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THE CORPORATION OF THE TOWN OF WHITBY

Central Lake Ontario Conservation

Lynde Creek Master Drainage Plan Update – Municipal Class Environmental Assessment

Master Plan Project File Report – Final

Town of Whitby in Partnership with Central Lake Ontario Conservation Authority

60566558

September 2022

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AECOM Canada Ltd.
300 Water Street
Whitby, ON L1N 9J2

T: 905 668 9363
F: 905 668 0221
www.aecom.com

Date: September 12, 2022

Project #: 60566558

Peter Angelo, P.Eng.
Director, Engineering Services
Town of Whitby
575 Rossland Road East
Whitby ON L1N 2M8

Perry Sisson
Central Lake Ontario Conservation Authority
100 Whiting Avenue
Oshawa ON L1H 3T3

Dear Mr. Angelo and Mr. Sisson:

Subject: Lynde Creek Master Drainage Plan Update – Municipal Class Environmental Assessment, Master Plan Project File Report – Final

Please find enclosed an electronic copy of the Lynde Creek MDPU Master Plan Project File that addresses updates and comments provided by the Town and CLOCA, based on the February 2020 Working Draft. These include updates to existing hydrologic parameters and design rainfall distributions, that account for the impact of climate change, as well as comments provided in August 2021.

The MDPU incorporates these changes, and others, by references to new studies provided by the Town and CLOCA including:

- Technical Guidelines for Stormwater Management Submissions (CLOCA October 2020)
- Town of Whitby Bridge and Culvert Master Plan (ERI December 2020)
- Michael Boulevard Flood Mitigation Study (MIG December 2020).
- Climate Change IDF Curve Development - Memo (KSGS March 2021)
- Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region (OCC February 2020)

This report is being submitted as final and will be made available for public comment for a period of 30 calendar days starting on September 12, 2022 and ending on October 12, 2022.

Should you have any questions regarding the Lynde Creek MDPU, please do not hesitate to contact me by email Paul.Frigon@aecom.com.

Sincerely,
AECOM Canada Ltd.

P. Frigon

Paul Frigon, P.Eng.
Senior Engineer, Water
Paul.Frigon@aecom.com

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Authors

Report Prepared By:

Karl Grueneis, B.A
Senior Environmental Planner
Karl.Grueneis@aecom.com

Report Reviewed By:

Paul Frigon, P.Eng.
Senior Engineer
Paul.Frigon@aecom.com

Prepared for:

Town of Whitby in Partnership with Central Lake Ontario Conservation Authority

Prepared by:

Paul Frigon, P.Eng.
Senior Engineer
Paul.Frigon@aecom.com

AECOM Canada Ltd.
300 Water Street
Whitby, ON L1N 9J2
Canada

T: 905.215.1400
F: 905.668.0221
www.aecom.com

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Revision History

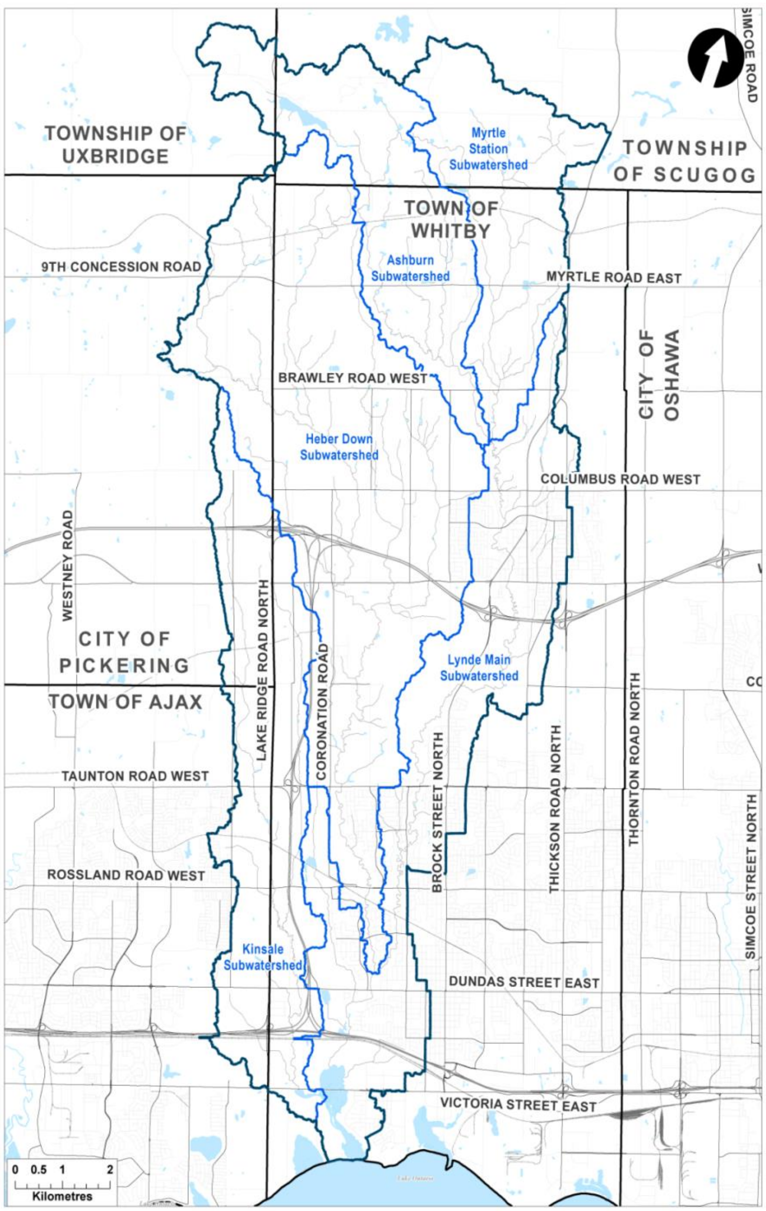
Revision Number	Date	Revised By	Revision Description
1	March 26, 2019	SZ, KG, PF	Address comments from the Town, CLOCA and KSGS Engineering
2	June 6, 2019	SZ, KG, PF	Address comments from the Town, MECP, MHSTCI, TRCA and Adjacent Municipalities
3	October 7, 2019	PF	Address comments from the Town – Figures 4-1 and 8-3, and Executive Summary
4	February 12, 2020	PF	Address comments from the Town regarding cost
5	May 12, 2021	PF	Update with revised Hydrology (Land Use and Climate Change) and Watercourse Crossing Upgrades
6	October 25, 2021	PF	Address comments from the Town and CLOCA
7	February 1, 2022	PF	Final
8	September 12, 2022	PF	Final posted for 30-day comment period

Executive Summary

Introduction

The Town of Whitby (hereafter "the Town" or "Whitby") in partnership with the Central Lake Ontario Conservation Authority (hereafter "CLOCA") through their consultant AECOM Canada Ltd. (hereafter "AECOM"), has completed a Municipal Class Environmental Assessment (EA) study for the preparation of a Master Drainage Plan Update (MDPU) for the Lynde Creek Watershed (see **Figure ES-1)**.

Figure ES-1: Study Area



The Municipal Class EA study is in keeping with the Ontario Environmental Assessment Act (EAA) and is following the Class EA Schedule A and A+ projects (Master Plan Approach #1) of the Municipal Class EA document (2000, as amended in 2007, 2011 and 2015), as published by the Municipal Engineer's Association (MEA) and provides the basis for future Schedule B projects.

The study is an update the original 1988 Master Drainage Plan (MDP) and considers a number of additional reports that have been prepared since 1988, including the Lynde Creek Watershed Plan (CLOCA 2012).

Study Area

The Lynde Creek Watershed is predominantly located in the Town of Whitby and also extends into adjacent municipalities to the north and west (Township of Uxbridge, Township of Scugog, City of Pickering, and Town of Ajax). The total drainage area of Lynde Creek and its tributaries is approximately 130 square kilometres and falls under the jurisdiction of CLOCA. The Lynde Creek watershed is divided into five subwatersheds: Lynde Main, Heber Down, Kinsale, Ashburn, and Myrtle Station. The watershed maintains an elongated shape that is approximately 21 kilometres long and varies in width from 5 kilometres near Lake Ontario to 8 kilometres near its headwaters. The Study Area is illustrated in **Figure ES-1**.

Purpose of the Study Update

The purpose of this MDPU is to provide guidance to both the Town of Whitby, CLOCA and other affected municipalities in continued management of the Lynde Creek watershed and stream corridors in terms of flows, erosion, resource protection and land development.

The MDPU recognizes that watershed planning and associated Master Drainage Plans have evolved over the years. The MDPU supports watershed management objectives as directed in the original Lynde Creek Master Drainage Plan (SERNAS, 1988) and in the Lynde Creek Watershed Plan (CLOCA, 2012). The Lynde Creek watershed has experienced and will continue to experience pressures from urban and rural uses. These pressures impact on the watershed's form and function, including but not limited to: flood potential, erosion potential, and natural heritage/ecosystem health. Effective management strategies are needed to protect and restore the Lynde Creek Watershed.

Overall, this Lynde Creek MDPU has been developed within the context of watershed goals and objectives. Goals have been identified in the categories of flood hazard management, stream and related habitat and significant natural heritage features. The MDPU goals are as follows:

- **Flood Hazard Management:**
  - Protect life
  - Protect property/buildings
  - Protect infrastructure – utilities/crossings
- **Streams and Related Habitat:**
  - Riparian aquatic and terrestrial restoration
  - Minimize erosion impacts
  - Improve water quality
- **Significant Natural Heritage Features:**
  - Identify and Protect Wetlands
  - Identify and Protect Species at Risk
  - Identify and Protect Woodlands
  - Identify and Maintain Recharge/Discharge Areas

Communications and Consultation Overview

As per the requirements of the Municipal Class EA process, a number of measures have been undertaken to notify and obtain feedback from agencies, Indigenous communities and the general public during Phases 1 and 2 of this study. Methods included:

- Publication of newspaper notices for all project milestones, including Notice of Study Commencement and PIC Number 1, Notice of Community Open House Number 2, and Notice of Completion
- Placement of notices on the Town's website
- Direct mailing of project milestone notices to stakeholders, study area residents (CN/GO Relief Culverts), review agencies, Indigenous communities and the general public that requested to be kept informed. Notifications were also sent via email, where requested
- Two Public Information Centres to provide an opportunity for the public, review agencies and stakeholders to learn about the project and provide feedback
- Individual meetings with key agencies and stakeholders, including Indigenous communities, as required, or as opportunities arose

Recommendations: Preferred Master Drainage Plan Update

The following alternatives were identified and evaluated to determine which was most effective in achieving the MDPU goals:

- Alternative 1: Do Nothing
- Alternative 2: Continued Implementation of the 1988 MDP
- Alternative 3: Implement the Objectives, as outlined in **Table ES-1,** for the 2021 MDPU

The comparative evaluation of alternative solutions concluded that the recommended preferred solution was **Alternative 3**. Refer to **Table ES-1** for a summary of the recommended watershed improvement projects, including tentative schedule, preliminary cost estimates and level of priority. The projects are addressed in more detail in **Section 8** of the report and are individually summarized in **Table 8-2** and shown in **Figures 8-1** through **8-4**. The following provides an overview related to the categories of watershed improvement projects identified in **Table ES-1**.

Stream and Related Habitat Upgrades and Natural Heritage Protection

The watercourses (streams) in all five subwatersheds have historically been classified as cold water, and have generally been downgraded to cool or warmwater, over time. Additionally, all subwatersheds have been recorded as having Redside dace (*Clinostomus elongatus*), a Species at Risk (SAR) listed as Endangered under the provincial *Endangered Species Act, 2007* (ESA) and the federal *Species at Risk Act* (SARA). Additional development impacts include barriers to fish migration and the loss of wetlands. The objective is to reinstate streams to coldwater status and at a minimum, maintain Redside dace habitat. This will be achieved by:

- Ensuring LID and BMP measures for all new development
- Retrofitting existing water quality stormwater management (SWM) ponds with bottom draw/cooling trench features
- Restoring natural channel characteristics and implementation of erosion protection measures at select locations
- Fish barrier removal
- Fen/wetland evaluation/restoration at selected sites

Barriers to wildlife movement at selected watercourse crossings have been identified and crossing upgrades recommended when the crossings are replaced. The recommended projects are summarised in **Table ES-1**.

Flood Hazard Management

The MDPU identifies existing flood vulnerable areas (Regulatory Flood), watercourse crossings (bridges/culverts) that require upgrading since they pose a risk to crossing failures by overtopping or otherwise failing during design events, and geomorphically undersized crossings (i.e., crossings in which bankfull channel width is greater than the crossing opening). The most significant flood vulnerable area is near Michael Boulevard, upstream of the Highway 401, CN and Metrolinx watercourse crossing complex where 185 structures are at risk from the Regulatory Flood. A recently completed EA evaluated appropriate measures to reduce or eliminate flood impacts in this area: it recommends a Flood Protection Berm to "protect almost all of the homes currently at risk of flooding during the 100-yr return period storm event ", as well as a "Flood Proofing and Education Program". The Lynde Creek MDPU recommended projects are summarised in **Table ES-1**.

Stormwater Management Plan

The stormwater management strategy is divided into four components: SWM for new development, SWM for existing urban areas, SWM during construction; and evaluated Climate Change impact in stormwater management.

The proposed Stormwater Management (SWM) Plan for the watershed is detailed in **Section 5.3** of the report and includes:

- Retrofit to two of the largest SWM ponds in the Town of Whitby, with both bottom draw and cooling trench upgrades to reduce temperature impacts.
- SWM ponds for water quantity and water quality control for the developing Secondary Plan (SP) areas of West Whitby and Brooklin, including erosion control, as identified in Secondary Plan studies.
- Stormwater quality control to MECP "enhanced" standards with an emphasis on thermal impact mitigation.
- On-Site Control Areas (LID) for the Brooklin SP area
- Guidelines for existing urban areas (intensification, re-development) that include:
  - Post to Pre water quantity control (2-Yr through 100-Yr storms) for all new development north of Dundas Street; Regulatory storm control not required
  - Requiring LID measures for infill and re-development; especially water quality control and maintenance of pre-development water balance (infiltration)

  - Ensuring SWM Pond, storm sewer, catchbasin maintenance through sediment removal
  - Downspout disconnection program
- SWM during construction through the implementation and monitoring of Erosion and Sediment Control Plans
- Climate change impact on major infrastructure design, as it relates to drainage, was reviewed and evaluated using the Town's proposed IDF curves that have been updated to reflect climate change. It was determined that riverine flow is increased approximately 30% when compared with normal flows, without climate change. The details of the climate change impact evaluation in drainage system is discussed in **Section 3.4.7** of the report.

Recommended projects for SWM are summarised in **Table ES-1**.

Studies, Guidelines and Monitoring

A series of studies, guideline development and monitoring programs being proposed as part of this MDPU will assist in:

- Confirming flow estimates for the watershed through hydrologic model calibration/validation
- Providing a comprehensive set of guidelines for SWM for both existing urban areas and future development
- Developing a Salt Management plan to improve water quality adjacent to roadways and maintenance buildings
- Providing data for the hydrologic model study and assessing the effectiveness of SWM measures implemented in the Heber Down subwatershed.

The proposed series of studies, guideline development and monitoring programs are summarised in **Table ES-1.**

Table ES-1: Recommended Projects: Lynde Creek Master Drainage Plan Upgrades

Category	Objective	Project Type	Project Description	Schedule (years)	Total Capital Cost (x $1,000)	Priority
Stream and Related Habitat upgrades; Erosion Protection; Significant Natural Heritage Features	Riparian Restoration	Vegetation Planting/ Management/ Bank Stabilization (Total projects: 11)	Plant native trees, shrubs, live stakes/native seed either side of watercourse	5 to 10	$650	low
	Wetland Enhancement	Fen Enhancement and Increase Land Connectivity (Total projects: 1)	Conversion of agricultural land into succeeding woodland to increase vegetation protection buffer around fen community and increase land connectivity.	5 to 10	$200	medium
	Fish Barrier Removal	Channel Restoration (Total projects: 13)	Allow for fish passage and connectivity of headwater communities where aquatic species at risk are potentially present	5 to 10	$950	low
	Erosion Protection	Erosion Restoration (Total projects: 11)	Channel Realignment away from residential property, riparian restoration, and localized bank stabilization.	5 to 10	$1,100	high
Stream and Related Habitat upgrades; Erosion Protection; Significant Natural Heritage Features	Wildlife Crossing Upgrades	Wildlife Crossing [Total projects: 18) [two project coincide between the eleven identified Watercourse Crossing Upgrade projects and the eight identified Geomorphically undersized projects]	Incorporation of wildlife crossing structure into culvert upsizing opportunities	10 to 20 integrated with roadway improvements	$1,800	low

Category	Objective	Project Type	Project Description	Schedule (years)	Total Capital Cost (x $1,000)	Priority
Flood Hazard Management – Watercourse Crossing Upgrades	Watercourse Crossing Upgrades	Culvert/Bridge upgrades (High Priority) (Total projects: 8)	Required to increase the hydraulic capacity of structure	10 to 20: integrated with roadway improvements	$6,400	medium
	Watercourse Crossing Upgrades	Potential Bridge Approach upgrades at Dundas (High Priority) (Total projects: 1)	Required to increase the hydraulic capacity of the crossing by raising the bridge approach	10 to 20: integrated with roadway improvements	$750	medium
Flood Hazard Management – Watercourse Crossing Upgrades	Watercourse Crossing Upgrades	CN/GO Bridge upgrades (High Priority) (Total projects: 2)	Required to increase the capacity of both rail crossings unless upstream floodplain structures can be flood proofed for Regional storm event and the two upstream watercourse crossings on Dundas are upgraded to achieve design criteria.	5 to 10	$10,000	medium
	Geomorphically Undersized Crossings	Crossing Replacement and Channel Restoration (Total projects: 8)	Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel	10 to 20: integrated with roadway improvements	$1,600	low
Studies, Guidelines and Monitoring	Updated Guidelines	Prepare guidelines for LID and BMPs; riparian and natural restorations; and salt management (Total projects: 3)	Mitigate development impacts for water quality and water quantity	0 to 5	$150	high
Studies, Guidelines and Monitoring	Monitoring Programs	Flow, rainfall and water quality monitor (Total projects: 4)	Establish the gauging stations for flow, rainfall and water quality monitoring	0 to 5	$200	high
	Study	Hydrological model Calibration (Total projects: 1)	Calibrate and validate the hydrological model used in flow estimation	0 to 5	$150	high

Category	Objective	Project Type	Project Description	Schedule (years)	Total Capital Cost (x $1,000)	Priority
	Studies	Fen Restoration Study; Wetland Evaluation Study (Total projects: 2)	Study and evaluate Fen and connecting Wetland system in Brooklin SP area	5 to 10	$150	medium
Stormwater Management (SWM) Plan	Stormwater Management Pond Retrofits	Thermal Impact Mitigation (Total projects: 2)	Bottom draw/cooling trench	0 to 5	$500	high
	New Stormwater Management Ponds	Water quality and quantity control (Total projects: 49)	9 SWM ponds being constructed under West Whitby Secondary Plan and about 40 SWM ponds are proposed under the Brooklin Secondary Plan study	As development proceeds	$0	As development proceeds
SWM Plan	LID - On Site Control Area from Brooklin Secondary Plan	Water quality and quantity control (Total projects: 14)	Treatment Train and LID	As development proceeds	$0	As development proceeds
	SWM Strategy for existing areas (intensification or re-development)	Water quality and quantity control (Total projects: identified as re-development proceeds)	SWMP Retrofits; Treatment Train and LID including: ▪ Stormwater quantity control: Post to pre control (2-Yr to 100-Yr storms) for all new development north of Dundas Street; Regulatory storm control not required ▪ Stormwater Quality control: use MECP “enhanced” standards with emphasis on thermal mitigation • Stream erosion control • Water Balance (Infiltration)	As development proceeds	$0	As development proceeds

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List of Acronyms

AGS ____________ Above ground surface
AIS ____________ Aquatic Invasive Species
ANSI ____________ Areas of Natural and Scientific Interest
ATSRAC ____________ Active Transportation & Safe Roads Advisory Committee
BCI ____________ Bat Conservation International
BGS ____________ Below ground surface
BMP ____________ Best Management Practices
BSP ____________ Brooklin Secondary Plan
CA ____________ Conservation Authority
CA ____________ Climate Change
CCDP ____________ Climate Change Data Portal
CEAA ____________ Canadian Environmental Assessment Agency
CLOCA ____________ Central Lake Ontario Conservation Authority
CN/GO Rail Line ____________ GO – Metrolinx Rail Corridor
CTC ____________ Central Lake Ontario-Toronto and Region-Credit Valley CAs
DFO ____________ Department of Fisheries and Oceans
DWWP ____________ Drinking Water Works Permit
EA ____________ Environmental Assessment
EAA ____________ Ontario Environmental Assessment Act
EBA ____________ Event Based Area
ECA ____________ Environmental Compliance Approval
EIS ____________ Environmental Impact Study
ELC ____________ Ecological Land Classification
ESA ____________ Endangered Species Act
ESC ____________ Erosion and Sediment Control
ESR ____________ Environmental Study Report
FV ____________ Factor Values
FVA ____________ Flood Vulnerable Areas
GGH ____________ Greater Golden Horseshoe
HVA ____________ Highly Vulnerable Aquifer
HVRA ____________ High Volume Recharge Area

HWY ____________ Highway
IEESC ___________ Institute for Energy Environment and Sustainable Communities
IO ________________ Infrastructure Ontario
IPCC ____________ Intergovernmental Panel on Climate Change
IPZ _______________ Intake Protection Zone
ISI _______________ Intrinsic Susceptibility Score
LID _______________ Low Impact Development
LIO _______________ Land Information Ontario
LSW ______________ Locally Significant Wetland
MCEA ___________ Municipal Class Environmental Assessment
MEA ______________ Municipal Engineer's Association
MECP ___________ Ministry of the Environment, Conservation and Parks
MDP ______________ Master Drainage Plan
MDPU ___________ Master Drainage Plan Update
MMAH ___________ Ministry of Municipal Affairs and Housing
MNRF ___________ Ministry of Natural Resources and Forestry
MOE ______________ Ministry of Environment
MOECC __________ Ministry of the Environment and Climate Change
MOI ______________ Ministry of Infrastructure
MHSTCI __________ Ministry of Heritage, Sport, Tourism and Culture Industries
MSIFN ___________ Mississaugas of Scugog Island First Nation
MTO ______________ Ministry of Transportation
NHIC ____________ Natural Heritage Information Centre
NHS ______________ Natural Heritage System
NOAA ____________ US National Oceanic and Atmospheric Association
OBBN ____________ Ontario Benthos Biomonitoring Network
OGS ______________ Ontario Geological Survey
OP _______________ Official Plan
OPA ______________ Official Plan Amendment
ORM ____________ Oak Ridges Moraine
ORMCP __________ Oak Ridges Moraine Conservation Plan
OSAP ____________ Ontario Stream Assessment Protocol

OWES ___________Ontario Wetland Evaluation System
PGMN ___________Provincial Groundwater Monitoring Network
PIC______________Public Information Centre
PPS _____________Provincial Policy Statement
PSW_____________Provincially Significant Wetland
PTTW____________Permit to Take Water
PWQMN__________Provincial Water Quality Monitoring Network Program
RCP _____________Representative Concentration Pathways
RGA _____________Rapid Geomorphic Assessment
ROP _____________Regional Official Plan
RSAT ____________Rapid Stream Assessment Technique
SAR _____________Species at Risk
SARA ____________Species at Risk Act
SAS _____________Sub-Area Studies
SCS _____________Soil Conservation Service
SGRA____________Significant Groundwater Recharge Area
SOCC ___________Species of Conservation Concern
SSFA ____________Single Station Frequency Analysis
SWM ____________Stormwater Management
SWMP ___________Stormwater Management Pond
TAC _____________Transportation Association Canada
TP ______________Time to Peak
VO ______________Visual Otthymo
WHN ____________Wildlife Habitat Network
WHPA ___________Well Head Protection Areas
WMP ____________Watershed Management Plan
WSC ____________Water Survey of Canada
WU______________Western University
WWIS____________Water Well Information System
WWSP ___________West Whitby Secondary Plan

Part A: Introduction / Background / Environmental Planning Process

1. Introduction

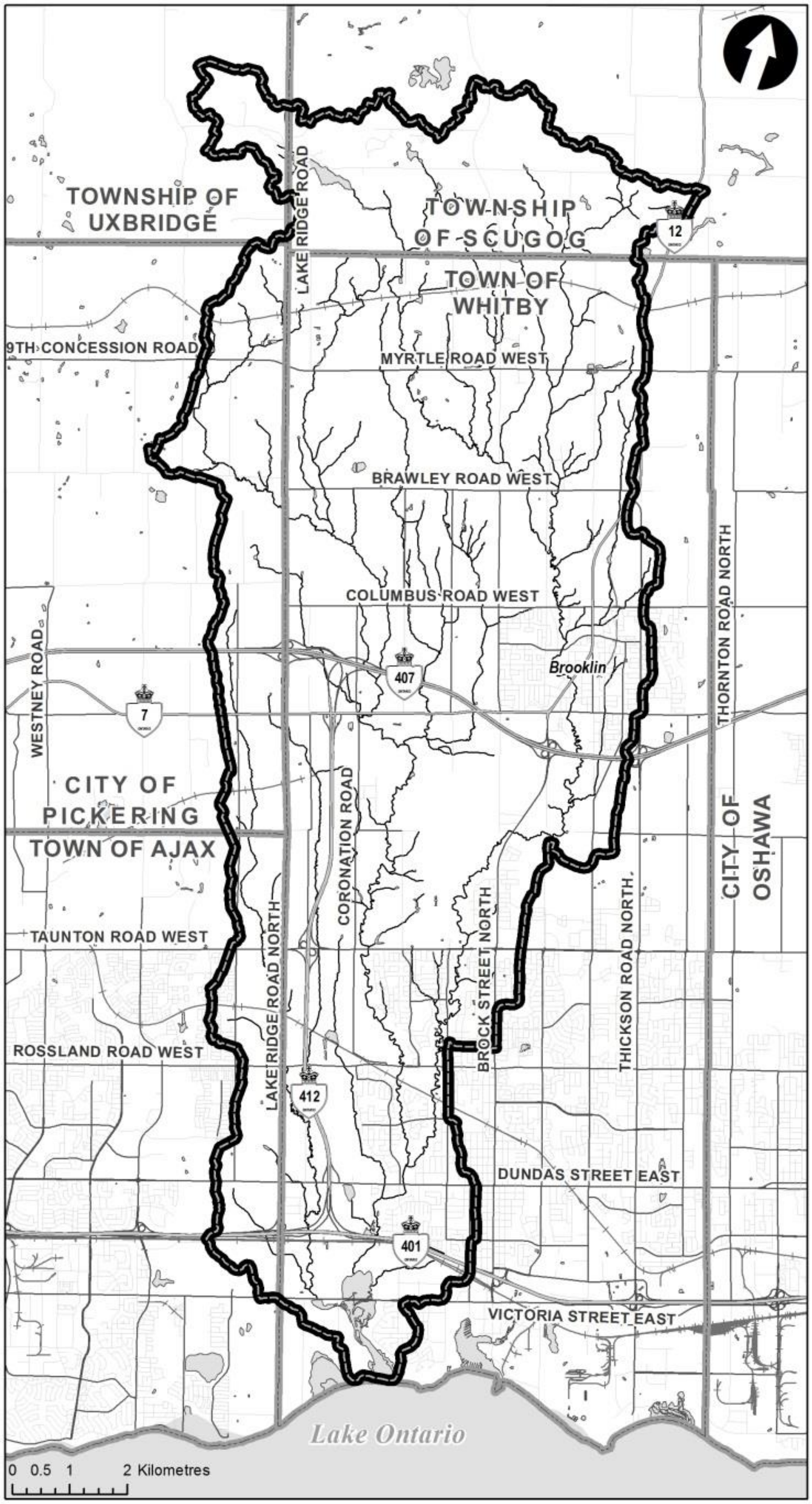
1.1 Background

The Town of Whitby (hereafter "the Town" or "Whitby") in partnership with the Central Lake Ontario Conservation Authority (hereafter "CLOCA") through their consultant AECOM Canada Ltd. (hereafter "AECOM"), has completed a Municipal Class Environmental Assessment (EA) study for the preparation of a Master Drainage Plan Update (MDPU) for the Lynde Creek Watershed (hereafter "Lynde Creek Watershed" or "the watershed), as identified in the map. The study is an update the original 1988 Master Drainage Plan and considers a number of additional reports that have been prepared since 1988, including the 2012 Lynde Creek Watershed Plan.

The Lynde Creek Watershed is predominantly located in the Town of Whitby and also extends into adjacent municipalities to the north and west (Township of Uxbridge, Township of Scugog, City of Pickering, and Town of Ajax). The total drainage area of Lynde Creek and its tributaries is approximately 130 square kilometres and falls under the jurisdiction of CLOCA.

This study follows the Master Plan Approach #1 planning process as outlined in the Municipal Engineer's Association (MEA) "Municipal Class Environmental Assessment" document (2000, as amended in 2007, 2011 and 2015). The study satisfies the planning requirements for Schedule A and A+ projects and provides the basis for future Schedule B projects.

Figure 1-1: Lynde Creek Watershed



1.2 Background Studies

1.2.1 1988 Lynde Creek Master Drainage Study

The original 1988 Lynde Creek Master Drainage Study was developed to provide guidance to the Town of Whitby and CLOCA for development in the Lynde Creek Watershed. Its focus was proposed development impacts on minor and major systems, including erosion and flood control, and floodplain management.

Minor System:	a minor drainage system comprises of roof gutters, rainwater leaders, catchbasins, and storm sewers. It is designed to convey runoff from frequent storms and to minimize stormwater ponding
Major System:	a major drainage system comprises of the natural streams and valleys and man-made streets, swales, channels and ponds. It is designed to accommodate runoff from less frequent, but more intense storms. The main purpose is to reduce damage due to major flooding

The 1988 Master Drainage Study identified and investigated 44 erosion sites along Lynde Creek and its tributaries and noted that erosion had occurred downstream of urban development.

The report was completed during a time when bank erosion was considered primarily as a negative process, rather than as an integral part of channel adjustment that is frequently accelerated by human intervention. The proposed plan to address the erosion sites involved only localized action, including:

- Creation of a 2-stage channel approach for 3 reaches between Taunton Road and Highway 2 addressing twenty-three erosion sites; and
- Traditional engineering erosion control measures, including re-grading, dredging, and armourstone and riprap bank protection.

Refer to **Appendix A** for excerpts from the original 1988 Master Drainage Plan.

1.2.2 2012 Lynde Creek Watershed Plan

The Lynde Creek Watershed Plan was completed by CLOCA in 2012 to guide future growth planning decisions for the entire watershed area. The goal of this Watershed Plan is to achieve healthy natural systems within the Lynde Creek Watershed which can positively respond to landscape changes and watershed conditions while sustaining its ecological health and integrity.

The Plan informs municipal official plan policies. It makes recommendations to ensure the protection, restoration and enhancement of the existing natural resources in the watershed in consideration of the quickly changing social, economic and natural landscape of the area. 23 Action Plans were identified to support the above and cover a wide watershed focus. The Action plans are as follows:

1. Natural Heritage System Restoration Plan;
2. Riparian Corridors Restoration Plan;
3. CLOCA Community Engagement Plan;
4. CLOCA Regulation and Plan Review Policies and Procedures Manual;
5. Wildlife Corridor Protection and Enhancement Plan;
6. High Volume Recharge Area (HVRA) Case Study;
7. CLOCA Data/Analytical Needs Co-ordination Assessment;
8. CLOCA Water Monitoring Program Review;
9. CLOCA Urban Land Use Low Impact Development (LID) Retrofits Plan;
10. Stewardship and Education Priorities and Plan;
11. CLOCA Land Securement Strategy;
12. Lynde Creek Watershed Imperiousness Report Card;
13. CLOCA Connected Imperviousness Best Management Strategy;
14. CLOCA Ecological Goods and Services Inventory;
15. CLOCA Salt Management Plan;
16. CLOCA Implementation of the Invasive Species Management Strategy;
17. Lynde Creek Watershed In-Stream Barriers Action Plan;
18. CLOCA Ecological Compensation Protocol;
19. CLOCA Lichen Pilot Project;
20. CLOCA Climate Change Monitoring/Adaptive Management Strategy;
21. CLOCA Stormwater Management Performance Monitoring and Maintenance Plan;
22. Highway 407 East Post-Construction Monitoring Plan; and
23. Flood Damage Centres Upgrading.

Recommended watershed improvement projects have been identified considering how they help implement specific Action Plans.

1.2.2.1 Other Key Relevant Studies Since 1988

Other key relevant studies completed since 1988 that impact this MDPU are as follows:

- Brooklin Master Drainage Plan (CPW, 1992);
- Floodplain Mapping – Lynde Creek Watershed (Earthtech, 2008) (see **Section 2.4.4**);
- West Whitby Secondary Plan (Phase 3); and
- Brooklin Community Secondary Plan (Phase 3).

1.3 Study Update Purpose and Objectives

The MDPU recognises that watershed planning and associated Master Drainage Plans have evolved over the years. The purpose of this MDPU is to provide guidance to both the Town of Whitby, CLOCA and other affected municipalities in continued management of the Lynde Creek watershed and stream corridors in terms of flows and erosion, resources protection and development. The Study also supports watershed management objectives as directed by the 2012 Lynde Creek Watershed Plan (CLOCA).

The MDPU identifies a list of recommended watershed improvement projects that will inform future capital works programs and budgets. Recommendations include: infrastructure improvements to reduce flooding; mitigation measures for streambank erosion; local stream improvements to improve fish passage; identification of additional studies and programs (including monitoring) to confirm Natural Heritage and Hydrotechnical-Hydrogeological conditions; and possible new, or changes to existing, objectives, guidelines and policies to protect, improve and enhance the Lynde Creek watershed.

Overall, this Lynde Creek MDPU has been developed within the context of watershed goals and objectives. Goals have been identified in the areas of flood hazard management, streams and related habitat, significant natural heritage features and groundwater recharge/discharge. The specific goals are as follows:

- Protect life;
- Protect property/buildings;
- Protect infrastructure- utilities/crossings;
- Riparian aquatic restoration;
- Riparian terrestrial restoration;
- Minimise erosion impacts;
- Improve water quality;
- Identify and Protect Wetlands;
- Identify and Protect Species at Risk;
- Identify and Protect Woodlands; and
- Identify and Protect Recharge/Discharge Areas.

1.4 Format of this Report

The format of this report is organized in four main parts:

1. **Part A: Introduction/Planning/Background/Planning Process** – introduces the Lynde Creek MDPU study area and background information. A high level overview of the Municipal Class EA process and schedules, including the Master Plan approach for the Lynde Creek MDPU Study is described. The Class EA documentation and filing process (i.e., public review period) for this study is also explained.
2. **Part B: Technical** – describes the technical aspects of the Lynde Creek MDPU. This includes existing conditions, including, but not limited to:
   - Land use planning and changes;
   - Natural heritage;
   - Fluvial geomorphology;
   - Hydrology;
   - Floodplain hydraulics;
   - Stormwater management;
   - Hydrogeology; and
   - Water balance – groundwater infiltration.
3. **Part C: Municipal Class EA** – details phases 1 (problem/opportunity statement) and 2 (alternative solutions) of the Municipal Class EA process for the Lynde Creek MDPU.

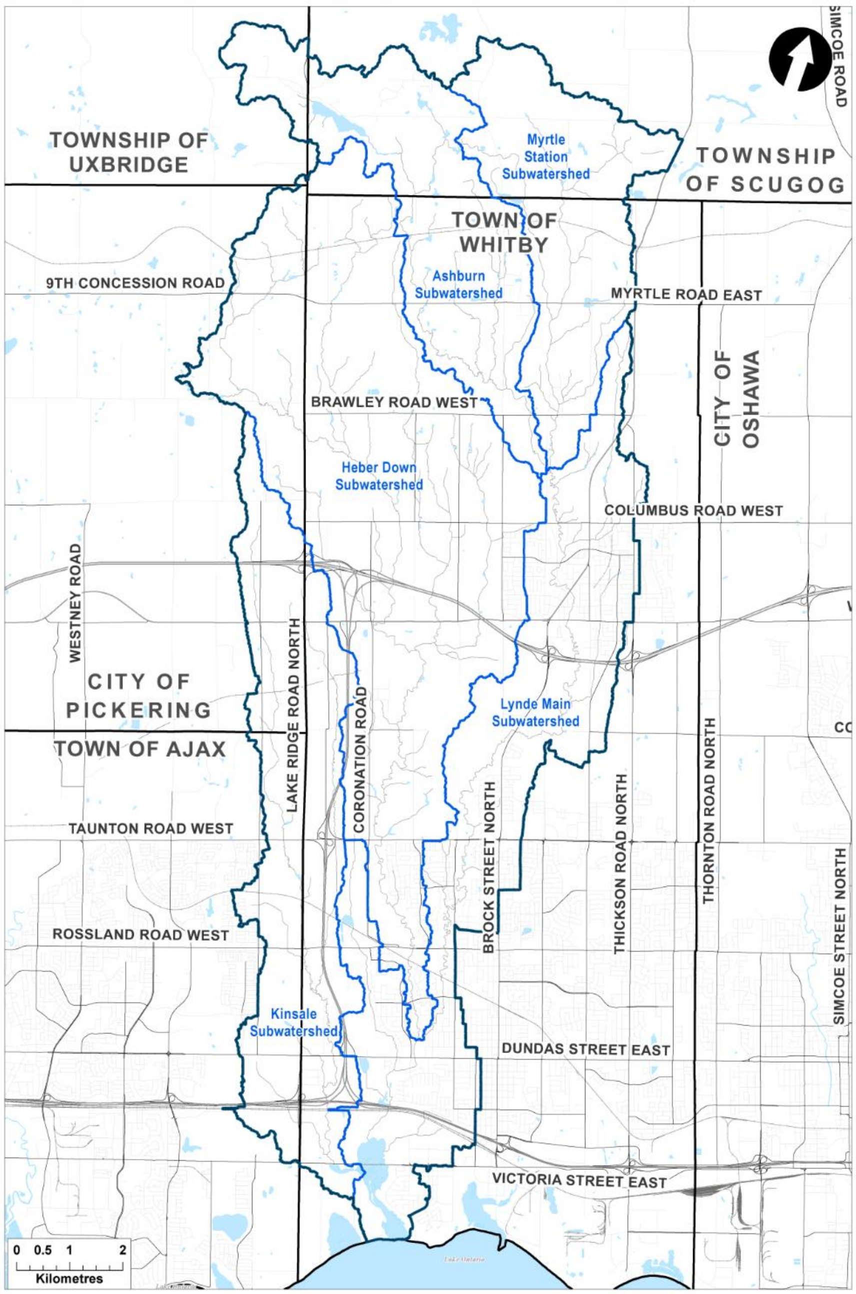
   This includes an overview of the relevant planning studies and policy context considered, the MDPU's problem/opportunity statement, as well as the identification and evaluation of alternative Master Drainage Plans. Watershed improvement projects are also identified.

   Part C also includes an overview of the consultation activities undertaken, and describes correspondence received from the public, agencies, and Indigenous communities. Preliminary mitigation measures are also presented to address potential impacts associated with the proposed watershed improvement projects impacts will be further developed for individual watershed improvement projects during subsequent Municipal Class EA planning phases and detailed design.
4. **Part D: Implementation** – sets out the implementation for the Lynde Creek MDPU, including associated watershed improvement projects that will inform future capital works programs and budgets.

1.5 Study Area

The Lynde Creek Watershed is predominantly located in the Town of Whitby (Durham Region) and also extends into adjacent municipalities to the north and west (Township of Uxbridge, Township of Scugog, City of Pickering, and Town of Ajax). The total drainage area of Lynde Creek and its tributaries is approximately 130 square kilometres and falls under the jurisdiction of the Central Lake Ontario Conservation Authority (CLOCA). See **Figure 1-2** for the Study area limits.

Figure 1-2: Study Area



1.6 Study Team Organization

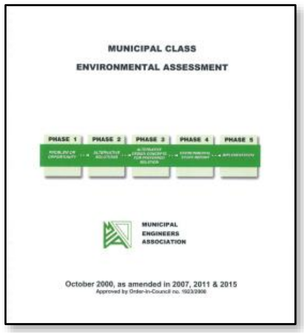
The Lynde Creek MDPU Municipal Class EA has been a collaborative effort between The Town of Whitby, CLOCA, the Regional Municipality of Durham and AECOM. Key team members from the Study Team are listed below.

- **Town of Whitby:**
  - Peter Angelo, Director, Engineering Services/Project Manager
  - Antony Manoharan, Program Manager/ Water Resources Engineer/Project Manager
  - Susan McGregor, Principal Planner, Long Range Policy Planning
- **CLOCA:**
  - Eric Cameron, Infrastructure Planner/Enforcement Officer
  - Chris Jones, Director, Planning and Regulation
  - Perry Sisson, Director, Engineering and Field Operations
- **Regional Municipality of Durham:**
  - Heather Finlay, Senior Planner, Planning and Economic Development
- **KSGS Engineering Corp:**
  - Ken Chow
- **AECOM:**
  - Paul Frigon, Senior Engineer, Water/ Project Manager
  - Abhi Sood/Ning Pan/Derek Gray, Water Resources Engineering
  - Karl Grueneis, Senior Environmental Planner
  - Samantha Zandvliet, Environmental Planner
  - Olga Hropach, Aquatic and Terrestrial
  - Rhonneke Van Riezen/Fabien Hugue, Fluvial Geomorphology
  - Jason Murchison/Matthew Alexander/Leslea McKie, Hydrogeological
  - Sean O'Raw/Rayna Carmichael, GIS Specialists

1.7 Municipal Class Environmental Assessment Planning Process

1.7.1 Overview

All municipalities in Ontario are subject to the provisions of the Ontario *Environmental Assessment Act* (*EAA*) and its requirements to prepare an EA for applicable public works projects. The Ontario Municipal Engineers Association (MEA) "Municipal Class Environmental Assessment" document (October 2000, as amended in 2007, 2011 and 2015) provides municipalities with a phased planning procedure, to plan and undertake all municipal sewage, water, stormwater management and transportation projects that occur frequently, are usually limited in scale and have a predictable range of environmental impacts and applicable mitigation measures.



In Ontario, infrastructure projects, such as those associated with Lynde Creek MDPU are subject to the Municipal Class EA process and must follow a series of mandatory steps as outlined in the Municipal Class EA document. The Municipal Class EA document consists of five phases and the application of the phases depends on the Municipal Class EA Schedule that applies to a project. The phases are summarized below:

- **Phase 1 – Problem or Opportunity:** Identify the problems or opportunities to be addressed and the needs and justification;
- **Phase 2 – Alternative Solutions:** Identify alternative solutions to the problems or opportunities by taking into consideration the existing environment, and establish the preferred solution taking into account public and agency review and input;
- **Phase 3 – Alternative Design Concepts for the Preferred Solution:** Examine alternative methods of implementing the preferred solution based upon the existing environment, public and agency input, anticipated environmental effects and methods of minimizing negative effects and maximizing positive effects;
- **Phase 4 – Environmental Study Report:** Document in an Environmental Study Report (ESR), a summary of the rationale, planning, design and consultation process for the project as established through Phases 1 to 3 above and make such documentation available for scrutiny by review agencies and the public; and,
- **Phase 5 – Implementation:** Complete contract drawings and documents, proceed to construction and operation, and monitor construction for adherence to environmental provisions and commitments. Also, where special conditions dictate, monitor the operation of the completed facilities.

As the Lynde Creek MDPU follows Master Plan Approach #1, it includes the first two phases of the Class EA process described above.

1.7.1.1 Project Planning Schedules

The Municipal Class EA defines four types of projects and the processes required for each (referred to as Schedule A, A+, B, or C). The selection of the appropriate schedule is dependent on the anticipated level of environmental impact, and for some projects, the anticipated construction costs. Projects are categorized according to their environmental significance and their effects on the surrounding environment. Below provides an overview of the planning schedules that may apply to recommended projects.

- **Schedule A:** Projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects are pre-approved and may proceed to implementation without following the full MCEA planning process;
- **Schedule A+:** The purpose of Schedule A+ is to ensure appropriate public notification for certain projects that are pre-approved under the MCEA. It is appropriate to inform the public of municipal infrastructure project(s) being constructed or implemented in their area;
- **Schedule B:** Projects have the potential for some adverse environmental effects. The proponent is required to undertake a screening process (Phases 1 and 2), involving mandatory contact with directly affected public and with relevant review agencies to ensure that they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation. At the end of Phase 2, a Project File documenting the planning process followed through Phases 1 and 2 shall be finalized and made available for public and agency review. However, if a concern is raised related to aboriginal and treaty rights which cannot be resolved, a Section 16 Order may be requested and considered by the Minister of the Environment, Parks and Conservation (MECP). Alternatively, the proponent may elect voluntarily to plan the project as a Schedule C undertaking; and,
- **Schedule C:** Projects have the potential for significant adverse environmental effects and must proceed under the full planning and documentation (Phases 1 to 4) procedures specified in the MCEA manual. Schedule C projects require that an Environmental Study Report (ESR) be prepared and filed for review by the public and review agencies. If concerns related to aboriginal and treaty rights are raised that cannot be resolved then a Section 16 Order may be requested.

The Municipal Class EA process ensures that all projects are carried out with effectiveness, efficiency and fairness. This process serves as a mechanism for understanding economic, social and environmental concerns while implementing improvements to municipal infrastructure.

1.7.1.2 MCEA Master Planning Process

The MEA Municipal Class EA manual recognizes that, in many cases, it is beneficial to start the master planning process by considering a group of related projects or an overall system, looking at the overall infrastructure system. By planning in this way, the need and justification for individual projects and the associated broader context are better defined.

The Town/CLOCA has carried out this approach in preparation of this Master Plan study as the project:

- Has a broad scope and includes an analysis of the entire watershed rather than a site-specific problem; and
- Recommends a set of works which are distributed geographically throughout the Lynde Creek study area that can be implemented over a period of time.

The MEA Municipal Class EA document outlines four approaches to the master planning process. This Master Plan follows Approach #1, concluding with a Master Plan document at the end of Phase 2. The Master Plan provides the basis for, and is used to support, the advancement of Schedule A/A+ and B projects as identified in **Table 8-2**.

1.7.2 Municipal Class EA Documentation and Filing

Placement of the Master Plan for public review completes the planning stage of the study. This Master Plan is available for public review and comment for a period of 30 calendar days starting on September 12, 2022 and ending on October 12, 2022. The Notice of Completion was published in order to notify the public and stakeholders about the 30-day review period. To facilitate public review of this document, the report is being posted to the City’s website and hard copies will be available for viewing at the following locations during regular business hours (availability subject to change based on applicable Covid restrictions):

- **Whitby Town Hall**
  575 Rossland Road East
  Whitby, Ontario L1N 2M8
  905-668-5803
- **Whitby Public Central Library**
  405 Dundas Street West
  Whitby, Ontario L1N 6A1
  905-668-6531
- **Town of Whitby – Garden Street Branch**
  3050 Garden St. Unit 02
  Whitby, Ontario L1R 2G7
  905-430-4305

The Master Plan is also available on the Town's website:
https://www.whitby.ca/en/play/resources/Plansand-Reports/RPT_2022-02 01_Whitby_LyndeCreek_MDPU_MasterPlan_60566558.pdf

Alternative arrangements to view the reports are available upon request. Interested persons are encouraged to review the MDPU report during the 30-day review period and provide comments to the Town's Project Manager and Clerk at the addresses listed below.

- **Peter Angelo, P.Eng.**
  Director, Engineering Services
  Planning and Development
  Town of Whitby
  575 Rossland Road East
  Whitby, Ontario L1N 2M8
  905-430-4918
  angelop@whitby.ca
- **Christopher Harris**
  Town Clerk
  Town of Whitby
  575 Rossland Road East
  Whitby, Ontario L1N 2M8
  clerk@whitby.ca

Subject to the comments received as a result of this notice, the Town intends to proceed with the implementation of the recommended Schedule A/A+ projects, and projects not subject to the Municipal Class EA process. All Schedule B projects identified in the MDPU require additional investigations that will be carried out at a later date.

All personal information included in your request – such as name, address, telephone number and property location – is collected, under the authority of section 30 of the Environmental Assessment Act and is collected and maintained for the purpose of creating a record that is available to the general public. As this information is collected for the purpose of a public record, the protection of personal information provided in the Freedom of Information and Protection of Privacy Act (FIPPA) does not apply (s.37). Personal information you submit will become part of a public record that is available to the general public unless you request that your personal information remain confidential.

Part B: Technical

2. Watershed Description

2.1 Watershed Area

The Lynde Creek watershed is divided into five subwatersheds: Lynde Main, Heber Down, Kinsale, Ashburn, and Myrtle Station. It is ~130 square kilometres in area. The watershed maintains an elongated shape that is approximately 21 kilometres long and varies in width from 5 kilometres near Lake Ontario to 8 kilometres near its headwaters (Lynde Creek Master Drainage Plan Study Update RFP, 2017).

2.2 Physiography, Geology and Superficial Soils

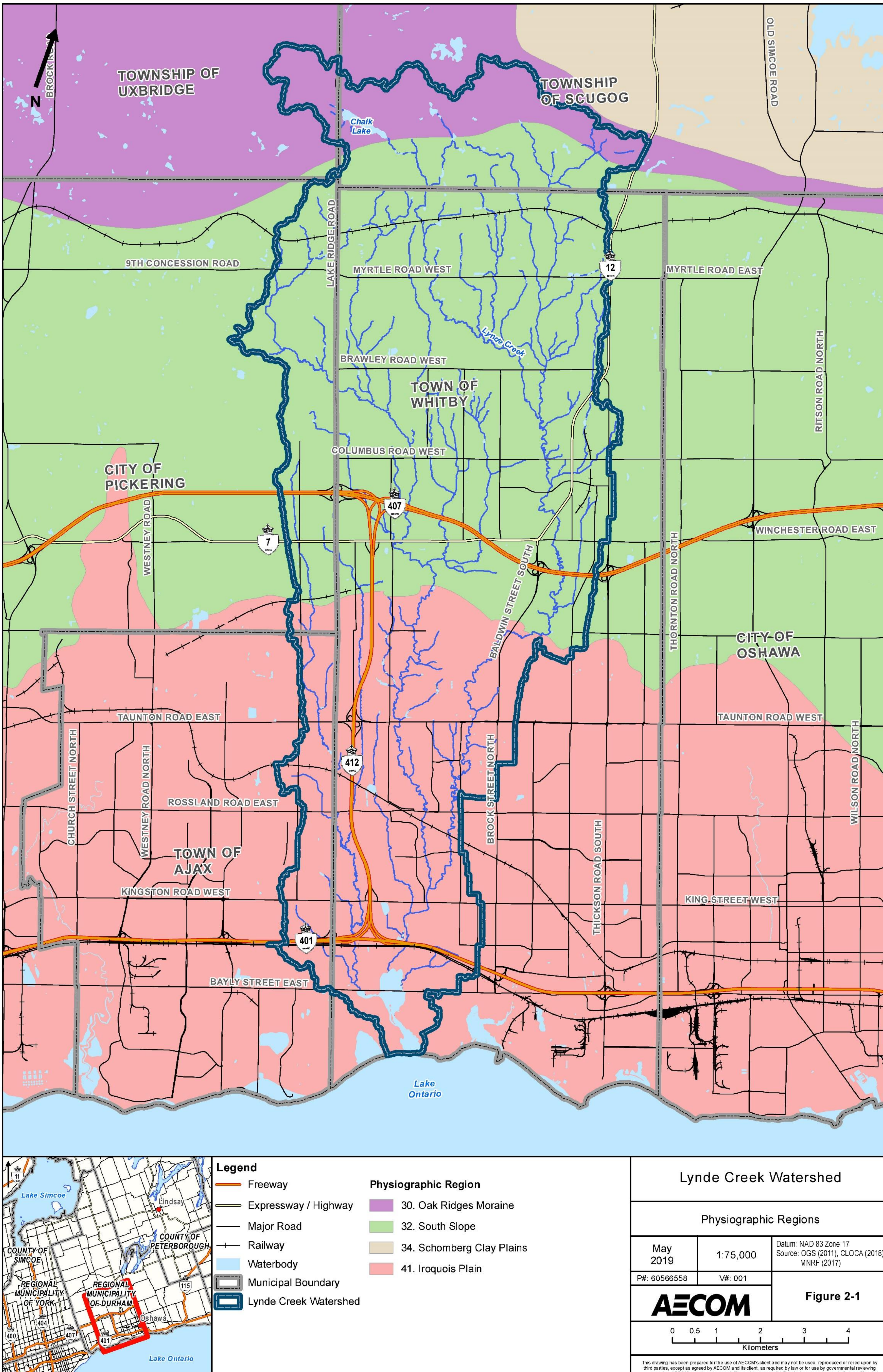
The geology of the Lynde Creek Watershed (subsequently referred to as "the Watershed") consists of variable thicknesses of sediments overlying Ordovician bedrock. In this area, a complex sequence of glacial, interglacial (glaciolacustrine/ glaciofluvial) and modern sediments have accumulated over the last 135,000 years. A desktop study was conducted to characterize the local stratigraphic conditions of the Watershed. Secondary source data interpreted for this assessment included:

- Physiographic regions mapping from the Ontario Geological Survey (OGS);
- Surficial and Quaternary geological mapping from OGS;
- Bedrock geological mapping from OGS;
- Drift thickness mapping from OGS;
- Credit Valley - Toronto and Region - Central Lake Ontario (CTC) Source Protection Plan (SPP) mapping;
- Ministry of the Environment, Conservation and Parks (MECP) Well Records and Permit to Take Water Records; and
- Other reports, as available.

