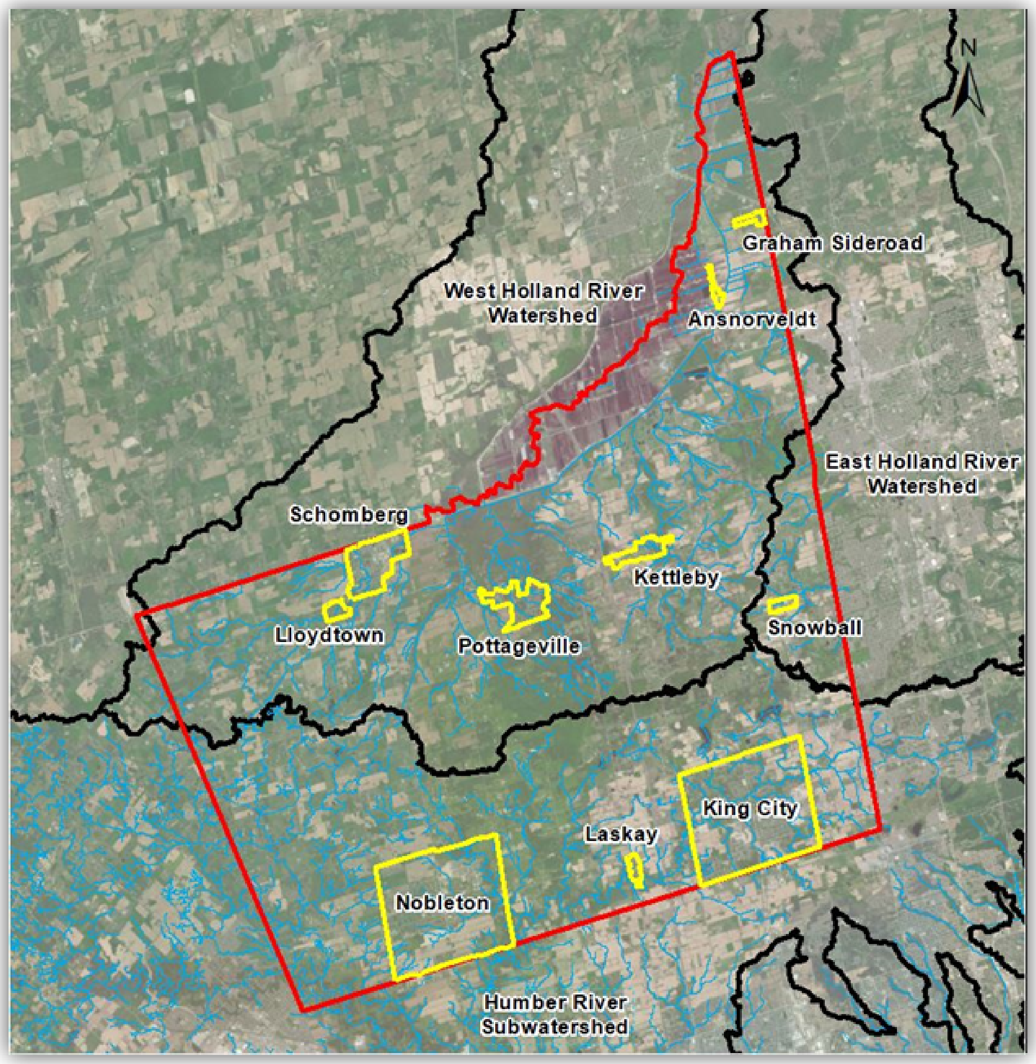
January 2022

CIVICA
Water Management Solutions

Township of King
Comprehensive Stormwater Management Master Plan
Final Report



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January 13, 2022 **CIVICA Ref: KNG18-0003**

Township of King
2585 King Rd, King City, ON, L7B 1A1

Attention: Mr. Daniel Wilkinson,
Environmental Project Manager, Public Works

Dear Daniel,

RE: Township of King Comprehensive Stormwater Management Master Plan

Please find attached the final version of the Township of King Comprehensive Stormwater Management Master Plan Report. This report is a consolidated document of the work completed by Civica, GEO Morphix, Banks Groundwater Engineering, and Natural Resource Solutions. We trust that this addresses the requirements set forth in the proposal.

Please do not hesitate to contact us for further clarification and/or comment.

Sincerely,

CIVICA INFRASTRUCTURE INC.

Ilmar Simanovskis, P.Eng., MBA
Project Manager

Cc: Carolyn Ali, Township of King
Mandy Paglia, Township of King

Encl. Township of King Comprehensive Stormwater Management Master Plan Report

Document History & QA/QC

Authorised for Release:

Ilmar Simanovskis, P.Eng., MBA
Project Manager
Civica Infrastructure Inc.

Revision History

Name	Date	Reason for Change	Version
Comprehensive Stormwater Master Plan Report Draft	**2021-05-06**	**Draft Submission – Internal Review**	**Version #1**
Comprehensive Stormwater Master Plan Report	**2021-06-29**	**Draft Submission – Public Review**	**Version #2**
Comprehensive Stormwater Master Plan Report	**2022-01-13**	**Final Submission with updated consultation results and final comment edits**	**Version #3**

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List of Abbreviations

Abbreviation	***Definition***
A	Catchment Area
ANSI	Areas of Natural and Scientific Interest
BMPs	Best Management Practices
CN	Curve Number
COSSARO	Committee on the Status of Species at Risk in Ontario
CSWM-MP	Comprehensive Stormwater Management Master Plan
CUM	Cultural Meadow
CUP	Cultural Plantation
CUT	Cultural Thicket
CUW	Cultural Woodlands
CWS	Canadian Wildlife Service
D.O	Dissolved Oxygen
DFO	Department of Fisheries and Oceans
DFO	Fisheries and Oceans Canada
EISs	Environmental Impact Studies
ELC	Ecological Land Classification
ESA	Endangered Species Act
FOC	Coniferous Forest
FOD	Deciduous Forests
FOM	Mixed Forests
GGH	Growth Plan for the Greater Golden Horseshoe
GTA	Greater Toronto Area
H	Humber
HADD	Harmful Alteration, Disruptions or Destruction
HVAs	Highly Vulnerable Aquifers
IA	Initial Abstraction
ICA	Issue Contributing Area
ICAs	Issue Contributing Areas
IPZs	Intake Protection Zones
KHFs	Key Hydrologic Features
KNHFs	Key Natural Heritage Features
L	Catchment Length
LID	Low Impact Development
LIO	Land Information of Ontario
LSPP	Lake Simcoe Protection Plan
LSRCA	Lake Simcoe Region Conservation Authority
MAFRA	Ministry of Agriculture and Food

Abbreviation	*Definition*
MAM	Meadow Marsh
MAS	Shallow Marsh
MBCA	Migratory Birds Convention Act
MMOP	Municipal Management/Operational Practices
MNRF	Ministry of Natural Resources and Forestry
MTO	Ministry of Transportation
MU	Management Units
N	Nobleton
NAPL	National Air Photo Library
NHIC	Natural Heritage Information Centre
NHS	Natural Heritage System
OAO	Open Aquatic
OBBA	Ontario Breeding Birds Atlas
OGS	Oil & Grit Separator
OP	Official Plan
ORAA	Ontario Reptile and Amphibian Atlas
ORM	Oak Ridges Moraine
P	Pottageville
PPM	Pollution Prevention Measures
PPS	Provincial Policy Statement
PSW	Provincially Significant Wetlands
RCPs	Representative Concentration
RGA	Rapid Geomorphological Assessment
ROWs	Right-of-ways
RSAT	Rapid Stream Assessment Technique
SAF	Floating-leaved Shallow Aquatic
SAM	Mixed shallow Aquatic
SAR	Species at Risk
SARA	Species at Risk Act
SARO	Species at Risk in Ontario
SAS	Submerged shallow aquatic
SCC	Species of Conservation Concern
SGBLS	South Georgian Bay Lake Simcoe
SGRAs	Significant Groundwater Recharge Areas
SPP	Source Protection Plan
SS	Suspended Solids
S_w	Catchment Slope
SWC	Coniferous Swamp
SWD	Deciduous Swamp

Abbreviation	***Definition***
SWH	Significant Wildlife Habitat
SWH	Significant Wildlife Habitat
SWHTG	Significant Wildlife Habitat Technical Guide
SWM	Stormwater Management
SWM	Mixed Swamp
SWMFs	Stormwater management facilities
SWT	Thicket Swamp
TIMP	Percent Total Impervious
T_p	Time to Peak
TRCA	Toronto and Region Conservation Authority
TSS	Total Suspended Solids
VO	Visual OTTHYMO
VPZ	Vegetation Protection Zones
WH	West Holland
WHPA-Q1/Q2	Water Quantity Vulnerable Areas
WHPAs	Wellhead Protection Areas
XIMP	Percent Directly Connected Impervious

1.0 Introduction

Civica Infrastructure Inc. (Civica) was retained by the Township of King (Township) to undertake a Comprehensive Stormwater Management Master Plan (CSWM-MP). This report will begin by identifying policy and regulatory direction relevant to the CSWM-MP. A characterization of each settlement area within the Township will then be provided. In this report, the term 'settlement area' refers to the urban and rural areas identified in The King Township Official Plan Draft (WSP, 2019) where development is concentrated, and lands are designated for future development. The settlement areas in this study include the Villages of King City, Nobleton, and Schomberg, as well as the Hamlets of Ansnorveldt, Snowball, Lloydtown, Laskay, Kettleby, Pottageville, and Graham Sideroad. Settlement areas and the extent of each study area are identified in **Figure 1-1** to **Figure 1-12**.

The Township of King is situated within watersheds managed by the Lake Simcoe Region Conservation Authority (LSRCA) and the Toronto and Region Conservation Authority (TRCA). Stormwater management criteria from the respective conservation authority is referenced based on the location of each settlement area and the corresponding watershed.

1.1 Master Planning Process

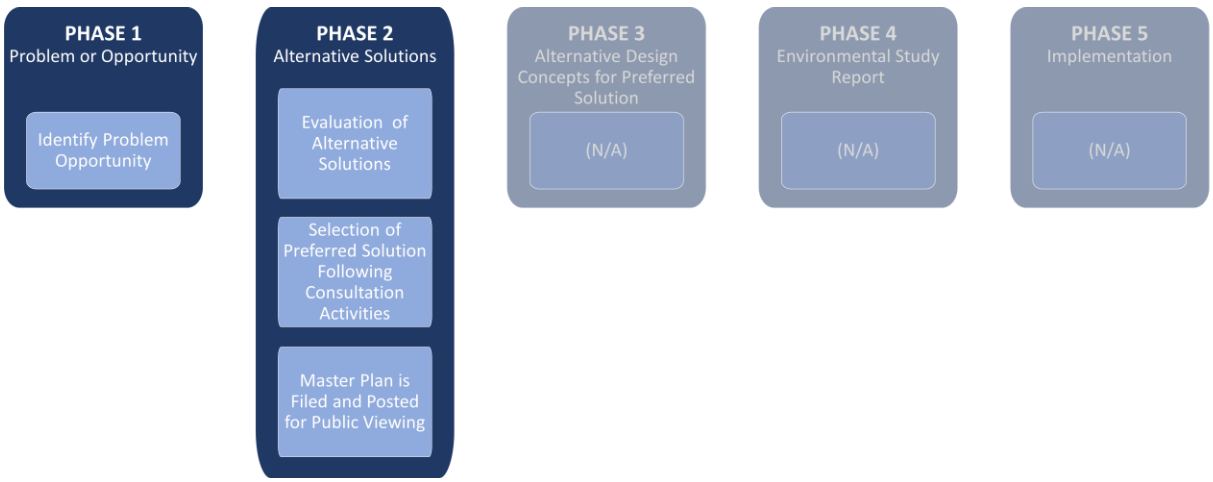
Municipalities recognize the benefits of comprehensive, long-range planning exercises that examine problems and solutions for an overall system of municipal services. The Municipal Class EA for Water and Wastewater Projects recognizes the importance of master plans as the basis for sound environmental planning. The Municipal Class Environmental Assessment (MCEA) Manual defines 3 different approaches for conducting Master Plans. This Master Plan follows Approach #1 as defined by the MCEA Manual where this approach involves the preparation of the Master Plan Document at the conclusion of Phases 1 and 2 of the MCEA process. Therefore, this Master Plan is conducted at a broad level of assessment thereby requiring more detailed investigations for specific Schedule B and Schedule C projects identified within the Master Plan.

The Class EA defines master plans as long-range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system or group of related projects to outline a framework for planning for subsequent projects and/or developments. Master plans have distinguishing features that set them apart from project specific studies. These features include:

- addresses the key principles of successful environmental planning as described in the MEA Class EA Manual
- addressed at least the first two phases of the Municipal Class EA and can also cover other phases
- allows for an integrated process with other planning initiatives
- provides a strategic level assessment of various options to better address overall system needs and potential impacts and mitigation
- is generally long term and should be reviewed at least every 5 years to integrate any changes that may have occurred and ensure continued accuracy and relevance.

- takes a system wide approach to planning which relates infrastructure either geographically or by a particular function
- recommends an infrastructure master plan which can be implemented through the implementation of separate projects
- includes a description of the specific projects

This report fulfills the requirements of Phase 1- Problem or Opportunity Statement and Phase 2- Identification and Evaluation of Alternative Solutions as presented in the following MEA Class EA Process Flowchart.



The structure of this report follows the step-by-step approach described in Phase 1 and Phase 2 of the Municipal Class EA as presented in the LSRCA Comprehensive Stormwater Management Master Plan Guidelines. The steps are identified below:

- **Step 1 – Scoping**
- **Step 2 – Determine the Study Area for the Settlement Area**
- **Step 3 – Develop a Characterization of the Study Area**
- **Step 4 – Divide the Area into Management Units**
- **Step 5 – Evaluate the Cumulative Environmental Impact of Stormwater from Existing and Planned Development**
- **Step 6 – Determine the Effectiveness of Existing Stormwater Management Systems**
- **Step 7 – Identify and Evaluate Stormwater Improvement and Retrofit Opportunities**
- **Step 8- Establish a Recommended Approach for Stormwater Management for Study Area**
- **Step 9- Develop and Implementation Plan for the Recommended Approaches**
- **Step 10- Develop Programs for Inspection and Maintenance of Stormwater management Facilities**

Figure 1-1: Township of King Study Area

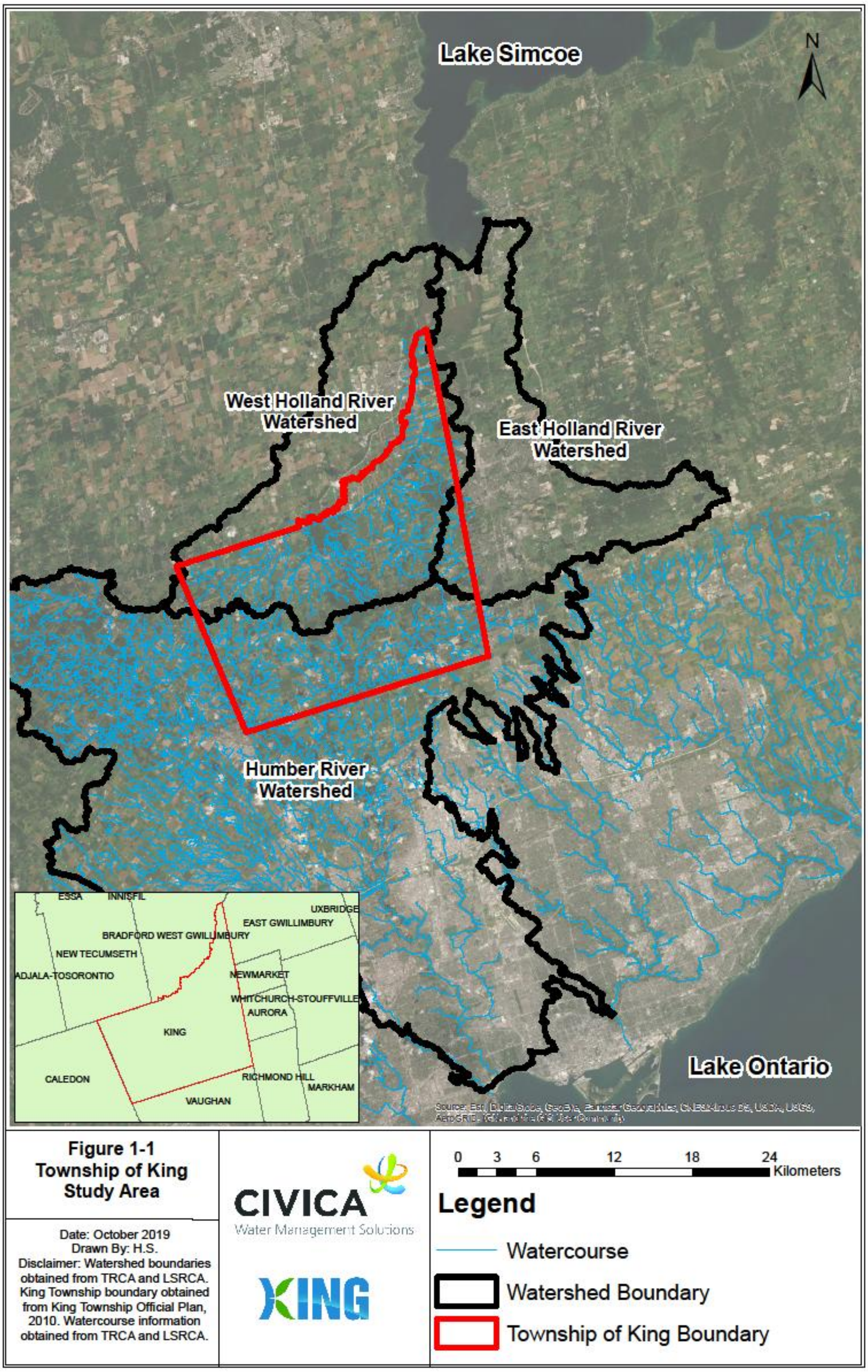


Figure 1-2: Settlement Areas

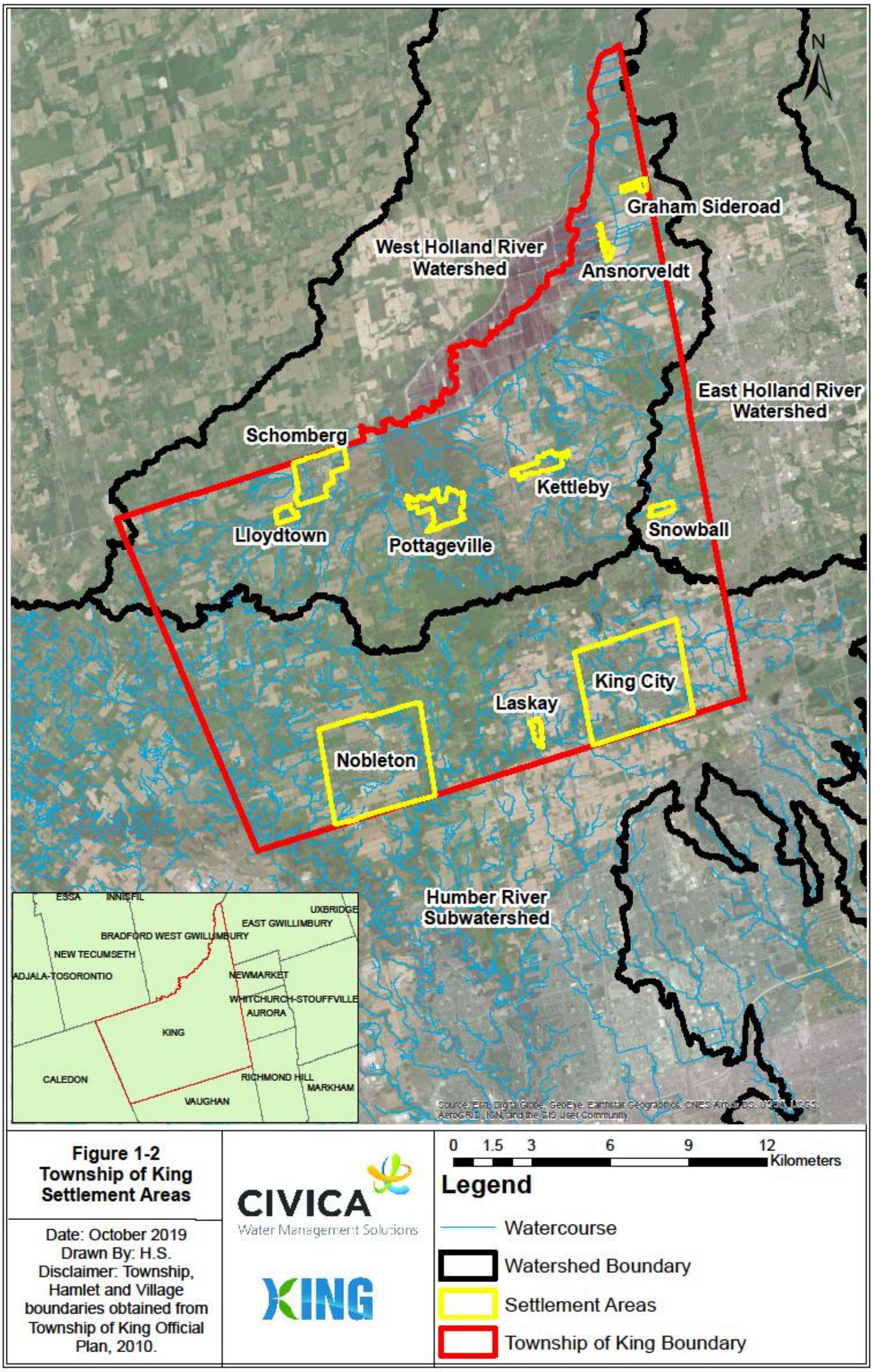


Figure 1-3: King City

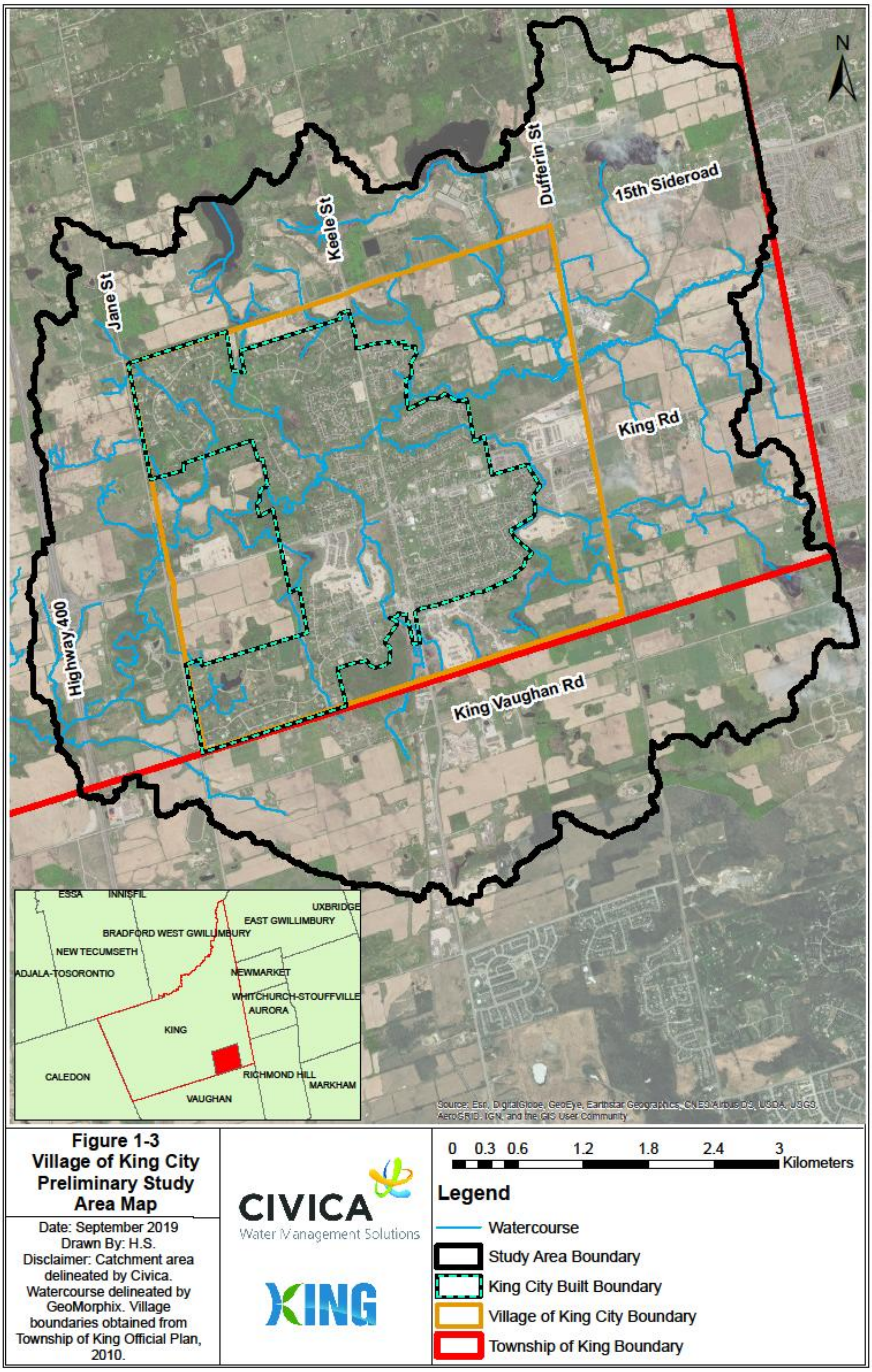


Figure 1-4: Nobleton

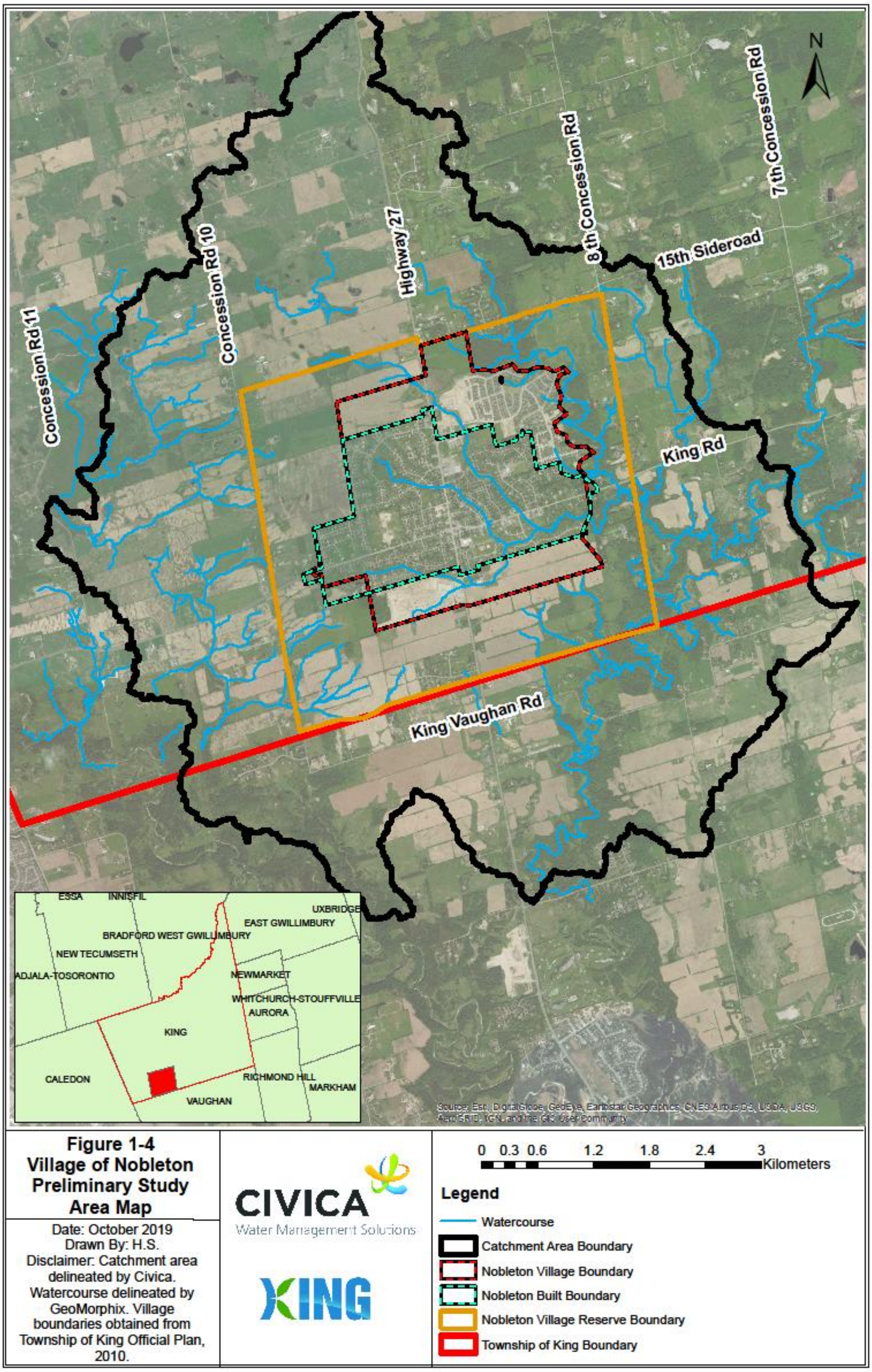


Figure 1-5: Schomberg

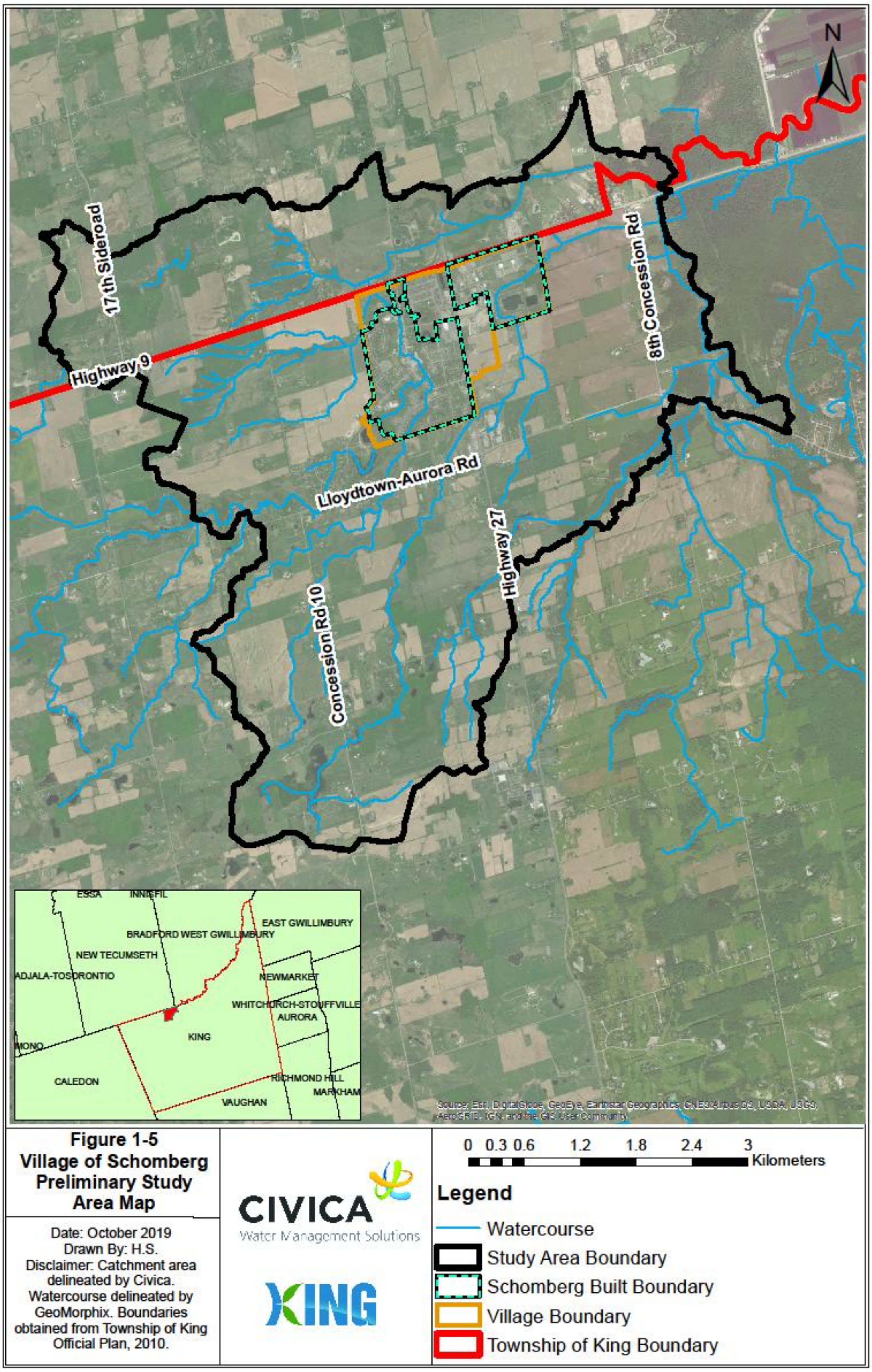


Figure 1-6: Ansnorveldt

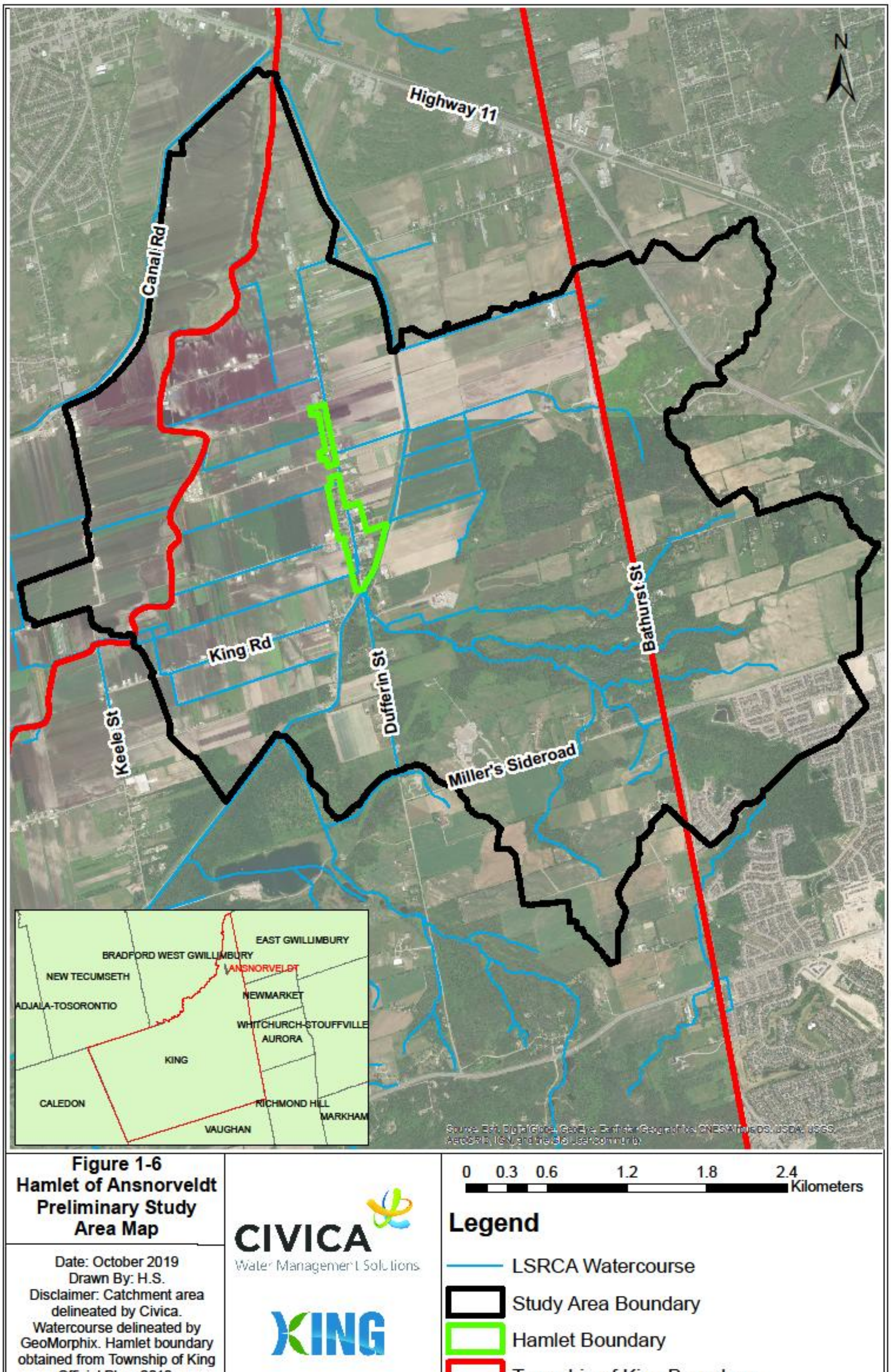


Figure 1-7: Snowball

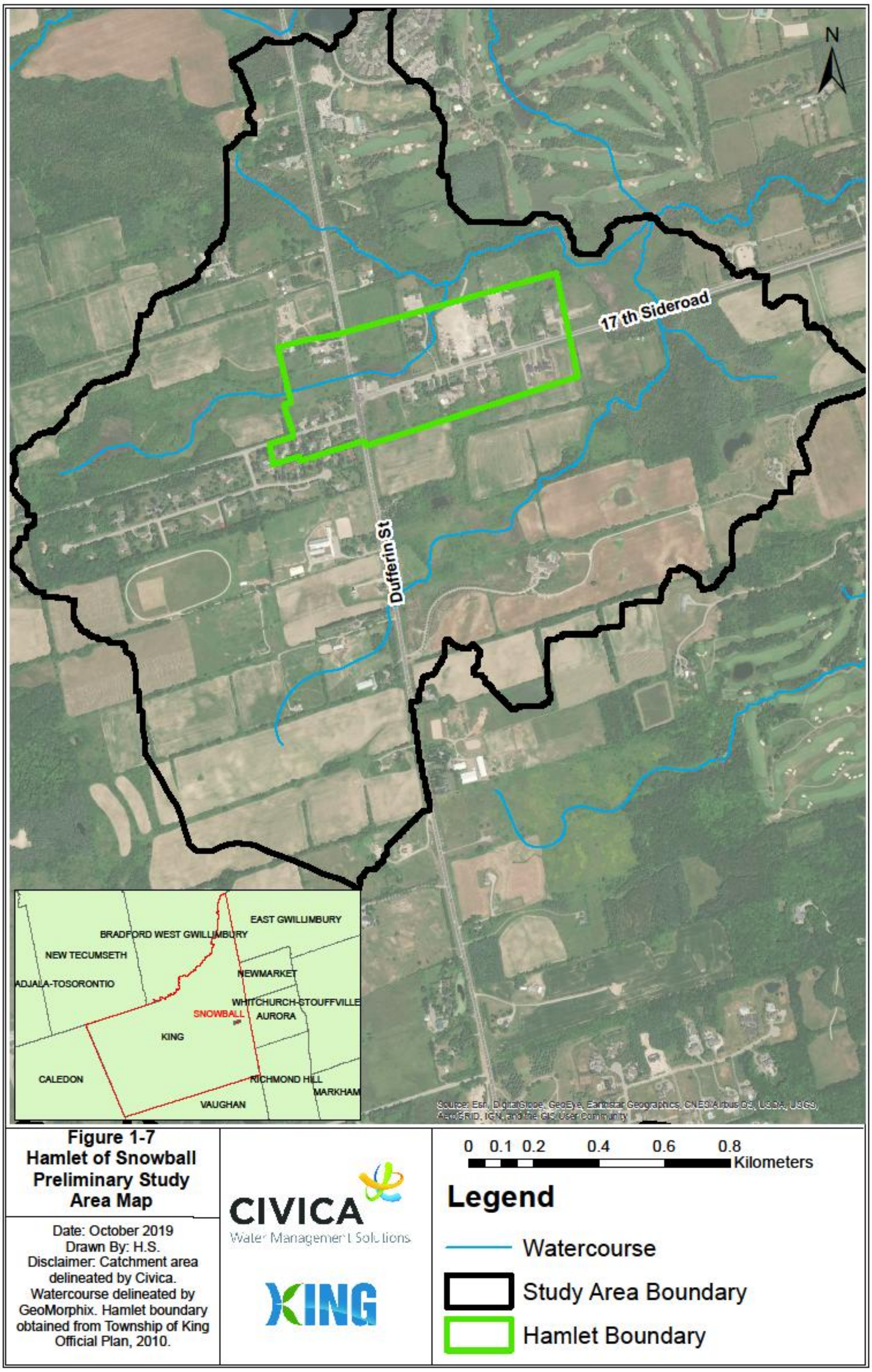


Figure 1-8: Lloydtown

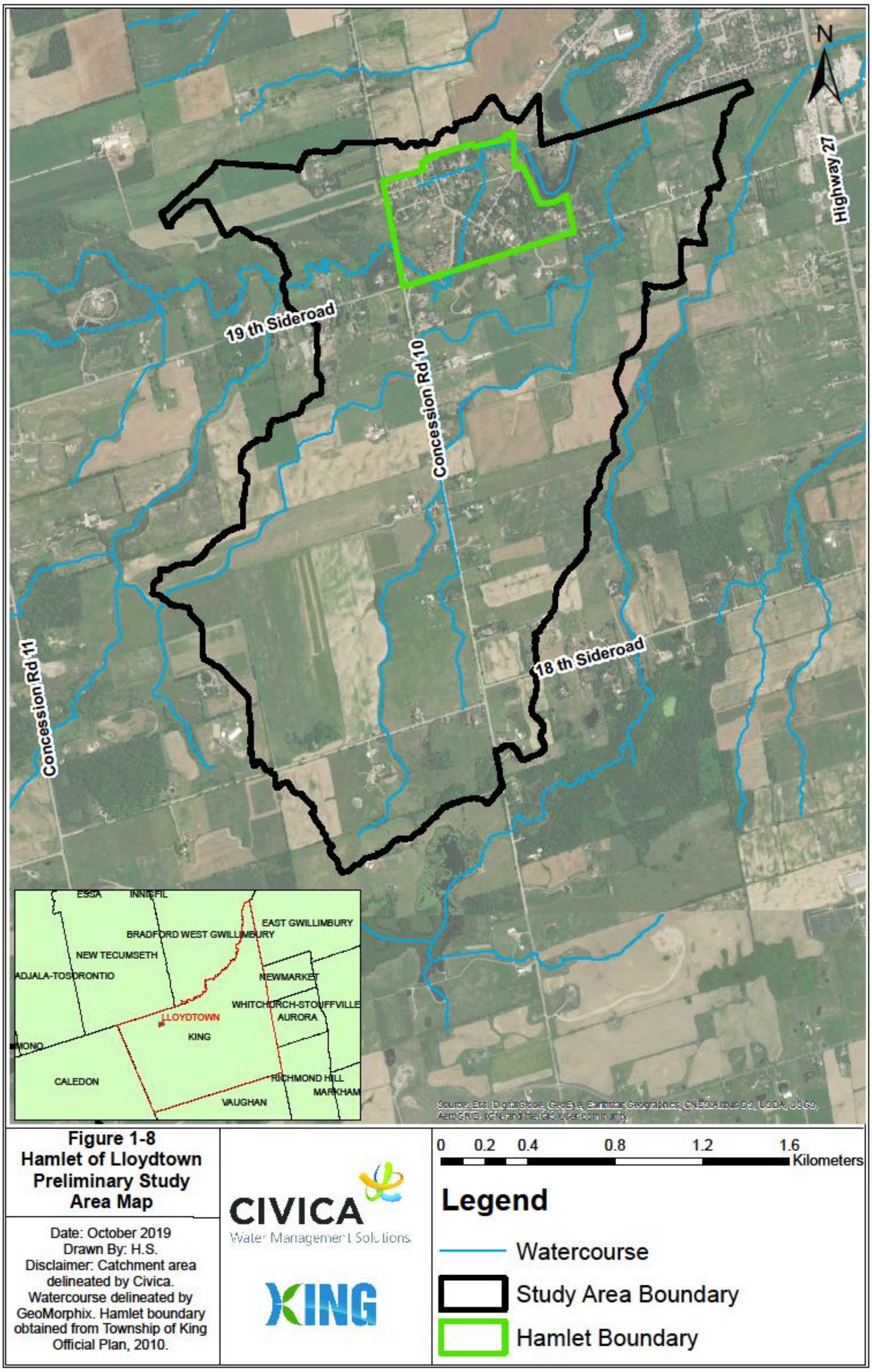


Figure 1-9: Laskay

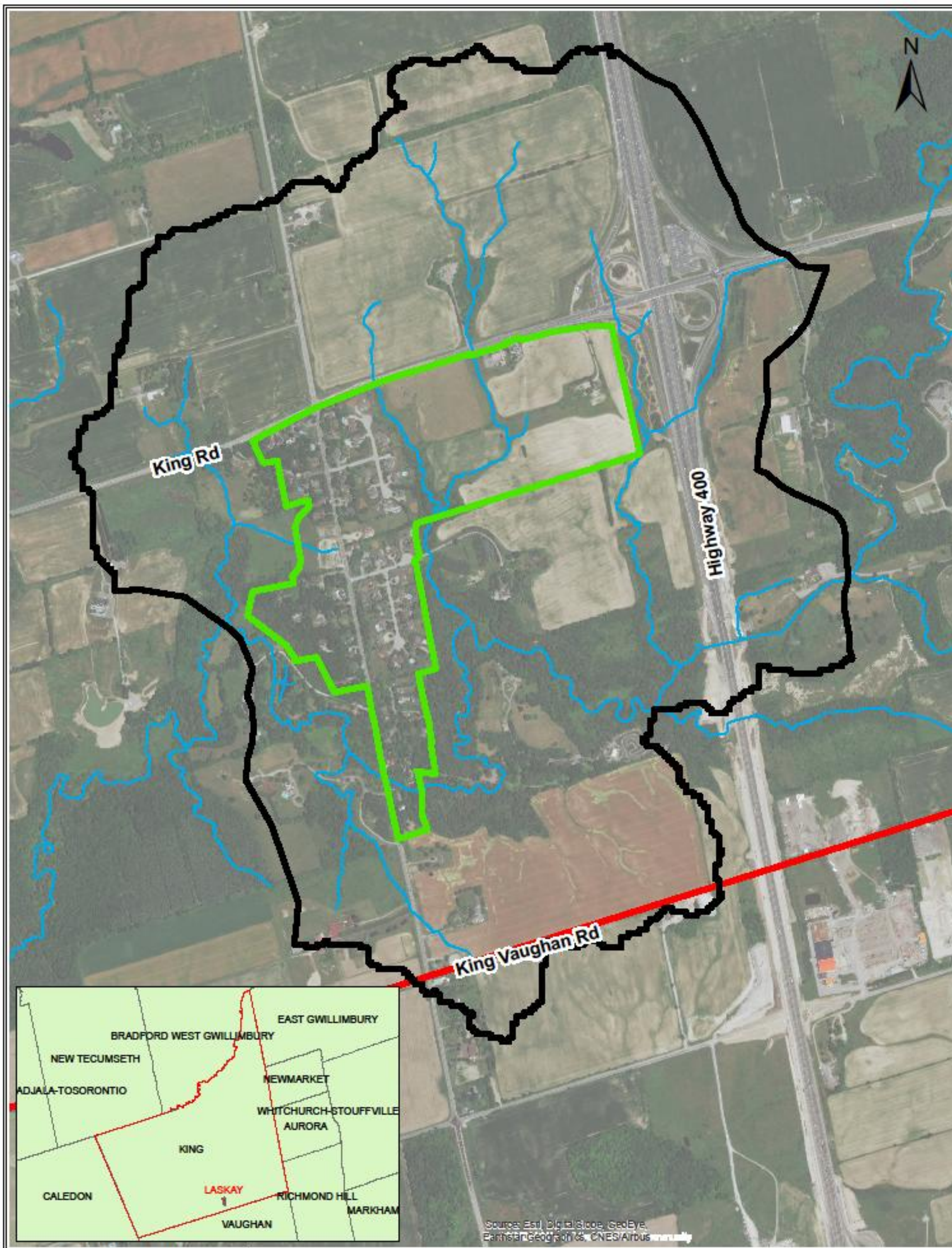


Figure 1-9
Hamlet of Laskay Preliminary Study Area Map

Date: October 2019
Drawn By: H.S.
Disclaimer: Catchment area delineated by Civica. Watercourse delineated by GeoMorphix. Hamlet boundaries obtained from Township of King Official Plan, 2010.

