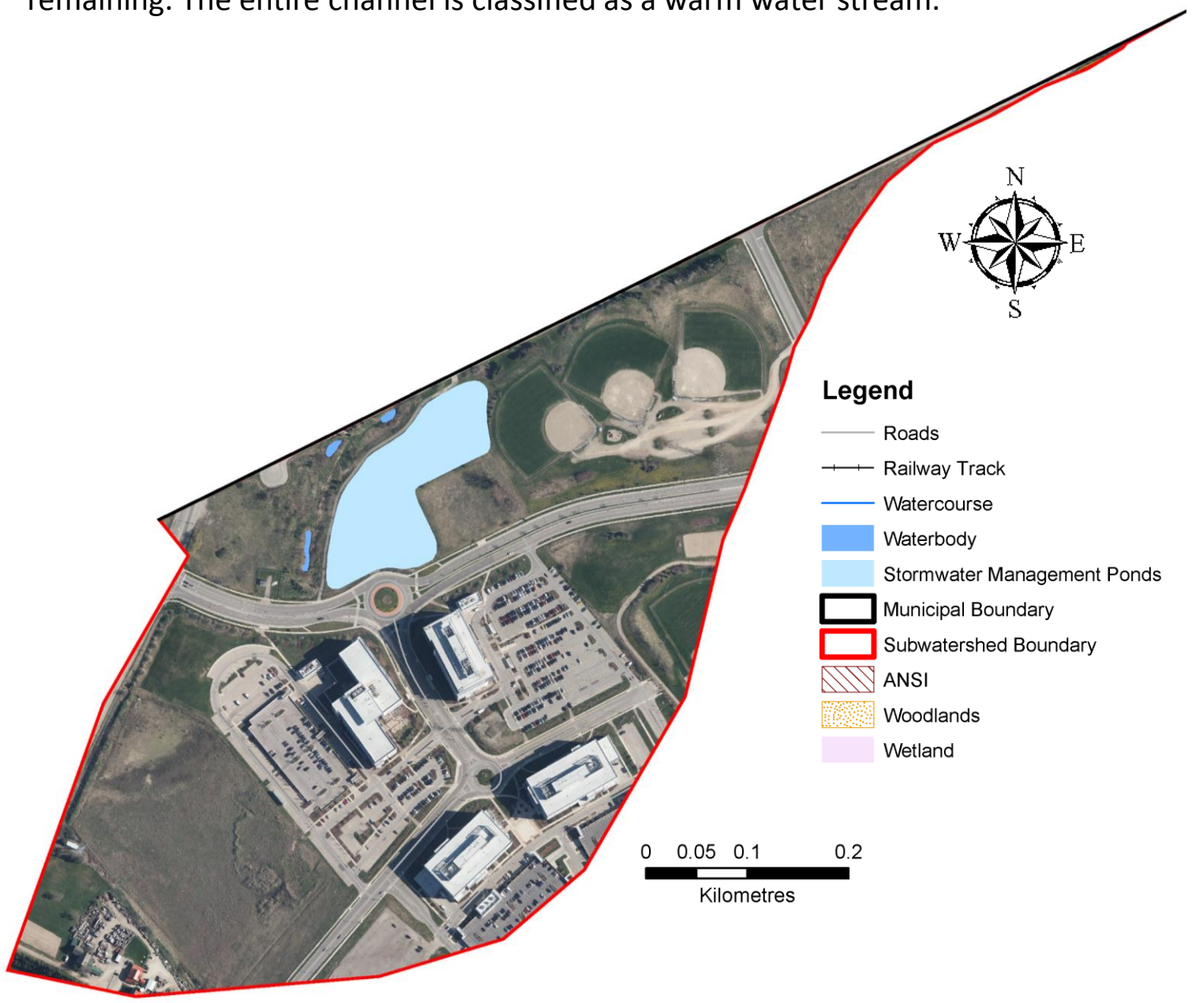
Land Use



Conestogo River – Lower Subwatershed

Conestogo River – Lower Subwatershed Overview

A small section of a tributary of the Conestogo River is located within the City of Waterloo. The Conestogo River is a tributary of the Grand River, located to the north of the City. Only 35 ha of the Conestogo River catchment is located in the City of Waterloo. The primary land use is industrial (60.7%) followed by agricultural (22.1%). The sole OGS unit in the subwatershed is owned by the City. Approximately 58% of the catchment is impervious, and there are no wetlands remaining. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
35.13	57.98	2.66	0	268

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Insufficient data	Insufficient data	Insufficient data	Poor

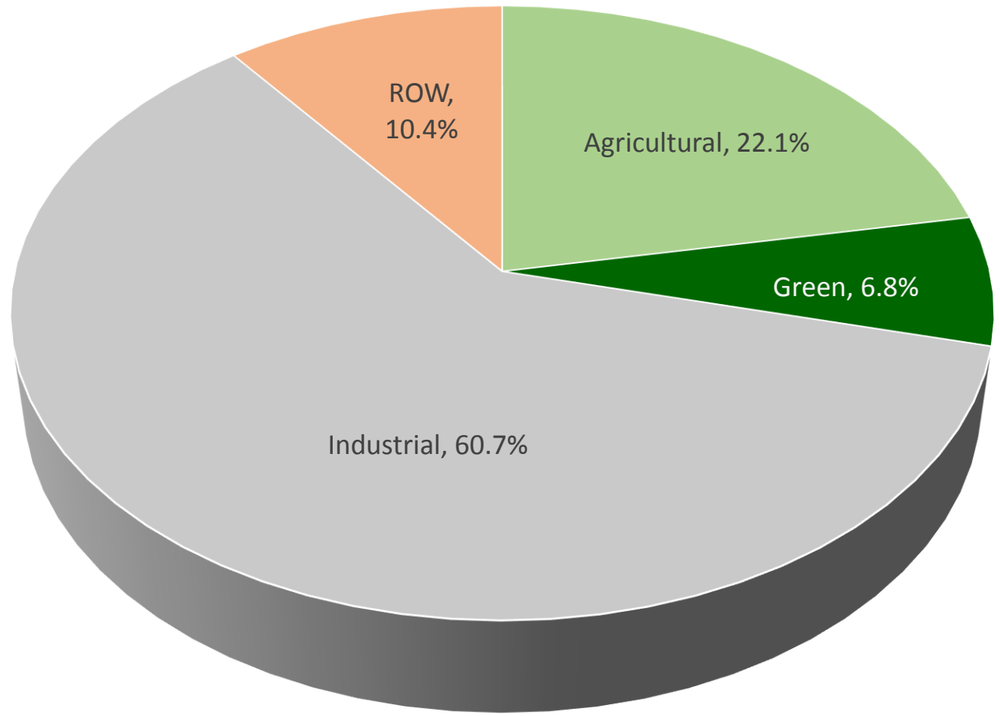
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
1	34.33	34.33	1

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	NA
Supporting Natural Features	Locally Significant and Other Woodlands