The physiography and geology of the Watershed are described in the following sections. **Figure 2-1** identifies the Watershed's physiographic regions.

2.2.1 Bedrock Geology

The bedrock subcrop beneath the watershed is the Blue Mountain Formation (previously known as the Whitby Formation; Russell and Telford, 1983) as shown on **Figure 2-2** (OGS, 1991; OGS, 2011). The Blue Mountain Formation consists of a blue-grey, predominately non-calcareous shale (Russel and Telford, 1983).



N
BROCK ROAD
TOWNSHIP OF UXBRIDGE
TOWNSHIP OF SCUGOG
OLD SIMCOE ROAD
Chalk Lake
LAKE RIDGE ROAD
9TH CONCESSION ROAD
MYRTLE ROAD WEST
MYRTLE ROAD EAST
12
Lynde Creek
BRAWLEY ROAD WEST
TOWN OF WHITBY
RITSON ROAD NORTH
COLUMBUS ROAD WEST
CITY OF PICKERING
407
7
WESTNEY ROAD
WINCHESTER ROAD EAST
BALDWIN STREET SOUTH
THORNTON ROAD NORTH
CITY OF OSHAWA
TAUNTON ROAD EAST
TAUNTON ROAD WEST
CHURCH STREET NORTH
WESTNEY ROAD NORTH
412
BROCK STREET NORTH
WILSON ROAD NORTH
ROSSLAND ROAD EAST
TOWN OF AJAX
THICKSON ROAD SOUTH
KINGSTON ROAD WEST
KING STREET WEST
401
BAYLY STREET EAST
Lake Ontario
Lake Simcoe
Lindsay
COUNTY OF PETERBOROUGH
COUNTY OF SIMCOE
REGIONAL MUNICIPALITY OF YORK
REGIONAL MUNICIPALITY OF DURHAM
Oshawa
Legend
Freeway
Expressway / Highway
Major Road
Railway
Waterbody
Municipal Boundary
Lynde Creek Watershed
Physiographic Region
30. Oak Ridges Moraine
32. South Slope
34. Schomberg Clay Plains
41. Iroquois Plain
Lynde Creek Watershed
Physiographic Regions
May 2019
1:75,000
Datum: NAD 83 Zone 17
Source: OGS (2011), CLOCA (2018), MNRF (2017)
P#: 60566558
V#: 001
AECOM
Figure 2-1
0 0.5 1 2 3 4
Kilometers
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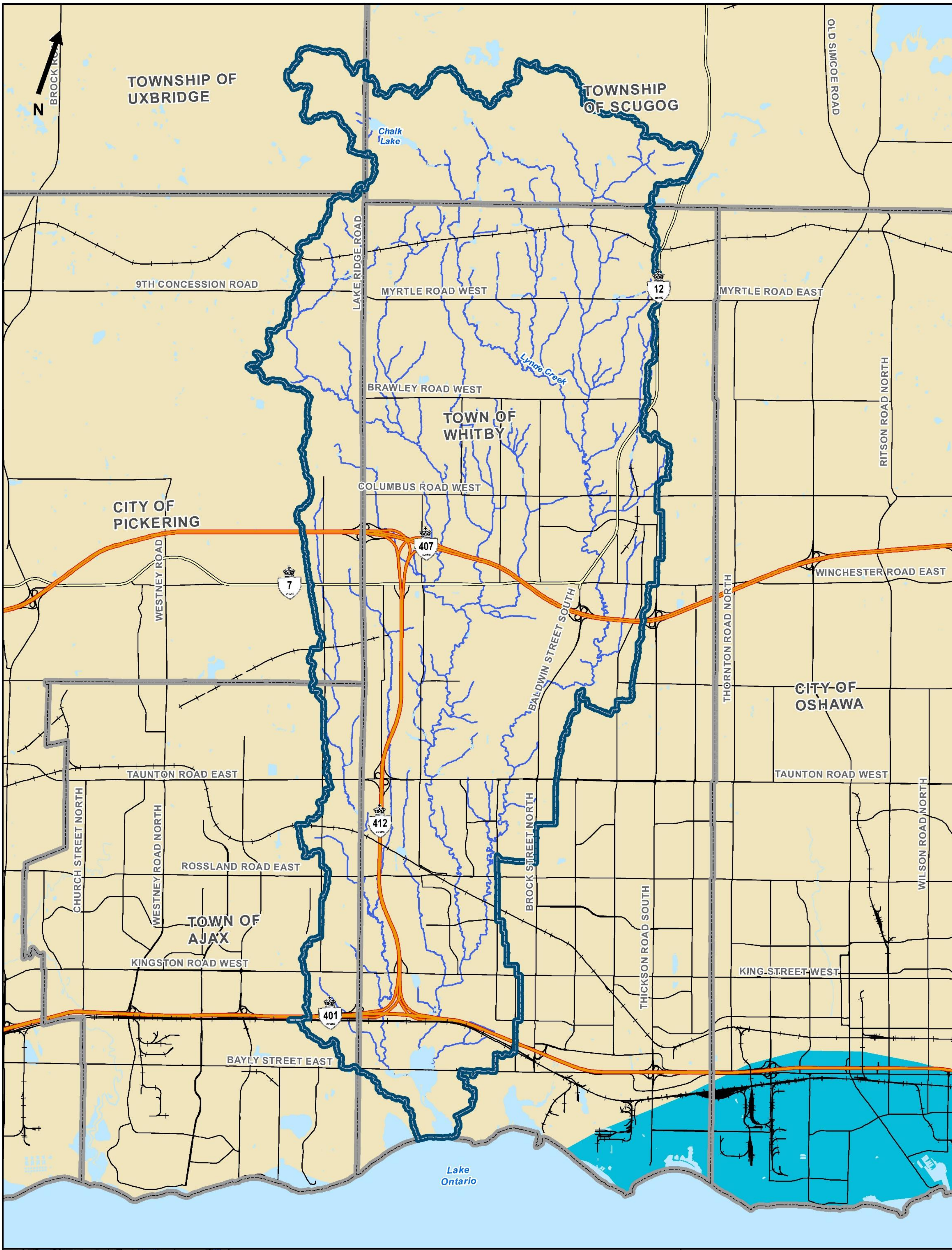

Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed

Bedrock Geology

- 55b: Georgian Bay Formation; Blue Mountain Formation; Billings Formation; Collingwood Member; Eastview Member; Shale, limestone, dolostone, siltstone
- 54a: Ottawa Group; Simcoe Group; Shadow Lake Formation; Limestone, dolostone, shale, arkose, sandstone

Lynde Creek Watershed

Bedrock Geology

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: OGS (2011), CLOCA (2018), MNRF (2017)
P#: 60566558	V#: 001	

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Figure 2-2

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Previously, the Whitby Formation was subdivided into three members: the Craigleigth Member (Collingwood equivalent), Rouge River Member, and the Thornbury Member (Zhang et al., 2011). There is only one confirmed bedrock outcrop in the entire watershed, in Lynde Creek within the Heber Down subwatershed (CLOCA, 2008). The bedrock subcrop in the south of the watershed area is the Ottawa Group, which consists of grey shale with interbedded limestone. To the north of the watershed area, the Lindsay Formation subcrops. The lower member of the Lindsay Formation is a carbonate unit that is argillaceous, nodular, fine-to coarse grained limestone and very fossiliferous. The upper member, known as the Collingwood member, is a black or brown carbonaceous and fossiliferous shale with limestone interbeds (Zhang et al., 2011). There is a northeast trending bedrock valley or ancient channel under the Oak Ridges Moraine near Ashburn Road and trending towards Lakeridge Road near Concession Road 8 (CLOCA, 2008).

2.2.2 Quaternary Geology

Overlying bedrock in the Watershed and surrounding area is a thick succession of deposits associated with the last 135,000 years of glacial and interglacial periods. The oldest sediments that may be found in the Watershed include the York Till and Don Formations. These are associated with the Illinoian Glaciation and Sangamon Interglacial periods, respectively. Deposits from the Wisconsinan period (early to late) comprise the majority of the succession of sediment in this area.

The Scarborough Formation, which marks the start of the Wisconsinan glaciation, is a deltaic deposit consisting of a lower clay layer overlain by cross bedded sands (CLOCA, 2008). Thin peat beds are common. This unit exceeds 40 metres in thickness west of the Watershed, and is modelled to have thicknesses approaching 60 metres in bedrock lows to the north near Chalk Lake, and thins/pinches out in areas underneath the watershed (CLOCA, 2007).

Overlying the Scarborough Formation is the Sunnybrook till/drift which is comprised of a massive clayey-silt till that is stone poor and has silty-clay laminations.

The Thorncliffe Formation, which overlies the Sunnybrook drift, is a sedimentary deposit of glaciolacustrine silt-clay rhythmites and cross-laminated and cross-bedded sands (CLOCA, 2008). Exposures of the Thorncliffe formation are common along the bluffs at Lake Ontario where the overburden remains of sufficient thickness. The unit is generally 20 meters or less within the Watershed and expands to up to 50 meters thick to the west (CLOCA, 2007).

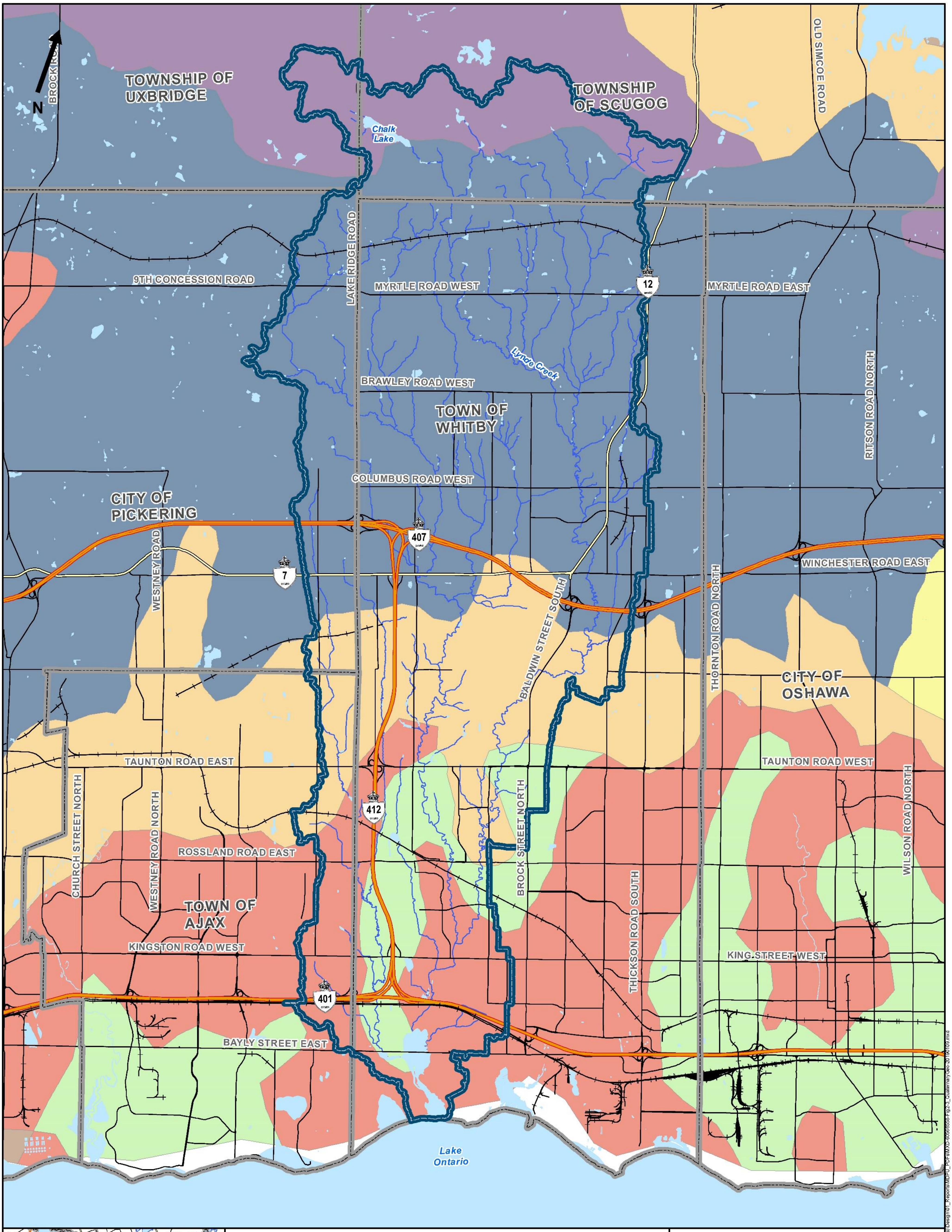
The Newmarket Till, also known as the Northern Till, overlies the Thorncliffe Formation and underlies the Oak Ridges Moraine. This sandy silt to silt till unit was deposited below the Lake Ontario ice lobe as it flowed southwestwards across the region as a major ice stream within the Laurentide Ice Sheet (Meriano and Eyles, 2009). The unit is a depositional succession of multiple till sheets, ranging in thickness from 1 to 6 metres each, which are stacked on top of one another. Often, the tills are separated by linear concentrations of boulders and thin (<30 cm) interbeds of waterlain sands. This unit is extensive and continuous throughout the Watershed and adjacent areas to the west and east. The Newmarket Till is thicker to the north of the Watershed, up to approximately 50 metres in some locations, and thins/pinches out to the south near Lake Ontario (CLOCA, 2007).

The Oak Ridges Moraine itself extends 160 kilometres across southcentral Ontario, trending east to west. It covers approximately 1,000 square kilometres in four sediment wedges, although only overlaps a narrow portion of the most northern areas of the Watershed (CLOCA, 2008). The Oak Ridges sediment complex is a result of interlobate glacial deposits and is composed mostly of silt and fine sands, becoming more gravelly to the east (Sharpe et al., 2007). Sections of the Oak Ridges Moraine sediments are exposed at surface at the north of the Watershed (ice contact stratified drift/glaciofluvial ice-contact sand and gravel deposits).

The Halton Till overlies the Oak Ridges Moraine and is exposed at surface (in places) along the moraine's south slope. It forms the surficial till unit extending southward to the Newmarket Till and Lake Iroquois Shoreline. The Halton till has a predominantly silty to silty clay matrix that has a high matrix carbonate content, has sand and gravel lenses but is generally stone poor. It is widely distributed to the west and east of the Watershed. The Halton Till is thin and poorly consolidated, and is drumlinized in places. **Figure 2-3** depicts the distribution of the upper most quaternary deposits across the Watershed (OGS, 2000).

2.2.3 Surficial Geology

Surficial materials create a discontinuous veneer over the Halton and Newmarket Tills across the watershed (OGS, 2003; **Figure 2-4**). In the very north of the Watershed, materials consist of ice-contact stratified deposits (sand and gravel, minor silt, clay and till), consistent with the Oak Ridges Moraine. At Chalk Lake, the surficial materials transition to glaciolacustrine derived silty to clayey till (likely Halton/Newmarket tills) with isolated patches of coarse-textured glaciolacustrine deposits. Between Brawley Road and Columbus Rd W, the surficial till unit transitions from glaciolacustrine-derived to a stone-poor, carbonate-derived silty to sandy till. This unit continues south to the 407 (approx.), and between the western boundary of the Watershed and the 412 down to Taunton Road. East of the 412 and south of the 407, a coarse-textured lacustrine deposit (sand, gravel, minor silt and clay) is wide spread from the 407 to south of Taunton Road, with modern alluvial deposits mapped in the river channels. From Taunton Road West south to Lake Ontario, the materials consist of fine or coarse textured glaciolacustrine deposits and modern alluvial deposits with some coarse textured lacustrine deposits.



Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed

Quaternary Geology

- Halton Till (Ontario-Erie lobe): predominantly silt to silty clay matrix, high in matrix carbonate content and clast poor
- Till: undifferentiated, predominantly sandy silt to silt matrix, commonly rich in clasts,
- Glaciofluvial ice-contact deposits: gravel and sand minor till includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits
- Glaciomarine deposits: silt and clay, minor sand basin and quiet water deposits
- Glaciomarine deposits: sand, gravelly sand and gravel nearshore and beach deposits
- Fluvial deposits: gravel, sand, silt and clay deposited on abandoned flood plains, terrace remnants
- Organic deposits: peat, muck and marl

Lynde Creek Watershed

Quaternary Geology

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: OGS (2011), CLOCA (2018), MNRF (2017)
P#: 60566558	V#: 001	

AECOM

Figure 2-3

0 0.5 1 2 3 4
Kilometers

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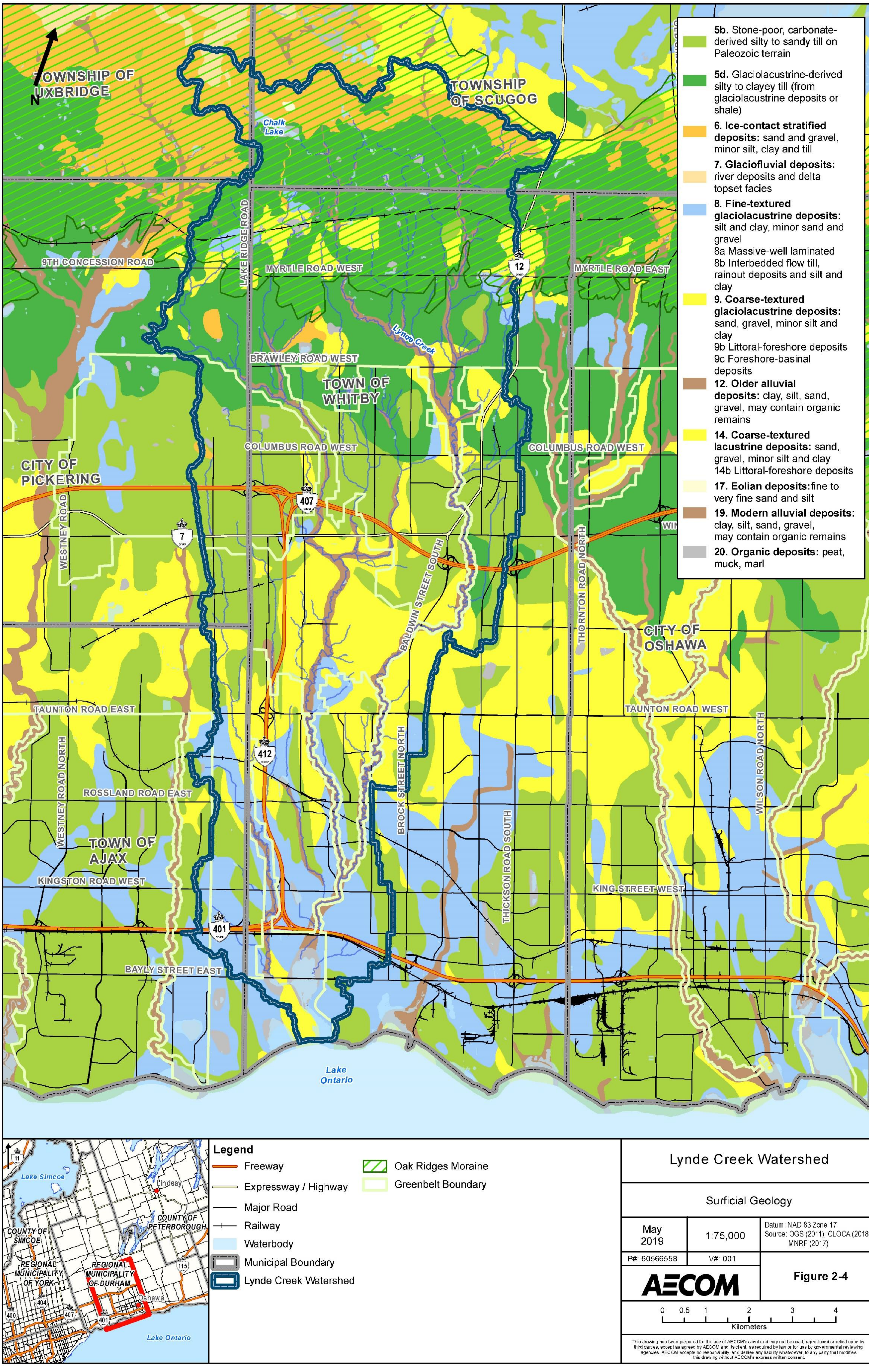


Lynde Creek Watershed

Surficial Geology

Figure 2-4

2.2.4 Drift Thickness

Drift Thickness mapping (**Figure 2-5**; Gao et al., 2006) shows over 260 metres of overburden overlying the bedrock in the Watershed. The overburden thickness is greatest to the north, at the Oak Ridges Moraine, and thins towards Lake Ontario. It is expected that the majority of the succession of quaternary sediments described in **Section 2.2.2**, would be present where the drift thickness is greatest. An "ideal" cross-section that transects the Watershed from north to south that shows the relationship between the units with depth is presented in **Figure 2-6** (CLOCA, 2008).

2.3 Land Use Classification

There are several methods for classifying land use. For the purposes of documenting overall changes in land use and the potential for change to impact drainage and the terrestrial and aquatic Natural Heritage Systems (NHS), land use has been broadly categorized as pervious (i.e., more infiltration, less runoff) and impervious (i.e., less infiltration, more runoff). These characteristics are reflected in both existing/current conditions and future conditions.

2.3.1 Existing Land Cover Classification

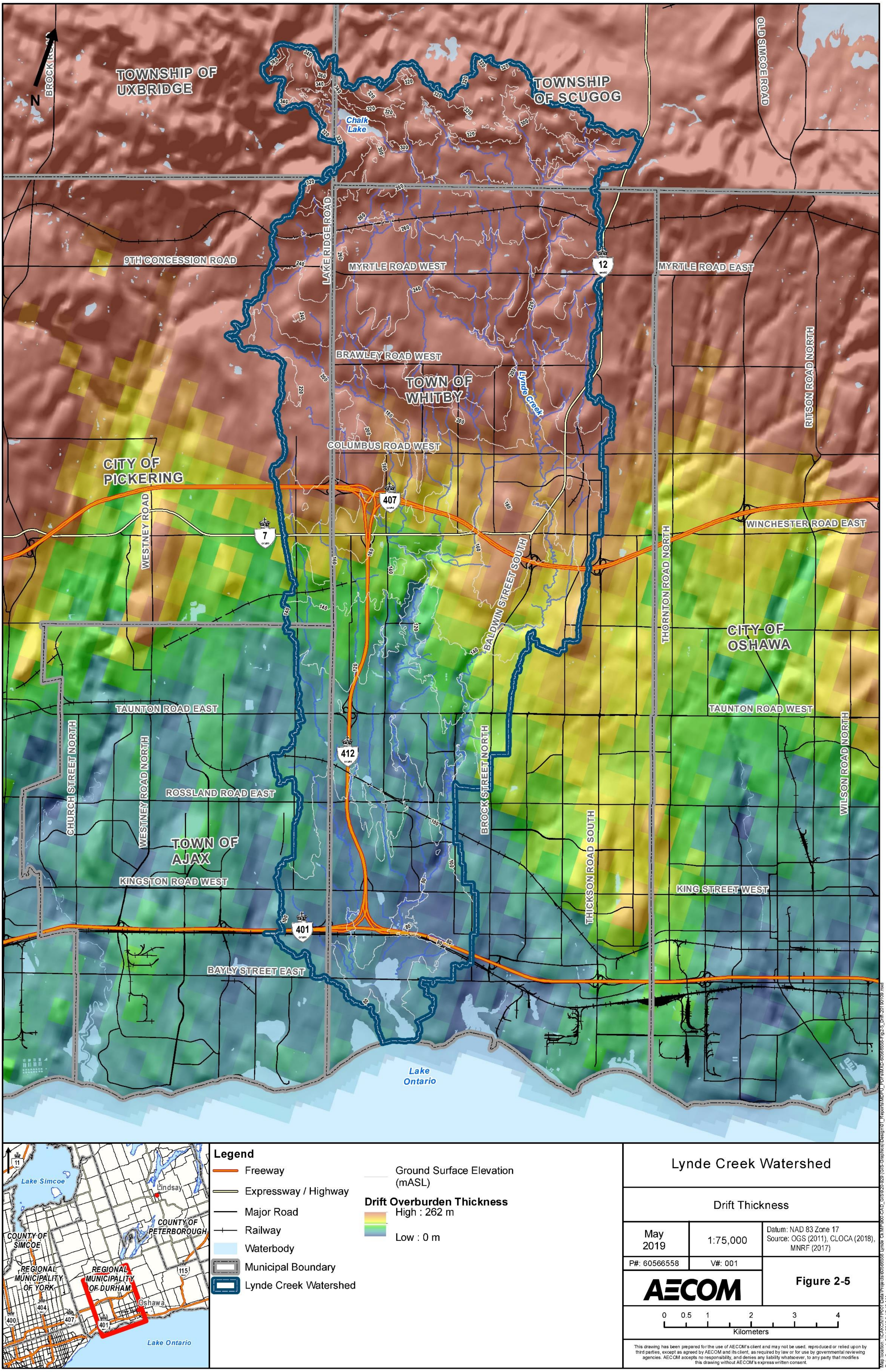
Existing conditions are typically reflected through air photo interpretation and result in multiple land use classifications. For Lynde Creek, the recent Lynde Creek Watershed Management Plan (WMP) (CLOCA 2012) was used as a base and is illustrated in **Figure 2-7**. Existing land use classification does not include current draft/and or approved development applications or development lands under construction.

2.3.2 Future Land Cover Classification

Future conditions are reflected in Municipal Official Plans (OPs) using general classification categories. More detailed land use interpretations are provided in subsequent Secondary Plans and Subdivision Plans. The planning horizon is to the year 2031.

For future flow estimates, more detailed land use information is required as provided in **Figure 2-8** which identifies future land use (Future Conditions - 2031 Horizon).

It is based on the Town of Whitby Official Plan (2018 Consolidation), the West Whitby Secondary Plan and the Brooklin Community Secondary Plan (as amended by OPA 108, under appeal), as provided in **Appendix B1**.



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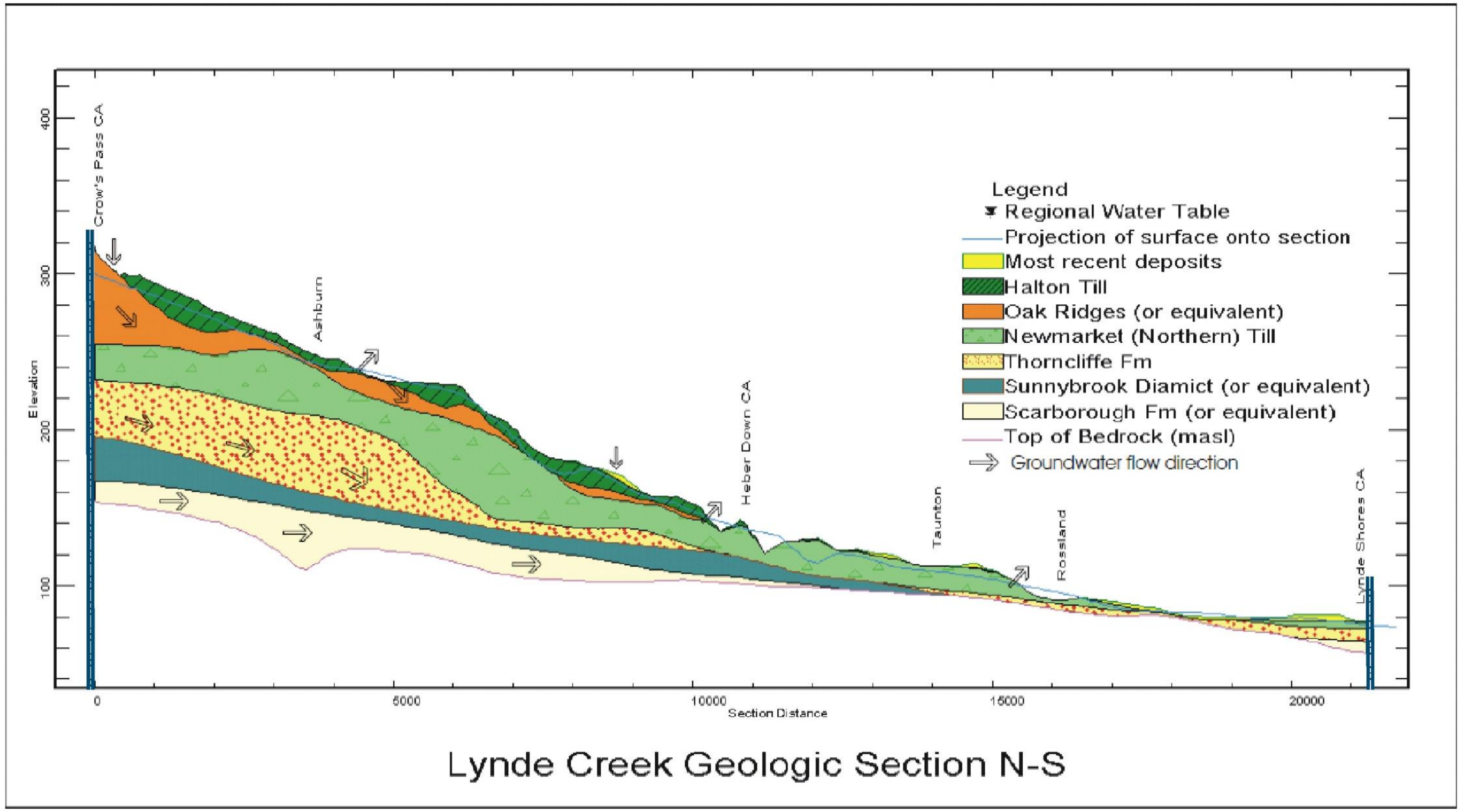
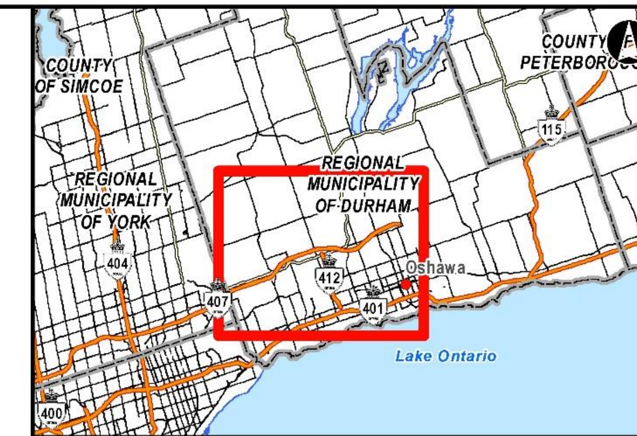


Figure 8: Lynde Creek watershed profile.

Source: Adapted from Figure 8. CLOCA. 2008. Lynde Creek Watershed Existing Conditions Report, Chapter 14 – Hydrogeology



Legend

Lynde Creek Watershed

Lynde Creek Watershed

Hydrostratigraphic Cross Section

May, 2019	NTS * when printed 11"x17"	Datum: NAD 1983 UTM Zone 17N Source: CLOCA, MNRF
P#: 60566558		**Figure 2-6**

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Figure 2-7: Existing Conditions – Land Use

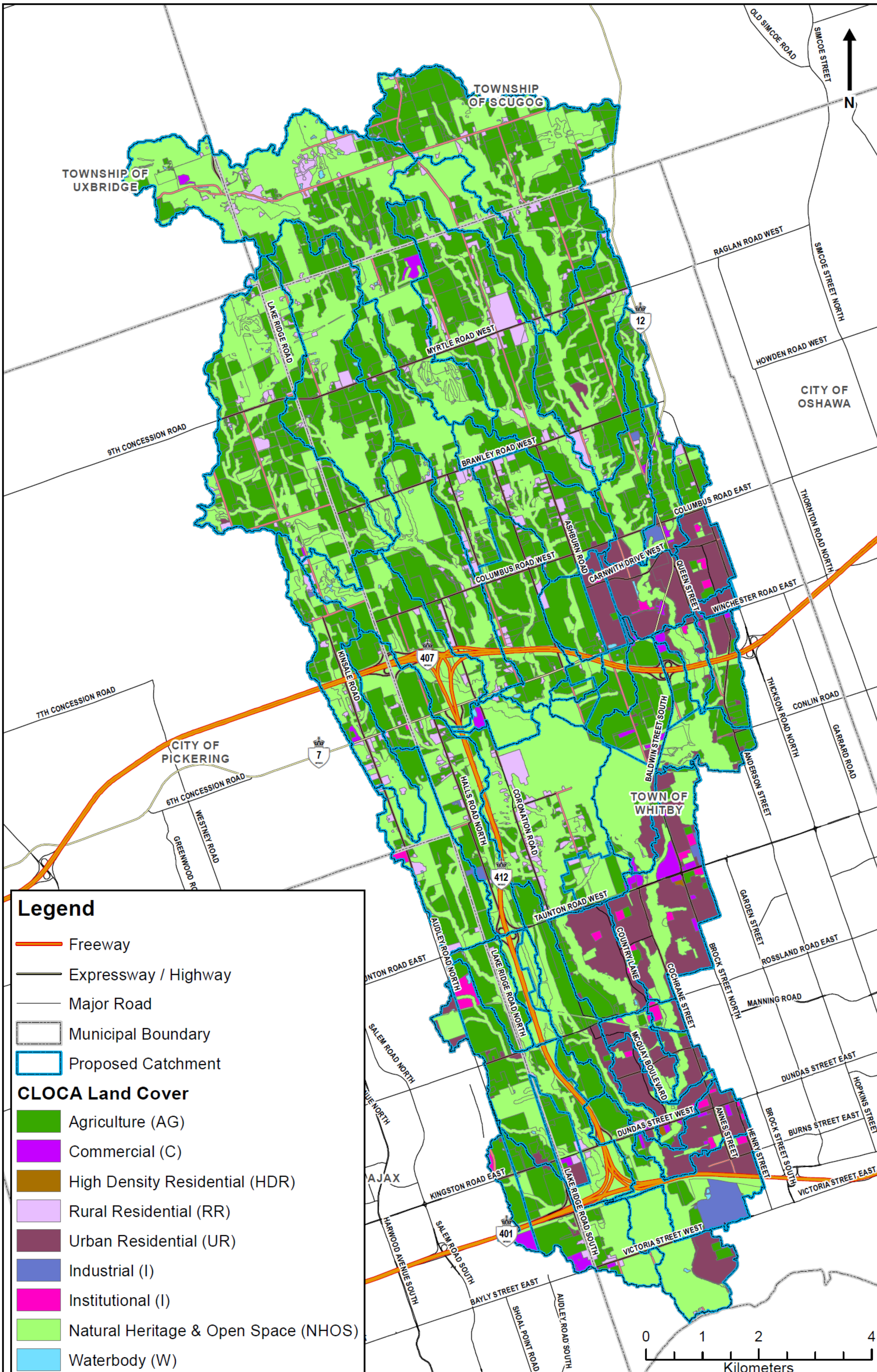
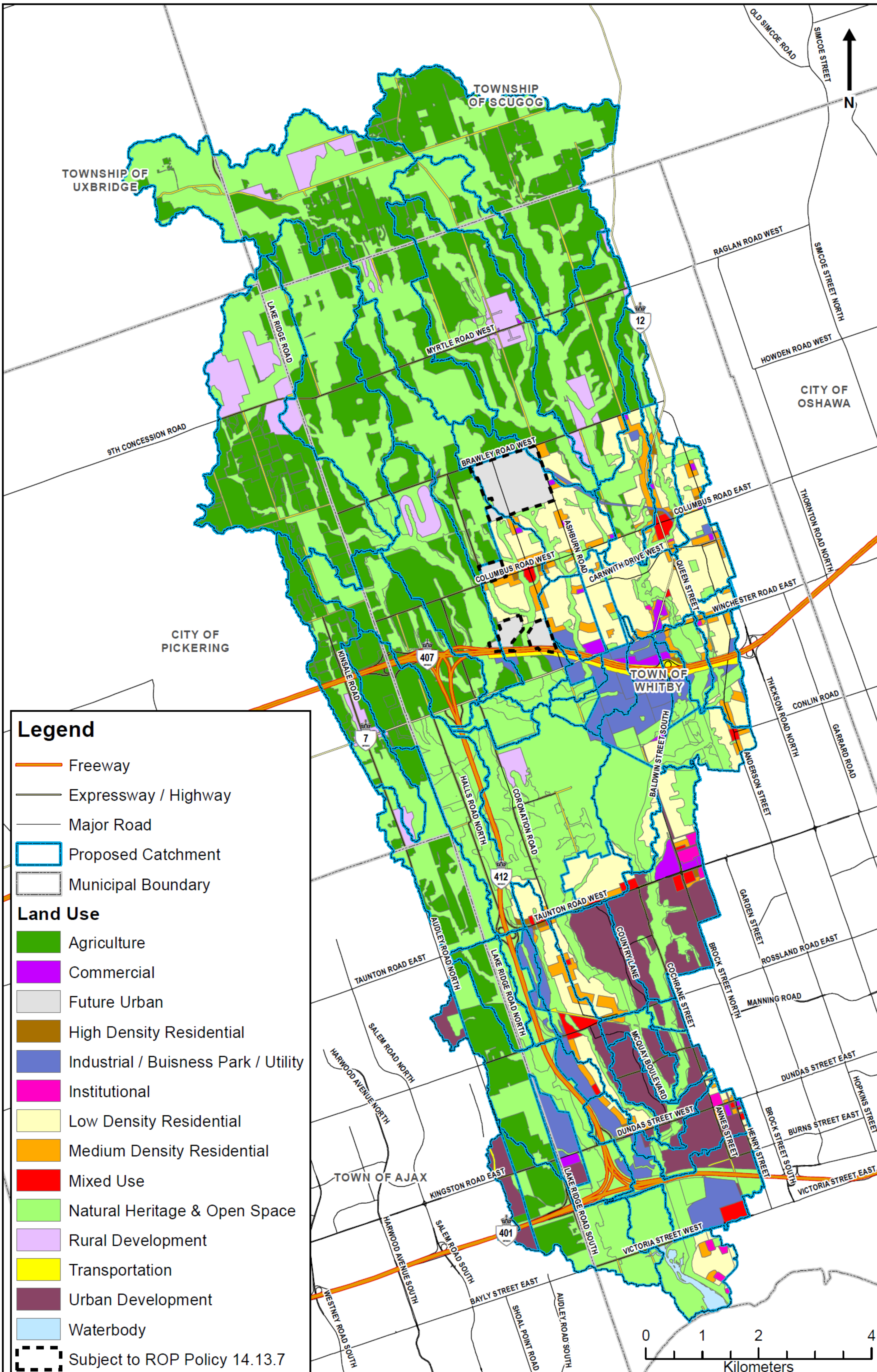


Figure 2-8: Future Conditions – Land Use



2.3.3 Land Use Comparison between 1988 and 2018

The 1988 MDPU land use was projected to the year 2031. As previously stated, for Lynde Creek, the recent Lynde Creek WMP (CLOCA 2012) was used for existing land use. Future land cover has been projected to year 2031.

As shown in **Table 2-1**, there is generally potential for a greater than 100% increase in impervious-type land use and a re-balancing of pervious-type land use between agriculture and natural heritage system.

Table 2-1: Existing (2012 WMP) and Future Land Use Comparison

Land Use	Existing (2012 WMP)	Future
Urban Development+ Transportation (Impervious)	11%	26%
Agricultural (Pervious)	63%	25%
Natural Heritage + Open Space + Rural Development (Pervious)	26%	49%

2.4 Surface Water Conditions

2.4.1 Hydrology

Since the release of the original 1988 Lynde Creek MDPU, the following has changed with regard to hydrologic conditions:

- Minor refinements to the watershed boundary based on latest topographic information provided by CLOCA/Town of Whitby;
- Updating of parameters in the hydrologic model, such as land use. For hydrologic modelling of existing conditions, the hydrologic parameters in several areas were modified by the Town (through the services of KSGS) and CLOCA, resulting in a consolidated hydrologic model with changes in land use, imperviousness and Time to Peak (Tp) in several locations. These changes are discussed further in **Section 3**;
- Official Plan (future land use) approved by the Town of Whitby;
- Updating of the rainfall input to the hydrologic model using 30 years of additional rainfall data: update rainfall intensity-duration-frequency relationship used in precipitation input to hydrologic model; and
- Change in Hydrologic Model from the original rural HYMO model in 1988, to the urban/rural Visual Otthymo V2 (VO2) in 2007 and to VO5 in 2018.

2.4.2 Infrastructure Inventories

2.4.2.1 Bridge and Culvert Structures

A tabular inventory and a location figure of seventy-seven watercourse crossings (bridges and culverts) are provided in **Appendix B2**. These have been extracted from the HEC-RAS hydraulic model files and have been identified by the ID numbers established in the 2008 Floodplain Mapping Study

2.4.2.2 Stormwater Management Facilities

A tabular inventory of twenty-seven existing SWM Ponds (a mixture of quantity and quality control) is provided in **Appendix B2** and SWM Ponds and oil/grit separators are illustrated in **Figure 2-9.** These have been identified through overlays of GIS shapefiles provided by the Town of Whitby and from the West Whitby and Brooklin Secondary Plans.

2.4.2.3 Storm Sewer Outfall Inventory

A graphical inventory of existing Town of Whitby and Region of Durham storm sewer outfalls and related storm sewers is illustrated in **Figure 2-10.** These have been identified through overlays of GIS shapefiles provided by the Town of Whitby and the Region of Durham.

2.4.3 Hydrometric and Hydrometeorologic Data

Hydrometric datum (flows- water levels) is provided by three Water Survey of Canada gauges:

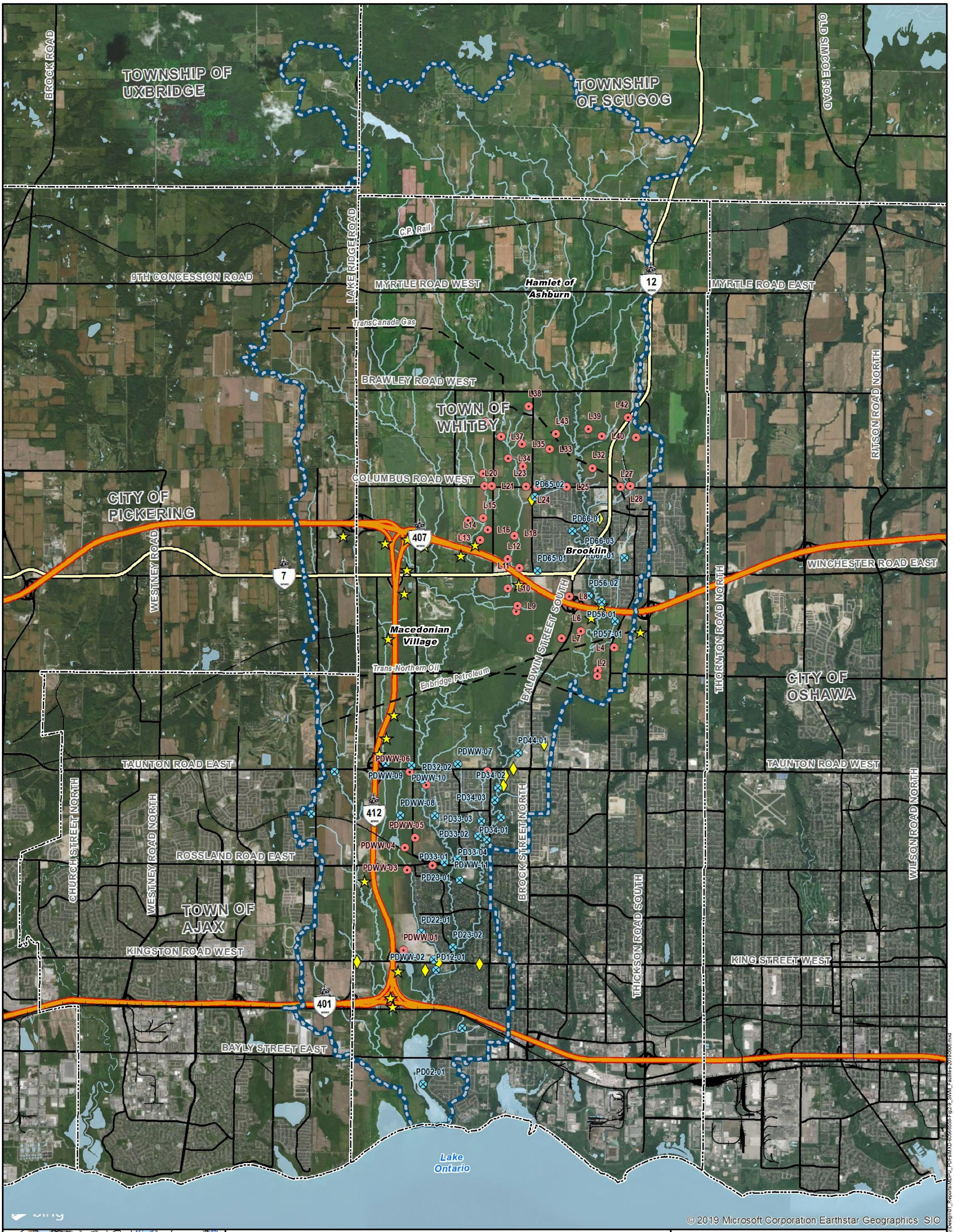
- 2HC018 – Lynde Creek at Dundas Street (58 years data);
- 2HC055- Heber Down Tributary near Heber Down CA (15 years data); and
- 2HC054-Lynde Creek at Brooklin (15 years data).

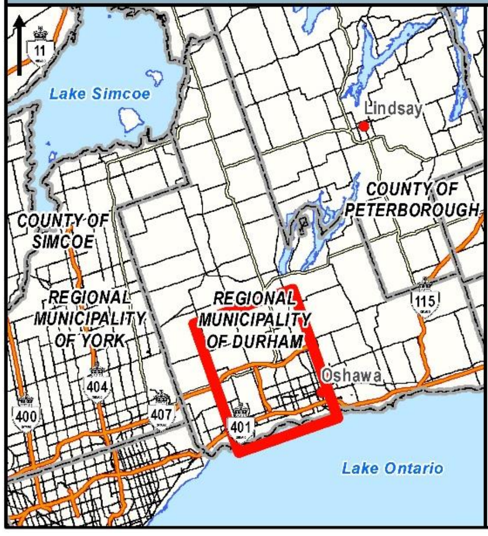
Hydrometeorologic datum (precipitation and temperature) is provided by three CLOCA hydromet stations:

- Heber Down Trib at Heber Down CA (12 years data);
- Brooklin at Lynde Creek (12 years data); and
- Dundas Street at Lynde Creek (12 years data).

Hydrometeorologic datum is also provided by two Atmospheric Environment Service (Environment Canada) hydromet stations:

- Oshawa WPCP (48 years data); and
- Toronto City Station (59 years data).





Legend

- Freeway
- Expressway / Highway
- Major Road
- Watercourse
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Existing OGS
- Existing Transportation SWM Pond
- Existing SWM Pond
- Proposed SWM Pond*

* PDWW-## => Source: West Whitby SWM Reports
L## => Source: Brooklin Secondary Plan
PD-## => Source: Existing Whitby

N

Lynde Creek Watershed

Stormwater Management Facilities

June 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
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AECOM

Figure 2-9

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Kilometers

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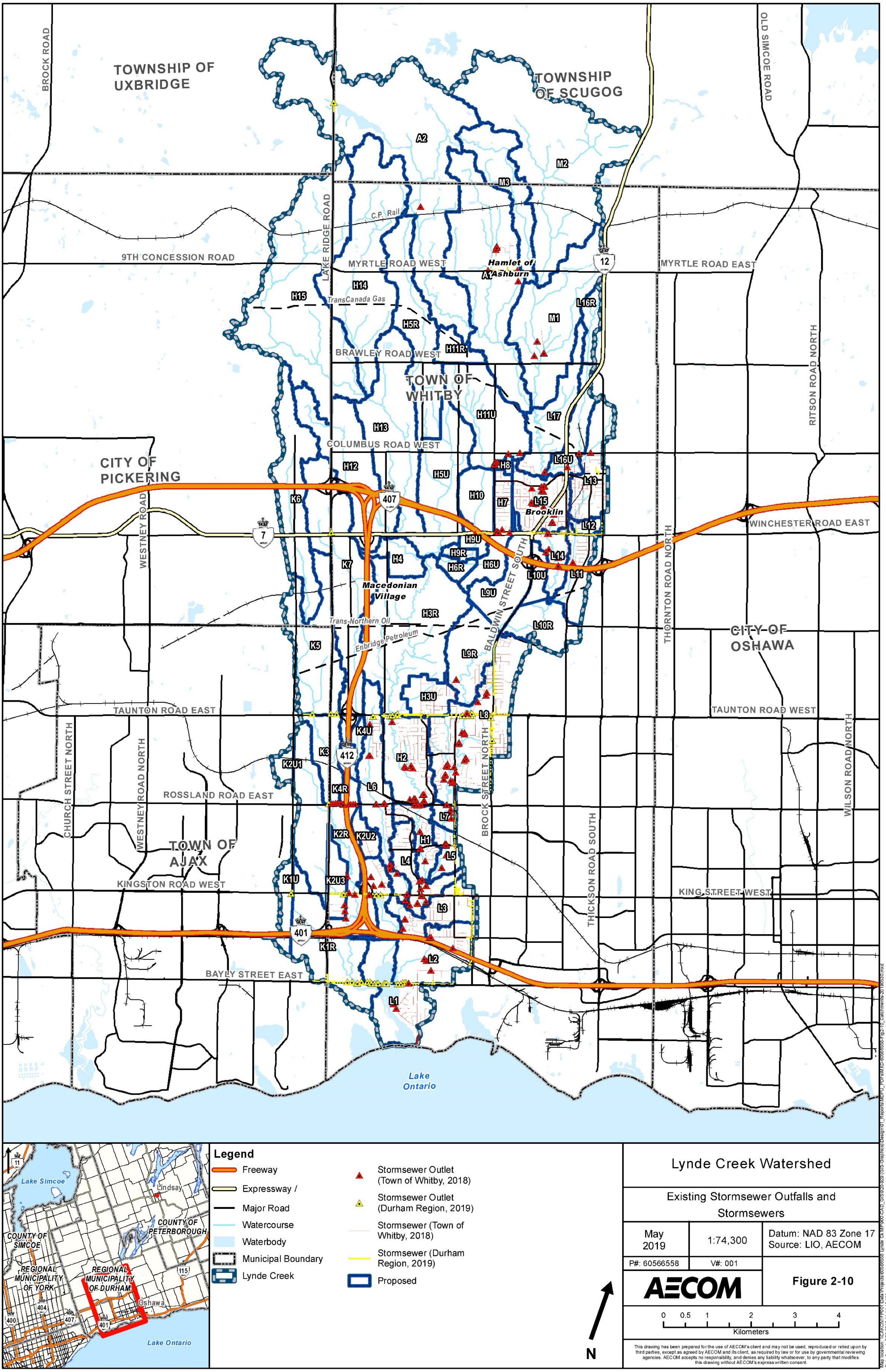


Lynde Creek Watershed

Existing Stormsewer Outfalls and Stormsewers

Figure 2-10

2.4.4 Existing Floodplain Mapping and Flood Vulnerable Areas

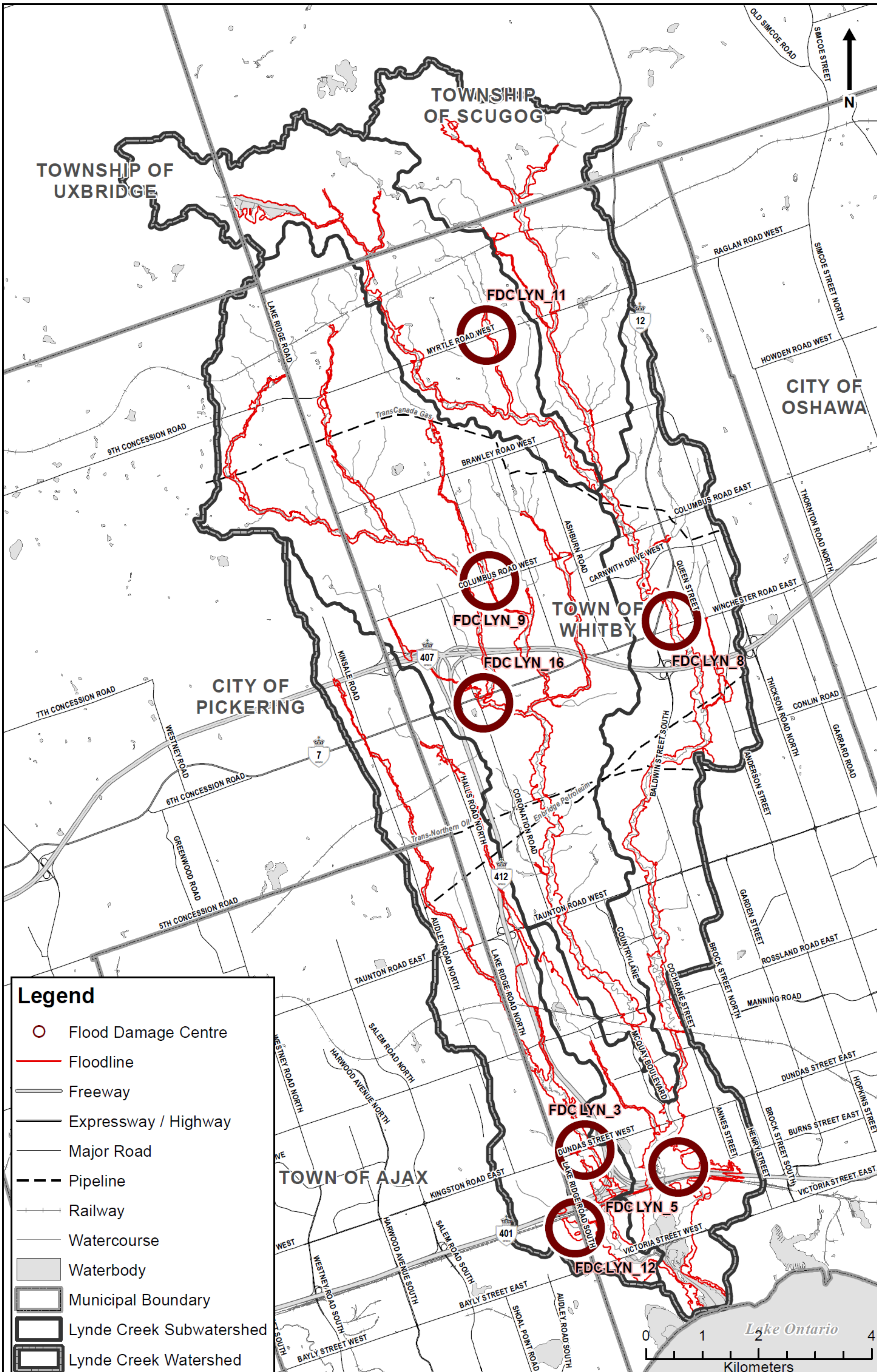
The extent of current (2008) floodplain mapping for the Lynde Creek watershed is provided in **Figure 2-11**. The seven Flood Vulnerable Areas (FVAs) are also identified in **Figure 2-11**. A FVA is an area containing several structures that suffer property damage in up to Regulatory Flood conditions: these are Type II Areas which are infrequently flooded by major events up to the 100 year event. These areas supersede the areas identified in the initial floodplain mapping study (EarthTech, 2008) in which over sixty bridges and culverts were identified for replacement due to flooding concerns: from reporting in the Lynde Creek Watershed Plan (CLOCA, 2012) it can be inferred that most of these upgrades were not warranted.