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0 0.125 0.25 0.5 0.75 1 Kilometers

Legend

- Watercourse
- Study Area Boundary
- Township of King Boundary
- Hamlet Boundary

Figure 1-10: Kettleby

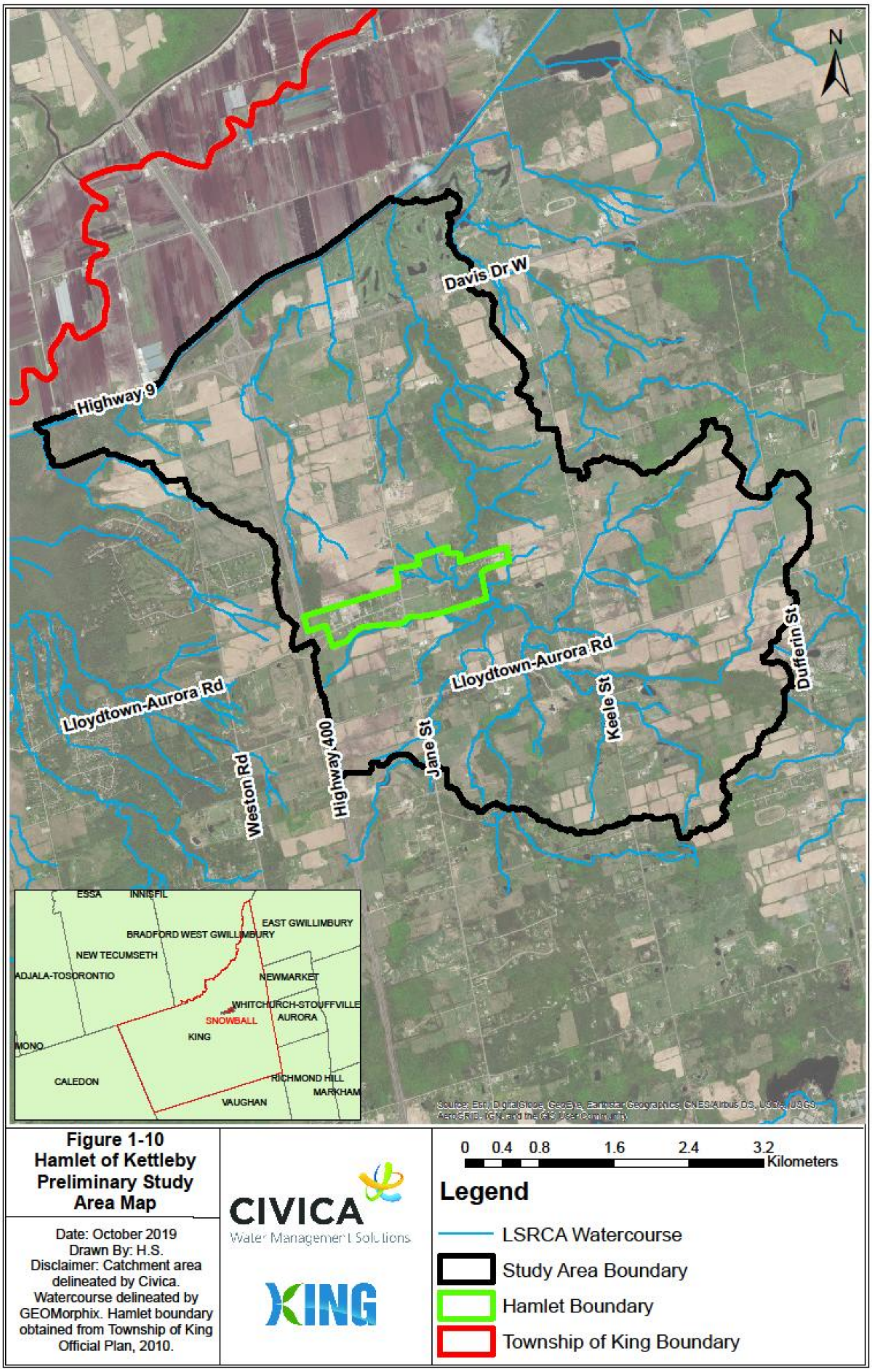


Figure 1-11: Pottageville

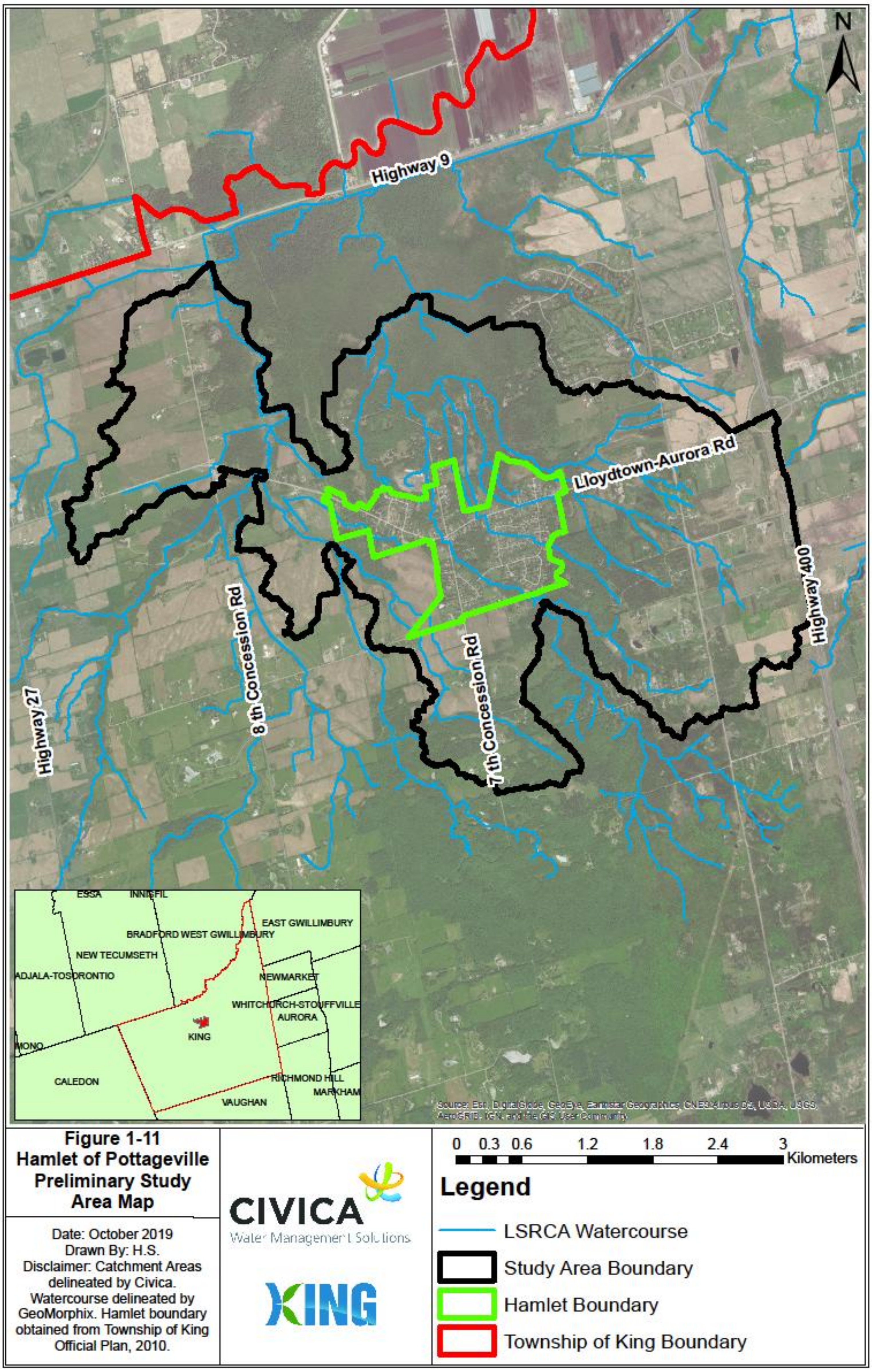
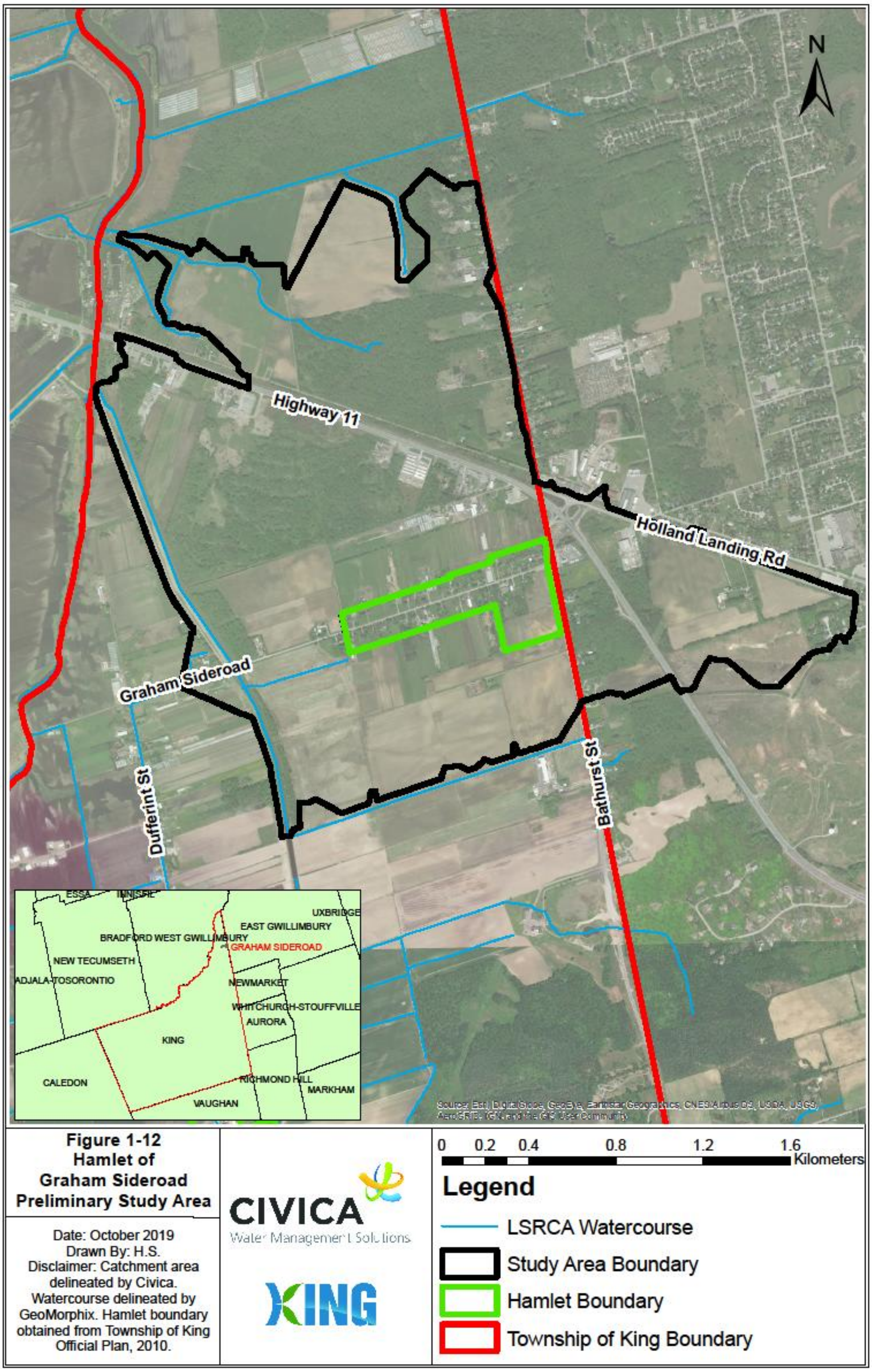


Figure 1-12: Graham Sideroad



2.0 Background

During the past several decades, the overall health of the Lake Simcoe watershed has been impaired by nutrient loading, pollutants, invasive species, climate change, and impacts associated with urban and rural uses, recreation, and agriculture (MOE, 2009). The *Lake Simcoe Protection Act* was passed by the provincial government in 2008 and provides amendments to the Lake Simcoe Protection Plan (LSPP, MOE, 2009). The LSPP establishes several objectives, some of which include the restoration of watershed ecological health (water quality, hydrology, key natural heritage features and functions, and key hydrological features and functions), restoration of self-sustaining cold water fish communities in Lake Simcoe and tributaries, management of invasive species, and the promotion of environmentally sustainable land and water uses, activities, and development practices. Multiple designated policies have been established to address water quality-related objectives of the LSPP through improvements to the management of stormwater for both existing and planned development. One of the designated policies of the LSPP is the establishment of comprehensive stormwater management master plans for settlement areas located in the Lake Simcoe watershed. The master plans are to be prepared in accordance with the Municipal Class Environmental Assessment.

3.0 Policy and Technical Background

Federal, provincial, and municipal documents were reviewed with focus on policies and guidelines that relate to stormwater management. The reviewed documents include:

- Provincial Plans
- Provincial and Conservation Authority Guidelines
- Official Plans
- Watershed and Subwatershed Plans

3.1 Relevant Policies, Legislation, and Planning Studies

Information on the hydrology, hydrogeology, geomorphology, and natural heritage features for each of the settlement areas was collected and assessed for significance. These features are evaluated against the relevant policies, legislation, and planning studies described in the sections below to help inform the CSWM-MP, identify areas to be protected, and identify areas that may require further study. **Table 3-1** identifies relevant policies, legislation, and planning studies.

Table 3-1: Relevant Policies, Legislation, and Planning Studies

Policy/Legislation	Description	Project Relevance
Provincial Policy Statement (OMMAH 2014).	• Issued under the authority of Section 3 of the Planning Act and came into effect on May 1, 2020, replacing the 2005 PPS (OMMAH 2005). • Section 2.1 of the Provincial Policy Statement (PPS) – Natural Heritage establishes clear direction on the adoption of an ecosystem approach and the protection of resources that have been identified as 'significant'. • The Natural Heritage Reference Manual (MNR 2010) and the Significant Wildlife Habitat Technical Guide (MNR 2000, MNRF 2015) were prepared by the MNRF to provide guidance on identifying natural features and in interpreting the Natural Heritage sections of the PPS.	• Based on a preliminary analysis, the following were identified within the study areas, which have implications under the PPS: ○ Significant Wildlife Habitat (SWH) has the potential to occur within the study areas. Field surveys are needed to confirm SWH's; ○ Significant wetlands; ○ Significant woodlands; ○ Significant valleylands; ○ Potential habitat for endangered and threatened species, and ○ Fish habitat.
Endangered Species Act, 2007	• The original Endangered Species Act (ESA), written in 1971, underwent a year-long review that resulted in several changes, which came into force in 2007. • The ESA prohibits killing, harming, harassing or capturing Species at Risk (SAR) and protects their habitats from damage and destruction.	• Based on a preliminary analysis, several SAR were identified as potentially occurring within the study areas. • These include plants, birds, reptiles, amphibians, mammals, odonates, and fish.
Canadian Fisheries Act, 1985	• The original Canadian Fisheries Act, written in 1985, was amended in 2013	• Future stormwater management facilities and retrofit upgrades will

Policy/Legislation	Description	Project Relevance
	• Manages threats to the sustainability and productivity of Canada's commercial, recreational, and Aboriginal fisheries. • The Act prohibits any harmful alteration, disruptions, or destruction (HADD) of fish habitat • Department of Fisheries and Oceans (DFO) has developed an online, self-assessment tool, where proponents can determine whether their projects require DFO review based on the type of water body the work is occurring in and the nature of the proposed activity.	have to consider fish habitat within the creeks of the West Holland, East Holland, and East Humber subwatersheds.
Migratory Birds Convention Act, 1994	• The federal Migratory Birds Convention Act (MBCA; 1994) states that "[…] no person shall disturb, destroy or take a nest, egg […] of a migratory bird." • This law protects migratory birds aside from the introduced species European Starling *(Sturnus vulgaris*), House Sparrow (*Passer domesticus*), and Rock Pigeon (*Columba livia*). • Bird nests that are destroyed during construction and other related activities are referred to as "incidental take", which is illegal except under the authority of a permit obtained through the Canadian Wildlife Service (CWS).	• Future stormwater management facility construction and retrofit upgrades will have to consider the MBCA, especially during vegetation clearing.
Species at Risk Act, 2002	• The federal Species at Risk Act (SARA) applies to all species listed in Schedule 1 that are on federal lands, are an aquatic species, or species of migratory bird protected by the MBCA. • Schedule 1 is the official list of SAR in Canada.	• SARA must be considered during any potential impact to terrestrial or aquatic habitats.
Fish and Wildlife Conservation Act, 1997	• This policy contains provisions for the protection of certain bird species not protected by the MCBA, such as raptors. • It also protects furbearing mammals and their den or habitual dwellings, other than for Red Fox (*Vulpes vulpes*) and Striped Skunk (*Mephitis mephitis*).	• Several fur bearers and raptors are reported within the Township, their dens or nests cannot be destroyed without a permit from the MNRF.
Greater Golden Horseshoe Growth Plan (2019)	• The most recent Growth Plan for the Greater Golden Horseshoe (GGH) came into effect May 16, 2019 (OMMAH 2019). • The Growth Plan includes a Natural Heritage System (NHS) that extends the Greenbelt Act NHS to all areas	• The NHS will have to be considered. • Policy 3.2.7 of the GGH Growth Plan describes what areas need stormwater master plans.

Policy/Legislation	Description	Project Relevance
	encompassed by this plan, outside of settlement areas.	
Greenbelt Plan (2017)	• Applies to the lands delineated in Ontario Regulation 59/05. It identifies areas where urbanization should not occur to protect ecological features and functions, as well as agriculture (Government of Ontario 2017a). • The Greenbelt Plan includes lands within the Oak Ridges Moraine Conservation Plan.	• Virtually the entire Township lies within the provincial Greenbelt (see Map 1). • Section 4.2.3 describes the policies on Stormwater Management and Resilient Infrastructure Policies. • Stormwater management systems are prohibited in key natural heritage features, key hydrologic features, and their associated vegetation protection zones. • The following settlement areas are within the Greenbelt Plan: o Ansnorveldt o Graham Sideroad o Laskay o Lloydtown o Nobleton o Schomberg
Oak Ridges Moraine Conservation Plan (2017)	• Provides protection for areas considered part of the Oak Ridges Moraine and provides implementation strategies set out in the O. Reg. 140/02 under the Oak Ridges Moraine Conservation Act, 2001 (Government of Ontario 2017b).	• A large portion of the Township is encompassed by the Oak Ridges Moraine (see Map 1). • Section 4.5 contains the stormwater management policies as it relates to this project. o Policy 4.5(2) states that development and planning design and construction practices must protect water resources. o Policy 4.5(6) states that the minimum standard for water quality is removal of 80% of suspended solids from stormwater runoff as a long-term average. o Policy 4.5(8) states that new stormwater management facilities are prohibited in key natural heritage features and key hydrologic features. • Section 4.6 lists the policies for stormwater management plans. • The following settlement areas are in the Oak Ridges Moraine Conservation Plan area: o Kettleby

Policy/Legislation	Description	Project Relevance
		○ King City ○ Nobleton ○ Pottageville ○ Snowball • Landform Conservation Areas 1 and 2 fall within some of the settlement areas. • Landform Conservation Area 1 is within Pottageville, Kettleby, and Snowball. Category 1 shall identify planning, design and construction practices that will keep disturbance to landform character to a minimum: ○ Maintaining significant landform features; ○ Limiting the portion of the net developable area of the site that is disturbed to not more than 25% of the total area of the site; and, ○ Limiting the portion of the net developable area of the site that has impervious surfaces to not more than 15% of the site. • Landform Conservation Area 2 is within Pottageville, Kettleby, Snowball, King City, and Nobleton. Category 1 shall identify planning, design and construction practices that will keep disturbance to landform character to a minimum: ○ Maintaining significant landform features; ○ Limiting the portion of the net developable area of the site that is disturbed to not more than 50% of the total area of the site; and, ○ Limiting the portion of the net developable area of the site that has impervious surfaces to not more than 20% of the site.
Lake Simcoe Protection Plan (2009)	• The LSPP comes from the strategies and implementation set out in the Lake Simcoe Protection Act, 2008.	• Section 4.5 goes through the Stormwater Management requirements set out under the

Policy/Legislation	Description	Project Relevance
	• The plan is to protect and restore the ecological health of Lake Simcoe and its watershed.	protection plan including minimizing phosphorus loadings. • Policy 6.23e) states no new stormwater management facilities are permitted within key natural heritage features or key hydrologic features. However, retrofitting existing stormwater management facilities is allowed, where no alternative work is permitted within key natural heritage or key hydrologic features. • The following settlement areas are within the Lake Simcoe Protection Plan Area: ○ Ansnorveldt ○ Graham Sideroad ○ Kettleby ○ Lloydtown ○ Pottageville ○ Schomberg ○ Snowball
Region of York Official Plan (2010)	• The Region of York Official Plan 2010 outlines current policies for the protection of natural areas and natural features within the Region of York, including the Township. • General natural environmental policies within the Region of York are detailed in Chapter 2.	• Policy 2.1.10a states that stormwater management systems and facilities may be permitted within the Regional Greenlands System if they are in accordance with an approved Environmental Impact Study. • Policies within Chapter 2 speak to the protection of natural features including but not limited to SWH, wetlands, and fish habitat.
Township Official Plan (2019)	• The Township recently developed a new Official Plan. It was adopted by Council September 23, 2019. • Land use designations under this Official Plan include: ○ The Village of King City ○ The Village of Nobleton ○ The Village of Schomberg ○ The Hamlet of Pottageville ○ The Hamlet of Laskay ○ The Hamlet of Kettleby ○ The Hamlet of Lloydtown ○ The Hamlet of Ansnorveldt ○ The Hamlet of Graham Sideroad ○ The Hamlet of Snowball	• Policy 8.4 contains the stormwater management requirements including protecting water quality, water balance, human safety, aquatic species, and their habitat.

Policy/Legislation	Description	Project Relevance
Lake Simcoe Region Conservation Authority (LSRCA) Regulation 179/06	• Regulation issued under *Conservation Authorities Act,* R.S.O. 1990. Through this regulation, the LSRCA has the responsibility to regulate activities in natural and hazardous areas (i.e., areas in and near the lakes, rivers and streams, floodplains, wetlands, and valleys) within their designated jurisdiction.	• LSRCA regulated lands are located within the study area. • The following settlement areas contain LSRCA regulated areas: ○ Ansnorveldt ○ Graham Side Road ○ Kettleby ○ Lloydtown ○ Pottageville ○ Schomberg ○ Snowball
Toronto and Region Conservation Authority (TRCA) Regulation 166/06	• Regulation issued under *Conservation Authorities Act,* R.S.O. 1990. Through this regulation, the TRCA has the responsibility to regulate activities in natural and hazardous areas (i.e., areas in and near the lakes, rivers and streams, floodplains, wetlands, and valleys) within their designated jurisdiction.	• TRCA regulated lands are located within the study area. • The following settlement areas contain TRCA regulated areas: ○ King City ○ Laskay ○ Nobleton
The Clean Water Act (2006)	• The Clean Water Act establishes a locally driven, science-based, multi-stakeholder process for safeguarding drinking water sources. As part of the Act and O.Reg. 287/07, as amended by O.Reg. 59/10, assessment reports have been developed in accordance with the regulations, Technical Rules: Assessment Report (MOE, 2009), and the Terms of Reference established for each Source Protection Area.	• All settlement areas are under the Clean Water Act.
Approved Source Protection Plan: CTC Source Protection Region (2015)	• The CTC Source Protection Region comprises three Conservation Authorities: Credit Valley Conservation, Toronto and Region Conservation Authority, and Central Lake Conservation.	• CTC regulated lands are located within the study area. • The following settlement areas contain CTC regulated lands: ○ Nobleton ○ Laskay ○ King City
Approved South Georgian Bay-Lake Simcoe Source Protection Plan: South Georgian Bay-Lake Simcoe Protection Region (2015)	• The SGBLS Source Protection Region comprises four watersheds: Black Severn, Lake Simcoe, Nottawasaga Valley, and Severn Sound.	• South Georgian Bay- Source Protection Region regulated lands are located within the study area. • The following settlement areas contain SGBLS regulated lands: ○ Snowball ○ Kettleby ○ Pottageville ○ Lloydtown ○ Schomberg ○ Ansnorveldt

Policy/Legislation	Description	Project Relevance
		○ Graham Sideroad
Township of King Development Charges Background Study (2020)	• Development Charges are fees levied upon growth development to help pay for costs of infrastructure required to support and service new growth. Development Charges do not fund operating, maintenance, or rehabilitation costs, as those are funded by property taxes from all Township properties, including the new growth properties.	• Relevant for capital planning for stormwater infrastructure

3.2 Stormwater Management Guidelines

The following sections provide a summary of the stormwater management guidelines for TRCA, LSRCA, Lake Simcoe Protection Plan (LSPP), and Redside Dace (*Clinostomus elongatus*), an Endangered fish species protected by the ESA.

3.2.1 TRCA Stormwater Management Criteria

The TRCA provides stormwater management guidance with respect to specific water management strategies and programs (TRCA 2012). This document provides guidelines in the planning and design of stormwater management infrastructure needed to address flooding, water quality, erosion, water balance, and natural heritage. The following guidance is provided:

- Stormwater Management (SWM) facilities must be located outside the 100-year floodplain;
- 80% Total Suspended Solids (TSS) removal;
- Implementation of a comprehensive SWM pond maintenance program is crucial to protect water quality in urbanizing watersheds;
- TRCA has a list of preferred native plant species for planting plans around SWM systems;
- Mitigation techniques for thermal impacts should be considered when designing SWM ponds, especially if discharging to sensitive streams;
- Oil and grit separators are recommended as a pre-treatment device or can be used in a treatment train approach; and,
- Low Impact Development (LID) is encouraged. TRCA provides additional guidance in the Low Impact Development Stormwater Management Planning and Design Guide (TRCA 2010).

3.2.2 LSRCA Stormwater Management Technical Guidelines

The LSRCA guidelines identify parameters for stormwater quantity control, stormwater quality control, stream erosion control, water balance, and erosion and sediment control (LSRCA 2016). Section 2.3 (Stormwater Quality Control) describes guidelines that will protect water quality within the LSRCA:

- Long term average removal of 80% of suspended solids;
- Any application for a major development should have a stormwater management plan that evaluates the phosphorus loadings between pre-development and post-development. The plan should propose mitigation measures on how phosphorus loading will be minimized;

- Removal of 80% of the annual Total Phosphorus load from all major development areas will be required;
- Due to the use of winter salt, SWM wet ponds become stratified with the highest salt concentration at the bottom of the ponds. LSRCA requires the use of submerged outlets which are to be located approximately at the midpoint of permanent pool depth, with a minimum of 0.6 m from the bottom of the facility and 1.0 m below the surface of the permanent pool;

End of pipe SWM facilities should be designed with the following features to minimize thermal impacts:

- Minimum length to width ratio of 5:1 to minimize large open areas of water or filtration media;
- Appropriate plantings to maximize shade coverage throughout the facility;
- Multi-draw or blended outlets with cooling trenches that account for both temperature and salt impacts; and,
- Manufactured Treatment Devices can be used to reduce oil and grit in stormwater facilities.

3.2.3 Lake Simcoe Protection Plan

As per Section 4.5 of the Lake Simcoe Protection Plan, SWM master plans are to include the following:

- A characterization of existing environmental conditions on a subwatershed basis, consistent with any relevant subwatershed evaluations, if available;
- An evaluation of the cumulative environmental impact of stormwater from existing and planned development;
- A determination of the effectiveness of existing SWM works at reducing the negative impacts of stormwater on the environment, including consideration of the potential impacts of climate change on the effectiveness of the works;
- An examination of any SWM retrofit opportunities that have already been identified by the municipality or the LSRCA for areas where stormwater is uncontrolled or inadequately controlled;
- The identification of additional SWM retrofit opportunities or improvements to existing SWM works that could improve the level of treatment within a particular settlement area;
- A description of existing or planned programs for regular maintenance of SWM works;
- An identification of the preferred solution for SWM in each settlement area; and,
- An implementation plan for the preferred solution.

New major development in the Lake Simcoe watershed will be designed to satisfy the Enhanced Protection Level specified in Chapter 3 of the Ministry of Environment’s Stormwater Management Planning and Design Manual.

3.2.4 Guidance for Development Activities in Redside Dace Protected Habitat

The Ministry of Natural Resources and Forestry (MNRF) has developed stormwater management guidelines for the protection of Redside Dace habitat (MNRF 2016). Section 4.6 (Stormwater Management) of the MNRF Stormwater Management guidelines describes regulations that will protect Redside Dace habitat when SWM facilities discharge into Redside Dace regulated habitat (MNRF 2016):

- Discharging water should not exceed 25mg/L of TSS above the background stream level;
- Discharge temperatures should be below 24˚C;
- Discharge should have dissolved oxygen concentrations of at least 7mg/L; and,
- Post-development water balance should match pre-development water balance.

The above objective can be achieved by using LID strategies such as (MNRF 2016):

- Site design strategies (conserving natural features and design to reduce impact);
- Evaporation and infiltration practices;
- Rainwater harvesting;
- Runoff conveyance; and,
- Runoff storage.

4.0 Characterization of the Study Area

The Township is within the Region of York and covers an area of approximately 333 km^2. According to Statistics Canada, the population in 2016 was 24,512 and is projected to grow to 34,900 by 2031. The Township is located within portions of two subwatersheds within the jurisdiction of the LSRCA, the West and East Holland Rivers, and one watershed within the jurisdiction of the TRCA, the Humber River.

4.1 Soil, Terrain, and Drainage

The Township is not heavily developed, with 38 percent of the Oak Ridges Moraine designated as Natural Core Area under the Oak Ridges Moraine Conservation Plan. The Township generally drains in two directions, north and south. The Schomberg and Holland Rivers drain north of the Township into Lake Simcoe. The Humber River drains south of the Township into Lake Ontario.

The Humber River watershed is situated in the south-central zone of the Greater Toronto Area (GTA), a catchment area of approximately 911 km^2. Within the Humber River watershed, there are five (5) subwatersheds: Main Humber, East Humber, West Humber, Lower Humber, and Black Creek. The Township is situated within the East and Main Humber subwatersheds near the headwaters of the Oak Ridges Moraine. The thermal regime of these subwatersheds is cool and stable, while water temperatures in the eastern most headwaters near King City fluctuate considerably due to the variability of the incoming water from inland lakes. The East Humber subwatershed is one of the healthiest subwatersheds within the Humber River watershed.

The Holland River watershed is in the north half of the Township. Both the West and East Holland subwatersheds are located within the Township. The headwaters of the Holland River are located within the Township and the watercourses have a cold thermal regime.

The Township's terrain ranges from smooth and moderate sloping to irregular and steeply sloping. The Township reaches a maximum elevation of 335 m above sea level (masl) along the northern watershed divide and a low of approximately 245 masl. The Township's soil mainly consists of silt loam, clay loam, clay loam steep phase, and underlying sandy glacial moraine. The soils also contain shale till mixed with lacustrine deposits and limestone. This permits internal drainage and relatively free surface water movement. The hummocky land and internally drained areas encourage substantial groundwater recharge and discharge.

Maps were developed to identify the soil types and quaternary geology within the Township. The information was collected from Ontario Geological Survey and Ministry of Agriculture and Food (MAFRA) open-source data. Soil types and quaternary geology are presented in **Figure 4-1** and **Figure 4-2**, respectively.

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Figure 4-1: Soil Series and Type

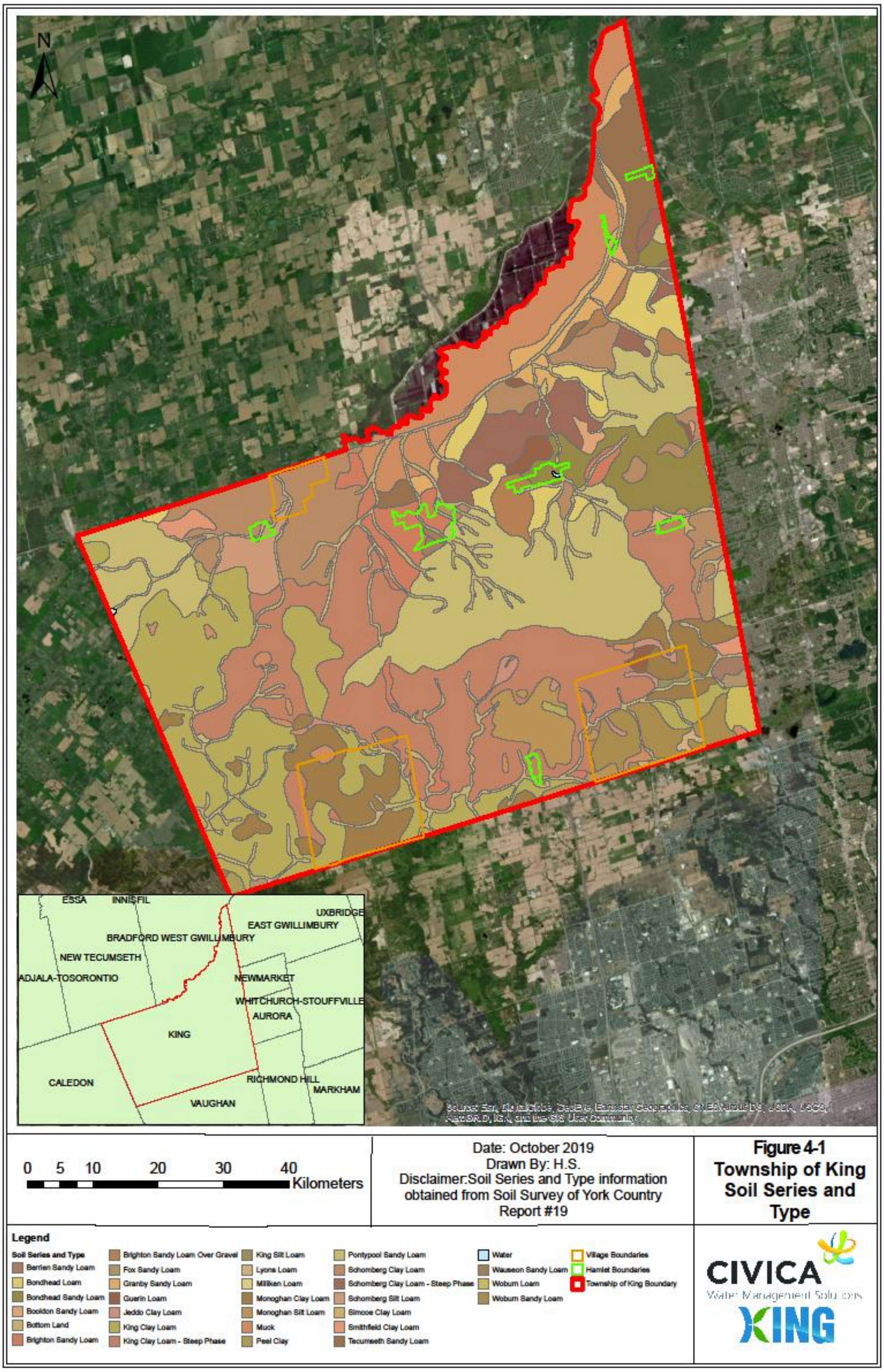
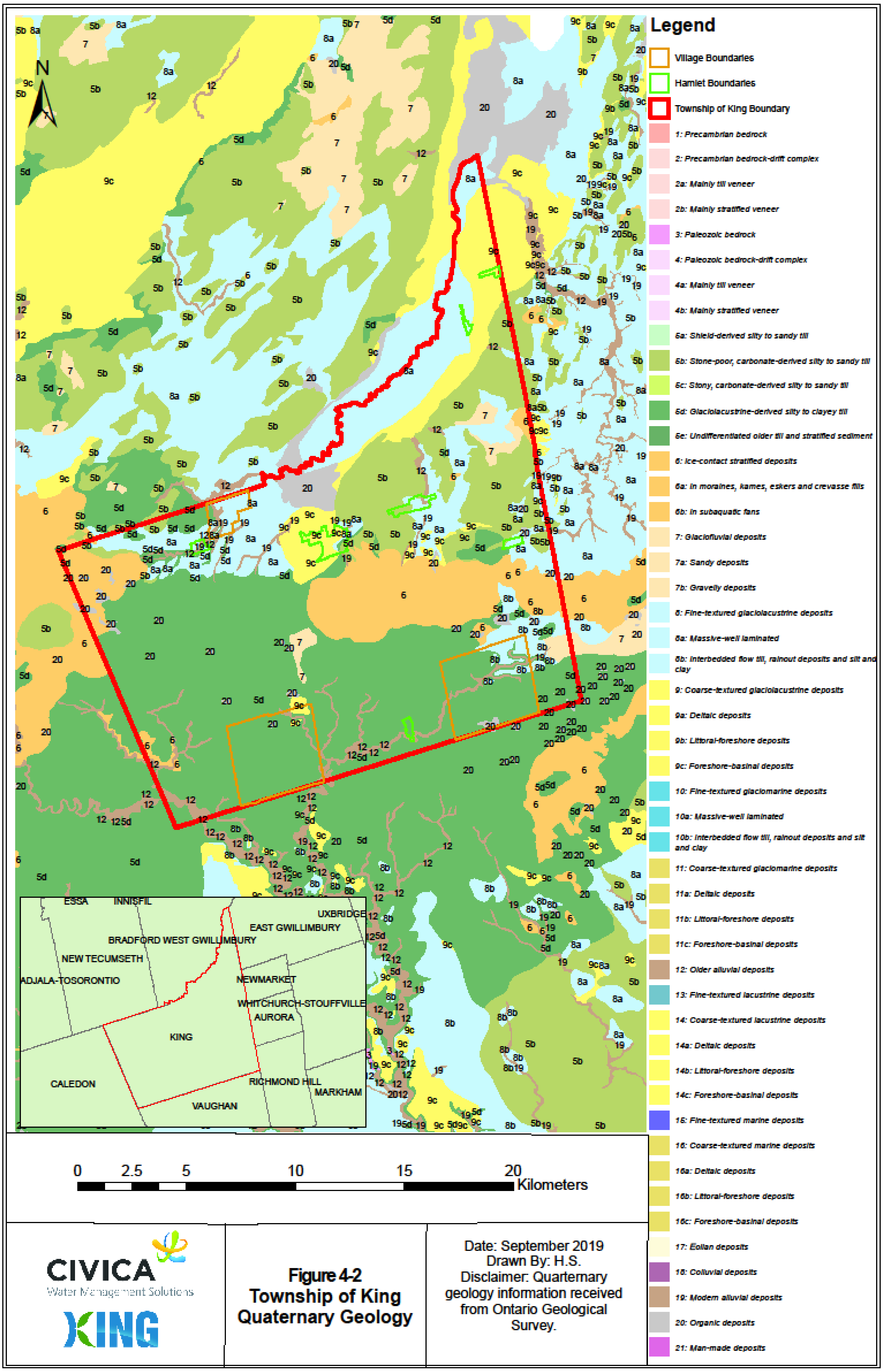


Figure 4-2: Quaternary Geology



4.2 Land Use

4.2.1 Existing Land Use

The Township consists of several villages and hamlets with various land use types. Urban land use is concentrated within the three main villages of King City, Nobleton, and Schomberg. Most of the Township consists of rural areas and agriculture areas within the Oak Ridges Moraine and Greenbelt.

Since the TRCA and LSRCA both regulate areas within the Township, the naming conventions for land use types differ. Therefore, land use areas were determined individually for each conservation authority. A breakdown of the land use types for the TRCA and LSRCA are shown in **Table 4-1** and **Table 4-2**, respectively.

Table 4-1: TRCA Land Use

Existing Land Use	Area (ha)	Percent of Humber River Watershed Within King (%)
Agricultural	6797.76	28.33
Beach/Bluff	0.0719	0.00
Cemetery	5.61	0.02
Commercial	50.95	0.21
Estate Residential	383.73	1.60
Forest	3445.85	14.36
Golf Course	82.41	0.34
High Density Residential	3.13	0.01
Industrial	33.29	0.14
Institutional	96.94	0.40
Lacustrine	226.61	0.94
Meadow	1569.45	6.54
Medium Density Residential	1145.03	4.77
Railway	7.54	0.03
Recreational/Open Space	271.79	1.13
Riverine	14.95	0.06
Roads	8043.34	33.52
Rural Residential	856.57	3.57
Successional Forest	439.43	1.83
Vacant Land	29.36	0.12
Wetland	490.18	2.04
Total	**23993.99**	**100.00**

Table 4-2: LSRCA Land Use

Existing Land Use	Area (ha)	Percent of Lake Simcoe Watershed Within King (%)
Commercial	37.60	0.15
Estate Residential	295.37	1.17
Industrial	43.36	0.17
Institutional	63.73	0.25
Intensive Agriculture	8455.56	33.48
Manicured Open Space	417.39	1.65
Natural Heritage Feature	8470.55	33.54
Non-Intensive Agriculture	3471.26	13.74
Rail	6.58	0.03
Road	2609.90	10.33
Rural Development	998.98	3.96
Urban	385.11	1.52
Total	**25255.39**	**100.00**

Existing land use designations for each settlement area are identified in **Appendix A.**

4.2.2 Future Land Use

The 2019 Township Official Plan (OP), along with aerial imagery, were reviewed to confirm areas proposed for future development. New development and changes in land use designation are isolated in the three villages of King City, Nobleton, and Schomberg. The following sections summarize the findings in each village.

4.2.2.1 King City

Four areas in the southeast quadrant of the King City village area are designated for low-density residential landuse. Aerial imagery shows that these areas are currently designated as open space and agriculture.

East of Keele Street, in the northeast quadrant of King City, several areas are designated to be developed into low-density residential subdivisions in the OP. Aerial imagery shows that these areas are currently used as agricultural land and remain undeveloped.

In the southwest quadrant of King City, on the west side of Jane Street, a section of land is marked in the OP as employment area. The aerial imagery shows that this section is used as agricultural land and is currently undeveloped. South of this area, two areas designated as low-density residential in the OP. Upon further review of aerial imagery, these areas remain undeveloped and are currently used for agricultural purpose.

The OP shows two areas in the northwest quadrant of the village, on the southwest corner of 15th Sideroad and Keele Street, designated as low-density residential subdivisions. Aerial imagery shows that these areas have been developed as planned. In the southwest corner of this quadrant, the OP marks three areas as low-density residential. Upon review of the aerial imagery, it is confirmed that these areas have yet to be developed and remain as agricultural land. Finally, on the north side of King Road in this quadrant, a section of land was designated as low-density residential and institutional areas. The aerial imagery of this area shows that this area has been developed into a residential subdivision as well as the King Township museum. The identified potential land use changes identified in the Village of King City are presented in **Figure A-11** of **Appendix A**.

4.2.2.2 Nobleton

The OP shows that there is proposed residential development in the southeast part of the village of Nobleton. After review of the aerial imagery, it was determined that the area has already been developed. A specific portion of the same area was designated in the OP as institutional area. This area remains undeveloped and, considering the new development in the area, it can be confirmed that this area will continue to be developed as planned. Just north of King Road, on the east side of the village, an area of land adjacent to a residential neighbourhood is designated in the OP to be developed into a low-density residential area. The aerial imagery shows that this open area adjacent the subdivision is currently unoccupied and can be further developed.

Just to the east of the development north of King Road, the OP identifies a section of land that is planned to be developed into low-density residential and employment areas. Aerial imagery review shows that this area is currently being used for agricultural purposes and has the potential for development as defined in the OP.

The northwest section of Nobleton has an area marked for low-density residential development. The aerial imagery showed that this area is currently being used for agricultural purposes but has the potential for development as planned. Just northeast of this section is an area designated as a rural and natural heritage area in the OP. Aerial imagery shows this area is also cleared and it is presumed that this area will be developed.

On the west side of the village, within an established residential area, the OP sections off an area that is to be further developed. Aerial imagery shows that this area is currently in the early stages of development.

The OP identifies an area in the southern portion of a low-density residential complex in the northeast corner of the village as an area that is to be further developed for low-density residential. It was confirmed through aerial imagery that this portion has been developed. Within the same residential complex, the OP shows two sections on the west side that were also marked to be developed into low-density residential subdivisions. Aerial imagery of this area shows that these areas have been developed into subdivisions. The identified potential land use changes in the Village of Nobleton are presented in **Figure A-12** of **Appendix A.**

4.2.2.3 Schomberg

In the northwest corner of the village, a small portion of the land is marked as undetermined special development area in the OP. The existing land use designation from the LSRCA is natural heritage, however, review of aerial imagery suggests that this area is open space and has potential for future development.

The OP designates a portion of the east and northeast section of the village as employment area. The aerial imagery shows that these areas are confirmed to be employment areas. A certain section is used for agricultural purposes and there is the potential for further development for employment purposes. The identified potential land use changes identified in the Village of Schomberg are presented in **Figure A-13** of **Appendix A.**

4.2.3 Transportation Networks

Several methods of transportation currently exist within the Township. The networks, modes and services within the Township include regional roads, provincial highways, GO Transit buses and trains, and York Region Transit buses. Existing transportation networks within the Township include:

- Major and minor roadways
    - Regional arterial roads (for cars, trucks, commercial vehicles, buses, cyclists, and pedestrians)
    - Township collector and local roads (for cars, commercial vehicles, cyclists, and pedestrians)
- Public Transit
    - Railway transit (GO Transit) and GO and York Regional Transit buses
- Active modes
    - Paved shoulders, cycling routes, sidewalks, walking paths

Several road network improvements are planned for the Township. These initiatives have been undertaken by a variety of organizations such as York Region and the Ministry of Transportation. Some of the road network improvements presently planned in or around the Township are:

- Highway 427 Extension (MTO)
- Highway 400 widening from King Rd to Highway 9 detailed design (MTO)
- West Vaughan arterial road improvements environmental assessment

The York Region Transportation Master Plan recommends several improvements to the transit network in the Township. The recommended transit improvements within the Township are:

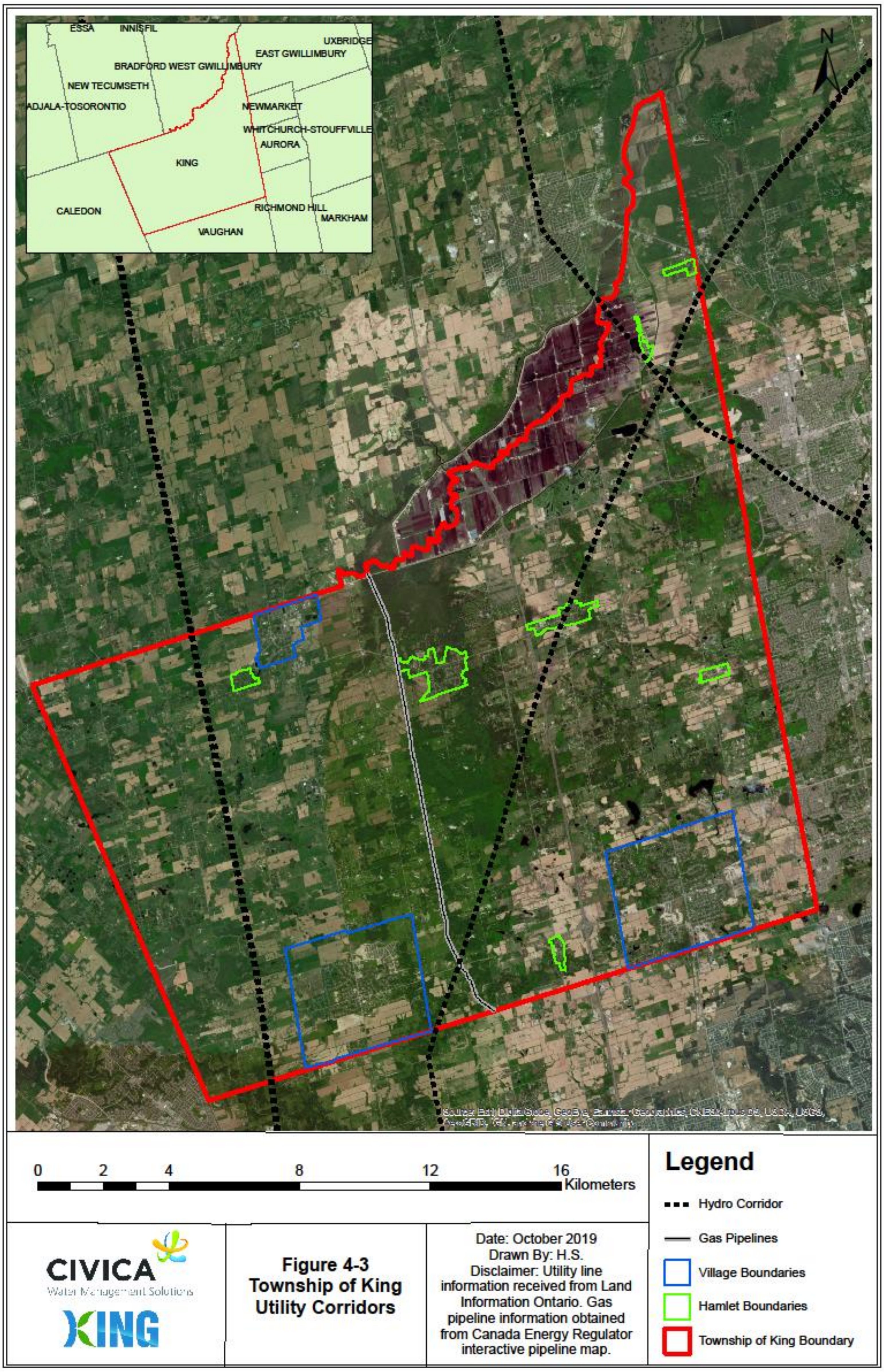
- Rural transit service along:
    - King Road between Hwy 50 and Bathurst Street
    - Hwy 27 between Hwy 9 and Kirby Road
    - Hwy 9 between Hwy 50 and Hwy 400
- Transit priority corridor along Hwy 9 east of Hwy 400
- Express bus service along Hwy 400
- New Go Station on the Barrie GO line at Bathurst Street and 15th Sideroad/Bloomington Road

An increasingly important element of the Township's transportation is active transportation. This includes components such as paved shoulders, cycling routes, sidewalks, and walking trails. Schedule J of the OP shows the existing and proposed active transportation routes in the hamlets and areas surrounding the villages in the Township. Schedules J-1, J-2, and J-3 of the OP show the existing and proposed active transportation networks within the villages of King City, Nobleton, and Schomberg, respectively.