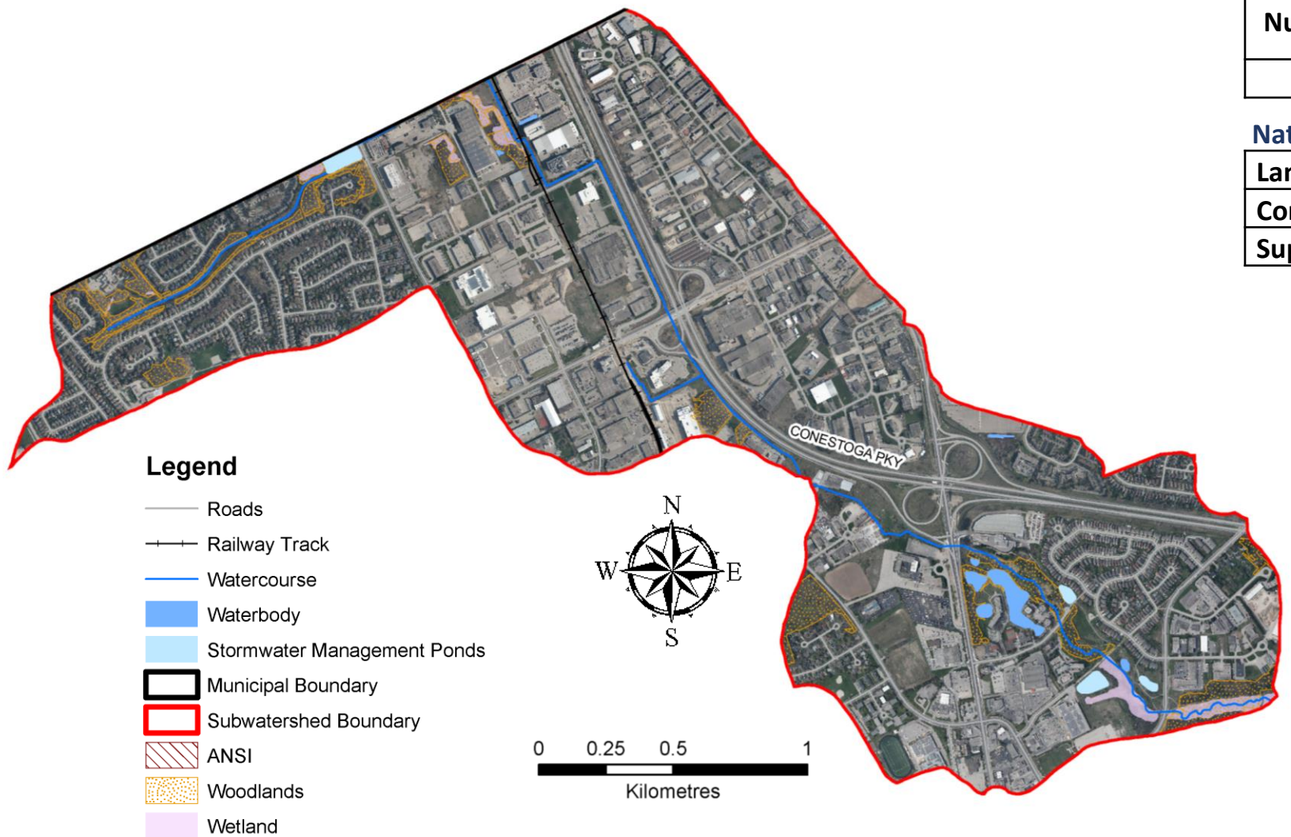
Land Use



Forwell Creek Subwatershed

Forwell Creek Overview

Forwell Creek is a tributary of Laurel Creek. This creek accepts flow from Cedar Creek. Approximately 509 ha of the catchment is located in the City of Waterloo, and the remainder is to the north of the City. The primary land use in the catchment is industrial (42.5%) followed by ROW (21.7%). Of the 35 OGS units in the subwatershed, 3 are owned by the City. Approximately 68% of the catchment is impervious. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
508.50	68.24	10.63	1.11	9,201

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Marginal	Insufficient data	Poor	Insufficient data	Poor

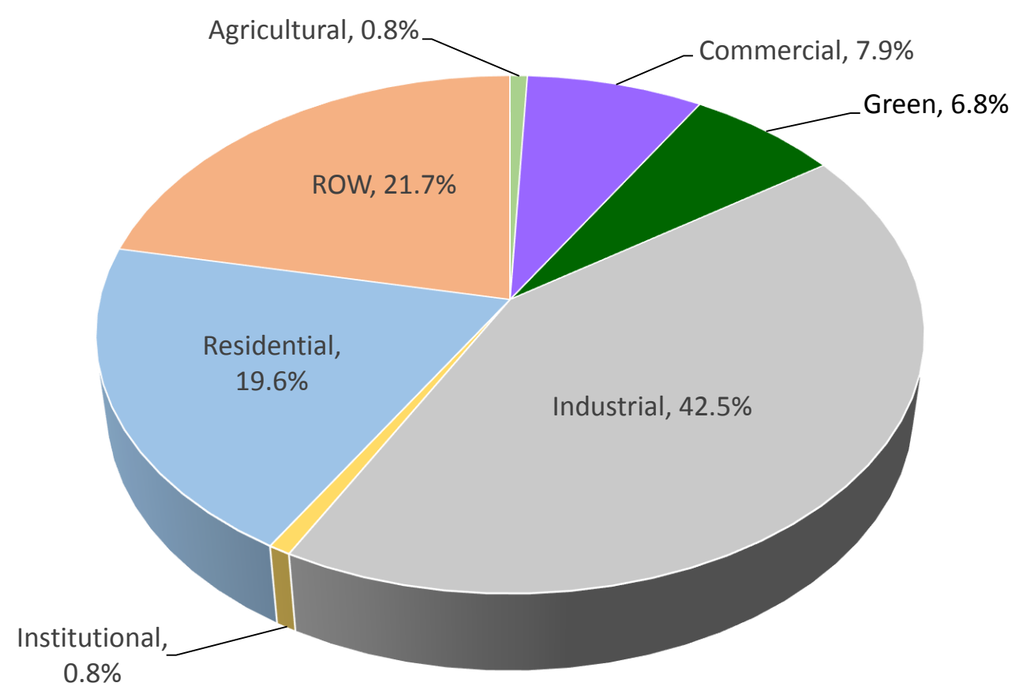
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
35	72.59	145.02	35

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Regionally Significant Woodlands
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

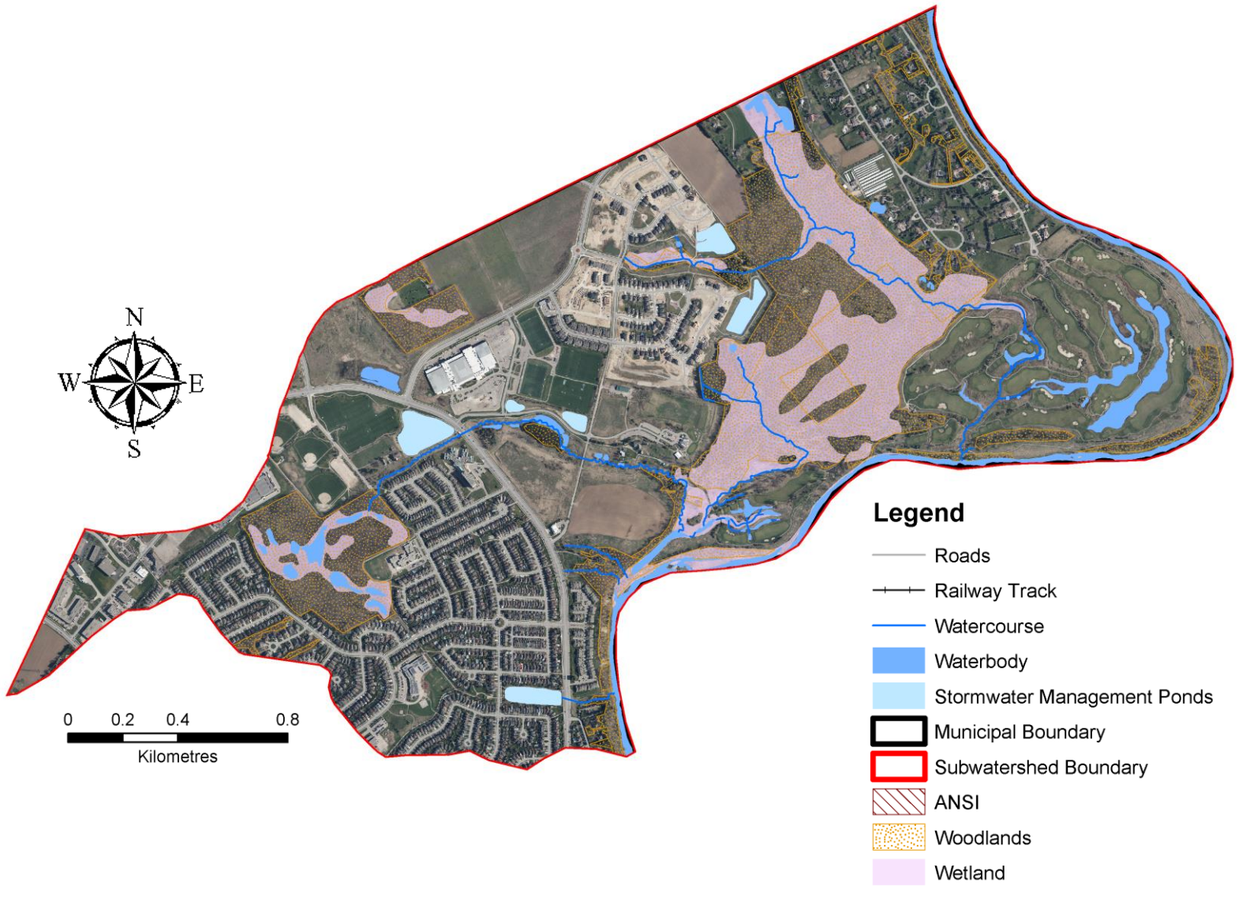
Land Use



Grand River Tributaries North Subwatershed

Grand River Tributaries North Overview

The Grand River Tributaries North include Horst Creek, Minnow Creek, Critter Creek, Willow Creek, Cuckoo Creek, and Cooper's Creek, which all flow directly into the Grand River. Approximately 541 ha of the catchment is located in the City of Waterloo, with a portion of Horst Creek extending north of the City. The primary land use in the catchment is agriculture (31.5%) followed by residential (25.0%). Approximately 31% of the catchment is impervious. Of the 9 OGS units in the subwatershed, 6 are owned by the City. Cooper's Creek subwatershed has 3 OGS units; Critter Creek has 5 OGS units; and Cuckoo Creek has 1 OGS unit. The subwatershed has retained many of its wetlands, as approximately 12% of land area is classified as wetlands. A high capacity significant recharge area is located within the watershed. All channels are classified as a warm water fishery.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
540.90	31.43	23.49	12.12	12,858

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Good	Insufficient data	Fair	Poor	Good