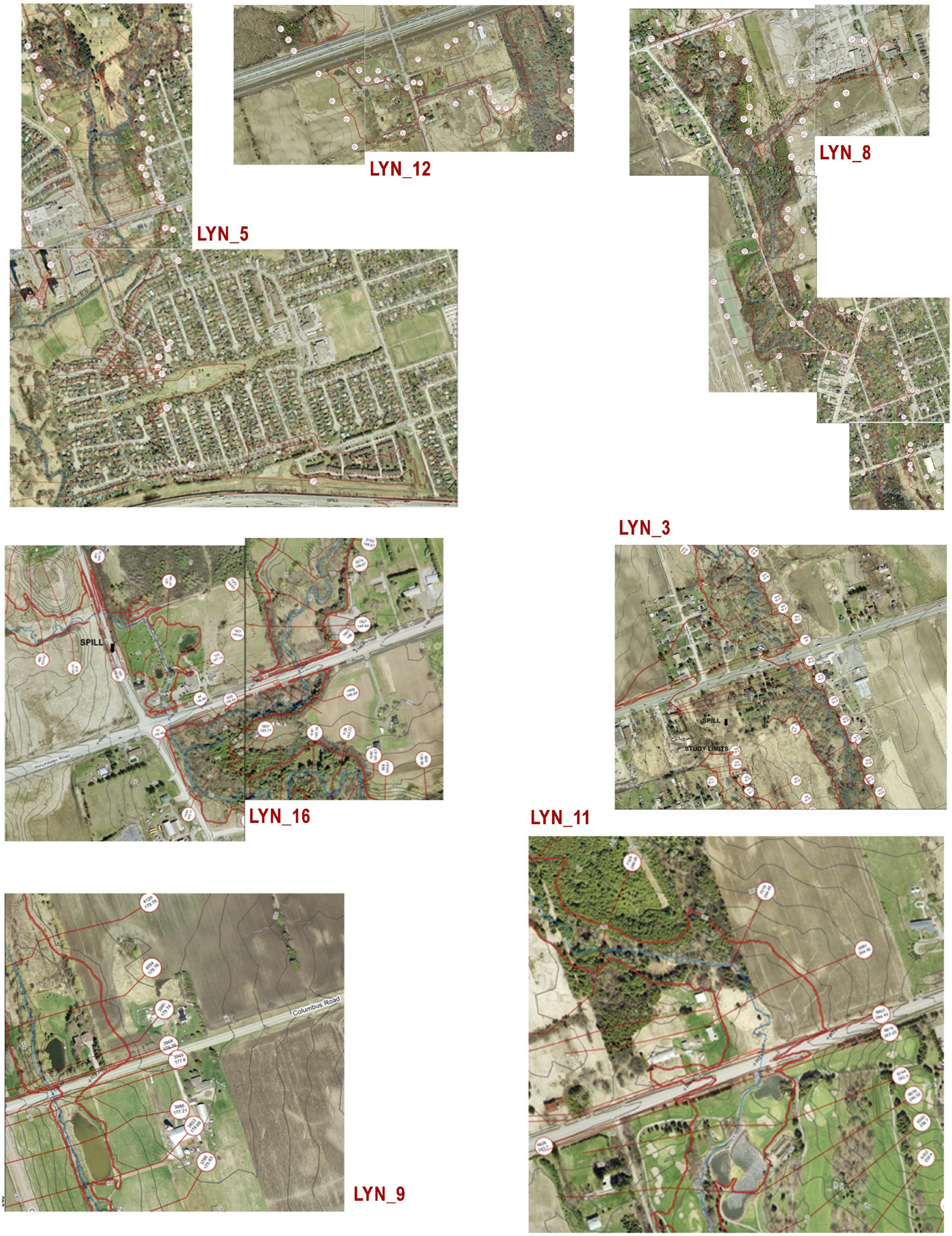
Table 2-2 identifies the number of flood vulnerable buildings and structures. Refer to **Figure 2-12** for the extent of the FVAs. CLOCA has recently completed a Watershed Flood-Risk Assessment (CLOCA, April 2017) that provides further details of flood risk in the Lynde Creek Watershed.

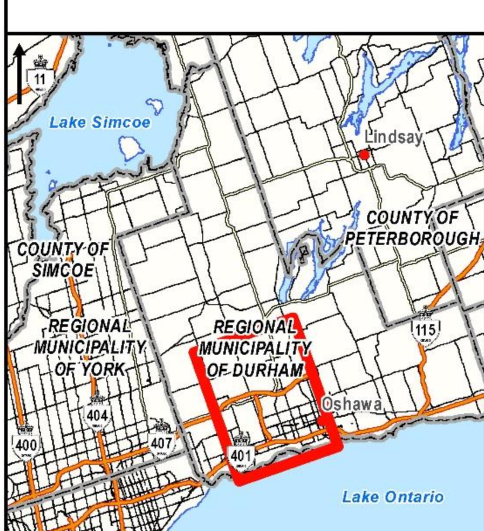
Table 2-2: Flood Vulnerable Areas

Location	Street Name	Number of Structures in FVA	Protection Level Provided – No Flooding
FDC_LYN_3	Dundas Street West at Halls Road (Regional Highway 2)	8	100-yr
FDC_LYN_5	Upstream of Highway 401/ Michael Boulevard	185	50-yr
FDC_LYN_8	Winchester Road (Regional Road 3) to Baldwin Street	5	100-yr
FDC_LYN_9	Columbus Road West, East of Country Lane	2	50-yr
FDC_LYN_11	Myrtle Road West (Regional Road 5) – West of Heron Rd.	1	100-yr
FDC_LYN_12	Upstream of Lake Ridge Road – Regional Road 23	4	100-yr
FDC_LYN_16	Winchester Road (Regional Road 3) at Coronation Boulevard	1	100-yr

Figure 2-11: Existing Floodplain Mapping and Flood Vulnerable Areas







Legend

Floodline

Lynde Creek Watershed

Flood Vulnerable Areas

May 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	

AECOM

Figure 2-12

0 0.5 1 2 3 4
Kilometers

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2.4.5 Surface Water Quality

Surface Water Quality was reviewed as part of the MDPU. As per the Lynde Creek Watershed Management Plan (CLOCA 2012):

> *Surface water quality is a key indicator of watershed health and has particularly strong impacts on fish and other aquatic life. As all municipal drinking water is provided from Lake Ontario, the quality of the surface water flowing into the Lake from watershed streams becomes important for human health as well. Different types of water quality information (biological and chemical indicators) have been collected by CLOCA and MOE through the Provincial Water Quality Monitoring Network Program (PWQMN) since 1964. The following outlines key conditions found in the Lynde Creek Watershed regarding surface water quality:*
>
> - *Benthics: 14 sites sampled, 7 considered impaired; 75% of urban sites impaired; 83% of sites in natural areas unimpaired; and 50% of sites in agricultural areas unimpaired;*
> - *Biological Oxygen Demand: The presence of a persistent organic load to the system in some reaches;*
> - *Dissolved Oxygen: All sites measured at 8-10 mg/L indicating sufficient levels to support cold water systems;*
> - *Chloride: Increasing trend but well below the 150 mg/L limit (higher in southern reaches of watershed and in winter months between December and March). Surface water quality and shallow aquifer systems are susceptible to road salting.*
> - *Phosphorus: Generally < 30 ug/L, meeting the Provincial Water Quality Monitoring Network (PWQMN) standards for streams;*
> - *Nitrates: Increasing trend; and*
> - *Copper: Decreasing trend (some exceedances of the 5 ug/L limit were recorded in SWQ9 in Lynde Creek).*

2.4.6 Water Balance

Since the publication of the original 1988 Lynde Creek MDP, a clearer understanding of current infiltration rates has been developed in the Lynde Creek Watershed Existing Conditions Study (CLOCA 2008).

Water budget targets or groundwater infiltration rates (mm/yr), for the five subwatersheds, have been identified based on the Lynde Creek Existing Conditions Study (CLOCA 2008):

- Lynde Main – 130 mm/yr;
- Heber Down – 154 mm/yr;
- Kinsale – 125 mm/yr;
- Ashburn – 209 mm/yr; and
- Myrtle – 210 mm/yr.

Refer to **Section 5.3** for further discussion regarding water balance – infiltration rates.

2.5 Stream Erosion and Fluvial Geomorphology

In support of the Lynde Creek MDPU, the fluvial geomorphological assessment has been updated with the following aims and objectives:

- Background review of previously completed geomorphological assessments and inventories from the study area;
- Data gap analysis to identify targeted reaches for addition investigations;
- Reach delineation, including confirmation of previously defined reach breaks;
- Targeted field reconnaissance of additional reaches;
- Historical assessment to identify land use and channel change; and,
- Recommendations for future development and mitigation.

2.5.1 Background Information

The following documents were reviewed and provide key information relating to watershed characteristics and geomorphological input that form the context for the Lynde Creek MDPU:

- G.M. Sernas and Associates Limited, 1988. Master Drainage Study, Lynde Creek;
- Cosburn Patterson Wardman Limited, 1992. Brooklin Master Drainage Plan East Lynde Creek;
- Central Lake Ontario Conservation Authority, 2008. Lynde Creek Watershed Existing Conditions – Report;

- SRM Associates (Prepared for the Town of Whitby), 2011. Schedule B Municipal Class Environmental Assessment – Whites Bridge Geomorphic and Hazard Assessment;
- AECOM, 2012. Fluvial Geomorphologic and Drainage Preliminary Risk Assessment of 3 metres or Wider Water crossing Structures;
- Brooklin Secondary Plan (BSP) Background Report 2014 Stage 2 Report 2016 on Watershed Planning, Hazard Lands and Stormwater Management;
- GEOMorphix, 2017. Lynde Creek at 26 Evans Court Erosion Protection – Report Prepared for the Town of Whitby; and
- GEOMorphix, 2017. Lynde Creek Valley Wall Regarding 36 Way Street, Brooklin – Report Prepared for the Town of Whitby.

The information that is most pertinent to the fluvial geomorphic assessment and design is summarized below and further detailed, as necessary, in **Appendix B3**. Additional details can be obtained within the referenced reports themselves.

2.5.1.1 Master Drainage Study, Lynde Creek, 1988

The 1988 Master Drainage Study indicated and investigated 44 erosion sites along Lynde Creek and its tributaries and noted that erosion had occurred downstream of urban development.

The highest concentration of erosion sites based on field reconnaissance was along the East and West Tributaries of Lynde Creek, between Highway 2 and Taunton Road. However, these sites were located within open land systems, with no clear immediate threat to infrastructure in the area.

From the photographs that are available, key issues included a lack of stabilizing riparian vegetation, also noted within the study itself. Some of the sites are also associated with valley slope instability.

The report was completed during a time when bank erosion was considered primarily as a negative process, rather than as an integral part of channel adjustment that is frequently accelerated by human intervention. The proposed plan to address the erosion sites involved only localized action, including:

- Creation of a 2-stage channel approach for 3 reaches between Taunton Road and Highway 2 addressing twenty-three erosion sites; and
- Traditional engineering erosion control measures, including re-grading, dredging, and armourstone and riprap bank protection.

2.5.1.2 Brooklin Master Drainage Plan East Lynde Creek, 1992

In 1992, seventeen erosion sites were identified in the area of the future Brooklin Community (Cosburn Patterson Wardman Limited, 1992). Eight of the sites were identified as requiring treatment (including localized bank protection measures and traditional engineering), and the other nine sites were identified as requiring monitoring. The erosion sites were primarily located where the watercourse was in close contact with the valley wall and bank erosion was in turn causing slope instability, ultimately causing the loss of tableland and/or structures.

In addition, the study noted areas of eroding stream banks occurring within meandering sections of the watercourse located approximately 2 kilometres south of Winchester Road. It was noted that bank erosion naturally occurs along the outside of meander bends and would be expected within meandering sections of the creek.

2.5.1.3 Lynde Creek Watershed Existing Conditions Report, 2008

Based on previous studies completed, an assessment of stream stability within the Lynde Creek watershed was completed in areas where channel erosion is a concern (Central Lake Ontario Conservation, 2008). In addition to this, two methods of field assessments, Rapid Stream Assessment Technique (Galli, 1996) and Rapid Geomorphic Assessment (MOE, 1999) were completed for eleven representative reaches throughout the urban portions of the watershed, including seven reaches within the Lynde Main subwatershed, two reaches within the Heber Down Subwatershed and two reaches within the Kinsale watershed.

Details of the ***Rapid Stream Assessment Technique*** (RSAT) and ***Rapid Geomorphic Assessment*** (RGA) techniques are discussed in more detail in **Appendix B3.**

The following summarizes key results from the RSAT survey with details provided in **Appendix B3**:

- Instability within Reaches 2, 5 and 6 due to livestock grazing and lack of riparian vegetation;
- Despite erosion protection, including armouring, within Reach 2, the stream continues to adjust. It was noted that armouring often encourages erosion downstream through translated energy as well as requires maintenance;
- Successful restoration of the riparian zone was noted within Reach 6, where old pasture land had been transformed into a healthy, renaturalized floodplain;

- Significant stream instability was noted within Reach 8, downstream of the stormwater management (SWM) pond located south of the Brooklin Community Centre; and
- Stream health within Reach 9 was adversely impacted by manicured lands associated with private residential lots, bordering the watercourse and reducing riparian zone structure and bank stability. It was noted that valleys should be kept intact and transferred to public ownership if the adjacent lands are to be developed.

The RGA technique uses visual indicators to document evidence of channel instability using presence/ absence methodology. The RGA classified four reaches within the Lynde Main subwatershed, two reaches within the Heber Down Subwatershed and one reach within the Kinsale watershed as transitional or stressed. Details are provided in **Appendix B3.**

2.5.1.4 Schedule B Municipal Class Environmental Assessment – Whites Bridge Geomorphic and Hazard Assessment, 2011

Field data and observations were collected along Lynde Creek as part of the Whites Bridge Replacement, located at Columbus Road, just west of Country Lane. Field reconnaissance was undertaken to identify active geomorphological processes, assess channel stability and characterize reach conditions through rapid assessment (SRM Associates 2011).

A RGA survey was undertaken along one reach within Lynde Creek beginning upstream of Whites Bridge and continuing downstream, and the overall stability index score of 0.29. The reach was classified as 'in transition' with channel degradation and widening noted as the most prominent factors that were contributing to the condition The overall RSAT score within the reach was classified as "fair", consistent with the CLOCA, 2008 rating.

The assessment indicated the following:

- Upstream of Columbus Road the channel is well-shaded by a dense cedar forest, bed material is coarse (at least partially sourced from armoured banks). The armour layer in combination with bank stability provided by dense tree roots has helped limit bank erosion within this area; and
- Bank erosion was higher in areas where the banks are composed of finer materials and there is low rooting density.

A meander belt assessment and channel migration assessment was conducted on Lynde Creek at White's bridge to assess the potential risk to infrastructure on Columbus

Road and to protect terrestrial habitat. Due to dense vegetation cover within the aerial photography obtained, the meander belt assessment relies primarily on empirical formulae to generate estimates of Meander Belt Width based on channel metrics. The Meander Belt Width assessment results are presented in **Appendix B3**. Various models were applied and in addition, field assessments were used to characterize systematic adjustments, channel stability and identify any areas of concern. Based on projects in which the channel is clearly visible on aerial photography, it was concluded that the Williams (1986) formula, based on cross-sectional area, would be the most similar with the measured meander belt. This resulted in a meander belt width of 40 metres and 48 metres with a 20% buffer.

A detailed geomorphological assessment was also completed within the study area, and the results are presented in **Appendix B3**.

2.5.1.5 Fluvial Geomorphic and Drainage Preliminary Risk Assessment of 3 metres or Wider Water Crossing Structures, 2012

AECOM was retained by the Town of Whitby to undertake the preliminary risk assessment for the thirty-nine watercourse crossings that have a span equal to, or greater than, 3 metres and that are situated within its urban boundary (AECOM, 2012). The intent of this study was to support development of a rehabilitation and maintenance program for these crossings and provide recommendations for rehabilitation/ maintenance and monitoring.

Watercourse crossings may adversely impact the watercourse as well as being subject to erosion risk. A field investigation was undertaken to examine fluvial geomorphologic conditions and processes operating at the crossings, observe interactions between the watercourse and crossing structure and document:

- Evidence of scour and erosion under bridge piers;
- Transitions between crossing structure and the bank materials; and
- Condition of engineering countermeasures placed on channel bed and banks in proximity to the crossing.

Several crossings exhibited local evidence of scour requiring measures to manage the risk. A summary of key observations from this study are provided in **Appendix B3.**

Development of a quantitative ranking scheme considered field observations and grouped these according to lateral, vertical or general instream fluvial risks, as well as hydraulic performance, erosion and scour and flooding risks in order to rank each crossing as presented in **Appendix B3.**

2.5.1.6 Brooklin Community Secondary Plan Background Report on Watershed Planning, Hazard Lands and Stormwater Management

This document is a background report on Watershed Planning, Hazard Lands and Stormwater Management Guidelines (December, 2014):

- Additional background work is ongoing to provide input to the delineation of erosion hazard limits associated with permanent and intermittent watercourses from a geomorphic perspective. Meander belt widths are being evaluated for confined and unconfined stream reaches along Lynde Creek, Pringle Creek and Oshawa Creek. This information is used to determine erosion hazards and setbacks to development as part of sub-area studies.
- Crossings were assessed from a Stormwater Management Perspective, which considers potential impacts to the quantity and quality of Stormwater resulting from the proposed development of the Brooklin Community Secondary Plan.

2.5.1.7 Lynde Creek Valley Wall Regarding 36 Way Street, Brooklin, 2017

GEOMorphix was retained by the Town of Whitby to assess erosion due to a large meander bend that has enveloped privately owned property located at 38 Way Street in Brooklin. The bend along the south property boundary migrated into the valley wall and therefore, presented an erosion hazard to the property. In the event of a failure it was noted that this could result in damage to the house, and sudden input of sediment into the creek (regulated as Redside Dace habitat).

It was recommended that due to the characteristics of the eroding valley wall (e.g., height, steepness and composition) and due to the risk of failure, that valley wall regrading was assessed as the appropriate mitigation strategy for this area. This would be followed by toe erosion protection to prevent continued bend migration. With consideration for Redside dace and other fish communities and aquatic life, the proposed design would also incorporate near-bank habitat enhancements in the form of woody plantings within the toe erosion protection as well as beyond the regraded valley wall. A rapid geomorphic assessment classified the reach stability index as 0.26 or ‘transitional’ primarily due to channel widening. The RSAT scored the stream health of the channel as “fair” bordering on “good” with an overall score of 24. A summary of the detailed geomorphic assessment is presented in **Appendix B3.**

2.5.1.8 Lynde Creek at 26 Evans Court Erosion Protection, 2017

GeoMorphix was retained by the Town of Whitby to assess erosion at 26 Evans Court. A residential subdivision was developed in the 1970s north of Highway 401 and east of

Lynde Creek. A retaining wall was constructed along the eastern boundary of the subdivision in close proximity to Lynde Creek. The gabion wall retained soils for the construction of the homes above the flood –prone elevation, and protected residential properties from Creek erosion. Findings of a desk-top and field assessment found that the gabion retaining wall would be restored by removing and reinstalling the top course of gabion baskets to form a level top surface. This would be followed by backfill replacement at the recommendation of a geotechnical engineer. Following the restoration a vegetated rock buttress will be constructed along the base to provide toe erosion protection and prevent future structure undermining.

Historical assessment results indicated that in 1946 there was a notable large meander bend located downstream of Dundas Street and through present-day Jeffery Street Park within the vicinity of the study area. In the 1970s the Lynde Creek Gardens residential development was constructed (including Evans Court) on the east side of Lynde Creek and north of Highway 401. Stacked gabion baskets 3' by 3' were proposed along the outside bank of the meander bends downstream of the gabion mattress (separated by a storm sewer headwall) to the south limit of the development. In 2004, the meander bend with the west facing apex west of the development near Highway 401 was cut off and there was limited evidence of a former meander bend within the aerial imagery. Channel straightening in the vicinity of the study area (natural and forced) increase the potential for channel adjustments.

A summary of the 2016 field reconnaissance and channel parameters for the channel reach in the vicinity of study area is presented in **Appendix B3**.

2.5.2 Reach Delineation

Reaches can be defined as lengths of channel that display similar physical characteristics and have a setting that remains nearly constant along their length. Reaches display relative homogeneity in channel form, functions and processes, and are influenced by similar controlling (discharge, slope) and modifying factors (vegetation) to which the channel has become adjusted to, or will become adjusted to in the future.

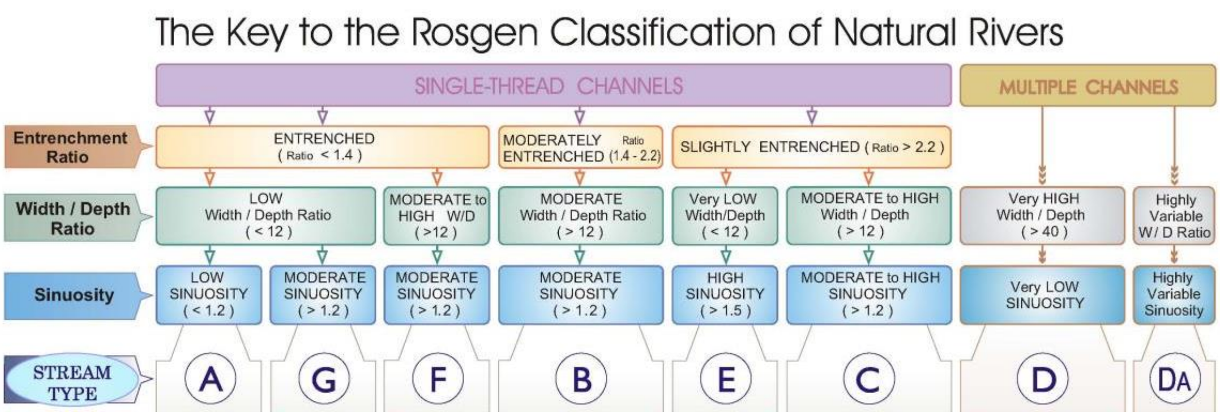
As previously described, many reaches within the Lynde Creek study area have previously been characterized in previous studies, presenting non-connected localized insight conditions within the watershed. In a goal to account for the entire Lynde Creek watershed, including the sub-watersheds (Ashburn, Heber Down, Kinsale, Lynde Main and Myrtle Station), a new reach classification was undertaken on the main river courses. The reach classification is presented in **Figure 2-14** and in **Table 2-4.**

2.5.3 Desk-Based Reach Characterisation

An initial characterisation of all of the reaches identified within the study area was undertaken based on GIS, aerial photography and findings of previous studies, according to the Level-1 Rosgen classification (geomorphic characterization). Rosgen classification - Level I categorize stream types into letters A - G based on their geomorphic characteristics that result from the integration of basin relief, land form, and valley morphology (**Figure 2-13**). This is a general way in which the morphology of a stream can be described. Many of the Level I criteria can be determined through topographic and landform maps, aerial imagery, and geospatial data (Rosgen 1994). This classification is based on the following factors:

- Entrenchment ratio;
- Width to depth ratio; and
- Sinuosity.

Figure 2-13: Rosgen Classification Model Used to Rank the Lynde Creek Watershed Main Streams



Reaches were classified according to entrenchment, width to depth ratio and sinuosity according to the criteria used in the Rosgen classification system, presented in **Table 2-3a-c**.

Table 2-3a: Parameters of Analysis

Entrenchment Ratio	W_{flood}/Q_{bf}	Classification
Entrenched	<1.4	1
Moderately Entrenched	1.4 to 2.2	2
Slightly Entrenched	>2.2	3

Table 2-3b: Parameters of Analysis

Width to Depth Ratio	W_{bf}/ D_{bf}	Classification
Low	<12	1
Moderate to High	>12	2

Table 2-3c: Parameters of Analysis

Sinuosity	$L_{channel}/ L_{valley}$	Classification
Low	<1.2	1
Moderate	1.2-1.5	2
High	>1.5	3

The resulting Rosgen classification for all the reaches identified in the Lynde Creek watershed is presented in **Figure 2-14**, together with the general trend towards increased lateral mobility. Basic reach characterisation details for all the reaches are presented in **Table 2-4**.

The reaches were further classified in terms of their relation to previous studies, existing and proposed development, in order to inform planning of targeted additional field work. The classification used were:

- Already assessed in 2008 (potential to compare geomorphological conditions) (CLOCA, 2008);
- New reach located within proposed development: Schedule K (WWSP) and Schedule V (BSP);
- Within existing residential area;
- Outside of proposed developments, but with potential for interaction;
- Within (or bordering) proposed development, already engineered for road crossings; and
- Downstream of proposed development.

According to the Rosgen classification and location in relation to existing and proposed development, the reaches were assigned a priority for further field investigation (**Table 2-4**).

2.5.4 Targeted Additional Field Reconnaissance

Within the Lynde Creek study area there is the presence of highly mobile reaches within some areas of development, these reaches became the focus for targeted field reconnaissance.

Figure 2-14: Identified Geomorphological Reaches within the Lynde Creek Watershed

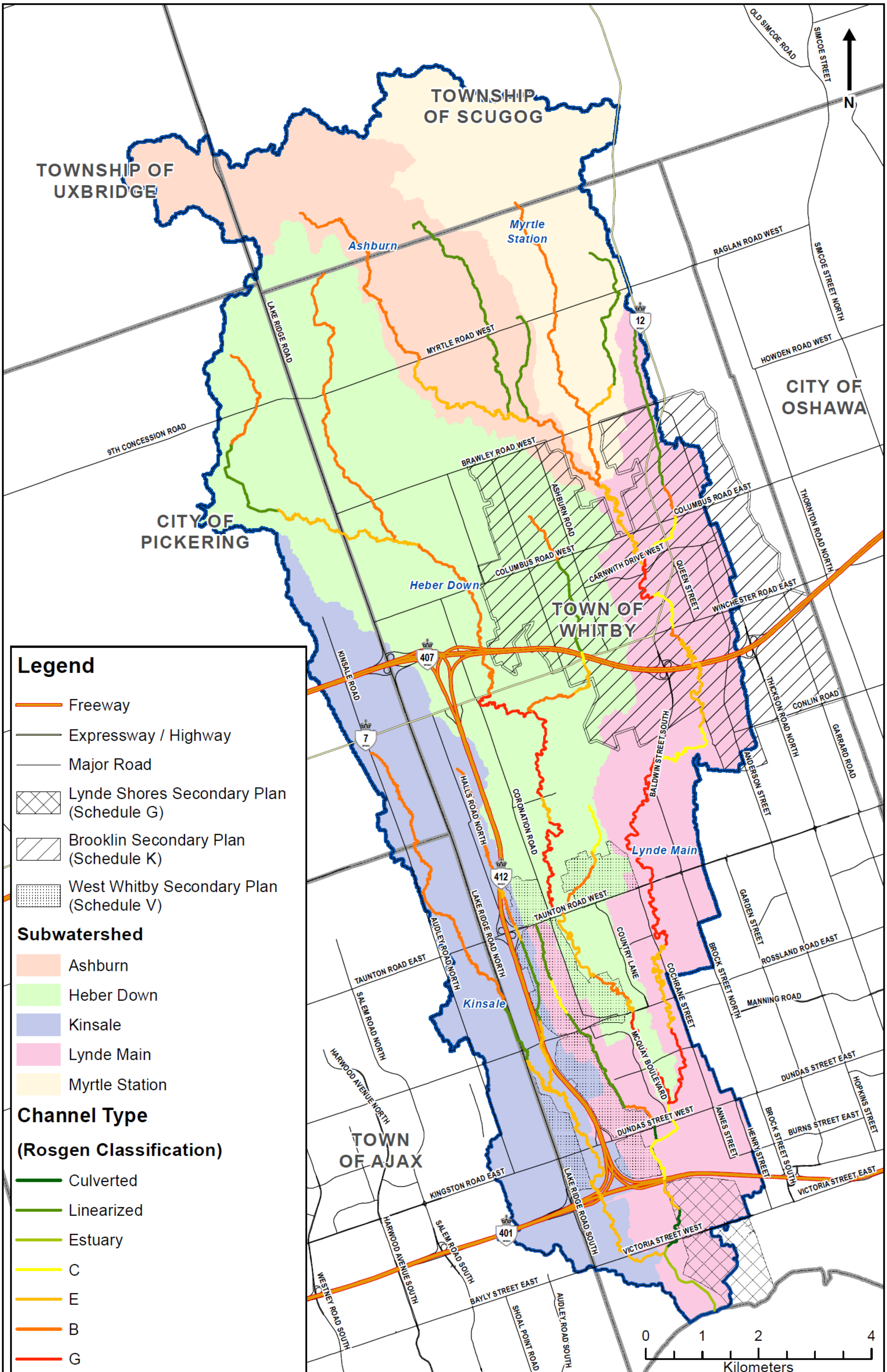


Table 2-4: Desk-Based Reach Assessment within the Lynde Creek Watershed

Subwatershed	Reach	Length (m)	Reach (CLOCA 2008)	Entrenchment Ratio	Width/ Depth (ratio)	Sinuosity	Rosgen Classification	Brooklin Secondary Plan Schedule V	West Whitby Secondary Plan Schedule K	Priority
Ashburn	A1	2482.2		2	2	2	B	No	Bordering	Low
Ashburn	A2	4307.8		3	2	3	E	No	No	N/A
Ashburn	A3	5140.8		2	2	2	B	No	No	N/A
Ashburn	A4	2083.3		3	2	1	Linearized	No	No	N/A
Ashburn	A5	4949.6		3	2	1	Linearized	No	No	N/A
Heber Down	H01	2277.2	3	1	1	2	G	No	No	N/A
Heber Down	H02	502.8		3	2	3	E	Bordering	No	Low
Heber Down	H03	1081.7		2	2	3	B	Within	No	High
Heber Down	H04	1965.9	5	3	2	3	E	Bordering	No	Low
Heber Down	H05	3130.5		1	1	2	G	Bordering	No	Low
Heber Down	H06	598.8		3	2	3	E	No	No	N/A
Heber Down	H07	4148.3		1	1	2	G	No	No	N/A
Heber Down	H08	4057.0		2	2	2	B	No	Bordering	Low
Heber Down	H09	1348.8		3	2	3	E	No	No	N/A
Heber Down	H10	2774.5		3	2	3	E	No	No	N/A
Heber Down	H11	2161.9		3	2	1	Linearized	No	No	N/A
Heber Down	H12	2331.2		2	2	2	B	No	No	N/A
Heber Down	H13	1110.7		2	2	2	B	Within	No	High
Heber Down	H14	295.6		3	2	3	E	Within	No	High
Heber Down	H15	1008.1		3	2	2	C	No	No	N/A
Heber Down	H16	1108.0		2	2	2	B	No	Bordering	N/A
Heber Down	H17	1016.1		3	2	3	E	No	Within	High
Heber Down	H18	206.0		3	2	2	C	No	Within	N/A
Heber Down	H19	1926.2		3	2	1	Linearized	No	Within	High
Heber Down	H20	1051.1		2	2	2	B	No	Within	High
Heber Down	H21	6319.6		2	2	2	B	No	No	N/A
Kinsale	K01	770.6		3	2	3	E	No	No	N/A
Kinsale	K02	1504.7		3	2	3	E	No	No	N/A
Kinsale	K03	540.1		3	2	3	E	No	No	N/A
Kinsale	K04	3146.0		3	2	3	E	Bordering	No	Low
Kinsale	K05	1826.8	2	3	2	3	E	Bordering	No	Low
Kinsale	K06	1322.5		3	2	1	Linearized	No	No	N/A
Kinsale	K07	7203.8		2	2	2	B	No	No	N/A
Kinsale	K08	685.0	7	3	2	3	E	No	No	N/A
Kinsale	K09	1220.0	7	3	2	3	E	Bordering	No	N/A
Kinsale	K10	1578.5		3	2	1	Linearized	Within	No	High
Kinsale	K11	368.6		3	2	3	E	Bordering	No	N/A
Kinsale	K12	602.6		2	2	2	B	Within	No	High
Kinsale	K13	450.6		3	2	3	E	Bordering	No	N/A
Kinsale	K14	2795.7		2	2	2	B	No	No	N/A
Lynde Main	L01	1588.5		3	2	1	Estuary	No	No	N/A
Lynde Main	L02	1001.2		3	2	3	Culverted	No	No	N/A
Lynde Main	L03	693.1		3	2	3	E	No	No	N/A
Lynde Main	L04	1843.0	1	3	2	2	C	Within	No	Highest

Subwatershed	Reach	Length (m)	Reach (CLOCA 2008)	Entrenchment Ratio	Width/ Depth (ratio)	Sinuosity	Rosgen Classification	Brooklin Secondary Plan Schedule V	West Whitby Secondary Plan Schedule K	Priority
Lynde Main	L05	1769.6	4	1	1	2	G	No	No	N/A
Lynde Main	L06	1217.6		3	2	3	E	No	No	N/A
Lynde Main	L07	2161.9	6	3	2	3	E	No	No	N/A
Lynde Main	L08	5758.7	11	1	1	2	G	Bordering	No	Low
Lynde Main	L09	1770.5	10	3	2	2	C	No	Bordering	N/A
Lynde Main	L10	568.8	8	3	2	3	E	No	Within	Highest
Lynde Main	L11	1032.7	8	3	2	3	E	No	Within	Highest
Lynde Main	L12	652.8	8	3	2	3	E	No	Within	N/A
Lynde Main	L13	932.8	8	3	2	3	E	No	Within	Highest
Lynde Main	L14	374.2		2	2	2	B	No	Within	Medium
Lynde Main	L15	936.4	9	3	2	2	C	No	Within	Highest
Lynde Main	L16	1172.4		1	1	2	G	No	Within	Medium
Lynde Main	L17	384.3		1	1	2	G	No	Within	Medium
Lynde Main	L18	932.1		3	2	2	C	No	Within	High
Lynde Main	L19	751.5		2	2	2	B	No	Within	High
Lynde Main	L20	3012.1		3	2	1	Linearized	No	Within	High
Lynde Main	L21	3236.9		3	2	3	E	No	Within	High
Lynde Main (trb)	LT1	255.4		0	0	1	Culverted	No	No	N/A
Lynde Main (trb)	LT2	798.2		2	2	2	B	Bordering	No	Low
Lynde Main (trb)	LT3	1558.3		3	2	1	Linearized	Bordering	No	Low
Lynde Main (trb)	LT4	611.1		3	2	1	Linearized	Within	No	High
Lynde Main (trb)	LT5	708.6		3	2	2	C	Within	No	High
Lynde Main (trb)	LT6	1070.0		3	2	1	Linearized	Within	No	High
Myrtle Station	M1	1657.1		2	2	2	B	No	Bordering	Low
Myrtle Station	M2	4880.5		2	2	2	B	No	No	N/A
Myrtle Station	M3	851.3		3	2	3	E	No	No	N/A
Myrtle Station	M4	3074.5		3	2	1	Linearized	No	No	N/A

2.5.4.1 Targeted Reach Delineation

After the completion of the above reach break assessment, reaches were further refined to identify priorities for field work. Targeted reaches were determined based on a desk-top assessment using background information and later confirmed in the field (**Section 2.5.3**).

Priority reaches were chosen based on existing conditions, proximity to new development and reach mobility. The location and rationale of geomorphological reach breaks is stated and displayed in **Table 2-5** and **Figure 2-15.** The reaches were confirmed during field reconnaissance in May, 2018.

2.5.5 Historical Assessment

Watercourses are dynamic features that naturally change over time in terms of their configuration as part of meander development, and migration processes and are also subject to anthropogenic changes. Historical aerial photographs of the assessment site taken in 1954, 1976, 1988 and 1991 and satellite imagery from 2004 and 2017 were reviewed to analyze changes in land use and channel planform. The historical channel configurations were digitized and analyzed using GIS software in order to identify any changes in channel planform over the time period from 1954 to present.

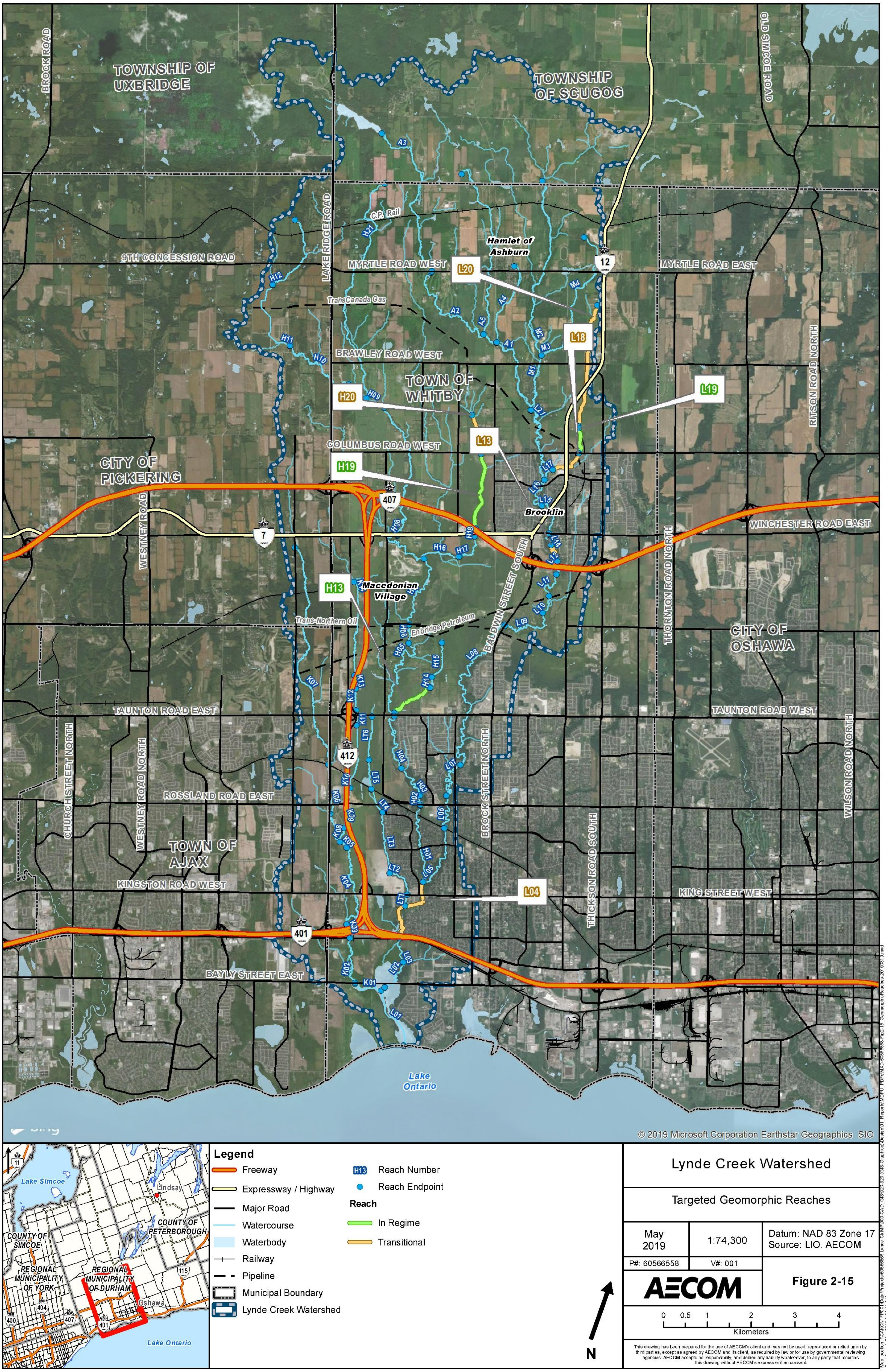
A summary of the historic observations of land use change and channel change/ modification within the study area is provided in **Appendix B4**, in addition to historical aerial photographs. Due to the quality of the historical aerial photographs the main flow pattern of the watercourses are difficult to determine in some areas.

The key observations were:

- The Brooklin Community has undergone major residential growth since 1990s. This has caused watercourses in the surrounding area to become straightened to work around the residential construction. For the purpose of the study this includes areas within Reaches L-18, H-20, H-19 and L-15;
- Significant growth has taken place in West Whitby Community. This has caused the reaches in this area to meander within close proximity to residential growth as the watercourse has changed planform since the construction of the neighbourhood;
- Reach L-18 is classified as a highly mobile reach based on aerial imagery; and
- Significant growth has occurred in the areas surrounding Highway 401.

Table 2-5: Targeted Reach Delineation within the Lynde Creek Watershed

Subwatershed	Reach	Upstream Boundary – Reason	Upstream Boundary – Co-ordinates	Downstream Boundary – Reason	Downstream Boundary - Co-ordinates	Priority Reasoning
Lynde Main Subwatershed	1 (CLOCA, 2008) L-04	Change in planform from meandering to straightened	43°52'33.30"N 78°57'40.02"W	Change in bed morphology from a mixture of fines to cobbles to predominantly fines material	43°51'59.69"N 78°57'46.90"W	Existing Conditions – Proximity to infrastructure
Lynde Main Subwatershed	8 (CLOCA, 2008) L-13	Channel splits into a multichannel	43°57'7.83"N 78°57'23.31"W	Change in riparian vegetation from wooded areas to herbaceous grasses.	43°56'18.37"N 78°57'10.06"W	Existing Conditions – Proximity to Infrastructure
Lynde Main Subwatershed	L-18	Transitions from a residential area to an agricultural area	43°58'18.78"N 78°57'24.95"W	Confluence	43°57'52.51"N 78°57'50.50"W	Highly Mobile – Based on aerial imagery
Lynde Main Subwatershed	L-19	Transitions from a wooded area to agricultural land (small herbaceous grasses)	43°58'36.31"N 78°57'33.69"W	Residential buildings and commercial land uses	43°58'18.85"N 78°57'24.94"W	New Development
Lynde Main Subwatershed	L-20	Flow is diverted toward Baldwin Street by driveway ditch	44° 0'7.83"N 78°57'55.12"W	Flows into an on-line pond	43°58'46.68"N 78°57'36.77"W	New Development
Heber Down Subwatershed	H-13	Transition in land use from agricultural to a wooded forest type area	43°55'8.04"N 78°58'38.09"W	Confluence	43°54'34.52"N 78°59'3.27"W	New Development
Heber Down Subwatershed	H-19	Transitions from agricultural setting to a forest type setting	43°57'54.66"N 78°58'59.55"W	Transition from a straightened planform in an agricultural setting to a sinuous planform	43°56'38.88"N 78°58'48.05"W	New Development
Heber Down Subwatershed	H-20	Watercourse transitions from wooded vegetation to herbaceous type vegetation	43°58'21.11"N 78°59'21.15"W	Transitions from agricultural land to a forest type setting	43°57'54.66"N 78°58'59.55"W	New Development


TOWNSHIP OF UXBRIDGE
TOWNSHIP OF SCUGOG
BROCK ROAD
OLD SIMCOE ROAD
LAKE RIDGE ROAD
C.P. Rail
Hamlet of Ashburn
9TH CONCESSION ROAD
MYRTLE ROAD WEST
MYRTLE ROAD EAST
TransCanada Gas
BRAWLEY ROAD WEST
TOWN OF WHITBY
RITSON ROAD NORTH
COLUMBUS ROAD WEST
CITY OF PICKERING
Brooklin
WINCHESTER ROAD EAST
WESTNEY ROAD
Macedonian Village
Trans-Northern Oil
Enbridge Petroleum
BALDWIN STREET SOUTH
THORNTON ROAD NORTH
CITY OF OSHAWA
TAUNTON ROAD EAST
TAUNTON ROAD WEST
CHURCH STREET NORTH
WESTNEY ROAD NORTH
ROSSLAND ROAD EAST
BROCK STREET NORTH
WILSON ROAD NORTH
TOWN OF AJAX
KINGSTON ROAD WEST
THICKSON ROAD SOUTH
KING STREET WEST
BAYLY STREET EAST
Lake Ontario
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L04
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Lindsay
COUNTY OF PETERBOROUGH
COUNTY OF SIMCOE
REGIONAL MUNICIPALITY OF YORK
REGIONAL MUNICIPALITY OF DURHAM
Oshawa
Lake Ontario
Legend
Freeway
Expressway / Highway
Major Road
Watercourse
Waterbody
Railway
Pipeline
Municipal Boundary
Lynde Creek Watershed
H13 Reach Number
Reach Endpoint
Reach
In Regime
Transitional
Lynde Creek Watershed
Targeted Geomorphic Reaches
May 2019
1:74,300
Datum: NAD 83 Zone 17
Source: LIO, AECOM
P#: 60566558
V#: 001
AECOM
Figure 2-15
0 0.5 1 2 3 4
Kilometers
N
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2.5.6 Field Reconnaissance

Field work was undertaken along the reaches within the study area in the Lynde Creek Watershed on May 22, 2018 and May 30, 2018. Field work verified the channel reach breaks and identified the local geomorphological form and function.

2.5.6.1 Targeted Reach-Scale Geomorphological Characterization

Basic geomorphological reach data, including the typical bankfull dimensions, bed and bank materials, surrounding land use, riparian vegetation, valley and bank slope stability, degree of channel floodplain connectivity, and the location of erosion and channel modification were collected during the reconnaissance survey. Factor Values (FV) were identified.

A photographic record (**Appendix B5**) was completed to document important channel features. Locations of geomorphological importance were also photographed and included bank erosion sites, channel modifications and large woody debris jams.

2.5.6.2 Rapid Geomorphic Assessment

The results of the rapid geomorphic assessment (RGA) for the priority reaches within the study area are presented in **Table 2-6.** The reach characterizations are described in **Appendix B6**.

2.5.7 Comparison with 2008 Geomorphological Assessment Findings

The Comparison with the 2008 Assessment findings identified the following:

- Reach L-04 and Reach 1 (CLOCA, 2008) were both considered ‘transitional’ or ‘stressed’ based on RGA results. The dominant processes occurring within the reach were aggradation and widening, as noted by both assessments;
- Reach L-13 and Reach 8 (CLOCA, 2008) were both considered ‘transitional’ or ‘stressed’ based on RGA results. The dominant processes occurring within the reach were aggradation and widening during both assessments; and
- Reach L-19 and Reach 9 (CLOCA, 2008) were both considered ‘in-regime’ based on RGA results. Reach L-19 is within an area of proposed development.

Table 2-6: Targeted Rapid Geomorphic Assessment

Subwatershed	Reach	FV - Aggradation	FV- Degradation	FV- Widening	FV- Planimetric Form Adjustment	Stability Index	Condition	Notes
Lynde Main Subwatershed	L-04 Reach 1 (CLOCA, 2008)	0.50	0.17	0.75	0.14	0.39	**Transitional *same as CLOCA, 2008**	**Aggradation:** Course material in riffle embedded, siltation in pools, medial bars, poor longitudinal sorting of bed materials **Widening:** Leaning trees, large organic materials, exposed tree roots, basal scour on inside of meander bends and on both sides of the channel through riffle greater than 50% of the Reach
Lynde Main Subwatershed	L-13 Within Reach 8 (CLOCA, 2008)	0.38	0.00	0.63	0.14	0.29	**Transitional *same as CLOCA, 2008**	**Aggradation:** Course material in riffle embedded, siltation in pools, medial bars **Widening:** Leaning trees, large organic materials, exposed tree roots, basal scour on inside of meander bends and on both sides of the channel through riffle
Lynde Main Subwatershed	L-18	0.38	0.14	0.25	0.14	0.23	**Transitional**	**Aggradation:** Lobate bar, coarse materials in riffle embedded, siltation in pools **Widening:** Leaning trees, large organic materials, exposed tree roots
Lynde Main Subwatershed	L-19 Reach 9 (CLOCA, 2008)	0.25	0.00	0.38	0.14	0.19	**In Regime *same as CLOCA, 2008**	Reach L-19 was classified as stable, aggradation and widening were dominant processes
Lynde Main Subwatershed	L-20	0.38	0.14	0.50	0.14	0.29	**Transitional**	**Aggradation: C**ourse material in riffle embedded, siltation in pools, poor longitudinal sorting bed materials **Widening:** Leaning trees, large organic materials, exposed tree roots, basal scour on both sides of the channel through riffle
Heber Down Subwatershed	H-13	0.25	0.00	0.00	0.29	0.13	**In Regime**	Reach H-13 was classified as stable, however aggradation and planimetric form adjustment were dominant processes
Heber Down Subwatershed	H-19	0.13	0.00	0.00	0.14	0.07	**In Regime**	Reach H-19 was classified as stable, aggradation and widening were the dominant processes.
Heber Down Subwatershed	H-20	0.13	0.14	0.25	0.29	0.20	**Transitional**	**Planimetric Form Adjustment:** cut-off channels, channel bar forms poorly formed/ reworked/ removed

2.5.8 Erosion Monitoring and Priority Sites

Watercourses are dynamic and naturally move sediment; therefore bank erosion is a natural process that is integral to the stability of meandering streams. Erosion risks can potentially arise when changes such as development occurs within the zone of long-term channel migration, and when erosional processes are accelerated as a result of a modified flow regime. Erosion processes can then lead to channel instability, degraded habitat, increased rates of bank erosion and channel migration. The dominant cause for erosion within the Lynde Creek watershed has been the ongoing changes in hydraulic regime due to increases in urbanization.