4.2.4 Utility Corridors

Hydro corridor information was obtained from the Land Information of Ontario (LIO) online database. The Township has three (3) sections of high voltage transmission lines running through the municipal boundaries. Gas pipeline information was obtained from the Canada Energy Regulator interactive pipeline map. A natural gas pipeline operated by TransCanada Pipelines Ltd was also identified within municipal boundaries. The pipeline starts just northwest of the City of Vaughan and continues running north through the Township to the City of Barrie and onwards. Utility corridors are shown in **Figure 4-3.**

Figure 4-3: Utility Corridors



4.3 Natural Heritage

The CSWM-MP requires that a characterization of the environmental and natural heritage features of each study area be prepared. This section is based on a desktop analysis of existing information and will inform the placements of future stormwater facilities, as well as prioritizing stormwater retrofits.

4.3.1 Collection and Review of Background Information

Existing natural heritage information was collected and reviewed to identify Key Natural Heritage Features (KNHFs), habitats, and species that are reported from or have the potential to occur in each study area. Background information was gathered and reviewed from the following sources:

- Natural Heritage Information Centre (NHIC) database (MNRF 2014);
- York Region Official Plan (2010);
- Township Official Plan (2019);
- Lake Simcoe Protection Plan (2009);
- Lake Simcoe Watershed: 2013 Environmental Monitoring Report (2007-2011 data) (LSRCA 2013a);
- Natural Heritage System & Restoration Strategy for the Lake Simcoe Watershed (LSRCA 2018);
- East Holland River Subwatershed Plan (LSRCA 2010a);
- West Holland River Subwatershed Management Plan (LSRCA 2010a);
- York Region Subwatershed Implementation Plan (LSRCA 2013b);
- LSRCA Technical Guidelines for Stormwater Management Submissions (LSRCA 2016);
- Natural Heritage System & Restoration Strategy for the Lake Simcoe Watershed (LSRCA 2018);
- Humber River State of the Watershed Report – Aquatic System (TRCA 2008b);
- TRCA Stormwater Management Criteria (TRCA 2012);
- Humber River Watershed Plan: Pathways to a Healthy Humber (TRCA 2008c);
- Humber River Watershed Scenario Modelling and Analysis Report (TRCA 2008d);
- Ecological Land Classification (ELC) within the LSCRA and TRCA jurisdictions;
- Fisheries data within the Township (LSRCA and TRCA);
- Fisheries and Oceans Canada (DFO) aquatic species at risk mapping (2019);
- Ontario Breeding Bird Atlas (Bird Studies Canada et al. 2006);
- Ontario Reptile and Amphibian Atlas (Ontario Nature 2019);
- Atlas of the Mammals of Ontario (Dobbyn 1994);
- Ontario Butterfly Atlas (Macnaughton et al. 2019); and
- Ontario Odonata Atlas (OOAD 2019).

A desktop review of Species at Risk (SAR), Species of Conservation Concern (SCC), and Significant Wildlife Habitat (SWH) was completed to guide the scope of work and field surveys presented. Based on the background species lists, numerous SAR and SCC have records of occurrences in the study areas. SAR are those listed on the Species at Risk in Ontario (SARO) list (MNRF 2018). These include species identified by the Committee on the Status of Species at Risk in Ontario (COSSARO) as provincially endangered, threatened, or special concern. Species listed by COSSARO as endangered or threatened are protected under the Endangered Species Act, 2007, which includes the protection of their habitat.

A desktop assessment was conducted to identify which species have suitable habitats in the settlement areas. This involved cross-referencing the preferred habitat for reported SAR against habitats occurring in the study areas. Full results of desktop assessment of the SAR and SCC are shown in **Appendix B.**

The Significant Wildlife Habitat Technical Guide (SWHTG) is a guideline document that outlines the types of habitats that the MNRF considers significant in Ontario, as well as criteria to identify these habitats. SWH are categorized into four (4) broad groups by the SWHTG: seasonal concentration areas, rare vegetation communities and specialized wildlife habitat, habitats of SCC, and animal movement corridors. The majority of the SWH is candidate for the study areas based on the desktop assessment shown in **Appendix C.**

4.3.2 Terrestrial Ecology

The following sections describe the existing ecological conditions of the study areas based on a desktop analysis of background data.

4.3.2.1 Vegetation

Ecological Land Classification (ELC) information and vegetation mapping was provided by the LSRCA and TRCA and is shown in **Figure A-14** to **Figure A-29** of **Appendix A**. Woodlands, wetlands, and waterbodies were mapped as per the Land Information Ontario (LIO) database where ELC data is unavailable. ELC data for the Hamlet of Laskay was not available. The ELC data in **Figure A-14** to **Figure A-29** shows color coded polygons identifying wooded features, meadows and three types of wetlands (treed swamps, thicket swamps, and meadow marshes). The three types of wetlands have different water balance sensitivities and tolerances to nutrient and pollution inputs. **Table 4-3** describes the different communities found within each of the generalized vegetation communities.

Table 4-3: Vegetation Community Descriptions

Generalized Vegetation Community (Figure A-14 to Figure A-29	**ELC Code**	**ELC Community**
Upland Wooded Communities	FOD	Deciduous forests
	FOM	Mixed forests
	FOC	Coniferous forest
	CUP	Cultural plantation
	CUW	Cultural woodlands
Upland Thicket Communities	CUT	Cultural thicket
Upland Meadow Communities	CUM	Cultural meadow
Open Aquatic Communities	OAO	Open aquatic
Treed Wetlands	SWD	Deciduous swamp
	SWM	Mixed swamp
	SWC	Coniferous swamp
Thicket Wetlands	SWT	Thicket swamp
Meadow Wetlands	MAM	Meadow marsh
	MAS	Shallow marsh
Shallow Aquatic Wetlands	SAF	Floating-leaved shallow aquatic

Generalized Vegetation Community (**Figure A-14** to **Figure A-29**)	ELC Code	ELC Community
	SAM	Mixed shallow aquatic
	SAS	Submerged shallow aquatic

The majority of the settlement areas are occupied by agricultural fields and anthropogenic uses. Anthropogenic uses include:

- Estate residential;
- Industrial;
- Intensive and non-intensive agriculture;
- Manicured open space; and
- Urban and rural development.

4.3.2.1.1 Vascular Flora

Three significant plant species are reported from the study areas or are potentially present within habitats located in the settlement areas based on records from the NHIC. The three species are Ginseng (*Panax quinquefolius*), Virginia Bluebells (*Mertensia virginica*), and Butternut (*Juglans cinerea*). **Appendix B** provides a summary of the species, current status, and preferred habitats. **Appendix D** provides a detailed list of plants recorded in the settlement areas.

4.3.2.2 Wetlands

Many wetland features are present within the settlement areas of the Township. These include unclassified wetlands, evaluated wetlands, and Provincially Significant Wetlands (PSW). The PSWs that are located within the settlement areas include:

- Ansnorveldt Wetland Complex;
- Black Duck Wetland Complex;
- East Humber River Wetland Complex;
- Eaton Hall-Mary-Hackett Lakes Wetland Complex;
- King-Vaughan Wetland Complex;
- Nobleton Wetland Complex; and
- Pottageville Wetland Complex.

PSW evaluations can be accessed through the MNRF. This information should be requested as part of future studies where development is proposed within 120 m of the wetlands in question. Environmental Impact Studies (EISs) are triggered when development is to occur within 120 m of a significant natural area, such as wetlands. **Table 4-4** lists the wetlands in each settlement area.

The Holland Marsh located within the Township was drained for farming purposes in the early 1900s. Ansnorveldt is the only hamlet located within this area. Currently, the marsh system is governed by the Holland Marsh Drainage System Joint Municipal Board.

Table 4-4: Significant Features Within Each Settlement Area

Hamlet	Wetland			Wooded Areas	ANSIs
	PSW	Evaluated	Unevaluated		
Ansnorveldt	Ansnorveldt Wetland Complex (Outside of settlement area)	-	-	Present	-
Graham Sideroad	-	-	Present outside of settlement area	Present	-
Kettleby	-	-	Present	Present	-
King City	Eaton Hall-Mary-Hackett Lakes Wetland Complex King-Vaughan Wetland Complex	-	Present	Present	Maple Uplands & Kettles (Candidate Life Science) Mary Eaton Hall Lakes (Candidate Life Science – outside of settlement area)
Laskay	Eaton Hall-Mary-Hackett Lakes Wetland Complex (Outside of settlement area)	-	-	Present	-
Lloydtown	-	-	Present	Present	-
Nobleton	Black Duck Wetland Complex Nobleton Wetland Complex	-	-	Present	Hall-Thompson Lake Kettles (Candidate Life Science – outside of settlement area) Linton Kelly Lake Channels (Earth Science – outside of settlement area)
Pottageville	Pottageville Wetland Complex	-	Present	Present	Pottageville Swamp (Life Science) Happy Valley (Candidate Life Science)
Schomberg	-	Present	Present	Present	-
Snowball	-	Present	Present	Present	-

4.3.2.3 Woodlands

Woodland boundaries were not surveyed for this study, but it is recommended that they are delineated as a part of more detailed studies. **Table 4-4** identifies that each settlement area contains wooded areas. **Figure A-14** to **Figure A-29** depicts wooded areas as mapped by the Province of Ontario and delineated by the ELC.

4.3.2.4 Areas of Natural and Scientific Interest (ANSI)

The MNRF defines ANSIs as land and water with landscapes and features that are important for natural heritage protection, appreciation, scientific study, or education. Life Science ANSIs represent biodiversity and natural landscapes, whereas Earth Science ANSIs are geologic in nature and contain bedrock, fossils, landforms, or ongoing geological processes that are to be protected. The following ANSIs are located in the Township and are shown in **Figure A-14** to **Figure A-29**:

- Hall-Thompson Lake Kettles (Candidate Life Science)
- Happy Valley (Candidate Life Science)
- Linton Kelly Lake Channels (Earth Science)
- Maple Uplands & Kettles (Candidate Life Science)
- Mary-Eaton Hall Lakes (Candidate Life Science)
- Pottageville Swamp (Life Science)

Table 4-4 lists the ANSIs in each hamlet.

4.3.2.5 Wildlife

4.3.2.5.1 Birds

In total, 155 bird species are reported from all the settlement areas based on data from the NHIC (MNRF 2014) and Ontario Breeding Birds Atlas (OBBA) squares: 17PJ06, 17PJ07, 17PJ16, 17PJ17, 17PJ18, 17PJ26, 17PJ27 (BSC et al. 2006). Data from the OBBA includes those species that have been observed within 10 km squares that overlap the settlement areas, are reported to nest within the squares, and/or have exhibited evidence of breeding in these areas. **Table 4-5** lists the settlement areas and their associated bird results based on the background review.

Table 4-5: Birds Reported from Each Settlement Area

Settlement Area	Total Number of Birds	SAR/SCC
Ansnorveldt	109	11
Graham Sideroad	108	10
Kettleby	100	9
King City	138	13
Laskay	133	13
Lloydtown	107	8
Nobleton	123	11

Settlement Area	Total Number of Birds	SAR/SCC
Pottageville	100	9
Schomberg	107	8
Snowball	103	10

Within the entire study area (including all settlement areas) eight bird SAR and 12 bird SCC are reported from the background review. SAR bird species reported from the study areas include:

- Acadian Flycatcher (*Empidonax virescens*);
- Bank Swallow (*Riparia riparia*);
- Barn Swallow (*Hirundo rustica*);
- Bobolink (*Dolichonyx oryzivorus*);
- Chimney Swift (*Chaetura pelagica*);
- Eastern Meadowlark (*Sturnella magna*);
- Least Bittern (*Ixobrychus exilis*); and,
- Loggerhead Shrike (*Lanius ludovicianus*).

SCC bird species reported from the study areas include:

- Black Tern (*Chlidonias niger*);
- Canada Warbler (*Cardellina canadensis*);
- Common Nighthawk (*Chordeiles minor*);
- Eastern Wood-Pewee (*Contopus virens*);
- Evening Grosbeak (*Coccothraustes vespertinus*);
- Golden-winged Warbler (*Vermivora chrysoptera*);
- Grasshopper Sparrow (*Ammodramus savannarum*);
- Redhead (*Aythya americana*);
- Red-headed Woodpecker (*Melanerpes erythrocephalus*);
- Short-eared Owl (*Asio flammeus*);
- Wood Thrush (*Hylocichla mustelina*); and,
- Yellow Rail (*Coturnicops noveboracensis*).

A complete list of bird species reported from the settlement areas is provided in **Appendix E**. The SAR/SCC screening is provided in **Appendix B**.

4.3.2.5.2 Herpetofauna

According to the Ontario Reptile and Amphibian Atlas (ORAA) (Ontario Nature 2019) and the NHIC (MNRF 2014), 30 species of herpetofauna (amphibians and reptiles) are reported from the 10 km squares that overlap the settlement areas. The ORAA squares that were used for analysis include: 17PJ05, 17PJ06, 17PJ07, 17PJ16, 17PJ17, 17PJ18, 17PJ26, 17PJ27 (Ontario Nature 2019). **Table 4-6** shows the settlement areas and their associated herpetofauna results from the background review.

Table 4-6: Herpetofauna Reported from Each Settlement Area

Settlement Area	Total Number of Herpetofauna	SAR/SCC
Ansnorveldt	17	2
Graham Sideroad	17	2
Kettleby	22	3
King City	24	3
Laskay	25	3
Lloydtown	14	1
Nobleton	20	4
Pottageville	23	3
Schomberg	14	1
Snowball	25	3

Three herpetofauna SAR and four herpetofauna SCC are reported from the background review. The herpetofauna SAR species that are reported from the study areas include:

- Blanding's Turtle (*Emydoidea blandingii*)
- Jefferson Salamander (*Ambystoma jeffersonianum*)
- Unisexual Ambystoma Jefferson dependent population (*Ambystoma laterale* - (2) *jeffersonianum*)

The SCC herpetofauna species include:

- Eastern Ribbon Snake (Great Lakes population) (*Thamnophis sauritus*)
- Northern Map Turtle (*Graptemys geographica*)
- Snapping Turtle (*Chelydra serpentina serpentine*)
- Jefferson/Blue-spotted Salamander Complex (*Ambystoma* sp.)

A complete list of reptile and amphibian species reported within the settlement areas is provided in **Appendix F** and the SAR/SCC screening is provided in **Appendix B**.

4.3.2.5.3 Mammals

According to the Mammal Atlas of Ontario (Dobbyn 1994), 44 mammal species are reported within the Township. The atlas is large-scale; thus, the mammals can only be reported from within the entire Township. Four SAR were reported within the background review and include:

- Eastern Small-footed Myotis (*Myotis leibii*)
- Little Brown Myotis (*Myotis lucifungus*)
- Northern Myotis (*Myotis septentrionalis*)
- Tri-coloured Bat (*Perimyotis subflavus*)

A complete list of mammal species reported from the settlement areas is provided in **Appendix G** and the SAR/SCC screening is provided in **Appendix B**.

4.3.2.5.4 Lepidoptera

According to the Ontario Butterfly Atlas (Macnaughton et al. 2019), 76 lepidoptera (butterfly) species are reported from the settlement areas. The Ontario Butterfly Atlas squares that were used for analysis include: 17PJ06, 17PJ07, 17PJ16, 17PJ17, 17PJ18, 17PJ26, 17PJ27 (Macnaughton et al. 2019). One SCC, Monarch (*Danuas plexippus*), is reported within all settlement areas. A complete list of lepidoptera species reported within the settlement areas is provided in **Appendix H** and the SAR/SCC screening is provided in **Appendix B**.

4.3.2.5.5 Odonata

According to the Ontario Odonata Atlas (OOAD 2019), 75 odonata (dragonfly and damselfly) species are reported to occur within the settlement areas. The Ontario Odonata Atlas Squares that were used for analysis include: 17PJ06, 17PJ07, 17PJ16, 17PJ17, 17PJ18, 17PJ26, 17PJ27 (Macnaughton et al. 2019). ***Table 4-7*** lists the settlement areas and their associated odonata results from the background review.

Table 4-7: Odonata Reported from Each Settlement Area

Settlement Area	Total Number of Odonata	SAR/SCC
Ansnorveldt	1	0
Graham Sideroad	1	0
Kettleby	35	2
King City	44	1
Laskay	32	1
Lloydtown	9	0
Nobleton	29	6
Pottageville	35	2
Schomberg	9	0
Snowball	24	1

One odonata SAR and seven odonata SCC are reported from the background review. The SAR species, Rapids Clubtail (*Phanogomphus quadricolor*), has been documented within the study areas. The SCC species include:

- Harpoon Clubtail (*Phanogomphus descriptus*)
- Azure Bluet (*Enallagma aspersum*)
- Clamp-tipped Emerald (*Somatochlora tenebrosa*)
- Lilypad Clubtail (*Arigomphus furcifer*)
- Painted Skimmer (*Libellula semifasciata*)
- Spadderdock Darner (*Rhionaeschna mutata*)
- Unicorn Clubtail (*Arigomphus villosipes*)

A complete list of odonata species reported within the settlement areas is provided in **Appendix I** and the SAR/SCC screening is provided in **Appendix B**.

4.3.3 Aquatic Ecology

The movement and quantity of water affects aquatic habitat features in creek systems. The factors that are affected by flow and movement are:

- Usability of the channels (i.e., baseflow);
- Ability to carry small organisms;
- Ability to carry organic debris and sediments downstream which can provide food for many organisms; and
- Ability to provide oxygen for both living creatures and chemical processes within streams.

The following section provides an overview of the aquatic habitats within the three (3) subwatersheds in the Township. The cold, cool, and warm water streams in the LSRCA and TRCA are displayed in **Figure 4-4**.

4.3.3.1 East Holland Subwatershed

The only settlement area in the Township located in the East Holland subwatershed is Snowball. Aquatic environments located within the subwatersheds include rivers, streams, lakes, and wetlands. Habitats found within these environments include:

- Vegetation;
- Food sources – algae, benthic invertebrates, fish;
- Flow;
- Cover;
- Spawning and nursery habitat;
- Vegetation;
- Temperature refugia; and
- Shelter.

The settlement of Snowball is located within a cold-water system.

4.3.3.2 West Holland Subwatershed

The largest in the Lake Simcoe basin, the West Holland subwatershed has several tributaries that vary in their habitat characteristics. The habitat features within the subwatershed include Ansnorveldt Creek, Keele Creek, Kettleby Creek, 400 Creek, Pottageville Creek and Schomberg River. The subwatershed also features the Holland Marsh and its extensive canal and Municipal Drain system. Ansnorveldt and Graham Sideroad are located in warm water systems while the remainder of the settlement areas within the LSRCA are part of cold-water thermal regimes.

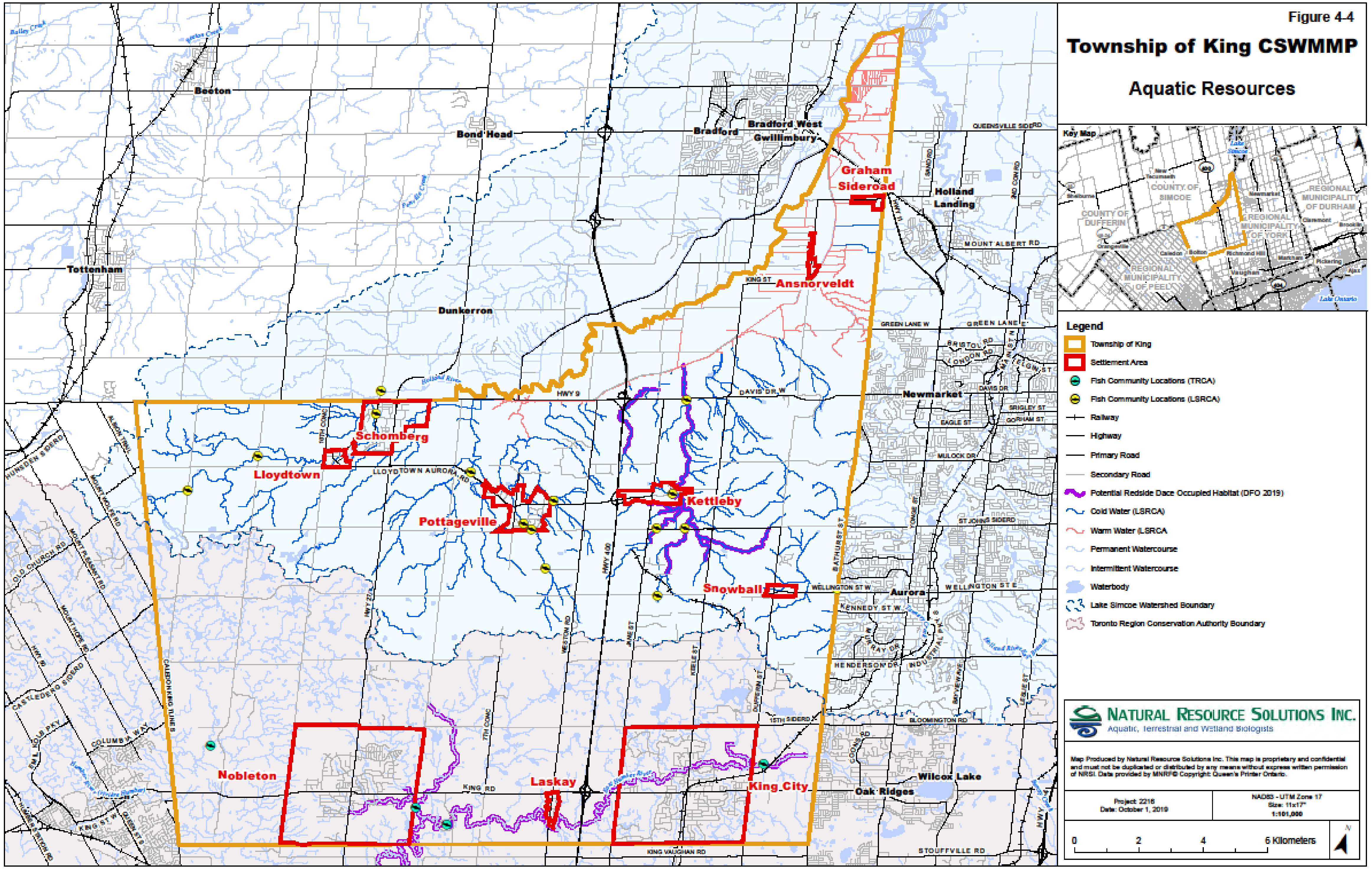
4.3.3.3 Humber Subwatershed

The East Humber subwatershed exhibits the best water quality within the Humber River Watershed. The East Humber contains five secondary subwatersheds. The Oak Ridges Moraine underlies the upper third of the Eastern Humber and influences King Creek. Approximately 48 percent of the length of the watercourses in this subwatershed is covered with woody riparian vegetation. In 2002, the East Humber subwatershed was thermally stable and exhibited moderately stable thermal conditions in 2004. The small change in thermal conditions is indicative that a large temperature change did not occur. The data is quite outdated, and it is recommended that the collection of water temperature monitoring data is considered for further SWM studies in this subwatershed.

4.3.3.4 Fish Community

According to the background information provided by LSRCA, TRCA, DFO, and the NHIC, 35 fish species are reported to occur in or near the settlement areas. The sub-section below describes the fish communities within each of the subwatersheds. Both cold and warm water fish communities are represented within the Township. Cold water communities feature species such as Brook Trout (*Salvelinus fontinalis*) and Mottled Sculpin (*Cottus bairdii*). **Figure 4-4** shows the locations of the fish community assessments within the LSRCA and the TRCA. A complete list of fish species reported from the settlement areas is provided in **Appendix J** and the SAR/SCC screening is provided in **Appendix B**.

Figure 4-4: Aquatic Resources



4.3.3.4.1 East Holland Subwatershed

A total of 35 species have been captured from the East Holland River since 1930 (LSRCA 2010a). The fish communities in the East Holland range from cold headwater communities to warm water communities. Generally, this subwatershed displays cold to cool water tributaries feeding a warmwater East Holland River Main Branch (LSRCA 2010a). The lower regions of the subwatershed (north of the Township) are classified as warmwater habitat, and warmwater species are captured in these areas. The East Holland River Subwatershed is only influenced by the Snowball hamlet.

Snowball
The data that the LSRCA provided only includes fish species downstream of Snowball. Three species are reported to occur downstream of Snowball: Mottled Sculpin, Blacknose Dace (*Rhinichthys atratulus*), and Creek Chub (*Semotilus atromaculatus*). The presence of Mottled Sculpin suggests that the East Holland River subwatershed located within the Township provides cold water habitat.

4.3.3.4.2 West Holland Subwatershed

There have been 34 species of fish captured in the West Holland River subwatershed since 1930 (LSRCA 2010b). Similar to the East Holland River Subwatershed, this subwatershed generally displays cold to cool water tributaries feeding a warmwater West Holland River Main Branch. The West Holland River Subwatershed is influenced by the following hamlets and villages: Ansnorveldt, Graham Sideroad, Kettleby, Lloydtown, Pottageville, and Schomberg.

Ansnorveldt
The data that LSRCA provided only includes fish species upstream of Ansnorveldt. Three species are reported to occur upstream: Johnny Darter (*Etheostoma nigrum*), Largemouth Bass (*Micropterus salmoides*), Brown Bullhead (*Ameiurus nebulosus*). These species are correlated with warm water systems, suggesting that Ansorvedlt would be a warm water system.

Graham Sideroad
Graham Sideroad is located north of Ansnorveldt. No fisheries data from the LSRCA is available from this area.

Kettleby
The data that LSRCA provided includes fish species upstream, within, and downstream of Kettleby. Seventeen species of fish are reported to occur in or near Kettleby. The fish community found both upstream and downstream include Mottled Sculpin and Brook Trout; both indicators of cold-water systems. Redside Dace is known to occur within the Kettleby settlement area (DFO 2019, Rob Wilson pers comm. 2019).

Lloydtown and Schomberg
Both Lloydtown and Schomberg are in the same watercourse system. Twenty-three (23) species of fish are found both upstream and downstream of these hamlets. Redside Dace and Mottled Sculpin, both indicators of cold water, are present suggesting that both hamlets have cold-water streams.

Pottageville

The LSRCA provided data for Pottageville that includes fish information from upstream, within, and downstream of the hamlet. Twelve fish species are found upstream and downstream of the hamlet. Brook Trout and Mottled Sculpin are found both upstream and downstream, and are indicators of cold water, indicating that the watercourses flowing through the hamlet are likely cold water as well.

4.3.3.4.3 East Humber Watershed

The East Humber is one of the most diverse systems in the watershed, second only to the Main Humber (TRCA 2008b). The Oak Ridges Moraine underlies the upper third of the East Humber influencing the upper branches. King Creek supports cold water species (American Brook Lamprey (*Lampetra appendix*), Mottled Sculpin), whereas the Upper Branch (of the East Humber) has never supported cold water species (TRCA 2008b). Brook Trout have not been observed in the Upper Branch. Redside Dace was historically reported as common within the East Humber River during surveys in 1972 (Clayton et al 2004).

<u>King City</u>
The TRCA provided data for King City that includes only one upstream site. Thirteen (13) fish species are present at this site including Mottled Sculpin, which is an indicator of cold-water systems.

<u>Laskay</u>
The fish community sites provided by the TRCA are not within or near the Laskay hamlet. The fish data provided for King City and Nobleton is most likely representative of the Laskay study area due to the connection of the watercourses as well as location in the subwatershed.

<u>Nobleton</u>
The TRCA provided data for Nobleton that includes only downstream sites. Twenty-two (22) fish species are found near Nobleton. Brook Trout, Mottled Sculpin, and American Brook Lamprey were reported from this area and are indicators of cold water.

4.3.4 Significant Wildlife Habitat

Significant Wildlife Habitat (SWH) categories were identified in the settlement areas based on background review of information and desktop analysis. Detailed site-specific field surveys are required to confirm SWHs. This level of detail was not attainable through background information. As a part of Environmental Impact Studies (EISs) or Natural Heritage Evaluations required by the Township's Official Plan and other relevant planning and policy documents reviewed as a part of this report, detailed field surveys targeting candidate SWHs should be completed. These studies typically accompany development or site alteration applications, and in the case of SWM facilities and retrofits, they are introduced once design work is initiated. The EIS will further delineate the environmental constraints and restoration opportunities based on site specific ecological surveys and are required when development and site alteration is proposed within 120 m of a natural feature and/or regulated area.

4.3.4.1 Seasonal Concentration Areas

Wildlife seasonal concentration areas are defined as areas where animals occur in relatively high densities for all, or portions, of their life cycle. These areas are relatively small when compared to the areas used by these species during other times of the year. Several seasonal concentration areas have been identified as candidate in the settlement areas, including:

- Waterfowl Stopover and Staging Area (Terrestrial & Aquatic);
- Raptor Wintering Area;
- Bat Maternity Colonies;
- Turtle Wintering Areas;
- Snake Hibernaculum; and
- Colonially – Nesting Bird Breeding Habitat (Tree/shrub).

Table 1 of **Appendix C** shows the general evaluation criteria for the wildlife habitats, as well as methods used to evaluate the significance of these habitats.

4.3.4.2 Rare Vegetation Communities

Rare vegetation communities contain rare species, usually plants and small invertebrates, that depend on such habitats to survive. The evaluation criteria for rare vegetation communities are identified in the MNRF SWH Criteria Schedules for Ecoregion 6E and can include a variety of ELC communities. Some rare vegetation communities have been identified as candidate in the settlement areas, including:

- Savannah;
- Old Growth Forest; and
- Other Rare Vegetation Communities.

Table 2 of **Appendix C** shows the general evaluation criteria used in the evaluation of the significance of these candidate features, as well as the methods used to evaluate the significance of these habitats.

<u>Other Rare Vegetation Communities</u>
The ELC file that was provided by the TRCA contained specific ELC codes (i.e., FOD7-2). As such, some provincially rare vegetation communities were identified within the Nobleton and King City villages as part of the background review, including:

- Fresh – Moist White Cedar – Hemlock Coniferous Forest Type (FOC4-2);
- Fresh – Moist Sugar Maple – Black Maple Deciduous Forest Type (FOD6-2); and,
- Silky Dogwood Mineral Thicket Swamp Type (SWT2-8).

The LSRCA provided only high-level ELC codes that contained non-specific ELC codes (i.e., FOD).

4.3.4.3 Specialized Wildlife Habitats

The MNRF SWH Criteria Schedules for Ecoregion 6E identifies evaluation criteria for specialized wildlife habitats. They can include a variety of habitats that are required for the long-term survival of certain species. Several specialized wildlife habitats have been identified as candidate in the settlement areas, including:

- Waterfowl Nesting Area;
- Bald Eagle and Osprey Nesting, Foraging and Perching Habitat;
- Woodland Raptor Nesting Habitat;
- Turtle Nesting Habitat;
- Seeps and Springs;
- Amphibian Breeding Habitat (Woodland & Wetland); and
- Woodland Area-Sensitive Bird Breeding Habitat.

Table 3 of **Appendix C** shows the general evaluation criteria used in the evaluation of the significance of these candidate features as well as methods used to evaluate the significance of these wildlife habitats.

4.3.4.4 Habitat for SCC

Evaluation criteria for habitats for SCC are identified in the SWH Criteria Schedules for Ecoregion 6E (MNRF 2015) and can include a variety of habitats that are required for the long-term survival of certain species or species groups. Several habitats for SCC have been identified as candidate in the settlement areas, including:

- Marsh Bird Breeding Habitat;
- Shrub/Early Successional Bird Breeding Habitat;
- Terrestrial Crayfish Habitat; and,
- Special Concern and Rare Wildlife Species.

General evaluation criteria used in the evaluation of significance of these candidate features, as well as methods used to evaluate the significance of these wildlife habitats, are outlined in **Table 4** of **Appendix C.**

<u>Special Concern and Rare Wildlife Species</u>
Many Special Concern and rare wildlife species were screened during the background review and analysis. See **Appendix B** for SAR and SCC screening, and the Wildlife Section above.

<u>Animal Movement Corridors</u>
Animal movement corridors are elongated areas used by wildlife to move from one habitat to another. They are important to ensure genetic diversity in populations, to allow for seasonal migration, and for animals to move throughout their home range (MNRF 2015). Both Amphibian Movement and Deer Movement Corridors cannot be ruled out within the settlement areas.

Amphibian movement corridors may be found in all communities associated with water; they connect amphibian breeding habitat with their summer habitats. Field studies must be conducted at the time of year when species are expected to be migrating or entering breeding sites (MNRF 2015). Movement corridors must be determined when Amphibian Breeding Habitat (Wetland) is confirmed as SWH.

Deer movement corridors are only significant in Ecoregion 6E and must be determined when deer wintering habitat is confirmed as SWH (MNRF 2015). These movement corridors are to be at least 200 m wide with gaps less than 20 m in width. If following a riparian area, corridors should be at least 15 m wide on both sides of the watercourse (MNRF 2015). These corridors must be determined when Deer Wintering Areas are confirmed as SWH.

General evaluation criteria used in the evaluation of significance of these candidate features, as well as methods used to evaluate the significance of these wildlife habitats, are outlined in **Table 5** of **Appendix C.**

4.3.5 Habitat for Endangered and Threatened Species

Numerous SAR are reported to occur within the settlement areas and have suitable habitat. The SAR that were screened within the settlement areas include:

- Butternut;
- Ginseng;
- Acadian Flycatcher;
- Bank Swallow;
- Barn Swallow;
- Chimney Swift;
- Eastern Meadowlark;
- Least Bittern;
- Loggerhead Shrike;
- Blanding's Turtle;
- Jefferson Salamander;
- Unisexual Ambystoma Jefferson dependent population;
- Eastern Small-footed Myotis;
- Little Brown Myotis;
- Northern Myotis;
- Tri-coloured Bat;
- Redside Dace; and,
- Rapids Clubtail.

Appendix B shows the SAR/SCC background screening analysis. Best measures for any proposed activities must be taken to ensure that Species at Risk identified are not killed, harmed, or harassed, and that their habitat is not damaged or destroyed as a result of the proposed activities being carried out. The "Suitable Habitats" outlined in **Appendix B** shall be reviewed for any proposed activities that may fall under a suitable habitat location for a species at risk identified in the Township and authorization under the Species at Risk Act shall be obtained for the proposed works.

4.3.6 Recommended Vegetation Protection Zones

Relevant legislation and policy documents have been reviewed and the vegetation protection zones (VPZ), also known as buffers, have been determined. **Figure A-30** to **Figure A-45 of Appendix A** shows the constraints within the settlement areas. **Table 4-8** identifies the VPZs for the different natural features found within the settlement areas.

Table 4-8: Vegetation Protection Zones

Natural Feature	Vegetation Protection Zones	Document/Legislation for the Buffer
Wooded Areas[1]	30m	York Regional Official Plan (2010) Greenbelt Plan (2017) Oak Ridges Moraine Conservation Plan (2017) Lake Simcoe Conservation Plan (2009)
Unevaluated and non-Provincially Significant Wetlands	30m	Greenbelt Plan (2017) Oak Ridges Moraine Conservation Plan (2017) Lake Simcoe Conservation Plan (2009)
Provincially Significant Wetlands	30m	York Regional Official Plan (2010)
Watercourses (Permanent and Intermittent Streams)	30m	Greenbelt Plan (2017) Oak Ridges Moraine Conservation Plan (2017) Lake Simcoe Conservation Plan (2009)
Fish Habitat	30m	Greenbelt Plan (2017) Oak Ridges Moraine Conservation Plan (2017)
Seepage Areas and Springs[2]	30m	Greenbelt Plan (2017) Oak Ridges Moraine Conservation Plan (2017)
ANSI	Determined through a natural heritage evaluation; generally based on the natural heritage features within the ANSI	Oak Ridges Moraine Conservation Plan (2017)
Significant Valleylands[3]	30m	Oak Ridges Moraine Conservation Plan (2017) Lake Simcoe Conservation Plan (2009)
Significant Wildlife Habitat	Determined through a natural heritage evaluation	Oak Ridges Moraine Conservation Plan (2017)

Natural Feature	Vegetation Protection Zones	Document/Legislation for the Buffer
Redside Dace Watercourses[4]	Occupied Habitat: Meander belt + 30m Contributing Habitat: A stream, permanent or intermittent headwater drainage feature, groundwater discharge area or wetland that augments or maintains the baseflow, coarse sediment supply or surface water quality of a part of a stream or watercourse used by Redside Dace at any time in the past.	Endangered Species Act

[1] Wooded Areas are a combination of the ELC provided by LSRCA and TRCA as well as LIO. No dripline surveys have been completed. Thus, this constraint is high-level and should only be used as a guideline.
[2] No seepage areas and springs have been identified during the background review. Field assessments are needed to determine if they are present.
[3] Significant Valleylands were not identified during the background review. Field assessments are needed to determine if they are present.
[4] MNRF will have to be contacted to determine Regulated Habitat for Redside Dace on a site and project specific basis.

As mentioned in the policy section, SWM retrofits can occur within the VPZs of natural features; however, new SWM facilities cannot be within the VPZs (Lake Simcoe Protection Plan).

4.4 Groundwater Resources

Source water is untreated water taken from rivers, lakes, or underground aquifers to provide private and public drinking water systems. Through the assessment reports established under the Clean Water Act and O.Reg 287/07, the location of potential threats to sources of drinking water supplies could be identified. Potential threats include activities that adversely impact drinking water quality or quantity from groundwater and/or surface water sources. Threats to drinking water are determined through source protection committees by determining and applying vulnerability scores to different types of vulnerable areas, and where they exist within each source protection area. The areas identified are:

- Intake protection zones (IPZs)
- Highly vulnerable aquifers (HVAs)
- Significant groundwater recharge areas (SGRAs)
- Wellhead protection areas (WHPAs)
- Issue contributing areas (ICAs)
- Water quantity vulnerable areas (WHPA-Q1/Q2)

4.4.1 Source Water Constraints within the Township

Situated on the north and south flanks of the Oak Ridges Moraine, the Township straddles two watersheds, thus, following two Source Protection Regions:

- CTC Source Protection Region (CTC comprises three conservations authorities: Credit Valley Conservation, Toronto and Region Conservation Authority, and Central Lake Ontario Conservation); and
- South Georgian Bay-Lake Simcoe Source Protection Region (comprises four watersheds: Black Severn, Lake Simcoe, Nottawasaga Valley and Severn Sound).

These source protection regions have been further divided into source protection areas. Within the Township there are the Toronto and Region Source Protection Area and the Lake Simcoe and Couchiching-Black River Source Protection Area. Relevant characterization of groundwater resources and map products can be found in the respective assessment reports. Based on these reports, it was determined that constraints within the Township would be evaluated on:

- Vulnerability scoring within the WHPA;
- HVAs;
- SGRAs; and,
- WHPA-Q1/Q2.

4.4.2 Background Review of Groundwater Resources Information

The following background information was reviewed and information as it relates to groundwater resources for the Township was specifically extracted. Documents and other relevant sources included:

- King Township Official Plan, 2019
    - Section G: Source Protection Plans provided policies for HVAs, SGRAs, WHPAs and WHPA-Qs
    - Schedules G, G1, G2, and G3 provided maps that show the HVAs and WHPA for the entire Township, King City, Nobleton, and Schomberg, respectively.
- Approved Update Assessment Report, Toronto and Region Source Protection Area, CTC Source Protection Committee, July 24, 2015
    - Provides information on the two Township municipal well fields located within the source protection area.
- Approved Source Protection Plan: CTC Source Protection Region, Effective December 31, 2015
    - Provides information on the two Township municipal well fields located within the source protection area.
- Lake Simcoe and Couchiching-Black River Source Protection Area, Part 1, Approved Assessment Report, Source Protection Committee for the South Georgian Bay Lake Simcoe Source Protection Region, January 26, 2015
    - Provides information on three municipal well fields located within the source protection area.

- Approved South Georgian Bay Lake Simcoe (SGBLS) Source Protection Plan, South Georgian Bay Lake Simcoe Source Protection Region, Effective July 1, 2015
    - Provides information on three municipal well fields located within the source protection area.
- Paleozoic and Quaternary Geology mapping from the Ontario Geological Survey (various years)
- Groundwater resources mapping products from the Oak Ridges Moraine Groundwater Program

4.4.3 Source Water Constraint Analysis

Maps depicting WHPAs (including vulnerability scoring), HVAs, and SGRAs for each settlement area are shown in **Figure A-46** to **Figure A-51, Figure A-52** to **Figure A-61, and Figure A-62** to **Figure A-71 of Appendix A**, respectively. Areas depicted by these maps pose potential constraints to the location of new or retrofitted stormwater management facilities (SWMFs). **Table 4-9** summarizes the settlement areas affected by each groundwater resource constraint:

Table 4-9: Source Water Constraints

Constraint	Settlement Areas Affected
Wellhead Protection Areas (WHPAs)	• King City • Nobleton • Schomberg • Lloydtown • Ansnorveldt • Graham Sideroad
Highly Vulnerable Areas (HVAs)	• King City • Nobleton • Schomberg • Snowball • Lloydtown • Laskay • Kettleby • Pottageville • Graham Sideroad
Significant Groundwater Recharge Areas (SGRAs)	• King City • Nobleton • Ansnorveldt • Laskay • Pottageville • Graham Sideroad

Source protection plans within the Township Official Plan provide specific guidelines related to stormwater management facilities, with reference to the respective source protection plans of the CTC and SGBLS source protection regions. Section G4.6 within the Township's Official Plan outlines constraints related to stormwater management facilities within WHPAs, HVAs, and SGRAs. The following are the constraints associated with stormwater management:

- G4.6.1 General
  - Item b) New SWM facilities shall be designed to reduce the risk of contaminating drinking water by directing discharge of stormwater, where possible, outside of vulnerable areas where it would be a significant drinking water threat pursuant to the CTC and SGBLS Source Protection Plan.
  - Item e) Where development, redevelopment or site alteration is proposed within HVA's as identified on Scheduled G, G1, G2 and G3, a Source Water Impact Assessment and Mitigation Plan or a hydrological study may be required to demonstrate that the groundwater quality and quantity will be protected, improved, or restored as deemed necessary by the Township in consultation with York Region's Risk Management Office.
  - Item f) New SWM ponds should be located, where possible, outside of HVA areas and SGRAs.
- G4.6.2 Within the CTC Source Protection Region
  - Item a) New SWM facilities are prohibited where discharge (including infiltration) of stormwater would occur in Significant Threat Area '1'.
  - Item b) Where stormwater discharge would be a significant threat, new SWM facilities shall only be permitted where it has been demonstrated by the proponent through an approved Environmental Assessment or similar planning process that the location of discharge from a stormwater retention pond is the preferred alternative and the safety of the drinking water system has been demonstrated in Significant Threat Area '2'.

The CTC source protection plan (SPP) states that a SWM facility designed to discharge stormwater to land or surface water would be considered a significant threat in the following areas:

- WHPA-A (i.e., Significant Threat Area '1' in the Township SPP);
- WHPA-B, where the vulnerability score is equal to or greater than 10 (i.e., Significant Threat Area '2' in the King Township SPP);
- WHPA-E, where the vulnerability score is equal to or greater than 8 (not included in the King Township SPP); and,
- Anywhere in an Issue Contributing Area (ICA) for nitrates, pathogens, or chlorides.

Table 10-4 of the CTC SPP and Section 18 of the SGBLS SPP address existing and future threats associated with stormwater.

The Township SPP includes Section G4.7 Significant Groundwater Recharge Areas and Wellhead Protection Quantity Areas. This entire section pertains to minimizing the risk of threats to groundwater quality, while maintaining pre-development recharge rates. An Infiltration Management Plan for major developments would be necessary to address the objective of having no net reduction in recharge. In support of development, a Salt Management Plan would be prepared. The purpose of this plan is to prevent stormwater to be discharged into Significant Threat Areas 1, 2 and 3, SGRA's, and HVA's, where possible or to storm sewers and provisions.

In the CTC and SGBLS Source Protection Region, the SGRA encompasses almost the entirety of the Township. The York-Durham-Future Significant Groundwater Quantity Threat Areas (CTC 2019) states that stormwater management reduces recharge to an aquifer.

4.4.4 Other Source Water Constraints

The quaternary geology is identified in **Figure 4-2** Reference will be made to the characteristics of the various overburden deposits in subsequent tasks to identify the potential locations for stormwater management facilities (SWMFs) that would promote groundwater recharge and, conversely, where deposits could limit recharge potential.

Drift thickness (i.e., depth of overburden) could be considered as a constraint to the location of SWMF in areas where bedrock is at or close to the surface. However, across the Township mapping indicates that the minimum drift thickness is in the range of 200 m. Therefore, drift thickness is not a constraint for stormwater management.

Depth to groundwater table is a major constraint as a considerable amount of the Township has high groundwater levels. This would influence the location, depth, and size of proposed SWMFs. This information is available and can be purchased from the Oak Ridges Moraine Groundwater Program. The online mapping portal shows that within the Township, the deepest depth that the groundwater table reaches is within the range of 70 m to 90 m just north of Laskay. Within the settlement areas, the depth of the groundwater table ranges from 0 m to 45 m. The settlement areas that have the greatest limitation with respect to SWMF development are Ansnorveldt, Graham Sideroad, Kettleby, and Snowball. In these areas, the depth to the groundwater table ranges between 0 m to 25 m and development of SWMFs could impact the groundwater at these locations. The depth to groundwater table for each settlement area can be seen in to **Figure A-72** and **A-73** of **Appendix A.**

Groundwater discharge is helpful in identifying areas where SWMFs should/should not be considered. This information is available and can be purchased from the Oak Ridges Moraine Groundwater Program.

4.5 Stormwater Management

4.5.1 Stormwater Management Facilities

The stormwater management facilities (SWMFs) were inventoried based on the data provided by the Township, LSRCA, TRCA, and MECP. Inventories were prepared for existing SWM ponds, proposed SWM ponds, oil and grit separator units, and one underground storage facility. General information for these facilities is summarized in the **Table 4-10** to **Table 4-13**. Additional information was uploaded to SWMSoft Asset Management software where the ponds are georeferenced and component details are specified (I.e., Inlets, outlets, spillways, etc.)