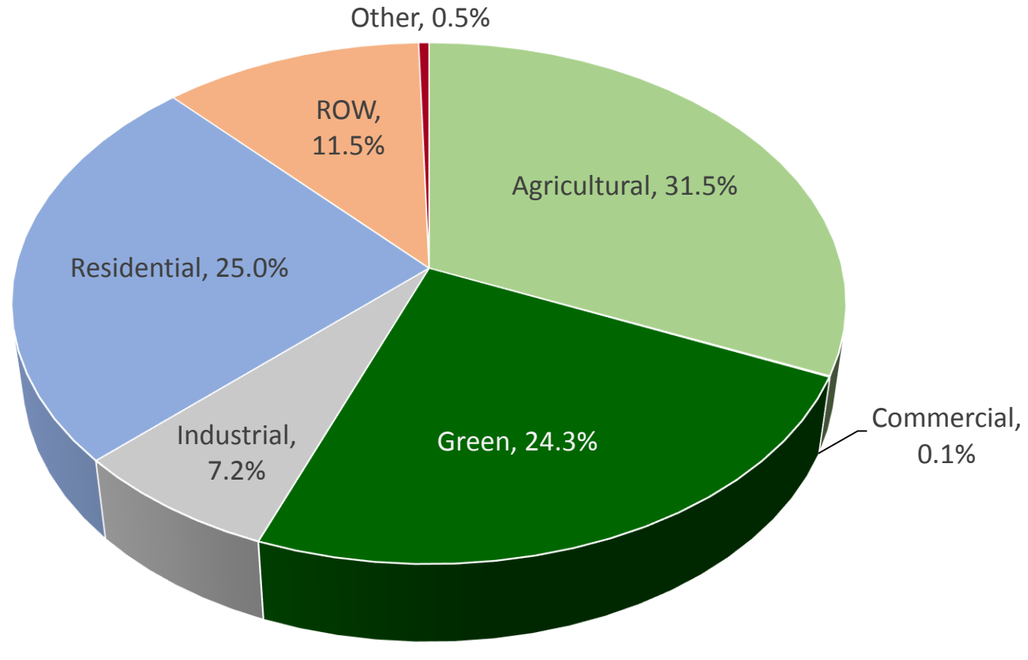
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
9	464.63	459.13	12

Natural Heritage

Landscape Level Systems	Significant Valleys
Core Natural Features	Provincially Significant Wetlands: *Waterloo Rural East Wetland* Regionally Significant Woodlands; Environmentally Significant Valley Features
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

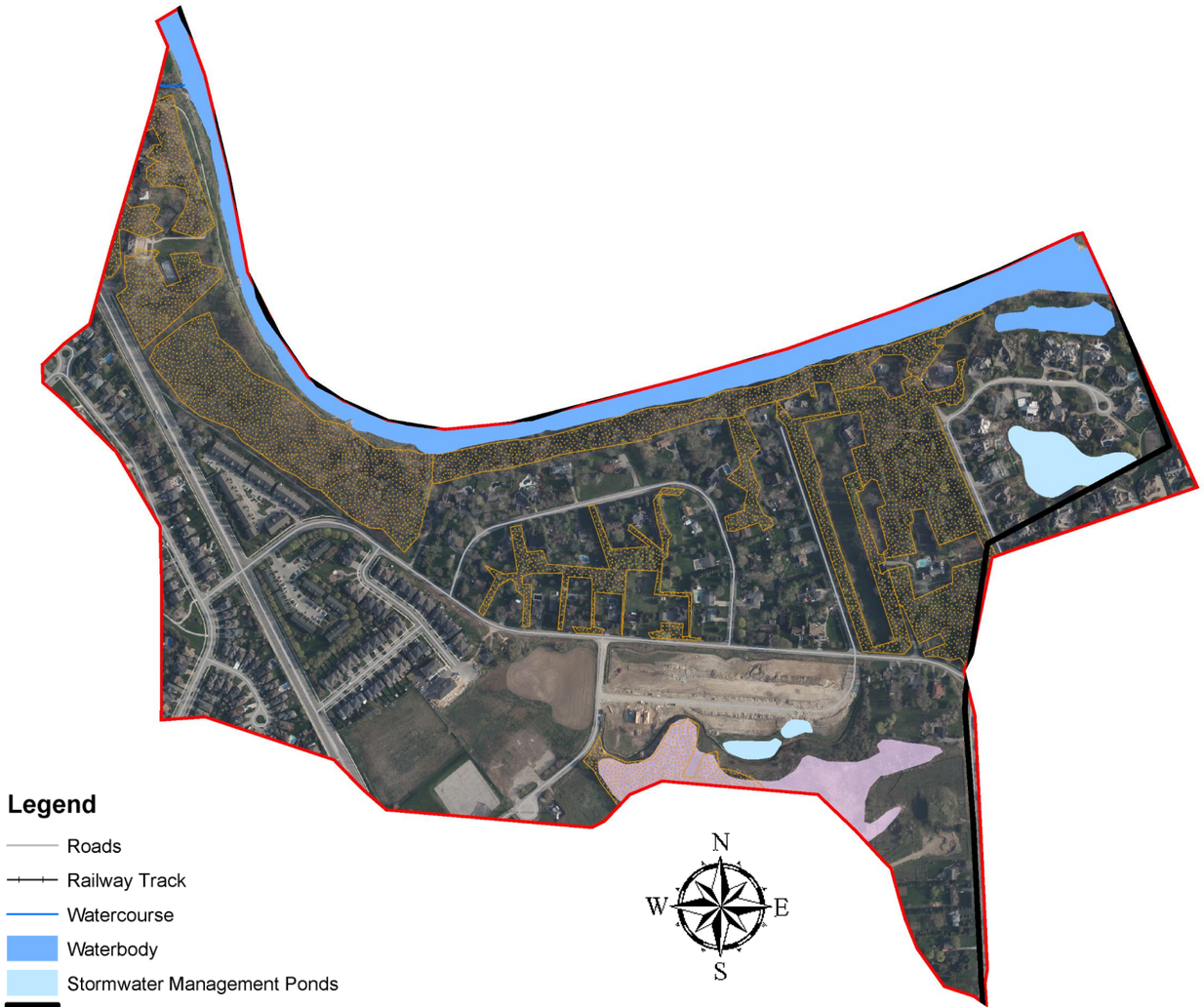
Land Use



Grand River Tributaries South Subwatershed

Grand River Tributaries South Overview

The Grand River Tributaries South has very little channel (only 37 m), but is an 82.7 ha area that drains into the Grand River. The primary land use within the catchment is agriculture (43.3%) followed by residential (25.2%). Approximately 32% of the catchment is impervious. Of the 4 OGS units in the subwatershed, 2 are owned by the City. A high capacity significant recharge area is located within the watershed. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
82.70	31.91	13.84	2.60	37

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Good	Insufficient data	Insufficient data	Insufficient data	Marginal

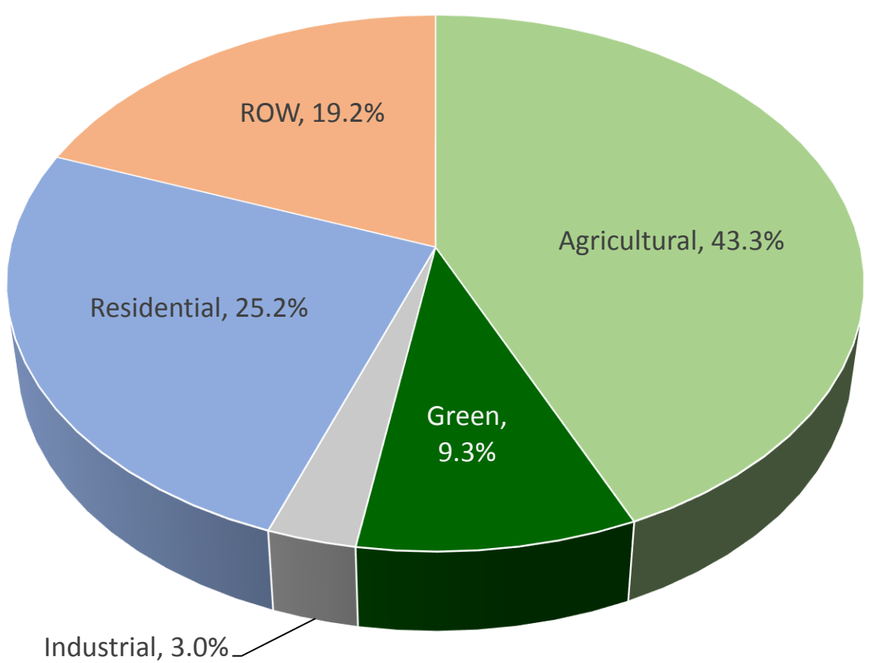
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
4	56.29	54.77	2

Natural Heritage

Landscape Level Systems	Significant Valleys
Core Natural Features	Regionally Significant Woodlands; Environmentally Significant Valley Features
Supporting Natural Features	Locally Significant and Other Woodlands

Land Use



Laurel Creek Reservoir Subwatershed

Laurel Creek Reservoir Overview

Laurel Creek was dammed in 1966 for flood control purposes, creating the Laurel Creek Reservoir. Laurel Creek is a tributary of the Grand River. The catchment retains many wetlands, as over 26% of the land is classified as wetlands. The subcatchment area within the City of Waterloo is 358.2 ha. The primary land use is agriculture (61.5%) followed by residential (17.4%). Of the 5 OGS units in the subwatershed, 2 are owned by the City. A high capacity significant recharge area is located within the watershed. Approximately 7% of the subwatershed is within a chloride/sodium/TCE Issue Contributing Area. The entire channel is classified as a warm water fishery.