Inappropriate riparian buffer zone management and instability relating to crossing and previous channel hardening are noted both in the desk-top background review and during field reconnaissance. **Table 2-7** and **Table 2-8** provide a detailed outline of specific sites and locations determined based on field reconnaissance.

2.5.9 Geomorphically Undersized Road Crossings

Crossings placed over a watercourse may be at risk of failure due to channel processes occurring along the channel, both in proximity to the crossing location, and also along the drainage network. The extent of the risk will depend on the crossing type (e.g., bridge vs. culvert), the type and extent of engineering countermeasures in proximity to the crossing, and the nature of channel processes that are occurring which could interfere with the crossing structure. Some channel processes that could contribute to risk of a bridge or culvert structure include:

- Channel bed degradation/lowering – this can lead to undercutting of bridge/culvert abutments/footings;
- Channel migration – movement of meanders could cause erosion of culvert/bridge embankments;
- Channel expansion – enlargement of cross-section areas (e.g., in response to urban hydromodification may lead to increased stress around culvert entrance leading to outflanking of a culvert and flow constriction; and
- Knickpoint regression along the channel bed profile.

Crossings situated along a watercourse interact with, and exert an influence on, channel processes. The scientific literature has identified common impacts of watercourse crossings both on channel functions and on aquatic species. Common impacts include destabilization of channel form and function, impediments to fish migration, and destruction of aquatic habitat. In some situations, impacts of a crossing on the channel result in a risk to the crossing. Typical adverse effects attributed to crossings include:

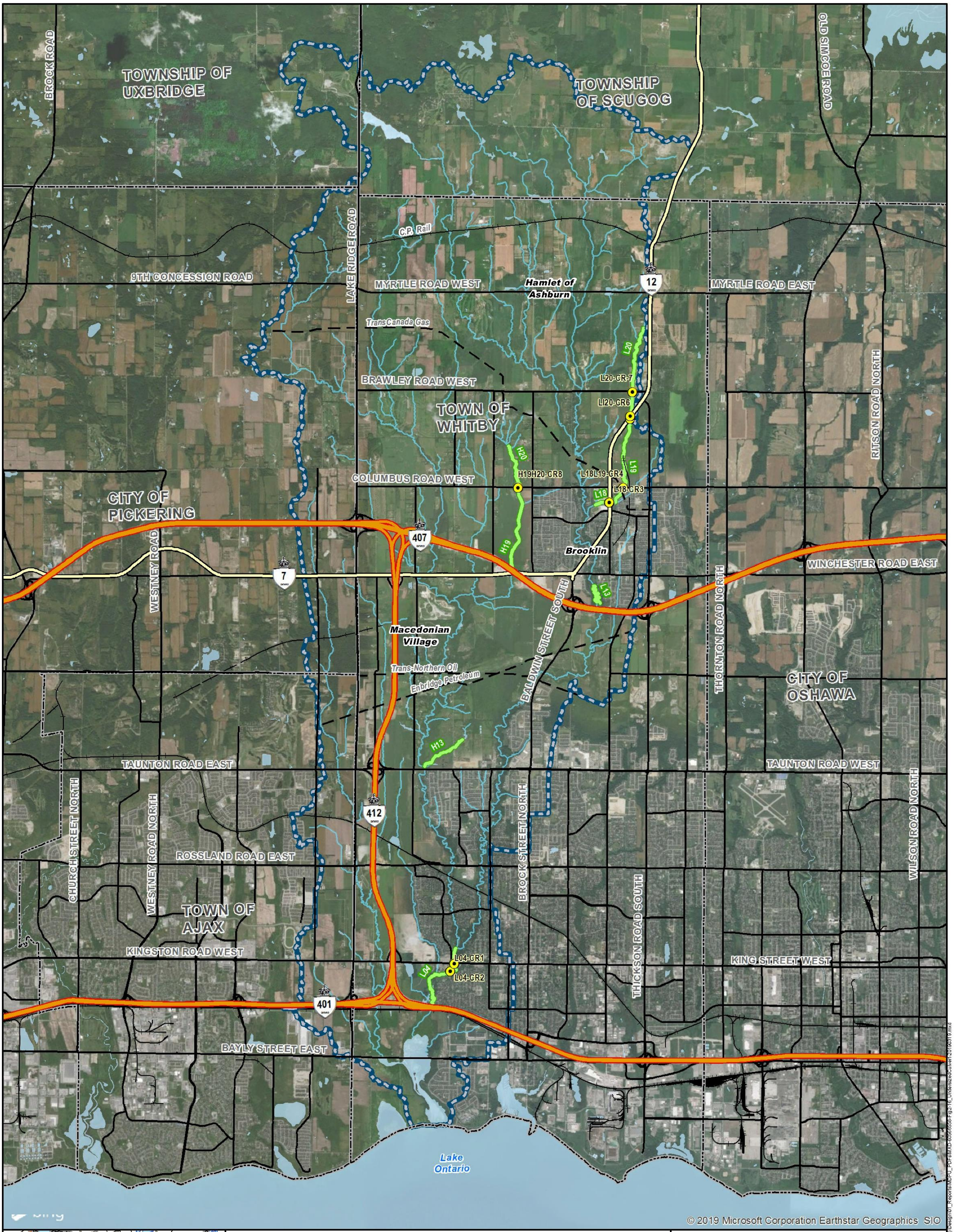
- Scour of banks at culvert inlet/outlet – due to flow contraction/expansion;
- Establishment of a local base level control point (e.g., closed bottom culvert) that affects channel bed profile development;
- Perched culvert – affecting channel profile and fish passage;
- Sediment deposition – due to a loss of sediment transport capacity upstream or within the culvert;
- Sediment loading – at road crossings due to the wash of road based sediment into the channel; and
- Channel bed degradation and/or instability.

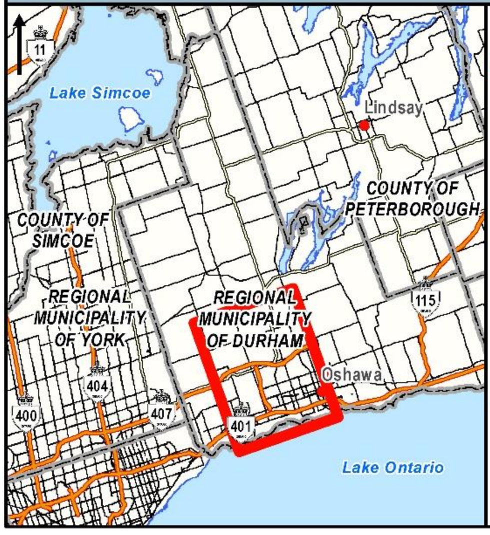
Table 2-7 and **Figure 2-16** provides a list and the location of the geomorphically undersized crossings that were determined during field reconnaissance.

Table 2-7: Existing Geomorphically Undersized Crossings within the Lynde Creek Watershed Study Area

Reach	Site	Location	Issues and Concerns	Photographs
L-04	L04-CR1 Structure ID 24 (Fig 8-4 + APPENDIX B) HEC-RAS section 605 Reach Lynde 3	43°52’26.44"N 78°57’40.06"W ■ Located at Jeffery Street between Dundas Street West and Michael Boulevard	■ Geomorphically undersized culvert – piers within the water ■ Does not extend past bankfull width	
L-04	L04-CR2 Structure ID 25 (Fig 8-4 + APPENDIX B) HEC-RAS section 323 Reach Lynde 3	43°52’32.24"N 78°57’38.75"W ■ Located at Dundas Street West between McQuay Boulevard and Raglan Street	■ Geomorphically undersized bridge – abutments in the water ■ Does not extend past bankfull width	
L-18	L18-CR3 (WCU-4) Structure ID 39 (APPENDIX B) HEC-RAS section 787 Reach Lynde T3	43°58’6.01"N 78°57’33.25"W ■ Located at Highway 7 between Columbus Road West and Carnwith Drive East	■ Geomorphically undersized culvert – water spans opening ■ Does not extend past bankfull width ■ Closed bottom corrugated metal pipe	
L-18 and L-19	L18L19-CR4 ■ Not identified as a crossing of significance in HEC-RAS ■	43°58’18.56"N 78°57’25.19"W ■ Located at Columbus Road West between Baldwin Street North and Croxall Boulevard	■ Geomorphically undersized culvert – water spans opening ■ Does not extend past bankfull width ■ No connection with the floodplain along the right bank	

Reach	Site	Location	Issues and Concerns	Photographs
L-20	L20-CR5 ■ Not identified as a crossing of significance in HEC-RAS	43°59’5.10"N 78°57’39.18"W ■ Located at Baldwin Street North between Duffs Road and Thickson Road	■ Geomorphically undersized culvert ■ Does not extend past bankfull width ■ Closed concrete bottom	
L-20	L20-CR6 ■ Not identified as a crossing of significance in HEC-RAS	43°59’6.72"N 78°57’39.67"W ■ Located at Baldwin Street North between Duffs Road and Thickson Road	■ Geomorphically undersized culvert ■ Does not extend past bankfull width ■ Closed concrete bottom	
L-20	L20-CR7 ■ Not identified as a crossing of significance in HEC-RAS	43°59’23.12"N 78°57’44.87"W ■ Located at Brawley Road West between Duffs Road and Baldwin Street North	■ Geomorphically undersized culvert – water spans opening ■ Does not extend past bankfull width ■ Closed bottom corrugated metal pipe	
H-19 and H-20	H19H20-CR8 Structure ID 54 (APPENDIX B) HEC-RAS section 3765 Reach Heber T2a	43°57’56.11"N 78°59’0.43"W ■ Located at Columbus Road West between Cochrane Street and Ashburn Road	■ Geomorphically undersized culvert ■ Culvert does not extend bankfull width ■ Closed bottom - concrete	





Legend

- Freeway
- Expressway / Highway
- Major Road
- Watercourse
- Waterbody
- Railway
- Pipeline
- Municipal Boundary
- Lynde Creek
- Existing Geomorphically Undersized Culvert
- Targeted Geomorphic Reach

Lynde Creek Watershed

Geomorphically Undersized Watercourse Crossings

May 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	
AECOM		Figure 2-16

0 0.5 1 2 3 4 Kilometers

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2.5.10 Existing Stream Erosion Potential

Lynde Creek and its tributaries are meandering creeks that flow for the most part through the previous Master Drainage Study (1988) area. Forty-four erosion sites were documented and noted that the erosion was occurring downstream of urban development. One of the key issues at the majority of the sites listed in 1988 as well as the sites listed within this study is the lack of stabilising riparian vegetation, as well as valley slope instability. Building on this study, the significant change in urbanization within the watershed has caused a change in the hydraulic regime within the study area causing the acceleration of natural erosion processes to occur.

Table 2-8 and **Figure 2-17** outlines the specific erosion sites and risk assessment as well as recommended mitigation and restoration measures to follow in **Section 2.5.13**. Erosion Sites L-04-ER-1, L-04-ER-2 and L0-4-ER-3 are located within the vicinity of "erosional prone areas" according to the 1988 Master Drainage Study (**Appendix A**). Comparison could not be completed, due to the quality of the photographs and no quantitative measurements. All other erosion sites were determined during 2018 field reconnaissance and are located outside of the boundaries of the 1988 study (north of Taunton Road). Inappropriate riparian buffer zone management and instability related to crossing and previous channel hardening are noted as ongoing issues, together with a natural susceptibility to erosion within the area of Lake Iroquois beach deposits.

2.5.11 Future Stream Erosion Potential with Stormwater Management

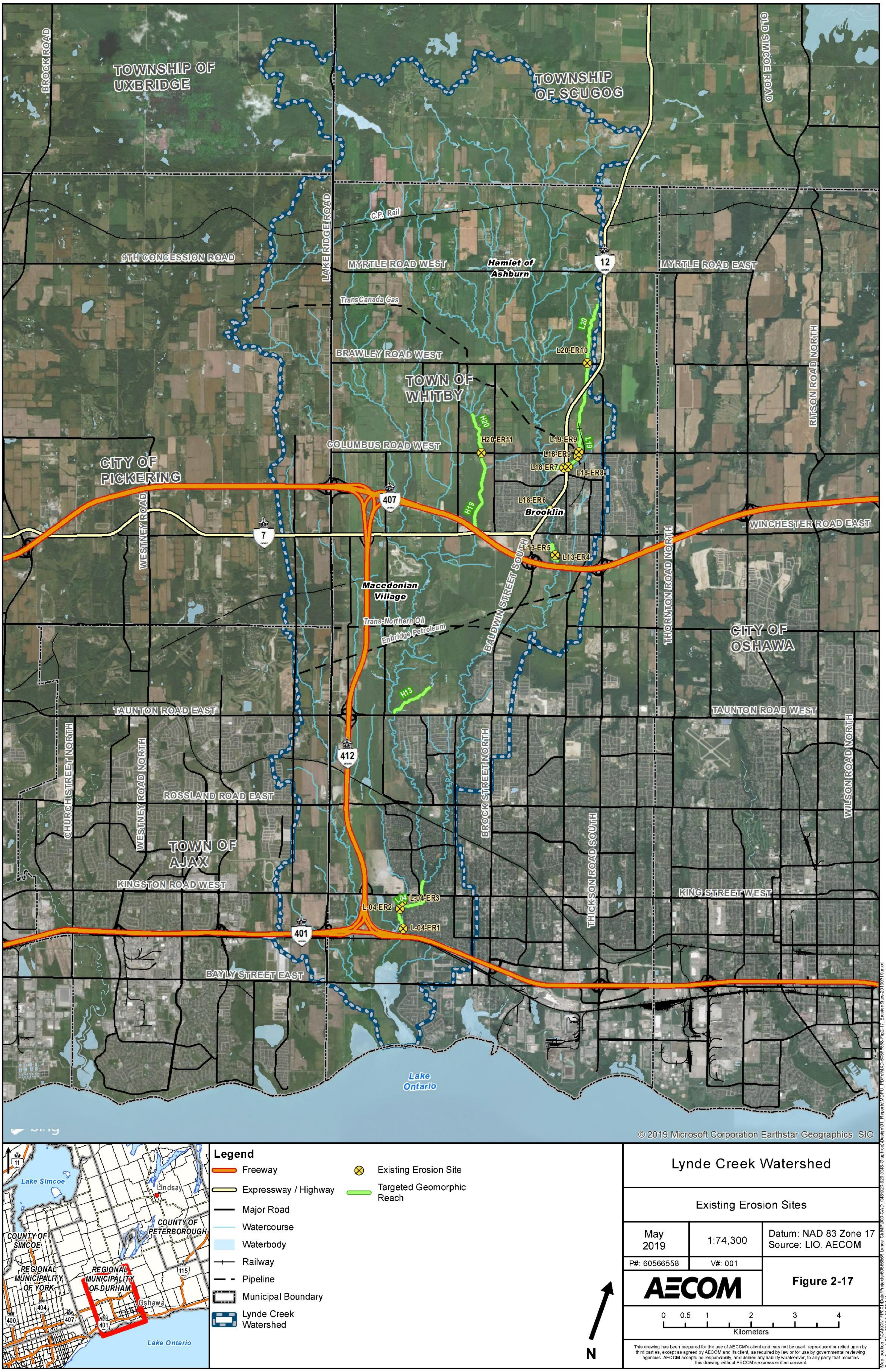
This section continues the discussion of water quantity impacts, identifying how proposed development affects the Lynde Main and Heber Down subwatersheds. Erosive flow impacts are characterized in terms of discharge, velocity, shear stress and stream power and have determined based on HEC-RAS outputs. Upon review of hydraulic results, as described in **Section 4.2.1,** the proposed SWM plans are predicted to control the potential impact of the proposed development on the hydraulic regime and limit the impact of climate change. The increase in 100-yr channel velocities, as a result of climate change and for existing conditions, is generally 5% to 6% although at some locations there is a greater increase and at others a reduction. This is summarised in **Table 4-2** (see **Section 4.2.1**). In general, future stream erosion potential should not significantly change from baseline conditions post-development.

Table 2-8: 2018 Channel Erosion Locations

Reach	Site	Location	Issues and Concerns	Photograph
Reach L-04	L-04-ER1	43°52’4.95"N 8°57’46.68"W ■ This site was listed in the vicinity of erosional prone areas in 1988 (refer to DWG 8 in Appendix A)	■ Tight meander bend along the gabion wall ■ Slight slumping and scouring of the bank downstream of the gabion baskets ■ Close proximity to residential property (~5 metres)	
Reach L-04	L-04-ER2	43°52’18.12"N 78°57’55.93"W ■ This site was listed in the vicinity of erosional prone areas in 1988 (refer to DWG 8 in Appendix A)	■ Tight meander bend ■ Active erosion including slumping and scouring ■ Close proximity to residential property (~15 metres)	
Reach L-04	L-04-ER3	43°52’23.72"N 78°57’44.93"W ■ This site was listed in the vicinity of erosional prone areas in 1988 (refer to DWG 8 in Appendix A)	■ Slumping and undercutting of existing banks	
Reach L-13	L13-ER4	43°57’1.71"N 78°57’15.12"W	■ Slight undercutting of placed bank protection	

Reach	Site	Location	Issues and Concerns	Photograph
Reach L-13	L13-ER5	43°57’1.88"N 78°57’16.38"W	■ Banks contain majority herbaceous grasses ■ Slight slumping along the right bank	
L-18	L18-ER6	43°58’5.33"N 78°57’34.78"W	■ Channel appears to be historically straightened with flow from culvert directed towards the left bank ■ Banks contain herbaceous grasses	
L-18	L18-ER7	43°58’6.79"N 78°57’31.34"W	■ Banks contain herbaceous grasses ■ Close proximity to commercial property (~10 metres) ■ Knickpoint (~0.10 metres depth) present	
L-18	L18-ER8	43°58’16.39"N 78°57’25.28"W	■ Banks contain primarily herbaceous grasses with little protection along the left bank ■ Channel appears to be historically straightened ■ Close proximity to residential property along the left bank (~20 metres)	

Reach	Site	Location	Issues and Concerns	Photograph
L-19	L19-ER9	43°58’19.67"N 78°57’25.51"W	■ Banks contain herbaceous grasses ■ Close proximity to roadway ■ Slight undercutting observed close to road crossing	
L-20	L20-ER10	43°59’24.14"N 78°57’45.16"W	■ Banks contain herbaceous grasses ■ Slight undercutting observed within close proximity to road crossing infrastructure	
H-20	H20-ER11	43°57’56.96"N 78°59’0.13"W	■ Banks contain herbaceous grasses ■ Slight undercutting observed within close proximity to road crossing infrastructure	



Lynde Creek Watershed

Existing Erosion Sites

May 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	

AECOM

Figure 2-17

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2.5.12 Geomorphically Undersized Crossing Mitigation

When crossings are placed over a watercourse without due consideration of the geomorphological processes that are occurring within the watercourse, risks to the crossing structure and/ or channel form and function may occur. Such risks could lead to the need for continual emergency maintenance of the crossing and/ or could adversely affect the channel stability, fish passage potential and aquatic habitat conditions. Mitigation measures to minimise development impacts on geomorphically undersized crossings include:

- Works within existing and new development to replicate the natural flow regime (e.g., Low Impact Development – Stormwater retention);
- Channel crossing should address the potential for in-channel erosion without impacting the local channel adjustment processes; and
- Crossings should extend greater than bankfull width and not impact natural sediment transport processes or channel velocity.

2.5.13 Erosion Mitigation

Mitigation measures to minimise development impacts on geomorphologic process include:

- Implement Low Impact Development and Stormwater Management best practices to replicate more natural flow conditions;
- Maintain or restore channel connection within the floodplain;
- Maintain appropriate bankfull width dimensions throughout the watercourse;
- Restore and maintain the riparian corridor with the addition of native plants, shrubs and trees; and
- Undertake erosion control works on reaches currently experiencing active erosion.

2.6 Hydrogeological Conditions

An aquifer is defined as a geological unit that is sufficiently permeable to permit the economical extraction of a useable supply of water, while an aquitard is a zone that limits the flow of groundwater between aquifers. Geological units may be subdivided into hydrostratigraphic units that characterize the behaviour of the unit as an aquifer/aquitard.

The succession of Quaternary deposits in the Watershed has been subdivided into eight hydrostratigraphic units (Eyles, 2002). The units are further grouped into the shallow groundwater flow system – representing groundwater movement from the surface to the immediately underlying units; and the deeper flow system – representing movement of groundwater from the upper units to the deeper, older units and the bedrock (where viable). The classification and characterization of each unit is described in **Table 2-9** and a north-south trending cross-section shows the theoretical relationship and distribution of each unit is shown on **Figure 2-6.**

Table 2-9: Hydrostratigraphic Units in the Lynde Creek Watershed

Groundwater Flow System (Shallow/Deep)	Unit	Description	Geology
Shallow Groundwater Flow System	Glaciolacustrine and Recent	Varied Aquifer/ Aquitard	Varied
Shallow Groundwater Flow System	Halton Till	Halton Aquitard	Silty/sandy till, sand and gravel lenses
Shallow Groundwater Flow System	Oak Ridges Moraine/Mackinaw Interstadial	Oak Ridges Aquifer Complex	Sand and gravel outwash/fluvial gravel with lacustrine silt and clay
Shallow Groundwater Flow System	Newmarket/Northern Till	Newmarket Aquitard	Silt till with sand lenses
Deep Groundwater Flow System	Thorncliffe Formation (or equivalent)	Thorncliffe Aquifer Complex	Glaciolacustrine silty clay and sand
Deep Groundwater Flow System	Sunnybrook Drift (or equivalent)	Sunnybrook Aquitard	Clayey silt massive and laminated with pebbles
Deep Groundwater Flow System	Scarborough Formation (or equivalent)	Scarborough Aquifer Complex	Deltaic sands and lacustrine deposits of silts and clays
Deep Groundwater Flow System	Bedrock	Regional Aquifer/ Aquitard	Black fractured/weathered shale

Note: Modified from CLOCA, 2008 and Meriano & Eyles, 2009

The variability in groundwater flow regimes and the hydraulic properties of an area are largely controlled by sediment composition, stratigraphic architecture and the distribution of confining units (Sharpe et al., 2007). There are three geologic features that are significant to groundwater flow and availability in the Watershed (CLOCA, 2008):

1. Orientation and connection of bedrock valleys. Sand and gravel deposits within the lows of the bedrock valleys can form productive aquifers.
2. The architecture of the Newmarket/Northern till. The Newmarket till acts as the hydraulic boundary between the upper and lower flow systems. The gradient between the two will be impacted by the variability in the distribution and thickness of the unit. A 3-dimensional quantitative groundwater flow model completed by Meriano & Eyles (2009) suggests that the Newmarket till typically functions as a 'leaky aquitard' where

underlying aquifers gain additional recharge by downward vertical leakage combined with horizontal flows along interbeds in the till succession (64% of total inflows to the Thorncliffe Formation).

3. Thickness and location of the coarse grained deposits of the Oak Ridges Moraine and the Lake Iroquois Shoreline that form recharge areas. Midway between Highway 7 and Taunton Road are deposits associated with the Iroquois Beach shoreline physiographic region. They form an approximately 2 kilometres wide band that traverses the watershed and are typically thin with an average thickness of less than 2 metres. This unit, typically a well sorted medium to fine beach sand, is highly permeable and capable of transmitting a considerable quantity of water both vertically and horizontally.

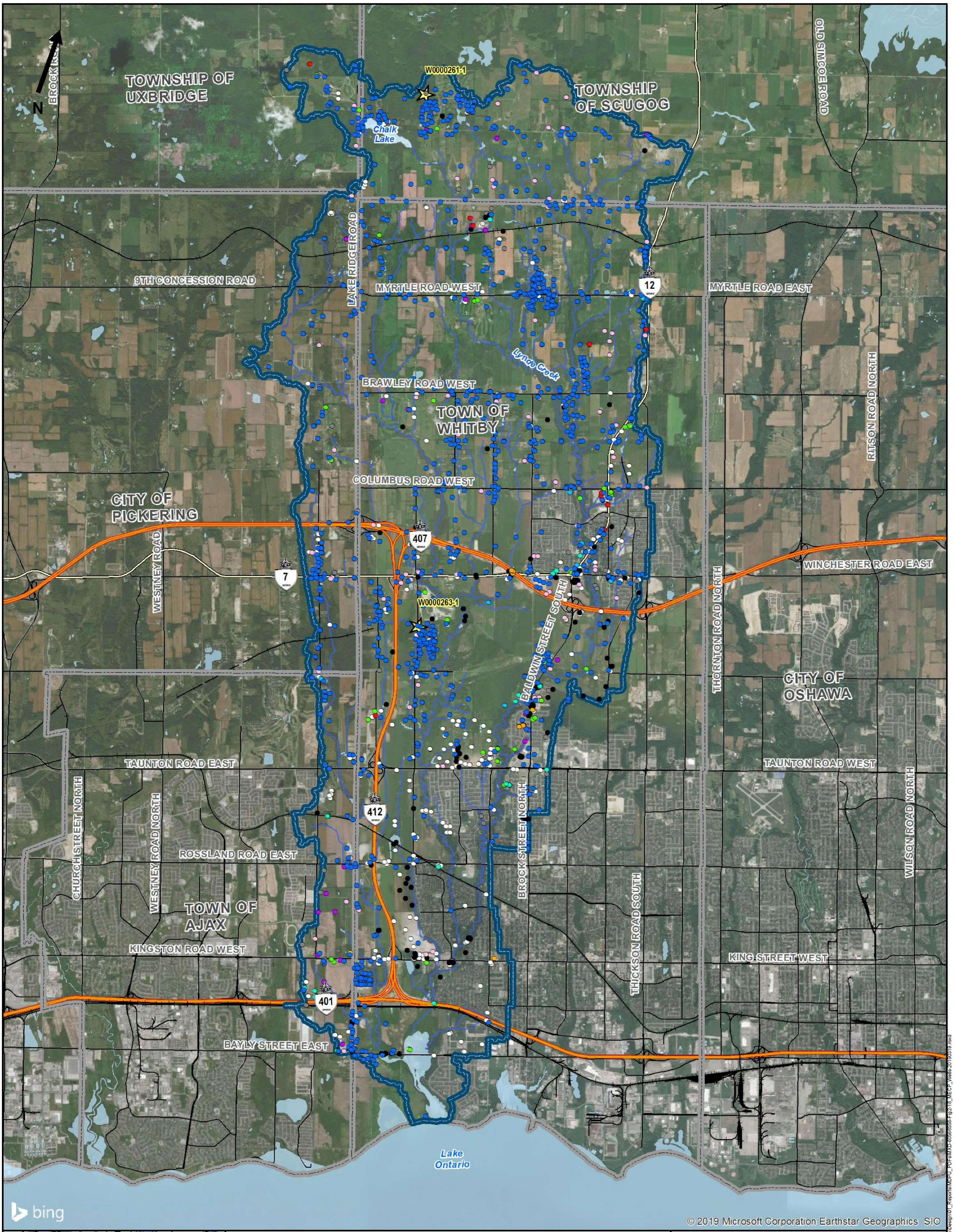
The hydraulic properties of the surficial units (Halton/Newmarket Till) have an influence on groundwater recharge. The Halton Till, for the most part, behaves as an aquitard, although is also usually considered leaky. It is estimated to allow an annual recharge of 125 to 200 mm/a (Gerber and Howard, 2000). In places, it may behave as an aquifer because of extensive weathering, fracturing and the presence of higher permeable zones. It may also provide pathways for groundwater flow (springs) from underlying ORM sediment.

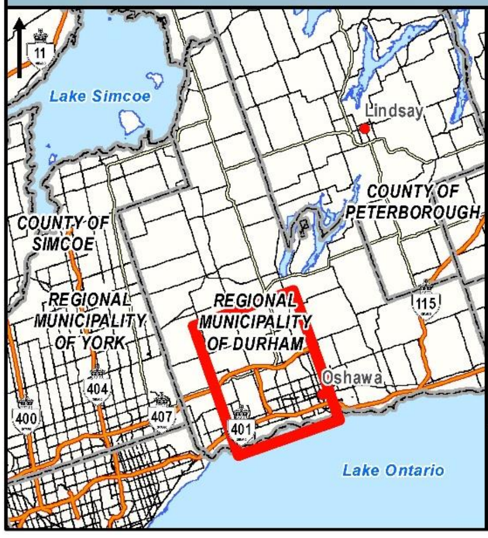
2.6.1 Groundwater Use

2.6.1.1 MECP Water Wells

There are no residential municipal groundwater supply wells associated with Well Head Protection Areas (WHPA) within the watershed.

A review of MECP's Water Well Information System (WWIS) (MECP, 2018) has identified approximately 2,119 well records within the Watershed, of which 1,944 were unique records (**Figure 2-18**). The location and depth of individual MECP water well records gives some indication of the presence of viable groundwater resources within the watershed. Approximately 9% of wells drilled within the watershed encountered bedrock (but may have been completed in overburden) and 55% are completed in overburden sediments. The remainder of the well records (36%) were incomplete with respect to overburden/bedrock completion. It should be noted that shallow wells, including dug wells, bored wells and sand points, are not typically reflected in the MECP database and thus the actual proportion of overburden well sources in the area may be greater than reported. In addition, the MECP WWIS database may have missing and/or inaccurate information for wells, as records either were not submitted, are incomplete, the physical well location is incorrect, the information was entered into the database incorrectly, etc. and so the data presented herein should be considered an estimate only.





Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- ☆ Provincial Groundwater Monitoring Network Well

MOECC Water Well Primary Water Use

- Domestic
- Municipal
- Public
- Commerical
- Cooling and A/C
- Dewatering
- Industrial
- Livestock
- Irrigation
- Monitoring and Test Hole
- Not Used
- Other
- Unknown

Lynde Creek Watershed

MECP Water Wells

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: MOECC (2018), CLOCA (2018), MNRF (2017), Bing (2014)
P#: 60566558	V#: 001	

AECOM

Figure 2-18

0 0.5 1 2 3 4
Kilometers

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As shown in **Table 2-10**, information obtained from the WWIS suggests that approximately 57% of wells in the Watershed were drilled for domestic water supply (**Figure 2-18**). The majority of domestic wells in the Watershed and surrounding area obtain water from the overburden sediments because the bedrock is very deep (in the north) typically considered low yielding and has poor water quality. Dewatering is listed as the primary use for 8% of the wells. Livestock, monitoring, and monitoring/test hole wells are each listed as the primary use for 4%, respectively, of the wells. The remainder of the wells are used for commercial, industrial, irrigation, etc., or are not used/a use is not listed. Well records are available via an interactive map on the MECP website: www.ontario.ca/environment-and-energy/map-well-record-data.

Table 2-10: Summary of MECP Water Well Database Records

Primary Water Use	Number of Well Records	Well Depth (m)	Primary Well Type – Overburden	Primary Well Type – Bedrock	Primary Well Type – Unknown
Domestic	1,204	3.0 – 223.1	926	125	153
Dewatering	160	3.4 – 57.9	0	0	160
Not Used	97	1.2 – 143.9	45	8	44
Livestock	83	4.9 – 104.9	71	9	3
Monitoring and Test Hole	80	1.2 – 13.0	0	0	80
Monitoring	76	3.6 – 35.1	0	0	76
Commercial	46	3.4 – 138.7	33	9	4
Public	29	7.3 – 154.5	19	5	5
Test hole	29	4.0 – 30.0	0	0	29
Irrigation	21	4.6 – 155.4	10	8	3
Industrial	11	6.7 – 89.3	7	3	1
Municipal	11	11.0 – 65.8	4	6	1
Other	2	3.0 – 29.0	0	0	2
Cooling and A/C	1	22.9	1	0	0
Blank	269	3.8 – 166.0	45	19	205

Groundwater level information obtained from local MECP well records is presented in **Table 2-11**. Shallow (<10 metres) and medium (10 metres to 20 metres) depth bedrock wells are reported to have static water levels ranging from 1.2 metres to 12.2 metres below ground surface (bgs), and 11 metres above ground surface (ags) (artesian) to 16.2 mbgs in shallow to medium depth overburden wells. Artesian conditions may occur in an overburden or bedrock aquifer where an overlying confining layer results in positive pressure within the aquifer causing water levels to rise above the local ground surface. In deeper bedrock wells (>20 metres), water levels range from approximately ground surface to 49.4 mbgs. In deeper overburden wells (>20 metres), water levels ranged from about 4.9 mags (artesian) up to about 75.6 mbgs. Fluctuations in groundwater levels likely will occur to varying degrees due to seasonal changes, individual precipitation events and/or local/regional groundwater use.

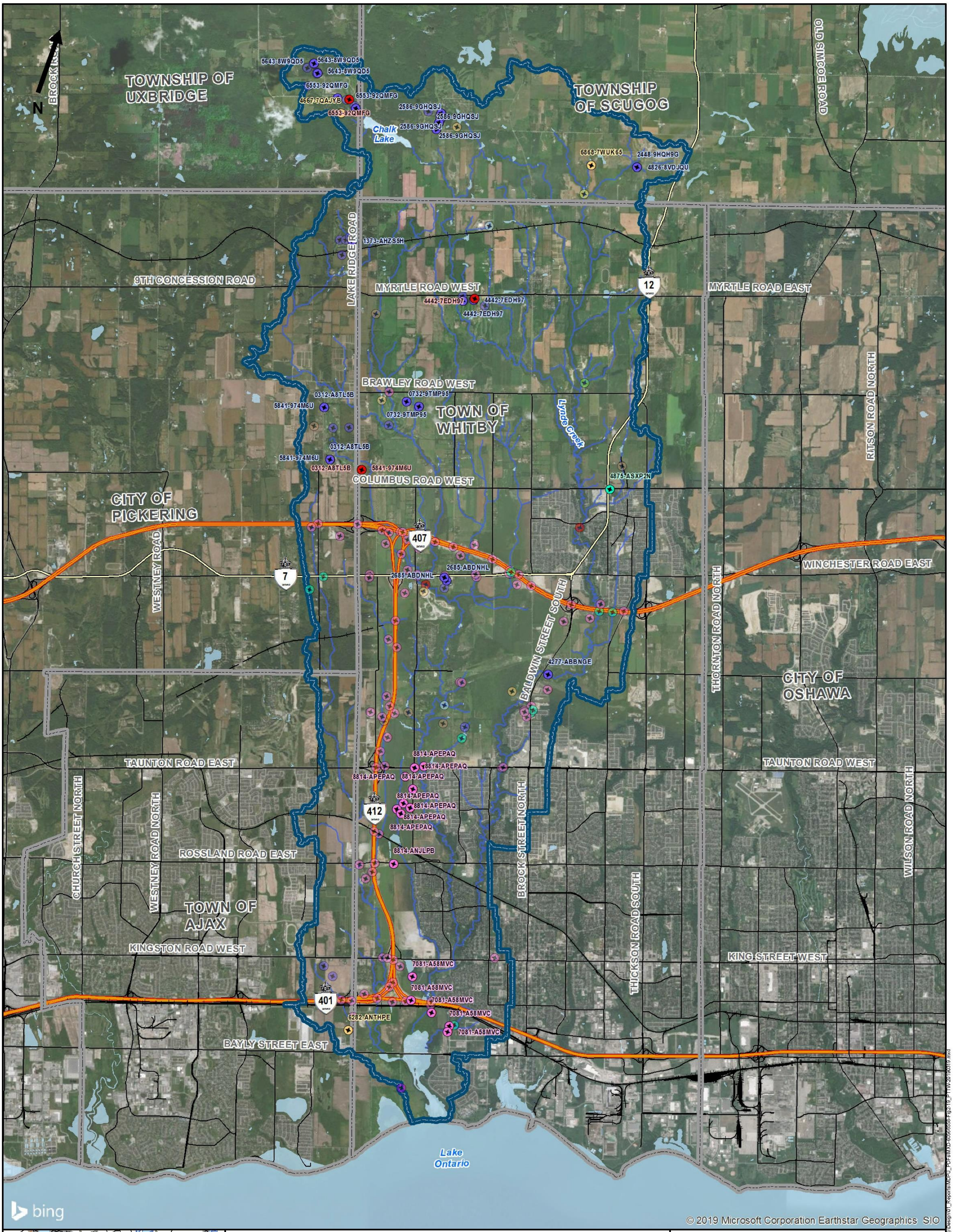
Table 2-11: Comparison of MECP Well Depths and Water Levels

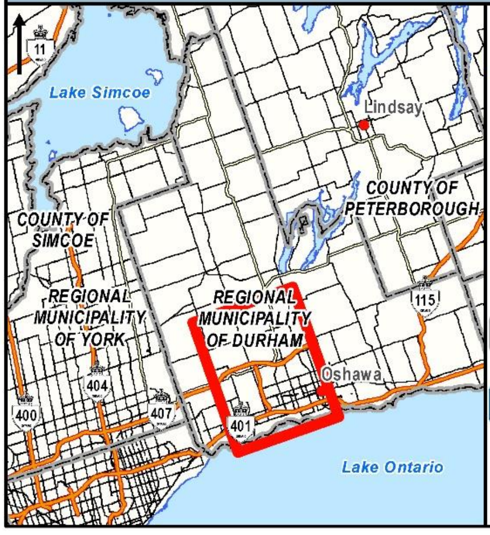
Aquifer Type	Well Depth (m)	Number of Well Records	Groundwater Level Range (mbgs)
Bedrock	<10	22	1.2 to 6.1
Bedrock	10 – 20	65	1.5 to 12.2
Bedrock	20 – 30	22	1.8 to 17.1
Bedrock	30 – 40	23	0.0 (ground surface) to 19.81
Bedrock	40 – 50	23	1.5 to 22.6
Bedrock	50 – 60	6	6.1 to 19.5
Bedrock	>60	31	0.3 to 49.4
Overburden	<10	347	0.0 (ground surface) to 8.2
Overburden	10 – 20	300	+ 11.0 above ground to 16.2
Overburden	20 – 30	143	+ 0.6 above ground to 23.5
Overburden	30 – 40	121	+ 0.3 above ground to 29.0
Overburden	40 – 50	81	+ 4.3 above ground to 43.9
Overburden	50 – 60	50	0.0 (ground surface) to 48.2
Overburden	>60	119	+ 4.9 above ground to 75.6

Of the available MECP records that encounter bedrock, the overburden thickness ranged from 0 metres (bedrock exposure at ground surface) up to about 154.8 mbgs. The median depth to bedrock is 12.2 metres, with the average recorded being 23.5 metres. Overburden thicknesses of less than 10 metres are reported for about 40% of the records, with 22% of records reporting 10 to 20 metres thickness, 23% reporting 20 to 40 metres overburden thickness, and the remainder reporting greater than 40 metres. Of the wells that do not report encountering bedrock, 20% were greater than 40 metres in depth. This variability is anticipated in an area of varying physiography, including drumlinized terrain, as reported within the Watershed.

2.6.1.2 MECP Permits to Take Water

A search of the MECP Permit to Take Water (PTTW) database was completed (MECP, 2018). Within the Watershed there are 322 PTTWs, of which 274 expired prior to January 1st, 2018 (**Figure 2-19**). **Table 2-12** below summarizes the details of the currently active permits. As shown, the majority of the active permits are related to construction activities and golf course irrigation (33 and 38% respectively). PTTWs are available via an interactive map on the MECP website: www.ontario.ca/environment-and-energy/map-permits-take-water.





Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed

Permits to Take Water (PTTW)

- Agricultural
- Commercial
- Construction
- Dewatering
- Dewatering Construction
- Industrial
- Miscellaneous
- Recreational
- Remediation
- Water Supply

Lynde Creek Watershed

MECP Permits to Take Water

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: MOECC (2018), CLOCA (2018), MNRF (2017), Bing (2014)
P#: 60566558	V#: 001	

AECOM

Figure 2-19

0 0.5 1 2 3 4
Kilometers

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Table 2-12: Summary of PTTW within the Lynde Creek Watershed

Primary Water Use	Number of Permits	Source – Groundwater	Source – Surface Water
Communal	2	2	0
Construction	16	16	0
Golf Course Irrigation	18	17	1
Other - Dewatering	1	1	0
Other - Water supply	3	3	0
Pumping Test	1	--	--
Snowmaking	5	5	0
Wildlife Conservation	2	0	2

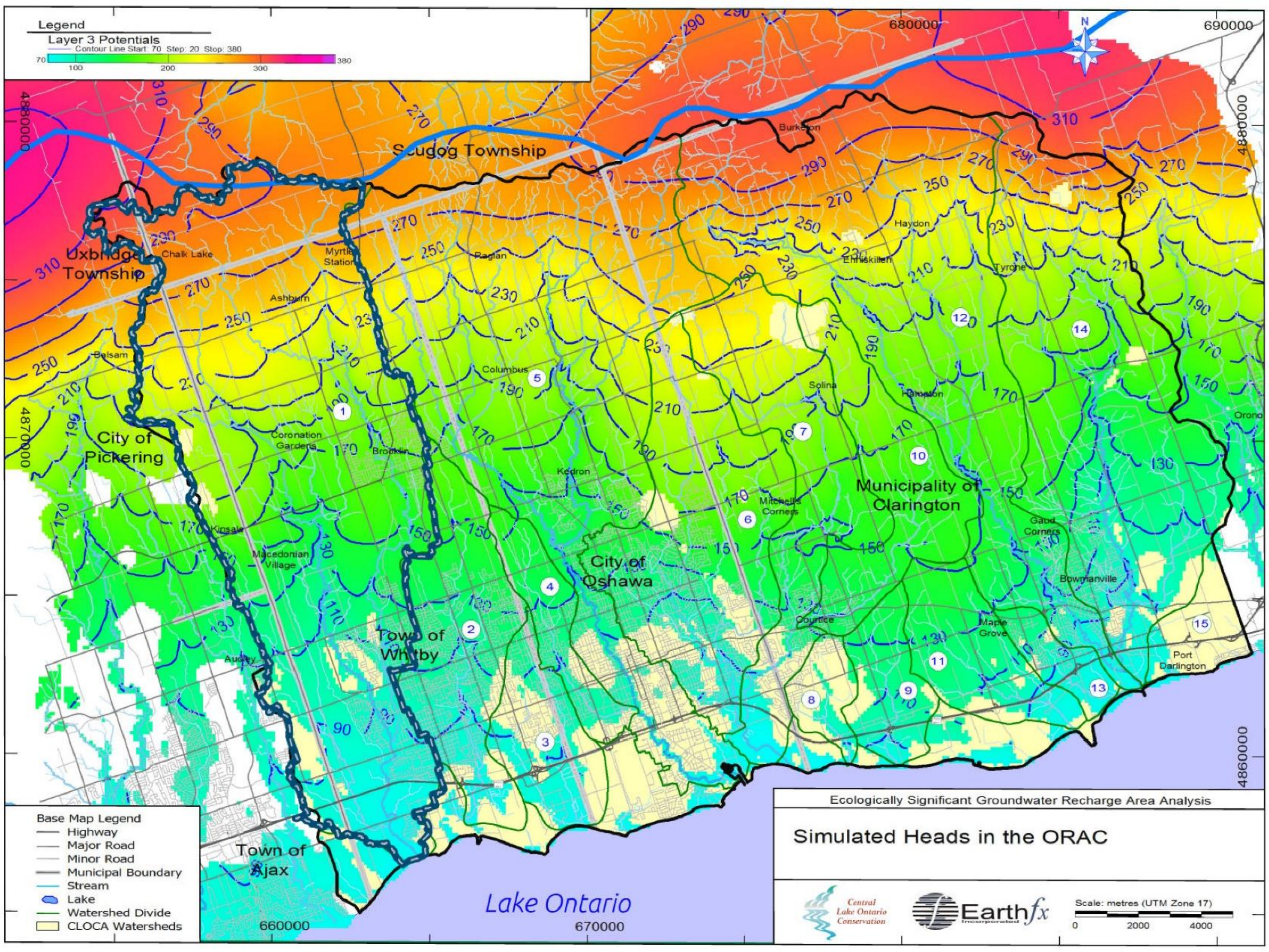
Note: data available as of May, 2018

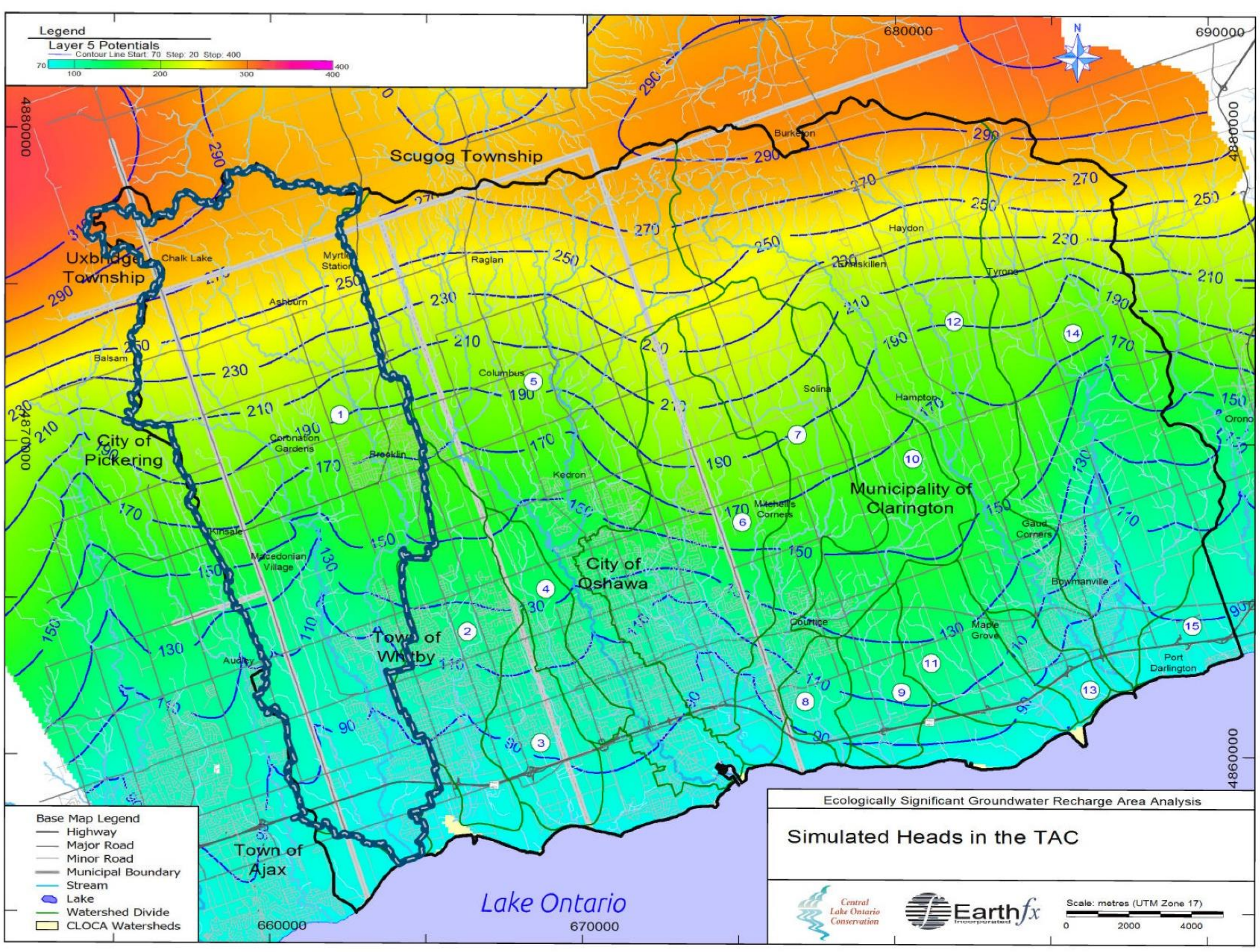
2.6.2 Groundwater Flow

Groundwater flow typically follows local topography, flowing from high elevation to low elevation. Regionally in the Watershed, groundwater flows from north to south, from the Oak Ridges Moraine towards Lake Ontario (**Figure 2-20**). Surface water features are expected to have a significant influence on the direction of shallow flow. Regional flow mapping shows groundwater flow in the upper units of the watershed (modelled Oak Ridges Aquifer Complex) is from north to south. Investigations of deeper systems (modelled Thorncliffe Aquifer Complex) indicate a similar flow pattern, from north to south towards Lake Ontario (CLOCA, 2008). There may be local variations in direction of groundwater flow as a result of climatic variability and the influence of local groundwater uses. The Oak Ridges Moraine forms a regional flow divide between the Watershed and adjacent areas.

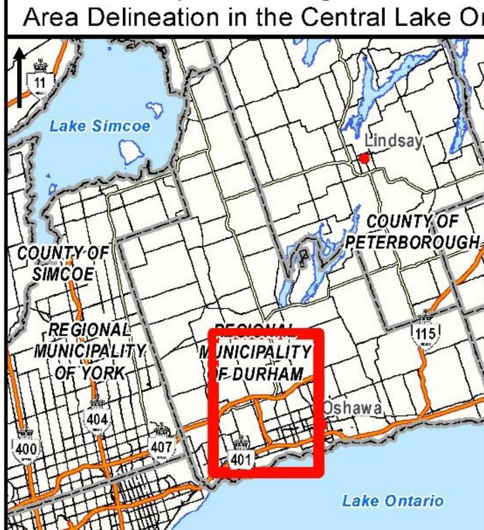
2.6.3 Aquifer Vulnerability

A Highly Vulnerable Aquifer (HVA) is one of the four vulnerable areas identified under the *Clean Water Act, 2006*. These aquifers are susceptible to contamination due to their location near the ground surface or the type of material found in the ground above the aquifer (CTC SPP, 2015). Aquifers that are near the ground surface and have a limited barrier between potential surface contaminants and the aquifer unit are considered to be HVAs. HVA areas are determined by calculating an intrinsic susceptibility score (ISI) using available subsurface information. The ISI is calculated using a formula that includes the geologic units recorded in a well record along with the thickness of the unit and a generic representation of permeability. Thick aquifers with high permeability that have a thin confining layer, for example, would result in a high ISI and therefore may be designated as HVA. **Figure 2-21** shows the areas designated as HVA in the Watershed.