Table 4-10: Existing Stormwater Management Facilities

Facility #	Village/Hamlet	Facility ID (Municipal ID)	Subwatershed	Facility Type	Drainage Area (ha)	Design Basis	Permanent Pool Volume (m^3)	Extended Detention Storage Volume (m^3)	Total Storage Volume (m^3)	Drawdown Time (Hour)
1	Schomberg	STPO_0001	West Holland	Wet Pond	16.28	Quantity & Quality Control	1,708	2,532	9,612	>30
2	Schomberg	STPO_0002	West Holland	Wet Pond	22.6	Quantity & Quality Control	5,624	2,932	8,557	>30
3	Schomberg	STPO_0003	West Holland	Information Unavailable for Pond						
4	Schomberg	STPO_0004	West Holland	Wet Pond	13	Quantity & Quality Control	750	700	1,450	>30
5	Schomberg	STPO_0005	West Holland	Information Unavailable for Pond						
6	King	KTPO_0001	Humber	Dry Pond	1.64	Quantity Control	N/A	54	200	24.8
7	King	KTPO_0002	Humber	Wet Pond	5.73	Quantity & Quality Control	912	796	3,890	>30
8	King	KTPO_0003	Humber	Dry Pond	3.6	Quantity Control	N/A	412	2,266	>30
9	King	KTPO_0004	Humber	Dry Pond	2.84	Quantity Control	N/A	319	1,408	>30
10	King	KTPO_0005	Humber	Wet Pond	14.36	Quantity & Quality Control	1,401	1,861	6,954	>30
11	King	KTPO_0006	Humber	Wet Pond	9.94	Quantity & Quality Control	1,467	1,496	4,070	>30
12	King	KTPO_0007	Humber	Wet Pond	21.13	Quantity & Quality Control	2,488	2,818	9,782	>30
13	King	KTPO_0008	Humber	Wet Pond	8.48	Quantity & Quality Control	1,759	1,124	5,652	>30
14	King	KTPO_0009	Humber	Wet Pond	9.16	Quantity, Quality & Erosion Control	1,903	1,920	6,707	>30
15	King	KTPO_0010	Humber	Wet Pond	15.23	Quantity, Quality & Erosion Control	4,491	1,980	20,263	>30
16	King	KTPO_0011	Humber	Wet Pond	9.13	Quantity, Quality & Erosion Control	1,528	1,187	6,680	>30
17	King	KTPO_0012	Humber	Information Unavailable for Pond						
18	King	KTPO_0013	Humber	Information Unavailable for Pond						
19	King	KTPO_0014	Humber	Information Unavailable for Pond						
20	Nobleton	NTPO_0001	Humber	Information Unavailable for Pond						
21	Nobleton	NTPO_0002 South Pond	Humber	Wet Pond	17.57	Quantity, Quality & Erosion Control	280	2170	2450	29.5
22	Nobleton	NTPO_0003	Humber	Wet Pond	14.03	Quantity, Quality & Erosion Control	2,057	1,111	6,974	31
23	Nobleton	NTPO_0004	Humber	Information Unavailable for Pond						
24	Nobleton	NTPO_0005	Humber	Wet Pond	7	Quantity, Quality & Erosion Control	1,220	1,060	2,860	>30

Facility #	Village/Hamlet	Facility ID (Municipal ID)	Subwatershed	Facility Type	Drainage Area (ha)	Design Basis	Permanent Pool Volume (m^3)	Extended Detention Storage Volume (m^3)	Total Storage Volume (m^3)	Drawdown Time (Hour)
25	Nobleton	NTPO_0009	Humber	Wet Pond	25	Quantity, Quality & Erosion Control	2,850	2,880	9,470	>30
26	Nobleton	NTPO_0006	Humber	Wet Pond	36.31	Quantity, Quality & Erosion Control	6,000	4,790	16,610	>30
27	Nobleton	NTPO_0007	Humber	Wet Pond	84.95	Quantity, Quality & Erosion Control	13,509	7,032	15,166	>30
28	Nobleton	NTPO_0008 North Pond	Humber	Dry Pond	7.84	Quantity Control	No Info	No Info	No Info	25
29	Nobleton	NTPO_0011	Humber	Wet Pond	12.16	Quantity, Quality and Erosion Control	2,104	1,785	9,449	n/a
30	Other	OTPO_0001	East Holland	Dry Pond	5.0	Quantity Control	n/a	520	520	n/a
31	Other	OTPO_0002	Humber	Wet Pond	Information Unavailable for Pond					

Table 4-11: Proposed Stormwater Management Facilities

Facility #	Village/Hamlet	Facility ID (Identified in Report)	Subwatershed	Facility Type	Drainage Area (ha)	Design Basis	Permanent Pool Volume (m^3)	Extended Detention Storage Volume (m^3)	Active Storage Volume (m^3)	Total Storage Volume (m^3)
1	Schomberg	Forestbrook Hills Phase II Pond	West Holland	Wet Pond	0.78	Quantity, Quality and Erosion Control	1,516	1,103	No Info	5,689
2	Nobleton	Via-Moto Pond	Humber	Wet Pond	12.16	Quantity, Quality and Erosion Control	2,104	1,785	7,345	9,449
3	King	Pond 1	Humber	Wet Pond	24.32	Quantity, Quality and Erosion Control	9,617	5,415	18,273	27,890
4	King	Pond 2	Humber	Wet Pond	15.56	Quantity, Quality and Erosion Control	4,791	3,633	11,620	16,411
5	King	Pond 3	Humber	Wet Pond	10.66	Quantity, Quality and Erosion Control	3,090	2,662	8,606	11,696
6	King	Pond 4	Humber	Wet Pond	37.07	Quantity, Quality and Erosion Control	13,535	8,459	22,392	35,927
7	King	Pond 5	Humber	Wet Pond	4.92	Quantity, Quality and Erosion Control	2,689	997	5,735	8,424

Table 4-12: Existing Oil and Grit Separators

Facility #	Location	Village/Hamlet	Subdivision	Model	Catchment Area (ha)	Sediment Storage Capacity (m^3)	Oil Storage Capacity (m^3)	Total Storage Volume (m^3)
1	NE Corner of Keele St and Sculptors Gate (MH 49)	Village of King	Hickory Hills	Stormceptor STC 2000	1.66	7.7	2.89	11
2	Northwest on-site (at Block 21)	Village of King	Dew Street Residential Sub-division	Stormceptor STC 750 or equivalent	1.64	3	0.915	4.07
3	Upstream of KTPO_0003 Facility	Village of King	Mary Lake Estates	CDS Model PMSU3025_6 or equivalent	3.35	2.40	0.795	4.92
4	Upstream of KTPO_0004 Facility	Village of King	Mary Lake Estates	CDS Model PMSU3025_6 or equivalent	2.84	2.40	0.795	4.92
5	King Rd, approximately 85 m E of Alex Campbell Cres	Village of King	N/A	Stormceptor STC 750	0.72	3.00	0.915	4.07
6	King Rd, approximately 107 m W of Spring Hill Dr	Village of King	N/A	Stormceptor STC 2000	1.77	7.70	2.89	11
7	Carmichael Cres (N of DiNardo Court)	Village of King	Acacia Estate Collection Residential Subdivision	Stormceptor STC 6000 or equivalent	3.22	26.95	3.93	31.29
8	13424 Keele St	Village of King	King's Den Residential Subdivision	PMSU20_20_5	2	1.67	0.376	3.15
9	Main St, approximately 150 m NW of Church St	Village of Schomberg	N/A	Stormceptor STC 9000 or equivalent	7.11	32.98	10.56	44.36

Facility #	Location	Village/Hamlet	Subdivision	Model	Catchment Area (ha)	Sediment Storage Capacity (m^3)	Oil Storage Capacity (m^3)	Total Storage Volume (m^3)
10	No Info	Village of Schomberg	Laurier Homes Schomberg Subdivision	Stormceptor STC 5000 or equivalent	1.31	16.49	3.36	24.71
11	Keele St, approximately 40 m N of Lloydtown-Aurora Rd	Hamlet of Snowball	N/A	Vorsentry VS40 or equivalent	0.29	1.1	0.5	2.5
12	Lloydtown-Aurora Rd, approximately 150 m W of Keele St	Hamlet of Snowball	N/A	Vorsentry HS96 or equivalent	0.71	2.8	2.06	15.8
13	No Info	Village of Nobleton	Fandor Subdivision	CDS Model CDS3020-W	No Info	2.29	0.59	2.88
Note: The Township shall verify the Ownership of each OGS unit in order to determine Operation & Maintenance responsibilities of each unit								

Table 4-13: Underground Storage Facility

Facility #	Location	Village/Hamlet	Subdivision	Function	Catchment Area (ha)	Storage Capacity (m3)
1	Britnell Court and Block 20	Village of King	King's Den Residential Subdivision	Quantity Control	1.95	173

4.5.2 SWMF Retrofit Opportunities Previously Identified

A major source of pollution to Lake Simcoe and its tributaries is stormwater runoff. Due to anthropogenic activities and increased stress due to urban growth, Lake Simcoe is already showing signs of impairment. The Lake Simcoe Basin SWM and Retrofit Opportunities (2007) report was created with the purpose of producing a complete, consistent, and present data set of all urban catchments, outlets and existing SWMFs within the LSRCA. In addition, the study calculated the phosphorus load associated with stormwater runoff and identified locations of potential SWMF retrofit opportunities in the Lake Simcoe Watershed.

The retrofit opportunities identified within the Township listed in the report include:

- Seven in Schomberg and Lloydtown; and,
- Five in Pottageville.

The study recommended that in order to mitigate the impacts of stormwater, small lot level controls could be effective if they were adopted at a large scale. Small lot level controls include disconnection of downspouts direct to storm drains, installation of rain barrels and soak-away pits, naturalization of grassed swales and ditches, minimizing the use of fertilizers and chemicals for landscaping and ensuring proper application and disposal. For stormwater remediation, options recommended included constructing SWM ponds in uncontrolled catchments and upgrading quantity control facilities to a higher control level (i.e., Level 1). **Table 4-14** below shows the retrofit opportunities within the Township per the 2007 LSRCA report.

Table 4-14: SWMF Retrofit Opportunities Identified by the LSRCA

Hamlet/Village	Location	Type of SWMP Retrofit	Size of SWMP (m3) (Assuming 1 m deep)	Estimated Cost ($) (assuming $150/m³ excavated)	Phosphorus Reduction (kg/yr)	Estimated Cost (per Kg P removed)	Constraints
Pottageville	NE of Edward Pottage Cres.	Existing quantity pond to level 1 wet pond	1,422.04	213,306.00	12.02	17,745.92	Some tree removal
	W of Archibald Rd. between Lloydtown Aurora Rd. and Cook Dr.	No pond exists, room for level 1 wet pond	1,748.20	262,230.00	14.77	17,754.23	Slight drainage diversion away from channel and some tree removal
	N of Lloydtown Aurora Rd. and West of Weedon Crt.	No pond exists, room for level 1 wet pond	1,485.97	222,895.50	12.55	17,760.60	Fisheries concern and tree removal
	SW corner of Lloydtown Aurora Rd. and 7th Concession	No pond exists, room for level 1 wet pond	634.41	95,161.50	5.36	17,754.01	Property ownership and tree removal
	NE side of Cook Dr. between Bachly Cres. and Archibald Rd.	No pond exists, room for level 1 wet pond	2,466.71	370,006.50	20.83	17,763.15	Tree Removal
Schomberg/Lloydtown	SE Corner of Centre St. and Rebellion Way	No pond exists, room for level 1 wet pond	1,320.61	198,091.50	11.16	17,750.13	Fisheries concern, some tree removal, property ownership
	W side of Western Ave. and NW of Elmwood Ave	No pond exists, room for level 1 wet pond	1,224.54	183,681.00	10.35	17,746.96	None
	NW corner of Main St. and Cooper Dr.	No pond exists, room for level 1 wet pond	2,090.65	313,597.50	17.67	17,747.45	Some tree removal
	NW of Marlynn Ct.	No pond exists, room for level 1 wet pond	802.40	120,360.00	6.77	17,778.43	Property ownership
	SE of Magnum Dr. and N of Proctor Rd.	No pond exists, room for level 1 wet pond	3,915.14	587,271.00	37.58	15,627.22	None
	SW of Main St. and NE of Mill Dam Crt.	No pond exists, room for level 1 wet pond	975.24	146,286.00	8.24	17,753.16	Tree removal and property ownership

Hamlet/Village	Location	Type of SWMP Retrofit	Size of SWMP (m3) (Assuming 1 m deep)	Estimated Cost ($) (assuming $150/m^3 excavated)	Phosphorus Reduction (kg/yr)	Estimated Cost (per Kg P removed)	Constraints
	SW of Main St. and SE of Brownsville Crt.	No pond exists, room for level 1 wet pond	1,467.99	220,198.50	12.73	17,297.60	Some tree removal

4.6 Fluvial Geomorphology

4.6.1 Site History

A series of historical aerial photographs were reviewed to determine changes to watercourse systems and surrounding land use/cover. This information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. Aerial photographs of various scales from the years 1946, 1951, 1960, 1962, from the National Air Photo Library (NAPL) and recent digital satellite imagery from Google Earth Pro were reviewed to complete the historical assessment.

4.6.1.1 Ansnorveldt

Prior to 1946, a canal had been constructed in the vicinity of Ansnorveldt to facilitate drainage within the Holland Marsh and agricultural activities. The portion of canal west of Dufferin Street, which drains to the Holland River, contained woodland riparian vegetation, while natural vegetation had been removed from areas along the portion of canal east of Dufferin Street. Agricultural crops were planted immediately adjacent to the canal banks. Minor tributaries that currently follow the road networks were not visible in the aerial imagery due to the size of the features and the scale of available historical photographs. Land use consisted primarily of agriculture, with rural residential homes concentrated along Dufferin Street.

Between 1946 and 1962, additional residential homes had been built along Dufferin Street and east-west sideroads. Agricultural activities had further encroached on the canal west of Dufferin Street, upstream of the settlement. Between 1962 and 2005 residential development continued to expand within Ansnorveldt, while surrounding land uses remained predominantly agricultural. There were no significant differences in the alignment of the canal, planform of the West Holland River, and/or land use over the period examined.

4.6.1.2 Graham Sideroad

No watercourses were documented within the settlement area as part of our assessment. In 1946, there were a few residential homes within the Graham Sideroad community. A drainage canal was present west of the settlement area. Land use consisted primarily of agriculture with a few rural residences abutting Graham Sideroad. A forest was present north of the settlement, near an existing rail line, and continues along the eastern canal bank southwest of the settlement area.

Regional Road 1 (Yonge St.) was constructed between 1946 and 1962 east and north of the settlement area; however, land use remained primarily agriculture. Small commercial/industrial developments were constructed on the south side of Regional Road 1 between 1962 and 2005 and the extent of woodland riparian vegetation south of the settlement area had been reduced adjacent to the canal to expand agricultural fields. By 2005, commercial/industrial developments were present along the south side of Regional 1; however, there were no significant changes within the settlement area or immediate vicinity.

4.6.1.3 Kettleby

In 1946, land use within Kettleby was primarily agricultural and rural, with natural areas present north and south of the settlement area. In the immediate vicinity of Kettleby Road and along the minor tributaries upstream, woody riparian vegetation was sparse. The channel planform of the main tributary flowing south to north across Kettleby Road was visible in the 1946 imagery. Significant portions of the tributaries appeared to be cultivated to the channel edge. This likely resulted in higher instream temperatures, limited natural channel form, and local inputs of fine sediment to the system.

By 1960, Highway 400 had been constructed and rural development had expanded in areas upstream of Kettleby along Lloydtown Aurora Road, as well as along the portion of Lloydtown Aurora Road within the settlement boundary west of Jane Street. While many of the minor tributaries remained impacted by agricultural activities, canopy cover in the wooded areas north and south of the settlement areas generally continued to expand/improve. These improvements likely moderated local instream temperatures and enhanced local channel stability.

Between 1960 and 2005, residential homes and a commercial lot had been built along Lloydtown Aurora Road within Kettleby and wooded areas had continued to naturalize. The main channel through Kettleby appeared to have naturally migrated over the period of available record, with the position of several meanders showing an overall increase in channel sinuosity. Lorne Avenue and a private driveway east of Jane Street were constructed between 1960 and 2005. This was followed by the construction of multiple online ponds in several upstream reaches between 2004 and 2013. These features currently generally do not contain any natural riparian vegetation, likely contributing to increased instream temperatures and affecting the natural flow and sediment transport regime. In addition, a small pond appears to have been created within the central portion of the natural area south of Kettleby Road. Based on the available record, it is uncertain as to whether this is an online or offline pond.

4.6.1.4 King City

In 1946, residential development in King City was concentrated near the rail line and intersection at Regional Road 11 and Keele Street, with the surrounding lands predominantly under agricultural use. Although several large woodlots were present, significant lengths of channel lacked natural riparian vegetation, and multiple sections of channel were cultivated to the edge of bank. Portions of the larger tributaries where the channel was clearly visible showed a meandering natural planform.

By 1960, residential development had expanded north and south of Regional Road 11. Due to the timing of development, these relatively small subdivisions lacked contemporary stormwater management measures such as stormwater management ponds; however, the scale of these subdivisions likely did not result in significant erosion concerns for reaches receiving stormwater discharge. Several of the minor tributaries flowing through agricultural lands appeared to have been channelized, likely to maximize arable land and development activities.

By 2005, the extent of residential subdivisions had expanded significantly, and as a result, many of these features began to receive stormwater discharge. In addition, sections of reaches appear to have been enclosed in storm sewers.

4.6.1.5 Laskay

In 1946, land use adjacent to the settlement of Laskay consisted of predominantly agriculture. Natural wooded areas were present along the Humber River corridor; however, major localized gaps were observed, which contained actively cropped fields. A few rural residences flanked Weston Road, and portions of channel visible in the imagery had a relatively natural channel planform. In addition, a section of Highway 400 and associated watercourse crossings appear to have been under construction in the 1946 image.

There was limited change in land use and vegetation between 1946 and 1960. One significant change to the channel planform was apparent west of the settlement boundary when 1946 and 1960 imagery were compared. It appeared that a channel realignment was underway on the west side of Weston Road within a private property. In the 2002 and 2018 images, this portion of channel was relatively straight and appeared to contain a weir structure. Current watercourse mapping shows the adjacent pond as directly connected to the watercourse, although it is not apparent in recent digital satellite imagery. By 2002, there had been a slight increase in residential development, including the construction of a relatively small residential neighbourhood.

4.6.1.6 Lloydtown

In 1946, land use within Lloydtown was primarily agriculture and rural residential. Natural riparian vegetation had largely been cleared from watercourse corridors, with the exception of a section of the West Holland River west of Lloydtown. The main channel flowing through the centre of the community had largely retained a meandering planform, while minor tributaries flowing through agricultural fields had been channelized for agricultural purposes. The overall lack of natural riparian vegetation likely resulted in degraded instream conditions. There was limited change in land use, vegetation, and channel conditions between 1946 and 1960.

Since 1960, land use upstream of Lloydtown has remained largely agricultural, with a minor expansion in residential development within the community. An artificial pond was constructed immediately west of the channel, and a control structure and head pond were constructed on the main channel immediately downstream of the settlement boundary prior to 2004. The head pond likely impacts the natural flow and sediment transport regime, and also results in locally higher instream temperatures during the summer months. Several landscaped ponds have been constructed on the south side of 19th Sideroad and Lloydtown Aurora Road. In some locations, these ponds appear to have a connection with main tributary flowing through the settlement boundary and may cause local increases in instream temperature.

4.6.1.7 Nobleton

In 1946, the Nobleton settlement area was primarily rural residential and agricultural. Residences were largely located near the intersection of King Road and Highway 27. Several reaches had been cleared of natural riparian vegetation and straightened to facilitate drainage and cultivation. This likely resulted in limited channel form and inputs of fine sediment to downstream reaches. In contrast, reaches downstream of Nobleton to the west and in vicinity of King Vaughan Sideroad, flowed through more natural wooded areas with significant gaps in canopy cover. Where the channel was visible, it had a sinuous channel planform.

By 1960, residential development had increased slightly, with relatively small subdivisions constructed off King Road and Highway 27. Additional channel modifications were apparent on the northeast of the intersection of King Road and Highway 27, with a straightened tributary flowing between maintained rear yard catchbasins. Land use remained primarily agricultural.

By 2005, residential development had expanded significantly, although areas upstream of the community remained under active cultivation. Residential subdivisions had encroached onto woodlots, watercourses, and other natural features. In order to facilitate development, the upstream portions of some tributaries appeared to be incorporated into the storm sewer network. Stormwater management ponds are present in newer developments, constructed as recently as between 2009 to 2013.

4.6.1.8 Pottageville

In 1951, development within the settlement area was limited to a few rural homes along Lloydtown Aurora Road. Upstream (north) of the settlement area, the predominant land use was agriculture.

Significant natural areas were also present north and south of the community (Pottageville Swamp Area of Natural and Scientific Interest/Pottageville Provincially Significant Wetland Complex). Due to the scale and resolution of available aerial photography, individual watercourses were not visible. By 1960, rural development had expanded, with a small residential subdivision on 7th Concession Road south of Lloydtown Aurora Road, as well as the construction of several other homesteads along Lloydtown Aurora Road and in areas upstream of Pottageville. Where forest vegetation was absent in areas predominantly upstream of Pottageville, several channelized tributaries were visible, which were likely straightened to facilitate cultivation.

Between 1960 and 2005, residential development expanded significantly within the settlement and surrounding area, extending from 18th Sideroad to the south to Lloyd's Lane/19th Sideroad to the north. By 2005, portions of agricultural lands upstream of Pottageville had been permitted to naturalize, resulting in the expansion of woodlands in areas that were once under active cultivation. This resulted in the reinstatement of natural riparian areas and presumably improvements to instream conditions along portions of the channel. In areas that remain under agricultural use, narrow riparian areas (i.e., width of single trees/shrubs) had established along several tributaries. As residential development began to encroach on tributaries within the community, portions of reaches appeared to have been straightened east of 7th Concession Road and manicured to the edge of bank. Several landscaped ponds were also visible as of 2005, although it is unclear as to whether many of them are directly connected to the tributaries of the West Holland River as watercourses are obscured by forest canopy in several areas. Limited additional residential development has occurred since 2005.

4.6.1.9 Schomberg

In 1946, residential development within the settlement area was largely located along Church Street and Main Street, while areas upstream and downstream of the settlement were primarily under active cultivation. Watercourse reaches had been straightened to enable residential development within the community, with lawns manicured to the channel banks in some locations. Natural riparian vegetation along reaches within agricultural fields had largely been removed or limited to single trees/shrubs, and the channels straightened to facilitate agricultural activities. These channel modifications likely resulted in limited natural channel form, degraded aquatic habitat, the creation of conditions conducive to bank erosion and inputs of fine sediments, and increased instream temperatures.

Residential development had expanded slightly by 1960, while adjacent lands remained under cultivation. What is now the Dufferin Wetland Complex began to form east of Main Street. Dr Kay Drive also appeared to be in the initial stages of construction to the north of the wetland feature. Overall, there were limited changes to channel planform between 1946 and 1960.

By 2004, an artificial offline pond, and control structure and head pond were constructed on the main channel immediately upstream of the settlement boundary. Residential development has expanded significantly since 1960; however, agriculture still remains the predominant land use in areas upstream and downstream of the community. Commercial/industrial facilities have been constructed in the northern extent of the community near Highway 9 and a treatment facility and watercourse realignments were completed east of Highway 27. Portions of watercourse corridor within the southern half of the community have been permitted to naturalize, which has likely enhanced channel stability. Watercourses in the northern portion of the study area remain largely straightened corridors, although there have been minor improvements to natural riparian vegetation since 1946.

4.6.1.10 Snowball

In 1946, the settlement of snowball and surrounding area consisted of rural residences and agricultural lands. The main tributary of the East Holland River that currently flows west to east through the community was faintly visible in the 1946 image and appeared to have been ploughed and cultivated. Channel planform characteristics downstream of Snowball were not visible in the 1946 imagery due to the presence of tree cover. There was limited change in land use and watercourse characteristics between 1946 and 1960 within the community, although portions of natural areas immediately north of the settlement had expanded and residential development was underway to the east within the Town of Aurora.

Between 1960 and 2005, a golf course had been constructed northeast of Snowball, and additional residential homes had been constructed along 17th sideroad/Wellington Street West. It is highly likely that the golf course resulted in modifications to an existing tributary as portions appeared to have been enclosed and/or are now connected via a series of landscaped ponds. While the riparian area along the main tributary immediately east of the settlement was no longer under active cultivation and had begun to naturalize, a portion of tributary west of Dufferin Street remained channelized to facilitate an industrial development, and also currently flows through two online pond features. Areas immediately downstream of the settlement area remain largely natural, with the channel planform obscured by vegetation.

4.6.2 Geology and Physiography

4.6.2.1 East Holland River

Channel morphology and planform are largely governed by the flow regime and the availability and type of sediments (i.e., surficial geology) within a given stream corridor. Physiography, riparian vegetation, and land use also physically influence the channel. These factors provide insight into existing conditions and perception to the future potential changes as they relate to a proposed activity. The geology of the East Holland River is complex and has been influenced by several glacial events. The bedrock geology is characterized as being from the Paleozoic Era, consisting primarily of the Middle Ordovician Simcoe Group in the north, and shale of the Upper Ordovician Blue Mountain in the south. The bedrock has been overlain by a sequence of sediments that have been deposited over the last 135,000 years by glacial, fluvial, and lacustrine environments.

Published surficial geology mapping for the East Holland subwatershed indicates that the upstream limit of the subwatershed is located within ice-contact stratified deposits of sand and gravel, minor silt, clay and till (ORM deposits), clay to silt textured till derived from glaciolacustrine deposits or shale, and stone-poor sandy silt to silty sand-textured till on Paleozoic terrain. Relatively small, isolated organic deposits are located northeast of the community of Snowball. Modern alluvial deposits are present along larger tributaries of the East Holland River within the Township. The portion of the East Holland River within the Township is located within three physiographic regions, the Oak Ridges Moraine, the Simcoe Lowlands, and the Schomberg Clay Plain. Topographic highs are located within the ORM, while topographic lows are located within the Simcoe Lowlands. The portion of the moraine within the subwatershed consists of surficial sand and gravel deposits up to 90 m thick. Along the northern side of the moraine, groundwater discharges in the form of seeps or springs, creating the headwaters of the East Holland River.

4.6.2.2 West Holland River

The geology of the West Holland River is complex and has been influenced by several glacial events. Similar to the East Holland River, bedrock geology is characterized as being from the Paleozoic Era, consisting primarily of the Middle Ordovician Simcoe Group in the north, and shale of the Upper Ordovician Blue Mountain in the south. Published surficial geology mapping indicates that the portion of the West Holland River within the Township drains areas of fine- and coarse-textured glaciolacustrine deposits, stone-poor sandy silt to silty sand textured till on Paleozoic terrain, and organic deposits. Where the headwaters emerge from the ORM, surficial geology consists of ice-contact stratified deposits in the eastern portion and clay to silt-textured till in the western portions. Modern and older alluvial deposits of clay, silt, sand, and gravel are mapped along various tributaries upstream of the Holland Marsh.

The portion of the West Holland River within the Township is located within three physiographic regions, the Oak Ridges Moraine, the Simcoe Lowlands, and the Schomberg Clay Plain. Topographic highs are located within the ORM, while topographic lows are located within the Simcoe Lowlands and the Schomberg Clay Plain. The portion of the moraine within the subwatershed consists of surficial sand and gravel deposits up to 90 m thick. Along the northern side of the moraine, groundwater discharges in the form of seeps or springs, creating the headwaters of the West Holland River.

4.6.2.3 Humber River

The geology of the Humber watershed is mainly comprised of Shale of the Georgian Bay Formation. Limestone bedrock is located only in the northern limits of the Humber River watershed, above the Niagara Escarpment. The bedrock has experienced extensive erosion resulting in the formation of a deep bedrock valley system, known as the Laurentian Valley, extending from Georgian Bay to Lake Ontario.

Surficial geological mapping shows that the majority of the East Humber River within the study area flows through clay to silt-textured till derived from glaciolacustrine deposits or shale. Fine-textured glaciolacustrine deposits of silt, clay, minor sand and gravel are located in the eastern half of the King settlement area. Several of the main tributaries of the East Humber that travel through Nobleton, Laskay and King are mapped as containing modern alluvial deposits comprised of clay, silt, sand, and gravel.

The portion of the Humber River within the study area is located within the Oak Ridges Moraine and South Slope physiographic regions. The majority of headwater features are located within the ORM, which consists of largely sand and gravel deposits. The South Slope is a gentle sloping glacial till plain located south of the ORM.

4.6.3 Drainage Density

The drainage density is a measure of the degree of dissection of the drainage basin. It is defined as the ratio of the total channel length over the drainage area of the basin and is usually expressed in units of km/km2. The drainage density increases as the average density between adjacent channels decreases. Drainage density depends on the precipitation rate, the permeability of the surface materials, the resistance to erosion, and the degree of vegetation cover. Drainage density generally decreases with distance downstream from the headwaters, but is relatively lower (i.e., less than 10 km/km^2) in temperate regions due to greater vegetation cover and runoff.

The existing drainage densities for the two tributaries within the study area were determined. In this case, existing subcatchments provided by the Township were used. The existing reach lengths were measured using available topographic mapping. **Table 4-15** contains the results of the drainage density analysis for the Humber West and West Holland River that drain King Township. Note that a small area located near the eastern limit of King Township drains towards the East Holland River, and was not included in the analysis due the small number of subcatchment areas in that location. Further, a lack of stream layer information was noted within the western portion of the West Holland Subwatershed nearby to King Township. The dataset was therefore supplemented with data from the OMNRF 2019 stream layer. It should be noted that the drainage density calculations do not include low order streams.

Table 4-15: Drainage Densities for the Humber River and West Holland River

Sub-Catchment	Stream Length (km)	Drainage Area (km^2)	Drainage Density (km/km^2)
Humber River	1302.769	494.7	2.63
West Holland River	628.381	316.68	1.98

4.6.4 Watercourse Characteristics

4.6.4.1 Reach Delineation

Reaches are homogeneous segments of channel used in geomorphological investigations. They are studied semi-independently as each is expected to function in a manner that is at least slightly different from adjoining reaches. This allows for a meaningful characterization of a watercourse as the aggregate of reaches, or an understanding of a particular reach, for example, as it relates to a proposed activity.

Reaches are delineated based on changes in the following:

- Channel planform
- Channel gradient
- Physiography
- Land cover (land use or vegetation)
- Flow, due to tributary inputs
- Soil type and surficial geology
- Certain types of anthropogenic channel modifications

This follows scientifically defensible methodology proposed by Montgomery and Buffington (1997), Richards et al. (1997), Brierley and Fryirs (2005), and the Toronto and Region Conservation Authority (2004). Reach maps for each settlement area are shown into **Figure K-1** to **Figure K-10 of Appendix K**.

The reaches were delineated and labelled based on the subwatershed and community. For example, reaches located the West Holland (WH) River watershed within the Pottageville (P) settlement area were labelled WHP and reaches located in the Humber (H) River watershed within the Nobleton (N) settlement area were labelled HN. Only Schomberg and Lloydtown had connecting reaches and were given a slightly different label, WHSL, for West Holland Schomberg Lloydtown.

4.6.4.2 General Reach Observations

Reach observations and channel measurements were collected during multiple site visits in August and September 2019 along accessible portions of channel on publicly owned lands and within road right-of-ways (ROWs) to gain insight into the existing watercourse conditions. Reach extents and ROWs assessed are indicated on the reach mapping provided in **Appendix K**.

General field reconnaissance included the following observations:

- Characterization of stream form, process, and evolution using the Rapid Geomorphological Assessment (RGA) (MOE, 2003; VANR, 2007);
- Assessment of the ecological function of the watercourse using the Rapid Stream Assessment Technique (RSAT) (Galli, 1996);
- Stream classification following a modified Downs (1995) and a modified Brierley and Fryirs (2005) River Styles Classification approach;
- Instream estimates of bankfull channel dimensions, access permitting; and
- Bed and bank material composition and structure.

Reach and crossing summaries pages are included in **Appendix K** and documented according to settlement area. These reach summary pages include general characteristics and measurements, rapid assessment results, and photographs for the accessible reaches.

4.6.5 Reconnaissance-Level Assessments

Channel stability and susceptibility to erosion were objectively assessed through the application of the Ontario Ministry of the Environment's (2003) Rapid Geomorphic Assessment (RGA). The RGA evaluates degradation, aggradation, widening, and planimetric form adjustment at the reach scale. The end result of the RGA is to produce a score, or stability index, which evaluates the degree to which a stream has departed from its equilibrium condition. A stream with a score of less than 0.20 is in regime, indicating minimal changes to its shape or processes over time. A score of 0.21 to 0.40 indicates that a stream is in transition or stress and is experiencing major change to process and form outside the natural range of variability. A score of greater than 0.41 indicates that a stream is in extreme adjustment, exhibiting a new stream type, or in the process of adjusting to a new equilibrium (MOE, 2003; VANR, 2007).

The Rapid Stream Assessment Technique (RSAT) was also employed to provide a broader view of the system and consider the ecological functioning of the watercourses (Galli, 1996). Observations were made of channel stability, channel scouring or sediment deposition, instream and riparian habitats, and water quality. The RSAT score ranks the channel as maintaining a poor (<13), fair (13-24), good (25-34), or excellent (35-42) degree of stream health.

Reaches were also classified according to a modified Downs (1995) Channel Evolution Model and the River Styles Framework (Brierley and Fryirs, 2005). The Down's Model describes successional stages of a channel as a result of a perturbation, namely hydromodification. Understanding the current stage of the system is beneficial as this allows one to predict how the channel will continue to evolve or respond to an alteration to the system. The River Styles Framework (Brierley and Fryirs, 2005) provides a geomorphological approach to examining river character, behaviour, condition, and recovery potential.

Due to the scale of the study, a general summary of the watercourses within each settlement area are provided for detailed descriptions of existing conditions refer to the summaries included in **Appendix K**.

4.6.5.1 East Holland River Subwatershed

Snowball was the only settlement area located within the East Holland River subwatershed. The branches of the East Holland River within and surrounding Snowball flow in an easterly direction through forests, agricultural lands, and scattered residential properties. Due to access, two ROWs were assessed, within and adjacent, to Snowball. Both tributaries consisted of wetland features with no defined channel and fully encroached with cattails. No erosion concerns were noted at either crossing.

4.6.5.2 West Holland River Subwatershed

There were five settlement areas within the West Holland River subwatershed. Moving from upstream to downstream (southwest to northeast) within the subwatershed, the settlement areas include Lloydtown, Schomberg, Pottageville, Kettleby, Ansnorveldt, and Graham Sideroad.

There was one branch of the West Holland River that flowed in a northeastern direction through Lloydtown. This branch was unconfined with a low sinuosity and flowed through the yards of multiple residential properties before entering a large pond between Lloydtown and Schomberg. The general land use was residential, and the riparian zone was fragmented due to manicured lawns.

There were generally two branches of the West Holland River that flowed through Schomberg. The first branch on the east side of Schomberg originated from Lloydtown and had two tributary confluences. This branch flowed in a northern direction through residential properties, was sinuous and partially confined at the upstream extent, and had been previously straightened at the downstream extent. The second branch on the west side of Schomberg flowed in a northeastern direction through agricultural fields and commercial properties. The reach was unconfined and possibly straightened in some sections for agricultural practices.

There are several small tributaries of the West Holland River that flow in a northern direction through Pottageville. These tributaries are generally small, unconfined, have a low sinuosity and flow through residential properties. One tributary, particularly reaches **WHP3-1** and **WHP3-2**, were confined, meandering, and had higher gradient and bankfull width. Some reaches, including **WHP4-2** and **WHP4-3**, had channelized sections due to urbanization.

In Kettleby, there was one large branch of the West Holland River that flowed in a northern direction and a few smaller tributaries that flowed in an eastern direction towards the larger branch. The main branch, particularly reach **WHK1**, consisted of a confined and meandering channel with a moderate gradient. The reach flowed through forest, the Tyrwhitt Conservation Area, and residential properties. The tributaries along Jane Street consisted of poorly defined headwater features.

In Ansnorveldt, the roadside ditch and agricultural ditch on the west side of Dufferin Street flowed into the main branch of West Holland River, **WHA2**, west of Ansnorveldt. The roadside ditch and agricultural ditches on the east side of Dufferin Street flowed into the east canal of the West Holland River, **WHA1**, east of Ansnorveldt. All features, including the canal of the West Holland River were unconfined with little to no riparian cover and were modified for agricultural purposes.

There were no watercourses through the Graham Sideroad settlement area. However, the east canal of the West Holland River flowed in a northern direction crossing Graham Sideroad approximately 500 m west of the settlement area. This canal, reach **WHG1**, had been straightened and dredged for ongoing agricultural activities within the surrounding area.

4.6.5.3 Humber River Watershed

There are three settlement areas within the Humber River Watershed. These settlements areas are King City, Laskay, and Nobleton moving from upstream to downstream (east to west) within the watershed.

A main branch of the Humber River flowed in a westerly direction through the middle of the King City settlement area. This main branch was assessed at a few ROWs, Dufferin Street at the upstream extent and Jane Street and King Road at the downstream extent, and along a couple reach extents downstream of Keele Street. The main branch consisted of a meandering channel through a partially confined valley with mixed riparian zones of forest and meadows. There are four tributary branches flowing in a southern direction towards the main branch and three tributary branches flowing in a northern direction towards the main branch. Most of these tributaries consisted of wetland and swale features that were heavily encroached with grasses and had little to no channel definition.

In Laskay, a main branch of the Humber River flowed in a westerly direction along the southern border of the settlement area. The reach was assessed within the ROW along Weston Road. The main branch consisted of a meandering channel within a partially confined valley. The forested riparian zone was fragmented due to manicured lawns. Two tributaries on the west and east side of the settlement area flow south towards the main branch. The tributary on the west side could not be assessed from King Road due to active construction of the road and crossing. The tributary on the east side split into two branches and both were assessed at King Road.

A main branch of the Humber River flowed in a southwestern direction at the far southeast corner of the Nobleton settlement area. This main branch was assessed within the ROW at King Vaughan Road. This branch was partially confined and highly sinuous within a forested riparian zone. Most of the tributaries within Nobleton flow in a southeastern direction towards the main branch of the Humber River. The upstream extent of these tributaries flow through a residential land use and have been modified to accommodate the stormwater management of the recently developed properties. The upstream extent of these tributaries are generally poorly defined channels within unconfined valleys. Further downstream of these tributaries, the reaches become more defined channels within confined or partially confined valleys that are forested. Along the western boundary of the Nobleton settlement area, a few headwater tributaries flow in a western direction through active agricultural fields.

4.7 Natural Hazards

4.7.1 Areas Highly Susceptible to Erosion

During rapid field reconnaissance, areas of erosion concerns were documented. These areas include reaches or crossings that are currently eroding, sensitive to erosion (i.e., high RGA score), or where current infrastructure or private property are at risk due to further erosion. It is recommended that additional assessment is conducted if stormwater management measures will be proposed to outlets to a reach that was only partially evaluated or not assessed in this study due to site access issues. **Table 4-16** below lists the areas of erosion concern for each reach or crossing that was accessed within each settlement area.

Table 4-16: Areas Highly Susceptible to Erosion

Reach	RGA Score/Condition	Reason(s) for Concern
Ansnorveldt		
No areas of concern - reach consisted of roadside ditches and a straightened/dredged canal		
Graham Sideroad		
No areas of concern - straightened tributaries/canal adjacent to settlement area		
Kettleby		
WHK1	0.31 In Transition/Stress	• Extensive bank erosion throughout reach. • Observations include valley wall contacts, fallen and leaning trees, and exposed till on channel bed banks. • A gabion wall along the outside meander bend near Kettleby Road was leaning towards channel. However, no evidence of degradation along the gabion toe.

Reach	RGA Score/Condition	Reason(s) for Concern
WHK1-1	0.23 In Transition/Stress	• Exposed bridge footings at Kettleby Road on downstream extent of crossing. • Observations include a knickpoint, a valley wall contact, exposed till, and fallen and leaning tree.
King City		
HK3	0.36 In Transition/Stress	• Elevated storm sewer outfall with a small scour pool. Outfall near the upstream reach break. • Observations include fallen and leaning trees, exposed till, and woody debris jams.
HK4	0.20 In Regime	• Reach is *In Regime*; however, one location of extensive bank erosion adjacent to residential property. Fence leaning into channel. Refer to photograph in **Appendix K HK4** reach summary
HK4-1	0.20 In Regime	• Reach is *In Regime*; however, one location of extensive bank erosion has compromised a section of the public trail. See photograph in **Appendix K HK4-1** reach summary.
Laskay		
No areas of concern		
Lloydtown		
WHSL7	N/A: Roadside assessment only	• Upstream CSP of Centre St was not in alignment with the creek. Potential of increased erosion around CSP. • Undercutting observed upstream of Centre St. Lawns were manicured to the top of bank.
Nobleton		

Reach	RGA Score/Condition	Reason(s) for Concern
HN1	N/A: Roadside assessment only	• Observation includes slumping on both sides of the road crossing, a leaning tree, and exposed roots
HN2	N/A: Roadside assessment only	• Bank Erosion observed on the downstream side of King Vaughan Rd. Observations include extensive root exposure, leaning and fallen trees, undercutting up to 0.4 m, and woody debris.
HN3	0.37 In Transition/Stress	• Extensive bank erosion throughout reach and aggradation of the channel bed. • Observations include undercutting up to 0.2 m, exposed roots, leaning and fallen trees, woody debris, and medial bars.
Pottageville		
WHP0	N/A: Roadside assessment only	• Minor bank erosion observed on both sides of crossing. • Erosion around the CSP at the upstream extent, indicating the crossing may be undersized and at risk to increased erosion.
WHP3-2	0.47 In Adjustment	• Extensive bank erosion throughout reach. • Observations include undercutting up to 0.65 m, leaning and fallen trees, exposed tree roots, a knickpoint, large woody debris jams, exposed till, and overbank sand deposits.
Schomberg		
WHSL1-1	0.21 In Transition/Stress	• Observations include cut face on bar forms, exposed till, undercutting up to 0.4 m, exposed tree roots, and cut-off channel

Reach	RGA Score/Condition	Reason(s) for Concern
WHSL2	0.24 In Transition/Stress	• Extensive bank erosion throughout reach. • Observations include exposed tree roots, leaning and fallen trees, undercutting up to 0.4 m, and exposed till. • Buildings within the downtown core (Main St.) are situated along the top of bank. One building foundation was exposed along the eroded channel banks.
WHSL2-1	N/A: Small portion of reach examined	• Observations include exposed till, suspended armour layer, fracture line along the top of bank, exposed roots, undercutting up to 0.3 m, and slumping. • Bank erosion on the right bank downstream of Main St. adjacent to a residential property. • Buildings appear close to top of bank downstream of Main St.
WHSL3	0.30 In Transition/Stress	• Extensive bank erosion throughout reach. • Observations include a cut off channel, thalweg out of alignment, valley wall contacts, exposed till, leaning, and fallen trees, exposed roots, undercutting up to 0.50 m, and a high density of woody debris jams.
Snowball		
No areas of concern - all wetland features		

4.7.2 Flood Prone Areas

Spill zones are defined as areas where portions of the floodplain are not physically contained within the valleyland. This spill would either re-enter the main channel downstream or be lost from the system. Hydraulic studies that analyze flooding within the Township include the Hydraulic Report for the West Holland River, East Holland River and Maskinonge River (CCL, 2005). The report identifies the following area(s) as spill zones within the Township areas under the jurisdiction of the LSRCA:

- 7th Concession Road in Pottageville – Spill to North;
- Birds Lane in Pottageville – Spill to West;
- 19th Sideroad in Lloydtown – Spill to East;
- Highway 27 just N of Schomberg – Spill to East; and
- 20th Sideroad just NW of Schomberg – Spill to South

Identification of spill zones in the TRCA were identified using TRCA shapefiles and mapping. The online TRCA Flood Plain Map Viewer was used to determine spill zones. The following spill zone were identified in the Township areas under the jurisdiction of the TRCA:

- East Humber River NE of King Rd and Dufferin St – Spill East to West
- East Humber River W of Bathurst Street – Spill East to West
- Intersection of Highway 27 and Ellis Avenue, Town of Nobleton

The spill zones identified above define locations where the floodplain is not constrained and spills into areas outside of the valleyland. It should be noted that additional flood prone areas may be identified at locations where properties, buildings, or other appurtenances are present within the Regional floodplains. When flood remediation is contemplated throughout the Township, consideration should be given to all flood prone areas and not just those within spill areas. **Figure 4-5** to **Figure 4-14** depicts these spill zones and regional floodplains in the Township.