General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
358.20	19.18	27.52	26.74	7,764

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Good	Insufficient data	Marginal	Marginal	Good

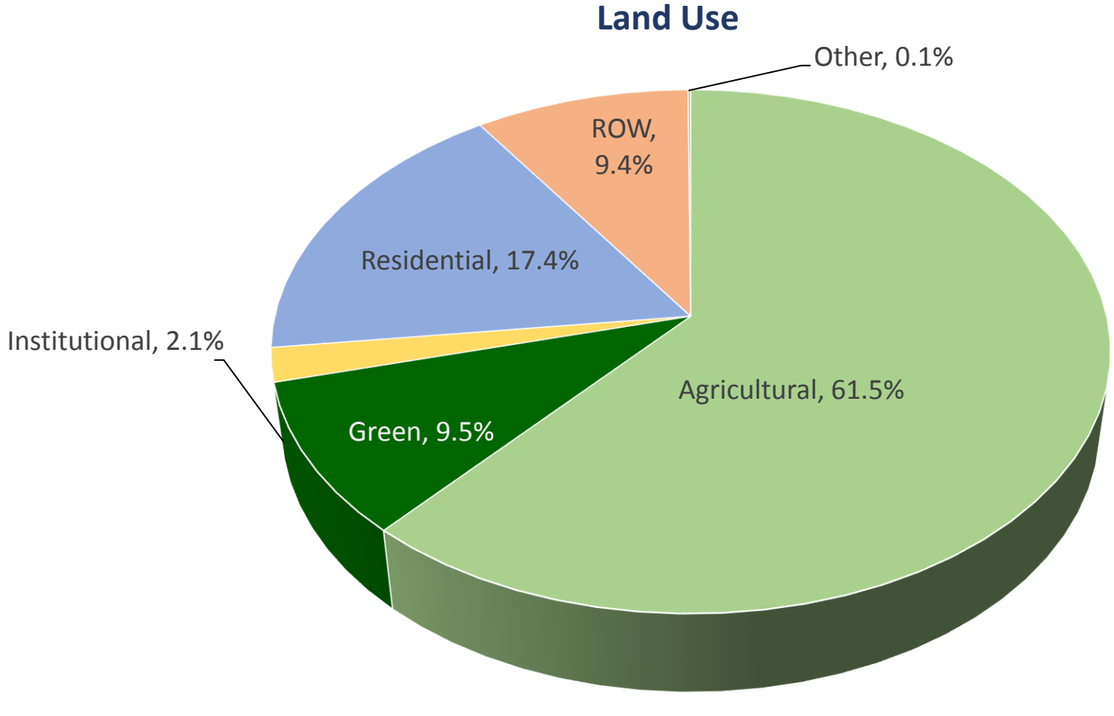
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
5	301.53	307.73	17

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Provincially Significant Wetlands: *Sunfish Lake – Laurel Creek Complex* Environmentally Sensitive Policy Areas: *Forested Hills; Laurel Creek Conservation Area* Environmentally Significant Valley Features
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

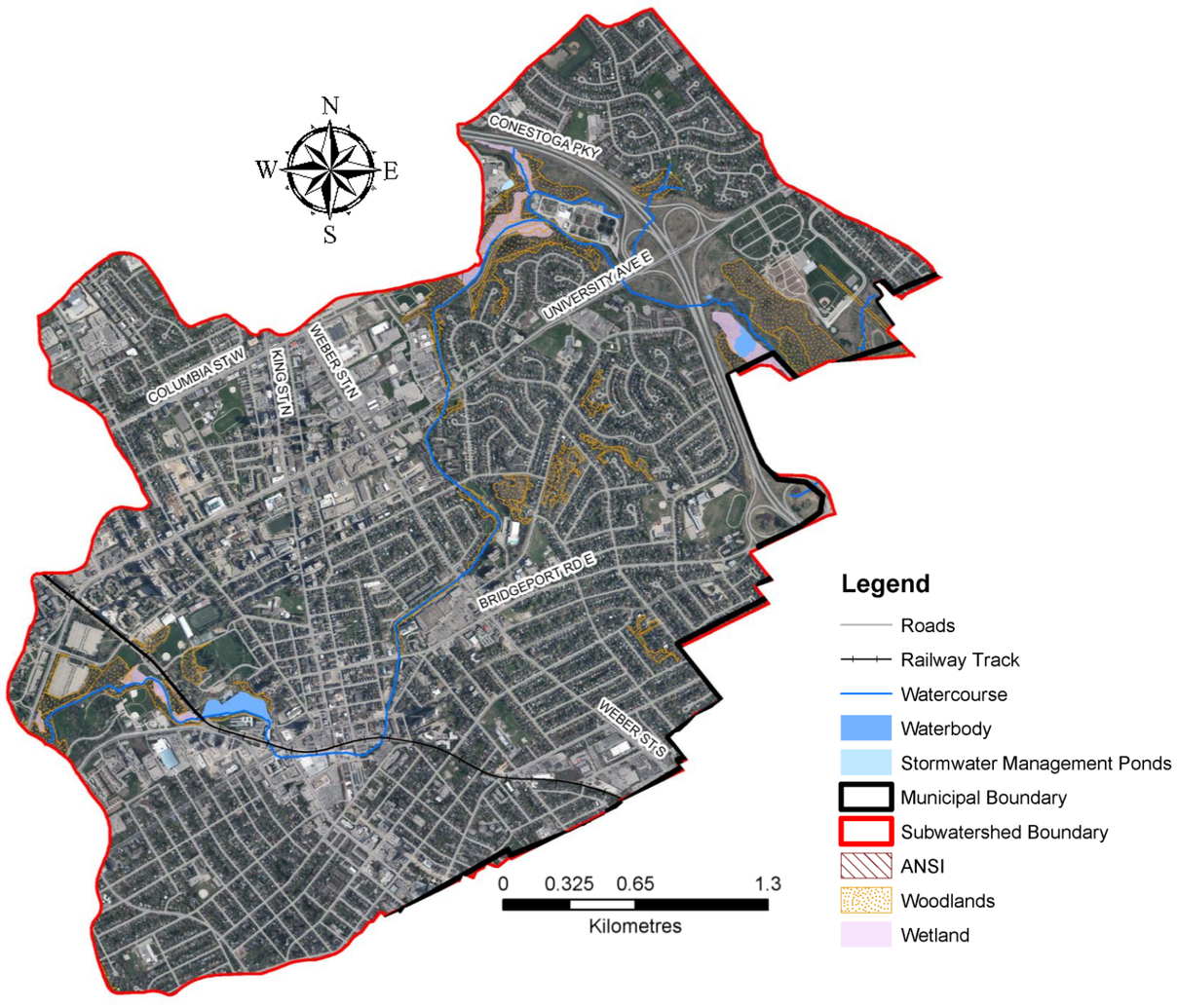
Land Use



Lower Laurel Creek Subwatershed

Lower Laurel Creek Overview

Laurel Creek is a tributary of the Grand River. The lower portion of Laurel Creek accepts flow from the upper sections of the creek, as well as its tributaries which include Maple Hill Creek, Clair Creek, Monastery Creek, Beaver Creek, Cedar Creek, and Forwell Creek. Approximately 1212 ha of the Lower Laurel Creek catchment area is located within the City of Waterloo. The primary land use is residential (42.4%), followed by ROW (26.6%). The catchment is approximately 57% impervious. Of the 85 OGS units in the subwatershed, 12 are owned by the City. A high capacity significant recharge area is located within the watershed. The William Street Wellfield is located within the Lower Laurel Creek subwatershed. Approximately 35% of the subwatershed is within a chloride/sodium/TCE Issue Contributing Area. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
1212.00	56.66	14.53	1.04	10,574

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Poor	Insufficient data	Marginal	Marginal	Marginal

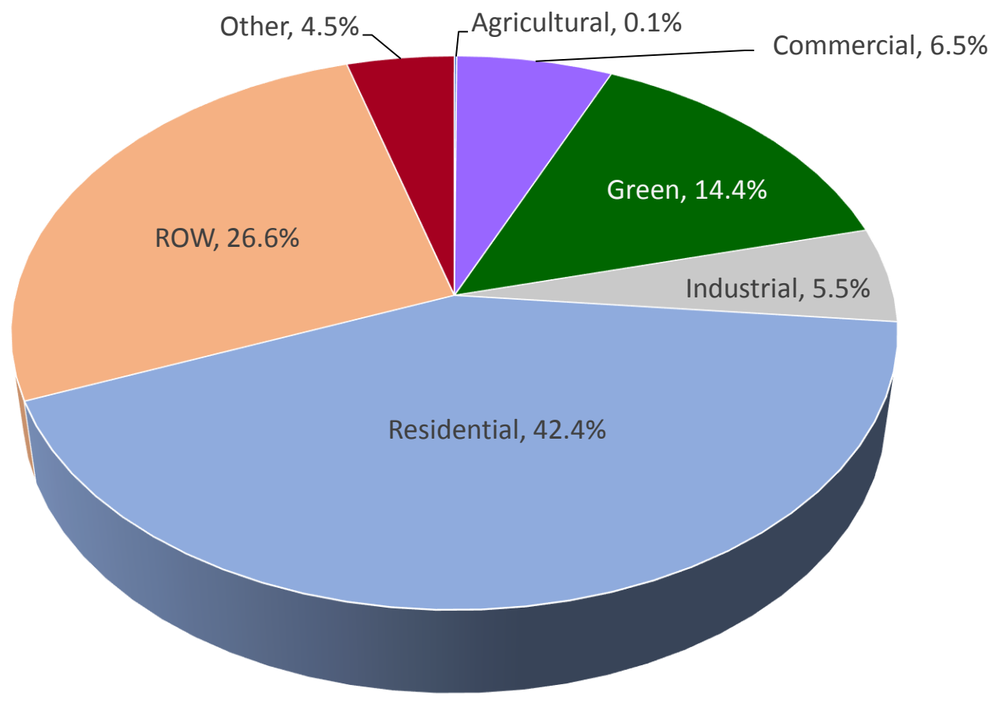
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
85	180.66	162.81	54