Source: Adapted from Figures 14 and 15. Earthfx. 2014. Ecologically Significant Groundwater Recharge Area Delineation in the Central Lake Ontario Conservation Authority, Final Report



Legend

Lynde Creek Watershed

Lynde Creek Watershed

Groundwater Flow

May 2019	NTS	Datum: NAD 83 Zone 17 Source: MOECC (2018), CLOCA (2018), MNRF (2017), Bing (2014)
P#: 60566558	V#: 001	
AECOM		**Figure 2-20**

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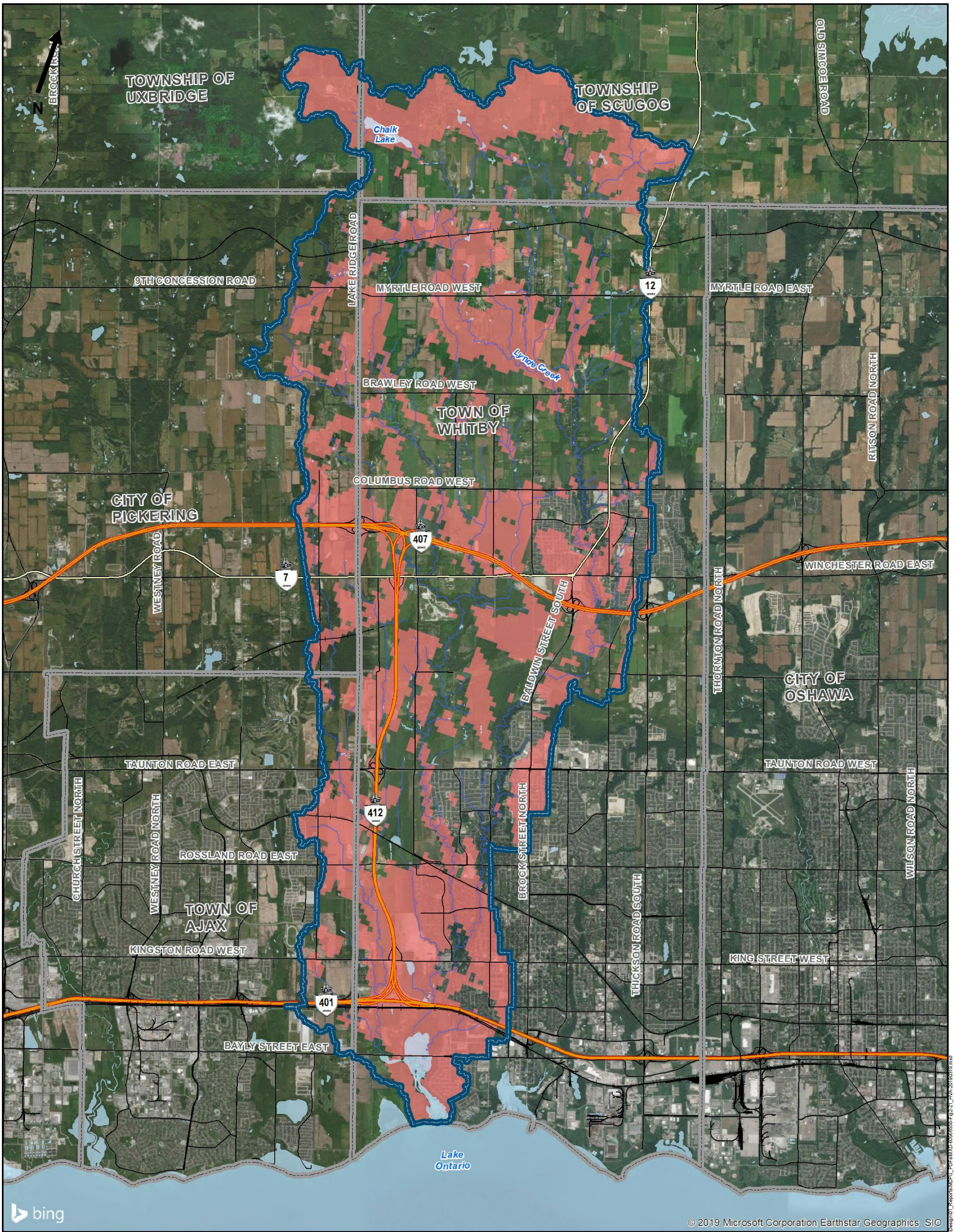

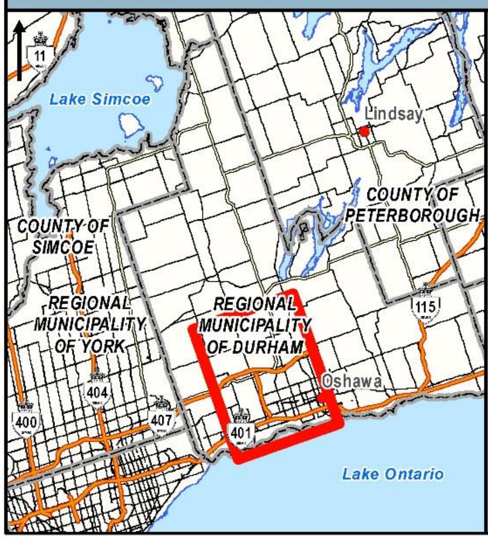

Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Highly Vulnerable Aquifer

Lynde Creek Watershed

Highly Vulnerable Aquifers

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: OGS (2011), CLOCA (2018), MNRF (2017), Bing (2014)
P#: 60566558	V#: 001	

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Figure 2-21

0 0.5 1 2 3 4
Kilometers

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Map location: \\CAKCN1FP001\Data\Projects\60566558 Lynde Ck MP\900-CAD_GIS\920-929 (GIS-Graphics)\Design\01_Reports\MDPU_PDFs\MXD-60566558-Fig2-21_HVA-20190319.mxd
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2.6.4 Groundwater Discharge

Groundwater discharge zones are areas where groundwater moves from the subsurface to the surface as a result of an upward vertical hydraulic gradient. Groundwater discharge can be observed in and around water courses in the form of springs, wetlands, seeps or as baseflow to streams. Typically, potential discharge areas have been identified where the water table surface is within 1 meter of ground surface. The most prominent potential discharge areas in the Watershed are along the southern fringe of the Oak Ridges Moraine and along water courses (CLOCA, 2007, Earthfx, 2014, **Figure 2-22**). Mapping prepared by Earthfx of simulated groundwater discharge to streams and wetlands shows discharge along many of the major rivers/streams in the Watershed (Figure 2-23). Modelled discharge values range, on average, from 0.1 to 1 L/s (Earthfx, 2014).

In May 2018, sixteen sites were visited and the potential for groundwater discharge was evaluated (**Appendix B7**). This included a visual search of valley walls, floodplains and stream beds at road crossings for signs of groundwater discharge. Sites were chosen based on the groundwater discharge mapping shown in **Figure 2-22**. Some qualitative signs of groundwater discharge to streams include: certain groundwater dependent plant species (e.g., watercress), iron staining and/or natural sheen at discharge locations, seeps at stream bank, permeable stream substrate and/or soft saturated floodplain sediments, etc. Of the 16 sites visited, eight had some indication that groundwater discharge may be occurring. Confirmation of groundwater discharge via more quantitative measures (piezometers, thermal mapping, etc.) is outside the scope of this study.

2.6.5 Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (SGRA) are areas on the landscape that are characterized by porous soils, such as sand or gravel, which allow water to seep easily into the ground and recharge an aquifer (CTC SPP, 2015). In a SGRA, the groundwater recharge is 1.15 times greater than the average rate of recharge. **Figure 2-24** shows areas designated as Significant Groundwater Recharge Areas in the Lynde Creek Watershed. These areas include zones where the predicted recharge is at least 15% above the mean calculated for the Watershed. These areas are generally associated with Oak Ridges Moraine sediments which have annual recharge estimates of between 300 and 400 mm/a (Gerber and Howard, 2000), and the Lake Iroquois sand deposit. Mapping prepared by Earthfx (2014) shows estimated recharge in mm/year from the CLOCA Groundwater Model (**Figure 2-25**). Modelling results show the higher rates of recharge in the vicinity of the Oak Ridges Moraine.

Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed

Potential Discharge Area (water table depth below ground surface)

- less than 1m

Lynde Creek Watershed

Groundwater Discharge Areas

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: OGS (2011), CLOCA (2018), MNRF (2017), Bing (2014)
P#: 60566558	V#: 001	

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Figure 2-22

0 0.5 1 2 3 4
Kilometers

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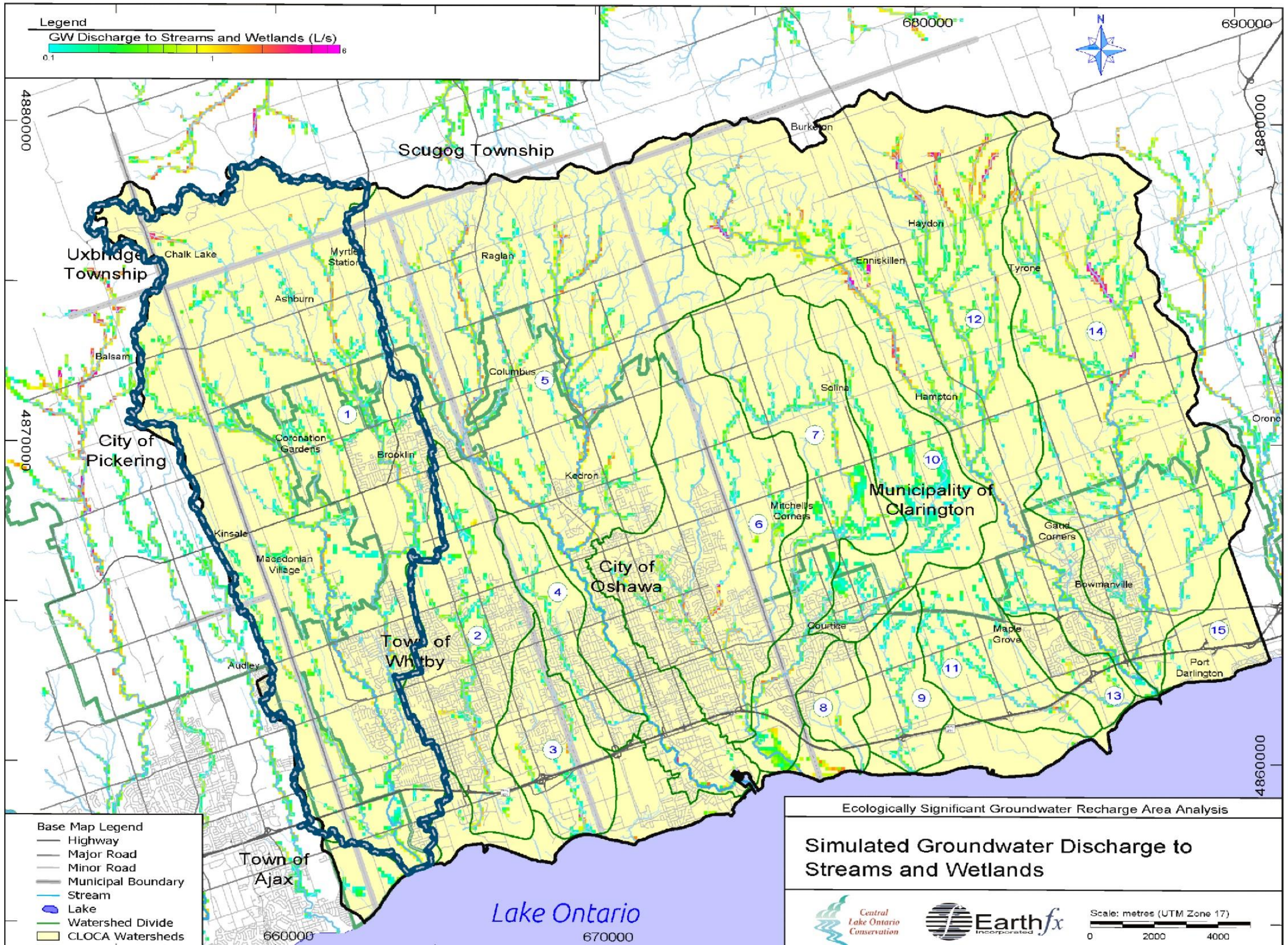
Legend

Lynde Creek Watershed



Source: Adapted from Figure 16. Earthfx. 2014. Ecologically Significant Groundwater Recharge Area Delineation in the Central Lake Ontario Conservation Authority, Final Report

Lynde Creek Watershed

Simulated Groundwater Discharge to Wetlands and Streams

May, 2019	NTS * when printed 11"x17"	Datum: NAD 1983 UTM Zone 17N Source: CLOCA, MNRF
P#: 60566558		Figure 2-23
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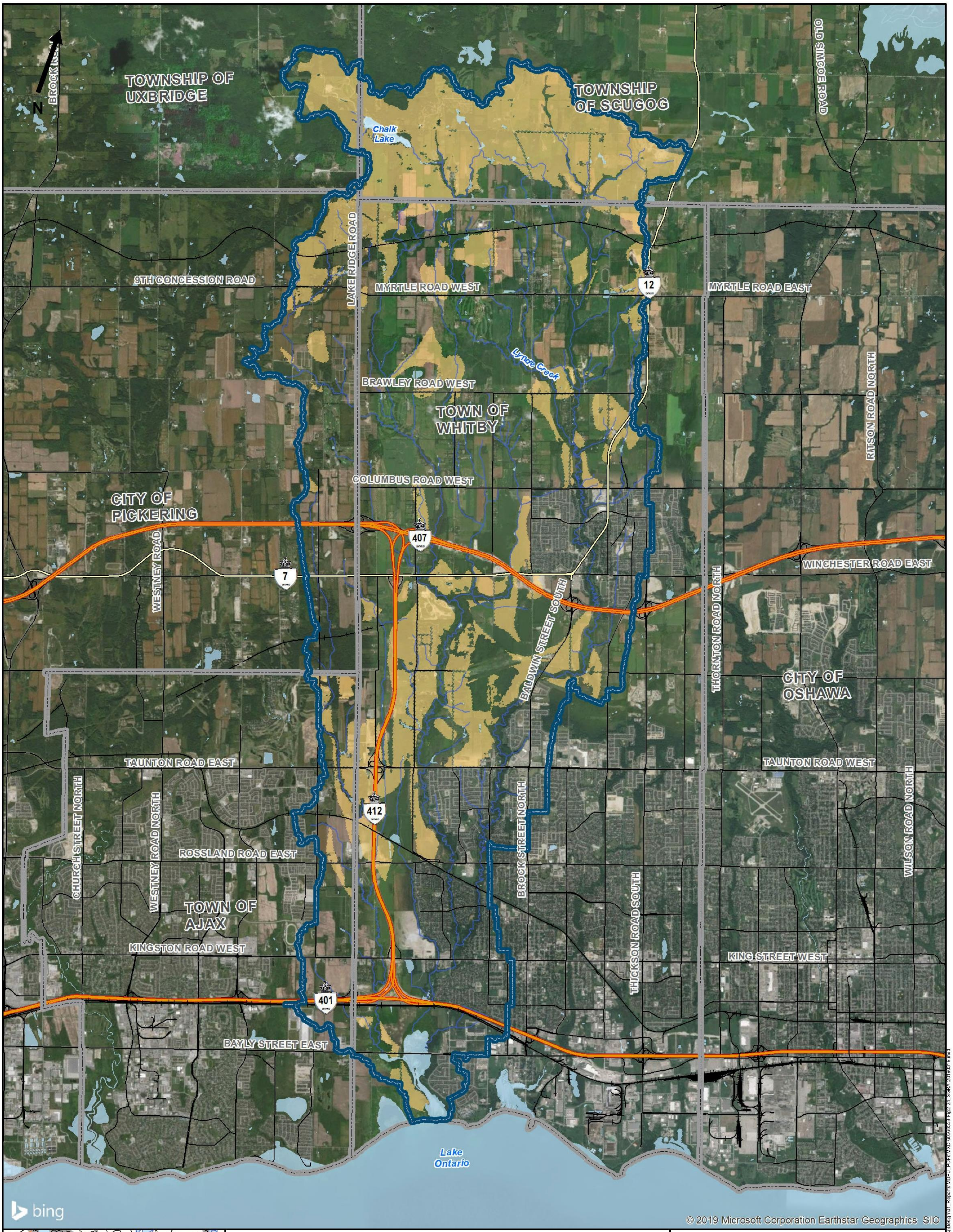

Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Significant Groundwater Recharge Area

Lynde Creek Watershed

Significant Groundwater Recharge Areas

May 2019	1:75,000	Datum: NAD 83 Zone 17 Source: OGS (2011), CLOCA (2018), MNRF (2017), Bing (2014)
P#: 60566558	V#: 001	

AECOM

Figure 2-24

0 0.5 1 2 3 4 Kilometers

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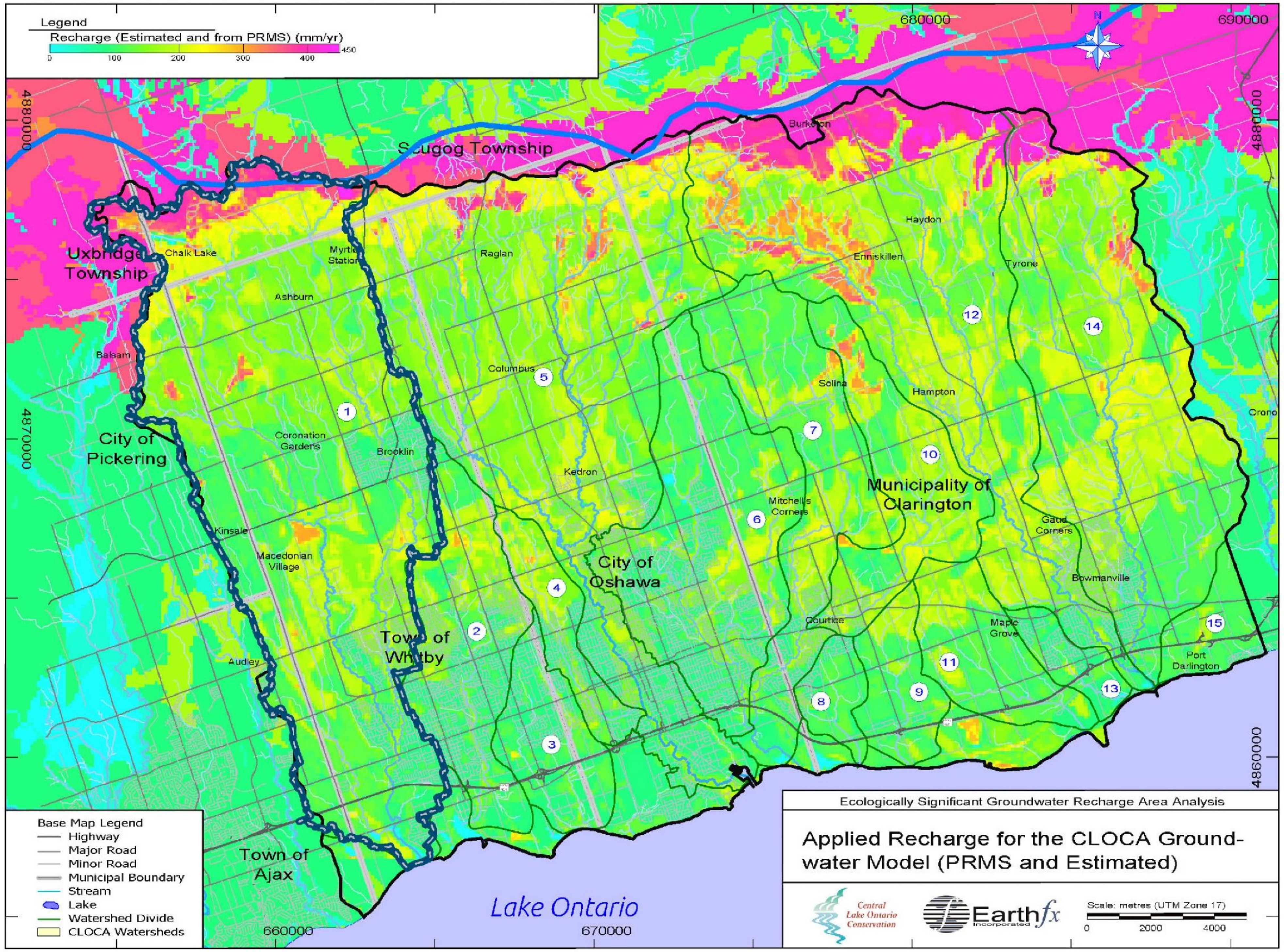

Legend

Lynde Creek Watershed

Source: Adapted from Figure 13. Earthfx. 2014. Ecologically Significant Groundwater Recharge Area Delineation in the Central Lake Ontario Conservation Authority, Final Report

Lynde Creek Watershed

Groundwater Recharge Model

May, 2019	NTS * when printed 11"x17"	Datum: NAD 1983 UTM Zone 17N Source: CLOCA, MNRF
P#: 60566558		Figure 2-25
AECOM		

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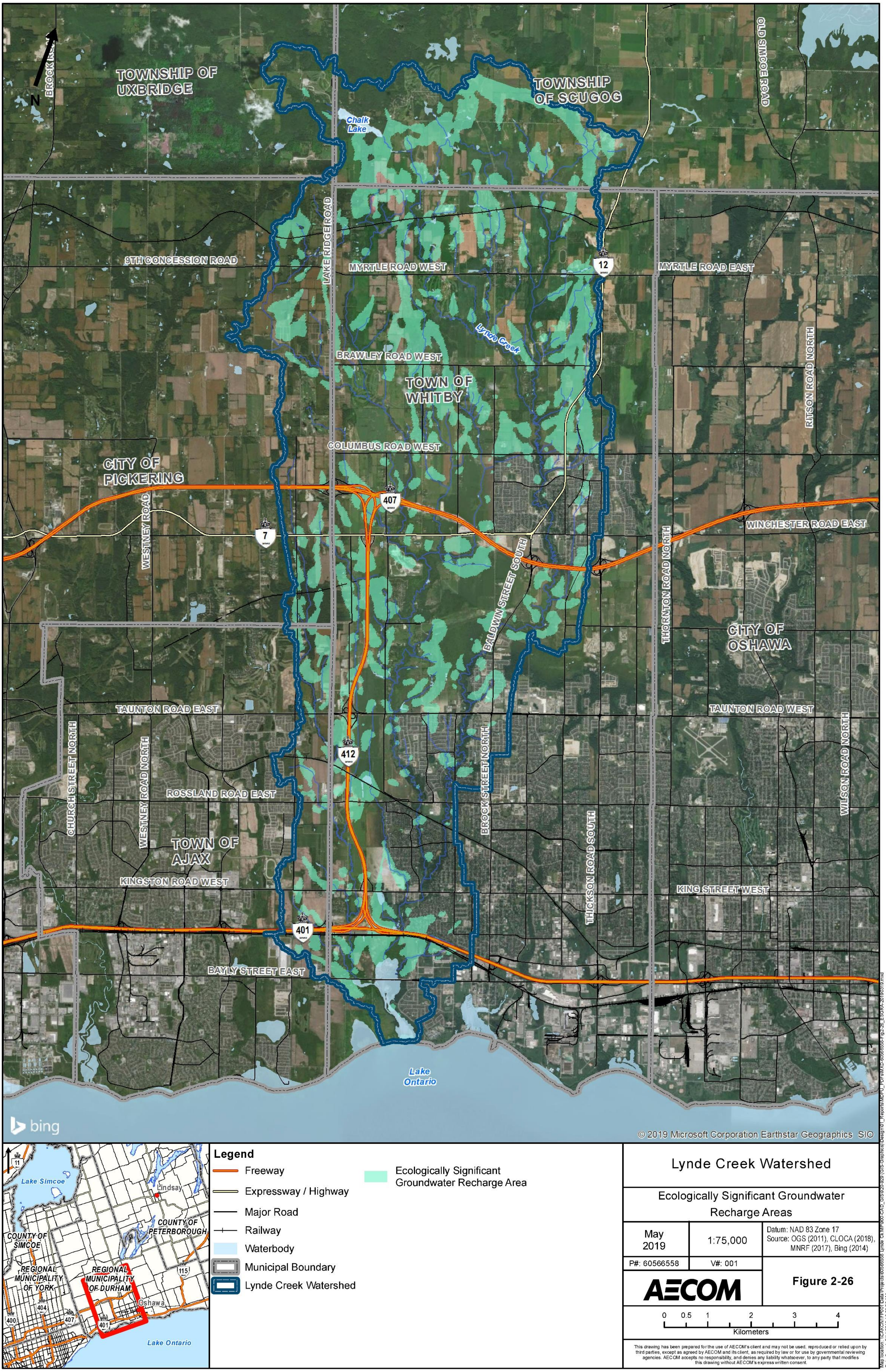
Ecologically Significant Groundwater Recharge Areas (ESGRAs) include areas where a linkage has been made between the recharge area and an ecological feature such as a provincially-significant wetland, cold water stream, or area of natural or scientific interest. These areas were established using a numerical model that traced the movement of water from the ecological feature back to the point of recharge (Earthfx, 2014). A map of the ESGRAs within the Watershed is shown on **Figure 2-26**. Recharge values ranged from 300 to 420 mm/year with highest values occurring over the Oak Ridges Moraine and Lake Iroquois/ Lake Algonquin beach deposits (Earthfx, 2014). Rates of recharge are lowest over the areas where till is found at surface and urban areas.

In May 2018, several locations were visited and samples were collected to confirm the nature of the surficial sediment, where possible. Site locations were chosen based on the surficial geology mapping (areas of coarser grained materials, see **Figure 2-4**) and the SGRA mapping to confirm the presence of materials that would promote infiltration (see **Figure 2-26**). A map showing the locations and a brief, qualitative description of the material encountered there is included in **Appendix B8**. Samples were taken immediately below the soil horizon, typically approximately 30 cm below ground surface. The majority of materials encountered were sandy in nature. In addition, there are many active quarries/aggregate extraction sites in the northern portion of the Watershed as shown on the appended map, which further confirms the presence of surficial materials that may support significant groundwater recharge.

2.6.6 Groundwater Quality

The Provincial Groundwater Monitoring Network (PGMN) has two monitoring wells located in the Watershed (**Figure 2-18**).

PGMN well W0000263-1 (well record number 1916117), is located near the centre of the Watershed on Coronation Road between Highway 7 and Taunton Road. It is screened in the shallow overburden from 6.5 to 7.32 mbgs (136.17 to 135.35 mASL) in fine to medium sand. Water levels have been monitored continuously from 2003 to 2016, and are displayed graphically in **Appendix B9**. Water levels in this well typically show a seasonal response with water levels recovering (increasing) during the first six months of the year in response to wet spring conditions and decreasing through the drier summer months and winter period where groundwater recharge events occur less frequently. Water levels in the dataset show variations of up to two meters over a single year. Over the monitoring period, water levels have ranged from a low of approximately 137 mASL in 2003 to a high of approximately 140.5 mASL in the summer of 2009. Water levels show a general rising trend from 2003 to 2009, followed by a decline from the peak in 2009 to the low in 2011, and then a generally steady trend from 2011 to the end of the monitoring period.



Lynde Creek Watershed

Ecologically Significant Groundwater Recharge Areas

Figure 2-26

PGMN well W0000261-1 (well record number 1916296), is located on the northern edge of the Watershed in the Crow's Pass Conservation Area, off of Middle March Road. The well is screened from 16.76 to 18.29 mbgs (303.85 – 302.32 mASL) in fine sand and silt. Water levels have been monitored continuously from 2003 to 2016, with the exception of June 2007 to September 2008, and are displayed graphically in **Appendix B9**. Water levels in this well show a muted seasonal response with variations up to 1 meter in a single year, although most years there is less than 0.5 meters of change. Over the monitoring period, water levels have ranged from a low around 295.25 mASL in 2003 to a high of 297.5 mASL in 2009. Water levels show a general rising trend from 2003 to 2009, followed by a decline from the peak in 2009, and then a consistent trend from 2012 to the end of the monitoring period.

Raw groundwater samples have been taken from both wells from 2003 to 2015 (**Appendix B9**). Annual sample analyses were completed at either the MECP laboratory or a private laboratory and included general chemistry, metals, major ions, and a suite of volatile organic compounds. Some pesticides and herbicides were monitored less frequently. Bacteria are not monitored under the PGMN program.

For discussion, water quality data has been compared against Ontario Regulation 169/03 Ontario Drinking Water Quality Standards (ODWQS) – Aesthetic Objectives (AO) and Operational Guidelines (OG) for a selection of parameters.

Well W0000263-1 experienced periodic exceedances of chloride between 2003 and 2007, and since then has remained below the ODWQS AO. Overall, concentrations appear to have declined between 2003 and 2010 after which concentrations have been stable until monitoring ended in 2015. Hardness (as $CaCO_3$) has also been consistently above the ODWQS OG. Overall, concentrations appear to have declined between 2004 and 2009 after which concentrations have been relatively stable until monitoring ended in 2015. Other parameters including Aluminum, Iron, Manganese, Nitrate + Nitrite as N, Sulphate, Conductivity, and pH appear to have a general declining trend from the on-set of the sampling program in 2003 to about 2009, and then a steady trend from 2009 to 2015.

Well W0000261-1 has had Hardness (as $CaCO_3$) values consistently above the ODWQS OG. Other parameters including Aluminum, Chloride, Iron, Manganese, Nitrate + Nitrite as N, Sulphate, Conductivity, and pH have remained below their respective ODWQS AO/OG. Over the monitoring period, Chloride and Nitrate + Nitrite concentrations, and Electrical Conductivity, have a generally increasing trend. Iron and Aluminum concentrations show a peaking trend between 2003 and 2009, and then have been steady over the remainder of the monitoring period. The other parameters have had a generally stable trend during the same time period.

2.7 Natural Heritage – Aquatic Resources

The purpose of this section is to review existing aquatic conditions and update the Lynde Creek Drainage Master Plan to include the following data, recommendations, management options, and legislation considerations:

- Provide a summary of the fisheries and aquatic resources of the watershed and outline the potential general impact of development on fisheries and aquatic resources and develop high-level recommendations regarding alternative protection and mitigation measures;
- Identify instream barriers;
- their impact on fish habitat and fish passage;
- Identify opportunities for riparian protection and restoration; and
- Identify potential data gaps or areas where additional, future data collection would be beneficial to more accurately assess potential impacts or provide more targeted recommendations.

Data and documentation that were collected and reviewed includes the following:

- Ministry of Natural Resources and Forestry (MNRF)'s Land Information Ontario (LIO) natural heritage GIS mapping (2018a);
- MNRF Make-a-Map: Natural Heritage Areas Application and Natural Heritage Information Centre (NHIC) Rare Species Records (2018b);
- Fisheries and Oceans Canada (DFO) Species at Risk (SAR) Online Mapping Tool (2018)
- Brooklin Secondary Plan Area Natural Heritage Assessment Background Report (Beacon Environmental Ltd. and R.J. Burnside and Associates Ltd., 2014);
- Lynde Creek Watershed Plan (CLOCA, 2012); and
- Digital ortho-imagery.

CLOCA also outlined 23 Action plans in their watershed, of which the following four relate to aquatic resources: Action Plan # 1 (Natural Heritage System Restoration Plan), Action Plan # 2 (Riparian Corridors Restoration Plan), Action Plan #5 (Wildlife Corridor and Enhancement Plan), and Action Plan #17 (Lynde Creek Watershed In-Stream Barriers Plan). These were reviewed and used as the foundation for restoration or enhancement opportunities.

2.7.1 Existing Conditions

The Lynde Creek watershed is comprised of five subwatersheds: Ashburn, Myrtle Station, Heber Down, Kinsale, and Lynde Main (**Figure 1-2**). The Lynde Creek watershed originates from the headwaters of the Oak Ridges Moraine north of Townline Road, and outlets into Lake Ontario approximately 22 kilometres to the south (CLOCA, 2013a). Approximately 30 fish species are known to inhabit the Lynde Creek watershed and its tributaries, including migratory salmonids (Rainbow Trout) and resident Brook Trout in the headwaters of multiple subwatersheds (CLOCA, 2013a).

The majority of the watercourses in the Lynde Creek watershed can be characterized as cold/coolwater systems based on available background information from the Ministry of Natural Resources and Forestry (MNRF) Land Information Ontario (LIO). Accordingly, all watercourses are managed by CLOCA as coldwater habitat (pers comm email). As shown on **Figure 2-1,** the headwaters of the Lynde Creek watershed are located on the Oak Ridges Moraine. The moraine, along with the till material associated with the glacial Lake Iroquois Beach to the south, are important physiographic features on the landscape that help regulate and facilitate the coldwater thermal regime and water quality that support migratory and resident salmonids (CLOCA, 2013a). Groundwater discharge areas help maintain coldwater habitat for sensitive fish species such as Brook trout and can provide upwellings that Brook trout are dependent upon for spawning. Groundwater discharge areas are shown on **Figure 2-22**.

During sampling in 2013 by CLOCA near an existing Victoria Road culvert, an abundance of Northern Pike were captured, suggesting that this location is likely suitable habitat for Northern Pike spawning and rearing (CLOCA, 2013b). A kettle lake named Chalk Lake is location within the headwaters of the Oak Ridges Moraine near the northern limits of the watershed (CLOCA. 2013a). The warmer thermal regimes in the southern reaches of the Lynde Creek watershed are favourable for numerous invasive or non-native species found in Lake Ontario. Currently, Round Goby, Common Carp, and Sea Lamprey are known to occur in the Lynde Creek watershed (CLOCA, 2013a).

Water temperature is one of many criteria used to assess the water quality of a stream and the health of the aquatic habitat within it. Many organisms have particular thermal requirements for existence, and cannot tolerate large changes in water temperature. As such, in stream thermal conditions are an important indicator of overall ecosystem health.

Historically, the Lynde Creek was predominantly a cold-water system; however changes in land use over recent decades have caused a general warming of stream temperatures in some areas of the watershed. The Lynde Creek watershed is now a predominantly cool and warm-water system, with cool-water areas in the upstream reaches of the watershed. Cold- water sites were found in Myrtle Station and in uppermost reaches of Heber Down and Kinsale subwatersheds.

Only 34% of the Lynde Creek length is protected by riparian vegetation, which may be contributing to the warm-water temperatures. Stormwater input and high proportions of impervious cover on the landscape are also likely contributing to the warm-water temperatures in Lynde Creek southern reaches. Numerous fish migration barriers (e.g., weirs) exist throughout the watershed.

Since no data gaps were identified during review of the background information, AECOM aquatic biologists limited field investigations to a single reconnaissance visit on May 11, 2018.

2.7.2 Aquatic Species at Risk

Redside Dace (*Clinostomus elongatus*) is a Species at Risk (SAR) listed as Endangered under the provincial *Endangered Species Act, 2007* (ESA) and the federal *Species at Risk Act* (SARA). This species has been recorded in all five Lynde Creek subwatersheds (CLOCA, 2013b). Eastern Pondmussel (*Ligumia nasuta*) is a SAR listed as Endangered under ESA and SARA and has been recorded within Lynde Creek Marsh along the southern edge of the watershed near Lake Ontario.

According to MNRF records, American Eel and Northern Brook Lamprey are present in the watershed (MNRF, 2018b). American eel is listed provincially Endangered under ESA and has no status under SARA. Northern Brook Lamprey is listed provincially Special Concern under ESA and federally Special Concern under SARA.

2.7.3 Future Development Impact Assessment

Without interventions, future development impacts will likely follow a similar trend as historic impacts. Drivers of change to aquatic ecosystems include urbanization and land use conversion resulting in loss of headwater streams and wetlands, removal of riparian vegetation, alteration of flow regimes leading to erosion and sedimentation, alteration of water quality leading to warmer average water temperatures, creation of fish migration barriers, etc. Development in important physiographic features that provide groundwater discharge to streams to sustain habitat conditions for sensitive coldwater species, such as the Oak Ridges Moraine and glacial Lake Iroquois Beach, have potential to further impact aquatic ecosystems in these areas leading to both local impacts and wider watershed-level impacts. In particular, the Brooklin Community Secondary Plan area stands to potentially impact Brook trout habitat for the reasons noted above.

2.7.4 Restoration and Enhancement Opportunities

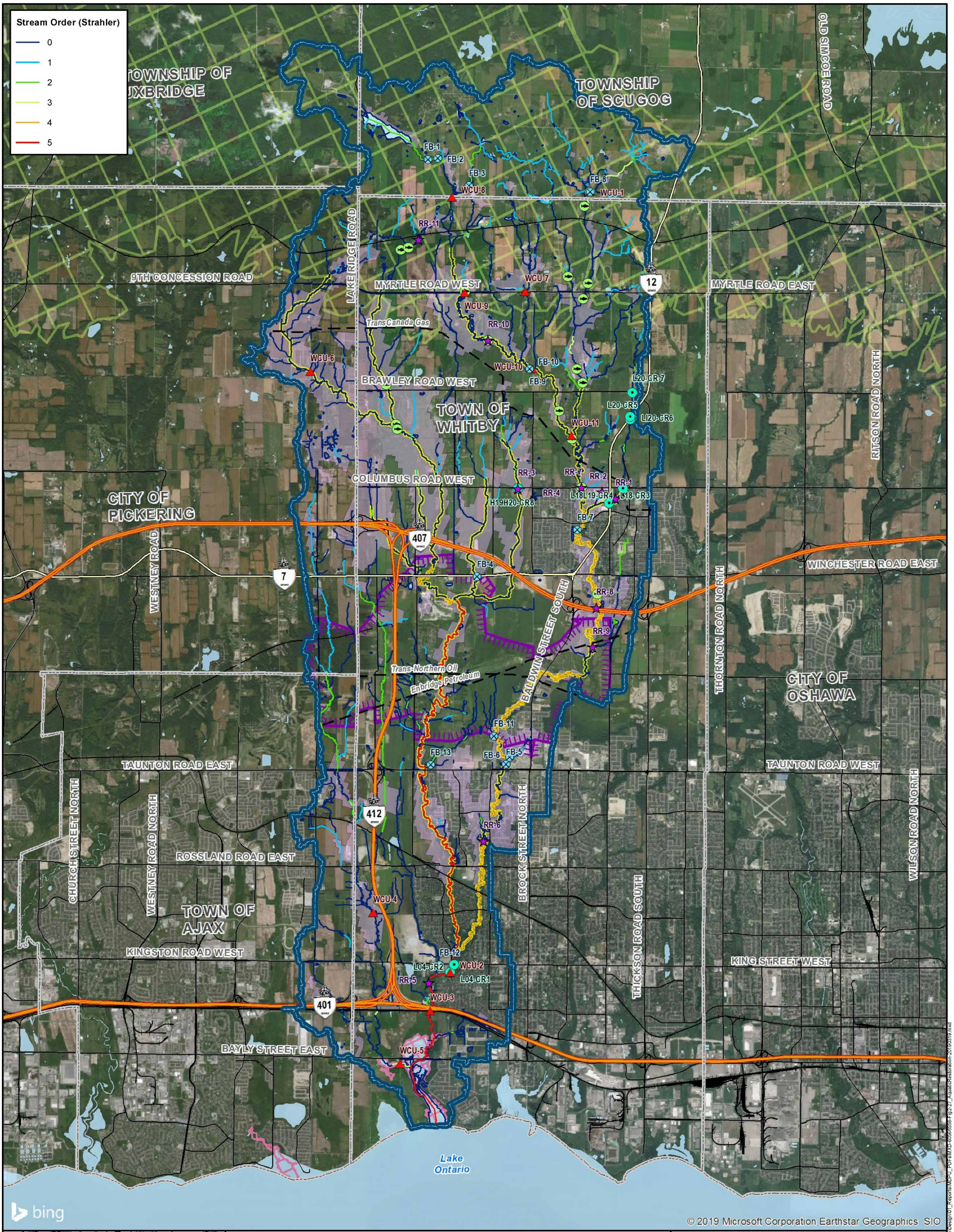
There are many opportunities throughout the watershed to improve fish and fish habitat and to provide benefit to aquatic SAR habitat while addressing flood and drainage-related issues as they pertain to land and infrastructure development. These opportunities include removing existing fish barriers, restoring riparian vegetation cover (particularly in headwater areas), improving water quality and quantity discharging from existing infrastructure facilities (i.e., stormwater ponds) and implementing Low Impact Development (LID) designs in urban areas.

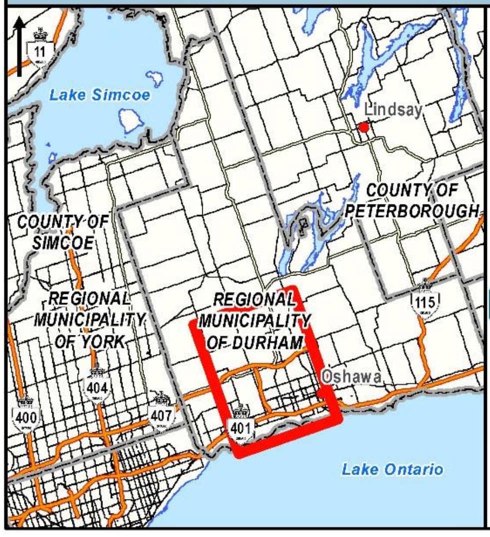
Additional opportunities are anticipated in the near future as private lands containing natural heritage features (e.g., watercourses, wetlands, woodlands, etc.) are converted to public ownership following development of the Whitby West Secondary Plan area and the Brooklin Community Secondary Plan area. Accordingly, this study has identified potential future drainage improvements on lands within these Secondary planning areas.

Recommendations identified in this study are intended to, where applicable, help drive results from the various Action Plans under the Lynde Creek Watershed Plan. Any in-water and near-water works need to account for permitting and timing restrictions associated with these SAR in particular and with fish and fish habitat in general.

Restoration opportunities identified in this Lynde Creek MDPU study are shown on **Figure 2-27.** Consideration may be given to the fact that some of the opportunities identified in this study may potentially be suitable as Overall Benefit activities for projects

1. **Riparian Restoration** – Riparian corridors are vegetated areas adjacent to watercourses and these areas have numerous benefits ranging from reducing riverine hazards (flooding and erosion), mitigating climate change impacts, protecting natural baseflow, improving water quality and stream temperature, offering biologically diverse habitat, providing corridors for wildlife movement and improving people's recreational experience. CLOCA's watershed plans acknowledge these benefits, recommending that adequate riparian corridors (30 metres on both sides) along 75% of the watershed's stream length be a fundamental watershed health target. To support achieving this recommendation, a Riparian Corridors Restoration Plan (Watershed Action Plan #2) has been prepared as part of the Lynde Creek Watershed Plan. Headwaters and low order streams are critically important to a stream's ecosystem and due to their small size are extremely susceptible to land use change and land care practices. As such, recommendations for riparian restoration in the Lynde





Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Iroquois Beach – Groundwater Recharge Area
- Oak Ridges Moraine
- Fish Barrier
- Potential Brook Trout Location
- Riparian Restoration Location
- Existing SWMP - High Priority
- Existing Geomorphically Undersized Culvert
- One or More Species Listed As Extirpated, Endangered or Threatened (DFO, 2017)
- Aquatic SAR Critical Habitat (DFO, 2015)
- Potential Discharge Area (water table depth within 1m of ground surface)

N

Lynde Creek Watershed

Aquatic Ecosystem Restoration Opportunities

May 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	

AECOM

Figure 2-27

0 0.5 1 2 3 4
Kilometers

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Creek MDPU specifically target headwater and low order streams, which in turn, may provide benefits to important fish species and aquatic SAR (e.g., Brook trout, Rainbow trout, Redside dace, etc.). The Lynde Creek MDPU represents an opportunity for municipalities and stakeholders to work toward improving the percentage of adequate riparian corridors within the Lynde Creek watershed (CLOCA, 2017b). Additional details pertaining to candidate riparian restoration sites are provided in **Table 8-2**. that documents the recommended Lynde Creek MDPU projects. Given the multitude of riparian restoration opportunities in the watershed, the list provided (**Table 8-2**) is not exhaustive and should only be considered preliminary.

2. **Fish Barriers -** Instream barriers result in impacts to fish movement and can negatively affect spawning activities and natural movement of fish species within a watershed, leading to reduced reproductive success. CLOCA's Instream Barrier Action Plan (Action Plan #17) prepared as part of the Lynde Creek Watershed Plan, has systematically assessed known barriers in the watershed and assigned a priority rating for removal. Prioritizing barriers for removal places an emphasis on restoring barriers located in the healthiest sections of the watershed and where sensitive species are abundant. Natural barriers such as debris jams and beaver dams are considered temporary and part of a natural system (CLOCA, 2017a). Barrier removal projects should be accompanied by assessment of potential impacts on the spread of Aquatic Invasive Species (AIS), in conjunction with consultation with CLOCA and Fisheries and Oceans Canada (DFO).

   According to CLOCA Instream Barrier Action Plan (Action Plan #17), the following barriers to fish passage remain present in the Lynde Creek watershed (as shown on **Figure 2-27**):

   - FB-1: McIntosh Berm (BARLYN01) – pond with top draw outlet
   - FB-2: Ashton Berm (BARLYN02) – pond with top draw outlet
   - FB-3: Muirhead Berm (BARLYN03) – pond with top draw outlet
   - FB-5: Cullen Gardens Dam (BARLYN05) – existing dam feature that is opened during the spring and fall to accommodate salmonid spawning seasons
   - FB-6: Step-pools (BARLYN06) - barrier to non-jumping species

- FB-7: Way Street (BARLYN07) - existing dam feature that is opened during the spring to accommodate the Rainbow Trout spawning season
- FB-8: Bryant Sideline Culvert (BARLYN08) – damaged corrugated steel culvert that restricts fish passage
- FB-9/10: Ashburn Road north of Brawley Road (BARLYN09 and 10) – online pond
- FB-11: Lynde Creek (BARLYN11) – weir is a barrier to non-jumping species.

Discussions with CLOCA held during the Lynde Creek MDPU study revealed the presence of additional barriers to fish passage, that were not previously identified in Action Plan #17, at the following locations:

- FB-12: Dundas Street West (Highway 2) approximately 40 metres west of White Oaks Court – buried stream.
- FB-13: Taunton Road between Coronation Road and Country Lane – rubble berm / online pond.

Additional details pertaining to barrier removals are provided in **Table 8-2**. that documents the recommended Lynde Creek MDPU projects. Although there may be other barriers in the watershed, the list provided in is considered comprehensive.

3. **Water Quality Improvements -** The Lynde Creek Watershed Plan identifies the importance of effective, low impact management of stormwater runoff to protect the ecological health of the watershed and contribute to the protection of human life and property during storm events including incorporation of a best management treatment train approach with increased emphasis on lot level/course, Low Impact Development (LID) technologies and conveyance methods in addition to traditional end-of-pipe methods. Alternative stormwater management designs and practices should be explored for all new developments to minimize and attenuate runoff volumes, peak flow rates to pre-development levels and appropriate temperatures of stormwater discharge to streams (CLOCA, 2012).
4. **Stormwater management facilities** are a vital component of municipal infrastructure and can directly impact fish and aquatic habitat if improperly design and maintained. Aquatic resources are particularly vulnerable when coldwater habitat is present (e.g., groundwater upwellings, brook

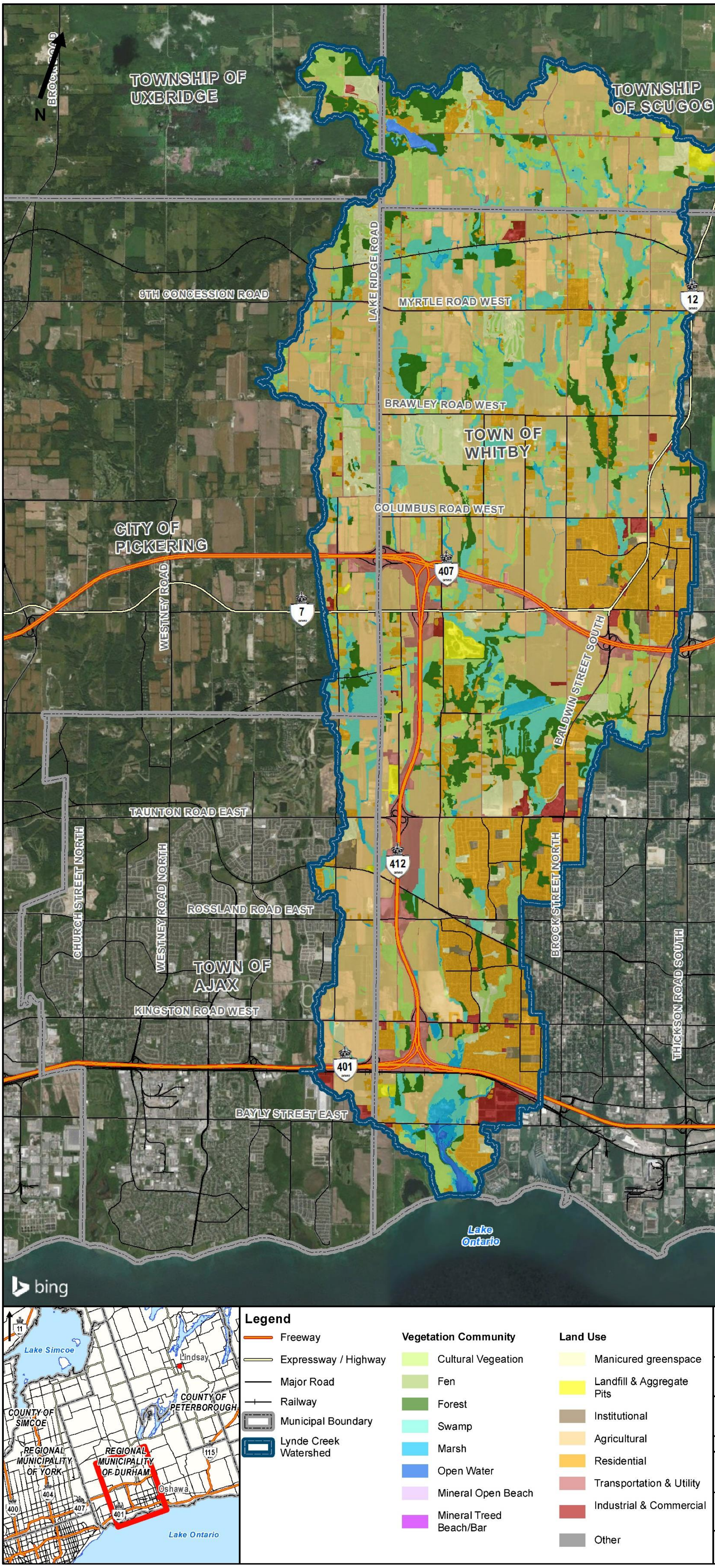
trout spawning habitat, presence of sensitive coldwater fish species such as Brook trout and Rainbow trout), or when aquatic SAR such as Redside dace and Eastern pondmussel are present. Accordingly, efforts directed at the retrofit of existing stormwater management facilities should be directed toward areas of highest vulnerability. Effective SWM is especially important in the Brooklin Community Secondary Plan area that will experience the greatest amount of land use change within the watershed as shown on **Figure 2-8.**

Additional details pertaining to SWM retrofits are provided in the recommended Lynde Creek MDPU Projects (see **Table 8-2** and **Figure 8-3**). The SWM retrofits were identified based on existing knowledge of existing and proposed SWM facilities at the time of report preparation. Additional SWM facilities are expected to be proposed as land use development continues throughout the watershed.

2.8 Natural Heritage – Terrestrial Resources

Terrestrial Natural Heritage includes land- based plants, animals, natural communities/habitats and land connectivity that are dependent on each other for survival and contribute to the overall long-term integrity and healthy functioning of an ecosystem. Specifically, it includes the following natural heritage features and areas as defined in the Provincial Policy Statement, 2014 (PPS): Significant Wetlands, Coastal Wetlands, Significant Woodlands, Areas of Natural and Scientific Interest (ANSIs), Significant Wildlife Habitat and Valleylands, as well as habitat for fish and SAR. AECOM completed a desktop review of available information to assess the current condition of terrestrial resources in the Lynde Creek Watershed. Data and documentation that were collected and reviewed includes the following:

- Ministry of Natural Resources and Forestry (MNRF)'s Land Information Ontario (LIO) natural heritage GIS mapping (2018a);
- MNRF Natural Heritage Information Centre (NHIC) Rare Species Records (2018b);
- Ontario Breeding Bird Atlas (BSC et al., 2006);
- Ontario Reptile and Amphibian Atlas (Ontario Nature, 2018);
- Bat Conservation International – Species Profiles (2018);
- Brooklin Secondary Plan Area Natural Heritage Assessment Background Report (Beacon Environmental Ltd. and R.J. Burnside and Associates Ltd., 2014);



Lynde Creek Watershed

Ecological Land Classification

May 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	

AECOM

Figure 2-28

0 0.5 1 2 3 4
Kilometers

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- Lynde Creek Watershed Existing Conditions Reports Chapter 17 and 18 (CLOCA, 2008a and b);
- Lynde Creek Watershed Plan (CLOCA, 2012);
- Town of Whitby Official Plan (2018 Consolidation);
- Region of Durham Official Plan (2017 Consolidation); and
- Digital ortho-imagery.

Requests for additional terrestrial natural heritage information that are not publically available were requested from the MNRF on April 10, 2018 and a response was received from the MNRF on August 1, 2018. Natural heritage information was also requested from CLOCA and the Town of Whitby on March 5, 2018.

CLOCA also outlined 23 Action plans in their watershed, of which the following five relate to terrestrial natural heritage: Action Plan #1 (Natural Heritage System Restoration Plan), Action Plan #2 (Riparian Corridors Restoration Plan), Action Plan #5 (Wildlife Corridor Protection and Enhancement Plan), Action Plan #15 (Salt Management Plan) and Action Plan #16 (Invasive Species Management Strategy). These were reviewed and used as the foundation for restoration or enhancement opportunities.

2.8.1 Existing Conditions

2.8.1.1 Vegetation

Vegetation communities within the Lynde Creek Watershed were classified by CLOCA using the *Ecological Land Classification (ELC) Manual for Southern Ontario: First Approximation and its Application* (Lee et al., 1998). **Table 2-13** below provides a summary of the ELC vegetation communities obtained from CLOCA and are shown in **Figure 2-28**. Approximately 71% of the Lynde Creek Watershed is dominated by anthropogenic land uses, of which agriculture is the most dominant. Urban development (i.e., residential, commercial, transportation, utility and manicured greenspace) is most predominant south of Columbus Road. The remaining 29% of the Lynde Creek watershed is naturally vegetated and consists of forests, wetlands and regenerating habitats (i.e., plantations and cultural meadow, thickets and woodlands).