Figure 4-5: King City Floodplain Mapping

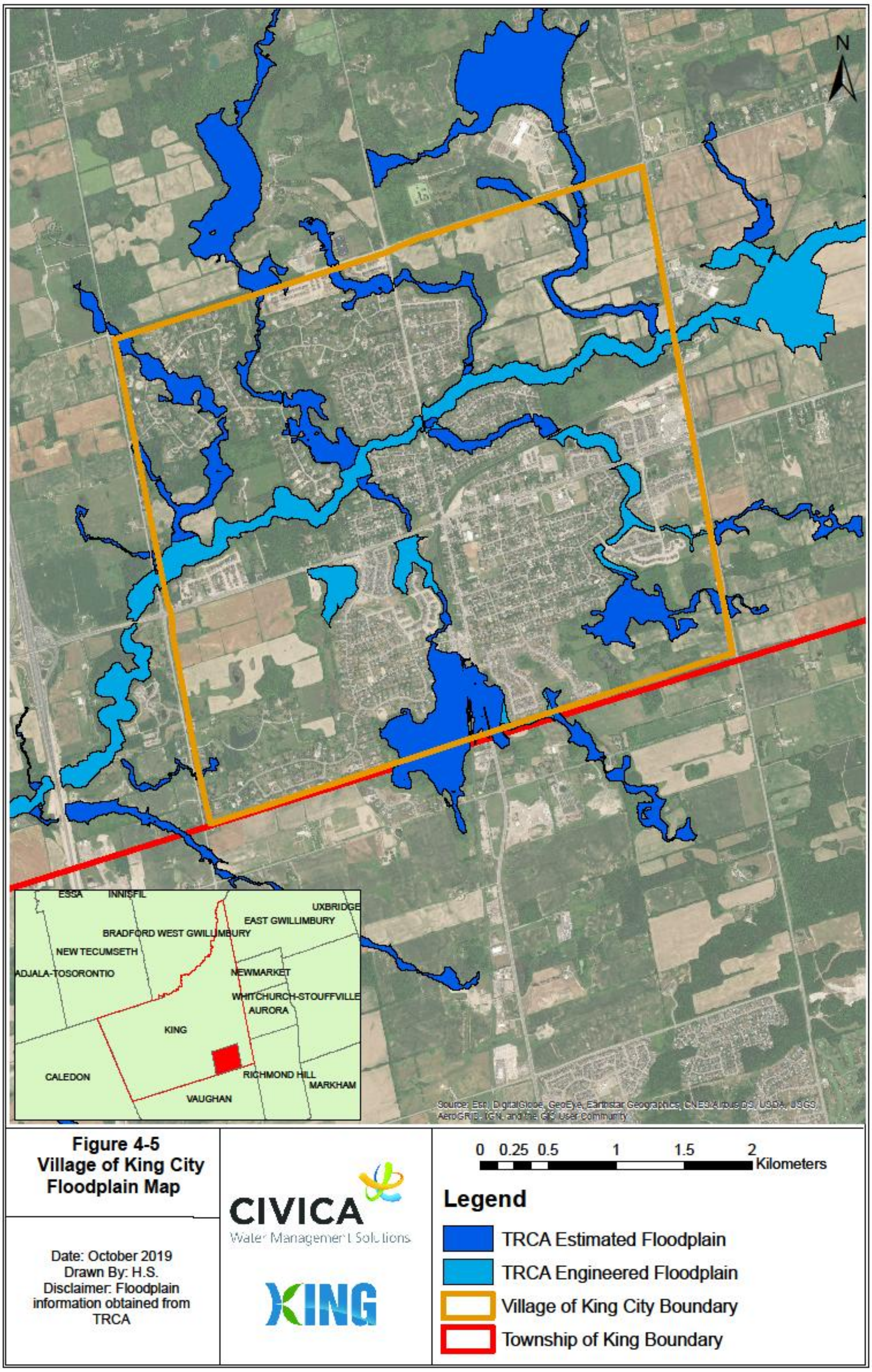


Figure 4-6: Nobleton Floodplain Mapping

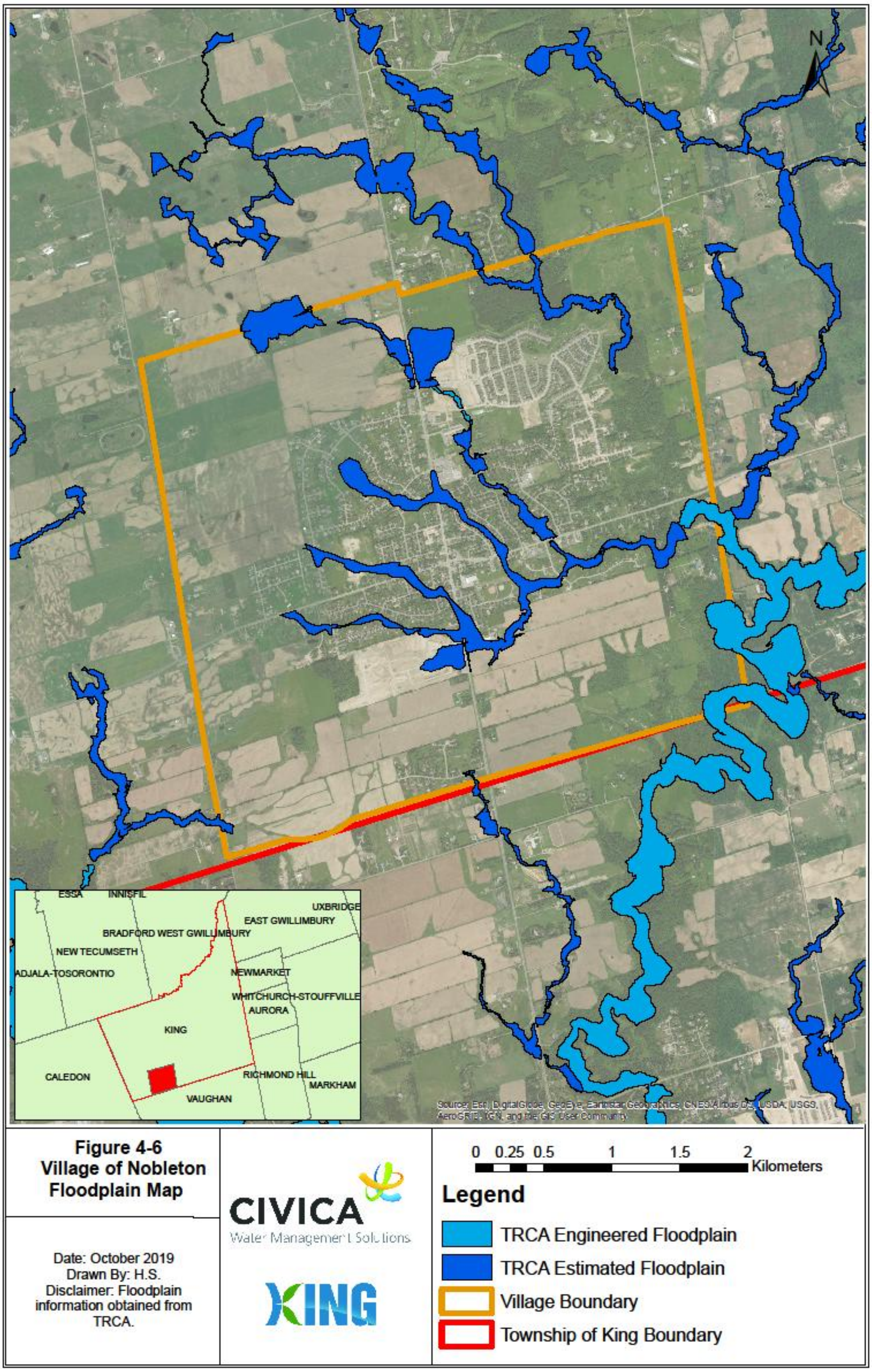


Figure 4-7: Schomberg Floodplain Mapping

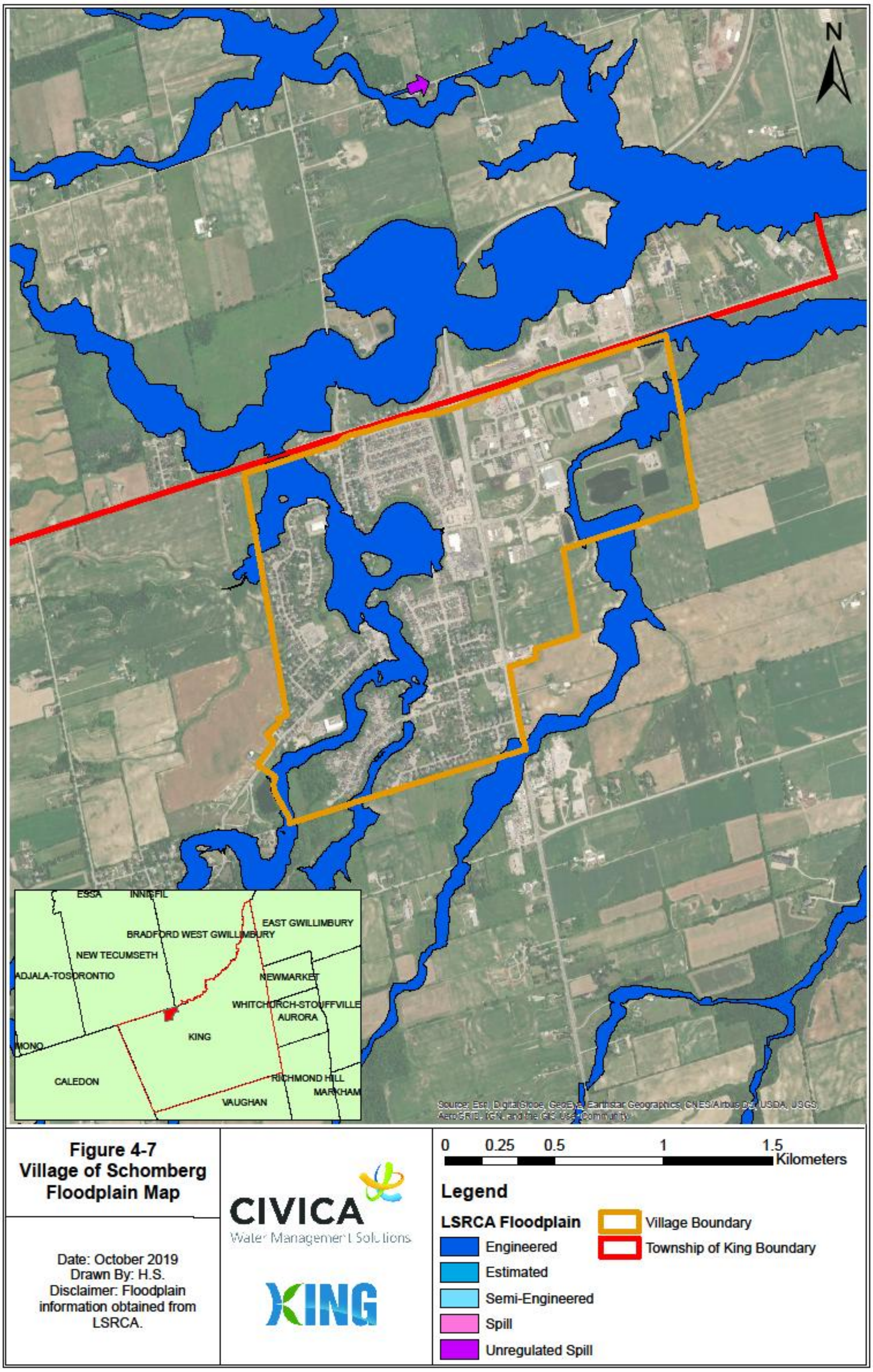


Figure 4-8: Ansnorveldt Floodplain Mapping

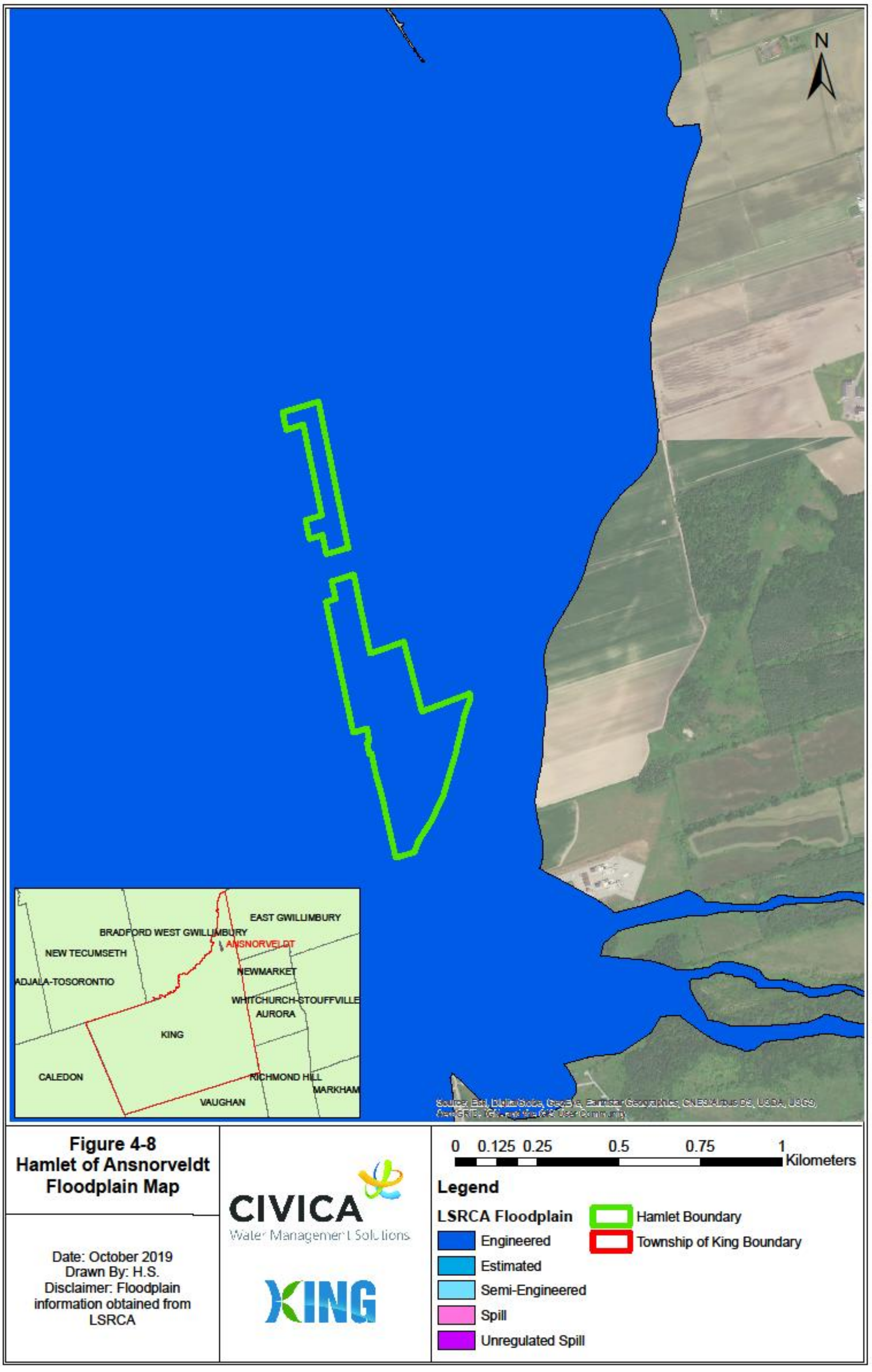


Figure 4-9: Snowball Floodplain Mapping

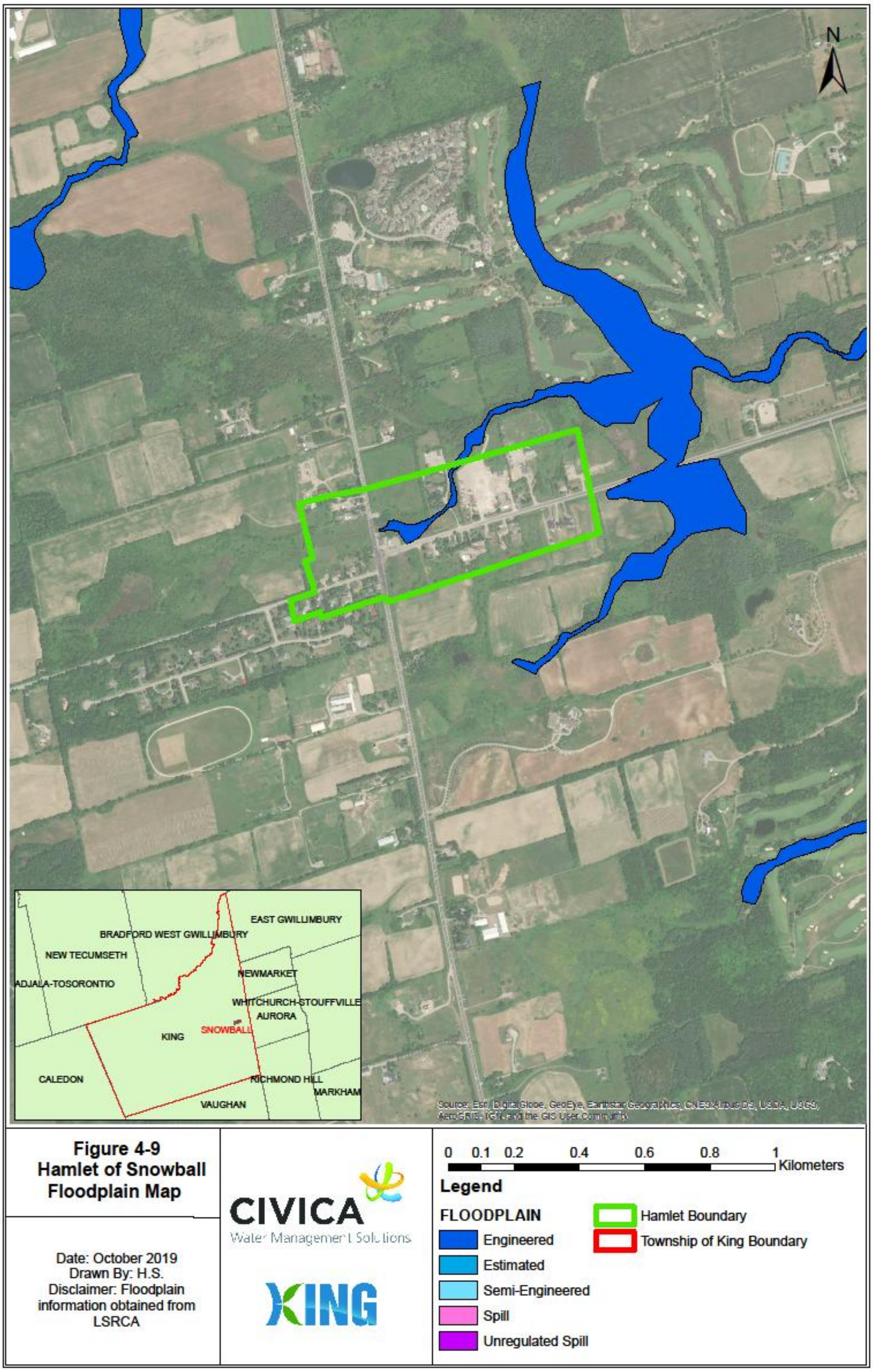


Figure 4-10: Lloydtown Floodplain Mapping

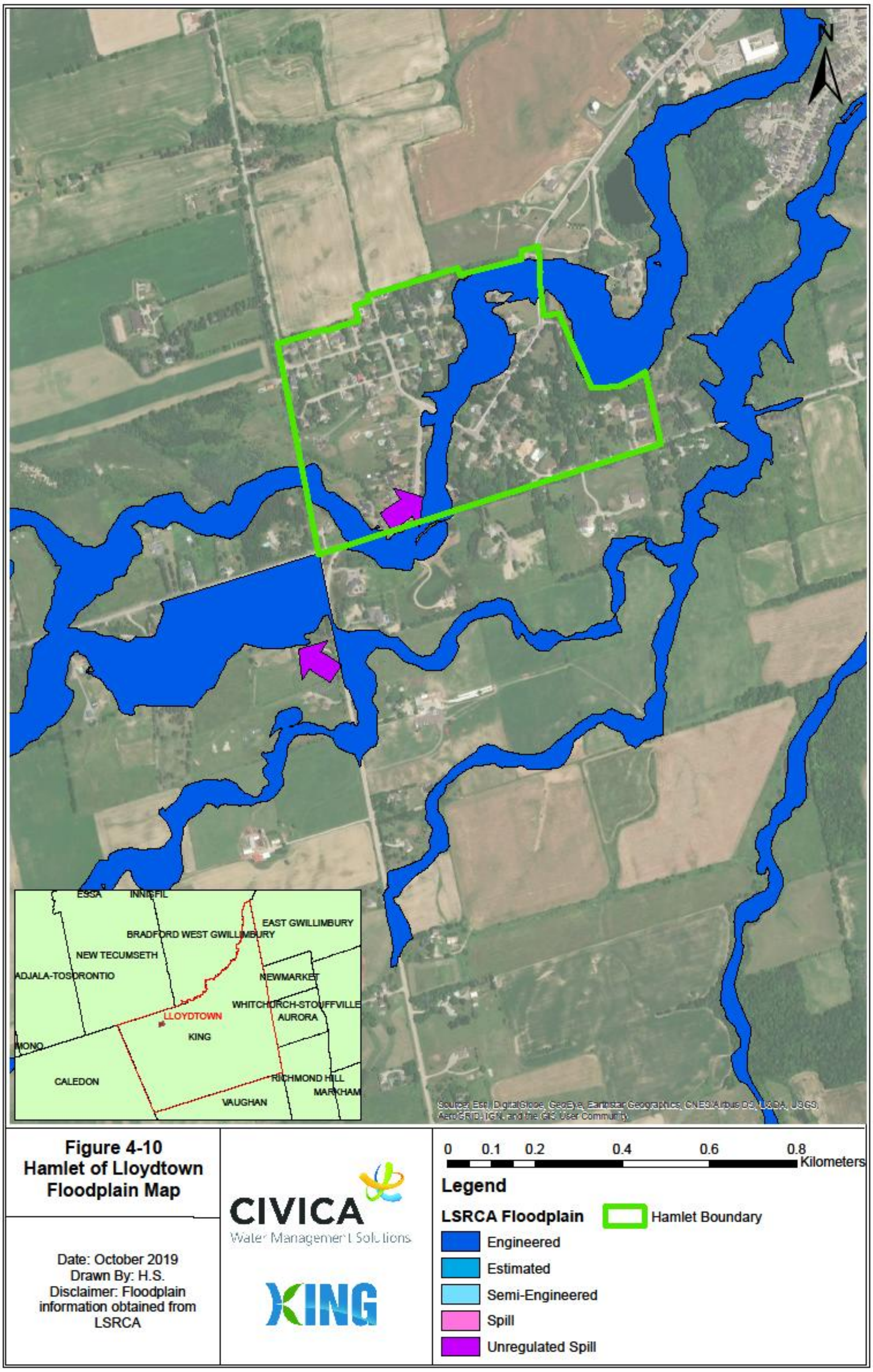


Figure 4-11: Laskay Floodplain Mapping

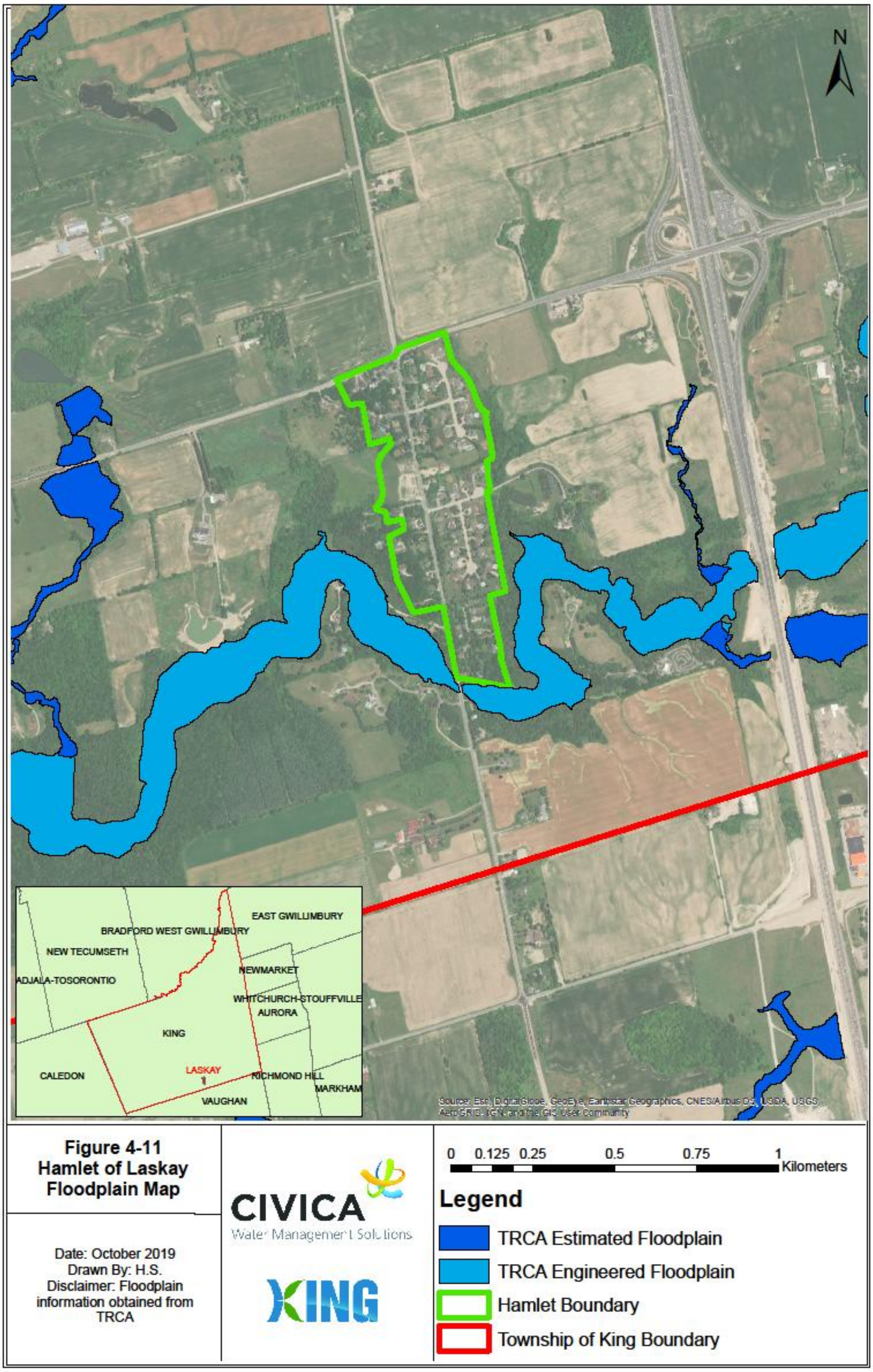


Figure 4-12: Kettleby Floodplain Mapping

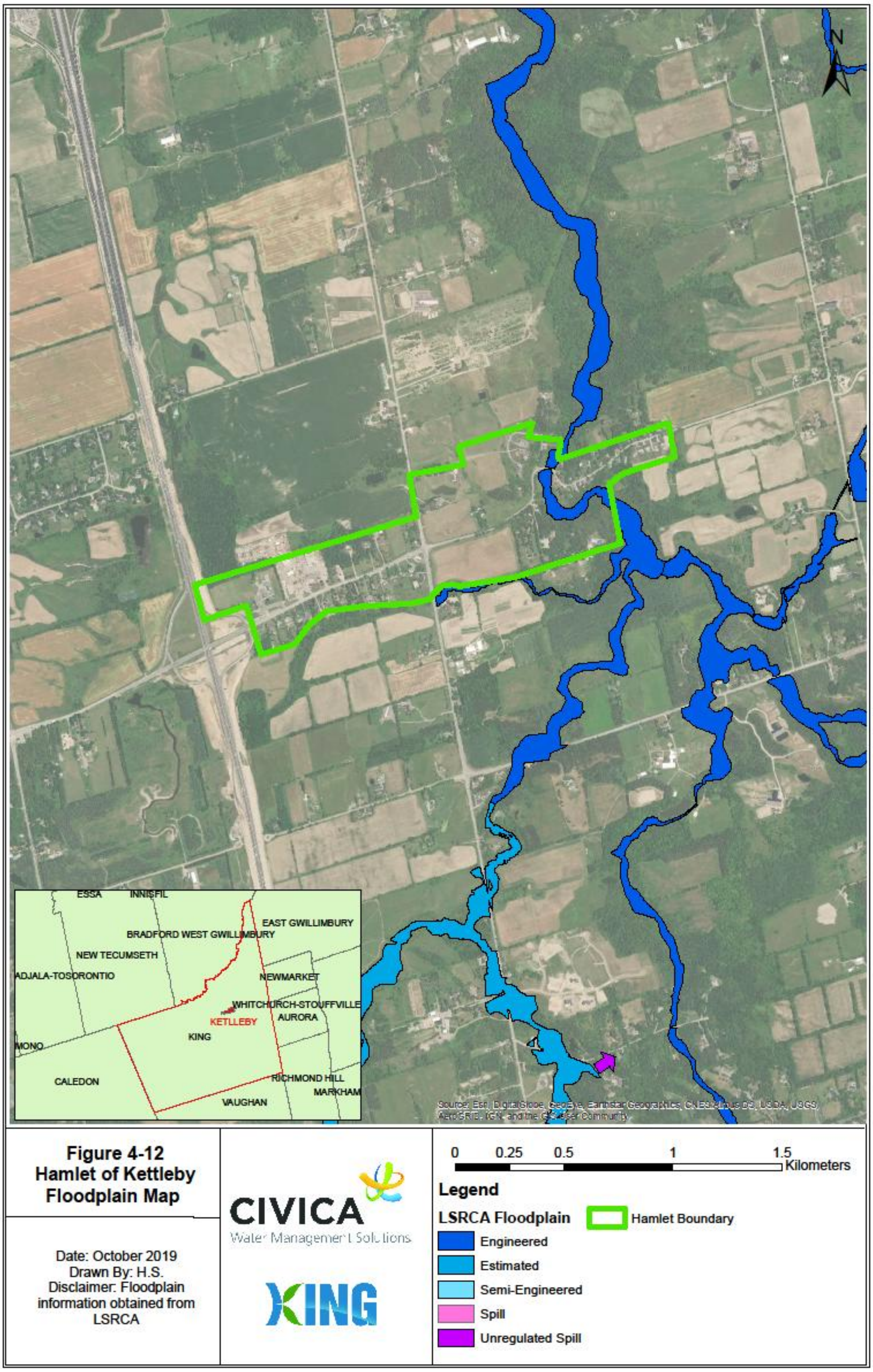


Figure 4-13: Pottageville Floodplain Mapping

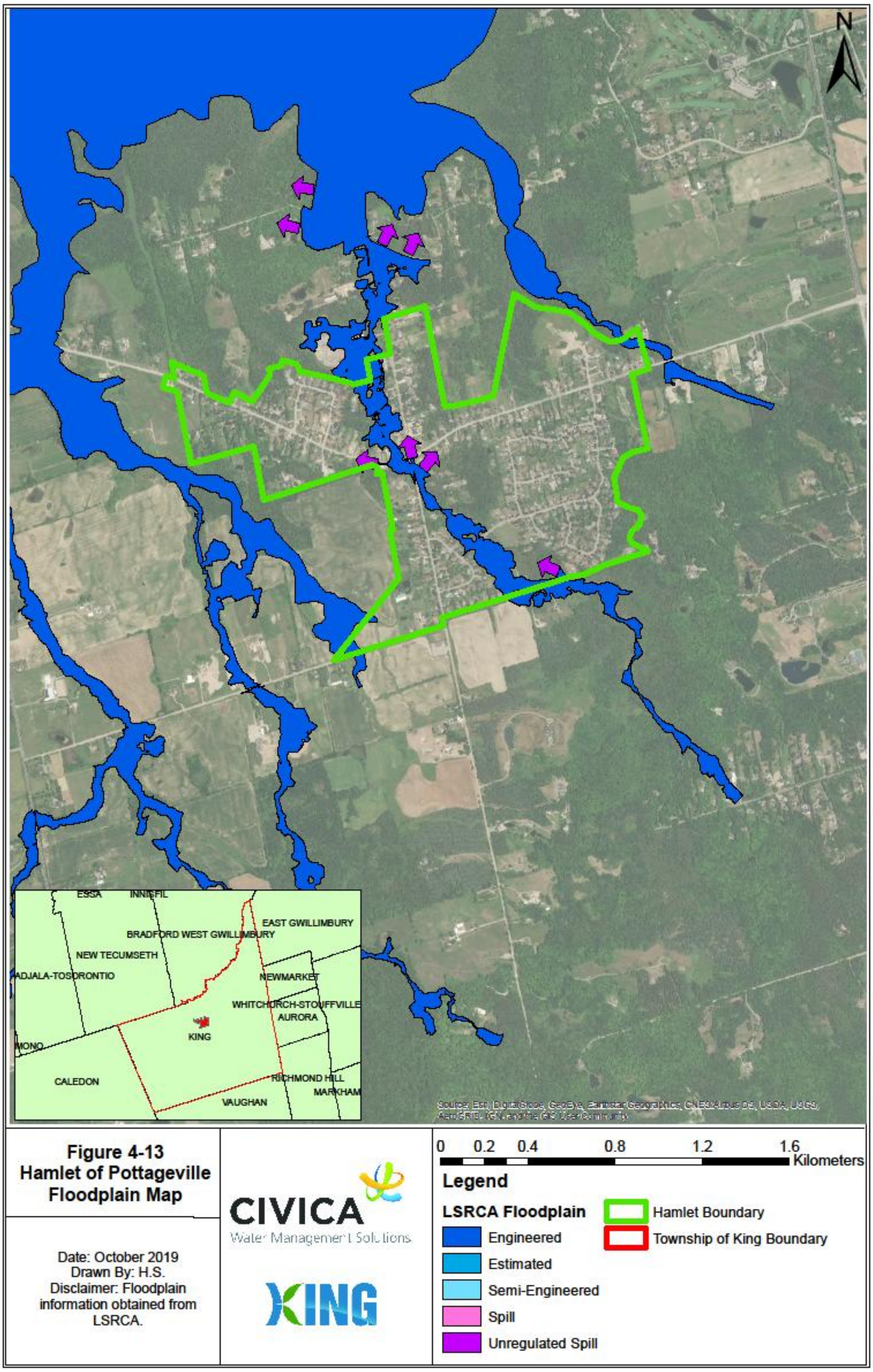
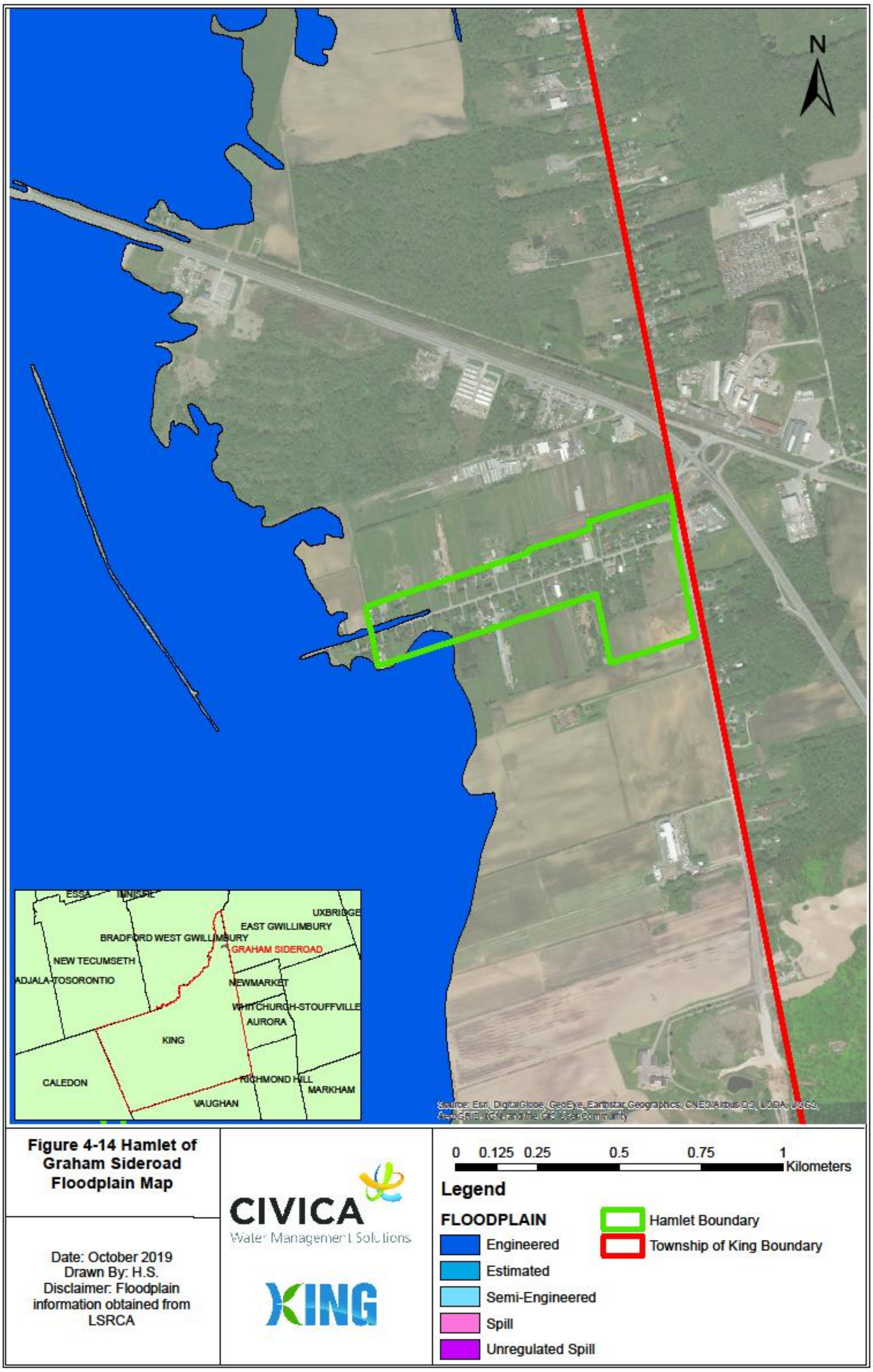


Figure 4-14: Graham Sideroad Floodplain Mapping



4.8 Potential Restoration Opportunities

As a part of the characterization component of the CSWMMP study, the LSRCA's Comprehensive Stormwater Management Master Plan Guidelines (2011) requires the identification of restoration and enhancement areas. To identify these potential restoration opportunities throughout the Township, several planning and policy documents were reviewed, including:

- York Region Official Plan (2010);
- Township of King Official Plan (2019);
- Lake Simcoe Protection Plan (2009);
- Natural Heritage System & Restoration Strategy for the Lake Simcoe Watershed (LSRCA, 2018);
- East Holland River Subwatershed Plan (LSRCA, 2010a);
- West Holland River Subwatershed Management Plan (LSRCA, 2010b);
- York Region Subwatershed Implementation Plan (LSRCA, 2013b);
- Humber River State of the Watershed Report – Aquatic System (TRCA, 2008b);
- Humber River State of the Watershed Report – Terrestrial System (TRCA, 2008c);
- Humber River Watershed Plan: Pathways to a Healthy Humber (TRCA, 2008d);
- Oak Ridges Moraine Conservation Plan (2017);
- Greenbelt Plan (2017); and,
- Growth Plan for the Greater Golden Horseshoe (2017).

This review included identifying specific restoration locations and strategies that these documents recommend. The following section provides a summary of the information compiled as well as recommendations for the Township's CSWMMP.

4.8.1 Restoration Strategies

A few common restoration strategy themes were identified during the review of the planning and policy documents. These themes included:

- Maintain, protect, restore/enhance/improve the health, diversity, and size of connections between Core Areas, Key Natural Heritage Features (KNHFs) and Key Hydrologic Features (KHFs) by identifying linkages and restoring/enhancing natural heritage features and linkages.
    - Connections between natural heritage features that are less than or equal to 50 m is a priority set out in the Lake Simcoe Watershed Restoration Strategy (LSRCA, 2018).
- Increase natural cover across all planning areas, including increasing streambank vegetation/ riparian vegetation, woodland cover, interior forest habitat, grassland communities, upland communities, and wetlands.
- Maintain, protect, and improve the ecological function of the Natural Heritage System, Core Areas, Linkages, KNHFs and KHFs throughout all planning areas.
- Protect and restore surface water quality.
- Design restoration projects based on specific physical conditions of the site and with Flora and Fauna diversity in mind.
- Development and site alteration proposals are required to identify VPZs and include restoration/enhancement of these areas in design plans.

- Focus on east-west connections between natural heritage features throughout all planning areas.

Other equally important but less common restoration strategies in the planning and policy documents reviewed include:

- Improve aquatic ecological function through the removal of fish barriers, the use of natural channel design techniques, restoring lost or impaired floodplain function and wetland creation (LSRCA, 2010b).
- Increase the size and improve the shape of existing terrestrial habitat patches (TRCA, 2008c).
- Restoration activities can include tree plantings, wetland creation, meadow marsh habitats with wildlife supporting features (bird boxes, snake hibernacula, amphibian refuges, etc.), replacement of plantation species with native species through succession, natural succession without human intervention, native species plantings, etc.

4.8.2 Specific Restoration Locations

Several documents reviewed included specific recommendations for the location of restoration and enhancement activities. None of these documents included mapping or site-specific analysis, particularly for identifying linkages and VPZs; the Natural Heritage System is mapped as a solid colour with no differentiation for linkages and VPZs. As such, each of these areas must be identified at the local scale, through consultation with the relevant agencies, localized analysis, and application of the relevant policies for VPZs. The following is a list of recommended locations for restoration and enhancement activities identified in the policy and planning documents that were reviewed:

- Linkages;
- VPZs and locations where VPZs are reduced as part of development and/or site alteration projects;
- Areas within KNHFs and KHFs where natural vegetation has been removed;
- Areas within 30m of Lake Simcoe, other lakes, permanent or intermittent watercourses, and wetlands;
- More generally, along watercourse corridors, riparian areas, and floodplains;
- Within the Holland Marsh, by working with landowners in the area; and,
- Old fields and manicured areas.

Within floodplains, specific comments in the documents suggested improving aquatic habitat by increasing natural cover and shading to reduce water temperatures, where appropriate, creating wetlands to improve water storage and filtration in the floodplain, and increasing the size/width of natural heritage features.

Specific to riparian areas, specific comments in the documents suggested increase natural cover to specifically target Redside Dace, Brook Trout, and other significant and sensitive aquatic species specific to the local area.

4.8.3 Recommendations for the CSWMMP

Once new SWM facility and retrofit locations are established as part of this CSWMMP, opportunities for restoration at each location should be explored. Opportunities could include native species plantings in

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VPZs, floodplains, and riparian corridors, in linkages or potential linkages, and widening Core Areas with plantings around the edge of features.

Species selection should be focused on native species, local to the watershed and should be geared towards the specific type of natural feature (woodland/wetland/watercourse/grassland, etc.), and local species present, including plant and wildlife species. Plantings should be chosen to support significant or sensitive species known or reported within the area (e.g., Redside Dace, Brook Trout, grassland bird species, interior forest species, reptiles, and amphibians, etc.). Plantings should also be self-sustaining and promote succession without human interference. Restoration of natural heritage features and areas adjacent to the proposed SWM facilities and retrofits should be included as a required element of detailed design and construction.

Restoration and enhancement also includes maintaining, or improving water quality and water temperatures for cold water systems (i.e. using technologies to reduce SWM effluent temperature discharge into cool or cold water systems, such as cooling trenches, underground cooling chambers, cooling towers, providing shading, increasing permanent pool depth, orienting a facility to minimize the duration of sun exposure) and by meeting specific water quality targets outlined by the LSRCA and TRCA in their SWM design documents.

Dissolved oxygen (D.O.) levels in SWM effluent should be addressed in the detailed design of retrofits and new treatment facilities. Where D.O. is not sufficient to support aquatic species, mitigation measures should be designed and implemented. Methods of satisfying D.O. requirements could include increasing the roughness of SWM discharge outlets (e.g., discharge directed over areas of riprap or other high roughness features to mix and incorporate oxygen into the water column), limiting bottom draw systems where anoxic conditions are more likely to occur, including elevation drops in discharge design and flow paths to receiving waters, outlet baffles, etc.). D.O. in SWM effluent and other water quality requirements should meet the conditions of the aquatic community at each specific location. For watercourses with Redside Dace habitat, the Redside Dace Recovery Strategy outlines targets for D.O. during and after construction. Similar documents may be available for other significant or sensitive species. Surveys to determine the composition of the aquatic community should be conducted at the EIS or detailed design stage to inform the specific design requirements for each SWMF and retrofit.

Erosion and sediment control and erosion protection are key elements to maintaining the ecological function, health, and stability of receiving systems. SWM designs and retrofits should include these to ensure sedimentation and erosion do not increase in receiving water bodies as a result of SWM discharge. Erosion and Sediment Control Guidelines from the TRCA and LSRCA should be followed during design and construction of the SWM facilities and retrofits.

4.9 Data Gap Analysis

Although a large amount of data was provided by the Township and regulating agencies, some gaps are still present. The following gaps were identified during the gap analysis that will either be useful or required for more detailed studies and further work for locating and designing new SWM facilities. The identified data gaps are presented in **Table 4-17**.

Table 4-17: Identified Data Gaps

Relevance	Data
Groundwater Protection	• Significant Groundwater Discharge Areas
Natural Heritage	• Ecological Land Classification verification for areas where data is available. Field surveys and mapping for areas that do not have background information • Natural feature boundary delineations • Driplines for woodlands • Site specific Redside Dace Occupied and Contributing habitat information from the MECP • Site specific wildlife field surveys and SWH analysis
Stormwater Management	• Missing SWMF data

Significant groundwater discharge mapping is the only gap identified that is beneficial for constraint analysis. This information can be requested through the Oak Ridges Moraine Groundwater Program. The remaining data is not required for this high-level study but will be important for site specific projects and more detailed studies moving forward.

As some information for the SWMFs was unavailable, it is recommended that the Township conduct component inspections and surveys to complete the SWMF inventory. Seven (7) ponds were identified where no information was available. Other ponds are missing information that is important for modelling purposes (i.e., storage discharge curves, permanent pool elevations, etc.).

5.0 Management Units

This study follows a landscape-based approach, where studying and understanding the landscape features and functions within the Township permits areas with shared characteristics to be grouped into discrete management units (MU). Understanding the SWM practices and criteria in each governing CA's lands can help to assess the environmental impacts of stormwater and provide recommendations to minimize them. Documents such as the Township's Official Plan (2019), East and West Holland Subwatershed Plan and the Humber River Hydrology Report were used to ascertain the following two management units:

Management Unit 1 (MU1): Lake Simcoe Watershed (LSRCA)

- **Holland River Subwatershed**
  - **Village Areas:** *Schomberg*
  - **Hamlet Areas:** Snowball, Kettleby, Pottagville, Lloydtown, Ansnorveldt, Graham's Side Road
  - **Rural, Agricultural and Natural Land**

Management Unit 2 (MU2): Humber River Watershed (TRCA)

- **Main and East Humber Subwatershed**
  - **Village Areas:** *King City, Nobleton*
  - **Hamlet Areas:** *Laskay*
  - **Rural and Agricultural areas**

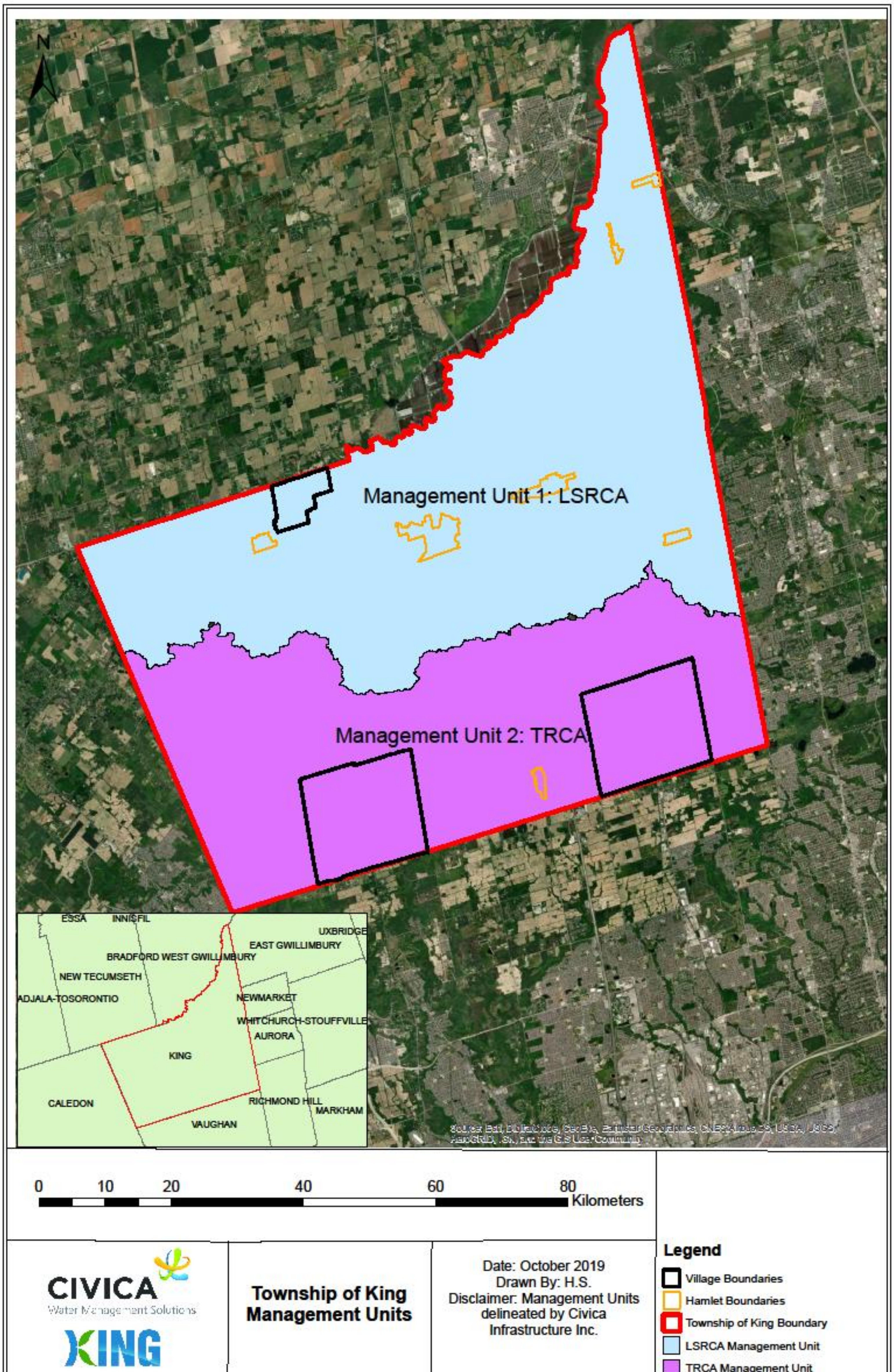
The division of the Township into the two management units is determined based on the shared characteristics of the lands within each watershed. The two management units fall under separate Conservation Authorities with different stormwater design guidelines. Therefore, the lands within these management units have shared characteristics as well as constraints such as:

- Stormwater management criteria
- Landuse Classifications
- Built-up environment in existing areas
- Planned SWM works in new development areas
- Sensitive natural features

Remediation and retrofit opportunities can be analyzed on a more specific scale using the above management units. The settlement areas within the Township are shown in **Figure 1-2** and the management units are presented in **Figure 5-1**.

The emphasis of the environmental impact assessment in Section 6.0 will be focused on the settlement areas and new development areas where the greatest change in impervious areas occur. Subsequent tasks will be governed by the criteria and specific requirements set out for each management unit.

Figure 5-1: Management Units



6.0 Evaluation of the Cumulative Environmental Impact of Stormwater

6.1 Background

Policy 4.5-SA in the Lake Simcoe Protection Plan outlines that the cumulative impacts of stormwater from existing and planned future development identified from the Township's 2019 Official Plan must be evaluated.

6.2 Land Use Changes

6.2.1 Existing and Future Land Use

The Township is primarily rural with its urban development concentrated mainly in the settlement areas of King City, Nobleton and Schomberg. The land use classification names vary depending on the governing conservation authority; however, the general land use classes are similar within the Township (i.e., industrial, residential, commercial, etc.). Land use classifications are presented in **Table 4-1** and **Table 4-2** for the TRCA and LSRCA, respectively.

Future land use and development was identified using the Township's updated 2019 Official Plan. Aerial imagery was used to confirm areas proposed for future development. All proposed development and changes in land use are concentrated in the Villages of King, Nobleton and Schomberg.

6.3 Model Objectives

A hydrologic model is established to represent the watershed in the Township and analyze the increase in runoff volumes and peak flows caused by proposed development under precipitation events. Since the Township resides in two watersheds consisting of different soil types and stormwater criteria, therefore, two hydrologic models have been created to replicate the different stormwater runoff responses in the Humber River watershed and the Holland River watershed. The objectives of the hydrologic models are to assess the effects of stormwater on water balance, water quantity and water quality under the following situations:

- Existing conditions; and
- Post development conditions that would exist after all proposed development was completed.

A comparison of the environmental impacts due to stormwater with respect to peak flows, infiltration, suspended solids and phosphorus loading will be examined in the following sections and set the targets for meeting stormwater runoff treatment demands.