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Regionally Significant Woodlands
Supporting Natural Features	Locally Significant Wetlands: *Bechtel Park Wetland* Other Wetlands; Locally Significant and Other Woodlands

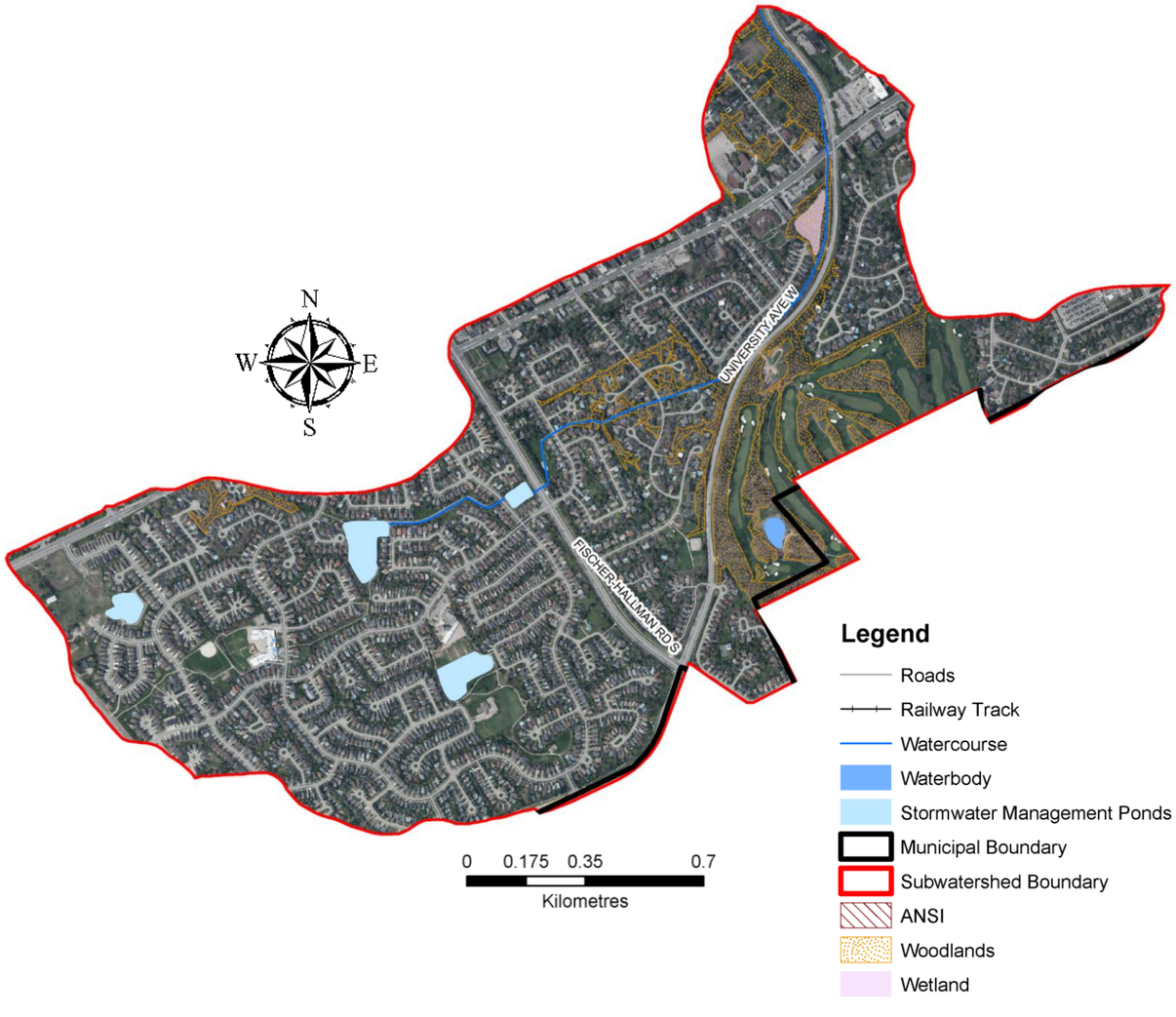
Land Use



Maple Hill Creek Subwatershed

Maple Hill Creek Overview

Maple Hill Creek is a tributary of Laurel Creek. Approximately 347 ha of the catchment is located in the City of Waterloo. The primary land use is residential (58.4%), followed by ROW (22.4%). Approximately 48% of the catchment is impervious, and 38% of the subwatershed is within a chloride/sodium/TCE Issue Contributing Area. None of the OGS units in the subwatershed are owned by the City. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
346.80	48.04	7.48	0.24	3,280

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Marginal	Insufficient data	Insufficient data	Marginal	Marginal

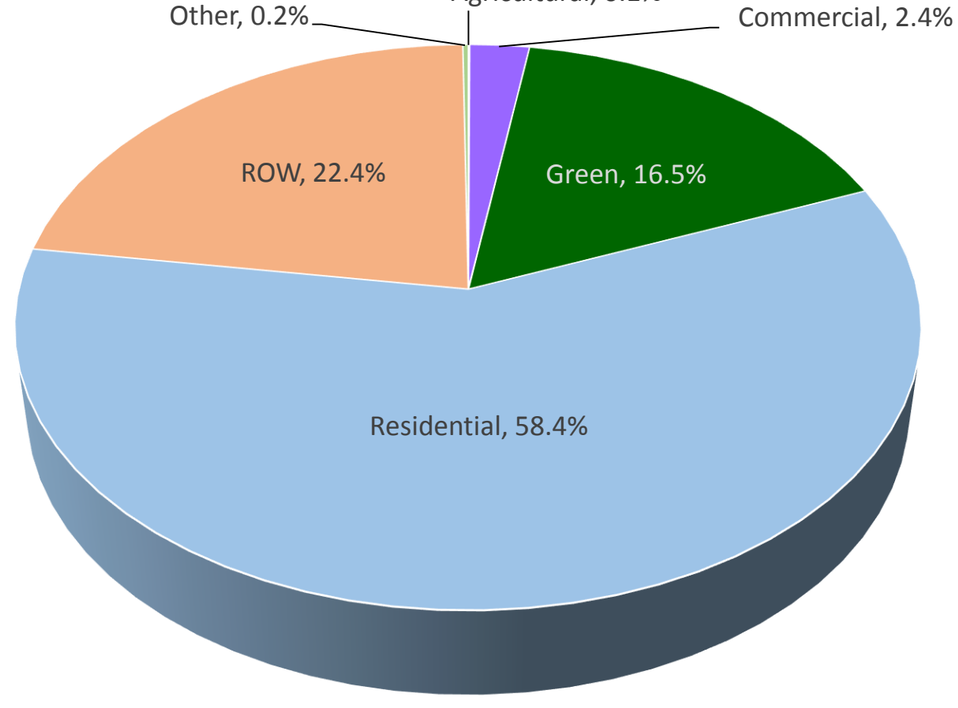
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
4	117.71	173.84	27

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Regionally Significant Woodlands
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