Table 2-13: Summary of Vegetation Communities in the Lynde Creek Watershed

Vegetation Communities	ELC Community Series	ELC Code	Area (hectares)	% of Lynde Creek Watershed
Anthropogenic	N/A	N/A	**9407.3**	70.94
Cultural Communities	Plantation	CUP	312.0	2.3
Cultural Communities	Cultural Meadow	CUM	566.7	4.2
Cultural Communities	Cultural Thicket	CUT	473.5	3.5
Cultural Communities	Cultural Woodland	CUW	256.5	1.9
Cultural Communities	Cultural Hedgerow	CUH	84.9	0.6
-	-	**Subtotal**	**1693.6**	**12.69**
Forest Communities	Coniferous Forest	FOC	161.7	1.2
Forest Communities	Mixed Forest	FOM	362.3	2.7
Forest Communities	Deciduous Forest	FOD	395.0	3.0
-	-	**Subtotal**	**919**	**6.93**
Wetland, Aquatic and Shoreline Communities	Coniferous Swamp	SWC	106.3	0.8
Wetland, Aquatic and Shoreline Communities	Mixed Swamp	SWM	401.4	3.0
Wetland, Aquatic and Shoreline Communities	Deciduous Swamp	SWD	272.6	2.0
Wetland, Aquatic and Shoreline Communities	Thicket Swamp	SWT	298.2	2.2
Wetland, Aquatic and Shoreline Communities	Open Fen	FEO	1.7	<1
Wetland, Aquatic and Shoreline Communities	Shrub Fen	FES	0.2	<1
Wetland, Aquatic and Shoreline Communities	Treed Fen	FET	1.1	<1
Wetland, Aquatic and Shoreline Communities	Meadow Marsh	MAM	107.5	0.8
Wetland, Aquatic and Shoreline Communities	Shallow Marsh	MAS	78.1	0.6
-	-	**Subtotal**	**1267.1**	**9.56**
Open Aquatic Communities	Open Aquatic	OAO	51.7	0.4
Open Aquatic Communities	Mixed Shallow Aquatic	SAM	1.0	<1
Open Aquatic Communities	Submerged Shallow Aquatic	SAS	4.4	<1
-	-	**Subtotal**	**57.1**	**0.43**
Shoreline Communities	Open Beach / Bar	BBO	0.7	<1
	Treed Beach / Bar	BBT	0.5	<1
-	-	**Subtotal**	1.2	0.01
-	-	**Total**	13260.4	100

CLOCA has developed the Lynde Creek Watershed Plan (2012) with the goal of protecting, restoring and enhancing ecological integrity and function of a healthy and resilient watershed in response to future growth and a changing social, economic and physical landscape. CLOCA has developed terrestrial natural heritage targets in line with Environment Canada's framework for restoring natural heritage features (CLOCA, 2012). The following are CLOCA's terrestrial natural heritage targets and current conditions as of 2012:

Table 2-14: CLOCA's Natural Heritage System Targets

Watershed Cover	Minimum Percent (%)Targets	Current % (as of 2012)
Natural Cover (all vegetation)	30%	29.16%
Forest Cover (FOD, FOC, FOM, SWD, SWC, SWM, CUP, CUW)	30%	16.78%
Interior Forest (i.e., core forest area with 100 metres buffer from edge)	10%	1.19%
Deep Interior Forest (i.e., core forest area with 200 metres buffer from edge)	5%	0.23%
Wetland	10%	10%
Riparian Cover	75% of all streams with 30 vegetated buffer	42%

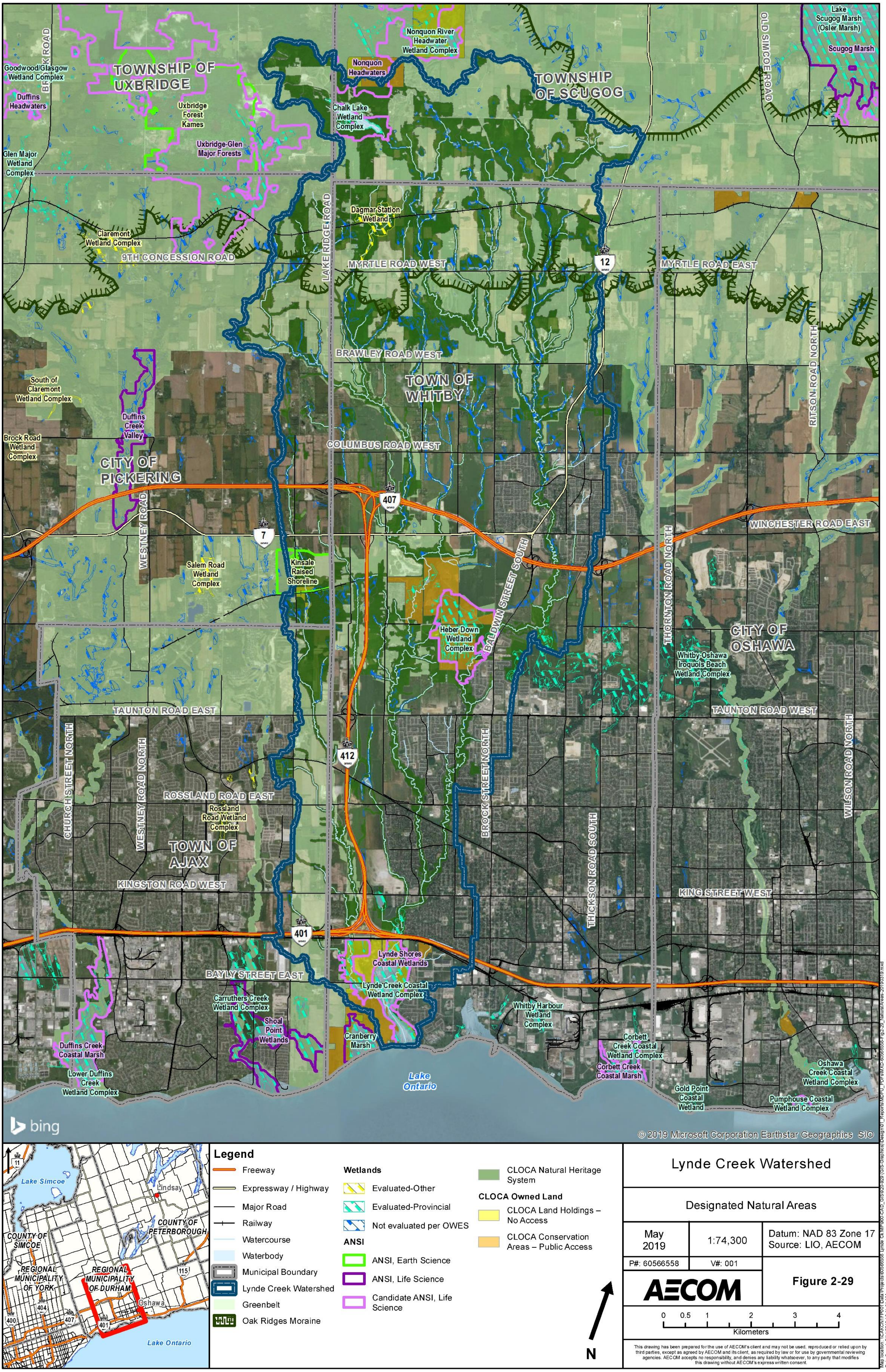
The majority of the natural area cover is concentrated along the glacial Lake Iroquois Beach physiographic region and along watercourses, valley lands, and within conservation areas and designated natural areas including Provincially Significant Wetlands (PSW), Locally Significant Wetland (LSW), Areas of Natural or Scientific Interest (ANSI) and environmentally sensitive areas. Designated natural areas within the Lynde Creek Watershed are summarized in **Table 2-15** and mapped on **Figure 2-29**. The significance status of wetlands and ANSIs are evaluated and identified by the MNRF as either provincially or locally/regionally significant.

Table 2-15: Designated Natural Areas within the Lynde Creek Watershed

Significant Natural Feature	Names	Significance Status
Provincially and Significant Wetlands	Chalk Lake Wetland Complex	Provincially Significant
Provincially and Significant Wetlands	Heber Down Wetland Complex	Provincially Significant
Provincially and Significant Wetlands	Lynde Creek Coastal Wetland Complex	Provincially Significant
Provincially and Significant Wetlands	Whitby-Oshawa Iroquois Beach Wetland Complex	Provincially Significant

Significant Natural Feature	Names	Significance Status
Provincially and Significant Wetlands	Dagmar Station Wetland	Locally Significant
Areas of Natural and Scientific Interest (ANSI)	Chalk Lake Life Science ANSI	Provincially Significant (Candidate)
Areas of Natural and Scientific Interest (ANSI)	Lynde Shores Coastal Wetlands Life Science ANSI	Provincially Significant (Candidate)
Areas of Natural and Scientific Interest (ANSI)	Kinsale Raised Shorelines Earth Science ANSI	Regionally Significant
Areas of Natural and Scientific Interest (ANSI)	Heber Downs Iroquois Beach Life Science ANSI	Provincially Significant (Candidate)
Areas of Natural and Scientific Interest (ANSI)	Nonquon Headwaters Life Science ANSI	Regionally Significant
Areas of Natural and Scientific Interest (ANSI)	Lynde Creek (Whitby Formation) Earth Science ANSI	Regionally Significant
Environmentally Significant Areas	Lynde Shores	Not applicable
Environmentally Significant Areas	Lynde Creek Valley	Not applicable
Environmentally Significant Areas	Lynde Valley-Iroquois Beach	Not applicable
Environmentally Significant Areas	Anderson Street Woods	Not applicable
Environmentally Significant Areas	Upper Lynde Creek to Chalk Lake	Not applicable
Environmentally Significant Areas	Northeast Tributary	Not applicable
Environmentally Significant Areas	Westerly Creek Valleys (Iroquois Beach to Hwy 401)	Not applicable
Environmentally Significant Areas	West Lynde Creek Valley (Till Plain)	Not applicable
Environmentally Significant Areas	South Dagmar Forest	Not applicable
Environmentally Significant Areas	Dagmar Forest	Not applicable
Environmentally Significant Areas	Chalk Lake Woods	Not applicable

All naturally occurring vegetation communities are currently threatened by invasive species such as common buckthorn (*Rhamnus cathartica*), garlic mustard (*Alliaria petiolata*), dog strangling vine (*Vincetoxicum rossicum*), common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), giant hogweed (*Heracleum mantegazzianum*), Russian olive (*Elaeagnus angustifolia*), Autumn olive (*Elaeagnus umbellata*), Asian long-horned beetle (*Anoplophora glabripennis*) and emerald ash borer (*Agrilus planipennis*).



TOWNSHIP OF UXBRIDGE
TOWNSHIP OF SCUGOG
TOWN OF WHITBY
CITY OF PICKERING
CITY OF OSHAWA
TOWN OF AJAX
Lake Ontario
Goodwood/Glasgow Wetland Complex
Duffins Headwaters
Glen Major Wetland Complex
Uxbridge Forest Kames
Uxbridge-Glen Major Forests
Nonquon River Headwater Wetland Complex
Nonquon Headwaters
Chalk Lake Wetland Complex
Lake Scugog Marsh (Osler Marsh)
Scugog Marsh
Dagmar Station Wetland
Claremont Wetland Complex
South of Claremont Wetland Complex
Brock Road Wetland Complex
Duffins Creek Valley
Salem Road Wetland Complex
Kinsale Raised Shoreline
Heber Down Wetland Complex
Whitby-Oshawa Iroquois Beach Wetland Complex
Rossland Road Wetland Complex
Lynde Shores Coastal Wetlands
Lynde Creek Coastal Wetland Complex
Carruthers Creek Coastal Wetland Complex
Shoal Point Wetlands
Cranberry Marsh
Duffins Creek Coastal Marsh
Lower Duffins Creek Wetland Complex
Whitby Harbour Wetland Complex
Corbett Creek Coastal Wetland Complex
Corbett Creek Coastal Marsh
Gold Point Coastal Wetland
Oshawa Creek Coastal Wetland Complex
Pumphouse Coastal Wetland Complex
9TH CONCESSION ROAD
LAKE RIDGE ROAD
MYRTLE ROAD WEST
MYRTLE ROAD EAST
OLD SIMCOE ROAD
BRAWLEY ROAD WEST
COLUMBUS ROAD WEST
RITSON ROAD NORTH
WINCHESTER ROAD EAST
WESTNEY ROAD
BALDWIN STREET SOUTH
THORNTON ROAD NORTH
TAUNTON ROAD EAST
TAUNTON ROAD WEST
CHURCH STREET NORTH
WESTNEY ROAD NORTH
BROCK STREET NORTH
ROSSLAND ROAD EAST
THICKSON ROAD SOUTH
WILSON ROAD NORTH
KINGSTON ROAD WEST
KING STREET WEST
BAYLY STREET EAST
12
407
7
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401
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Lake Simcoe
Lindsay
COUNTY OF PETERBOROUGH
COUNTY OF SIMCOE
REGIONAL MUNICIPALITY OF YORK
REGIONAL MUNICIPALITY OF DURHAM
Oshawa
Lake Ontario
Legend
Freeway
Expressway / Highway
Major Road
Railway
Watercourse
Waterbody
Municipal Boundary
Lynde Creek Watershed
Greenbelt
Oak Ridges Moraine
Wetlands
Evaluated-Other
Evaluated-Provincial
Not evaluated per OWES
ANSI
ANSI, Earth Science
ANSI, Life Science
Candidate ANSI, Life Science
CLOCA Natural Heritage System
CLOCA Owned Land
CLOCA Land Holdings – No Access
CLOCA Conservation Areas – Public Access
N
Lynde Creek Watershed
Designated Natural Areas
May 2019
1:74,300
Datum: NAD 83 Zone 17
Source: LIO, AECOM
P#: 60566558
V#: 001
AECOM
Figure 2-29
0 0.5 1 2 3 4
Kilometers
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2.8.1.2 Wildlife

The Lynde Creek watershed supports various habitats for numerous terrestrial wildlife including birds, amphibians, reptiles, mammals, and invertebrates to complete their critical life stages and processes. Based on the review of available background data, reports and mapping, the following Significant Wildlife Habitats (candidate or confirmed) as identified in the *Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E* (MNRF, 2015) are present within the Lynde Creek Watershed:

- Seasonal Concentration Areas of Animals:
  - Waterfowl Stopover and Staging Areas (Terrestrial)
  - Waterfowl Stopover and Staging Areas (Aquatic)
  - Shorebird Migratory Stopover Area
  - Raptor Wintering Area
  - Bat Maternity Colonies
  - Turtle Wintering Areas
  - Reptile Hibernacula
  - Colonially – Nesting Bird Breeding Habitat (Bank and Cliff)
  - Colonially – Nesting Bird Breeding Habitat (Trees/Shrubs)
  - Migratory Butterfly Stopover Areas
  - Landbird Migratory Stopover Areas
  - Deer Winter Congregation Areas
- Rare vegetation
- Specialized Habitat for Wildlife
  - Waterfowl nesting Aras
  - Bald Eagle and Osprey Nesting, Foraging and Perching Habitat
  - Woodland Raptor Nesting Habitat
  - Turtle Nesting Areas
  - Seeps and Springs
  - Amphibian Breeding Habitat
  - Woodland Area Sensitive Bird Breeding Habitat
- Habitat for Species of Conservation Concern (Not including Endangered or Threatened Species under the ESA):
  - Marsh Bird Breeding Habitat
  - Open Country Bird Breeding Habitat
  - Shrub/Early Successional Bird Breeding Habitat

  - Terrestrial Crayfish
  - Habitat for 73 Species of Conservation Concern (those listed as Special Concern under the ESA and have a provincial S-Rank of S1-S3)
- Animal Movement Corridors

The Lynde Shores Conservation Area and surrounding lands located south of Highway 401 provide important migratory stopover habitat for migratory songbirds, waterfowl and shorebirds, habitat for wintering owls and refuge for deer, as well as amphibian and reptile breeding habitat, and supports habitat for many rare species, including SOCC and SAR (CLOCA, 2008a).

Suitable habitats are also available through the watershed and are connected by vegetation patches that allow for animal movement. CLOCA has developed a Natural Heritage System (NHS), which is an existing connected system comprised of natural heritage features (CLOCA, 2012).The NHS supports the Wildlife Habitat Network (WHN) which consists of wildlife habitats and movement corridors that allow for wildlife to move from one type of habitat to another in order to fulfill their life cycles (e.g., breeding, foraging, nesting and overwintering habitats). CLOCA has identified three movement corridors at different spatial scales, including the regional, landscape and local corridors.

Within the Lynde Creek Watershed, wildlife and their habitats are primarily affected by habitat loss, introduction of invasive species, and barriers to animal movements (e.g., roads) resulting in injury or mortality.

2.8.1.3 Species at Risk

Based on a background review and records received from MNRF and CLOCA, a total of 31 terrestrial SAR listed as Threatened or Endangered under the ESA have been recorded within the Lynde Creek watershed in a variety of natural and anthropogenic habitats. These species, and their habitats, receive protection under the ESA. A comprehensive list of SAR species are provided in **Appendix B10.** Records are concentrated in public natural areas, where observers and natural enthusiasts can record and report sightings, and are particularly lacking from privately owned lands and in the north end of the watershed (CLOCA, 2008a). The Lynde Shore habitat area, which provides important migratory stopover habitats, is most significant to SAR (CLOCA, 2008a); however, other naturally covered areas or anthropogenic areas (e.g., agricultural fields, buildings, bridges, culverts, etc.) also provide suitable habitat for SAR.

2.8.2 Future Development Impact Assessment

Wetlands, woodlands and other vegetation communities, as well as wildlife habitat may be susceptible to future development land use changes that lead to the following as result of vegetation removal and increased impervious surfaces:

- Potential decrease in natural cover and/or ecological integrity of vegetation communities;
- Changes in soil moisture and vegetation community hydrology leading to changes in species composition and community structure;
- Increase in spread and establishment of invasive species throughout watershed;
- Habitat loss and degradation due to loss of natural cover;
- Increased habitat fragmentation and movement barriers resulting in decreased land connectivity; and
- Increased wildlife collisions with vehicles or buildings in injury or mortality.

The West Whitby Secondary Plan and the Brooklin Community Secondary Plan represent the largest future land use change in the Lynde Creek watershed.

The West Whitby Secondary Plan (WWSP) proposes the development and addition of major open space, residential areas and employment area near Highway 412 between north of Highway 401 and south of Lynderbrook Brook. The WWSP area mostly consists of agricultural land uses; however, natural areas are present supporting very high sensitive areas including valleys, woodlands, large woodlands and wetlands wherein development is prohibited due to their significance with respect to environment function. An Environmental Impact Statement (EIS) is required within 50 metres of very high or high sensitivity areas as identified in the WWSP

Similarly, the Brooklin Secondary Plan (BSP) proposes the development of residential areas, commercial areas, industrial areas, business parks and major open space. The *Brooklin Secondary Plan Natural Heritage Assessment Background Report* (Beacon Environmental Ltd. and R.J. Burnside and Associates Ltd., 2014) identifies Level 1 Natural Areas wherein no development should occur, unless granted by permit from the appropriate regulatory agency or demonstrated that there will be no negative ecological impact through an Environmental Impact Study (EIS), where identified and include: significant woodlands, CLOCA’s floodplains, PSWs or other wetlands such as fens, valleylands, fish habitat, watercourses and habitat for SAR (Beacon Environmental Ltd. and R.J. Burnside and Associates Ltd., 2014). The Brooklin Community Secondary Plan Area currently contains one of the two known fen community locations within the Lynde

Creek Watershed. This fen community is located on privately-owned land, northeast of the intersection of Columbus Road and Cochrane Street, and is situated in an agricultural field. This fen is buffered by a thicket swamp along its west side, but lacks a vegetation protection buffer along the east side from agricultural lands and its associated activities. Future development for the Brooklin Community Secondary Plan should consider restoration opportunities in this area to retain and enhance this fen's ecological integrity and function.

As described in **Section 2.8.1.1**, the majority (71%) of the Lynde Creek watershed is dominated by anthropogenic land uses, predominately agriculture, Potential impacts on terrestrial resources from future development proposed in anthropogenic area (e.g., agricultural lands) are anticipated to be relatively minor as vegetation removal will be typically limited to less sensitive vegetation communities and wildlife habitat. However, as noted in **Section 2.8.1.3**, although SAR records may be lacking in privately owned lands due lack of reported observations, it does not mean that SAR are absent from anthropogenic areas. As such, any development proposed in anthropogenic areas should consider the possibility of SAR occurring in their Project Study Area if suitable habitats are present. Common SAR that are known to occur in anthropogenic areas, include but are not limited to the following:

- Barn Swallow (Hirundo rustica);
- Bobolink (Dolichonyx oryzivorus);
- Eastern Meadowlark (Sturnella magna);
- Chimney Swift (Chaetura pelagica);
- Butternut (Juglans cinerea); and
- Bat SAR.

Incorporation of appropriate SAR absence/presence surveys following MNRF's most recent protocols into the Study Design should be considered in order to determine where there are any potential effects on SAR as result of the development and to identify appropriate authorization requirements under the ESA.

The remaining 21% of the Lynde Creek Watershed is naturally vegetated, and consist of more sensitive natural heritage features (e.g., wetlands, woodlands, wildlife habitat, watercourses, fish habitat, etc.) and are more susceptible to the potential effects associated with future development. Of the remaining natural cover, approximately 1580.3 ha (12%) are situated in PSWs, ANSIs or ESAs and lands owned by CLOCA and thus receive some level of protection from the PPS, ORMCP, Greenbelt Plan, municipal official plans and/or CLOCA's natural heritage policies. The remaining 88% of natural cover are more susceptible to future growth and land development pressures.

Vegetation occurring outside of these features in CLOCA's or Municipal NHS, the ORMCP and Greenbelt Plan receive some level of protection through a completion of an Environmental Impact Study (EIS).

An EIS may be required for development proposed within 50 to 120 metres of a natural heritage feature (depending on the feature) in order to demonstrate that there will be no negative impacts on the natural features or their ecological functions as result of the development. The EIS generally documents existing natural heritage features in the study area, assesses impacts on said features, identifies the appropriate mitigation and avoidance measures to minimize impacts, and evaluates the total net impact of the proposed development. The requirements of the EIS (e.g., reporting, required ecological surveys, etc.) need to be confirmed with CLOCA and the appropriate municipality.

Future developments will need to incorporate and maintain vegetation protection zones (i.e., buffers) to certain natural heritage features from development as prescribed by the various planning documents within the Lynde Creek Watershed. The minimum vegetation protection zone around natural heritage features that fall within the boundaries or jurisdiction of each respective planning document are summarized in **Table 2-16**. It should be noted the buffers may be adjusted or developed based on detailed site-specific investigation through completion of an EIS.

Table 2-16: Summary of Vegetation Protection Buffers Based on Current Planning Context

Feature	Oak Ridges Moraine Conservation Act (MMAH, 2017a)	Greenbelt Plan (MMAH, 2017b)	CLOCA's Policy and Procedural Document for Regulation and Plan Review (2014)	Region of Durham Official Plan (2017 Consolidation)	Town of Whitby Official Plan (2018 Consolidation)
Habitat of endangered and threatened species	None	-	To be determined by MNRF	-	To be determined by MNRF
Wetlands	30 m	30 metres	30 metres for PSW and 15 metres for other wetlands	30 metres	30 metres for PSW and 15 metres for other wetlands
Woodlands	-	-	10 metres from drip line	-	10 metres from the dripline
Significant Woodlands	30 m	30 metres	-	30 metres	30 metres
Significant Wildlife habitat	To be determined through EIS	30 metres (assumed)	To be determined through EIS	30 metres (assumed)	To be determined by EIS
ANSIs (Life and Earth Science)	To be determined through EIS	30 metres (assumed)	To be determined through EIS	30 metres (assumed)	-
Watercourse and waterbodies	30 metres	30 metres	30/15 metres	30 metres	30 metres of meander belt
Cold or cool water watercourse	-	-	-	-	30 metres
Warmwater watercourse	-	-	-	-	15
Significant valleyland	30 metres of stable top of bank	30 metres (assumed)	-	30 metres (assumed)	30 metres of stable top of bank
Fish habitat	30 m	30 metres	-	30 metres	30 metres
Seepage areas and springs	30 metres	30 metres	-	30 m	30 m
Sand barrens, savannahs and tallgrass prairie	30 metres	30 metres (assumed)	-	30 metres (assumed)	30 metres

2.8.3 Restoration and Enhancement Opportunities

In addition to future developments and municipal planning assessing and mitigating ecological impacts on or adjacent natural heritage features, consideration should be given to opportunities for restoration and enhancement that are in line with CLOCA's 23 Action Plans in order to maintain or increase the overall ecosystem health of the Lynde Creek Watershed. The following restoration and enhancement opportunities have been identified within the Lynde Creek Watershed to aid in the goal of achieving healthy natural systems amidst a changing landscape and are shown on **Figure 2-30:**

1. **Wetland Enhancement/Creation Opportunities:** Currently, the wetland cover within the Lynde Creek Watershed meets CLOCA's target of 10% as identified in the Action Plan #1 (Natural Heritage System Restoration Plan) and Environment Canada's guidelines for healthy watershed (CLOCA, 2008b). Wetlands (e.g., meadow marshes, shallow aquatic marshes, fens, swamps and Wildlife Restoration Areas swamp thickets) should be foremost retained and protected from future development impact through the use of appropriate vegetation protection buffers (refer to **Table 2-16**).

   In particular, fens should be protected, given their rarity within the Lynde Creek Watershed. There are two locations of fen communities including those fen communities located along the shoreline of Chalk Lake that are part of a provincially protected PSW, and the one open fen community on privately-owned land within the Brooklin Secondary Plan Area. Generally, creation or restoration of fens is not as successful or widely implemented as restoration of marshes and, to a lesser extent, swamps (Environment Canada, 2013). Therefore, the best management strategy for the enhancement of protection of fens is to limit changes in the watershed and to protect its existing water sources (Environment Canada, 2013).

   The fen community and connecting wetlands (i.e., within 750 metres of each other) located on privately-owned lands within the Brooklin Secondary Plan Area should be evaluated using the Ontario Wetland Evaluation System to determine its significance and associated protection status. A restoration opportunity currently exists in the agricultural land pocket located along the east side of the fen community and an existing natural corridor. This agricultural pocket, which is assumed to consist of dryer soil conditions, should be restored and planted with native shrubs on the fringe and native trees in the core with the intent of it succeeding into a woodland in order to provide a vegetation protection buffer to the fen community and increase land connectivity.

Wetland creation or restoration should be considered where removal of low-functioning meadow marshes is necessary for future developments. As noted in the Brooklin Secondary Plan (Beacon Environmental Ltd. and R.J. Burnside and Associates Ltd., 2014), "the creation of larger expanses (e.g., >2 ha) of shallow standing water marsh with deeper pockets would enhance wetland function in the watershed".

2. **Riparian Restoration:** Restoration of a 30 metres riparian buffer along both sides of headwater features and low order streams and shown on **Figure 2-27** will aid in achieving CLOCA's target of 75% riparian cover as identified in Action Plans #1 and #2 (Natural Heritage System Restoration Plan and Riparian Corridors Restoration Plan), as well contribute to the goals set out in Action Plan #5 (Wildlife Corridor Protection and Enhancement Plan) and Action Plan #16 (Invasive Species Management Strategy). Plantings within riparian buffers should include native, overhanging vegetation (e.g., shrubs, trees, grasses, forbs), that are local to the area and appropriate to the existing soil moisture conditions as determined through site-specific investigations, and consistent with CLOCA policies. Site-specific investigations completed for proposed developments as part of an EA or EIS should include a botanical inventory of existing watercourses in order to recommend appropriate plantings within the riparian buffer, as well as identify areas of established invasive plant populations and assess feasibility of implementing invasive plant control programs that can be considered by the municipalities or stakeholders.

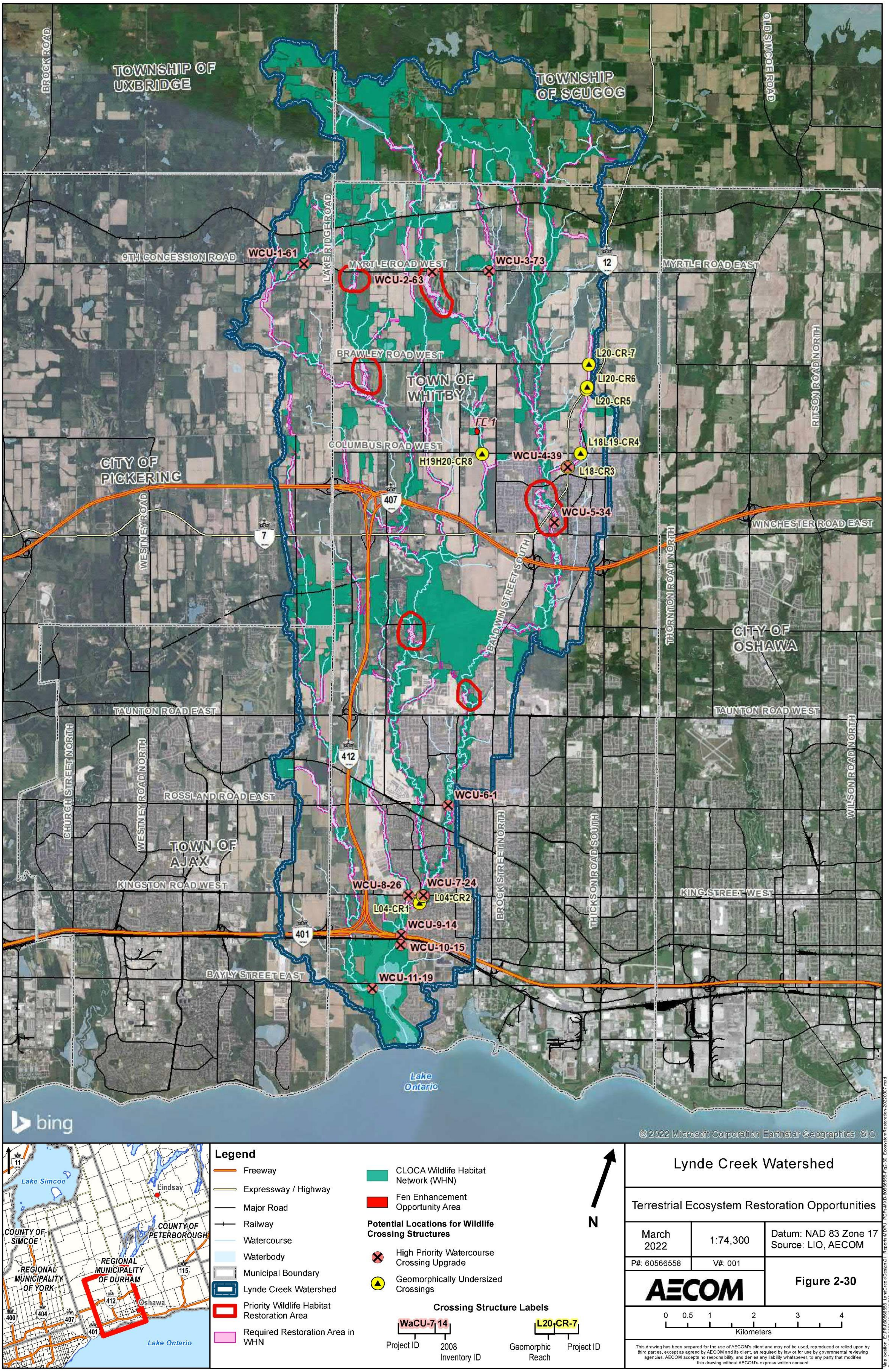
   Restoration of riparian buffers will not only improve water quality and fish habitat but will also increase natural cover as well as land connectivity which will facilitate wildlife movement along local corridors between secondary habitat patches and core habitats.

3. **Wildlife Crossing Opportunities:** Wildlife such as mammals, birds, amphibians and reptiles are susceptible to collision with vehicles as they try to cross roads and railways in an attempt to move in between habitats within the WHN (CLOCA, 2015). CLOCA has evaluated and identified the potential for wildlife passage opportunities at 115 existing road crossing within the WHN as part of their Wildlife Corridor Protection & Enhancement Plan (CLOCA, 2015); of which 38% were deemed to have poor or very poor potential to support wildlife movement. AECOM has identified potential culvert upgrade opportunities wherein design consideration for culvert size, substrate type, openness ration, length,

metal mesh ledges, riparian planting and funneling techniques to encourage wildlife to use culverts to cross roads can be considered. Potential culvert upgrade opportunities are mapped on **Figure 2-30** though it should be noted that additional investigations are required to confirm whether incorporation of wildlife crossing structures are feasible at each identified candidate location. The type of wildlife crossing structure suitable at a specific location is dependent on which species are crossing this area and consultation with CLOCA. The Ontario Ministry of Transportation (MTO)'s Environmental Guide for Wildlife Mitigation (2015) provides advice on the design and implementation of different types of wildlife crossing structures based on a comprehensive literature review and should be referred to when considering incorporation wildlife crossings structures in either existing or future road crossings in consultation with CLOCA.

4. **Wildlife Restoration Areas:** CLOCA has identified six priority restoration areas in the Lynde Creek Watershed in their Wildlife Corridor Protection & Enhancement Plan (CLOCA, 2015) as shown on **Figure 2-30.** In addition, as stated in the West Whitby Secondary Plan, there are several habitat patches/ vegetation communities that are fragmented south of Taunton Road where opportunities exist to expand woodland and riparian habitat. Other linkage opportunities as identified in the Brooklin Community Secondary Plan include restoration of small open space adjacent to a woodland that would provide an east-west linkage between two river valleys located north of Columbus Road and east on either side of Thickson Road North. Restoration/enhancement opportunities within but not limited to CLOCA's priority restoration areas and those areas identified in the West Whitby and Brooklin Community Secondary Plans should be considered during an EIS for any future developments as this would increase the overall land connectivity.

   Restoration/enhancement opportunities should include planting native, local plants that are suitable to the site conditions which would also increase the land cover and be in line with CLOCA's Action Plan #1 (Natural Heritage System Restoration Plan) and Action Plan 16 (Invasive Species Management Strategy).


TOWNSHIP OF UXBRIDGE
TOWNSHIP OF SCUGOG
TOWN OF WHITBY
CITY OF PICKERING
CITY OF OSHAWA
TOWN OF AJAX
BROCK ROAD
OLD SIMCOE ROAD
LAKE RIDGE ROAD
9TH CONCESSION ROAD
MYRTLE ROAD WEST
MYRTLE ROAD EAST
BRAWLEY ROAD WEST
COLUMBUS ROAD WEST
WINCHESTER ROAD EAST
TAUNTON ROAD EAST
TAUNTON ROAD WEST
ROSSLAND ROAD EAST
KINGSTON ROAD WEST
KING STREET WEST
BAYLY STREET EAST
WESTNEY ROAD
WESTNEY ROAD NORTH
CHURCH STREET NORTH
BALDWIN STREET SOUTH
BROCK STREET NORTH
THICKSON ROAD SOUTH
THORNTON ROAD NORTH
RITSON ROAD NORTH
WILSON ROAD NORTH
12
7
407
412
401
WCU-1-61
WCU-2-63
WCU-3-73
WCU-4-39
WCU-5-34
WCU-6-1
WCU-7-24
WCU-8-26
WCU-9-14
WCU-10-15
WCU-11-19
L20-CR-7
LI20-CR6
L20-CR5
L18L19-CR4
L18-CR3
H19H20-CR8
L04-CR1
L04-CR2
FE-1
Lake Ontario
bing
© 2022 Microsoft Corporation Earthstar Geographics SIO
Lake Simcoe
Lindsay
COUNTY OF PETERBOROUGH
COUNTY OF SIMCOE
REGIONAL MUNICIPALITY OF YORK
REGIONAL MUNICIPALITY OF DURHAM
Oshawa
Lake Ontario
Legend
Freeway
Expressway / Highway
Major Road
Railway
Watercourse
Waterbody
Municipal Boundary
Lynde Creek Watershed
Priority Wildlife Habitat Restoration Area
Required Restoration Area in WHN
CLOCA Wildlife Habitat Network (WHN)
Fen Enhancement Opportunity Area
Potential Locations for Wildlife Crossing Structures
High Priority Watercourse Crossing Upgrade
Geomorphically Undersized Crossings
Crossing Structure Labels
WaCU-7 14
Project ID
2008 Inventory ID
L20 CR-7
Geomorphic Reach
Project ID
N
Lynde Creek Watershed
Terrestrial Ecosystem Restoration Opportunities
March 2022
1:74,300
Datum: NAD 83 Zone 17
Source: LIO, AECOM
P#: 60566558
V#: 001
AECOM
Figure 2-30
0 0.5 1 2 3 4
Kilometers
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5. **Salt Management Plan:** Increase in impervious surfaces (e.g., roads, sidewalks, parking lots, etc.) as part of future development and would therefore require municipalities to use more road salt during icy conditions for public safety than compared to existing conditions. Salt-laden runoff damages roadside vegetation and can also attract wildlife to the road by creating artificial salt-licks, which in turn would increase the risk of road mortality. Co-ordinating with municipalities to address negative impacts of salt use is the intent of CLOCA's Action Plan #15 (Salt Management Plan). Salt sensitive areas will be identified by CLOCA and generally should include natural heritage features such as PSWs, LSWs, wetlands, ANSIs, ESAs, woodlands and watercourses. Municipalities and stakeholders are encouraged to prepare Salt Management Plan for future developments that consider using alternatives to traditional road salt (e.g., a salt-free de-icer or sand) and planting native, salt tolerant plants within vegetation protection buffers to affected natural heritage features.

   Best management practices are also promoted for the application of road salt to protect sources of municipal drinking water in Highly Vulnerable Areas and Significant Groundwater Recharge Areas (VS ≥ 6).

3. Hydrologic Assessment

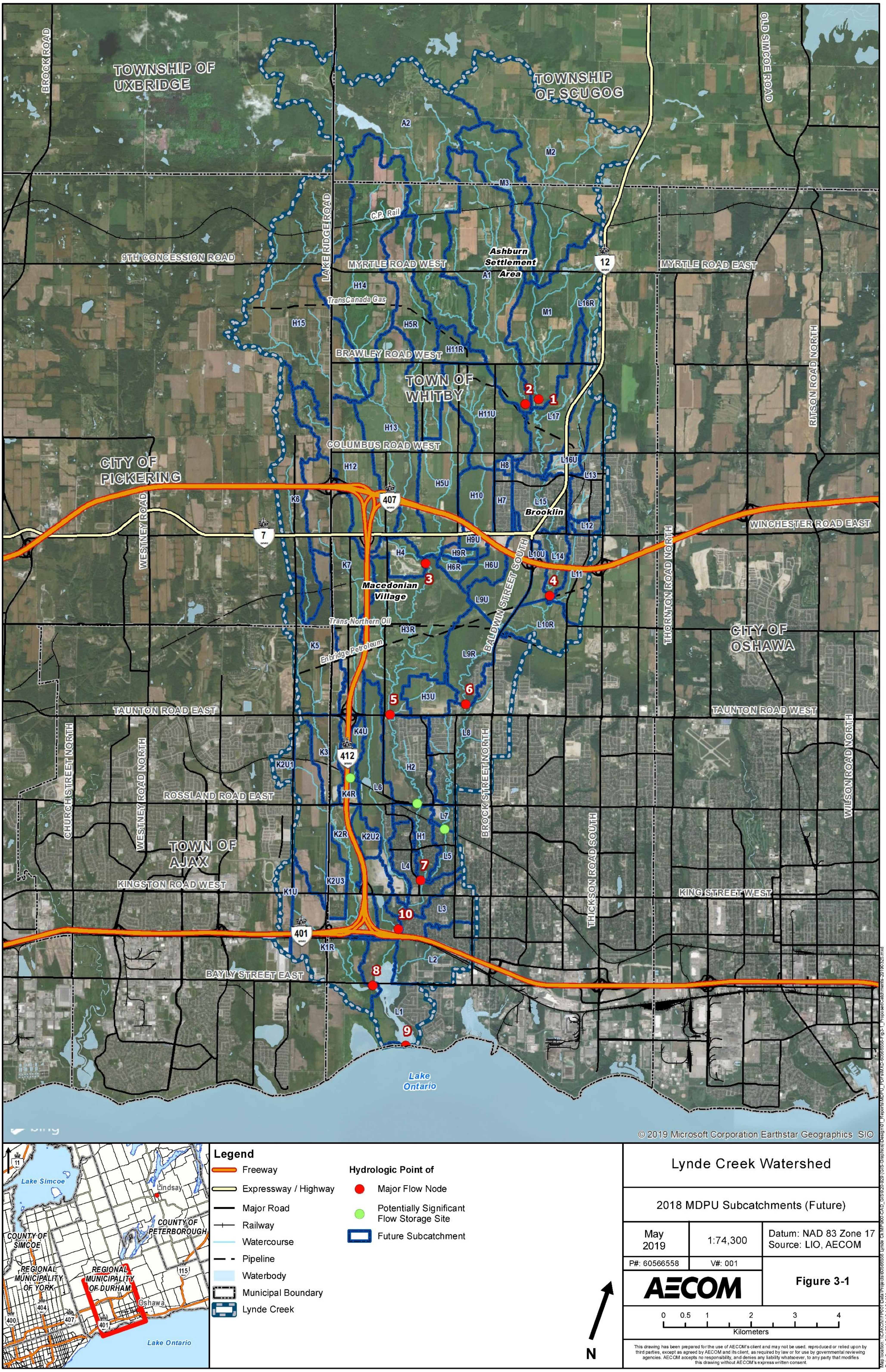
The development of Return Period flow and Regional Storm (Hazel) flow estimates for the Lynde Creek watershed are based on the hydrologic model Visual Otthymo (VO). Return Period Flows have been estimated for the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-yr Return Periods with the 2-yr, 10-yr and 100-yr being summarily reported within the text of the report and full reporting provided in the Appendices

The initial model was provided by CLOCA and reflected an existing land use condition from 2012 as provided in **Figure 2-7**. As previously mentioned, existing land use and hydrologic parameters have been modified in several areas based on input from the Town/CLOCA. These updates are included in **Table 3-1** and detailed in **Appendix C9**.

For future flow estimates, future land use information is required, as provided in **Figure 2-8.** The future conditions (2031 horizon) are based on the Town of Whitby Official Plan (2018 Consolidation), the West Whitby Secondary Plan and the Brooklin Community Secondary Plan (as amended by OPA 108, under appeal).

3.1 Catchment Delineation

The original subcatchment delineation provided by CLOCA was reviewed and no significant revisions were made to the overall catchment layout. Based on future land use, the subcatchments were further sub-divided to reflect homogeneous proposed developed areas and are illustrated in **Figure 2-8** and **Figure 3-1.**


TOWNSHIP OF UXBRIDGE
TOWNSHIP OF SCUGOG
BROCK ROAD
OLD SIMCOE ROAD
LAKE RIDGE ROAD
C.P. Rail
9TH CONCESSION ROAD
MYRTLE ROAD WEST
MYRTLE ROAD EAST
Ashburn Settlement Area
TransCanada Gas
BRAWLEY ROAD WEST
TOWN OF WHITBY
COLUMBUS ROAD WEST
CITY OF PICKERING
RITSON ROAD NORTH
WINCHESTER ROAD EAST
Brooklin
WESTNEY ROAD
Macedonian Village
Trans-Northern Oil
Enbridge Petroleum
BALDWIN STREET SOUTH
THORNTON ROAD NORTH
CITY OF OSHAWA
TAUNTON ROAD EAST
TAUNTON ROAD WEST
ROSSLAND ROAD EAST
CHURCH STREET NORTH
WESTNEY ROAD NORTH
BROCK STREET NORTH
TOWN OF AJAX
KINGSTON ROAD WEST
KING STREET WEST
THICKSON ROAD SOUTH
WILSON ROAD NORTH
BAYLY STREET EAST
Lake Ontario
A1 A2 M1 M2 M3 L16R H14 H15 H5R H11R H11U L17 H13 H12 L16U L13 H8 H5U H10 H7 L15 K6 L12 H9U H9R H4 H6R H6U L10U L14 L11 K7 L9U L10R H3R K5 L9R H3U L8 K4U K3 H2 K2U1 L6 K4R L7 K2R K2U2 H1 L5 L4 K2U3 L3 K1U K1R L2 L1
1 2 3 4 5 6 7 8 9 10
7 12 401 407 412
© 2019 Microsoft Corporation Earthstar Geographics SIO
Lake Simcoe
Lindsay
COUNTY OF PETERBOROUGH
COUNTY OF SIMCOE
REGIONAL MUNICIPALITY OF YORK
REGIONAL MUNICIPALITY OF DURHAM
Oshawa
Lake Ontario
Legend
Freeway
Expressway / Highway
Major Road
Railway
Watercourse
Pipeline
Waterbody
Municipal Boundary
Lynde Creek
Hydrologic Point of
Major Flow Node
Potentially Significant Flow Storage Site
Future Subcatchment
N
Lynde Creek Watershed
2018 MDPU Subcatchments (Future)
May 2019
1:74,300
Datum: NAD 83 Zone 17
Source: LIO, AECOM
P#: 60566558
V#: 001
AECOM
Figure 3-1
0 0.5 1 2 3 4
Kilometers
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3.2 Hydrologic Modelling Parameters

Revisions were made to the VO model so that existing and future land use conditions were appropriately represented by the hydrologic parameters. A consolidated existing conditions VO model was provided by the Town of Whitby, through their consultant KSGS, as outlined in minutes, memos and reports provided in **Appendix C9**. The consolidated model was based on the VO model provided in the *Lynde Creek MDPU - Working DRAFT* (AECOM February 2020) with modifications to: existing SWM Ponds; existing land uses as identified by Candevcon in their work on the Brooklin SP; and Time to Peak (Tp) in one or more catchments. Overall, this required changes in subcatchment delineation as well as choice of runoff module (NashHyd-rural or StandHyd– urban), Tp and impervious ratio. The resulting hydrologic parameters for existing and future conditions were reviewed; considered acceptable and are provided in **Table 3-1.** It is noted that portions of subcatchments L2 and K2 drain to a recently constructed Mattamy SWMP in subcatchment L2. The drainage areas presented in **Table 3-1,** for subcatchments L2 and K2, are totals and do not necessarily reflect the actual values in the VO model of the additional subcatchments apportioned to the Mattamy SWMP. As well, the hydrologic parameters, presented for these two catchments, are a weighted average of the actual values in the additional subcatchments.

The largest changes in %impervious, between existing and future conditions, occur in:

- Heber Down subwatershed subcatchments H3 (47%), H5 (46%), H6 (80%), H9 (71%) and H11 (49%) in response to the Brooklin SP;
- Lynde Main subwatershed subcatchments L9 (72%), L10 (64%) and L16 (43%) in response to the Brooklin SP; and
- Kinsale subwatershed subcatchments K1 (65%), K2 (65%, 70% and 80%) and K4 (74%) in response to the West Whitby SP.

3.3 Selection of Rainfall Distribution (Chicago 12hr) and Rainfall Volumes (IDF Curves)

For the current study, both a Chicago 12hr distribution and a Soil Conservation Service (SCS) 24hr distribution were simulated to determine which distribution produced the highest peak flow for the watershed. These were similar to the distributions used in the *Lynde Creek Watershed Existing Conditions Study (CLOCA 2008)* and the *Hydrologic Modelling for Lynde Creek – Documentation (CLOCA 2010)*. The Chicago distribution was chosen as being the best representative event for peak flow assessment.

Table 3-1: Hydrologic Parameters – Existing (consolidated) and Future

Catchment Name	Existing/Future Condition (see Figure 3-1)	Subwatershed Command	Area (hectare)	Impervious Ratio	Time to Peak (hour)	SCS Curve Number (CN)	Initial Abstraction (Ia - mm)
A1	A1 (Existing)	NashHyd	624.4	-	0.86	77	6
A1	A1 (Future)	NashHyd	624.4	-	0.86	77	6
A2	A2 (Existing)	NashHyd	1103.6	-	0.95	58	7
A2	A2 (Future)	NashHyd	1103.6	-	0.95	58	7
H1	H1 (Existing)	StandHyd	92.6	0.32	-	-	-
H1	H1 (Future)	StandHyd	92.6	0.53			
H10	H10 (Existing)	NashHyd	110.2	-	0.6	81	7
H10	H10 (Future)	StandHyd	110.2	0.52			
H11	H11 (Existing)	NashHyd	351.8	-	1.3	68	6
H11	H11R (Future)	NashHyd	62.2	-	0.2	68	6
H11	H11U (Future)	StandHyd	289.5	0.49			
H12	H12 (Existing)	NashHyd	356.1	-	1.3	70	6
H12	H12 (Future)	NashHyd	356.1	-	1.3	70	6
H13	H13 (Existing)	NashHyd	421.4	-	1.1	67	6
H13	H13 (Future)	NashHyd	421.4	-	1.1	67	6
H14	H14 (Existing)	NashHyd	595.3	-	1.96	66	7
H14	H14 (Future)	NashHyd	595.3	-	1.96	66	7
H15	H15 (Existing)	NashHyd	870.6	-	1	68	6
H15	H15 (Future)	NashHyd	870.6	-	1	68	6
H2	H2 (Existing)	StandHyd	210.9	0.31	-	-	-
H2	H2 (Future)	StandHyd	210.9	0.31			
H3	H3 (Existing)	NashHyd	648.9	-	2	58	6
H3	H3R (Future)	NashHyd	560.7	-	2	58	6
H3	H3U (Future)	StandHyd	88.2	0.47	-	-	-
H4	H4 (Existing)	StandHyd	76.4	0.35	-	-	-
H4	H4 (Future)	StandHyd	76.4	0.21			
H5	H5 (Existing)	NashHyd	637.5	-	0.9	69	6
H5	H5R (Future)	NashHyd	330.3	-	0.5	69	6

Catchment Name	Existing/Future Condition (see Figure 3-1)	Subwatershed Command	Area (hectare)	Impervious Ratio	Time to Peak (hour)	SCS Curve Number (CN)	Initial Abstraction (Ia - mm)
H5	H5U (Future)	StandHyd	307.2	0.46			
H6	H6 (Existing)	NashHyd	108.0	-	0.4	75	7
H6	H6R (Future)	NashHyd	32.8	-	0.6	75	7
H6	H6U (Future)	StandHyd	75.2	0.8			
H7	H7 (Existing)	StandHyd	4.4	0.14	-	-	-
H7	SWMP1	StandHyd	54.0	0.33			
H7	H7 (Future)	StandHyd	4.4	0.14			
H7	SWMP1	StandHyd	54.0	0.33			
H8	H8 (Existing)	StandHyd	12.1	0.45	-	-	-
H8	H8 (Future)	StandHyd	12.1	0.43			
H9	H9 (Existing)	NashHyd	54.4	-	0.5	77	5
H9	H9R (Future)	NashHyd	21.8	-	0.2	75	5
H9	H9U (Future)	StandHyd	32.6	0.71			
K1	K1 (Existing)	NashHyd	359.3	-	1.4	79	6
K1	K1R (Future)	NashHyd	293.2	-	1.4	79	6
K1	K1U (Future)	StandHyd	66.1	.65			
K2	K2 (Existing)	NashHyd	555	-	1.1	81	7
K2	K2R (Future)	NashHyd	406.1	-	1.1	81	7
K2	K2U1 (Future)	StandHyd	33.3	0.65	-	-	-
K2	K2U2 (Future)	StandHyd	42.7	0.77	-	-	-
K2	K2U3 (Future)	StandHyd	72.9	0.8	-	-	-
K3	K3 (Existing)	NashHyd	119.9	-	0.8	78	6
K3	K3 (Future)	NashHyd	119.9	-	0.8	78	6
K4	K4 (Existing)	NashHyd	93.9	-	1.3	70	7
K4	K4R (Future)	NashHyd	64.9	-	1.3	70	7
K4	K4U (Future)	StandHyd	29	0.74			
K5	K5 (Existing)	NashHyd	309.9	-	1.2	62	5
K5	K5 (Future)	NashHyd	309.9	-	1.2	62	5
K6	K6 (Existing)	NashHyd	312.8	-	1.1	67	6
K6	K6 (Future)	NashHyd	312.8	-	1.1	67	6

Catchment Name	Existing/Future Condition (see Figure 3-1)	Subwatershed Command	Area (hectare)	Impervious Ratio	Time to Peak (hour)	SCS Curve Number (CN)	Initial Abstraction (Ia - mm)
K7	K7 (Existing)	NashHyd	446.9	-	0.8	71	6
K7	K7 (Future)	NashHyd	446.9	-	0.8	70	6
L1	L1 (Existing)	NashHyd	227.8	-	1.7	71	3
L1	L1 (Future)	NashHyd	227.8	-	1.7	71	3
L10	L10 (Existing)	NashHyd	183.6	-	0.6	54	4
L10	L10R (Future)	NashHyd	134.9	-	0.6	54	4
L10	L10U (Future)	StandHyd	48.7	0.64			
L11	L11 (Existing)	Standhyd	69.0	0.32			
L11	SWMP2	StandHyd	49.2	0.26			
L11	L11 (Future)	StandHyd	69.0	0.54			
L11	SWMP2	StandHyd	49.2	0.54			
L12	L12 (Existing)	StandHyd	23.3	0.45	-	-	-
L12	L12 (Future)	StandHyd	23.3	0.47			
L13	L13R (Existing)	NashHyd	69.3		0.6	82	3
L13	SWMP3	StandHyd	100.85	0.54			
L13	L13R (Future)	NashHyd	69.3		0.6	82	3
L13	SWMP3	StandHyd	100.85	0.54			
L14	L14 (Existing)	StandHyd	67.0	0.09			
L14	SWMP4	StandHyd	10.5	0.73			
L14	L14 (Future)	StandHyd	67.0	0.09			
L14	SWMP4	StandHyd	10.5	0.73			
L15	L15 (Existing)	StandHyd	165	0.41	-	-	-
L15	L15 (Future)	StandHyd	165	0.41			
L16	L16 R(Existing)	NashHyd	122.3	-	1.5	74	6
L16	L16U(Existing)	StandHyd	47.8	0.28			
L16	L16R (Future)	NashHyd	122.3	-	1.5	74	6
L16	L16U (Future)	StandHyd	47.8	0.28			
L17	L17 (Existing)	NashHyd	192.3	-	0.9	70	6
L17	L17 (Future)	StandHyd	192.3	0.37			
L2	L2 (Existing)	StandHyd	307.1	0.21	-	-	-

Catchment Name	Existing/Future Condition (see Figure 3-1)	Subwatershed Command	Area (hectare)	Impervious Ratio	Time to Peak (hour)	SCS Curve Number (CN)	Initial Abstraction (Ia - mm)
L2	L2 (Future)	StandHyd	307.1	0.21			
L3	L3 (Existing)	StandHyd	139.3	0.40	-	-	-
L3	L3 (Future)	StandHyd	139.3	0.71			
L4	L4 (Existing)	StandHyd	122.7	0.41	-	-	-
L4	L4 (Future)	StandHyd	122.7	0.71			
L5	L5 (Existing)	StandHyd	59.9	0.34	-	-	-
L5	L5 (Future)	StandHyd	59.9	0.53			
L6	L6 (Existing)	StandHyd	230.7	0.46			
L6	L6 (Future)	StandHyd	230.7	0.54			
L7	L7 (Existing)	StandHyd	29.1	0.28	-	-	-
L7	L7 (Future)	StandHyd	29.1	0.45			
L8	L8 (Existing)	StandHyd	421.4	0.32	-	-	-
L8	L8 (Future)	StandHyd	421.4	0.32	-	-	-
L9	L9 (Existing)	NashHyd	349.1	-	1.4	76	4
L9	L9R (Future)	NashHyd	180.4	-	1.4	76	4
L9	L9U (Future)	StandHyd	168.8	0.72			
M1	M1 (Existing)	NashHyd	443.4	-	1.7	69	6
M1	M1 (Future)	NashHyd	443.4	-	1.7	69	6
M2	M2 (Existing)	NashHyd	896.8	-	0.9	63	7
M2	M2 (Future)	NashHyd	896.8	-	0.9	63	7
M3	M3 (Existing)	NashHyd	221.7	-	1.2	61	7
M3	M3 (Future)	NashHyd	221.7	-	1.2	61	7

Rainfall volume data for development of the Intensity-Duration-Frequency (IDF) relationship was provided by the long term record at the Toronto City Station (formerly the Toronto Bloor Street Station). These IDF have been used in the Working Draft report to identify existing flows. The Town has recently proposed to revise its Design Rainfall IDF to include the impacts of climate change. These proposed IDF have been used to determine flows that reflect the impact of climate change and this is discussed further in **Section 3.4.4**

3.4 Hydrologic Model Simulations and Peak Flow Assessment

3.4.1 Existing Conditions

3.4.1.1 Model Validation

Validation of the hydrologic model was not successful and the model overestimates Return Period flows. Until there is further investigation, and the model is calibrated, the results from the current model will continue to be used as they are conservative.