6.4 Model Development

In order to determine the environmental effects of stormwater, it was first necessary to develop a hydrologic model that would imitate the existing conditions within the Township. Two separate models were created for the Township, one encompassing the area under jurisdiction of the TRCA and one for the LSRCA. The existing conditions model would then be updated to reflect future conditions using the proposed future development identified in the Township Official Plan. Since a hydrologic model for the Township did not exist, a new model was developed using Visual OTTHYMO (VO) Version 6.0. VO allows for the user to input hydrologic features such as catchment areas, SWMFs and rivers, parameterize them, and input storm events to obtain information such as peak flows, infiltration measurements, etc. The modelling parameters that were applied in the development of the model are described below:

- StandHyds
    - An area input command used to simulate runoff flows from mainly urban (impervious) areas
- NasHyds
    - An area input command used to simulate runoff flows from mainly rural (pervious) areas
- AddHyds
    - An input command that combines flows from two (2) or more areas together
- Route Reservoir
    - A command used to model stormwater management facilities;
    - A rating curve can be input to represent the storage-discharge relationship of the facility.

Catchment areas from the Humber River Hydrology Model were modified as the existing catchment areas were broad and did not allow for accurate analysis of specific areas within the Township. Catchment areas were discretized based on a combination of three factors:

- Stormwater Controls (i.e., culverts, SWMFS and etc.);
- Land Use Classifications (i.e., employment, industrial and etc.)
- Contour Data

Catchment areas were discretized using SWM control such as SWMFs and culverts so that the model could analyze the amount of flow from a catchment outletting into the specific control structure. For example, if the runoff in a residential area drained into a SWMF, the catchment area would encompass the residential area with the outlet being the SWMF. The land use classifications were used to discretize the catchments and analyze the runoff produced by that specific land use based on the runoff coefficients defined in the stormwater guidelines for both the TRCA and LSRCA. The model was discretized so that it would allow the user to isolate and compare flows from increased development within each study area.

The discretized catchments were exported into VO and converted into NasHyds and StandHyds as necessary. The “Route Channel” command along with a shapefile containing all the channels within the Township were used to connect the catchment areas and build the overall storm network. The SWMFs were modelled using the “Route Reservoir” command. Each SWMF had a corresponding storage discharge relationship obtained from the background review portion of the study. In the case that a facilities storage discharge relationship was unavailable, field survey of the active storage of the pond was completed, and a storage discharge relationship was developed and input into the VO model. VO software requires input of the land cover and soil type for each catchment area to reflect the existing conditions and estimate values for the following parameters:

- Curve number (CN),
- Initial abstraction (IA),
- Time to peak (T_p),

- Percent total impervious (TIMP), and
- Percent directly connected impervious (XIMP)

CN values were estimated using the Modified SCS Curve Method. A shapefile containing the soil series and type within the Township and the existing land use shapefiles for the TRCA and LSRCA were input into VO for estimating CN values. Since multiple soil types and land uses could exist within a single catchment, the area weighted CN was calculated for each catchment area.
Similarly, the IA value was determined using the Modified SCS Curve Method. The existing land use shapefile for the TRCA and LSRCA was used and standard IA values for each land use designation (i.e., industrial, residential, natural heritage system, etc.) were input into the VO software. Since multiple land uses could exist within a single catchment, the area weighted IA was calculated for each catchment area.
The T_p value for each NasHyd was calculated using the Bransby-William's Formula:

$$t_p = \frac{0.14465L}{{S_w}^{0.2}A^{0.1}}$$

where:

t_p = time to peak (*min*)
L = catchment length, (*m*)
S_w = catchment slope (*%*)
A = catchment area (*ha*)

The VO software contains GIS tools which use contour data, digital elevation models, and area calculating tools to estimate catchment length (L), catchment slope (S_w) and catchment area (A) once catchment areas have been developed.

For each StandHyd command representing an urban or developed catchment area, TIMP and XIMP values were estimated in each catchment area by using an area-weighted calculator tool in the VO software. The VO software delineates the percentage of area a specific landuse classification represents within a single catchment. Standard TIMP and XIMP values are designated for each landuse classification represented within the model. The VO software used the area-weighted method to estimate the weighted TIMP and XIMP values for each catchment area based on the percentage of each landuse reflected in the catchment.

Upon completion of the existing conditions model, the future conditions model was completed by duplicating the existing conditions model and updating the area commands identified with future development from NasHyds to StandHyds. The shapefiles containing the existing land use for the LSRCA and TRCA were modified to reflect the land use changes from the 2019 Township Official Plan for the future condition's scenario. The future conditions scenario model was then parameterized like the existing conditions model.

Water quantity analysis (i.e. peak flows) was conducted using the 1:2 to 1:100 year design storms and the Hurricane Hazel regional storm event as per Policy 6.4 of the LSRCA's Development Policies. To determine water balance and water quality, it was necessary to obtain continuous rainfall and minimum and maximum temperature data for input into VO. Historical rainfall monitoring data was obtained from the TRCA and was selected based off the proximity of the rain gauge to the study area and how complete the data was. For this study, four (4) years of data was collected. After reviewing the data from various rain gauges located around the study area, rain gauge HY083 located at Yonge Street and King Road was selected because it contained the most complete annual data. Minimum and maximum temperature data was also collected from this gauge. The climate data was input, and the model run and further analyzed to obtain output results.

6.5 Modelling Results

The VO model was simulated using updated design storm rainfall intensity IDF curves which consider the affects of climate change presented in **Table 6-1.** The continuous model was developed using the four years of data available from rain gauge HY083 as mentioned in section 6.4 above**.** The results analyzed in the model for water quantity, water balance, and water quality are discussed in the following sections. These results help define the design targets resulting from increased runoff that must be addressed through the stormwater master plan process. The analysis location for each settlement area is chosen at a point downstream of the settlement area which would best reflect the change in environmental factors being analyzed. The locations chosen for analyzing the environmental factors of stormwater runoff are identified in **Figure 6-1.**

6.5.1 Water Quantity

For stormwater management purposes, the results of the single event flow model for storm events ranging from the 2-year design storm to the Regional Storm event is summarized below in **Table 6-2**. The table identifies the differences between existing peak flows and modelled future peak flows for each storm event. Three (3) flow nodes were chosen at outlet points from the Villages of King City, Nobleton and Schomberg; where future development was identified. These outlet points were chosen for analysis because the change in land use would affect the peak flows at these locations and the difference between existing and future peak flows could be quantified. The flow node locations for each settlement area are identified in **Figure 6-1**Error! Reference source not found.. The difference between the existing peak flows a nd the future increase peak flows becomes the measurable design target that must be addressed to control post-development flows back to their original pre-development flows. The resulting volume required to reduce peak flows will be required to be stored on-site future developments.

The model results showed that the Village of King City experienced the greatest increase in peak flows for all design storm scenarios. The increase in peak flow rates was examined at all flow points designated in the VO model under each storm scenario. The increase in peak flows is expected due to the intensification of urban areas within the villages which results in a higher percentage of impervious surfaces. Best management practices are required to mitigate the increase in peak flows and meet pre-development flow conditions. Recommendations for these BMPs are discussed in section 9.0 of this report.

6.5.1.1 Erosion Control

Increased peak flows result in the potential for increased erosion and degradation of watercourses. The increase in peak flows observed in the model from future development must be attenuated on-site for 24-48 hours in order to minimize any downstream erosion resulting from future development.

6.5.1.2 Climate Change Scenario

Resilience, adaptation, and mitigation to climate change has now become an integral part of stormwater management design and implementation. Most stormwater infrastructure is designed assuming that historical climate is a good predictor of future events, however, it is now understood that this is not the case and that SWMFs must be designed or retrofitted to consider the effects of climate change. The climate change scenario was set up to quantify the peak flow increase as a result of climate change. To complete this analysis, the IDF_CC Tool 4.0 developed by the University of Western Ontario was utilized. The purpose of the tool is to update the IDF curves under changing climate conditions. The tool uses future emission scenarios known as Representative Concentration Pathways (RCPs) to update the IDF curves under climate change conditions. For this analysis, the worst-case scenario was assumed, and RCP 8.5 was considered. **Table 6-1** below shows the updated IDF curve for the 1:2 to 1:100-year storm events.

Table 6-1: Updated Design Storm IDF Curves Considering Climate Change Conditions (RCP 8.5)

T (years)	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
2	122.82	92.07	76.52	46.1	26.63	15.68	6.48	3.94	2.35
5	160.92	129.07	109.61	68.09	38.27	21.13	8.76	5.33	3.3
10	182.78	150.63	128.42	83.17	47.17	25.34	10.76	6.38	3.92
25	211.13	178.29	152.23	104.15	59.79	31.24	14.18	7.88	4.78
50	230.58	197.58	168.69	120.41	70.48	36.27	17.49	9.13	5.44
100	246.4	213.6	181.8	136.83	81.91	41.62	20.71	10.46	6.08

Note: IDF values in this table represent intensity in mm/hr

The IDF curve information was uploaded into the VO model and was converted to precipitation events respective to their return period. 24-hour events in 10-minute intervals (i.e. 2 Year 24 Hour Chicago Storm) were obtained through VO software and were used to simulate the future conditions model. The results of the model are presented in **Table 6-3**. The results show that the peak flows and runoff volumes increase under climate change scenarios which serve as measurable targets for stormwater runoff control.

Figure 6-1: Model Analysis Location

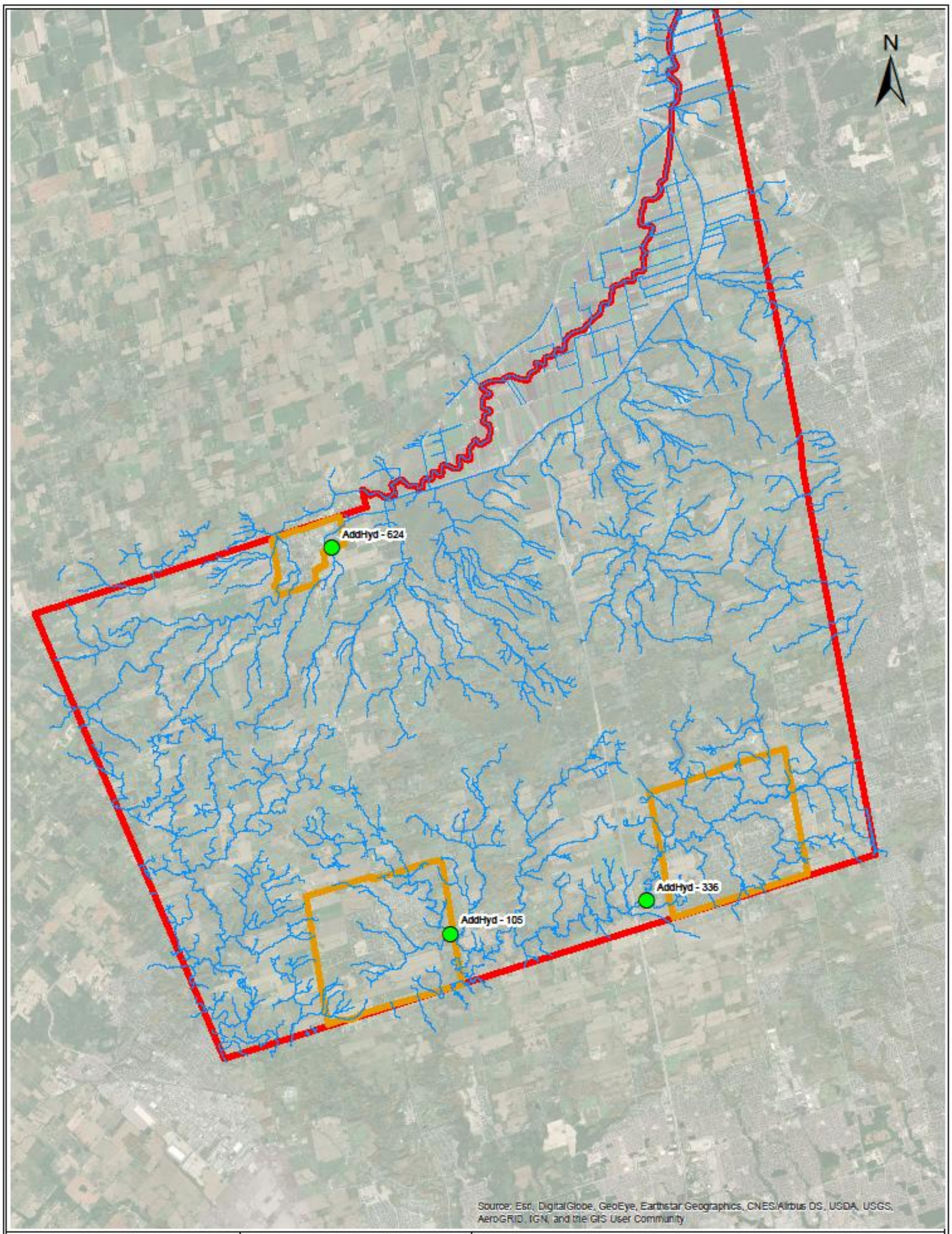


Figure 6-1
Model Analysis Location

Date: April 2021
Drawn By: J.K.
Disclaimer: Floodplain information obtained from TRCA.

0 1.25 2.5 5 7.5 Kilometers

Legend

- Analysis Location
- Watercourse
- Village Boundary
- Township of King Boundary

Table 6-2 - Existing and Future Flows

Village	Flow Point	Total Contributing Drainage area (Ha)	Type of Simulated Peak Flow	Peak Flows (m3/s) under Design and Regional Storms						
				2 year	5 year	10 year	25 year	50 year	100 year	Regional
Nobleton	**AH105**	1854.55	Peak Flow - Existing (m3/s)	15.36	23.94	29.82	37.48	43.28	49.19	77.67
			Peak Flow - Future (m3/s)	16.57	25.14	31.14	38.90	44.63	50.59	80.50
			Peak Flow Difference (m3/s)	1.21	1.20	1.32	1.42	1.35	1.39	2.83
			Peak Flow Difference (%)	7.88	5.03	4.44	3.79	3.12	2.83	3.65
King City	**AH336**	6159.92	Peak Flow - Existing (m3/s)	44.42	67.44	84.25	106.53	123.30	140.80	234.27
			Peak Flow - Future (m3/s)	50.26	74.13	91.22	113.59	130.86	148.72	243.46
			Peak Flow Difference (m3/s)	5.84	6.69	6.97	7.06	7.56	7.92	9.19
			Peak Flow Difference (%)	13.15	9.92	8.27	6.63	6.13	5.63	3.92
Schomberg	**AH602**	2651.59	Peak Flow - Existing (m3/s)	14.09	22.49	28.64	37.00	43.60	50.37	85.25
			Peak Flow - Future (m3/s)	14.10	22.50	28.64	37.02	43.62	50.39	85.30
			Peak Flow Difference (m3/s)	0.01	0.02	0.00	0.02	0.02	0.02	0.04
			Peak Flow Difference (%)	0.05	0.08	0.01	0.05	0.05	0.05	0.05

Table 6-3 - Peak Flows Adjusted to Climate Change Conditions

Village	Flow Point	Drainage Area (Ha)	Type of Simulated Peak Flow	Peak Flows m^3/s Under Design Storms					
				2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Nobleton	105	1854.55	Peak Flow - Future (m3/s)	25.48	42.03	55.46	76.93	93.97	112.12
King City	336	6159.92	Peak Flow - Future (m3/s)	69.04	115.98	155.61	216.12	270.26	326.89
Schomberg	602	2651.59	Peak Flow - Future (m3/s)	19.10	35.09	48.48	68.97	87.39	109.86

6.5.2 Water Quality

Water quality (i.e. suspended solids and phosphorus) was assessed for both the existing and future conditions scenario in the Township. An increase in the generation of suspended solids and phosphorus is expected due to the changes in land use from low to higher export lands. To calculate the annual suspended solids and phosphorus loading for pre- and post-development conditions, it was first necessary to input event mean concentrations for different land uses across the Township that the model could reference. Standard event mean concentrations were obtained for the TRCA and LSRCA and are presented in **Table 6-4** and **Table 6-5,** respectively.

Table 6-4 - TRCA Event Mean Concentrations

Land Cover	TSS (mg/L)	TP (mg/L)
Aggregate Extraction	177	0.33
Agricultural	100	0.23
Airport	201	0.25
Beach/Bluff	0	0
Cemetery	176	0.13
Commercial	201	0.25
Estate Residential	132	0.4
Forest	55	0.23
Golf Course	100	0.32
High Density Residential	132	0.4
Industrial	177	0.33
Institutional	91	0.21
Lacustrine	0	0
Landfill	177	0.33
Meadow	55	0.23
Medium Density Residential	132	0.4
Mixed Commercial	201	0.25
Railway	114	0.43
Recreational/Open Space	27	0.2
Riverine	0	0
Roads	90	0.23
Rural Residential	132	0.4
Successional Forest	55	0.23
Vacant Land	27	0.2
Wetland	13	0.81

Table 6-5 - LSRCA Event Mean Concentrations

Land Use	TSS (mg/L)	TP (mg/L)
Commercial	201	0.25
Employment	201	0.25
Estate Residential	132	0.4

Land Use	TSS (mg/L)	TP (mg/L)
Industrial	177	0.33
Institutional	91	0.21
Intensive Agriculture	100	0.23
Manicured Open Space	27	0.2
Natural Heritage Feature	55	0.23
Non-Intensive Agriculture	100	0.23
Rail	114	0.43
Road	90	0.23
Rural Development	132	0.4
Urban	132	0.4
Utility	177	0.33

Similar to the water quantity assessment, total suspended solids and total phosphorus loading was determined for the three flow nodes at the final outlet point of each village to be able to quantify the loading changes under existing and future development conditions. **Table 6-6** and **Table 6-7** below summarize the pre- and post-development total suspended solids and phosphorus loading changes, respectively. The increased pollution concentration found in surface runoff must be treated to establish the satisfactory level of quality control.

As expected, there is an increase in the suspended solids and phosphorus loading in the post development scenario due to the intensification of urban areas. The village of King City experiences the largest increase in suspended solids and phosphorus loading because King City has more development planned in comparison to Schomberg and Nobleton. The changes in loading presented in **Table 6-6** and **Table 6-7** represent the target TSS and TP removal level in each settlement area that must be satisfied when developing alternative SWM solutions.

Table 6-6 - Total Increase in Suspended Solids

Pre-Development vs. Post-Development Total Suspended Solids								
Village	Node ID	Drainage area (Ha)	Pre-development Conditions		Post-development Conditions		Change in Annual Suspended Solid Loading	
			Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)
Nobleton	AH105	1854.55	731715.00	394.55	789706.16	425.82	+ 57991.16	+ 31.27
King	AH336	6159.92	2031294.70	329.76	2224818.60	361.18	+ 193523.90	+ 31.42
Schomberg	AH602	2651.59	713291.64	269.01	719238.00	271.25	+ 5946.36	+ 2.24

Table 6-7 - Total Increase in Phosphorus Loading

Pre-Development vs. Post-Development Total Phosphorus								
Village	Node ID	Drainage area (Ha)	Pre-development Conditions		Post-development Conditions		Change in Annual Total Phosphorous Loading	
			Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)
Nobleton	AH105	1854.55	2335.50	1.26	2496.50	1.35	+ 161.00	+ 0.09
King	AH336	6159.92	6930.20	1.13	7563.17	1.23	+ 632.97	+ 0.10
Schomberg	AH602	2651.59	1908.70	0.72	1927.20	0.73	+ 18.50	+ 0.01

6.5.3 Water Balance

The increase in impervious area from urban development will change the natural hydrological cycle with an increase in surface runoff and decrease in infiltration. The increase in surface runoff is generally accompanied by larger peak flows, greater volume of flows and a change in the duration of peak flows. Impacts experienced in the watershed from increased runoff and decreased infiltration are environmental issues such as increased flooding, decreased water quality, erosion, and degradation of aquatic habitats. A water balance model was constructed to simulate existing and future watershed conditions.

Four years of continuous precipitation and minimum and maximum temperature data were input into the model to estimate rainfall and evapotranspiration values. Within the Township, soils are mainly clay loams and sandy loams. The soils have been used along with the other parameters for land use to allow the model to calculate a water balance scenario based on the typical infiltration rates of the soils present in the study area. The model was simulated, and an overall average infiltration was obtained. Three flow points located at the overall outlet of each of the villages were selected as touch points to quantify the changes in infiltration in the existing and future development conditions. The water balance results can be seen below in **Table 6-8**.

Based on the water balance assessment, a general increase in runoff will occur during the post-development scenario with a reduction in infiltration. The largest decrease in infiltration occurs within the villages of King City and Nobleton as these two areas will experience the greatest amount of development. Use of Low Impact Development techniques will be investigated to mitigate the loss of infiltration from the proposed land use changes. Recommendations for typical LIDSs are discussed in Section 10.0 below.

Table 6-8 - Water Balance Results

Village	Node ID	Drainage area (Ha)	Pre-development Conditions		Post-development Conditions		Infiltration Deficit	
			Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m³/yr)	Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m³/yr)	Depth (mm/yr)	Volume (m³/yr)
Nobleton	AH105	1854.55	365.43	6777133	349.29	6477697	16.15	299435
King	AH336	6159.92	429.52	26458328	412.94	25436758	16.58	1021570
Schomberg	AH602	2651.59	486.21	12892401	484.27	12840854	1.94	51546

7.0 Determine the Effectiveness of Existing SWM Systems

As a part of Policy 4.5 SA of the Lake Simcoe Protection plan outlines that an analysis of the effectiveness of the existing SWM facilities is required to assess the capabilities to reduce the negative impacts of stormwater on the environment. There are approximately 28 SWM facilities which are owned and operated by the Township of King with facilities being constructed as early as 1994 to as recent as 2019. The main types of facilities within the Township include:

- Dry ponds (4) – provide water quantity control
    - designed to drain runoff following a storm event
- Wet ponds (24) – provide water quantity, quality, and erosion control
    - provides temporary storage of stormwater as well as permanent storage through the permanent pool

Also located in the Township is a natural channel (KTPO_0014). This channel was inspected to locate a control structure that would provide water quantity control. A control structure was not present; therefore, it was assumed that this pond was a natural channel that did not provide any control.

The main objective of to determine the effectiveness of existing SWM systems was to determine the efficiency of these existing facilities to remove sediment and to determine the approximate level of sediment within the facilities to prioritize them based on their need for maintenance. An approximate cost for remediation will also be determined for the prioritized facilities. A lack of inspection and maintenance of these facilities has caused for some issues to arise within the Township. For example, downstream of facility NTPO_0001 in the Village of Nobleton, flooding issues have arisen, which could be explained by a lack of maintenance of the facility and its components (i.e. outlet structures). This was also taken into consideration when analysis was conducted to prioritize the facilities for maintenance needs.

Facility inspections were completed to provide conditions assessments for components of each facility to identify non-functional components or potential safety hazards that affect the effectiveness of the existing SWM systems. These condition assessments are presented in **Appendix O** and should be referenced when considering operation & maintenance planning for the facilities in the Township.

Restoring these SWMFs to their original design function will help to reduce the potential for flooding on public/private property, reduce degradation to the environment downstream and help to extend and maximize the lifespan of the facilities. Retrofitting opportunities will also be discussed in Section 9.0 for facilities where complete restoration is not necessary.

7.1 Sediment Volume Analysis

Sediment volume analysis was conducted for all wet ponds within the Township to determine the effectiveness and level of suspended solids (SS). The dry ponds were not analyzed as they are only used for quantity control. It must be noted that the analysis conducted resulted in an approximate volume of SS in the facilities. To determine the actual volume of SS in each facility, detailed inspection and bathymetric surveys must be conducted and was not within the scope of this study.

The hydrologic model was used along with the four years of continuous precipitation data to determine the volume of SS in each pond individually. The mass of SS inflow and outflow in the facility was output from the model and the difference between these two values resulted in the total mass SS in each facility for the four years of analysis. To obtain an approximate average annual SS mass, the total mass of SS was divided by the number of years of data used in the model. The age of each facility was determined and multiplied by the average annual SS mass to determine an approximate total mass of SS build up in the facility since it was built. To obtain the volume of SS, a dry sediment bulk density of 780 kg/m^3 (Poesen et al., 2000) was used. **Table 7-1** below summarizes the results of the sediment volume analysis for the SWM facilities in the Township. The calculations performed to determine the volume of sediment in each facility are based on standard TRCA and LSRCA loading values based on the landuse types in the contributing area. The loading values and settling capacity of each SWM facility varies and may not represent the actual sediment volume accumulation in each facility. Therefore, detailed bathymetric surveys are required to determine the volume of sediment in each facility.

Table 7-1 – Facility Sediment Volumes

Number	Facility ID	Facility Type	Node ID	Year Constructed	Average SS_{in} (kg)	Average SS_{out} (kg)	Total Sediment Volume (m^3)
1	KTPO_0001	Dry Pond	RR359	2015	7305.29	7305.29	N/A
2	KTPO_0002	Wet Pond	RR355	2016	1031.99	257.46	3.97
3	KTPO_0003	Dry Pond	RR356	2016	329.74	329.52	N/A
4	KTPO_0004	Dry Pond	RR357	2016	389.25	389.03	N/A
5	KTPO_0005	Wet Pond	RR351	2011	3271.28	817.82	31.45
6	KTPO_0006	Wet Pond	RR352	2011	2971.85	742.96	28.57
7	KTPO_0007	Wet Pond	RR362	2012	13569.77	3373.23	104.58
8	KTPO_0008	Wet Pond	RR363	2012	7804.96	7774.43	0.31
9	KTPO_0009	Wet Pond	RR350	2015	12653.16	1594.87	70.89
10	KTPO_0010	Wet Pond	RR353	2011	13491.42	3364.69	116.85
11	KTPO_0011	Wet Pond	RR354	2011	8326.39	1000.96	84.52
12	KTPO_0012	Wet Pond	RR361	2012	39634.77	8292.48	321.46
13	KTPO_0013	Wet Pond	RR360	2012	4935.61	1232.65	37.98
14	KTPO_0014	n/a	n/a	n/a	n/a	n/a	n/a
15	NTPO_0001	Wet Pond	RR130	>20 years	52414.37	9522.31	1099.80
16	NTPO_0002	Wet Pond	RR21	1996	8909.81	2231.46	205.49
17	NTPO_0003	Wet Pond	RR29	2011	14732.94	3682.74	127.50
18	NTPO_0004	Wet Pond	RR8	>20 years	425.31	106.33	8.18
19	NTPO_0005	Wet Pond	RR10	2010	6430.15	1605.17	61.86
20	NTPO_0009	Wet Pond	RR9	2010	23294.46	5813.85	224.11
21	NTPO_0006	Wet Pond	RR7	2010	36275.41	9066.25	348.84
22	NTPO_0007	Wet Pond	RR32	2015	54297.40	7937.16	297.18
23	NTPO_0008	Dry Pond	RR18	1996	6294.06	1573.51	145.25
24	NTPO_0011	Wet Pond	n/a	2019	n/a	n/a	n/a
25	STPO_0001	Wet Pond	RR766	2011	14538.97	0.00	167.76

Number	Facility ID	Facility Type	Node ID	Year Constructed	Average SS_{in} (kg)	Average SS_{out} (kg)	Total Sediment Volume (m^3)
26	STPO_0002	Wet Pond	RR767	2009	60108.72	2701.62	809.59
27	STPO_0003	Wet Pond	RR763	2000	4819.93	1201.39	92.78
28	STPO_0004	Wet Pond	RR764	2003	16763.70	1617.66	330.11
29	STPO_0005	Wet Pond	RR765	2006	10407.16	209.00	183.04
30	OTPO_0001	Dry Pond	n/a	2005	n/a	n/a	n/a
31	OTPO_0002	Wet Pond	n/a	2005	n/a	n/a	n/a

7.2 Prioritization of Improvement Works

7.2.1 Water Quality

The methodology outlined in section 7.1 above was used for calculating the sediment volume in each facility. The volume of sediment in the facility was than compared to the original permanent pool design volume to estimate the percent full of the facility (i.e., Percent Full = Sediment volume/design volume *100%). the higher the percent full of a facility, the less the facility performs to its design function. A pond cleanout is typically triggered once a facility is determined to be 50% full and perform to half of its original design capacity. **Table 7-2** prioritizes facility cleanouts from highest priority to lowest priority based on the percentage of available storage. For example, Nobleton SWM Pond NTPO_0002 has the highest priority for cleanout since the facility is more than 70% full of sediment which can cause flooding and create water quality and erosion issues downstream of the facility.

Table 7-2 – Facility Cleanout Prioritization

Pond Cleanout Priority Number	Facility ID	Facility Type	Node ID	Year Constructed	Total Sediment Volume (m³)	Permanent Pool Volume (m³)	Permanent Pool Storage Remaining (m³)	% of Storage Remaining
1	**NTPO_0002**	**Wet Pond**	**RR21**	**1996**	205.49	280	74.51	26.61
2	**NTPO_0001**	**Wet Pond**	**RR130**	**>20 years**	1099.8	2330	1230.2	52.8
3	**STPO_0004**	**Wet Pond**	**RR764**	**2003**	330.11	750	419.89	55.99
4	**STPO_0005**	**Wet Pond**	**RR765**	**2006**	183.04	450	266.96	59.32
5	**STPO_0003**	**Wet Pond**	**RR763**	**2000**	92.78	644	551.22	85.59
6	**STPO_0002**	**Wet Pond**	**RR767**	**2009**	809.59	5624	4814.41	85.6
7	**STPO_0001**	**Wet Pond**	**RR766**	**2011**	167.76	1708	1540.24	90.18
8	**NTPO_0009**	**Wet Pond**	**RR9**	**2010**	224.11	2850	2625.89	92.14
9	**NTPO_0003**	**Wet Pond**	**RR29**	**2011**	127.5	2057	1929.5	93.8
10	**NTPO_0006**	**Wet Pond**	**RR7**	**2010**	348.84	6000	5651.16	94.19
11	**KTPO_0011**	**Wet Pond**	**RR354**	**2011**	84.52	1528	1443.48	94.47
12	**NTPO_0005**	**Wet Pond**	**RR10**	**2010**	61.86	1220	1158.14	94.93
13	**KTPO_0007**	**Wet Pond**	**RR362**	**2012**	104.58	2488	2383.42	95.8
14	**KTPO_0009**	**Wet Pond**	**RR350**	**2015**	70.89	1903	1832.11	96.27
15	**KTPO_0012**	**Wet Pond**	**RR361**	**2012**	321.46	10356	10034.54	96.9
16	**KTPO_0010**	**Wet Pond**	**RR353**	**2011**	116.85	4491	4374.15	97.4
17	**KTPO_0005**	**Wet Pond**	**RR351**	**2011**	31.5	1401	1372.6	97.76
18	**NTPO_0007**	**Wet Pond**	**RR32**	**2015**	297.18	13509	13211.82	97.8
19	**KTPO_0006**	**Wet Pond**	**RR352**	**2011**	28.58	1467	1438.42	98.05
20	**KTPO_0013**	**Wet Pond**	**RR360**	**2012**	37.98	2651	2613.02	98.57
21	**KTPO_0002**	**Wet Pond**	**RR355**	**2016**	3.97	912	908.03	99.56

22	**KTPO_0008**	**Wet Pond**	**RR363**	**2012**	0.31	1759	1758.69	99.98
23	**KTPO_0001**	**Dry Pond**	**RR359**	**2015**	N/A	N/A	N/A	N/A
24	**KTPO_0003**	**Dry Pond**	**RR356**	**2016**	N/A	N/A	N/A	N/A
25	**KTPO_0004**	**Dry Pond**	**RR357**	**2016**	N/A	N/A	N/A	N/A
26	**NTPO_0008**	**Dry Pond**	**RR18**	**1996**	N/A	N/A	N/A	N/A
27	**NTPO_0004**	**Wet Pond**	**RR8**	**>20 years**	Further investigation showed that pond has been decommissioned and additional flows drain into NTPO_0006			
28	**OTPO_0001**	**Dry Pond**	**N/A**	**2005**	N/A	N/A	N/A	N/A
29	**OTPO_0002**	**Wet Pond**	**N/A**	**2005**	N/A	N/A	N/A	N/A
30	**KTPO_0014**	**n/a**	**N/A**	**N/A**	N/A	N/A	N/A	N/A
31	**NTPO_0011**	**Wet Pond**	**N/A**	**2017**	N/A	N/A	N/A	N/A

7.2.2 Water Quantity & Erosion Control

SWM facilities must provide quantity control to minimize peak flows for erosion control and provide storage for flooding protection. The analysis in **Table 4-10** shows that the existing facilities provide the 24–48-hour drawdown times required by the TRCA and LSRCA for erosion control. **Table 7-3** shows preliminary estimated volumes of active storage required to meet the current quantity control criteria for each existing SWM facility in the Township. The constraints associated with existing SWM facilities make it difficult to increase active storage volumes in each facility to meet these requirements. Site reconnaissance will be required to determine feasibility for retrofits and upstream LID implementation for water quantity and erosion control.

Table 7-3 – Facility Upgrade Considerations

Pond Cleanout Priority Number	Facility ID	Facility Type	Node ID	Year Constructed	Drainage Area (Ha)	Permanent Pool Volume (m³)	Total Permanent Pool Volume Required to Meet MOE Level 1 Enhanced Treatment Criteria (m³)	Active Detention Storage Volume (ha.m)	Required Active Detention Storage Volume (ha.m)
1	NTPO_0002	Wet Pond	RR21	1996	17.57	280	2635	0.22	0.86
2	NTPO_0001	Wet Pond	RR130	>20 years		2330			
3	STPO_0004	Wet Pond	RR764	2003	13	750	1950	0.07	0.05
4	STPO_0005	Wet Pond	RR765	2006		450			
5	STPO_0003	Wet Pond	RR763	2000		644			
6	STPO_0002	Wet Pond	RR767	2009	22.6	5624	Satisfactory	0.30	0.09
7	STPO_0001	Wet Pond	RR766	2011	16.28	1708	2442	0.79	0.07
8	NTPO_0009	Wet Pond	RR9	2010	25	2850	3750	0.66	1.87
9	NTPO_0003	Wet Pond	RR29	2011	14.03	2057	2104	0.49	1.16
10	NTPO_0006	Wet Pond	RR7	2010		6000		1.06	2.93
11	KTPO_0011	Wet Pond	RR354	2011	9.13	1528	Satisfactory	0.52	1.00
12	NTPO_0005	Wet Pond	RR10	2010	7	1220	Satisfactory	0.16	0.49
13	KTPO_0007	Wet Pond	RR362	2012	21.13	2488	3170	0.73	1.51
14	KTPO_0009	Wet Pond	RR350	2015	9.16	1903	Satisfactory	0.48	1.09
15	KTPO_0012	Wet Pond	RR361	2012		10356			
16	KTPO_0010	Wet Pond	RR353	2011	15.23	4491	Satisfactory	1.58	1.12
17	NTPO_0007	Wet Pond	RR32	2015	84.95	13509	Satisfactory	0.70	5.50
18	KTPO_0013	Wet Pond	RR360	2012		2651			
19	KTPO_0002	Wet Pond	RR355	2016	5.73	912	Satisfactory	0.30	0.34
20	KTPO_0008	Wet Pond	RR363	2012	8.48	1759	Satisfactory	0.39	0.58

Pond Cleanout Priority Number	Facility ID	Facility Type	Node ID	Year Constructed	Drainage Area (Ha)	Permanent Pool Volume (m^3)	Total Permanent Pool Volume Required to Meet MOE Level 1 Enhanced Treatment Criteria (m^3)	Active Detention Storage Volume (ha.m)	Required Active Detention Storage Volume (ha.m)
21	**KTPO_0001**	**Dry Pond**	**RR359**	**2015**	1.64	N/A	246	0.20	
22	**KTPO_0003**	**Dry Pond**	**RR356**	**2016**	3.6	N/A	540	0.23	
23	**KTPO_0004**	**Dry Pond**	**RR357**	**2016**	2.84	N/A	426	0.14	
24	**NTPO_0008**	**Dry Pond**	**RR18**	**1996**		N/A			
25	**NTPO_0004**	**Wet Pond**	**RR8**	**>20 years**	Further investigation showed that pond has been decommissioned and additional flows drain into NTPO_0006				

7.3 Conveyance Infrastructure

In addition to stormwater maintenance facilities, the Township is responsible for maintaining conveyance infrastructure such as culverts and storm sewers. There is approximately 350 km of road-side drainage ditches and 1458 culverts that convey stormwater in the Township. These assets must be further inspected to properly assess their condition and function. The Nobleton Drainage Study performed by R.J. Burnside & Associates Limited in 2016 identifies multiple culverts that do not meet the necessary criteria to convey flows from 25-year storm events. The current GIS inventory shows that the existing inadequate culverts that were identified are still operating. Further studies are recommended throughout the Township within the flood prone areas defined in Section 4.7.2 to determine the effectiveness of the existing conveyance system. The upgrades necessary to mitigate flooding should be completed and the Township inventory shall be updated as upgrades occur. The Township currently owns and operates approximately 100 km of storm sewers used to convey stormwater runoff. These sewers must be further inspected using CCTV to properly assess the conditions of the Township conveyance infrastructure.

7.4 Existing OGS & Chambers

Several OGS Units and one underground storage unit have been identified in ***Table 4-12*** and ***Table 4-13,*** respectively. Applying the Drainage Act, the Township has authority to inspect the operation & maintenance condition of these units as they exist on private property. Condition assessments should be completed to ensure the units identified are operating at the acceptable treatment levels for conveying stormwater runoff into the municipal storm sewer system.

8.0 Phase 1 Problem/Opportunity Statement

In consideration of the existing environment and the impacts of development on water balance, water quality, and water quantity; the problem/opportunity statement of this study can be defined. It has been found that with the increase of development across the Township the existing stormwater infrastructure is insufficient for satisfying the stormwater management requirements to control and convey the increased peak flows and runoff volumes. The results of these impacts include instream erosion and deposition, flooding issues, infrastructure and property damage, and negative affects on wildlife habitats and the natural environment. The problem of inadequate infrastructure creates the opportunity to develop a comprehensive strategy that will establish measures for improving the stormwater quality and quantity management by adopting watershed management strategies such as flood mitigation, stormwater facility retrofits, and LID implementation.

King Township believes that to support the ***growth of vibrant communities*** *and* ***enhance the quality of life for its residents****, accommodations must be made to provide the adequate controls for the anticipated stormwater needs generated by planned development in an* ***efficient, effective, safe, and sustainable matter****.*

The following sections discuss the preferred solution to addressing the opportunities for improving the SWM deficiencies throughout the Township.

9.0 Identify & Evaluate Stormwater Improvement and Retrofit Opportunities

Identifying and assessing alternative solutions to the problems that arise from stormwater due to urbanization, and selecting the preferred methodology constitutes the second phase of the Class EA process. Using the findings from the characterization study in Section 4.0 and the results from the evaluation of environmental impacts in Section 6.0 and Section 7.0, alternative solutions are presented in this section with focus on addressing water quantity, water quality and water balance issues within the Township. Within this section, an evaluation of these alternatives and a preferred solution will be provided.

9.1 Overview of Stormwater Management

SWM methods have evolved over the past three decades to address the effects of urban development on the downstream environment, as seen in **Figure 8-1** below. In the 1980s and before, earlier SWM practices focused solely on controlling water quantity and providing flood protection through rapid conveyance measures. By the 1990s, focus on water quality and erosion control was increased. Today, systematic improvements in watershed management and better understanding of environmental features and function have led to improved stormwater management techniques that address a wide variety of issues including stream morphology, protection of groundwater resources and protecting fish and terrestrial habitats.

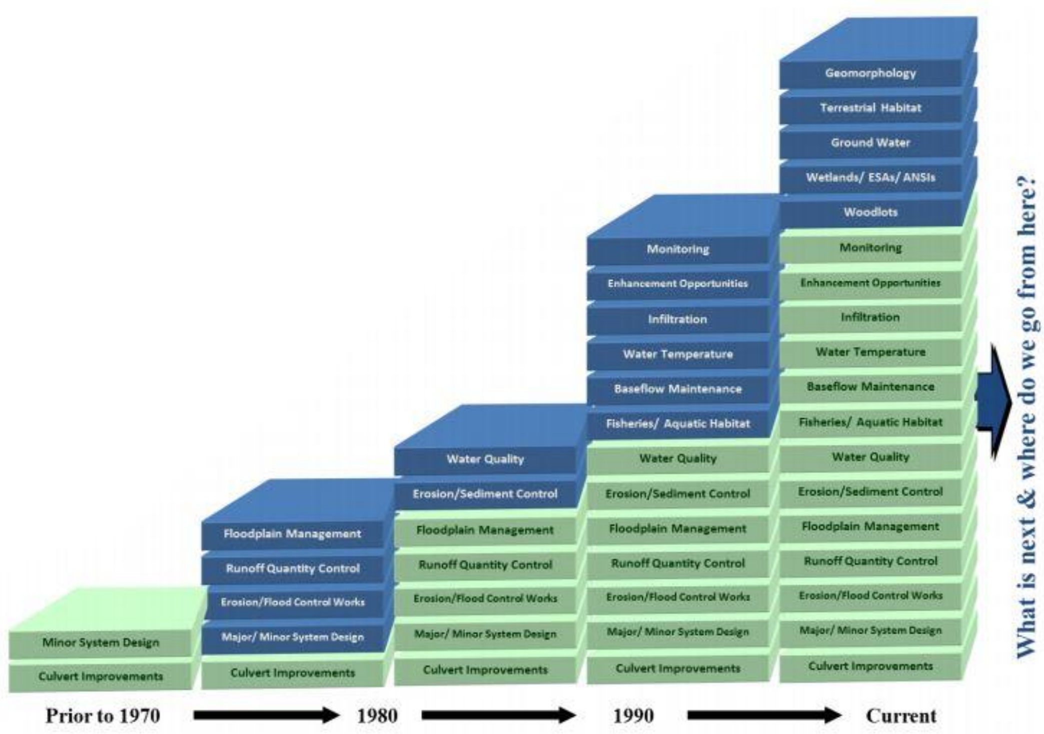


Figure 9-1: The Evolution of SWM (Adapted from MOE, 2003)

Stormwater runoff from urban areas may cause degradation to the environment during construction and post-development phases. The increase in urbanization alters the way water moves through the landscape and results in increased pollutants in overland flow when rainwater cannot infiltrate into the ground. Pollutant loading from post-construction urban areas are significant and may pollute watercourses with pathogens, excess nutrients, heavy metals, and other toxins. These pollutants impact the environment in several ways when they are conveyed into the watercourse and receiving waterbodies.

Research pertaining to the evaluation of SWM treatment strategies has proven that pipe and pond stormwater treatment strategies alone are not sufficient to meet general water quantity, water quality and water balance objectives. The West Holland Subwatershed plan states the shortcoming of traditional SWM strategies by stating that the overall goal of improving stormwater management must be achieved through the utilization of new and innovative best management practices, as well as LID practices, that will further reduce pollutant loadings in the subwatershed. Typically, a treatment train approach (i.e. combination of lot level, conveyance, and end-of-pipe SWM practices) is considered to meet the multiple objectives of SWM.

9.2 List of Alternative Solutions

Various alternative solutions have been identified to address stormwater impacts from existing and future urban development in the Township as a part of the Class EA process. The alternative solutions are listed below and will be discussed in further detail in the subsequent sections:

- Alternative 1 – Traditional SWM (Do Nothing)
- Alternative 2 – Low Impact Development (LID) measures
- Alternative 3 – Combining Traditional and LID measures

9.2.1 Alternative 1 – Traditional SWM (Do Nothing)

As required by the MOECC, Lake Simcoe Protection Plan, and the Township of King Design Criteria, the “do nothing” approach provides the minimum level of stormwater management where possible. This approach includes traditional stormwater management systems consisting of conventional storm sewers to convey runoff and guide it to a traditional end-of-pipe SWM pond before it is discharged into its receiving watercourse. Traditional end-of-pipe treatment consists of detention ponds where stormwater is collected, stored to allow sediment to settle, and then released. They are typically constructed to provide sufficient capacity to settle pollutants and provide flood and erosion control protection. However, age and lack of maintenance can prevent these facilities from functioning as they were designed resulting in various environmental impacts. Some options are presented below for existing and future developments.

9.2.2 Alternative 2 – Low Impact Development (LID) measures

LID measures can be implemented, in areas where runoff is controlled or uncontrolled, to provide additional stormwater quantity and quality controls. The existing developed areas within the Township may release stormwater completely uncontrolled into the neighboring watercourses and streams. These areas present unique opportunities for innovative LID measures to be implemented to increase quality and quantity control, as well as promote infiltration and groundwater recharge. LIDs can be integrated into community features and improve the aesthetics of the overall communities they are in. These opportunities would depend on available space, development type and soil and groundwater conditions.

The following sections will introduce some source control and conveyance control LID methods that can be implemented.

9.2.2.1 Soakaways, Infiltration Trenches and Chambers

Soakaway pits and infiltration trenches (**Figure 9-2**) are circular or rectangular excavations lined with geotextile fabric and filled with granular stone, or any void forming material, that receives runoff through a perforated pipe inlet and allows for it to infiltrate into the native soil. They are typically designed to service individual lots but can also be designed to receive overflow from rainwater harvesting systems. Infiltration trenches are typically more suitable for areas where space available for infiltration is limited to narrow strips of land between properties.

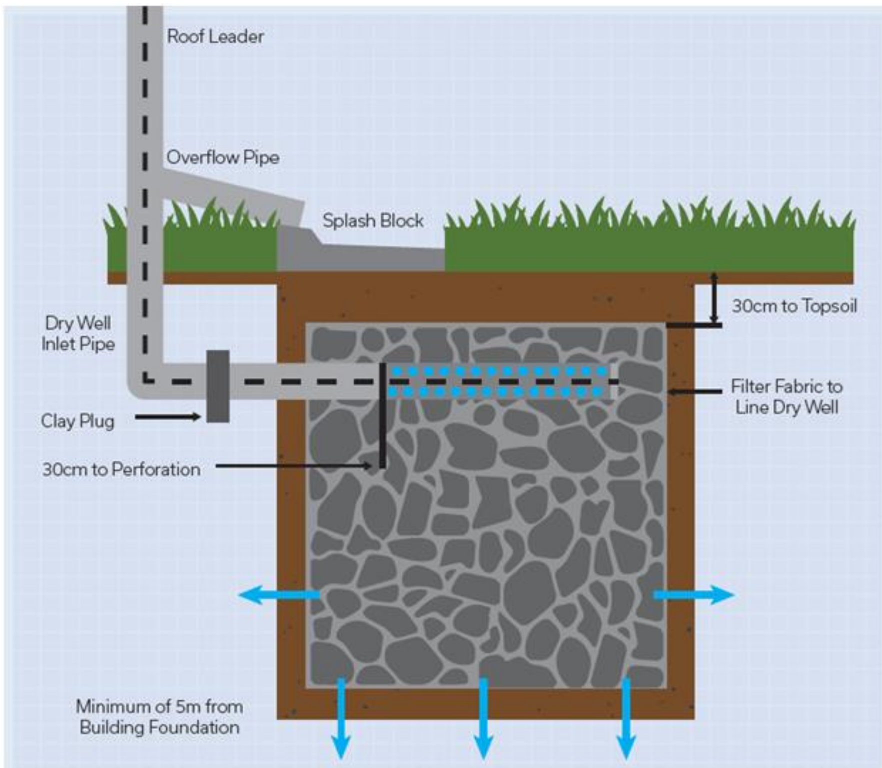


Figure 9-2: Typical Soakaway Pit Design

Soakaways are advantageous because they are underground structures that have a minimal visual impact and can be integrated into surrounding development. Most importantly, they allow for infiltration and contribute to groundwater recharge and reduce the amount of water directly entering watercourses. However, soakaways provide relatively little pollutant removal and therefore run the risk of contaminating groundwater and soil. To combat this, pre-treatment processes (i.e. grass swales) may be implemented to treat runoff prior to entering the infiltration and contaminating groundwater and soil.
Some constraints that must be considered before implementing a soakaway are:

- Wellhead Protection
    - Runoff received from road or parking lots should not be located within the two (2) year time-of-travel wellhead protection areas.

- Water Table
    - Facilities should be vertically separated by one (1) metre from the seasonally high-water table or top of bedrock elevation.

9.2.2.2 Permeable Pavement

Permeable pavement is an innovative alternative to traditional impervious pavement. Stormwater is allowed to drain through to a stone reservoir where it is infiltrated into the underlying soil. Permeable pavement can be used for roads with low traffic, parking lots, driveways, and pedestrian plazas. They are ideal for sites that are limited on space for surface stormwater BMPs. Depending on site conditions (e.g. soil and groundwater conditions), the pavement system can be designed for full infiltration, with an underdrain for partial infiltration, or with an underdrain and an impermeable liner to provide filtration only. Permeable pavements allow for infiltration and filtration of runoff, storage and can reduce stormwater flows when compared to traditional pavement methods.