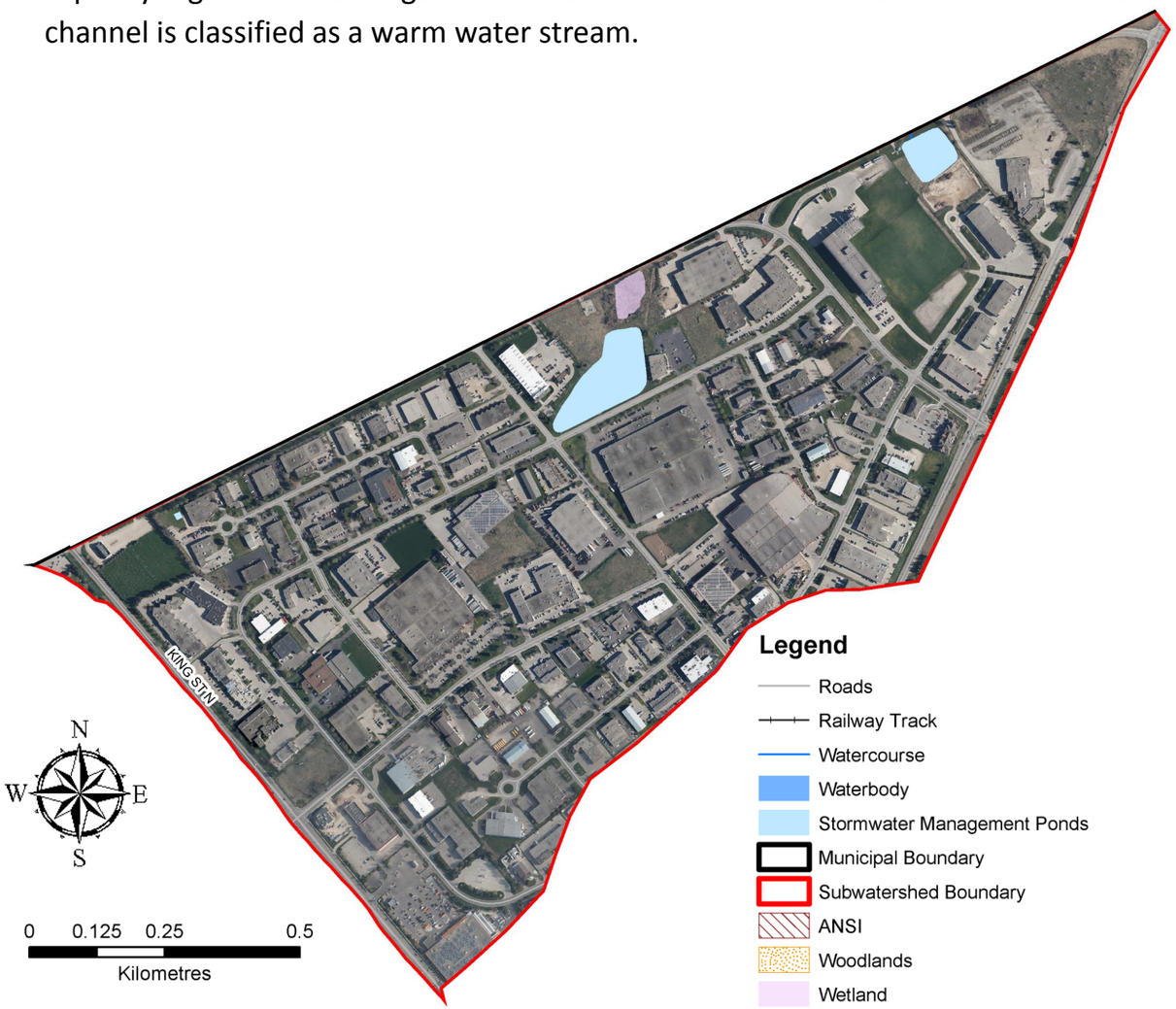
Land Use



Martin Creek East Subwatershed

Martin Creek East Overview

Martin Creek is a tributary of the Conestogo River, north of the City of Waterloo. The subwatershed is divided into an east and west segment for the SWM-MP. Martin Creek East subwatershed consists of 142 ha within the City of Waterloo, but it continues north of the City. The primary land use is industrial (77.1%) followed by ROW (17.1%). Approximately 78% of the catchment is impervious. None of the OGS units in the subwatershed are owned by the City. A high capacity significant recharge area is located within the watershed. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
142.00	78.48	0	0.25	134

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Insufficient data	Insufficient data	Insufficient data	Poor

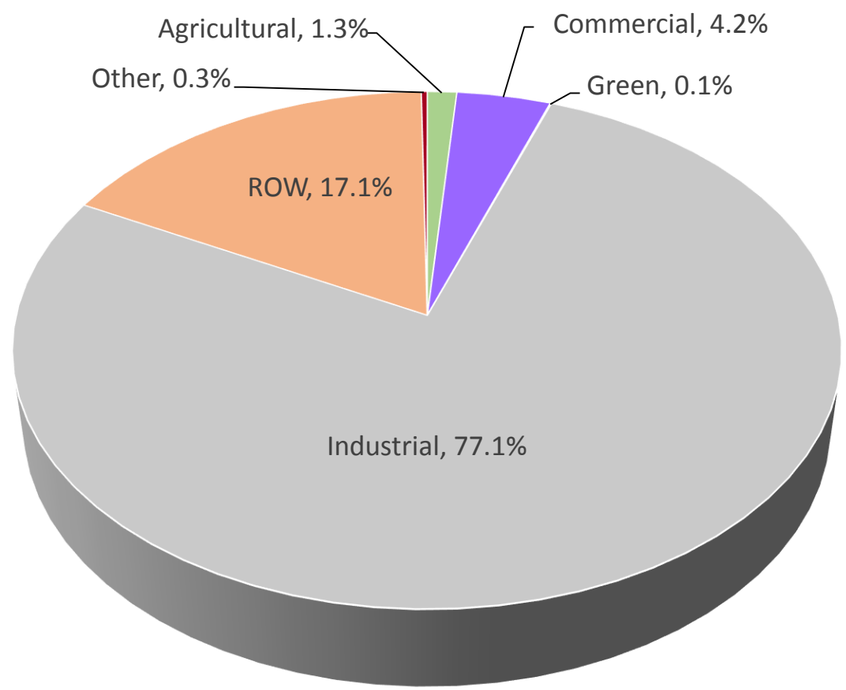
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
14	82.28	126.84	3

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	NA
Supporting Natural Features	Other Wetlands

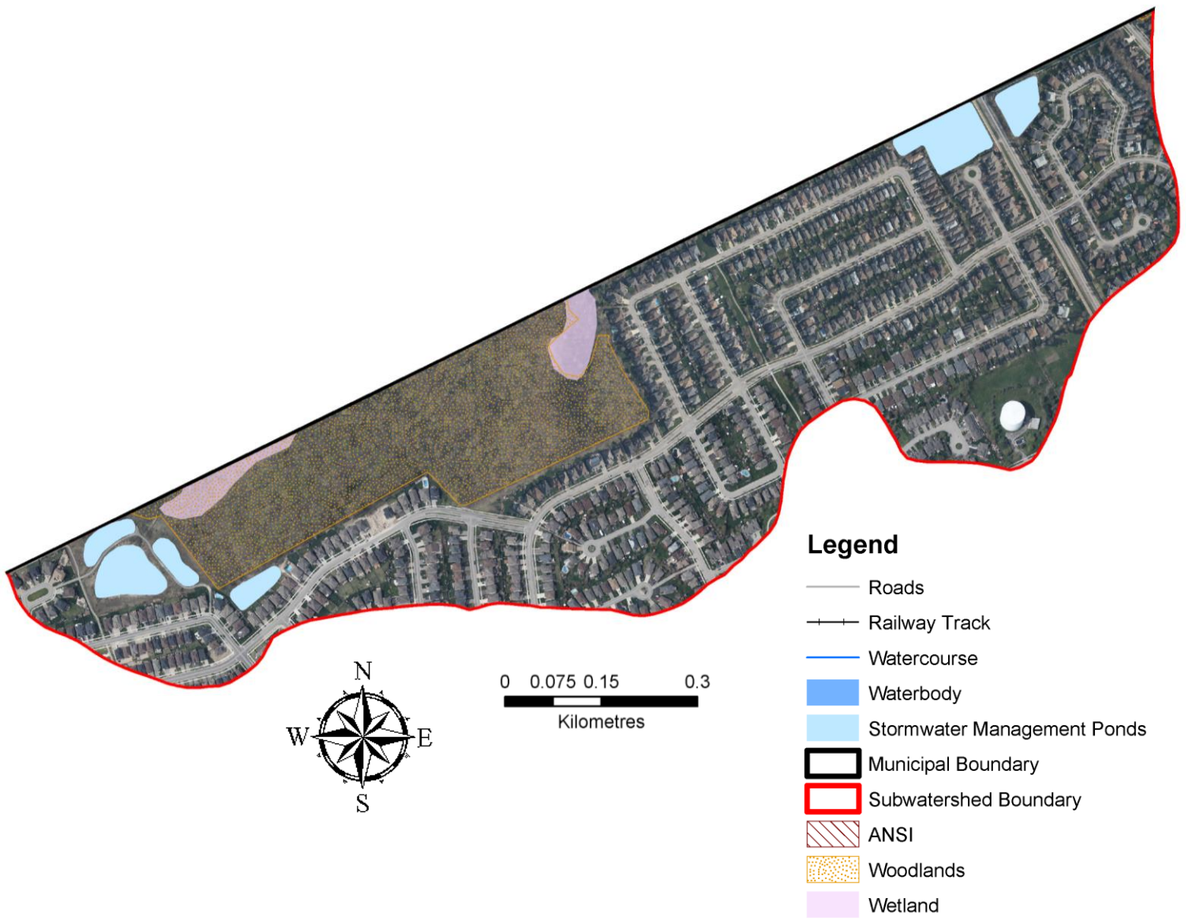
Land Use



Martin Creek West Subwatershed

Martin Creek West Overview

Martin Creek is a tributary of the Conestogo River, north of the City of Waterloo. The subwatershed is divided into an east and west segment for the SWM-MP. Martin Creek West subwatershed consists of 74 ha within the City of Waterloo, but it continues north of the City. The primary land use is residential (51.9%) followed by green space (27.0%). The catchment is approximately 45% impervious. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
74.25	44.64	0	0.92	164

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Insufficient data	Insufficient data	Insufficient data	Fair