The validation process compared simulated and observed flows for three larger rainfall events in the Lynde Creek Watershed and the results are provided below in **Table 3-2.**

Table 3-2: Flow Comparison at Dundas Street – Observed vs Simulated – Three Rainfall Events

Date	Rainfall Magnitude (mm)	Rainfall Duration (hour)	Flow (m^3/s) – Observed	Flow (m^3/s) – Simulated	Observed Flow – Return Period (YR)	Ratio: Simulated to Observed
3-Jun-06	45	8	10	35	Q<2	3.5
29-Jul-06	100	6	50	200	20<Q<50	4
23-Jun-17	65	9	40	100	10<Q<20	2.5

A discussion of the process and the results are provided below:

Simulated:

- Land Use conditions were confirmed for 2006 and 2017 using relevant aerial photography and there was no significant difference: the AECOM existing conditions hydrologic model (before consolidation) was used in the analysis.
- Summer rainfall event data identified three summer rainfall events that were relatively large in magnitude and small in duration. The events of June 3rd 2006, July 29th 2006 and June 23rd 2017 were 8hr to 45 millimetres; 6hr to 100 millimetres and 9-hr 65 millimetres in duration and magnitude, respectively. The observed rainfall for

the former two events were obtained from CLOCA rainfall gauges at Heber Down and Dundas Street; the latter event was synthesized from radar data correlated to daily rainfall data from the Oshawa WPCP since the CLOCA gauges appeared to be inoperative during the event.

- The observed rainfall hourly event volumes were discretized, in 30 minute intervals, across the watershed using rainfall radar data acquired from the US National Oceanic and Atmospheric Association (NOAA). This accounted for the spatial and temporal distribution of the observed rainfall during the event (see below). Figures illustrating the temporal and spatial distribution of the three rainfall events are provided in **Appendix C1**.
- These events were applied to the existing conditions hydrologic model and peak flows of 35 m^3/s, 200 m^3/s and 100 m^3/s were determined at the Dundas Street WSC Gauge Site (see simulated hydrographs in **Appendix C2**).

Observed:

- Peak flows at the gauge site, for these events, were 10 m^3/s, 50 m^3/s and 40^3 m/s respectively (see observed hydrographs in **Appendix C2**).
- A Single Station Frequency Analysis (SSFA) of maximum annual summer peak flows (for a 57 year period of record -1959 to 2015) at the Water Survey of Canada (WSC) gauge at Dundas Street (02HC018) was developed.
- The SSFA identified the 2yr, 10yr and 20yr Return Period flows as 22 m^3/s, 39 m^3/s and 48 m^3/s, respectively. The supporting data and analysis are provided in **Appendix C3**.

Modelled peak flows were approximately two to four times the magnitude of observed flows. A similar pattern is seen at the two other WSC gauge sites in the watershed: Brooklin and Heber Down.

As well, a review of the simulated and observed hydrographs for any given event suggests a difference in runoff volume, not just the peaks, with simulated volumes significantly larger than observed. The observed Rainfall-Runoff relationship for watershed sub-catchments is, generally, observed to be smaller than simulated and there is possibly a significant interception-infiltration-storage factor unaccounted for in the modelling simulations.

Confidence in these results is supported by the following considerations:

- Review of the HEC-RAS rating curve confirms flow was likely within banks for both larger events (6-hr 100 millimetres and 9-hr 65 millimetres) which suggests the WSC rating curve was accurate at this level;

- The observed rainfall was distributed in time and space to better capture a simulated rainfall distribution for the simulated; and
- Natural storage effects, not accounted for in the model, would not occur for the 03-June-06 event which had less than a 2-YR Return Period.

3.4.2 Existing Conditions - Peak Flows

Applying consolidated existing land use, consolidated hydrologic parameters and Return Period rainfall events to the VO hydrologic model, 100-yr, 10-yr and 2-yr Return Period Flows are provided in **Table 3-3** at various points of interest in the watershed. These are identified as “Existing”: peak flows are attenuated by existing SWM Ponds but were not attenuated by routing through watercourse crossings that are undersized and currently providing potential peak flow reduction. Additional Return Period flows and related hydraulic information may be found in **Appendix D3** which provides detailed summary printouts at all river sections in HEC-RAS for all Return Period flows. A risk management exercise, provided in Section 3.4.4 addresses the impact of additional routing at significant locations

The impact of existing SWM Ponds on peak flow attenuation was determined by introducing existing quantity control SWM Ponds to the hydrologic model with appropriate adjustments to drainage area and land use. A total of four older SWM quantity control ponds were added to the existing hydrologic model plus the recent Mattamy SWMP. Details regarding the older SWM pond locations are provided in **Appendix C4.** Also, a SWMP#11 had been previously identified in the working-draft hydrologic model (L8a) but was removed since it, in fact, drains to Pringle Creek, not Lynde Creek.

3.4.3 Future Conditions

Applying Future Land Use conditions; consolidated hydrologic parameters; and Return Period Rainfall events to the VO hydrologic model, 100-yr, 10-yr and 2-yr Return Period Flows are provided in **Table 3-3** at various points of interest in the watershed. These are identified as “Future”: peak flows are attenuated by routing through existing SWM Ponds but were not attenuated by routing through watercourse crossings that are undersized and currently providing potential peak flow reduction. Future flows with future SWM ponds have not been modelled. It has been assumed that this condition will have peak flow magnitudes very similar to existing condition flows. Additional Return Period flows and related hydraulic information may be found in **Appendix D3** which provides detailed summary printouts at all river sections in HEC-RAS.

3.4.4 Existing Conditions with Climate Change

The Town of Whitby, in response to their declared climate change emergency, has proposed to revise their design standard for rainfall volumes (Intensity-Duration-Frequency (IDF) curves) to include the impacts of climate change. In a study by KSGS, *Climate Change IDF Curve Development (KSGS March 2021)* appropriate CC IDF curves were identified. The proposed IDF curves were based on conclusions from a recent study by the Ontario Climate Consortium (OCC): *Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region (OCC February 2020)*. These proposed IDF curves have been reviewed and are considered acceptable. Additional details are provided in **Appendix C5.**

Applying existing land use conditions; consolidated hydrologic parameters; and Return Period Rainfall events using the proposed CC IDF curves to the VO hydrologic model, 100-yr, 10-yr and 2-yr Return Period Flows are provided in **Table 3-3** at various points of interest in the watershed. Additional Return Period flows and related hydraulic information may be found in **Appendix D3** which provides detailed summary printouts at all river sections in HEC-RAS.

In the Working Draft report (February 2020) of the Lynde Creek MDPU, the impact of climate change on flows was addressed by using CC IDF curves developed by the University of Western Ontario through their IDF-CC-Tool application. It was determined, at that time, that existing riverine flows could increase by ~25% throughout the watershed with the difference ranging between 20% and 30% at major points of interest. In the Final report (January 2022) of the Lynde Creek MDPU, the following sections identify that climate change, as expressed by the proposed Town of Whitby CC IDF curves, could increase existing riverine peak flows by ~30% throughout the watershed with the differences ranging between 10% and 35% at major points of interest. There is not a significant difference between the two approaches.

3.4.5 Existing Conditions with Risk Management (RM)

Three large “flow storage” sites were identified and added to the original unconsolidated hydrologic model, as reservoirs or flow attenuation points, to gain an understanding of the impact of this type of storage on peak flows. It is useful when assessing Flood Risk to have a sense of the impact of such structures on downstream flows. Although not permitted to be considered for floodplain mapping purpose, such structures can be significant and may still be able to function during major flow events. This would add a degree of safety to floodplain risk management assessments and could influence decisions regarding major flood protection works. The chosen sites were at the CNR rail crossings of Kinsale Creek, Heber-Down Creek and Lynde Creek and the locations are illustrated in **Figure 3-1**. The resulting 100-yr, 10-yr and 2-yr Return Period Flows were established using the earlier pre-consolidated existing conditions hydrologic model and the results are summarised in **Appendix C4 – Table 2a), 2b)** and **2c)**.It is important to note that the flows in these tables will differ from those in **Appendix C4 - Table 1**, since **Table 1** uses the newer consolidated hydrologic model.

3.4.6 Future Conditions – Areas Requiring No Quantity Control

In areas where minor land development is proposed outside a Secondary Plan, it may be possible to provide SWM for quality control (including erosion control) only, since the peak runoff from a quantity perspective, could have negligible impact on the receiving watercourse due to the timing of the peak flow from upstream. This was reviewed in the downstream reaches of Lynde, Kinsale and Heber Down Creeks by applying future land use conditions to specific subcatchments of the existing conditions model and identifying any changes in peak flow at points of interest.

The original *Lynde Creek MDP (Senes, 1988)* identified that, at the time and in keeping with future development plans of the time, any development downstream of Taunton Road could proceed without water quantity control. Since then, this study has determined that, for lands downstream of Dundas Street, development would only require SWM control for water quality, including erosion, and that no quantity control for major events would be required. Details of the assessment are provided in **Appendix C6**.

3.4.7 Discussion - Comparison of Peak Flows.

A review of **Table 3-3**, with points of interest presented in **Figure 3-1**, provides the following observations:

- Future flows, <u>without future SWM</u>, would increase over existing flows, due to land use change. The largest increases occur in the minor riverine flow regimes, represented by the 2-yr and 10-yr storms, where flows are estimated to increase by up to 50%. For the major riverine flow regimes, represented by the 100-yr storm, flow increases up to 25% are anticipated. Flow increases are particularly noticeable in the Heber Down tributary and on Lynde Creek downstream of Dundas Street. Details are provided in **Appendix C4 – Table 1**;

  However, these impacts will be mitigated by SWM/LID implementation during land development for the West Whitby SP (9 SWMP sites) and Brooklin SP (40 have SWMP sites + 14 LID On-Site Control Areas) areas: there should be no change in peak flows due to land development. It should be noted that all future SWMPs and LID features are yet to be formally sized and located and that for the BSP, this will be achieved through the application of Sub-Area Studies (SAS) at the time of development.

Table 3-3: Existing and Future Land Use – Peak Flows - by Return Period Rainfall and Regional Storm and Climate Change

Point of Interest[1]	Hydraulic Model - River Station	Hydrologic Model - HYD ID	Location	Existing Flow (m^3/s) 2	Existing Flow (m^3/s) 10	Existing Flow (m^3/s) 100	Existing Flow (m^3/s) REG	Future Flow (m^3/s) 2	Future Flow (m^3/s) 10	Future Flow (m^3/s) 100	Future Flow (m^3/s) REG	Existing – Climate Change Flow (m^3/s) 2	Existing – Climate Change Flow (m^3/s) 10	Existing – Climate Change Flow (m^3/s) 100	Future – Climate Change Flow (m^3/s) 2	Future – Climate Change Flow (m^3/s) 10	Future – Climate Change Flow (m^3/s) 100
1	106	190	Myrtle 1. Upstream Columbus	14.5	22.9	38.1	107	14.5	22.9	38.1	107	16.1	25.8	49.1	16.1	25.8	49.1
2	160	183	Ashburnham 1. Upstream Columbus	10.0	24.1	50.72	129.2	10.0	47.0	87.9	129.2	12.2	30.6	65.4	12.2	30.6	112.3
3	11615	84	Heber 2. Downstream Winchester	13.2	33.9	72.0	235.61	21.8	46.1	91.8	244.2	16.7	43.0	96.2	25.2	56.7	117.2
4	13232	45	Lynde 4. Downstream Brooklin	22.9	53.7	107.3	304.5	26.6	60.3	116.8	310.2	29	66.7	138.3	32.9	73.8	148.4
5	5799	5	Heber 1. at Taunton	14.1	35.2	73.6	255.7	21.8	46.3	89.8	266.8	17.8	44.6	97.3	26	56.4	117.4
6	7698	49	Lynde 4. Upstream Whitby	24.2	57.1	113.2	328.1	29.5	65.4	123.9	334.7	30.8	71.2	145.7	36	79.7	156.5
7	636	13	Lynde 3 .at Dundas	36.9	86.9	181.2	601.2	54.2	114.2	222.4	645.5	47.5	110.0	239.2	64.5	141.1	286.2
8	376	24	Kinsale 1. Downstream Victoria	10.4	25.7	54.9	161.0	13.3	29.4	59.6	163.6	13.03	32.6	72.6	15.9	36.4	77.2
9	240	221	Lynde 1. at Lake Ontario	40.9	99.3	210.2	736.7	60.0	130.1	259.0	819.5	53.5	127.5	280.7	73.0	162.1	336.1
10	3383	59	Lynde 2. at Highway 401	37.9	88.5	183.8	606.0	56.8	118.4	229.5	662.6	48.7	112.1	243.0	67.4	145.9	295.4

*Notes: [1] Point of Interest locations are provided in **Figure 3-1***

The difference between existing and future flows for the Regional Storm (Hurricane Hazel) is not significant over most of the watershed, with only a 2% to 4% increase in flows. In the lower reaches, downstream of Dundas Street, the increase is between 10% and 15%. These increases in flow represent only a minor increase in water level, for most reaches of interest, and can be considered a minimal impact.

- Climate change, as expressed by the proposed Town of Whitby IDF curves, would increase existing riverine peak flows by ~30% throughout the watershed for all Return Period Storms. The differences range between 25% and 35% at eight points of interest that reflect the impact of urban catchments on peak flow i.e. points 3 through 10; while differences in flows in the two strictly rural catchments (Myrtle Creek and Ashburnham Creek) range between 10% and 30%. More detail on Climate Change assessment is provided in **Appendix C5**.

  Climate change impact on minor municipal infrastructure design, such as local and trunk storm sewers is, generally, minimal with no loss in storm sewer capacity. For larger infrastructure such as SWM Ponds and watercourse crossings, flow increase between 25% and 35% should be anticipated. The difference in climate change impact, between minor and major infrastructure, can be attributed to the duration of design storms used and the size of the drainage areas. More detail on Climate Change assessment is provided in **Appendix C5**.

- Other Climate Change studies in Ontario (*Trent-Severn Waterway – Evaluation of Current Approach to Water Management (AECOM 2010)*) conservatively estimate a potential decrease in peak Spring flows and occurrence of Spring flows earlier in the season.
- Climate Change downstream impacts could include:
  - Increased watercourse crossing vulnerability
  - Increased erosion
  - decrease in channel stability
  - Increased size of flood vulnerable areas
  - potentially new flood vulnerable areas.
- Measures to address Climate Change impact could include:
  - Ongoing review of institutional analysis of Climate Change to ensure most recent findings are being used
  - Risk Management Studies to assess implications of assumed Climate Change impact
  - Implementation of measures that account for increase in peak flows such as increased watercourse crossing size and erosion protection.

- An earlier element of this study, using a pre-consolidated hydrologic model, indicated that existing SWM Quantity Control Ponds decrease existing flows by ~1% to ~2%. This suggests that, generally, and in the future, SWM Ponds will not have a significant effect on existing flows in the watershed when lands are developed. The results are provided in **Appendix C4 - Table 2a), 2b)** and **2c)**. Although there is potential that, with peak flow duration increased as a result of SWM Pond attenuation, the timing of downstream peak flows could be more coincidental and a flow regime could develop in which the resulting future downstream peak (with SWM) is larger than existing.
- An earlier element of this study, using a pre-consolidated hydrologic model, indicated that major storage points in the system, from roadway and railway embankments, could reduce peak flows by an additional ~2% over SWM storage impacts. This additional storage could be considered in future Risk Management studies. The results are provided in **Appendix C4.**

Calibration and Validation of the hydrologic model should be undertaken by CLOCA as a precursor to the next MDP Update in 5 to 10 years' time. This study should be accompanied by additional flow, precipitation and groundwater monitoring.

Visual Otthymo (VO) schematics, for the various scenarios, are provided in **Appendix C7** and model input/output data in **Appendix C8**.

4. Hydraulic Assessment

The following sections describe the hydraulic modelling and corresponding results used to identify changes in floodplain extent and to identify locations in the watershed where road crossing infrastructure works could reduce the impact of the existing and future flow regimes.

4.1 Hydraulic Modelling

Hydraulic modelling, using HEC-RAS, was completed for several of the flow scenarios developed in the hydrology component of this study. The model was updated to include new or upgraded/re-surveyed watercourse crossings (number of crossings identified in brackets):

- Highway 412 (7) and Highway 407 (8) from Highway 407 East Extension – Part B – West Durham Link – Design Segments B-1, B-2, B-3 – Civil Plans (JSE 05May15) and Highway 407 East Extension – Part A– 407 Main – Design Segment A-2 – Civil Plans (JSE 05May15). The new/upgraded locations may be found in Figure D-1 in **Appendix D1**;

- Victoria Street (2) from: Region of Durham Construction Drawings which were completed during upgrading of the existing Lynde Creek and Kinsale Creek crossings; and
- Dundas Street (2) from: the Town of Whitby Bridge and Culvert Master Plan (RCI 2020) and from Highway 407 East Extension – Part B – West Durham Link – Design Segment B-1 – Civil Plans (JSE 05May15) which, respectively, re-surveyed the crossing of the Lynde Creek Tributary west of Lynde Creek and upgraded the Kinsale Creek crossing East of Halls Road and West of the WDL/Dundas interchange.

Other Lynde Creek HEC-RAS models have been and are being developed subsequent to the study in hand. These will include updates to the current model based on:

- Increases to rail crossing elevations downstream of Highway 401 in the *Michael Boulevard Flood Mitigation Study (MIG 2020)*.
- Other detailed surveys in the *Town of Whitby Bridge and Culvert Master Plan (RCI 2020)*;
- Floodplain mapping study by CLOCA underway in 2021/2022 to update Lynde Creek floodlines from Lake Ontario to Bonacord Avenue.

Once completed, the CLOCA model will provide the most appropriate HEC-RAS model for relevant reaches.

4.2 Model Simulations and Assessment of Results

The Working Draft (February 2020) of the Lynde Creek MDPU did not have the benefit of the Town’s proposed climate change update to IDF design curves and there was also a change in methodology for identifying watercourse crossing upgrades, after review of the *Bridge/Culvert Master Plan (RCI 2020)*. These factors contributed to a change in those structures identified for upgrades in this Final report when compared to those identified in the Working Draft report. The final recommended upgrades are identified and discussed in the sections below.

4.2.1 Watercourse Crossing Upgrades

A total of 76 crossing structures (bridges/culverts) were identified in the HEC-RAS model that could be considered for infrastructure upgrade works. The upgrades would achieve both design flow and 100-yr water level criteria to reduce to reduce roadway flooding, potential structure loss and risk to life. It was assumed that water levels related to the 100-yr flow would be a sufficient determinant for upgrade prioritization; the Regulatory Flow was not considered.

The flows were developed using the proposed Town of Whitby IDF curves, that include climate change, and using the consolidated existing hydrologic parameters. The assessment process is summarized below and detailed in **Appendix D1**:

- Roadways were classified by type (local, collector, arterial) and characteristic (rural, urban) based on Official Plans for the Township of Scugog, the Towns of Ajax and Whitby, the City of Pickering and the Region of Durham;
- Design Flow Return Period was based on road classification and crossing span (MTO 2008);
- The criteria used to establish acceptable water level (wl) crossings were:
  - MTO Design Flow - freeboard (wl to top road) and clearance (wl to crossing soffit/obvert) criteria for bridges
  - MTO Design Flow - freeboard and flood depth (wl to crossing invert) criteria for culverts;
  - Design Flow - 100-yr road overtop less than 0.3 metres
  - Additional Risk Assessment - 100-yr road overtop greater than 0.3 metres.
- Two evaluations were used to assist in prioritizing crossing upgrades; with priorities ranging between NONE, LOW, MEDIUM and HIGH. Using risk assessment concepts identified in the *Whitby Bridge/Culvert Master Plan (ERI 2020*), one evaluation was the likelihood of failure and the other was the consequence of failure.
  - Likelihood represents the probability that the crossing would fail due to flooding as identified by whether or not the design criteria is achieved. In the assessment, structures were given a PASS or FAIL for each of the three design criteria and a YES or NO for 100-yr flow greater than 0.3 metres over the roadway. Initial upgrade priority for a structure was assigned based on risk of failure as follows:
    - HIGH – All three design flow criteria FAIL; or roadway overtop >0.3 metres for 100-yr
    - MEDIUM - Two design flow criteria FAIL and no roadway overtop >0.3 metres for 100-yr
    - LOW – One design flow criteria FAIL and no roadway overtop >0.3 metres for 100-yr
    - NONE – All three design flow criteria PASS and no roadway overtop for 100-yr
  - Consequence represents the severity of the potential impact of the failure were it to occur, as identified by traffic volume through roadway

classification. For roadways classified as a Collector, the upgrade priority due to risk of failure was reduced by one; for those classified as Local, the upgrade priority due to risk of failure was reduced by two.

Eleven crossing structures were identified as HIGH priority. Two of these are Dundas Street on the lower reaches of Lynde Creek. They are upstream of the CN/GO rail crossings at Highway 401 and their priority is HIGH due to the backwater impacts from the rail crossings, at major flows. If these backwater impacts were significantly reduced by increasing the hydraulic capacity of the crossings at the CN/GO rail lines, the priority of upgrades for the two upstream structures could be reduced or eliminated. Currently, to meet 100-yr water level requirements and assuming there is no increase in the downstream rail line crossing capacity, the Dundas Street bridge of Lynde Creek is acceptable: however, the eastern approach by the roadway would have to be raised in order to eliminate the 100-yr roadway flooding. The other culvert that conveys Lynde Creek Tributary T1 would have to be replaced. Costs have been attributed to any potential upgrades for these two impacted crossings: but additional study is required to more confidently define the upgrade needs in this reach of Lynde Creek.

Ten structures have been identified as MEDIUM priority for upgrading. These are located in **Figure 4-1** and summarized in **Table 4-1.** Another thirty-one structures have LOW priority while twenty-four require no upgrading.

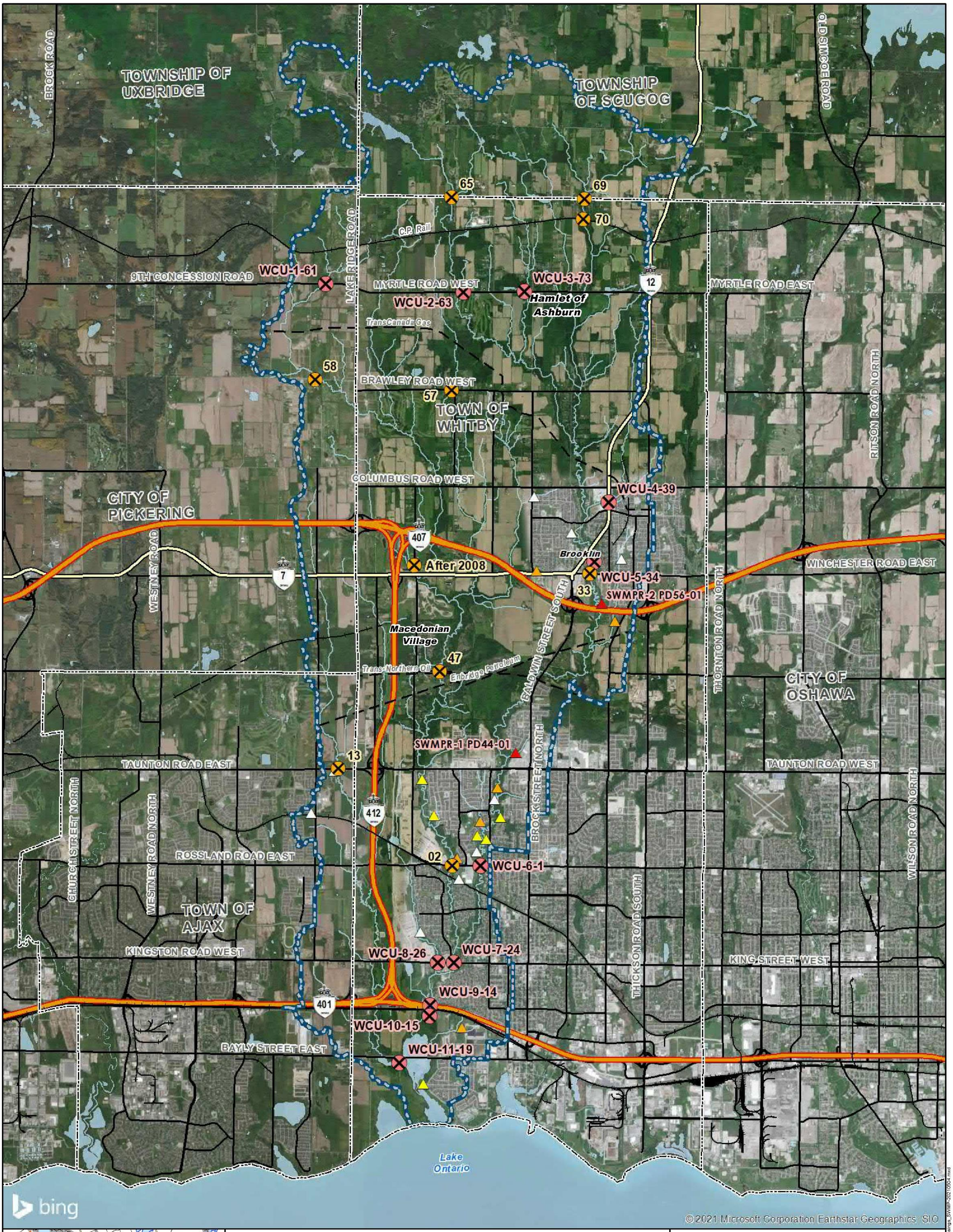
HEC-RAS schematics showing cross-section locations are provided in **Appendix D2** and model output data in **Appendix D3.**

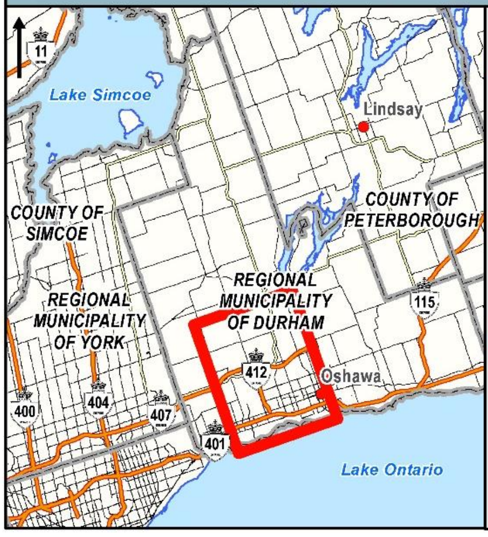
4.2.2 Future Flood Vulnerable Areas

As previously stated, although future peak flows have the potential to increase by ~10% to ~20%%, over existing, this impact will be mitigated by SWM/LID implementation during land development in the West Whitby and Brooklin Secondary Plan area: there should be no change in peak flows due to land development and no change in the size or location of FVAs.

4.2.3 Geomorphology Considerations

Assessment of flow, velocity, shear and stream power were developed using the HEC-RAS model with 100-YR existing flow conditions. This was provided to the Fluvial Geomorphology component of the MDPU for their use in identifying erosion prone reaches within the watershed. A summary of the results for the nine points of interest are found in **Table 4-2.**





Legend

- Freeway
- Expressway / Highway
- Major Road
- Watercourse
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed

Crossing Structure Priority

- High
- Medium

SWMP Retrofit - Priority

- H > 100 ha
- 50 ha < M < 100 ha
- 10 ha < L < 50 ha
- NA

Crossing Structure Labels

WaCU-7 | 14 — Project ID | 2008 Inventory ID

29 — 2008 Inventory ID

SWMP Retrofit Labels

SWMPR-2 | PD56-01 — Project ID | Inventory ID

N

Lynde Creek Watershed

Recommended Lynde Creek MDPU Projects – SWMP Retrofit and Watercourse Crossing Upgrades

October 2021	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 003	

AECOM

Figure 4-1

0 0.5 1 2 3 4
Kilometers

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Table 4-1: Watercourse Crossing Upgrades – Medium and High Priority

River	Reach	River Station C-culvert B-bridge	River Station C-culvert B-bridge	2008 Inventory ID	Project ID #	Design Storm (Return Period - YR)	Clearance Criteria (BRIDGES)	Freeboard Criteria (CULVERTS+ BRIDGES)	Depth Criteria (CULVERTS)	Road Overtop 100-Yr event	100-Yr Overtop Depth >0.3 metres	Potential For Failure (likelihood)	ROAD / RAIL Crossing: Classification 3. (consequence)2	Priority for Improvement	Project Count for High Priority	Project Count for Medium Priority	Location
Myrtle	3	6479	C	69		25	N/A	PASS	FAIL	FAIL	Yes	HIGH	collector	MEDIUM	0	1	Townline Rd
Myrtle	3	5928	C	70		50	N/A	PASS	FAIL	FAIL	No	MEDIUM	RAIL	MEDIUM	0	1	RR crossing
LyndeT3	1	787	C	39	WCU-4	50	N/A	FAIL	FAIL	FAIL	No	HIGH	R-B urban arterial	HIGH	1	0	Baldwin St. N
LyndeT1	1	245	C	26	WCU-8	50	N/A	FAIL	FAIL	FAIL	Yes	HIGH	P-urban arterial	HIGH	1	0	Dundas St. W.
Lynde	5	3670	B	34	WCU-5	50	FAIL	FAIL	N/A	FAIL	No	HIGH	rural arterial	HIGH	1	0	Cassells Rd
Lynde	5	3387	B	33		100	FAIL	FAIL	N/A	PASS	N/A	MEDIUM	R-B urban arterial	MEDIUM	0	1	Winchester Rd. E.
Lynde	4	3642	B	1	WCU-6	50	FAIL	FAIL	N/A	FAIL	No	HIGH	R-rural arterial	HIGH	1	0	Rossland Rd. W
Lynde	3	605	B	24	WCU-7	100	FAIL	FAIL	N/A	FAIL	Yes	HIGH	P-urban arterial	HIGH	1	0	Dundas St
Lynde	2	3262	B	15	WCU-9	100	FAIL	FAIL	N/A	FAIL	Yes	HIGH	RAIL-GO	HIGH[1.]	1	0	RR crossing-GO
Lynde	2	3243	B	14	WCU-10	100	FAIL	PASS	N/A	PASS	N/A	LOW[1.]	RAIL-CN	HIGH[1.]	1	0	RR crossing-CN
Kinsale	4	10686	C	13		50	N/A	FAIL	FAIL	PASS	N/A	MEDIUM	R-A urban arterial	MEDIUM	0	1	Taunton Rd. E.
Kinsale	1	791	B	19	WCU-11	100	FAIL	FAIL	N/A	FAIL	No	HIGH	R-A urban arterial	HIGH	1	0	Victoria St. W,
HeberT4	1	6725	C	61	WCU-1	25	N/A	FAIL	FAIL	FAIL	No	HIGH	Pick-type B arterial	HIGH	1	0	9th Con Rd.,
HeberT4	1	3285	C	58		25	N/A	FAIL	PASS	FAIL	No	MEDIUM	Pick-type B arterial	MEDIUM	0	1	8th Con Rd.
HeberT3	1	344.5	B	after 2008		25	FAIL	FAIL	N/A	FAIL	No	HIGH	collector	MEDIUM	0	1	Coronation Rd
HeberT2	3	6534	C	57		25	N/A	FAIL	FAIL	FAIL	Yes	HIGH	collector	MEDIUM	0	1	Brawley Rd. W.,
Heber	2	9468	B	47		50	FAIL	FAIL	N/A	PASS	N/A	MEDIUM	rural arterial	MEDIUM	0	1	Lyndebrook Rd.
Heber	1	2269	B	2		50	FAIL	FAIL	N/A	PASS	N/A	MEDIUM	rural arterial	MEDIUM	0	1	Rossland Rd W.
AshburnT1	1	1913	C	73	WCU-3	50	N/A	FAIL	PASS	FAIL	No	HIGH	R-B urban arterial	HIGH	1	0	Myrtle Rd. W.
Ashburn	2	9657	C	65		25	N/A	FAIL	FAIL	FAIL	Yes	HIGH	collector	MEDIUM	0	1	Townline Rd.
Ashburn	2	6839	C	63	WCU-2	50	N/A	FAIL	PASS	FAIL	No	HIGH	R-B urban arterial	HIGH	1	0	Myrtle Rd. W.
														TOTAL	**11**	**10**	

Notes: 1 Impacts u/s structures at sections 605 and 245
2 If collector; reduce by one priority; if local, reduce by up to two priorities
3 Road Prefix: R=regional; P=provincial; unless otherwise noted, no prefix=Whitby

Table 4-2: 100-yr Existing Conditions with Climate Change - Flow, Velocity, Shear and Stream Power

Point	River	Reach	River Station	Shear Chan (N/m^2)	Shear LOB (N/m^2)	Shear ROB (N/m^2)	Shear Total (N/m^2)	Power Chan (N/m s)	Power LOB (N/m s)	Power ROB (N/m s)	Power Total (N/m s)	Q Channel (m^3/s)	Q Left (m^3/s)	Q Right (m^3/s)	Q Total (m^3/s)	Vel Chnl EX-CC (m/s)	Vel Chnl EX (m/s)	Change in Vel due to CC	W.S. Elev (m)
1	Myrtle	1	106	402.7	209.8	49.3	236	1041.6	351.3	31.4	448.1	17	32	0	49	2.6	2.4	0%	179.7
2	Ashburnham	1	160	104.8	71.3	112.5	94.4	119.6	62.9	217.8	134.6	7	7	23	37	1.1	1.1	-6%	179.7
3	Heber	2	11615	116.3	12.8	24.3	79.7	378	9.5	27.8	239.4	81	0	4	84	3.3	3.1	-7%	126.4
4	Lynde	4	13232	49.8	31.2	21	26.9	75.4	34	17.9	29.1	58	19	61	138	1.5	1.4	14%	144.3
5	Heber	1	5799	15.7	4.1	10.2	9.6	9.6	1	4.6	4.6	32	5	61	97	0.6	0.7	11%	103.3
6	Lynde	4	7698	20.3	12.4	13.3	14.2	15.3	7.7	7.6	9	43	49	53	146	0.8	0.9	13%	112.1
7	Lynde	3	636	8.5	5	3.9	5.1	6.3	2.2	1.7	2.4	54	152	33	239	0.7	0.8	-20%	82.3
8	Kinsale	1	376	3.1	0.8	2.3	1.3	1.8	0.3	1.1	0.6	11	24	44	79	0.6	0.5	0%	77.3
9	Lynde	1	240	4.2	2.9	2.5	2.7	2.7	1.5	1.2	1.4	34	135	140	309	0.6	0.6	0%	76.6

5. Water Resources Management

5.1 Regulatory Flood Control

There is no requirement, at this time, for attenuation of Regulatory peak flows using SWM. For most of the watershed there is no significant increase in Regulatory Flood peaks due to future land use conditions. A noted potential exception is the Heber Down reach downstream of the BSP developments. While current hydrotechnical assessment suggests there would be no major impact due to development on downstream water levels, analysis should be included in Subcatchment Area Studies (SAS) as development proceeds in the BSP area.

5.2 Stormwater Management Strategy

The stormwater management strategy can be broken into four components:

1. SWM for new development;
2. SWM for existing urban areas;
3. SWM during construction; and
4. Addressing Climate Change.

Elements of the first component are summarised in **Table 5-1** and all components are detailed below; including a summary of CLOCA's latest *Technical Guidelines for Stormwater Management Submissions (2020)* which are also reflected in **Table 5-1**.

Table 5-1: Stormwater Management Criteria for New Development

Element	Criteria
Quantity Control	■ Control of post development flows for the 2 through 100 year storm events to pre-development levels (12 hour Chicago Storm) for lands north of Dundas Street.
Quality Control	■ "Enhanced" level of control based on MOE (2003) Guidelines (80% Total Suspended Solids removal). To address the hierarchy approach identified by CLOCA that includes LID, SWM and MTD measures and their related design requirements
Erosion Control	■ Runoff from a 25 millimetres rainfall event must be captured, retained, or detained from all new and/or fully reconstructed impervious surfaces. The criteria must be first addressed by retaining flows on site through infiltration, evapotranspiration, reuse, bio-retention, etc. Any remaining runoff volume from the 25 millimetres event is to be detained on site and slowly released to the creek or storm sewer over 24 to 48 hours.

Element	Criteria
Erosion Control (continued)	■ Sites greater than 10 ha and with any portion of the site located within a CLOCA Regulation Area, must complete an erosion and sediment control risk assessment in accordance with the Erosion and Sediment Control Guidelines for Urban Construction (2019)
Water Balance (Development Area > 5 ha or located within an identified HVRA or ESGRA)	■ Completion of a hydrogeological and water balance assessment. Mitigation of impacts to infiltration in the form of LID measures to match post-development to pre-development recharge.
Water Balance (Development Area < 5 ha or located within an identified HVRA or ESGRA)	■ Retention, detention or infiltration at as minimum, of the first 5 millimetres of runoff from impervious surfaces.
Quantity Control	■ Control of post development flows for the 2 through 100 year storm events to pre-development levels (12 hour Chicago Storm) for lands north of Dundas Street.

In an effort to mitigate the impacts of **new development** on the hydrologic cycle, MECP has developed an approach to Stormwater Management that requires consideration of a “treatment train” approach. These impacts are shown in **Figure 5-1** below. The MECP Draft LID Guidelines (MOECC 2017) state that SWM must be addressed through the hierarchy (treatment train) of SWM practices starting with source (lot-level) controls followed by conveyance controls and then end-of-pipe SWM facilities.

An additional summary of MECP potential requirements, in the DRAFT LID Guidelines, for source and conveyance controls, that integrate a Water Balance or infiltration component, is provided in the *Pringle Creek MDPU (CANDEVCON 2017)* and is presented and modified as follows:

> *A DRAFT Low Impact Development (LID) Stormwater Management Guidance Manual (MOECC 2017) has been produced to complement the 2003 MOE Guidelines and includes direction and guidance with respect to the requirement for Runoff Volume Control. The key principles of the Draft LID SWM Guidance Manual (MOECC, 2017) are as follows:*
>
> - *Mandatory maintenance of the pre-development water balance;*
> - *Return of precipitation volume to the natural hydrologic pathways of infiltration, evapotranspiration and runoff;*
> - *Application of a consistently derived, geographically specific volume control target across the province of the 90th percentile rain event;*
> - *Limit total runoff volume to 10% (or less) of total rainfall volume; and*
> - *Control 90% of rainfall volume and return it to natural pathways.*

> *MOECC is recommending 90th Percentile Volume Targets for Ontario indicates that Runoff Volume Target for the Lynde Creek watershed will be between 26 millimetres and 27 millimetres*.

The *Low Impact Development Stormwater Management Planning and Design Guide* (CVC and TRCA 2010) should be referred to for LID options and design guidance.

To summarize, the preferred treatment train measures (MOECC 2017), including infiltration, are as follows:

- Source (Lot-Level) Control for LID BMPs:
  - Rainwater Harvesting
  - Green Roofs
  - Roof Downspout Connection
  - Soakaways, Infiltration Trenches and Infiltration Chambers
  - Bioretention
  - Permeable Pavement
  - Perforated Pipe Systems
- Conveyance Control for LID BMPs:
  - Bioretention
  - Bioswales
  - Permeable Pavement
  - Perforated Pipes
- End-of-Pipe Control for LID BMPs:
  - Wet Ponds
  - Constructed Wetlands
  - Hybrid Wet Pond/wetland Systems
  - Dry Ponds
  - Centralized Infiltration Facility

For development in the secondary planning areas of Brooklin, West Whitby and Lynde Shores, relevant documents in support of the Secondary Plan should be used to direct the local SWM Strategy. These documents include the *Brooklin Secondary Plan Phase 3 Report* (Candevcon, 2017) that identifies 40 potential SWM Ponds and 14 LID-Onsite Control Areas and the *West Whitby Secondary Plan Phase 2 Report - Evaluation of Land Use Options and Recommended Plan (Planning Alliance et al. 2010)* that identifies 16 SWM Ponds. These facilities are subject to change based on the results of Suba-Area Studies and the site plan approval process.

For development and re-development in **existing urban areas,** the following SWM approaches are recommended:

- Implementing a roof downspout disconnection program;
- Consistent application of street sweeping, catchbasin sump cleanout and storm sewer flushing. Frequency to be reviewed and updated as necessary;
- Ensure water quality control measures are implemented in all road and/or sewer construction or reconstruction projects;
- Consider LID requirements in cases of re-development; and
- Regular maintenance of existing SWM Facilities and implementation of high and medium priority retrofits for thermal impact mitigation as recommended in *Section 2.7.4 Restoration and Enhancement Opportunities* and identified in **Table 8-2** and **Figure 8-3.**

For **SWM during construction**, the implementation of Erosion and Sediment Control (ESC) measures are required. These are provided in more detail in *Section 13.3 Erosion and Sediment Control Planning (Construction)*. Measures include: sediment traps, dewatering traps; sediment control fencing; check dams; inceptor swales and ditches; temporary stabilization measures of exposed soils (e.g., erosion control matting, seeding, hydro seeding, and mulches); and protecting surface inlets with filter cloth.

In general, to **address climate change** and its impact on infrastructure design, as it relates to drainage, it is recommended that the discussion in **Section 3.4.6 Comparison of Peak Flows** be considered. It was observed that increases in flow of approximately 25% over existing flows occurred when Climate Change was accounted for using Town of Whitby proposed CC IDF curves. Until additional insight and analysis is developed, this conservative assumption could be used for infrastructure design to account for Climate Change.

An update to CLOCA's *Technical Guidelines for Stormwater Management Submissions* was released in 2020. The document is consistent with the above stormwater management strategy and states the following:

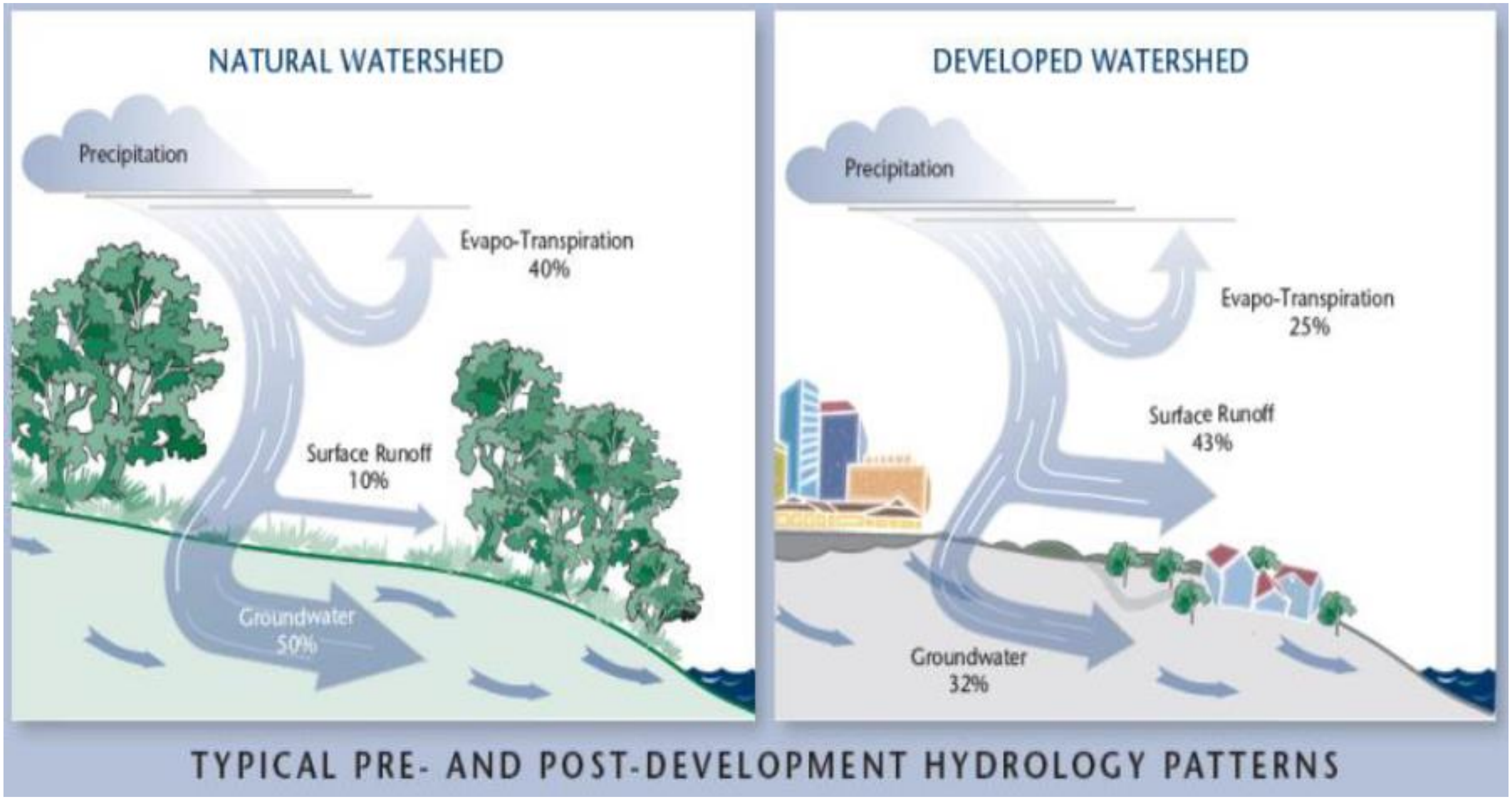
- Stormwater Management requirements must be addressed using a hierarchy of SWM practices or "treatment train" approach that starts with lot level controls, followed by conveyance controls and then end-of-pipe SWM facilities.
- Runoff from a 25 millimetres rainfall event must be captured, retained, or detained from all new and/or fully reconstructed impervious surfaces. The criteria must be first addressed by retaining flows on site through infiltration,

evapotranspiration, reuse, bio-retention, etc. Any remaining runoff volume from the 25 millimetres event is to be detained on site and slowly released to the creek or storm sewer over 24 to 48 hours.

- Quality control should be addressed using a hierarchy of SWM practices prioritized as follows:
  1. Low Impact Development Measures (LIDs)
  2. Stormwater Management Facilities
  3. Manufactured Treatment Devices (MTDs)
- CLOCA will accept OGS devices designed as per manufacturer specifications to achieve 80% Total Suspended Solids (TSS) removal, operating alone, can achieve a TSS removal efficiency of 50%. TSS removal rate calculations must be provided to ensure the 80% TSS removal criteria is met through a treatment train approach.
- Areas identified as High Volume Recharge Areas (HVRAs) and Ecologically Significant Groundwater Recharge Areas (ESGRAs) are important areas which replenish and maintain groundwater aquifers and/or support environmentally sensitive features. A water budget is required as a component of the stormwater management submission for any development sites which contain an area identified as an HVRA or ESGRA. HVRA and ESGRA Mapping is available on CLOCA's online open data portal.
- Sites greater than 10 ha and with any portion of the site located within a CLOCA Regulation Area, must complete an erosion and sediment control risk assessment in accordance with the Erosion and Sediment Control Guidelines for Urban Construction (2019). Enhanced best management practices are required for sites with medium to high risk. General requirements for all erosion and sediment control (ESC) plans are outlined in the guidelines. Specified ESC requirements for LIDs are also provided.
- Design requirements for Low Impact Development Measures include:
  1. Groundwater level monitoring for one year to inform design
  2. In situ infiltration testing at the location of proposed LIDs. A safety factor must be applied.
  3. Monitoring of LIDs during and post-construction

CLOCA may require climate change considerations be incorporated into development applications, such as, sensitivity analyses, risk evaluation, flexible designs, easements, safety factors, freeboard, buffers, monitoring, etc.

Figure 5-1: Hydrologic Cycle – Before and After Land Development – No SWM Strategy



5.3 Water Balance – Infiltration

Water budget targets or groundwater infiltration rates (mm/yr), for the five subwatersheds, have been identified based on the Lynde Creek Existing Conditions Study (CLOCA 2008):

- Lynde Main – 130 mm/yr;
- Heber Down – 154 mm/yr;
- Kinsale – 125 mm/yr;
- Ashburn – 209 mm/y; and
- Myrtle - 210 mm/yr.

For development areas (Brooklin and West Whitby Secondary Plans) water budgets have been identified with the principle of maintaining a pre-development water balance so that precipitation volumes return to the natural hydrologic cycle of runoff, infiltration and evapotranspiration. The onus will be on the developer to provide the necessary water budget analysis which will be reviewed and approved by CLOCA.

Using a simplistic analysis (Class A methods (MOECC 2017)), general infiltration targets have been established within the two Secondary Plan areas and are identified in **Table 5-2**. Details are provided in **Appendix B11**.

Table 5-2: Water Balance for West Whitby SP (WWSP) and Brooklin SP (BSP) – Existing and Future Land Use Conditions

Hydrologic Cycle Component	WWSP Existing (mm/yr)	WWSP Future (mm/yr)	WWSP % Change	BSP Existing (mm/yr)	BSP Future (mm/yr)	BSP % Change
Precipitation	872	872	0%	872	872	0%
Runoff	221	298	35%	316	373	18%
Infiltration	117	89	-24%	104	64	-38%
Evapotranspiration	533	485	-9%	452	435	-4%

It is noted that the more detailed examination of the water budget for the two Secondary Plan areas identifies a lower infiltration rate than at the subwatershed level: 104 millimetres per year vs 130 millimetres per year for the BSP in the Lynde Main subwatershed and 117 millimetres per year vs 125 millimetres per year for the WWSP in the Kinsale subwatershed.