9.2.2.3 Roof Downspout Disconnection

Downspout disconnections involve directing flow from roof downspouts to a pervious area that drains away from the property. This prevents stormwater from entering the storm sewer system or flowing across a directly connected impervious surface (i.e. driveways) and into a storm sewer. The CVC LID Design Guidelines recommend that downspout disconnections require a minimum flow path length of 5 m across a pervious area. When the native soil in the pervious area is less than 15 mm/hr (i.e. hydraulic conductivity of less than $1x10^{-6}$ cm/s), the area should be tilled to a depth of 300 mm. Compost should also be added to the area to achieve an organic content in the range of 8 to 15% by weight or 30-40% by volume.

9.2.2.4 Rainwater Harvesting

Rainwater harvesting is the practice of intercepting, conveying, and storing rainfall, usually from rooftops and other impervious surfaces, for future use. The water is stored in tanks and used for non-potable uses such as washing cars, irrigating lawns, and flushing toilets. Storage tanks can range from a barrel at the bottom of a home's downspout to a large industrial size facility with multiple tanks, pipes, pumps, and controls. As a part of their Water for Tomorrow program, designed to promote water conservation, York Region offers rain barrels to homeowners at a reduced price. This practice is usually supplemented with downspout disconnections and can help to reduce the demand for water at peak times. However, for the purpose of stormwater management, a rather aggressive approach is required.

An example of this being implemented successfully is in the City of Portland. Rainwater harvesting for the purpose of stormwater management is encouraged through reduced development fees when the runoff is retained on site. This has led to many commercial, institutional, and industrial landowners to undertake rainwater harvesting projects based on the reduced fee and savings associated with the decrease in water use.

9.2.2.5 Bioretention & Rain Gardens

As a stormwater infiltration/filtration practice, rain gardens use a bioretention system to temporarily store, treat and infiltrate stormwater runoff. The primary component of a bioretention facility is the filter bed which contains a mixture of sand, fines, and organic material. Another important element of bioretention includes plants adapted to the conditions of stormwater practice. Pre-treatment practices (i.e. settling forebay, vegetated filter stripes, etc.) usually precede the bioretention to remove particles that would otherwise clog the filter bed. They can be designed without an underdrain for full infiltration, with an underdrain for partial infiltration, or with an impermeable liner and underdrain for filtration only, which is referred to as a biofilter. Bioretention facilities are usually designed to capture small storm events, therefore, an overflow by-pass is necessary to pass larger storm events.

9.2.2.6 Enhanced Grass & Dry Swales

Enhanced Grass Swales are vegetated open channels that are designed to convey, treat, and attenuate stormwater runoff. Simple grassed channels have been long used to convey stormwater, particularly for roadway ditches. Check dams and vegetation in the swale slows the runoff flow to allow for sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. Dry swales are a variation of enhanced grassed swales which incorporates an engineered soil media bed and optional perforated pipe underdrain system. Dry swales provide greater benefits for water balance and quality.

Where development density, topography, and depth to water table permit, enhanced grassed swales are the preferred alternative to both curb and gutter and storm drains as a conveyance system. When incorporated into a site design, they can reduce the amount of impervious cover, accent natural landscape and provide many aesthetic benefits.

9.2.3 Alternative 3 – Combining Traditional SWM and LID Measures

This alternative considers the combination of traditional SWM practices such as end of pipe measures (i.e., wet ponds and dry ponds) and LID measures. New opportunities for the development of these practices must be identified in more detailed depending on specifics such as available space, soil conditions, depth to bedrock and groundwater, etc.

9.3 Rural Stormwater Management

The Township of King has a large percentage of land dedicated to rural and agricultural uses. Agricultural lands produce runoff with higher concentrations of Phosphorus and other nutrients that are crucial for crop and animal production. As phosphorus has become a key water quality concern in the Lake Simcoe Watershed, proper stormwater management of these lands is important and can be done by prescribing Best Management Practices (BMPs) aimed for rural properties. Policies 8.5-SA through 8.11-SA in the Lake Simcoe Protection Plan provides several policies to reduce the phosphorus loading from rural and agricultural sources. These practices are critical to achieving the ambitious and aggressive reductions in phosphorus needed to restore Lake Simcoe's water quality and overall health. These BMPs include practices that targets Phosphorus and other nutrients at the source and in transport. The following are some of these BMPs:

- Fertilizer, manure and other nutrient management techniques through appropriate storage and land application methods;
- Buffer in riparian areas along stream banks;
- Improved cropping systems;
- Water supply management;
- Runoff control;
- Erosion control structures and cover crops; and,
- Balance livestock feed to maximize efficient use of phosphorus.

9.4 Constraints Associated with SWM Practices

Table 9-1 below summarizes some constraints that are associated with the aforementioned SWM practices.

Civica Infrastructure Inc. • 330 Rodinea Road, Unit 3, Vaughan, Ontario, Canada, L6A 4P5 •905-417-9792 | www.civi.ca | info@civi.ca

Table 9-1 – Physical Constraints for SWM Practice Types

SWM Practice	Topography	Soil	Groundwater/Bedrock	Drainage Area	Other Concerns
Wet Pond	None	None	None	≥ 5 ha	
Dry Pond	None	None	None	≥ 5 ha	
Wetland	None	None	None	≥ 5 ha	
Infiltration Basin	None	Loam (min. infiltration rate ≥ 60 mm/h)	≥ 1 m below bottom	≤ 5 ha	
Downspout Disconnection	1% ≤ Slope ≤ 5%	min. infiltration rate ≥ 15 mm/h	None	Contributing Roof Area ≤ 100 sqm	- Standing water and ponding. Standing water should be infiltrated within 24hrs of each runoff event - Proper homeowner education on maintenance for systems installed on private lots
Soakaways, Infiltration Trench/Chambers	Natural Slopes ≤ 15%	Loam (min. infiltration rate ≥ 15 mm/h)	≥ 1 m below bottom	Impervious drainage area to treatment facility area ratio between 5:1 and 20:1. A maximum ratio of 10:1 for facilities receiving road/parking lot runoff	- Risk of soil and groundwater contamination - Proper homeowner education on maintenance for systems installed on private lots
Bioretention	1% ≤ Slope ≤ 5%	Can be located over any soil type but HSG A & B are best suited for water balance benefits	≥ 1 m below bottom	Typical contributing drainage area 100 sqm ≤ Slope ≤ 0.5 ha Maximum recommended contributing drainage area is 0.8 ha	- Risk of soil and groundwater contamination - Proper homeowner education on maintenance for systems installed on private lots - Bioretention applications located in high traffic areas must be designed to prevent pedestrian traffic through the facility
Enhanced Grass Swale	0.5% ≤ Slope ≤ 6%	None	≥ 1 m below bottom	≤ 2 ha	- Risk of soil and groundwater contamination - Proper homeowner education on maintenance for systems installed on private lots - Major maintenance required with grass swales is mowing and occasional sediment removal - Standing water and mosquitoes in grassed swales that are poorly designed and pond water for longer than 24hrs after an event
Dry Swales	0.5% ≤ Slope ≤ 4% Use check dams where slope exceeds 3%	Can be located over any soil type but HSG A & B are best suited for water balance benefits. Underdrain required where infiltration rates ≤ 15 mm/h	≥ 1 m below bottom	Typically treat drainage areas of ≤ 2 ha	- Risk of soil and groundwater contamination - Proper homeowner education on maintenance for systems installed on private lots - Major maintenance required with grass swales is mowing and occasional sediment removal - Standing water and mosquitoes in grassed swales that are poorly designed and pond water for longer than 24hrs after an event
Perforated Pipe Systems	Natural Slopes ≤ 15% Gravel Bed: 0.5% ≥ Slope ≥ 6%	Can be located over any soil type but HSG A & B are best suited for water balance benefits	≥ 1 m below bottom	Impervious drainage area to treatment facility area ratio between 5:1 and 10:1	- Risk of soil and groundwater contamination - Should be set back at least 4 m from building foundations to prevent damage during freeze/thaw cycle
Permeable Pavement	0.5% ≤ Slope ≤ 6%	Native soils with infiltration rate ≤ 15 mm/hr require the installation of a perforated pipe underdrain	≥ 1 m below bottom	Area Treated ≤ 1.2 * (Area of Permeable Pavement)	- Risk of soil and groundwater contamination - Proper homeowner education on maintenance for systems installed on private lots - Clogging - Not suitable for heavy vehicle loads
Vegetated Filter Strips	1% ≤ Slope ≤ 5%	None	≥ 1 m below bottom	Flow path length across filter strip should be 5m ≤ Slope ≤ 25m	- Risk of soil and groundwater contamination - First two years requires greatest maintenance as vegetation is becoming established and involves regular inspection, replacing dead or invasive vegetation and possibly watering - Proper homeowner education on maintenance for systems installed on private lots
Rainwater Harvesting	Influences placement of tanks and design of stormwater conveyance and overflow systems	Cisterns should be placed on or in native soils rather than fill soils.	If underground, then ≥ 1 m below bottom	Tanks must be sized to handle runoff from individual rooftops. Drainage area size determines tank size.	- Standing water and mosquitoes - Child safety concerns for above ground home cisterns - Proper homeowner education on maintenance for systems installed on private lots

(Adopted from MOE SWM Design Guidelines and CVC LID Fact Sheets

9.5 Other Opportunities for Improvement

9.5.1 Pollution Prevention Measures (PPM) & Municipal Management/Operational Practices (MMOP)

Applying PPM and MMOP often include changing behaviours, current practices, and educational programs. These practices are not site specific and can be applied generally across a watershed or municipal boundary to prevent sources of pollution from entering the drainage system. PPM are methods that intend to improve the operation and maintenance of privately and publicly owned lands, buildings, and infrastructure to reduce pollution generation. Certain municipal programs such as road salt management plans, street sweeping, and parks maintenance activities are known to impact water quality.

PPM and practices are activities that are generally implemented to fulfil the following objectives:

- Minimize the potential for spills and contaminated run-off into the storm drainage network;
- Reduce chemical loading rates (e.g. road salt);
- Reduce the discharge of stormwater pollutants generated from vehicle emissions; and
- Promote the use of surface storage and drainage

Based on consultation with the Township, it was noted that the existing PPM undertaken by the Township include street sweeping and catch basin cleanouts. Accordingly, there is always room to improve the PPM and MMOP within the Township. Other measures that would be recommended to the Township include:

- Erosion and Sediment Control Program
- Salt Management Planning
- Public Education Programs

Public education is a huge component of improving the management of stormwater in communities. Controlling stormwater at the source requires the involvement and commitment of homeowners. Educating homeowners on the importance of the need for controls at the lot-level to help manage stormwater and protect the environment as well as educating homeowners on how to properly maintain LIDs on their property is crucial to properly managing stormwater in the long term.

9.5.2 Stream Restoration

Stream restoration measures include those designed to address problems including erosion and flooding to restore stream function and stability. They are typically applied on a stream reach basis and include rehabilitation works that use engineered or natural channel design principles and naturalization of stream riparian zones using native materials. As a part of this study, rapid field reconnaissance was done to identify areas where erosion was of concern. These areas included reaches or crossings that are currently eroding, sensitive to erosion, or where current infrastructure or private property are at risk due to further erosion. Conducting more detailed inspections are recommended to identify in further detail any reaches that were only partially or not assessed in this study due to access issues. **Table 17 in Section 4.7 above** identifies these areas of erosion concern for each reach or crossing that was accessed or assessed in each settlement area.

9.5.3 Climate Change Adaptation

The LSRCA and TRCA have prepared "Climate Change Adaptation Strategies" for both respective conservation areas. Each report analyzes global scale climate change data and localizes it to their respective watersheds to identify watershed functions with high vulnerability to climate change. The following four goals have been determined as recommendations for action in the TRCA and LSRCA watersheds:

1. **Goal 1 - Ensure that people, properties, and communities remain sufficiently protected as climate conditions change**

2. **Goal 2 - Increase watershed resistance and resilience to climate change through conservation, restoration, and improvement of natural ecosystems**

3. **Goal 3 - Enhance knowledge of the watershed's natural environment and its response to a changing climate through science and monitoring for informed and adaptive decision-making**

4. **Goal 4 - Facilitate partnerships and connect people to the watershed in order to build awareness and capacity to adapt to a changing climate in the Lake Simcoe watershed**

Conservation authorities are responsible for working with municipalities to address ongoing climate change by identifying vulnerable areas, identifying significant groundwater recharge areas for LID implementation, updating design storm IDF curves to consider climate change, and implementing recommendations for planting plans from the "Adapting Forestry Programs to Climate Change" (LSRCA, 2019) report. As discussed in **Section 6.5.1.2** above, to complete the analysis considering climate change, the IDF_CC Tool 4.0 developed by the University of Western Ontario was utilized to accurately represent the affects of climate change in the Township in order to satisfy the four goals of addressing climate change.

9.6 2007 LSRCA Retrofit Opportunities

The Lake Simcoe Basin SWM and Retrofit Opportunities (2007) report was created with a purpose of producing a complete, consistent, and present data set of all urban catchments, outlets and existing SWMFs in the LSRCA. In addition, the study calculated the phosphorus loading associated with stormwater runoff and identified locations for potential SWMF retrofit opportunities in the Lake Simcoe Watershed. The report identified the following number of retrofit opportunities in the settlement areas within the Township:

- Seven (7) in Schomberg and Lloydtown
- Five (5) in Pottageville

These locations have been summarized in **Table 4-14** in **Section 4.5.2** of the report. Retrofit opportunities recommended in the report include constructing SWM ponds in uncontrolled catchments and upgrading quantity control facilities to a higher control level (i.e. Level 1 - 80% TSS removal). These locations should be subject to further investigation to determine whether the selected opportunities have any constraints aside from the ones identified in the report (i.e. actual space available, soil conditions, groundwater constraints, etc.). The study also recommended that implementing small lot level controls could be effective in mitigating the impacts of stormwater if they were adopted at a larger scale. The report mentions practices such as downspout disconnections, rainwater harvesting, grassed swales and ditches and minimizing and ensuring the proper application of fertilizers and chemicals.

9.7 TRCA Retrofit Opportunities

Facilities have been identified which do not satisfy the permanent pool volumes required to service their respective drainage areas to meet MOE level 1 enhanced treatment criteria. **Table 7-2** outlines the approximate permanent pool volume required for each facility to successfully provide enhanced level 1 treatment to stormwater runoff. Upstream LID measures can be used in a treatment train approach to assist in meeting stormwater management criteria.

9.8 Evaluation of Alternatives

The following sections describe the evaluation process and evaluation criteria to prioritize the works and fulfill the Class EA process. This study was carried out using Approach 1 for Master Plans in accordance with the Municipal Engineers Association Class Environmental Assessment (Class EA) process (MEA 2000, as amended in 2015). This study is intended to address phase 1 and 2 of the Class EA process and is to be used as foundational support for future investigations of specific schedule B and C projects identified within.

To properly evaluate the alternatives, it is first important to set the target criteria that must be achieved for water quality, water quantity, and water balance objectives. Once targets are set, an evaluation criterion must be developed to evaluate the retrofit opportunities. The Lake Simcoe Protection Plan states that each opportunity needs to be evaluated and rated in terms of:

- Feasibility;
- Construction costs;
- Long term operation & maintenance costs;
- And effectiveness in terms of improving water quality and overland flow characteristics to closely replicate pre-development conditions, including under climate change conditions.

9.8.1 Evaluation Criteria

To incorporate all the above factors, the evaluation criteria used to select the preferred alternative was assessed in a qualitative matter under four general categories. Furthermore, the four categories are evaluated using criteria with weighted values between one and three. The three alternative approaches introduced in **Section 8.2** will be given a positive rank from one to three.

A ranking of 3 means the subject alternative approach meets the criteria to the highest standard, a ranking of 2 means the subject alternative approach does not satisfy all the criteria or is feasible but is not ideal or constructable, and a ranking of 1 means the alternative does not satisfy the proposed criteria. **Table 9-2** below shows the four categories, the associated evaluation criteria, and its respective weight.

Table 9-2 – SWM Alternative Evaluation Criteria

Criteria	**Criteria Weight (1 to 3)**		
Technical/Engineering Factors	**Traditional SWM (Do Nothing)**	**Low Impact Development (LID) Measures**	**Combining Traditional SWM and LID Measures**
Proven effectiveness/performance • Has the alternative proven to be effective through implementation, science, or literature in dealing with runoff quantity, quality, and water balance issues?	1	3	3
Impact on existing infrastructure • Does the proposed alternative pose any threat to existing SWM infrastructure or other structures (i.e. roads, services, etc.)?	3	3	3
Operation & maintenance requirements • What is the level of anticipated long-term maintenance required for the proposed alternative?	1	2	2
Constructability • What is the degree of difficulty to construct the SWM alternative given the existing site conditions and constraints?	3	2	1
Regulatory Agency Acceptance • Does the SWM alternative meet the general level of acceptance by the various regulatory agencies (Municipal, Provincial, and CAs) with respect to water quantity & quality, water balance, erosion control, flood protection, and the conservation of natural lands?	1	3	3
Physical and Natural Factors			
Water Quality • Does the SWM alternative meet the water quality objectives outlined by the various regulatory agencies (Municipal, Provincial,	1	2	3

and CAs) for phosphorus loadings and other nutrients of concern? • Has the SWM alternative shown an ability to improve water quality conditions for the criteria identified in the 2003 MOE SWM Guideline and by the governing municipal authority (TRCA & LSRCA)?			
Water Quantity & Flood Control • Does the SWM alternative meet flood control criteria? • Control post-development peak flows to pre-development conditions for the 2 to 100-year design storms as identified in Chapter 6 of this study. • Has the SWM alternative shown an ability to reduce flood risks to public and private property and address climate change issues identified in the LSPP?	1	1	3
Water Balance • Is the SWM alternative able to minimally impact pre-development water balance (as identified in chapter 5 and existing site hydrology? • Does the SWM alternative maintain existing recharge and discharge areas? • Does the SWM alternative minimize the impact on natural hydrological and hydrogeological features (i.e. wetlands, woodlands)?	1	3	3
Terrestrial and Aquatic Habitat • Does the SWM alternative prevent the impact to aquatic and terrestrial habitat? • Does the SWM alternative provide the opportunity for the sustainability and the improvement of our aquatic and terrestrial habitat?	2	2	3
Social and Cultural Factors			
Impacts to Existing Lands • Does the SWM alternative impact the existing land use or natural landscape negatively?	3	3	3
Benefits to Community	3	2	2

Does the SWM alternative provide an aesthetic benefit to the existing and proposed development areas? • Does the SWM alternative provide a benefit to the community with regards to general public acceptance? • Can the SWM alternative be integrated visually into the existing public and private areas?			
Financial Factors			
Capital Costs • Which SWM alternative is the most financially feasible?	3	2	1
Operation and Maintenance Costs • What are the relative maintenance and operation costs for each SWM alternative?	2	2	2
	Traditional SWM (Do Nothing)	**Low Impact Development (LID) Measures**	**Combining Traditional SWM and LID Measures**
Average Criteria Weighting	1.9	2.3	**2.5**

10.0 Establish a Preferred Solution for SWM for the Study Area

A key component of a Masterplan is to define and describe the preferred solution and the proposed alternative solutions within each management unit. The preferred solution must establish an overall strategy that effectively manages stormwater flow characteristics, water quantity and water quality within the study area. The VO models described in Section 6.4 above are used to simulate the function of each alternative solution under various design storm events. The results were analyzed to determine the effectiveness of each alternative solution at achieving the stormwater control targets presented in **Table 6-6**, **Table 6-7** and **Table 6-8** above**.** The combination of the model results and the evaluation criteria presented in **Table 9-2** above will support the implementation of the preferred solution.

*10.1 **Management Unit Criteria***

Review of the Township's current SWM criteria was completed to determine the adequacy of the level of service for supporting growth and development. The two management units defined in the Township employ different SWM criteria as set out by their respective Conservation Authority. The distinct TRCA and LSRCA criteria define different targets for each management unit which must be considered when developing the preferred solution within each subwatershed. The recommendations provided for the preferred solution are preliminary, where future developments will require detailed analysis of existing conditions and approval from review agencies will be required. The preferred solution in both management units will implement traditional SWM and LIDs for lot level, conveyance, and source controls. The following sections will define the preferred SWM strategy and design criteria for each management unit which define the targets that must be satisfied for stormwater runoff treatment. Any change to design criteria will supersede the criteria presented in the forthcoming sections.

10.1.1 **Management Unit 1 (MU1): Lake Simcoe Watershed (LSRCA)**

The LSPP is a vital document for master planning within the Lake Simcoe Watershed. The LSPP outlines the degradation of health in the Lake Simcoe Watershed as a result of increased development. Therefore, the LSPP has identified specific requirements that must be considered for Stormwater Master Plans within the watershed as outlined in Section 3.2.3 Lake Simcoe Protection Plan. The objectives of the LSPP and The Lake Simcoe Technical Guidelines for Stormwater Management Submissions (2016, LSRCA) assist in defining the SWM criteria within Management Unit 1. **Table 10-1** identifies the SWM criteria that must be adhered to in Management Unit 1.

Table 10-1: LSRCA SWM Criteria

Stormwater Aspect	Analysis	Criteria
Quantity Control	Peak flow Control	Post development flow Rates not to exceed corresponding pre-development flow rates for 2–100-year design storms
	Volume Control	Retain runoff volume from 25mm storm on site
Quality Control	Total Suspended Solids	Enhanced Level of Protection (80% TSS Removal)
	Phosphorous	80 % Total Phosphorous
Stream Erosion	Erosion Study	Minimum detain runoff from 25mm storm and release over 24 hours
Water Balance	Ground Water Recharge study	Match pre-development groundwater Recharge
Erosion and Sediment Control	Erosion Sediment Control Plan	Erosion and Sediment Control Guidelines for Urban Construction

10.1.2 **Management Unit 2 (MU2): Humber River Watershed (TRCA)**

The TRCA Stormwater Management Criteria (TRCA, 2012) provides detailed direction for stormwater management regarding development. These guidelines define targets for quality & quantity control, erosion control, and water balance within Management Unit 2.

TRCA guidelines contain specific unit flow rate equations for each watershed within the TRCA. The Township is located within Sub Basin 10 of the Humber River watershed and therefore, the peak flow rates generated by developments within the Township must be controlled to the 2-year post development peak flows for the unit flow relationship calculated using 'Equation C' from the Humber River Stormwater Management Quantity Control Release Rates. The stormwater management targets defined in **Table 10-2** will be used to develop broad management approaches and techniques employed within each settlement area of Management Unit 2.

Table 10-2 TRCA SWM Criteria

Stormwater Aspect	Analysis	Criteria
Quantity Control	Peak flow Control	Unit Flow Relationship for Humber River Area
Quality Control	Total Suspended Solids	Enhanced Level of Protection (80% TSS Removal)
Stream Erosion	Erosion Study	Minimum retain runoff from 25mm storm and release over 48 hours with minimum 5mm onsite retention
Water Balance	Ground Water Recharge study	Match predevelopment groundwater Recharge
Erosion and Sediment Control	Erosion Sediment Control Plan	Erosion and Sediment Control Guidelines for Urban Construction

10.2 Alternative Solutions

10.2.1 Alternative 1 – Traditional SWM (Do Nothing)

The analysis of the status quo scenario without any SWM improvements or LID implementation outlines the severe risks present to both the built & natural environment. The do-nothing alternative is the most feasible alternative because the status quo would be maintained and no upgrades, analysis, or construction would be required. However, flooding issues already exist in the Township, notably in Nobleton, prior to the increased peak flows and runoff volumes anticipated by future development in the Township. Since the existing SWM facilities do not have the capacity to control and convey the resultant runoff from storm events, allowing development to continue without improving the inadequate infrastructure will directly impact the built environment by causing property damage and creating severe safety risks to residents. Increased development also increases the concentration of pollutants entering our waterways. Large degradation to streams will occur and natural habitats will be destroyed.

Great communities always thrive with good balance and connection between the built and natural environment. Destroying this connection will not only endanger many species and habitats but decrease the overall quality of life in the Township. Therefore, an alternative solution must be considered to address the growing concerns of stormwater runoff as well as create a framework for improving the existing stormwater system.

10.2.2 Alternative 2 – Low Impact Development (LID) measures

Implementing LIDs is a great technique for addressing stormwater quality and quantity issues on small development sites. LID's alone have the capability of meeting requirements for protecting the built and natural environment within the Township. However, the capability of LID's to meet design targets becomes difficult effectively and efficiently on large development sites because the size of the LID becomes too large and expensive to feasibly construct. Large LIDs would likely minimize the amount of available space for developable land which becomes difficult to implement. Therefore, the most reasonable approach is to combine LIDs with traditional stormwater management techniques.

10.2.3 Preferred Solution

When determining the preferred solution, it is important to consider: Why create a stormwater master plan, what are the goals of our stormwater master plan, and does our plan successfully achieve these goals?

Ontario is constantly growing and adapting growth plans for communities. As part of the Township's official plan to meet provincial growth rates, planned development has been designated across the township. This increased development results in increase stormwater runoff and requires planning to mitigate the effects on the natural and built environment of the township, while also meeting economic and sustainability goals to guarantee long-term success.

The important factors to consider when determining the preferred solution are:

1. Increased flooding
2. Increased Pollution
3. Stream Erosion
4. And Reduced Groundwater Recharge

Achieving the above goals through the Master Planning Process will consider the following characteristics:

1. Feasibility – Is the application of the proposed solution practical and affordable?
2. Constructability – How easy or realistic is it to construct the proposed solution?
3. Environmental Impact – What are the potential environmental impacts caused by the proposed solution?
4. Benefit to the residents – Will the proposed solutions help resolve current SWM issues that residents of the Township are currently facing?

10.2.3.1 Alternative 3 – Combining Traditional SWM and LID Measures

The analysis of the proposed alternative solutions identifies the preferred SWM strategy for both management units as the Combination of Traditional SWM and LID measures. Combining traditional SWM and LID measures employs a treatment train approach to effectively and efficiently address concerns created from stormwater runoff. Traditional SWM facilities typically address peak flows while LID's help address runoff volumes and recreate the natural hydrological cycle. In addition to addressing stormwater management criteria, LIDs can be integrated into the built-environment and provide more opportunities for open space or development when combined with traditional SWM facilities. Therefore, the combination of traditional SWM and LID measures for stormwater treatment proves to be feasible, constructible, least impact on the environment, and the highest benefit to residents.

10.3 Model Results Summary

The hydrology modelling techniques are used to reflect the existing and future conditions of stormwater runoff treatment within each settlement area. The findings show an increase of negative stormwater impacts when considering future development. The SWM criteria presented in **Section 10.1.1** and **Section 10.1.2** are used for model development as they set the targets for meeting stormwater runoff treatment demands. Infiltration chambers were used in the VO model development to estimate the overall effectiveness of the proposed solution. Infiltration chambers were used for this study because they can be implemented underground which minimizes the landuse required to implement, they provide storage for stormwater runoff, and provides water balance depending on the existing soil types. Therefore, these provide reasonable estimates for the function of LID's once implemented on a future development, however, site specific LID's will be determined at the detailed design stage of development. The future controls introduced into the model consider LIDs and traditional SWM facilities that meet the criteria defined for each management unit.

ADS Storm Tech Chamber (DC-780) with an impermeable liner was considered as an Infiltration Chamber in the VO model. Infiltration chamber was designed with an outflow, an underdrain, and an overflow. Maximum Storage volume (m^3) was generated for the infiltration chamber after parameter adjustments. Max volume in an Infiltration chamber after parameter adjustments was 2078 m^3. Values of all the parameters for the infiltration chambers considered in VO model are as follows:

1. Number of individual storage chambers used in design = 900
2. Base of Stone/Storage Elevation (m) = 100
3. Depth of Stone Above chambers (mm) = 150
4. Depth of Stone Below chambers (mm) = 230
5. System Footprint (m^2) = 3000
6. Voids in Stone (Porosity) = 0.4
7. Max Storage Volume (m^3) = 2078
8. Max Storage Rating Curve = 46
9. Initial water Level (m) = 0

It should be noted that, as per the Oak Ridges Moraine Conservation Plan Technical Memo 17 – Stormwater Management Plans, rapid infiltration basins are prohibited in the Oak Ridges Moraine. The following sections summarize the results after implementing the preferred solution.

10.3.1 Downstream Major Settlement Areas

Section 6.5.1 defines 3 target locations downstream of each major settlement area where peak flows, sediment and phosphorous loadings, and water balance targets were measured. The analysis locations are chosen downstream of the settlement areas where the greatest impact from future development will occur resulting in high levels of peak flow, runoff volume, and suspended solids. The locations for each analysis point are presented in **Figure 6-1**. The tables in Section 6.5 show an increase in stormwater peak flows, increase in pollutants, and decrease in water balance at each analysis point if the do-nothing approach is followed. The results of the preferred solution were analyzed at these locations to determine the effectiveness of the solution at meeting the design requirements. The following **Table 10-3** to **Table 10-5** outline the results of the preferred solution at reducing negative impacts of stormwater runoff as analyzed in the VO model downstream of all major settlement areas.

Table 10-3 – Existing, Future Flows and Future Flow with Preferred Solution Control Results

Village	Flow Point	Total Contributing Drainage area (Ha)	Type of Simulated Peak Flow	Peak Flows (m3/s) under Design and Regional Storms						
				2 year	**5 year**	**10 year**	**25 year**	**50 year**	**100 year**	**Regional**
Nobleton	**AH105**	1834.62	Peak Flow - Existing (m3/s)	15.09	23.64	29.5	37.07	42.77	48.6	77.14
			Peak Flow – Future Do-Nothing(m3/s)	16.21	24.76	30.69	38.34	44.1	49.92	80.18
			Peak Flow – Preferred Solution (m3/s)	14.08	22.15	27.62	34.67	39.95	45.38	71.22
			Preferred Solution Change in Peak Flow (m3/s)	-1.01	-1.49	-1.88	-2.4	-2.82	-3.22	-5.92
			Preferred Solution Change in Peak Flow (%)	-6.69	-6.3	-6.37	-6.47	-6.59	-6.63	-7.67
King City	**AH336**	6159.92	Peak Flow - Existing (m3/s)	44.7	67.84	84.58	106.87	123.96	141.63	238.24
			Peak Flow – Future Do-Nothing(m3/s)	50.58	74.49	91.59	114.22	131.54	149.41	247.99
			Peak Flow – Preferred Solution (m3/s)	43.78	66.14	82.3	103.79	120.27	137.32	231.06
			Preferred Solution Change in Peak Flow (m3/s)	-0.92	-1.7	-2.28	-3.08	-3.69	-4.31	-7.18
			Preferred Solution Change in Peak Flow (%)	-2.06	-2.51	-2.7	-2.88	-2.98	-3.04	-3.01
Schomberg	**AH624**	602.21	Peak Flow - Existing (m3/s)	4.64	7.4	9.4	12.07	14.13	16.25	27.82
			Peak Flow – Future Do-Nothing(m3/s)	4.68	7.45	9.45	12.12	14.17	16.29	27.8
			Peak Flow – Preferred Solution (m3/s)	4.54	7.27	9.26	11.9	13.93	16.03	27.46
			Preferred Solution Change in Peak Flow (m3/s)	-0.1	-0.13	-0.14	-0.17	-0.2	-0.22	-0.36
			Preferred Solution Change in Peak Flow (%)	-2.16	-1.76	-1.49	-1.41	-1.42	-1.35	-1.29

Table 10-4 - Total Suspended Solids Deficit and Preferred Solutions Control Results

Pre-Development vs. Post-Development Total Suspended Solids Deficit										
Village	Node ID	Drainage area (Ha)	Pre-development Conditions		Post-Development Conditions				Change in Annual Suspended Solid Loading	
					Do-Nothing		Preferred Solution		Preferred Solution	
			Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)
Nobleton	AH105	1834.62	731715	398.84	789706.16	430.45	703096.3	383.24	-28618.73	-15.60
King	AH336	6159.92	2031294.7	329.76	2275222	369.36	1973479	320.37	-57816	-9.39
Schomberg	AH624	602.21	225137.5	373.85	252347.5	419.04	219737.3	364.88	-5400.24	-8.97

Table 10-5 - Total Phosphorus Deficit and Preferred Solutions Control Results

Total Phosphorous Deficit										
Village	Node ID	Drainage Area (Ha)	Pre-development Conditions		Post-Development Conditions				Change in Annual Total Phosphorous Solid Loading	
					Do-Nothing		Preferred Solution		Preferred Solution	
			Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)
Nobleton	AH105	1834.62	2335.5	1.27	2496.5	1.36	2239.67	1.22	-95.82	-0.05
King	AH336	6159.92	6930.2	1.13	7620.51	1.24	6801.8	1.10	-128.39	-0.02
Schomberg	AH624	602.21	598.44	0.99	624.88	1.04	585.45	0.97	-12.98	-0.02

Table 10-6 - Water Balance Results

Village	Node ID	Drainage area (Ha)	Pre-development Conditions		Post-development Conditions		Post-development Conditions Control		Infiltration Deficit	
			Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m^3/yr)	Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m^3/yr)	Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m^3/yr)	Depth (mm/yr)	Volume (m^3/yr)
Nobleton	AH105	1834.62	365.43	670425.18	349.29	6477697.93	361	647620.86	-4.43	-8127.37
King	AH336	6159.92	429.52	2645808.83	411	2531727.12	419	2550206.88	-10.52	-64802.4
Schomberg	AH624	602.21	396	238475.16	386	23453.06	396	238475.16	0	0

10.3.2 Erosion Concern Locations Model Results Summary

The following section summarizes the results of implementing the preferred solution as analyzed in the VO model at areas highly susceptible to erosion as outlined in Section 4.7.1, and at flood prone locations identified in Section 4.7.2. Each analysis location is shown in **Figure 10-1** to **Figure 10-3** and their results defined in **Table 10-7** to **Table 10-10**. These results assist in justifying the selection of the preferred solution for mitigating the negative impacts of stormwater runoff.

Table 10-7: Peak Flow Analysis of Preferred Solution Results at Erosion Concern & Flood Prone Areas

Village	Flow Point	Flow Location Description	Type of Simulated Peak Flow	Peak Flows (m3/s) under Design and Regional Storms						
				2 year	5 year	10 year	25 year	50 year	100 year	Regional
Nobleton	AH82	Floodplain	Peak Flow - Existing (m3/s)	1.998	3.036	3.674	4.52	5.156	5.867	10.211
			Peak Flow – Preferred Solution (m3/s)	1.62	2.47	2.97	3.64	4.16	4.7	8.1
			Preferred Solution Change in Peak Flow (m3/s)	-0.38	-0.57	-0.7	-0.88	-1	-1.17	-2.11
			Preferred Solution Change in Peak Flow (%)	-18.92	-18.64	-19.16	-19.47	-19.32	-19.89	-20.67
Nobleton	AH83	Erosion Concern - HN3	Peak Flow - Existing (m3/s)	9.562	14.383	17.947	22.22	25.22	28.2	55.64
			Peak Flow – Preferred Solution (m3/s)	8.68	12.99	16.19	20	22.66	25.28	50.02
			Preferred Solution Change in Peak Flow (m3/s)	-0.88	-1.39	-1.76	-2.22	-2.56	-2.92	-5.62
			Preferred Solution Change in Peak Flow (%)	-9.22	-9.69	-9.79	-9.99	-10.15	-10.35	-10.1
Nobleton	AH98	Floodplain	Peak Flow - Existing (m3/s)	0.711	0.938	1.09	1.281	1.422	1.565	3.464
			Peak Flow – Preferred Solution (m3/s)	0.71	0.935	1.08	1.273	1.412	1.553	3.456
			Preferred Solution Change in Peak Flow (m3/s)	0	0	-0.01	-0.01	-0.01	-0.01	-0.01
			Preferred Solution Change in Peak Flow (%)	-0.14	-0.32	-0.92	-0.62	-0.7	-0.77	-0.23
Nobleton	AH99	Floodplain	Peak Flow - Existing (m3/s)	2.8	5.28	6.88	8.56	9.66	10.77	23.9
			Peak Flow – Preferred Solution (m3/s)	2.65	5.065	6.6	8.18	9.22	10.26	22.81
			Preferred Solution Change in Peak Flow (m3/s)	-0.15	-0.22	-0.28	-0.38	-0.44	-0.51	-1.09
			Preferred Solution Change in Peak Flow (%)	-5.36	-4.07	-4.07	-4.44	-4.55	-4.74	-4.56
Nobleton	AH112	Floodplain	Peak Flow - Existing (m3/s)	0.255	0.369	0.447	0.546	0.62	0.69	1.65
			Peak Flow – Preferred Solution (m3/s)	0.17	0.241	0.289	0.349	0.394	0.44	1.04
			Preferred Solution Change in Peak Flow (m3/s)	-0.09	-0.13	-0.16	-0.2	-0.23	-0.25	-0.61
			Preferred Solution Change in Peak Flow (%)	-33.33	-34.69	-35.35	-36.08	-36.45	-36.23	-36.97
King	AH293	Erosion Concern - HK4	Peak Flow - Existing (m3/s)	36.91	55.72	69.37	87.47	101.32	115.62	202.79
			Peak Flow – Preferred Solution (m3/s)	36.24	54.5	67.7	85.23	98.6	112.42	196.96
			Preferred Solution Change in Peak Flow (m3/s)	-0.67	-1.22	-1.67	-2.24	-2.72	-3.2	-5.83
			Preferred Solution Change in Peak Flow (%)	-1.82	-2.19	-2.41	-2.56	-2.68	-2.77	-2.87
King	AH298	Floodplain	Peak Flow - Existing (m3/s)	1.71	2.65	3.33	4.23	4.93	5.63	10.75
			Peak Flow – Preferred Solution (m3/s)	1.41	2.18	2.72	3.46	4.02	4.6	8.41
			Preferred Solution Change in Peak Flow (m3/s)	-0.3	-0.47	-0.61	-0.77	-0.91	-1.03	-2.34
			Preferred Solution Change in Peak Flow (%)	-17.54	-17.74	-18.32	-18.2	-18.46	-18.29	-21.77
King	AH318	Erosion Concern - HK4	Peak Flow - Existing (m3/s)	43.28	65.75	82.14	103.96	120.7	138.18	242.38
			Peak Flow – Preferred Solution (m3/s)	42.61	64.51	80.41	101.6	117.84	134.8	236.41
			Preferred Solution Change in Peak Flow (m3/s)	-0.67	-1.24	-1.73	-2.36	-2.86	-3.38	-5.97
			Preferred Solution Change in Peak Flow (%)	-1.55	-1.89	-2.11	-2.27	-2.37	-2.45	-2.46
Schomberg	AH624	Floodplain	Peak Flow - Existing (m3/s)	4.64	7.4	9.4	12.07	14.13	16.25	27.82

Village	Flow Point	Flow Location Description	Type of Simulated Peak Flow	Peak Flows (m3/s) under Design and Regional Storms						
				2 year	5 year	10 year	25 year	50 year	100 year	Regional
			Peak Flow – Preferred Solution (m3/s)	4.55	7.29	9.27	11.91	13.94	16.04	27.8
			Preferred Solution Change in Peak Flow (m3/s)	-0.09	-0.11	-0.13	-0.16	-0.19	-0.21	-0.02
			Preferred Solution Change in Peak Flow (%)	-1.94	-1.49	-1.38	-1.33	-1.34	-1.29	-0.07

Table 10-8: Total Suspended Solids Analysis of Preferred Solution Results at Erosion Concern & Flood Prone Areas

Total Suspended Solids Deficit										
Village	Node ID	Flow Location Description	Drainage Area	Pre-development Conditions		Post-Development Conditions				Change in Annual Suspended Solid Loading	
						Do-Nothing		Preferred Solution		Preferred Solution	
			(Ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)	Average TSS (kg/yr)	Average TSS (kg/yr/ha)
Nobleton	AH82	Floodplain	167.92	55234.24	328.93	71100.06	423.42	43677.88	260.11	-11556	-68.82
Nobleton	AH83	Erosion Concern - HN3	712.98	357807.2	501.85	411989	577.84	337643	473.57	-20164	-28.28
Nobleton	AH98	Floodplain	113.33	33814.06	298.37	36192.52	319.36	32348.01	285.43	-1466	-12.94
Nobleton	AH99	Floodplain	209.81	116951.6	557.42	131682.7	627.63	114563.4	546.03	-2388	-11.38
Nobleton	AH112	Floodplain	13.81	8909.8	645.17	12095.48	875.85	6541.07	473.65	-2369	-171.54
King	AH293	Erosion Concern - HK4	4157.6	1578843.8	379.75	1693547.87	407.34	1515329.08	364.47	-62644	-15.07
King	AH298	Floodplain	160.05	53934.68	336.99	79104.04	494.25	53888.69	336.70	-45.98	-0.29
King	AH318	Erosion Concern - HK4	5360.76	1876863.36	350.11	2018596.3	376.55	1833758.32	342.07	-43105	-8.04
Schomberg	AH624	Floodplain	602.21	225137.5	373.85	252347.5	419.04	225091.7	373.78	-45.78	-0.08

Table 10-9: Total Phosphorous Analysis of Preferred Solution Results at Erosion Concern & Flood Prone Areas

Total Phosphorous Deficit											
Village	Node ID	Flow Location Description	Drainage Area	Pre-development Conditions		Post-Development Conditions				Change in Annual Suspended Solid Loading	
						Do-Nothing		Preferred Solution		Preferred Solution	
			(Ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)	Average TP (kg/yr)	Average TP (kg/yr/ha)
Nobleton	AH82	Floodplain	167.92	185.1	1.10	238.766	1.42	157.566	0.94	-28	-0.17
Nobleton	AH83	Erosion Concern - HN3	712.98	1102.81	1.55	1248.78	1.75	1028.482	1.44	-74	-0.10
Nobleton	AH98	Floodplain	113.33	113.96	1.01	124.47	1.10	106.85	0.94	-7	-0.06
Nobleton	AH99	Floodplain	209.81	360.07	1.72	399.34	1.90	348.24	1.66	-12	-0.06
Nobleton	AH112	Floodplain	13.81	25.28	1.83	36.67	2.66	20.498	1.48	-5	-0.36
King	AH293	Erosion Concern - HK4	4157.6	5300.91	1.27	5674.33	1.36	5143.35	1.24	-151	-0.04
King	AH298	Floodplain	160.05	193.67	1.21	271.84	1.70	193.67	1.21	0	0.00
King	AH318	Erosion Concern - HK4	5360.76	6409.55	1.20	6872.15	1.28	6315.96	1.18	-93.58	-0.02
Schomberg	AH624	Floodplain	602.21	598.44	0.99	624.88	1.04	594.77	0.99	-3.66	-0.01

Table 10-10: Water Balance Analysis of Preferred Solution Results at Erosion Concern & Flood Prone Areas

Village	Node ID	Flow Location Description	Drainage area (Ha)	Pre-development Conditions		Post-development Conditions		Post-development Conditions Control		Infiltration Deficit	
				Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m³/yr)	Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m³/yr)	Average Infiltration Depth (mm/yr)	Average Infiltration Volume (m³/yr)	Depth (mm/yr)	Volume (m³/yr)
Nobleton	AH82	Floodplain	167.92	378	63473.76	343	57596.56	347	58268.24	-31	-5205.52
Nobleton	AH83	Erosion Concern - HN3	712.98	299	213181.02	260	185374.8	268	191078.64	-31	-22102.38
Nobleton	AH98	Floodplain	167.92	308	51719.36	276	46345.92	279	46849.68	-29	-4869.68
Nobleton	AH99	Floodplain	209.81	276	57907.56	243	50983.83	260	54550.6	-16	-3356.96
Nobleton	AH112	Floodplain	13.81	366	5054.46	276	3811.56	283	3908.23	-83	-1146.23
King	AH293	Erosion Concern - HK4	4157.6	412	1712931.2	400	1663040	403	1675512.8	-9	-37418.4
King	AH298	Floodplain	160.05	414	66260.7	373	59698.65	377	60338.85	-37	-5921.85
King	AH318	Erosion Concern - HK4	5360.76	429	2299766.04	415	2224715.4	418	2240797.68	-11	-58968.36
Schomberg	AH624	Floodplain	2242.7	511	1146019.7	510	1143777	510	1143777	-1	-2242.7