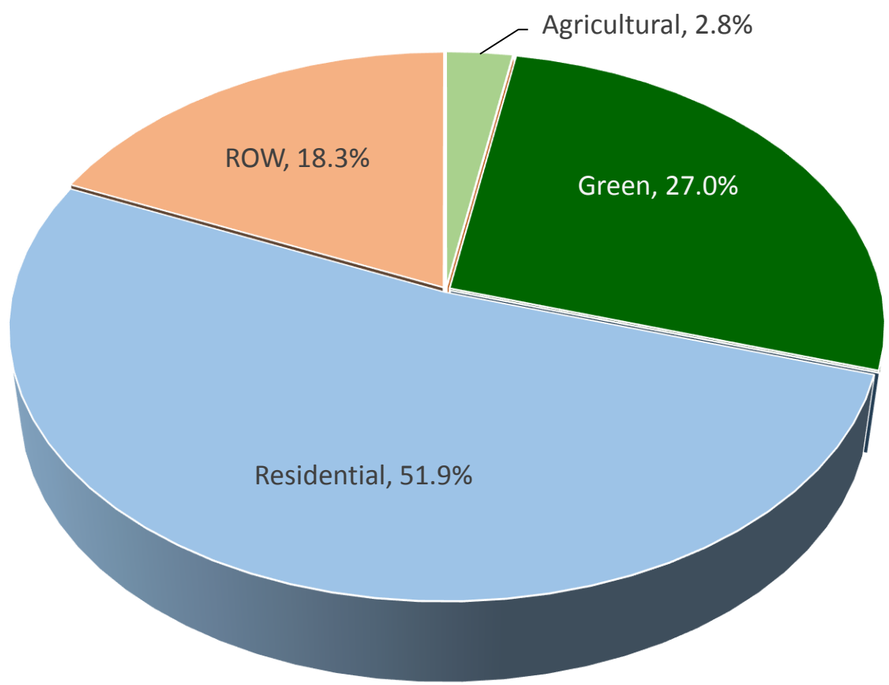
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
0	56.57	70.53	13

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	NA
Supporting Natural Features	Locally Significant and Other Woodlands

Land Use



Melitzer Creek Subwatershed

Melitzer Creek Overview

Melitzer Creek is a tributary of the Grand River, the headwaters of which are located in the City of Waterloo. The catchment area in the City is 134.5 ha. The primary land use is residential (49.9%) followed by green space (22.3%). The catchment is approximately 46% impervious and nearly 14% wetlands. Of the 5 OGS units in the subwatershed, 1 is owned by the City. The entire channel is classified as a cold water stream.

General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
134.50	45.71	6.39	13.61	1,509

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Insufficient data	Insufficient data	Fair	Fair

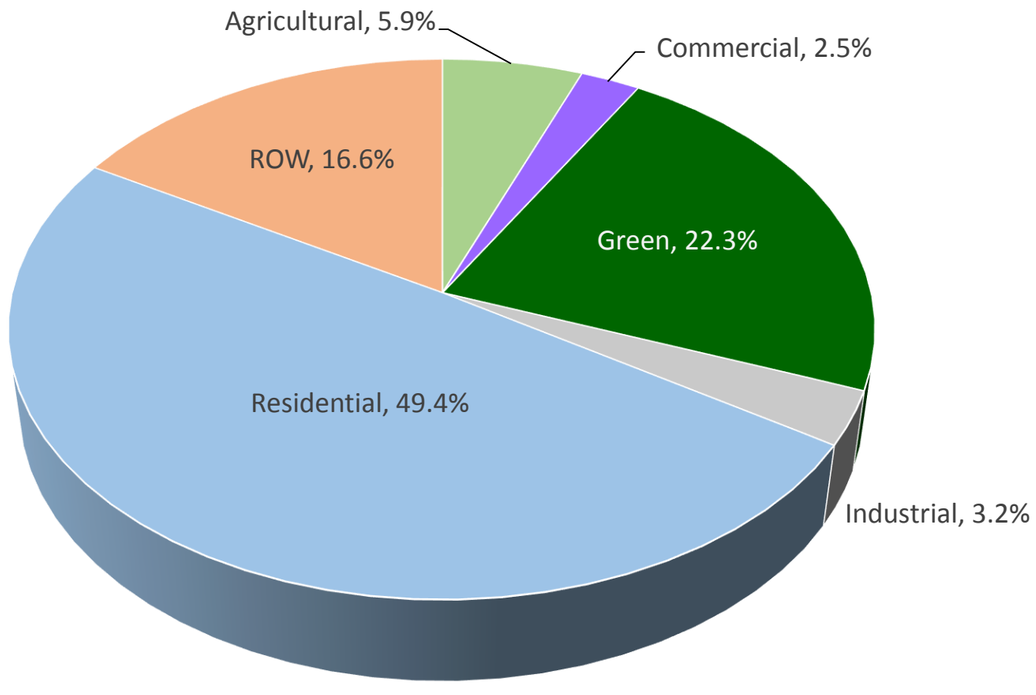
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
5	121.15	121.84	5

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Provincially Significant Wetlands: *Melitzer Creek Wetland Complex* Regionally Significant Woodlands
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

Land Use



Middle Laurel Creek Subwatershed

Middle Laurel Creek Overview

Laurel Creek is a tributary of the Grand River. Middle Laurel Creek is located downstream of Laurel Creek Reservoir, and its catchment is 609.7 ha. The primary land use is institutional (54.2%), as this catchment includes the University of Waterloo and Wilfred Laurier University, followed by agriculture (14.3%). The catchment is approximately 58% impervious. Of the 32 OGS units in the subwatershed, 7 are owned by the City. A high capacity significant recharge area is located within the watershed. Municipal well Waterloo North W05 is located in the subwatershed. Approximately 61% of the subwatershed is within a chloride/sodium/TCE Issue Contributing Area. The entire channel is classified as a warm water stream.

General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
609.70	58.29	13.00	3.01	8,894

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Fair	Fair	Marginal	Marginal	Fair

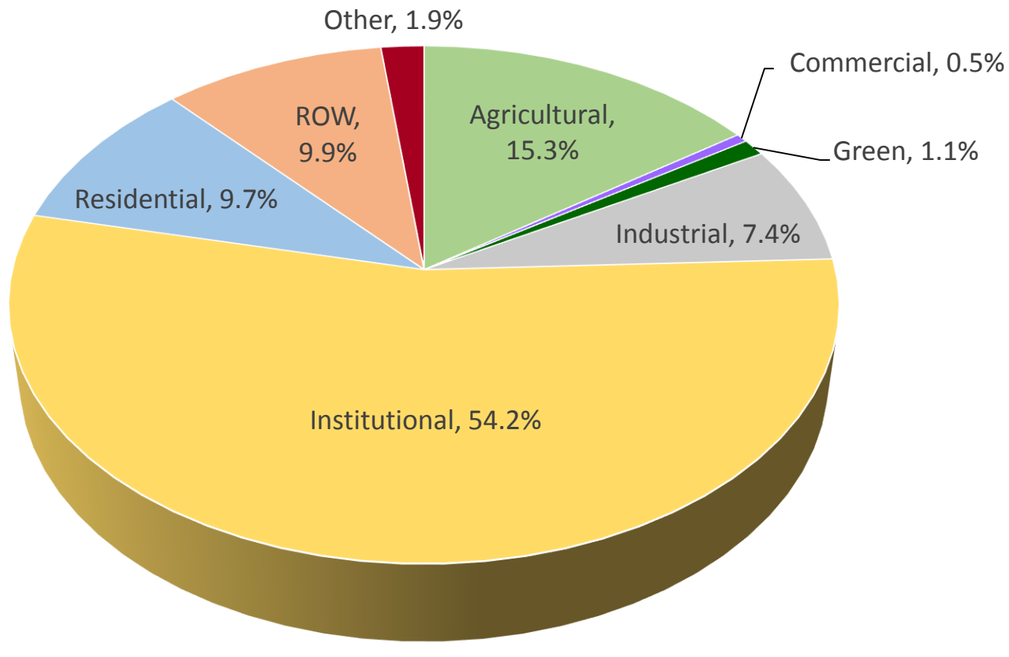
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
32	309.39	296.26	47

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	Provincially Significant Wetlands: *Sunfish Lake – Laurel Creek Complex* Regionally Significant Woodlands
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