Figure 10-1: King City Model Analysis Locations

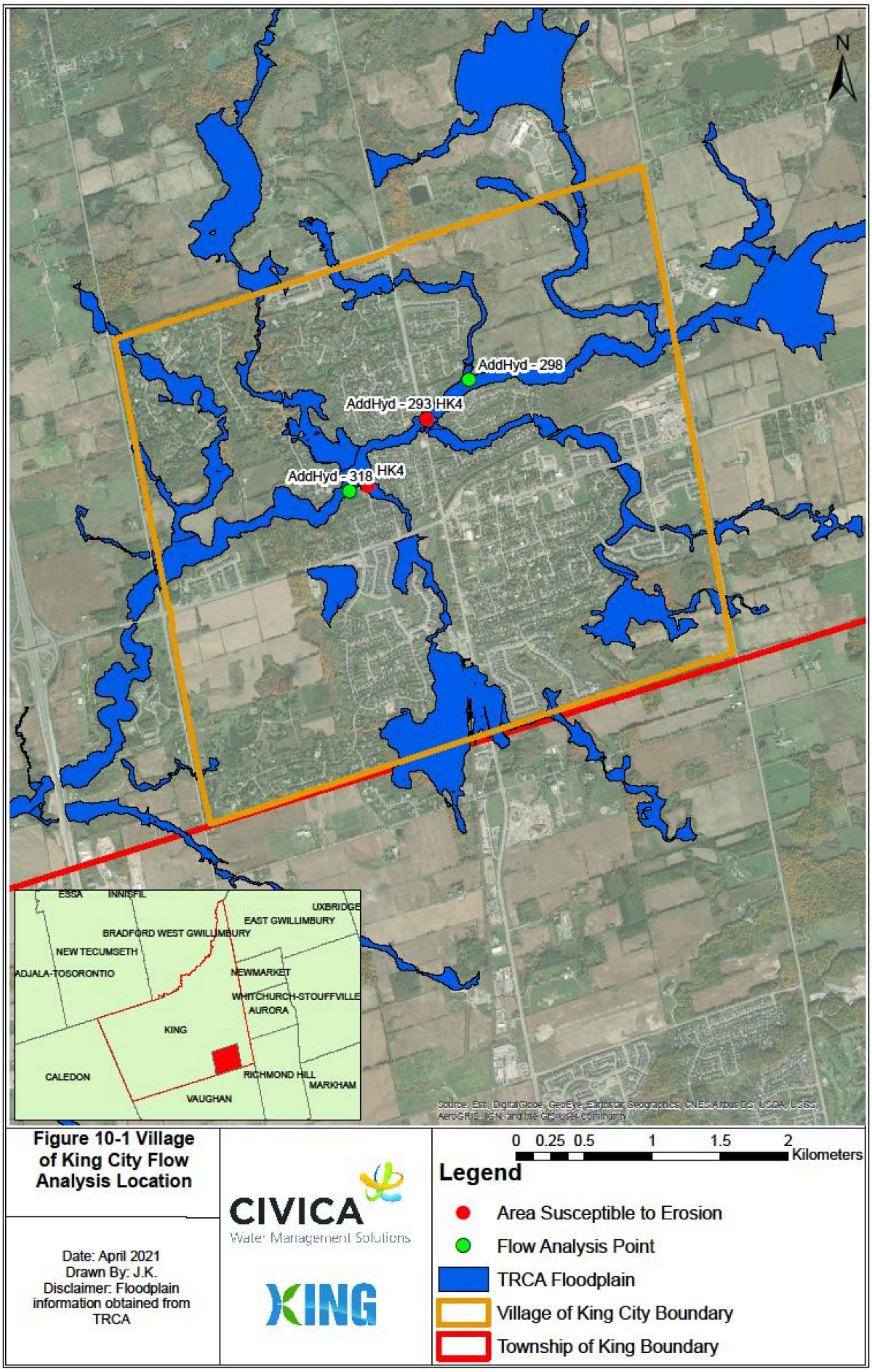


Figure 10-2: Nobleton Model Analysis Locations

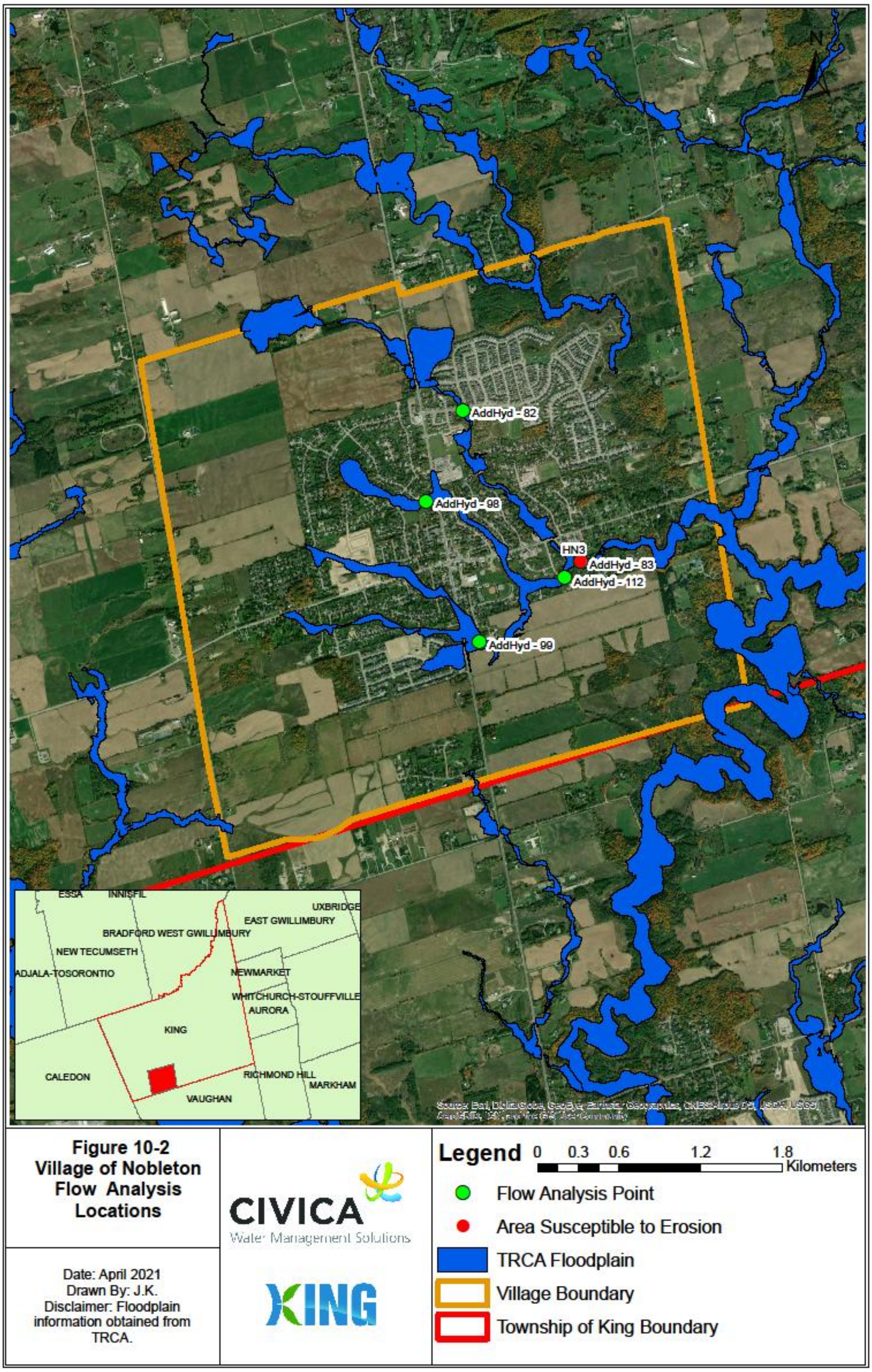
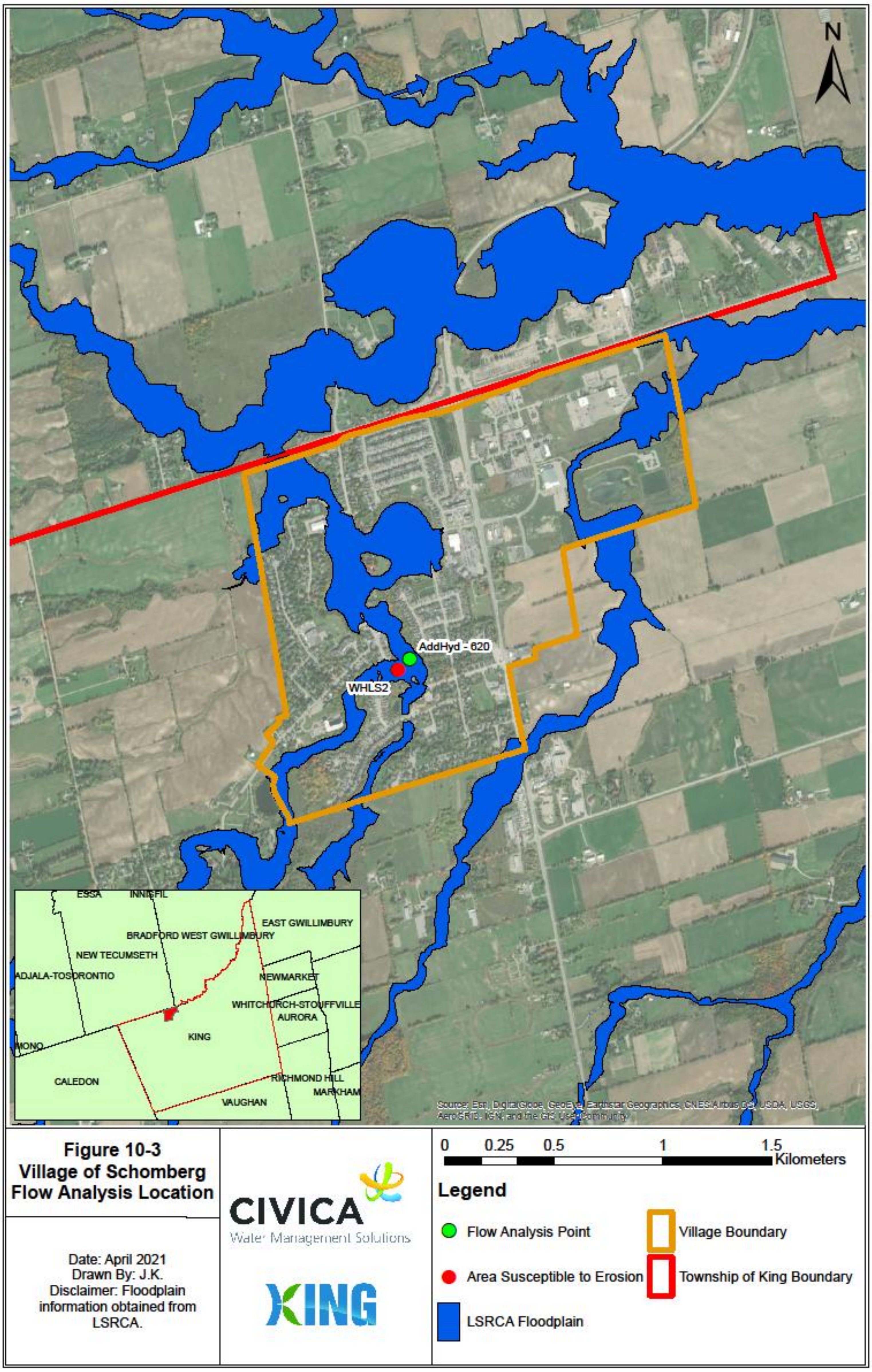


Figure 10-3: Schomberg Model Analysis Locations



10.3.3 Results Summary

10.3.3.1 Water Quantity

The model results show that the preferred solution is effective of at reducing peak flows downstream of all future developments to flows less than the existing conditions. These results prove that implementing traditional SWM and LIDs efficiently and effectively achieves the design targets required for stormwater runoff treatment. The results show reduced peak flow at erosion concern areas and flood prone areas. Therefore, implementing the preferred solution not only meets the targets required for mitigating the affects of increased development but also provides some relief to the existing system. The reduced peak flows analyzed will assist in minimizing degradation of streams due to erosion and assist in reducing flooding.

10.3.3.2 Water Quality

The model shows that traditional SWM measures combined with LIDs designed to meet the criteria defined in Section 10.1 reduce the total amount of pollutants in the natural water courses to less than pre-development levels. The level of treatment provided not only satisfies the criteria set out by conservation authorities for the allowable TSS and TP rates to be released from developments but also improves the quality of water in watercourses from pre-development levels. Therefore, implementing the preferred solution exceed expectations for water treatment quality for protecting natural watercourses and habitats.

10.3.3.3 Water Balance

To increase infiltration that is lost due to future development, LIDs are implemented for each development area. From an infiltration theory, ponding water would penetrate the soil layer through the bottom areas of each LID. Hence, larger contact areas could have higher infiltration and lower runoff. The post conditions with LID controls implemented still show lower infiltration rates than the pre-construction condition because the total area of the LID bottoms is smaller than the area of pervious surface that was available prior to development. To achieve water balance, a detailed hydrological water budget analysis is recommended to be performed during detailed design of each future development to match pre-development infiltration volumes and recharge quality to pre-development levels.

11.0 Develop an Implementation Plan for the Preferred Solution

As the preferred solution provides for comprehensive stormwater management opportunities, there is potential to apply this recommendation at various stages of the stormwater system life cycle as identified in **Figure 11-1**. At each stage of the stormwater system life cycle, it is recommended that a process of investigation and evaluation be followed that will guide the program from the broader challenge or opportunity to a specific solution or action for implementation. This implementation process is summarized in **Figure 11-2**.

This approach will ensure that every stage of the stormwater management life cycle will be considered and that a process is in place to lead to an executable action plan that is sustainable, compliant with regulatory requirements and captured within the long-range planning and funding framework of the Township.

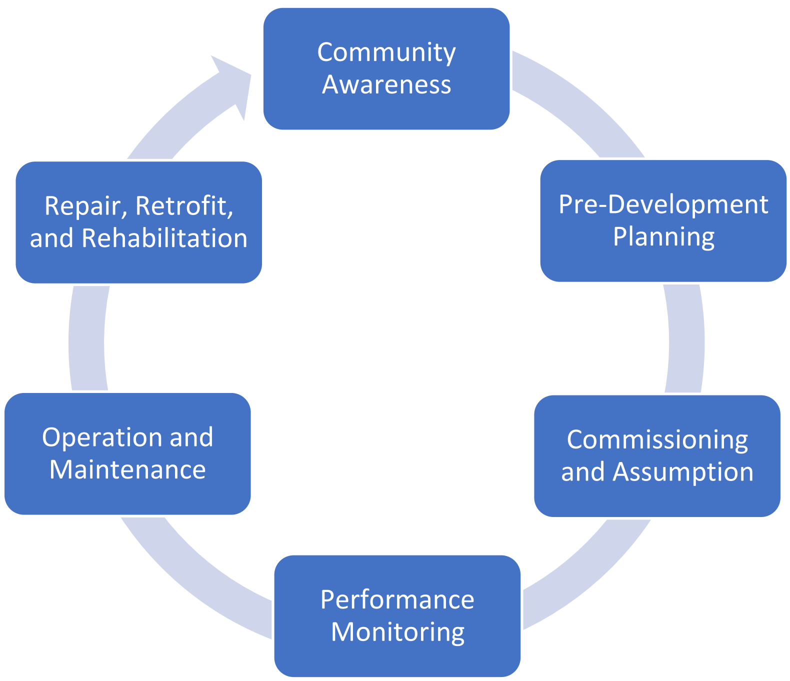


Figure 11-1: Stormwater Maintenance Lifecycle

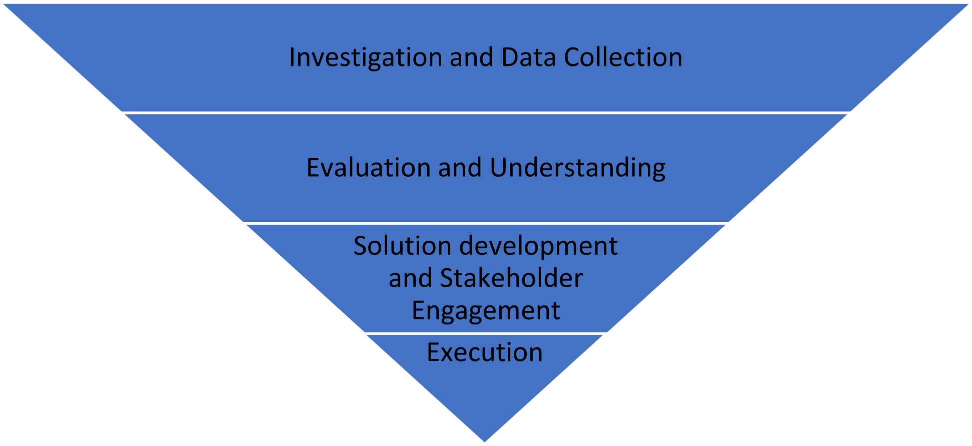


Figure 11-2: Implementation Process

11.1 Stormwater System Life Cycle Stages

As part of a comprehensive approach to managing the Township stormwater assets, it is recommended that a life cycle perspective be adopted that provides for a systematic process for considering the various stages of the asset life. This approach is in line with best practice asset management principles and will further advance other required programs such as the Provincially legislated requirements for asset management plans for core assets. The following sections provide a description of the life cycle stage and considerations that are specific for the Townships current situation.

11.1.1 Community Awareness

Stormwater management begins at the source and a first line of engagement is the community. As a Municipality within York Region, the Township benefits from a comprehensive and mature water reuse program which is primarily focused on reducing water use and wastewater generation. However, this program does have several elements related to an at-source stormwater capture and re-use as a strategy for potable water use reduction. Since the responsibility for stormwater management is a local concern, the Township would benefit from considering the programs presented in **Table 11-1**.

Table 11-1 Community Awareness Programs

Item	Considerations
Integrated Community Sustainability Plan	At the time of the next review, increase the content on stormwater management opportunities and the individual, local and community opportunities to participate in sustainability enhancement.
Education and Awareness Programs	Provide content, tools and best practices materials on Township website Develop partnership with school boards, community groups and special interest groups to advance stormwater management sustainability

Item	Considerations
	Provide incentive program for residents and businesses to learn about and increase their awareness and on-site management contribution for stormwater generation through various opportunities Showcase environmental champions and projects through a Council endorsed awards or existing community recognition program

11.1.2 Pre-Development Planning

Pre-development planning sets the groundwork for future development goals and expectations and is an integral part of community building. The Town sets direction and expectations based on the various planning and engineering policies, guidelines, and plans. This section provides recommendations on improving or adding further content to advance stormwater planning and water resource management in a way that will further advance the Problem/Opportunity Statement. This first stage is laid out to consider the water cycle from source generation to final discharge back to the natural environment and what can be considered to advance these goals and is presented in **Table 11-2**

Table 11-2 Policy and Management Update Considerations

Item	Considerations
Township of King Official Plan	During the OP update cycle, review stormwater planning sections with considerations to the findings and recommendations of this Master Plan
Township of King Design Criteria and Standard Detail Drawings	At next update opportunity include content that further clarifies expectations and requirements for lot level capture, beneficial re-use, in line sediment and quality management requirements
Draft Plan of Subdivision or Condominium Approval Process	Consider request for more extensive submissions for full considerations of stormwater management with emphasis on source control Consider including final assumption fee for first 5 years costs of stormwater treatment feature (ponds, OGS, LID) for operation and maintenance Increase monitoring and reporting requirements for private systems

11.1.3 Commissioning and Assumption

As most stormwater management assets will be a result of development, there is a benefit to having a comprehensive and robust commissioning and assumption process to ensure that the asset meets both the construction and operating requirements and that any deficiencies are properly documented and corrected by the developer prior to assumption by the Township. Opportunities to enhance current practices are presented in **Table 11-3**.

Table 11-3 Commissioning Policy

Item	Considerations
Township of King Design Criteria and Standard Detail Drawings	Include engineer's certification letter requiring verification that as built conditions meet design intent and deviations are documented and compliant with requirements Investigate best management practices in the industry for performance compliance and pre-assumption sediment and erosion management to avoid receiver impacts during construction Include penalties and charges related to non-compliance
Planning Agreements	Identify security for pre-assumption response to performance failure should the developer not respond in a timely manner Include requirement for financial contribution to long-term operating and maintenance costs for first 5 years of Township ownership after assumption (fee structure to be based on industry best practices)
Operation and Maintenance Manual	Every facility should be accompanied by a properly detailed operations and maintenance manual that meets the requirements outlined in comprehensive guidelines such as the Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands prepared by the TRCA

11.1.4 Performance Monitoring

Performance monitoring is a requirement of certification and should be included in the owner's overall operations and maintenance strategies. **Table 11-4** outlines some key considerations and opportunities.

Table 11-4 Performance Monitoring Considerations

Item	Considerations
On site storage and treatment systems	Prepare inventory of significant features to both demonstrate the progress made in private system uptake and as a contact list for future engagement, education and follow up Provide one-on-one inspection, education and training on the use, performance, and benefits of these systems

Item	Considerations
	Establish a program of formal monitoring and compliance tracking where a private system has a regulatory approval requirement to both mitigate owner and Township liability due to system failure resulting from negligence Review and update sewer use and related by-laws to incorporate best practices in private side entry, investigation, and enforcement where stormwater compliance is required
End of Pipe Treatment	Establish a storm pond inspection and monitoring program to verify system components are functional, effective and in good repair Develop a sediment accumulation investigation program to verify sediment quantities and expected clean out schedules to ensure performance targets are met Develop a program for periodic water quality testing for compliance

11.1.5 Operation and Maintenance

The operational and maintenance aspects of stormwater management create the long-term opportunity to optimize the performance and sustainability of stormwater systems. Planned, proactive and integrated coordination of efforts at this level will create long lasting benefit and cost reduction in the life cycle of these assets. Stormwater management operation and maintenance planning and procedures to be implemented within the Township are identified below in **Section 11.3**.

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Table 11-5: Operation & Maintenance Considerations

Item	Considerations
Road maintenance	Largest risk for introduction of deleterious materials occurs from the road network as stormwater is collected from the major system Review street cleaning program with intention of advanced runoff protection practices through review of cleaning cycle, target areas and removal of deleterious materials Educate community on catch basin purpose and responsibility to not introduce contaminants directly into the collection system Review winter maintenance practices with a focused view on stormwater runoff impacts
Collection System	Review and update catch basin cleaning program with intent on proactive response to grit accumulation management to maintain effectiveness of grit retention at source Increase awareness of cross connection issues and risk of introducing wastewater into the stormwater system through CCTV, fog testing and sample bacteria testing Consider catch basin flow control if needed to manage design capacity of minor system and reduce system surcharge and sediment flushing
Receiving and Natural Drainage Systems	Inspect and evaluate downstream receiving conditions and performance based on design criteria, natural watercourse erosion and bank stability and impact of adjacent property owners related to encroachment, structures, and other water course impedances

11.1.6 Repair Retrofit and Rehabilitation

The central aspect of an optimized life cycle is the consideration of how the short- and medium-term activities in operation and maintenance can benefit the long-term performance, sustainability, and cost of SWM facilities. Ultimate need for significant investment in rehabilitation is inevitable but can be mitigated and safely deferred when the short-term operational opportunities and impacts are acted on in a comprehensive and consistent manner. Considerations for best practice opportunities are presented in **Table 11-6**.

Table 11-6 SWM Facility Best Practices

Item	Considerations
Define Service Levels	Define service level expectations for the various stormwater management facility types that consider regulatory compliance, community service and safety, financial performance, and environmental impact
Complete inventory assessment	Verify infrastructure ownership and inventory hierarchy and develop a complete inventory of stormwater assets owned by the Township. Asset risk based on best practices and document risk profiles for each asset class and asset. Identify appropriate risk mitigation, avoidance or assumption approaches and document the preferred risk mitigation strategies being adopted
Condition Assessment and Risk Prioritization	Complete the necessary field inspections and record review to create a comprehensive condition assessment and response strategy. This review will result in a comprehensive repair and maintenance program that can be allocated appropriate operating and capital funding
Pond Sediment Investigation	Initiate a bathymetric survey of the storm ponds to assess actual remaining storage capacity and refine the sediment removal program
Create a 10-year project list and financial forecast	To establish the long-term investment needs for creating affordable and effective SWM facility best practices
Explore alternate funding strategies	Consider alternate funding strategies for stormwater infrastructure operation, maintenance, and capital investment-based on examples from industry best practices

11.2 Implementation Process

11.2.1 Investigation and Data Collection

The foundation for effective decision making is to identify the most important information needs and initiate projects and programs to incorporate routine investigation and data collection practices for the Township.

Key areas for investigation are identified in the previous sections and will form the basis for better decision making and planning. Specific areas include:

- LiDAR Survey of municipal right-of-ways to have current and accurate topographical data
- Rural ditch survey to confirm rural network functionality and interconnection to quality and quantity control features

- Updated CCTV and related condition assessments to inform any maintenance and future capital needs
- Culvert inspection program to inform any maintenance and future capital needs
- Continuous flow monitoring and water quality monitoring to assess performance and update/calibrate system models
- Rainfall monitoring to gather environmental data and relate system performance to environmental events for calibration and validation of system model

11.2.2 Evaluation and Understanding

Once the investigation and data collection are complete, various tools and framework models should be updated or implemented to allow for effective information evaluation and system understanding. Where there are no existing tools or a framework in place, new tools will be developed to benefit the future management of the stormwater infrastructure. The proposed tools are as follows:

- Stormwater model update and calibration- Utilizes minor and major system data collected to assist in determining required capital projects. The accuracy of the model is dependent on the quality of the data collected.
- Climate change adaption and mitigation policy- As climate change progresses, there are indications that the intensity, duration, and frequency of storm events are changing. An adaption strategy and infrastructure mitigation policy will assist in increasing infrastructure resilience
- Stormwater Policy and By-Law Review and Update- A comprehensive review and update to the Township's existing stormwater management policies, by-laws, and other supportive documents to ensure that they are both in place and up to date as appropriate. The goal is to create consistency with existing and future planned updates to Provincial and Federal regulations and to support the implementation of the proposed stormwater management strategies.
- Stormwater infrastructure update funding studies and associated policy- Stormwater funding within the Township is currently tax supported in its entirety. A policy determining potential user rates would support the capital requirements for operational and maintenance upgrades. The tools and framework above will support the studies required to determine the most practical and cost-effective strategies for implementation and can leverage previous model guidelines prepared by Civica.

11.2.3 Solution development and Stakeholder Engagement

As an outcome of the above actions, the Township in consultation with the relevant stakeholders will be in a position to identify and recommend appropriate solutions to the identified challenges and opportunities. Depending on the scope and scale of the final recommendations, further approval activity may be required depending on the MEA Class EA schedule the specific projects fall under. As a preliminary assessment of potential future projects, a number of expected projects are documented.

11.2.4 Execution

Delivery of future projects will be based on the priority and funding availability of the Township. Ideally, the long-term financial plan will be incorporated into the Townships annual and forecast funding model and considered/ reviewed on an annual basis as new information is collected and as future needs dictate. Through a systematic approach of planning, forecasting, and requesting the necessary long-term funding, the program will deliver the required projects and capital investments when needed to create the expected benefits to the community and natural environment.

11.2.5 LID Implementation

Low Impact Development strategies are discussed separately due to the importance of these features as an approach to at source capture and treatment. Implementation of these features will significantly benefit the performance and capacity availability of the downstream collection, treatment and receiving water bodies.

An important consideration in the use of LID options is that the villages in the Township are typically in, or in the vicinity of, a wellhead protection area, highly vulnerable aquifer, or significant groundwater recharge areas. The benefits of maximizing infiltration options are that these natural features will be more sustainable and beneficial reuse will be maximized.

As these communities all have similar characteristics, it is recommended that a standard approach be taken across the entire Township for infiltration LID solutions. Infiltration LIDs should only be considered in areas with low potential for contaminated water such as roof-drain connections and landscaped areas. Further analysis may be conducted in consultation with the appropriate approval agency, during the detail design stage for proposed developments, to determine the impact of infiltration to nearby aquifers or wellhead protection areas if LIDs are implemented over an entire development area. Infiltration methods are preferred LID techniques because of their efficiency and affordability. The soil types in the area identified by the Soil Survey of York Country Report No. 19 are predominantly clay loam which are not ideal for infiltration LID methods. However, some benefit will be gained, and detailed design is required to include assessment of site-specific percolation and infiltration capacity in coordination with a hydrogeologist.

The proposed development land uses within the Township consist of low-rise residential, employment, commercial, mix-use, and transit stations. Land use classifications can be grouped together to form two land use classification groupings. The land use classifications identified for each grouping are classified based on similar lot-level LID opportunities which can be feasibly promoted based on the opportunities provided by the typical land cover of the land use classification groupings (available open space, parking area, underground storage opportunities, etc.). The proposed land use classifications for identifying potential LIDs are residential and non-residential. These two groups allow flexibility in development standards to incorporate alternative SWM designs and techniques. Typical LID options are presented in **Table 11-7**.

Table 11-7: Typical LID Techniques

Residential LID Techniques	Non-Residential LID Techniques	End-of-Pipe LID Techniques
• Rear-Yard Soak Away Pit/Infiltration Trench • Grassed-swale • Rain gardens	• Rainwater Harvesting • Permeable Pavement • Underground Storage Chamber • Oil-Grit-Separator	• Bioswale • Perforate Pipe System

Table 11-10 presents typical LID operation & maintenance practices and average costs that can be found in public documents.

11.3 Stormwater Management Operations and Capital Planning

11.3.1 General Considerations

To facilitate the long-term performance and peak operational condition of all stormwater management assets, it is recommended that consideration be given to the life cycle of the various types of control and treatment facilities. This section provides best practices for the management of the Township's assets related to stormwater ponds, LID features, and oil grit separators. An asset management approach is provided wherein the focus for this section is specifically for asset assumption, inspection, and maintenance of the stormwater treatment and control components. Future expected capital requirements are also identified for planning and financial needs analysis, however, will require verification once further information and evaluation is completed.

11.3.2 Asset Management Planning Process

Asset management best practices provide a framework for a systematic approach to the governance, management, and maintenance of infrastructure assets to assist in realizing the delivery of the highest and best value for the purpose intended. This is achieved through applying a life cycle approach to the process of need identification, design, creation, operation, and long-term maintenance of these facilities. There are several recognized organizations providing useful management models and the following is the International Infrastructure Management Model (IIMM) process model as an example of the full life cycle considerations.

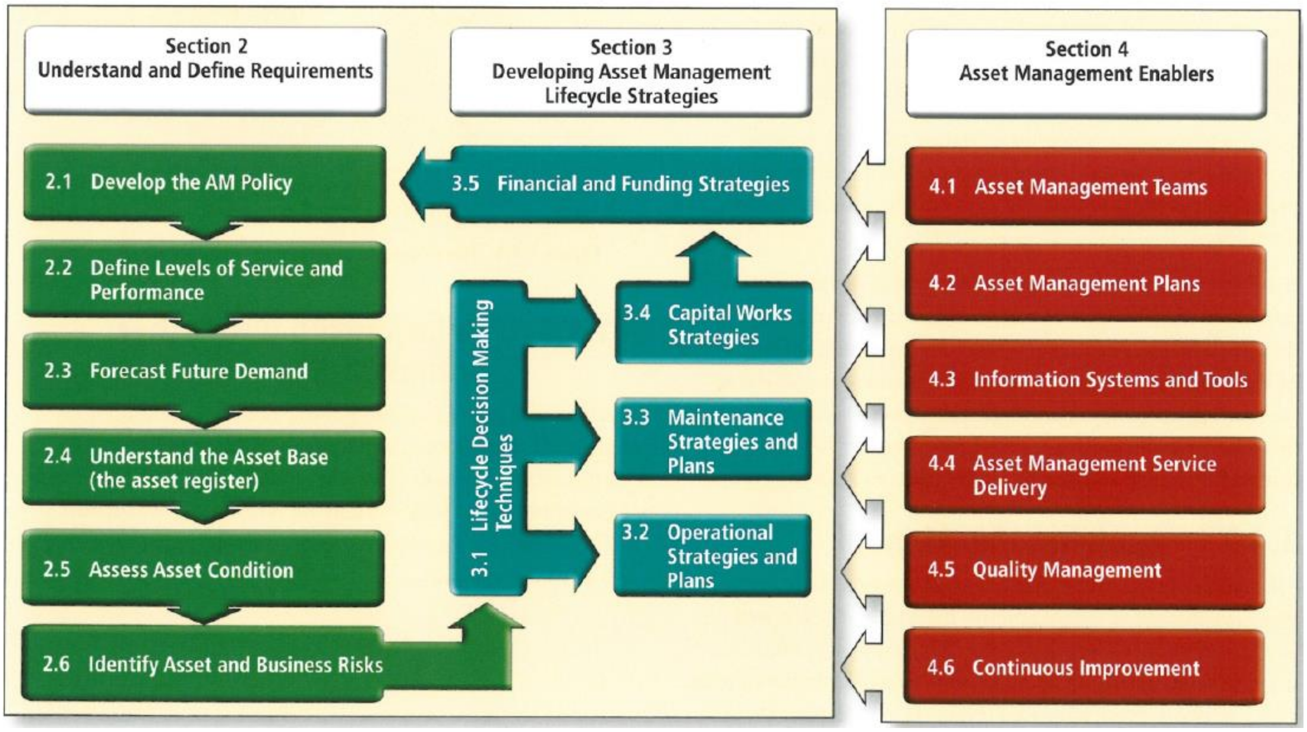

Figure 11-3: Asset Management Planning Process

The Township's most recent asset management plan was prepared by GHD in 2016. It provides a high-level summary of the various assets captured in that plan. As part of the recommendations, it identifies the stormwater assets as an area where more accurate information is required to be collected and includes in future asset management plans. As part of the Municipal Asset Management Planning Regulation (O.Reg. 588/2017), all municipalities are required to provide updated Asset Management Plans for core assets by July 1, 2022 (Province deferred one year). The Township is currently developing an updated asset management plan for core infrastructure assets. The guidance and information provided here will assist the Township in advancing their information and decision-making capabilities for the stormwater treatment and flow control systems.

The Regulation requires a summary level of information for the following:

- Asset type (Storm Pond and OGS data with capacity, location and other high-level characteristics)
- Replacement cost valuation (which is now a forward-looking account of future costs including inflation which is a departure from the previous asset valuation requirements that were based on asset book value)
- Average age of asset
- Asset condition (providing the municipalities approach to assessing the condition such as excellent, good, fair, or poor)

This model is provided as a guide for future activities and as part of the short-term need for a revised asset management plan.

11.3.3 System Investigation and Studies

Previous sections within this report define various potential for projects and solutions necessary to improve the quality of the existing SWM system in the Township are included in the financial plan along with timing and expected outcomes. **Table 11-8** summarizes the recommendations in this report to be considered when implementing the SWM operation & maintenance program.

Table 11-8: Specific Project Implementation Recommendations

Recommendation	Description/Next Steps	Section Reference
Floodprone Area Studies	Determine the capacity of existing conveyance structures upstream and downstream of floodprone areas identified	4.7.2
Inventory and condition assessment of existing conveyance systems	Detailed surveys are required throughout the Township to identify and quantify the amount and type of stormwater conveyance infrastructure owned & operated by the Township	7.3
Nobleton Flooding Remediation	Implement the culvert upgrade recommendations identified in The Nobleton Drainage Study performed by R.J. Burnside & Associates Limited in 2016 to improve conveyance capacity for flood remediation	7.3
Easement Investigations	Review MPAC Township property ownership for potential unidentified easements and verify the presence of existing Township stormwater infrastructure	7.3
Pollution Prevention Measures and Municipal Management/Operational Practices	Adopt PPM measures and practices identified by Conservation Authorities to provide source control for pollutants entering SWM facilities	9.5.1
Stream/Erosion Restoration	Implement stream restoration methods and strategies to erosion concern areas identified	4.7.1, 4.8 and 9.5.2
Climate Change Adaptation	Consider climate change data analysis for design criteria when designing future SWM controls	9.5.3

11.3.4 Operational and Maintenance Program

Maintenance should be planned and perform in a proactive program cycle including, condition assessment inspections, scheduled maintenance responses, approved funding, and reporting. Ideally the maintenance schedule can be divided into routine operational maintenance and repair activities and longer term more capital-intensive projects requiring separate funding approval, design and permitting efforts and contracted specialty services. The Township does not currently have an active operation and maintenance plan and implementing one would create new work for the Township portfolio that did not previously exist. Additional staffing will be required to provide support for the stormwater operation & maintenance program.

For the purposes of this study, it is assumed that each site will be visited on a quarterly basis for routine maintenance and operational needs. Activities beyond that will be considered as part of more extensive capital requirements or as later identified through more detailed investigations. Several publicly available manuals and guides are available to support the Township in creating comprehensive operation and maintenance plans including the S.T.E.P. Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands from TRCA (2018), LSRCA LID Guidance Documents (Web Library), S.T.E.P. Maintenance of Hydrodynamic Separators: Case Studies from Three Ontario Municipalities TRCA (2012).

Typical routine operation and maintenance activities for Traditional SWM facilities and LID's are outlined in **Table 11-10** along with the typical frequency and costs associated with each maintenance activity. The Township shall reference these activities when developing their operation & maintenance program but shall continue to update their procedures based on specific maintenance requirements identified through the asset management planning process. The cost of maintenance activities may vary due to site specific conditions and changes required to typical maintenance procedures based on new information or an increase in maintenance and operation standards. As maintenance occurs, the cost of each activity should be well documented in the asset management process to identify typical costs associated with the Township to improve budget forecasting. The estimated Township's annual O&M costs presented in **Table 11-10** are preliminary, high-level estimates, which assume that inspection services will be carried out annually and that the entire SWM system is in good condition and meets the required level of service. These costs may vary based on actual conditions found in the stormwater system. For example, the annual cost of storm sewer operation is determined assuming 1% of Township wide storm sewers will require maintenance annually. Implementing inspection programs will assist in determining the Township specific requirements for annual maintenance.

Table 11-9: SWM Facility Condition Assessment Repair Costs

Facility ID	Component ID	Condition	Maintenance Cost	Priority
NTPO_0001	Outlet_03	Side walls around culvert have collapsed	$ 6,000.00	Medium
NTPO_0002	Inlet_01	Significant sediment buildup	$ 3,000.00	Medium
	Outlet_01	Outlet pipe is bent and there is significant sediment surrounding the hickenbottom structure	$ 3,000.00	High
	Outlet_02	Tree blocking inlet and concrete headwall is cracked	$ 2,500.00	Low
NTPO_0004	Inlet_01	Significant sediment buildup	$ 3,000.00	Medium
NTPO_0005	Inlet_01	Headwall and fence is damaged	$ 1,500.00	Low
NTPO_0008	Inlet_01	Inlet Pipe is fully submerged	$ 1,000.00	Medium
	Outlet_01	Outlet pipe is bent and there is significant sediment in the hickenbottom structure	$ 2,500.00	High
	Outlet_02	Tree obstructing outlet pipe	$ 1,000.00	Low
NTPO_0009	Inlet_01	Crack in pipe	$ 1,500.00	Low
	Outlet_03	Crack in pipe	$ 1,500.00	Low

Table 11-10: Average Annual Operation & Maintenance Costs

Operation/Maintenance Activity	Frequency	Type of Stormwater Management Structure												
		Wet Pond / Wetland / Dry Pond	Infiltration Basin	Infiltration Trench	Filter Strip	Superpipe Storage	Filters	Oil/Grit Separator	Soakaway Pit	Pervious Pipe	Grassed Swales & Roadside Ditches	Catchbasin	Culvert	Storm Sewer
Inspection	Annually & After Significant Rain Event	$250/ha	$150/ha	$150/ha	$150/ha	$150/m	$150/ha	$350/ea	$150/ha	$150/m	$150/m	$150ea		
Grass cutting	Bi-Weekly	$300/ha	$300/ha	$300/ha			$300/ha				$300/ha			
Weed Control	Annually	$2500/ha	$2500/ha		$2500/ha						$2500/ha			
Upland vegetation replanting	Annually	$200/ha	$200/ha	$200/ha	$200/ha		$200/ha							
Roof leader filter cleaning/replacement	Annually & After Rain Event								$100/ea					
Pipe flushing (Inlet, outlet, subdrain, perforated)	Annually/Bi-Annually	$200 to $850/m				$200 to $850/m				$850/m			$200 to $850/m	$200 to $850/m
Oil/Grit separator or Catchbasin cleaning	Annually							$2100/ea				$500/ea		
Closing of infiltration facility inlet for winter months	Annually		$100/ea	$100/ea			$100/ea			$100/ea				
Trash/debris removal	Monthly	$50/ha	$50/ha	$50/ha	$50/ha		$50/ha		$50/ha		$50/ha			
Average Annual O&M Costs		$6850/ha ~$525/m	$3900/ha $100/ea	$700/ha $100/ea	$2900/ha	~$725/m	$700/ha $100/ea	$2450/ea	$200/ha $100/ea	$1000/m $100/ea	$2850/ha $150/m	$650/ea	~$600/m	~$600/m
Estimated Township Annual O&M Costs		$155,000/yr						$30,000/yr				$286,000/yr	$200,000/yr	$100,000/yr

Note: Estimated Township O&M costs are estimated based on the following available information

Total Pond Black Area = 15ha   Total Length of Culvert = 18km (Culvert cleaning frequency is very case-by-case specific).

Total Catchbasins = 2191   Total Length of Storm Sewer = 87km

Table 11-11: Average Cleanout Costs

Operation/Maintenance Activity	Frequency	Type of Stormwater Management Structure									
		Wet Pond / Wetland / Dry Pond	Infiltration Basin	Infiltration Trench	Filter Strip	Superpipe Storage	Filters	Oil/Grit Separator	Soakaway Pit	Pervious Pipe	Grassed Swales & Roadside Ditches
Shoreline Fringe and Flood Fringe vegetation replanting	Facility Cleanout	\$1000/ha									
Aquatic vegetation replanting	Facility Cleanout	\$3500/ha									
Removal of accumulated sediments	Facility Cleanout (~5 years)	\$1000/m^3	\$1000/m^3	\$1000/m^3	\$1000/m^3		\$1000/m^3	\$1000/m^3		\$1000/m^3	\$1000/m^3
Outlet valve adjustment	Facility Cleanout	\$200/ea									
Infiltration basin floor tilling	Facility Cleanout		\$2800/ha								
Filter Media Replacement/Restoration	Facility Cleanout			\$1500/ha	\$1500/ha				\$1500/ha		
Cleanout & Retrofit Design		~\$15000/ea									
Average Costs		\$4500/ha \$1000/m^3 \$15200/ea	\$1000/m^3 \$2800/ha	\$1000/m^3 \$1500/ha	\$1000/m^3 \$1500/ha		\$1000/m^3	\$1000/m^3	\$1500/ha	\$1000/m^3	\$1000/m^3
Estimated Township Cleanout Costs		\$400,000+/facility						\$3,000/ea			

Note: Estimated Township O&M costs are estimated based on the following available information
Total Pond Black Area = 15ha

Table 11-12: 10-year Operation & Maintenance Costs

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Annual Operation & Maintenance	\$ 761,000.00	\$ 783,830.00	\$ 807,344.90	\$ 831,565.25	\$ 856,512.20	\$ 882,207.57	\$ 908,673.80	\$ 935,934.01	\$ 964,012.03	\$ 992,932.39	\$1,022,720.36
Annual Capital Costs	\$ 600,000.00	\$ 550,000.00	\$ 1,100,000.00	\$ 450,000.00	\$ 450,000.00	\$ 450,000.00	\$ 600,000.00	\$ 550,000.00	\$ 700,000.00	\$ 550,000.00	\$ 850,000.00
Total Costs	\$ 1,361,000.00	\$ 1,333,830.00	\$ 1,907,344.90	\$ 1,281,565.25	\$ 1,306,512.20	\$ 1,332,207.57	\$ 1,508,673.80	\$ 1,485,934.01	\$ 1,664,012.03	\$ 1,542,932.39	\$ 1,872,720.36

11.3.5 Capital Project Plan

Typically, capital projects are defined as those activities that result in an addition to the Township's asset base, are non-routine and require a prioritization or considering in the overall funding envelope available to all departments. The projects identified in this study are primarily related to the maintenance and rehabilitation of storm ponds. Although not specifically identified in this assessment, those facilities that may require advanced capacity recovery or performance improvement due to the need created by community growth and development should be considered is eligible projects for developer funding under the provision of the Development Charges Act. The Township should consider this funding opportunity when growth is a consideration in any capital investment on the stormwater infrastructure collection and treatment systems. The plan provides a budget guide for various activities and any potential need for further MEA Class EA activities. The infrastructure costs for stormwater servicing identified in the Development Charges Report (2020) are provided in **Appendix M**.

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Table 11-13: Capital Projects

Project Description	Type	Class EA Schedule	Priority	Year(s)	Recurrence	Estimated Budget
Studies and Programs						
Pond Sediment and Bathymetric Survey (20 sites all wet ponds)	Study	NA	High	2022	5 -10 yrs	$300,000
Township Wide Stormwater Asset Inventory and Condition Assessment	Study	NA	High	2023	Ongoing	$200,000
Stormwater Policy Review and Update	Study	NA	High	2023	5 yrs	$25,000
Design Standards and Planning Approval Requirements Review	Study	NA	Medium	2023	5 yrs	$25,000
Continuous Water Quality Monitoring and Flow Monitoring Reporting (20 sites for 2 years)	Study	NA	Medium	2024	Ongoing	$800,000
Stormwater Model Update	Study	NA	Medium	2025	5 yrs	$150,000
Climate Change Action Plan and Best Practice Review	Study	NA	Medium	2026	10 yrs	$50,000
Community Awareness and Education Program develop	Study	NA	Low	2026		$50,000
Stormwater Revenue and Rate Options Study	Study	NA	Low	2026		$50,000
Enhanced Treatment Study Dry Pond Retrofit Options (4 sites)	Study	NA	Low	2027		$150,000
Total Studies and Programs						**$1,800,000**
Operation and Maintenance Considerations						
SWM Pond Sediment Removal NTPO-1, 2 and STPO-4, 5	Maintenance	A+	High	2022-2026	10 - 15 yrs	$800,000
SWM Pond Sediment Removal STPO-2, 3	Maintenance	A+	Medium	2027-2030	10 -15 yrs	$400,000
SWM Pond Sediment Removal NTPO-3, 5, 6, 7, 9 STPO-1, KTPO-1, 2, 3, 4, 7, 8, 9,10, 11, 12, 13	Maintenance	A+	Low	2030+	10 – 15 yrs	$3,400,000
SWM Pond Operation and Maintenance Activities (assume 31 sites)	Maintenance	NA	High	Annually		$155,000
OGS Maintenance Program (12 sites)	Maintenance	NA	High	Annually		$30,000
Total Annual Maintenance						**$180,000**
Capital						
Pond Construction as Per LSRCA Report 2007 (12 potential sites)	Construction	B	Medium	2028+ Individual Priority	2 – 5 yr	$3,000,000

11.3.6 Stormwater Levy

Operation & maintenance of SWM facilities is a costly endeavor which often struggles to receive funding within municipalities due to the competition for funding of other municipal projects. The benefits and of maintaining and cleaning out SWM facilities are typically not directly observed by residents or council as the impacts affect downstream receiving bodies and the natural environment. Stormwater issues are typically funded until flooding or damages occur. It is important to preserve the quality of the natural environment as it indirectly affects the quality of life in municipalities. A study has been performed by Civica to assess the potential for implementing a stormwater levy to provide a dedicated funding source in support of stormwater related capital projects and operations and maintenance activities and is included in **Appendix O**. The purpose of the study is to identify the most fair and effective way to implement a SWM Levy within the Township, with specific consideration given to the large percentage of rural and farm landuse in the Township. The SWM Levy report concludes that implementing a SWM levy would be beneficial for providing funding for SWM maintenance and capital projects. The SWM levy implementation would be phased in over multiple years which will allow a shift of funds to slowly be integrated to balance out payments and prevent on overall tax increase for residents and businesses.

12.0 Public Consultation

12.1 Public Consultation Process and Project Applicability

The public consultation for this project followed the MEA Class EA Planning and Design process for Phases 1 and 2 of the planning process. The key stakeholder and public engagement events that were undertaken in this project are as follows:

- Public Notice of Project Commencement
- Notice to Indigenous Communities
- Phase 1 Discretionary Public Information Centre No. 1 Advertisements
- Phase 2 Public Information Centre No. 2 Advertisements
- Notice of Completion

The outcome of this master planning effort has primarily identified further studies and operations and maintenance activities that are either exempt from the Class EA process as schedule A/A+ projects or are not considered in the process. However, a previous LSRCA Report (2007) identified capital improvements that could contain Schedule B project as further scoping is undertaken.

For this reason, this project has followed the full consultation process to ensure that all reported public and stakeholder concerns are addressed. This study is intended to address phase 1 and 2 of the class EA process and is to be used as a foundational support for future investigations of specific schedule B and C projects identified within.

12.2 Key Stakeholders

Four categories of stakeholders were identified for this project and a summary list of non-public stakeholders addressed for this project can be found in Appendix N. The main groups considered for this project are:

- Public- Individual community members, land owners, interested parties, community representatives and other with general or specific interest in the project based on their engagement through public notifications and other broadly distributed communication channels
- Review Agencies- Representatives of policy positions, and agencies whose position may result in regulatory or statutory approval and whom are communicated with directly to establish early contact and interest in the project.
- Indigenous Communities- Those communities who have a potential interest caused by location, activity or other priority concern or interest and whom are communicated with directly to establish early contact and interest in the project.
- Municipalities- other than the proponent that either may experience an impact or have other municipal interest/review authority in the outcome of the project.

12.3 Notice of Commencement

The notice of commencement was prepared and distributed to stakeholders and review agencies for their feedback on August 15, 2019. The notice informs stakeholders of the of the Master Plan initiation and the

Master Plan's proposed adherence to the Municipal Class Environmental Assessment Process. Background information is provided regarding the purpose of the study for evaluating stormwater practices to meet the growth defined in the Township Official Plan. In addition, it is stated that additional information is provided through the Township website throughout the study (www.king.ca). The Notice of Commencement was made available to the public on www.king.ca.

12.4 Notice to Indigenous Communities

The notice to indigenous communities was prepared and distributed to indigenous communities for their feedback on April 20, 2021. The notice describes the procedure taken to complete the Master Plan and informs of the preferred solution for addressing increased stormwater runoff in the Township.

The notice, the list of indigenous communities notified about the Master Plan, and resulting correspondence are provided in **Appendix N.**

12.5 PIC#1

Due to Covid-19 restrictions, PIC#1 was held virtually using WebEx meetings on November 27, 2020. A presentation was held explaining the Stormwater Master Plan and its process. PIC#1 was advertised through the Township website, social media, and local newspaper. The key topics presented at PIC#1 were:

- Objectives of the Stormwater Master Plan
- The Municipal Class Environmental Assessment Process
- Township Existing Conditions and Future Growth
- Problem/Opportunity Statement
- Stormwater Improvement Alternatives

Following the presentation, a discussion granting participants the opportunity to ask questions and provide feedback on the Master Plan. A comment sheet was made available to the public on the king website (https://speaking.king.ca/stormwater-master-plan). One of the main themes of discussion from the attending participants was concern for flooding risk and the benefit of LID features to better manage surface water. One attendee commented that stormwater flooding is a reoccurring issue in Nobleton that requires addressing when planning for stormwater in the future. The major concerns identified in the completed comment sheet are issues relating to existing flooding issues within the Township, specifically downstream of new developments and within floodplains. These issues will be addressed in future phases of the EA process where detailed design will incorporate the preferred solution to address flooding issues relevant to the specific project. The overall analysis completed in this report reflects that implementing the preferred solution at new developments and retrofit opportunities at end-of-pipe controls decreases flows and increases water balance which directly reduce the amount of flooding within the Township.

12.6 PIC#2

PIC#2 was held virtually using WebEx meetings on April 1, 2021 following the same procedures as PIC#1. PIC#2 was advertised through the Township website, social media, and local newspaper. The key topics presented at PIC#2 were:

- Stormwater Management Preferred Solution

- Implementation Plan
- Inspection & Maintenance Plan

There was further focus on flooding concerns and support for LID features as a possible benefit to these challenges. It was further communicated that the Master Plan is a high level document and that more detailed design considerations and investigations would be undertaken at the project implementation stage.

All comment sheets, list of attendees, and PIC presentations are available in **Appendix N.** Following PIC#2, no comment sheets were submitted by attendees or the general public.

12.7 Notice of Study Completion

The notice of completion was prepared and distributed to stakeholders, review agencies, and indigenous communities on July 8, 2021 to inform of the completion of the study for public review and comments. The notice states the preferred solution for implementing LID's along with traditional SWM operations as part of the King Township Stormwater Master Plan to address stormwater runoff issues. The Notice of Study Completion was published for public review on https://speaking.king.ca/stormwater-master-plan.

One comment sheet and comments from the TRCA and MECP were received and responded to Responses are noted in **Appendix N**.