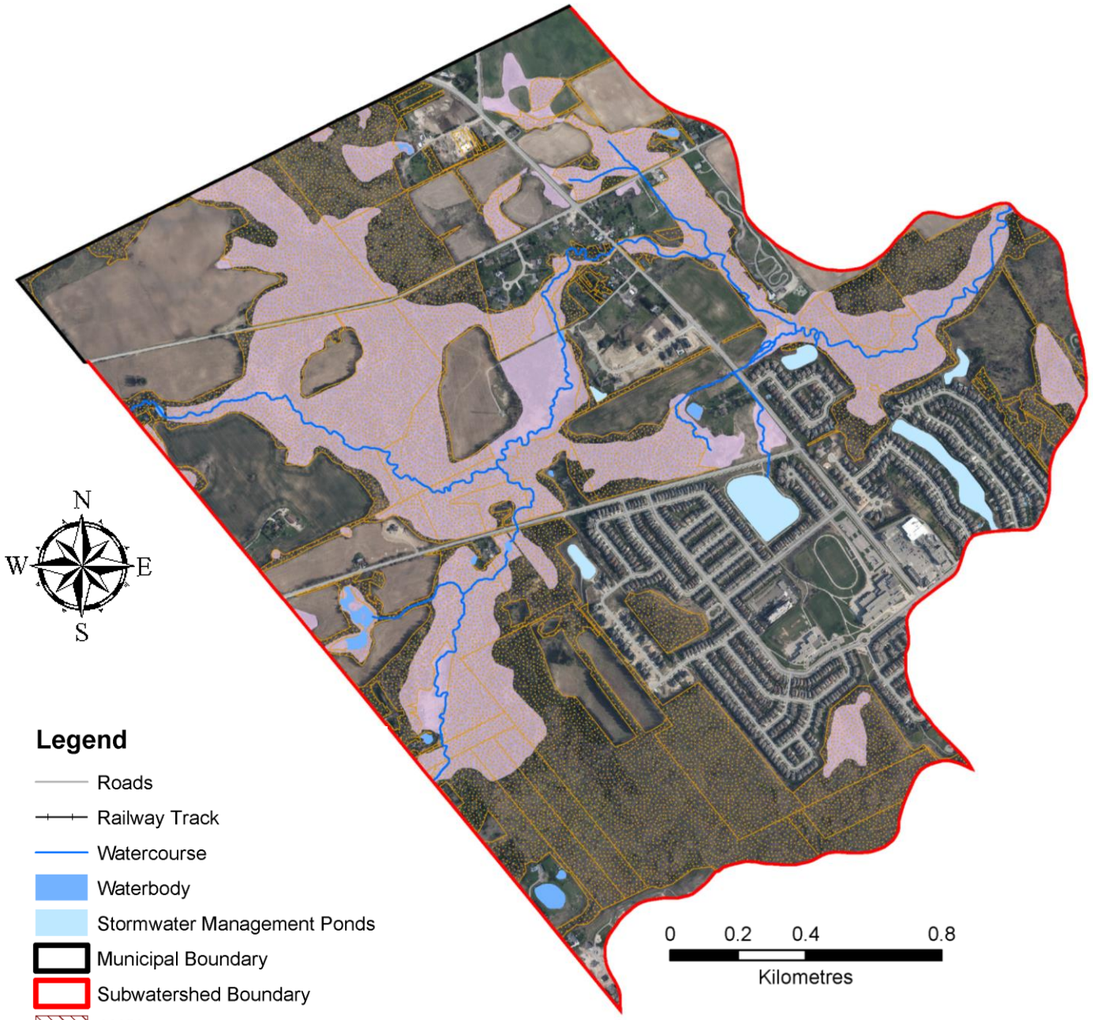
Land Use



Monastery Creek Subwatershed

Monastery Creek Overview

Monastery Creek is a tributary of Laurel Creek, and 488.8 ha of its catchment are located within the City of Waterloo. Much of the upper reaches of the subwatershed are located within the Environmentally Sensitive Landscape of the Laurel Creek Headwaters. The catchment has retained many of its wetlands (24% of the area), and is only 15% impervious. The primary land use is agriculture (62.3%) followed by green space (16.5%). Of the 10 OGS units, 8 are owned by the City. A high capacity significant recharge area is located within the watershed. The entire channel is classified as a warm water stream.



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
488.80	15.16	21.80	24.15	9,683

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Good	Fair	Insufficient data	Fair	Good

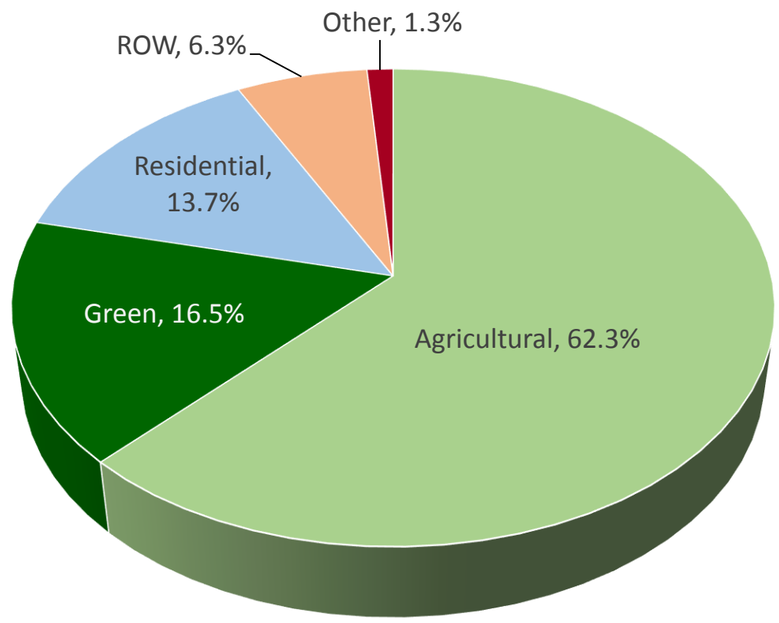
Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
10	400.92	407.23	4

Natural Heritage

Landscape Level Systems	Environmentally Sensitive Landscapes: *Laurel Creek Headwaters*
Core Natural Features	Provincially Significant Wetlands: *Sunfish Lake – Laurel Creek Complex* Environmentally Sensitive Policy Areas: *Forested Hills; Schaefer's Woods; Laurel Creek Forest* Regionally Significant Woodlands
Supporting Natural Features	Other Wetlands; Locally Significant and Other Woodlands

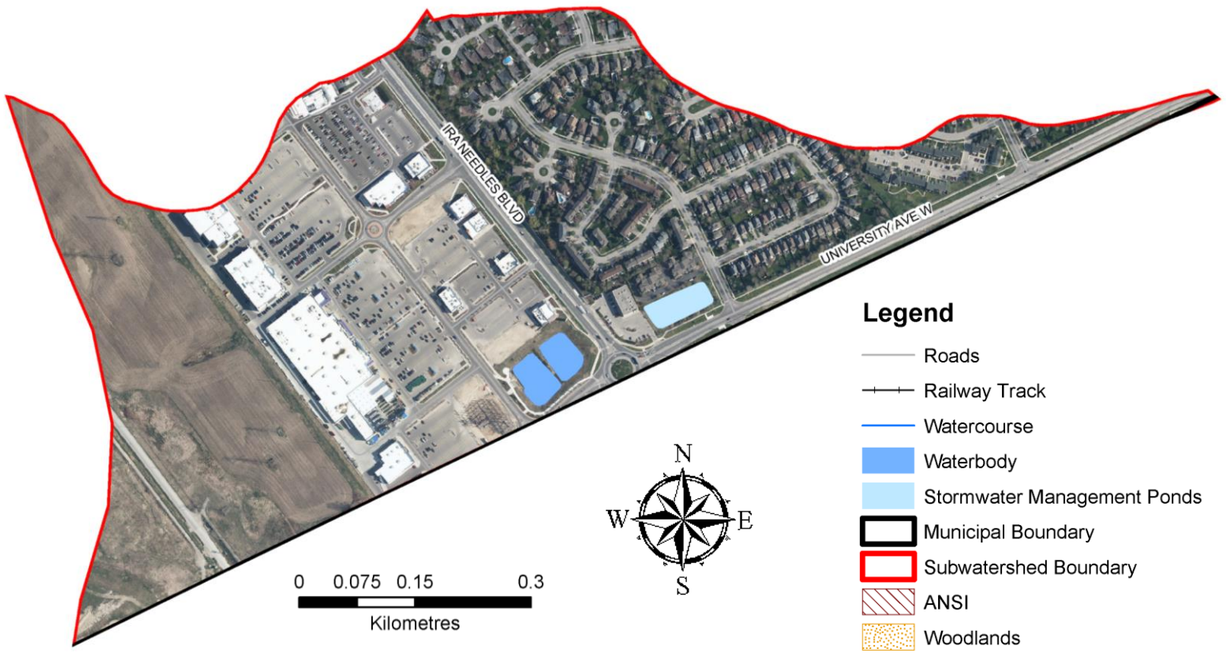
Land Use



Schneider Creek Subwatershed

Schneider Creek Overview

Schneider Creek is a tributary of the Grand River. No section of the stream channel is located within the City of Waterloo, but approximately 51 ha of its catchment area is located in the City. Downstream of the municipal boundary, Schneider Creek is a major conveyance and natural heritage feature within the City of Kitchener. The catchment is approximately 48% impervious. No OGS unit in the subwatershed is owned by the City. The primary land use is commercial (32.9%) followed by agriculture (25.6%).



General Subwatershed Stats

Area (ha)	% Impervious	% Floodplain	% Wetlands	Stream Length (m)
51.10	48.41	0	0	0

Subwatershed Evaluation

SWM	Water Quality	Stream Health	Aquatics	Terrestrial
Marginal	Insufficient data	Insufficient data	Insufficient data	Poor

Urban Stormwater Management

Number OGS Units	Area with Quality Control (ha)	Area with Quantity Control (ha)	Number SWM Outfalls
1	16.64	23.34	2

Natural Heritage

Landscape Level Systems	NA
Core Natural Features	NA
Supporting Natural Features	Other Wetlands

Land Use