It is also noted that runoff is generally increased by 20% to 35% in these areas with a corresponding reduction in infiltration of between 25% and 40%. Current targets for SWM to achieve on developing lands could initially be set at 117 millimetres per year for the WWSP and 104 millimetres per year for the BSP. This is based on total precipitation, not just the rainfall component.

5.4 Monitoring Strategy Considerations

Traditional master drainage planning has evolved since the 1970s into the comprehensive Master Drainage Planning (MDP)/ Subwatershed Planning now practised (for the purposes of this report, Subwatershed Planning and Master Drainage Planning requirements are assumed the same; Sub-Area Studies (SAS) are requirements of Secondary Plans such as the Brooklin SP). The concerns addressed have increased the complexity and scope of the studies from quantity control for flood and erosion protection, with the addition of many issues such as water quality, aquatic biota and habitat, and geomorphology. Monitoring has been included in the more recent studies as an integral part of implementation. The Subwatershed Planning Report (MOECC, MNRF, 1993) stated the following:

> *A subwatershed plan cannot be considered complete until its monitoring program is established. Monitoring programs should be designed to assess environmental changes in the subwatershed, to evaluate compliance with the plans, goals and objectives, and to provide information which will assist custodians of the plan to implement it and update it. The monitoring program should be presented as part of the subwatershed implementation plan.*

The following principles are proposed as the basis of the monitoring framework:

- Monitoring must be directed at fulfilling one or more objective sets, be subject to analysis and lead to potential actions;
- Monitoring of receiving streams should be for identifying problems, establishing a background reference, and evaluating the effectiveness of controls;
- Technology performance monitoring should be to confirm that the facility operates as designed, if not, determine if remedial design improvements are needed, or if it needs maintenance. This will assist in improving future designs;
- An ideal monitoring program should be directed at connecting receiving stream impact analysis with technology performance assessment in a watershed context;
- The strategy should recognize and incorporate existing monitoring programs; and
- Reporting on results and taking appropriate follow-up action is a key component that fulfils due diligence expectations.

Additional information concerning monitoring plans can be found in **Section 12: Master Drainage Plan Update - Implementation and Monitoring Strategy**.

Part C: Municipal Class Environmental Assessment

6. Planning Studies and Policy Context

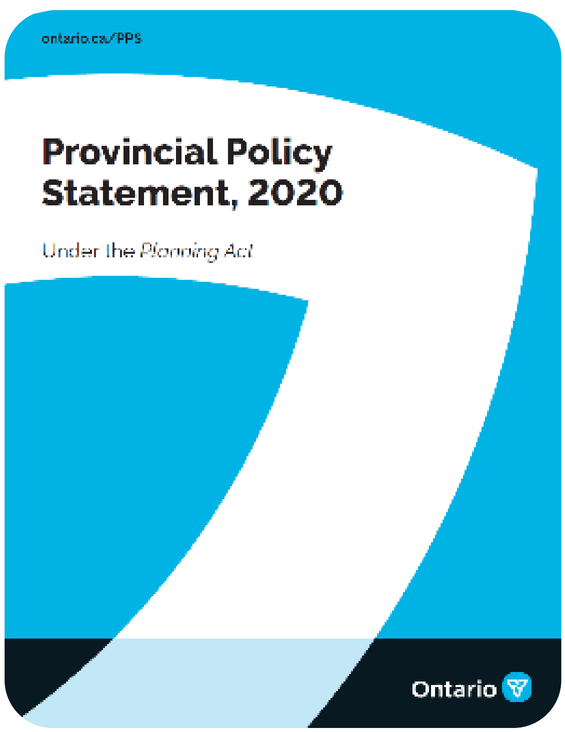
6.1 Planning Studies and Policy Context

Since the release of the original 1988 Lynde Creek MDPU, there have been several changes in regard to planning legislation that has implications for the Lynde Creek watershed. The following provides a high level overview of the current applicable planning studies and policy context which govern the recommended Lynde Creek MDPU.

6.1.1 Provincial Policy Statement (2020)

The 2020 Provincial Policy Statement (PPS) came into effect May 1, 2020. It replaces the Provincial Policy Statement issued April 30, 2014. The PPS provides policy direction on matters related to land use planning and development and applies to any land use planning decisions made under the *Planning Act* by municipal councils, local boards, planning boards, provincial ministers, provincial government and agency officials. Regional and municipal planning decisions are to be consistent with the policies of the PPS.

Figure 6-1: PPS (2020)



The key sections of policies relevant to the MDPU and associated solutions and strategies include the following:

- 1.1 Managing and Directing Land Use to Achieve Efficient and Resilient Development and Land Use Patterns;
- 1.2 Co-ordination;
- 1.6 Infrastructure and Public Service Facilities;
- 2.1 Natural Heritage;
- 2.2 Water;
- 2.6 Cultural Heritage and Archaeology; and
- 3.0 Protecting Public Health and Safety.

Relevance to Study: Pursuant to PPS policy 1.2.1, the MDPU and associated solutions and strategies are consistent with the PPS through the implementation of a co-ordinated, integrated and comprehensive approach to dealing with planning matters, including, among others, managing natural heritage, water, agricultural, mineral, and cultural heritage and archaeological resources.

The long term wise use and management of natural heritage resources, water resources, agricultural resources, mineral resources, and cultural heritage and archaeological resources is a key provincial interest. This is highlighted in Section 2.0 *Wise Use and Management of Resources,* which signifies the long term protection of these resources, including the recognition of linkages between and among natural heritage features and areas, surface water features and groundwater features. The recommended Lynde Creek MDPU considers these linkages.

Pursuant to Section 2.2 (Water), water quality and quantity shall be protected, improved or restored through various means, including, among others, utilizing the watershed as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development. The Lynde Creek MDPU has completed future development impact assessments as part of this Municipal Class EA study.

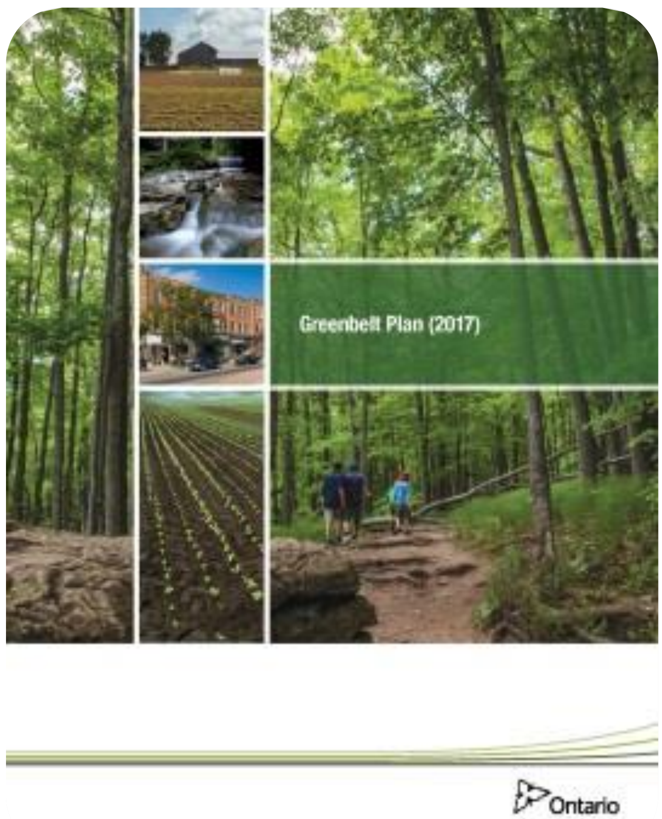
Section 3.0 of the PPS relates to the protection of public health and safety and accordingly provides direction to guide development outside of natural hazard areas (e.g., lands impacted by flooding and/or erosion hazards) in most areas. The MDPU has considered these policies, including not creating new or aggravating existing hazards.

In addition, policy 3.1.3 of the PPS cites the potential impacts of climate change that may increase the risk associated with natural hazards are to be considered. Climate Change is considered as part of the Lynde Creek MDPU.

6.1.2 Greenbelt Plan (2017)

The Greenbelt Plan, 2017 was established and approved under the *Greenbelt Act, 2005*. All decisions regarding planning matters within a specific geographic area must conform with the Greenbelt Plan. The Plan is intended to protect against the loss of agricultural land and provide permanent protection to natural heritage and water resource systems by identifying where urbanization should be limited and other lands protected. It includes lands within, and builds upon the ecological protections provided by the Niagara Escarpment Plan and the Oak Ridges Moraine Conservation Plan (ORMCP).

Figure 6-2: Greenbelt Plan (2017)



Relevance to Study: The Study Area falls within the designated Protected Countryside and Natural Heritage System of the Greenbelt Plan Area. The following key sections of policies associated with the aforementioned areas provide apply to this study:

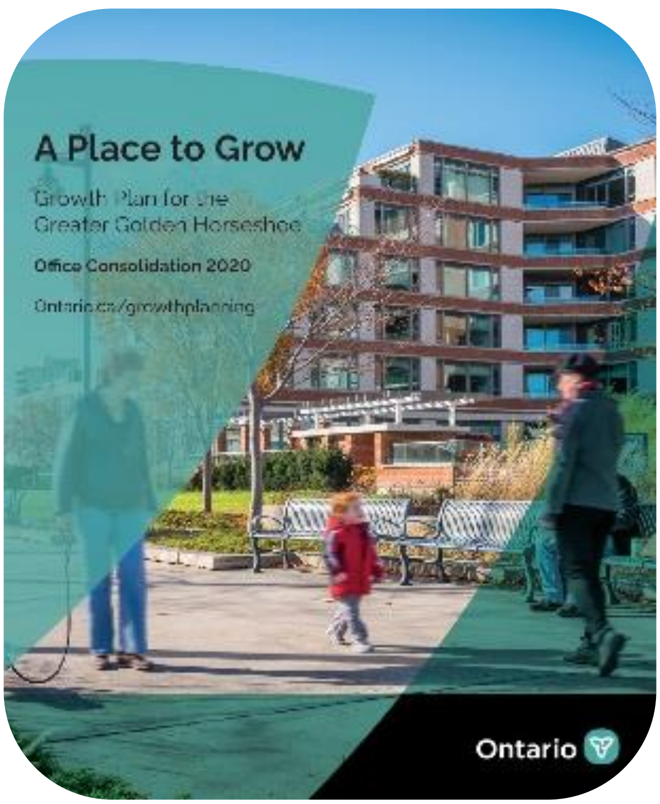
- 2.4 Lands within the Protected Countryside Area;
- 3.2.2 Natural Heritage System Policies;
- 3.2.3 Water Resource System Policies;

- 3.2.4 Key Hydrologic Areas;
- 3.2.5 Key Natural Heritage Features and Key Hydrologic Features Policies; and
- 4.0 General Policies for the Protected Countryside.

6.1.3 A Place to Grow: Growth plan for the Greater Golden Horseshoe (2020)

The Growth Plan for the Greater Golden Horseshoe (2020 Office Consolidation) was established and approved under the *Places to Grow Act, 2005*. All decisions regarding planning matters must conform with the Growth Plan. The Growth Plan's framework supports complete communities, which includes a strong economy, a clean and healthy environment, and social equity. This includes providing direction on watershed-based, integrated water, wastewater, and stormwater master planning.

Figure 6-3: Growth Plan for the GGH (2020)



In addition, the Growth Plan sets out population and employment forecasts for all upper and single tier municipalities in order to better co-ordinate planning and accommodate growth in complete communities within the Greater Golden Horseshoe (GGH). The GGH also contains the Oak Ridges Moraine, the Niagara Escarpment and the other natural areas in the Greenbelt Area.

Relevance to Study: The Growth Plan provides the policy context for the MDPU and associated solutions and strategies. Section 2.2 provides policy direction for where and how to grow within the study area. The study area contains Delineated Built-up Areas, Designated Greenfield Areas, as well as the Greenbelt Area within the GGH Growth Plan Area.

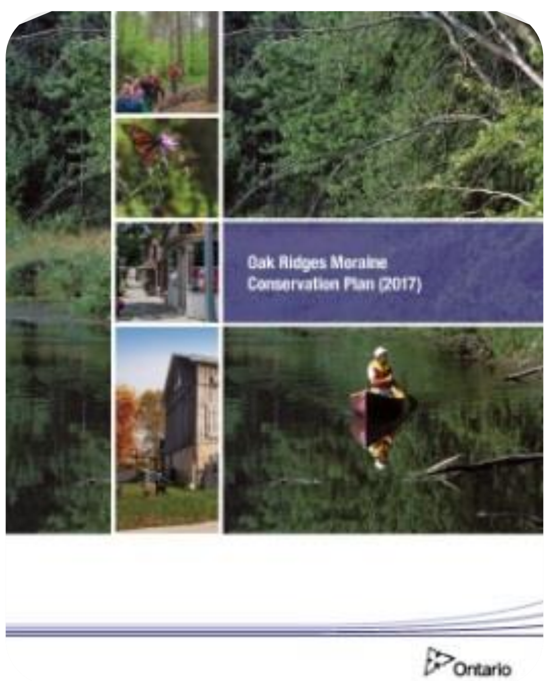
The MDPU supports the vision that characterizes the GGH as a healthy natural environment, in addition to natural areas contributing to the GGH's resilience and ability to adapt to a changing climate.

The Growth Plan also includes set population and employment targets for the Regional Municipality of Durham. Targets from the Growth Plan were included when developing the future land use scenario, and as such, are reflected in the MDPU's future conditions.

6.1.4 Oak Ridges Moraine Conservation Plan (2017)

The Oak Ridges Moraine Conservation Plan (ORMCP, 2017) was established and approved under the *Oak Ridges Moraine Conservation Act, 2001*. All decisions regarding planning matters must conform with the ORMCP. The ORMCP provides land use and resource management planning direction on how to protect the Moraine's ecological and hydrological features and functions. The ORMCP is categorized by the following land use designations: Natural Core Areas, Natural Linkage Areas, Countryside Areas, and Settlement Areas.

Figure 6-4: ORMCP (2017)



The Plan's water resource policies require municipalities to prepare watershed plans, water budgets and water conservation plans to incorporate into their official plans. Development in wellhead protection areas and areas highly vulnerable to groundwater contamination is restricted. Limitations are also set on impervious surfaces in areas outside settlement areas.

Relevance to Study: The north section of the Study Area (just south of Myrtle Road West to northern Study Area limits) is located within the Natural Core Area, Natural Linkage Area, in addition to the Countryside Area that includes the Rural Settlement Area, of the Oak Ridges Moraine Conservation Plan Area. The northern study area limits also captures Category 1 and Category 2 of the Landform Conservation Area. As such, the key sections of the ORMCP associated with the aforementioned areas provide the policy context for the MDPU and associated solutions and strategies:

- Part II Land Use Designations
  - 11. Natural Core Areas
  - 12. Natural Linkage Areas
  - 13. Countryside Areas
- Part III Protecting Ecological and Hydrological Integrity
  - Key Natural Heritage Features
  - Hydrological Features
  - Landform Conservation Areas
- Part IV Specific Land Use Policies

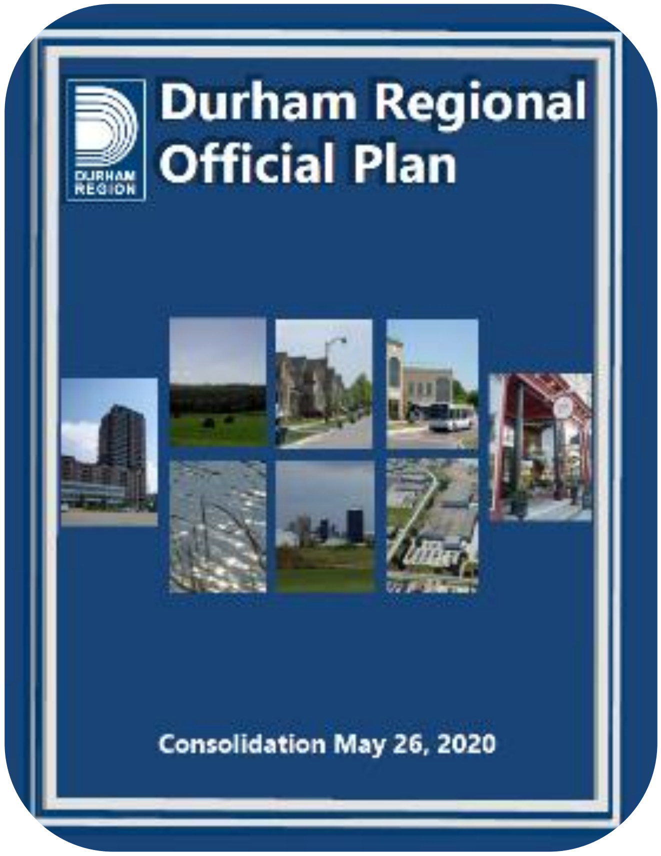
6.1.5 Durham Regional Official Plan

The Regional Municipality of Durham's Official Plan (ROP; May 26, 2020 Consolidation) provides policy directions that establish the future development pattern of the Region to 2031. The Region of Durham is currently completing a comprehensive review of their ROP to establish a planning vision and framework for the Region to 2041.

Relevance to Study: The study area is located within the Regional Municipality of Durham. Schedule 'A' – Map 'A4' (Regional Structure) identifies the Urban, Rural, Greenlands and Transportation systems within the study area.

As per Schedule 'B' – Map 'B1d' (Greenbelt Natural Heritage System and Key Natural Heritage and Hydrologic Features), outside the urban areas, the study area is comprised of Key Natural Heritage and Hydrologic Features, the Greenbelt Natural Heritage System and the ORMCP Area.

Figure 6-5: Durham Regional OP (May 26, 2020 Consolidation)



In addition to the above, the study area contains several major roads. Pursuant to Schedule ‘C’ – Map ‘C1’ and ‘C2’ Road Network, designated existing Freeways include Highway 407, Highway 412, and Highway 401. The main existing Type A Arterials roads in the study area include Victoria Street, Thickson Road, Lake Ridge Road, Taunton Road, Highway 7, and Highway 7-12. There are also several existing Type B and Type C Arterial roads within the study’s urban area, primarily south of Highway 407.

Schedule ‘D’ High Potential Aggregate Resource Areas identifies areas of high potential aggregate resources with the study area, more specifically south of Highway 407, east and west of Highway 412.

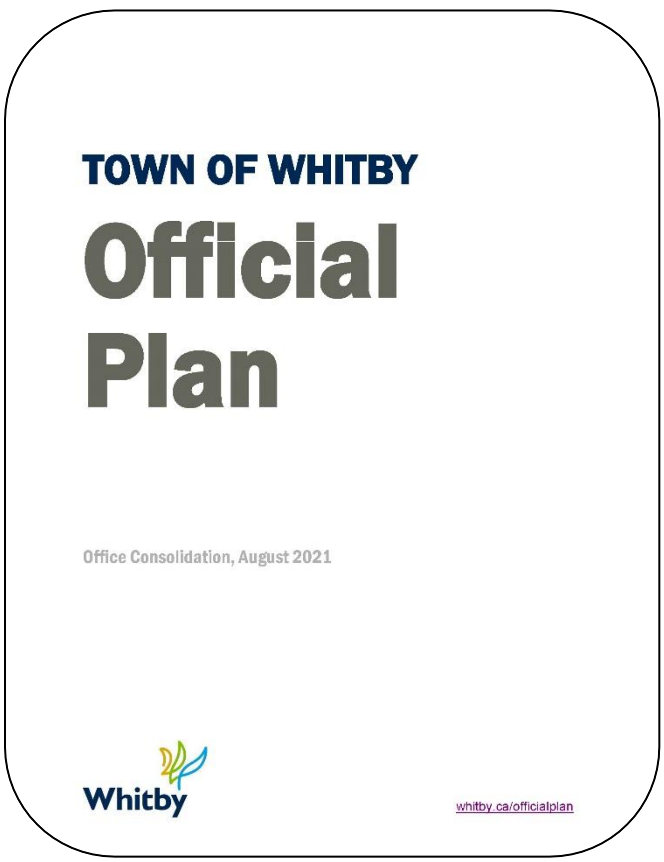
The ROP policies applicable to the above schedules provide the context for the MDPU and associated solutions and strategies. This includes Section 2 (Environment) that provides direction in regard to goals and policies for the Environment, including, among others, the Greenbelt Natural Heritage System and Key Natural Heritage and Hydrological Features.

The ROP also includes intensification policies to implement the Province’s Growth Plan, as per **Section 6.1.3**. The ROP currently reflects the density targets, and policies of the previous Provincial Plans. The Region will review, study and recommend new density and intensification targets through their Municipal Comprehensive Review. Targets from the Growth Plan were included when developing the future land use scenario, and as such, are reflected in the MDPU's future conditions.

6.1.6 Town of Whitby Official Plan

The Whitby Official Plan (OP) was originally adopted by Council in 1994 and approved by the Council of the Regional Municipality of Durham in 1995. The Whitby OP has recently been updated through a municipal comprehensive review (Official Plan Amendment 105, approved on June 15, 2018). The OP (August 2021 Office Consolidation) sets out a framework with a vision, goals, strategic objectives, and policies to guide the physical development of the Municipality and the assessment and management of the social, economic, and environmental effects of growth in the Municipality. The OP policies and designations guide development and redevelopment to the year 2031.

Figure 6-6: Town of Whitby OP (2021 Consolidation)



Relevance to Study: Map 1 (Municipal Structure), consistent with the ROP, identifies the Municipal Structure within the study area, that includes, among others, the Greenbelt Protected Countryside and Oak Ridges Moraine. As per Schedule A (Land Use), there are a variety of land uses in the study area. South of Highway 407, the study area is primarily comprised of Residential, Major Open Space, Prestige Industrial and Mixed Use, among other designations. North of Highway 407, the study area is primarily Agricultural, Major Open Space, Residential and Hamlet, among other designations.

Schedule B (Intensification) identifies the intensification areas and corridors within the Town. The Downtown Brooklin Intensification Area, helped inform the future conditions for this study.

Schedule C (Environmental Management) identifies the Natural Heritage System, Natural Hazards, Greenbelt Natural Heritage System that are located within the study area, as well as the southern boundary of Oak Ridges Moraine and Greenbelt Protected Countryside boundary.

Schedule D (Transportation) classifies the Town's road network, including Freeways, Type A, B and C Arterial Roads, Collector Roads, Local Road and Unopened Road Allowances. The major freeways within the study area are Highway 407, Highway 412, and Highway 401.

Schedule E (Secondary Plans and Community Improvement Areas) identifies the boundaries for the Brooklin Community Secondary Plan Area and West Whitby Community Secondary Plan Areas, both of which represent the largest future land use change in the Lynde Creek watershed.

The OP policies associated with the above noted planning schedules form the context for the MDPU and associated solutions and strategies. The Town's OP was used to inform future land use conditions (2031 horizon). The future conditions (2031 horizon) are based on the Town of Whitby Official Plan (2018 Consolidation), the West Whitby Secondary Plan and the Brooklin Community Secondary Plan (as amended by OPA 108, under appeal).

6.1.7 Other Municipalities

The Lynde Creek watershed boundaries extend beyond the Town of Whitby to the following municipalities:

- City of Pickering;
- Town of Ajax; and

- Township of Scugog; and
- Township of Uxbridge.

Relevance to Study: The OP schedules from each municipality have been reviewed to help inform future land use conditions.

6.1.8 Lynde Creek Watershed Plan (2012)

The Lynde Creek Watershed Plan was completed by CLOCA in 2012 to guide future growth planning decisions for the entire watershed area. The goal of this Watershed Plan is to achieve healthy natural systems within the Lynde Creek Watershed which can positively respond to landscape changes and watershed conditions while sustaining its ecological health and integrity.

Figure 6-7: Lynde Creek Watershed Plan (2012)

The Watershed Management Plan is presented in two parts; Part 1 focuses on the background preparation the Plan and Part 2 identifies the recommended directives for managing the Lynde Creek Watershed. In Part 2, municipal policy recommendations are categorized under three headings: Fundamental, Key and Voluntary. In accordance with the Watershed Plan, the Fundamental policies represent the high level goals and targets. Key policies are more detailed, directly impact the achievement of watershed health targets, and provide direct support for the fundamental policies. Voluntary policies were developed to provide municipalities more specific policy guidance for dealing with detailed planning situations or operating stand.

Twenty three Action Plans were identified to support the Lynde Creek Watershed Plan and encompass a wide watershed focus, including:

- Regulation and policy;
- Wildlife corridor protection and enhancement;
- Data/analytical needs/co-ordination including enhancement on addressing data gaps;
- Protection of High Volume Recharge Areas (HVRA);
- Water monitoring;
- Urban land use Low Impact Development (LID) Retrofits;
- Watershed instream barriers: potential mitigation;
- Ecological compensation;
- Climate change monitoring/adaptive management;
- Stormwater management performance monitoring and maintenance
- HWY 407/412 post construction monitoring and maintenance;
- Flood Damage Centres: potential mitigation; and,
- Natural Heritage System/Riparian Corridors Restoration Plans.

Relevance to Study: Existing conditions for the study area are based on the Lynde Creek Watershed Management Plan. The recommended watershed improvement projects, as listed in **Section 9**, have also been identified considering how they help implement the specific Action Plans.

6.1.9 CTC Source Protection Plan

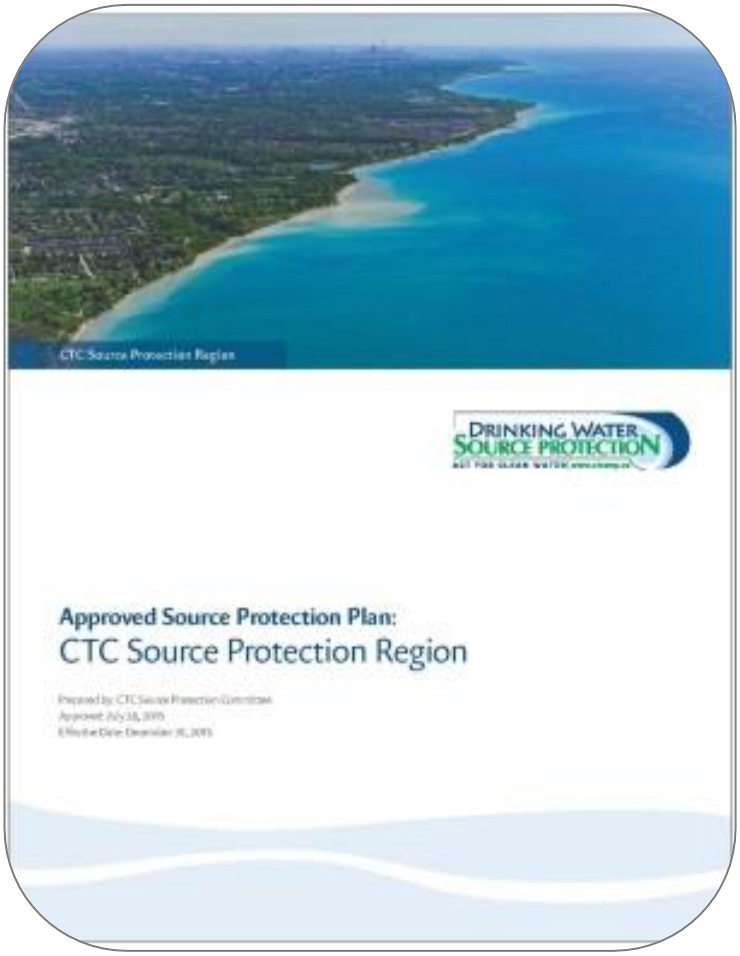
The Source Protection Plan (SPP) for the CTC Source Protection Region came into effect on December 31, 2015 and contains policies to protect vulnerable areas identified under the *Clean Water Act, 2006*. The CTC Source Protection Region encompasses three areas: Credit Valley, Toronto and Region, and Central Lake Ontario. Lynde Creek is located in the Central Lake Ontario Source Protection Area. The applicable SPP is entitled the “Approved Source Protection Plan: Credit Valley-Toronto and Region-Central Lake Ontario Source Protection Region”. The Approved Updated Assessment Report: Central Lake Ontario Source Protection Area, also referred to as the Assessment Report, identifies the location and threats to the municipal drinking water system.

Relevance to Study: The study area transects the following vulnerable areas identified under the *Clean Water Act, 2006*:

- Wellhead Protection Area – Quantity (WHPA-Q);
- Intake Protection Zone (IPZ);
- Event Based Area (EBA);

- Significant Groundwater Recharge Area (SGRA); and
- Highly Vulnerable Aquifers (HVA).

Figure 6-8: CTC Source Protection Plan



HVAs and SGRAs are delineated in **Figure 2-21** and **Figure 2-24**, respectively. Correspondence in **Appendix F2** further identifies the above identified vulnerable areas that transect the study area, including the corresponding policies. Policies that apply in each of the vulnerable areas are summarized as follows:

- WHPA-Q: DEM and REC policies apply and include those directed at activities that take water from an aquifer without returning it (DEM policies), and reduce recharge to an aquifer (REC policies);
- EBAs: Lake Ontario (LO) policies apply in EBAs; and

- SGRAs and HVAs: SAL 10-12 (application of road salt), DNAP-3 (handling and storage of dense non-aqueous phase liquids), and OS-3 (handling and storage of organic solvents) policies apply.

There are no policies that apply in intake protection zones; however drinking water source protection should be considered in planning.

7. Phase 1: Problem/Opportunity Statement

Phase 1 of the Municipal Class EA process requires the proponent of an undertaking (i.e., the Town/CLOCA), to first document factors leading to the conclusion that the improvement is needed, and to develop a clear statement of the identified problems or opportunities to be addressed. As such, the Problem/Opportunity Statement is the main starting point in the undertaking of a Municipal Class EA and therefore, becomes the central theme and integrating element of the project and helps to provide a scope for the study.

The Problem/Opportunity Statement for the Lynde Creek MDPU (2021) is as follows:

Problem:

- The Lynde Creek Watershed has experienced and will continue to experience pressures from urban and rural uses. These pressures impact the watershed's form and function, including but not limited to: flood potential, erosion potential and natural heritage/ecosystem health.
- Effective management strategies are needed to protect and restore the Lynde Creek Watershed.

Opportunity:

- Completion of a MDPU provides an opportunity to build on watershed management planning work completed to date and develop a long term road map for watershed improvement initiatives that can guide current land use and future growth.
- Completion of the MDPU will identify a suite of watershed improvement projects that can support future funding applications and be implemented in accordance with approved capital works budget.

8. Phase 2: Alternative Solutions

The purpose of the original Lynde Creek MDP (1988) was to *ensure stormwater drainage systems are developed in a manner compatible with the watershed needs*; and was focused on the watershed downstream of Taunton Road*.* The 1988 MDP recommended measures for flood control, flood hazard reduction upstream of Highway 401, stream erosion mitigation, and erosion and sediment control (ESC) during construction. In addition, the 1988 MDP included an inventory/assessment of watercourse crossings, costs for the various measures and cost sharing. The 1988 MDP did not provide an implementation schedule.

The Lynde Creek MDPU (2021) is comparatively more comprehensive and addresses an expanded suite of watershed needs. This MDPU updates the findings of the 1988 MDP using current hydrologic and hydraulic modelling, hydrogeologic, geotechnical, geomorphologic and natural heritage (aquatic/terrestrial) inventories, as well as current land use policies. Climate change influences are also considered.

With regard to the selection of a preferred MDPU and its Implementation Plan, a management strategy that identifies the MDPU goals and objectives has been developed and is presented in **Table 8-1**. The preferred MDPU is based on a prioritization of the various objectives and projects that have been identified for implementation so that the goals and objectives may be achieved. It is recognized that priorities will change with time, as will the MDPU.

The Lynde Creek MDPU identifies a more extensive set of concerns regarding land development and its impact on surface water, groundwater and natural heritage as well as various measures for mitigating runoff impacts and improving surface water, groundwater and Natural Heritage features. The Lynde Creek MDPU includes assessments of Natural Heritage (aquatic and terrestrial), geomorphology, hydrogeology (recharge-discharge-water balance) and watercourse crossing capacity. The MDP also continues to address flood hazard and streambank erosion issues in the watershed.

The physical measures have been identified in the previous sections and are summarized in **Table 8-2**, as well as being presented in **Figures 8-1 to 8-4**. Measures, among others, include:

- Low Impact Development (LID) techniques that provide for more “lot-level” drainage control using groundwater infiltration methods; and
- Current Best Management Practices (BMPs) for Lot-Level, Conveyance and End-of-Pipe runoff control (SWM Ponds) which form the sequential components of a treatment train approach to mitigating runoff impacts from development.

Table 8-1: Lynde Creek MDPU - Goals and Objectives

Area of Concern	Goal[1]	Objective[2]	Strategy[3] - Priority	Strategy[3] - Who	Strategy – Cost [4]
Flood Hazard	Protect life	floodplain delineation	medium	CLOCA	medium
Flood Hazard	Protect life	watercourse crossing upgrade - improve capacity	medium	Whitby	high
Flood Hazard	Protect life	Floodproofing/berming	high	Whitby/ CLOCA	high
Flood Hazard	Protect life	Planning/Zoning-Control Land Development	high	Whitby/ CLOCA	low
Flood Hazard	Protect life	Land Development - flow reduction through SWM BMP; LID [4.]	high	Whitby/ CLOCA	low
Flood Hazard	Protect property/buildings	floodplain delineation	medium	CLOCA	medium
Flood Hazard	Protect property/buildings	watercourse crossing upgrade - improve capacity	medium	Whitby	high
Flood Hazard	Protect property/buildings	Floodproofing/berming	low	Whitby/ CLOCA	high
Flood Hazard	Protect property/buildings	Planning/Zoning-Control Land Development	high	Whitby	low
Flood Hazard	Protect property/buildings	Land Development - flow reduction through SWM BMP; LID	high	Whitby/ CLOCA	low
Flood Hazard	Protect infrastructure-utilities/crossings	Bank stabilization	high	Whitby/ CLOCA	medium
Flood Hazard	Protect infrastructure-utilities/crossings	Meander belt identification	medium	CLOCA	medium
Flood Hazard	Protect infrastructure-utilities/crossings	Land Development - flow reduction through SWM BMP; LID	high	Whitby/ CLOCA	low
Streams and Related Habitat	Riparian aquatic restoration	Fish barrier removal	medium	CLOCA	low
Streams and Related Habitat	Riparian aquatic restoration	Riparian restoration	medium	CLOCA	medium
Streams and Related Habitat	Riparian aquatic restoration	Thermal regulation-stream cover	medium	CLOCA	medium
Streams and Related Habitat	Riparian terrestrial restoration	Thermal regulation-stream cover	medium	CLOCA	medium
Streams and Related Habitat	Riparian terrestrial restoration	Riparian restoration	medium	CLOCA	high
Streams and Related Habitat	Riparian terrestrial restoration	Wildlife crossing	medium	CLOCA	medium
Streams and Related Habitat	Riparian terrestrial restoration	Bank stabilization	medium	CLOCA	high

Area of Concern	Goal[1]	Objective[2]	Strategy[3] - Priority	Strategy[3] - Who	Strategy – Cost [4]
Streams and Related Habitat	Minimize erosion impacts	Bank stabilization	medium	Whitby/ CLOCA	high
Streams and Related Habitat	Minimize erosion impacts	Meander belt identification	medium	CLOCA	low
Streams and Related Habitat	Improve water quality	SWM Pond retrofits	high	Whitby	medium
Streams and Related Habitat	Improve water quality	Salt Management Plan	medium	Whitby	low
Streams and Related Habitat	Improve water quality	Land Development - water quality improvement through SWM BMP; LID	high	Whitby/ CLOCA	low
Significant Natural Heritage	Identify and Protect Wetlands	Planning/Zoning-Control Land Development	high	Whitby	low
Significant Natural Heritage	Identify and Protect Wetlands	Mapping/Inventory	high	CLOCA	medium
Significant Natural Heritage	Identify and Protect Species at Risk	Planning/Zoning-Control Land Development	high	Whitby	low
Significant Natural Heritage	Identify and Protect Species at Risk	Mapping/Inventory	high	CLOCA	medium
Significant Natural Heritage	Identify and Protect Woodlands	Planning/Zoning-Control Land Development	high	Whitby	low
Significant Natural Heritage	Identify and Protect Woodlands	Mapping/Inventory	high	CLOCA	medium
Groundwater Recharge/Discharge	Identify and Protect Recharge/Discharge Areas	Planning/Zoning-Control Land Development	high	Whitby	low
Groundwater Recharge/Discharge	Identify and Protect Recharge/Discharge Areas	Land Development -water balance improvement through SWM BMP; LID	high	Whitby/ CLOCA	low
Groundwater Recharge/Discharge	Identify and Protect Recharge/Discharge Areas	Mapping/Inventory	high	CLOCA	medium

Notes: 1. The overall goal of the MDP is to mitigate the impact of land development on the defined watercourse system and maintain, restore or enhance the adjacent natural environment. Four areas of concern are identified.
2. Objectives identify actionable items that can be implemented to achieve the stated goals. In achieving most objectives, additional study, the development of guidelines and provision of a monitoring program would be required
3. Strategy is the approach to achieve each objective requires strategic planning to prioritize objectives and is based on assessments of risk to life and risk to the natural environment. It is typically achieved by the responsible agency through evaluation of risks and associated cost. Direct Costs to Implement: Planning, Design, Construction (low<$500K; $500k<medium<$5M; high>$5M)
4. Typically SWMP costs are not borne by government - however O+M costs are.

Table 8-2: Recommended Lynde Creek MDPU Projects (Cost Year - 2020)

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Riparian Restoration	RR-1	Riparian Restoration and Bank Stabilization	■ Vegetation Planting/ Management/ Bank Stabilization	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse ■ ~110 metres length of riparian area	CLOCA	Helps achieve Action Plan #1,#2, #5, and #16	North of Bayberry Court 663797 4870511 to 663847 4870595 **Figure 8-1**	<$100	■ 1st order stream ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-2	Riparian Restoration and Bank Stabilization	■ Vegetation Planting/ Management/ Bank Stabilization	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse ■ ~120 metres length of riparian area	CLOCA	Helps achieve Action Plan #1,#2, and #5	South of Columbus Road, East of Camber Court 663423 4870374 to 663485 4870549 **Figure 8-1**	<$100	■ 1st order stream ■ Assess for bank stabilization opportunity ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-3	Riparian Restoration and Bank Stabilization	■ Vegetation Planting/ Management/ Bank Stabilization	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse ■ ~315 metres length of riparian area	CLOCA	Helps achieve Action Plan #1,#2, and #5	South of Columbus Road, west of Ashburn Road 661967 4869753 to 661778 4870024 **Figure 8-1**	<$100	■ 1st order stream ■ Agricultural field, likely private land within Brooklin Community Secondary Plan area. Aquatic species at risk present ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-4	Riparian Restoration and Bank Stabilization	■ Vegetation Planting/ Management/ Bank Stabilization	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse ■ ~195 metres length of riparian area	CLOCA	Helps achieve Action Plan #1, #2 and #5	South of Columbus Road, west of Ashburn Road 661975 4869753 to 662126 4869874 **Figure 8-1**	<$100	■ 2nd order stream ■ Agricultural field, likely private land ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-5	Riparian Restoration and Bank Stabilization	■ Vegetation Planting/ Management/ Bank Stabilization	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse ■ ~120 metres length of riparian area	CLOCA	Helps achieve Action Plan #1, #2 and #5	West of Ann Arbour Court 663520 4859431 to 663459 4859534 **Figure 8-1**	<$100	■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-6	Riparian Restoration and Bank Stabilization	■ Vegetation Planting/ Management/ Bank Stabilization	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse ■ ~195 metres length of riparian area	CLOCA	Helps achieve Action Plan #1, #2 and #5	West of Lockridge Street 663549 4862652 to 663556 4862747 **Figure 8-1**	<$100	■ Assess for bank stabilization opportunity. Potentially multiple restoration areas within location	A

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Riparian Restoration	RR-7	Riparian Restoration and Thermal Regulation	■ Riparian cover to maintain thermal requirements- Brook Trout	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of Brook Trout habitat where there is currently no canopy cover (~70 metres).	CLOCA	Helps achieve Action Pan #1, #2 and #5	Main Lynde Creek immediately north of Columbus Road. **Figure 8-1**	<$100	■ 3rd order stream. ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-8	Riparian Restoration and Thermal Regulation	■ Riparian cover to maintain thermal requirements for aquatic species at risk	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse	CLOCA	Helps achieve Action Pan #1, #2 and #5	Main Lynde Creek immediately north of the Highway 407. **Figure 8-1**	<$100	■ 4th order stream ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-9	Riparian Restoration and Thermal Regulation	■ Riparian cover to maintain thermal requirements for aquatic species at risk	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse	CLOCA	Helps achieve Action Pan #1, #2 and #5	South of Highway 407, west of Anderson Street. **Figure 8-1**	<$100	■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-10	Riparian Restoration and Thermal Regulation	■ Riparian cover to maintain thermal requirements for Brook Trout ■ Manage potential in-stream barriers due to pedestrian bridges	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse through golf course	CLOCA	Helps achieve Action Pan #1, #2 and #5, as well as potentially #17	South of Myrtle Road west, west of Ashburn Road 660142 4872779 **Figure 8-1**	<$100	■ Brook Trout potential in the headwaters ■ Ensure no barriers due to pedestrian bridges at golf course ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Riparian Restoration	RR-11	Riparian Restoration and Thermal Regulation	■ Riparian cover to maintain thermal requirements- Brook Trout	■ Plant native trees, shrubs, live stakes/native seed 30 metres on either side of watercourse	CLOCA	Helps achieve Action Pan #1, #2 and #5	North of Myrtle Road west, east of Lake Ridge Road 657892 4874069 to 658040 4874302 **Figure 8-1**	<$100	■ Brook Trout capture site downstream ■ Assess for bank stabilization opportunity ■ Complete a botanical inventory of existing watercourse and identify established populations of invasive species	A
Fish Barriers	FB-1	McIntosh Berm	■ In-stream barrier removal	■ Allow for fish passage and connectivity of headwater communities to and from Chalk Lake	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN01 **Figure 8-1**	$50	■ Private property ■ South of Chalk Lake Road, North of Townline Road ■ 657669 4875964 ■ Low priority barrier	Not applicable
Fish Barriers	FB-2	Ashton Berm	■ In-stream barrier removal	■ Allow for fish passage and connectivity of headwater communities to and from Chalk Lake	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN02 **Figure 8-1**	$50	■ South of Chalk Lake Road, North of Townline Road ■ 657853 4876056	Not applicable

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Fish Barriers	FB-3	Muirhead Berm	■ In-stream barrier removal	■ Allow for fish passage and connectivity of headwater communities	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN03 **Figure 8-1**	$50	■ Private property ■ Northeast of Townline Road and Heron Road ■ 658669-4875730 ■ Not included in priority assessment.	Not applicable
Fish Barriers	FB-4	Highway 7 Culvert Replacement – PROJECT COMPLETED	■ PROJECT COMPLETED	■ Not applicable	CLOCA	N/A	BARLYN04 **Figure 8-1**	NA	■ Highway 7 west of Cochrane Street ■ 661571-4867974	Not applicable
Fish Barriers	FB-5	Cullen Gardens Weir	■ Dam removal and channel restoration	■ Existing dam feature that is opened during the spring and fall to accommodate salmonid spawning seasons. Dam removal/channel restoration would allow for fish passage and connectivity to upstream habitat for non-jumping species	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN05 **Figure 8-1**	$100	■ Cullen Gardens ■ 663470-4864433 ■ Lowest priority barrier	B
Fish Barriers	FB-6	Cullen Gardens Side Channel	■ Channel planform adjustment	■ Revise channel planform to eliminate step pools and allow for fish passage	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN06 **Figure 8-1**	$50	■ Cullen Gardens ■ 663484-4864601 ■ Not included in priority assessment	Not applicable
Fish Barriers	FB-7	Way Street Dam	■ Dam removal	■ Allow for fish passage and connectivity of headwater communities where Brook Trout are potentially present. Remove concrete dam and restore passage for non-jumping fish species	CLOCA	Helps achieve Action Plan #1, # 5 and #17	BARLYN07 **Figure 8-1**	$100	■ Private property ■ Way Street, south of Carnwith Drive West ■ 663245-4869616 ■ Priority barrier – 2nd highest score (In-stream barrier action plan)	B
Fish Barriers	FB-8	Bryant Side Road Culvert	■ In-stream barrier removal / Culvert upgrading	■ Allow for fish passage and connectivity of headwater communities where Brook Trout are potentially present. Remove perched CSP culvert (0.5 metres x 0.5 metres) and potentially replace with concrete structure or larger CSP properly embedded into substrate ■ Incorporation of wildlife crossing for reptiles, amphibians and mammals	CLOCA	Helps achieve Action Plan #1, # 5 and #17	BARLYN08 **Figure 8-1**	$250	■ Private property ■ Bryant Side Road, north of Townline Road ■ 661139-4876460 ■ Priority barrier- highest score (In-stream barrier action plan)	A

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Fish Barriers	FB-9	Ashburn Road Dam	■ In-stream barrier removal	■ Allow for fish passage and connectivity of headwater communities where aquatic species at risk are potentially present	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN09 South of Ashburn, West of Ashburn Road 661167-4872502 **Figure 8-1**	$50	■ Private property ■ Two barriers in this immediate area (BARLYN09 and BARLYN10). Would improve habitat for aquatic species at risk	Not applicable
Fish Barriers	FB-10	Ashburn Road Dam	■ In-stream barrier removal	■ Allow for fish passage and connectivity of headwater communities where aquatic species at risk are potentially present	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN10 South of Ashburn, West of Ashburn Road 661167-4872502 **Figure 8-1**	$50	■ Private property ■ Two barriers in this immediate area. BARLYN10 is a priority barrier – 3rd highest score (In-Stream Barrier Action Plan). Would improve habitat for aquatic species at risk	Not applicable
Fish Barriers	FB-11	Lynde Creek Weir	■ Weir removal and channel restoration	■ Allow for fish passage and connectivity to upstream habitat for non-jumping species and where aquatic species at risk are potentially present	CLOCA	Helps achieve Action Plan #1 and #17	BARLYN11 **Figure 8-1**	$50	■ North of Cullen Gardens ■ 663027-4864908	B
Fish Barriers	FB-12	Dundas Street Buried Stream	■ Reinstate stream with culvert	■ Allows for daylighting of a buried portion of watercourse and removal of hard engineering causing barrier	CLOCA	Helps achieve Action Plan #1 and #17	Dundas Street West near White Oaks Court 663545 4859961 **Figure 8-1**	$100	■ Limited access due to adjacent buildings and roads ■ Not assessed in CLOCA Instream Barrier Action Plan	Potential Schedule B – to be confirmed when project initiated
Fish Barriers	FB-13	Rubble Berm / Online Pond	■ In-stream barrier removal	■ Allow for fish passage and connectivity to upstream habitat for non-jumping species	CLOCA	Helps achieve Action Plan #1 and #17	Taunton Road east of Coronation Road 661964-4863893 **Figure 8-1**	$50	■ Private property ■ Not assessed in CLOCA Instream Barrier Action Plan	Not applicable
Wildlife Crossing Structures	WCU-1 to WCU-11 and CR-1 to CR-8 (refer to rows below)	Wildlife Crossing	■ Incorporation of Wildlife Crossing Structures into Culvert Upsizing Opportunities ■ Duplication: (WCU-4 and CR-3)	■ Allows for reptile, amphibian and mammal movement and land connectivity, while reducing road mortality, within CLOCA's Wildlife Habitat Network	CLOCA	Helps achieve Action Plan #5	Culverts identified for upsizing opportunities. **Figure 8-1**	$1,800	■ Design considerations for culvert size, substrate type, openness ratio, length, metal mesh ledges, riparian planting and funneling techniques to encourage wildlife to use culverts to cross roads	Not applicable
Wetland Enhancement	FE-1	Fen Enhancement and Increase Land Connectivity	■ Conversion of agricultural land into succeeding woodland to increase vegetation protection buffer around fen community and increase land connectivity	■ Agricultural pocket of land between fen community and natural corridor located on private property northeast of Columbus Road and Cochrane Road should be restored and planted with native shrubs on the fringe and native trees in the core with the intent of it succeeding into a woodland	CLOCA	Helps achieve Action Plan #1 and #5.	**Figure 8-1**	$100	■ See Studies S-1 and S-2 below	Not applicable

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Study	S-1	Fen Restoration Study	--	■ Site-specific investigations should be completed to determine soil conditions and develop restoration plan appropriate to the site	CLOCA	--	--	$50	■ In support of Fen Enhancement	Not applicable
Study	S-2	Wetland Evaluation Study	--	■ OWES evaluation should be conducted for fen and connecting wetland communities to determine significance and any added protection	CLOCA	--	--	$50	■ In support of Fen Enhancement	Not applicable
Erosion	ER-1	L-04-ER1	■ Erosion Restoration ■ Channel Restoration	■ Channel Realignment away from residential property, Riparian restoration, Localized bank remediation measures and Replace gabion with a more naturalized bank material	Whitby	Helps support Action Plan # 9	L-04 **Figure 8-4**	$100		B
Erosion	ER-2	L-04-ER2	■ Erosion Restoration ■ Channel Restoration	■ Channel realignment away from residential property, riparian zone restoration and localized bank remediation measures	Whitby	Helps support Action Plan # 9	L-04 **Figure 8-4**	$100		B
Erosion	ER-3	L-04-ER3	■ Erosion Restoration	■ Future restoration of riparian vegetation for greater bank stability	Whitby	Helps support Action Plan # 9	L-04 **Figure 8-4**	$100		A
Erosion	ER-4	L-13-ER4	■ Erosion Restoration	■ Future restoration of riparian vegetation for greater bank stability	Whitby	Helps support Action Plan # 9	L-13 **Figure 8-4**	$100		A
Erosion	ER-5	L13-ER5	■ Erosion Restoration	■ Future restoration of riparian vegetation for greater bank stability	Whitby	Helps support Action Plan # 9	L-13 **Figure 8-4**	$100		A
Erosion	ER-6	L18-ER6	■ Erosion Restoration	■ Future restoration of riparian vegetation for greater bank stability	Whitby	Helps support Action Plan # 9	L-18 **Figure 8-4**	$100		A
Erosion	ER-7	L18-ER7	■ Erosion Restoration	■ Future restoration of riparian vegetation for greater bank stability	Whitby	Helps support Action Plan # 9	L-18 **Figure 8-4**	$100		A
Erosion	ER-8	L18-ER8	■ Erosion Restoration	■ Future restoration of riparian vegetation for greater bank stability	Whitby	Helps support Action Plan # 9	L-18 **Figure 8-4**	$100		A
Erosion	ER-9	L19-ER9	■ Erosion Restoration ■ Channel Restoration	■ Channel realignment away from roadway, riparian zone restoration and localized bank remediation measures	Whitby	Helps support Action Plan # 9	L-19 **Figure 8-4**	$100		B

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Erosion	ER-10	L20-ER10	■ Erosion Restoration	■ Channel realignment away from roadway, riparian zone restoration and localized bank remediation measures	Whitby	Helps support Action Plan # 9	L-20 **Figure 8-4**	$100		B
Erosion	ER-11	H20-ER11	■ Erosion Restoration	■ Channel realignment away from roadway, riparian zone restoration and localized bank remediation measures	Whitby	Helps support Action Plan # 9	H-20 **Figure 8-4**	$100		B
SWMP-Retrofits	SWMPR-1	Baldwin Estates PD44-01	■ Thermal Impact Mitigation	■ Bottom Draw/Cooling Trench	Whitby	--	**Figure 8-3**	$250		A
SWMP-Retrofits	SWMPR-2	Brooklin Meadows Subdivision PD56-01	■ Thermal Impact Mitigation	■ Bottom Draw/Cooling Trench	Whitby	--	**Figure 8-3**	$250		A
SWMP – New	BSP-SWMPs	Brooklin SP	■ Water Quantity & Quality Control	■ Stormwater management pond	Developer		Lynde **Figure 8-2**	NA	■ Forty SWM Ponds have been identified in the Brooklin Secondary Plan – Phase 3 Study – Their eventual number and location will be determined by Sub-Area Studies (SAS) at the Site Plan development stage ■ To be addressed under the *Planning Act*	A
SWMP – New	PDDW-01	West Whitby SP	■ Water Quantity Control	■ Mattamy West Site quantity pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the *Planning Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A
SWMP – New	PDDW-02	West Whitby SP	■ Water Quantity Control	■ Hiddenbrook Site quantity pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the *Planning Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A
SWMP – New	PDDW-03	West Whitby SP	■ Water Quantity Control	■ West Whitby Holdings quantity pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the *Planning Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A
SWMP – New	PDDW-04	West Whitby SP	■ Water Quality Control	■ Tribute Chelseahill Site quality pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the *Planning Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A

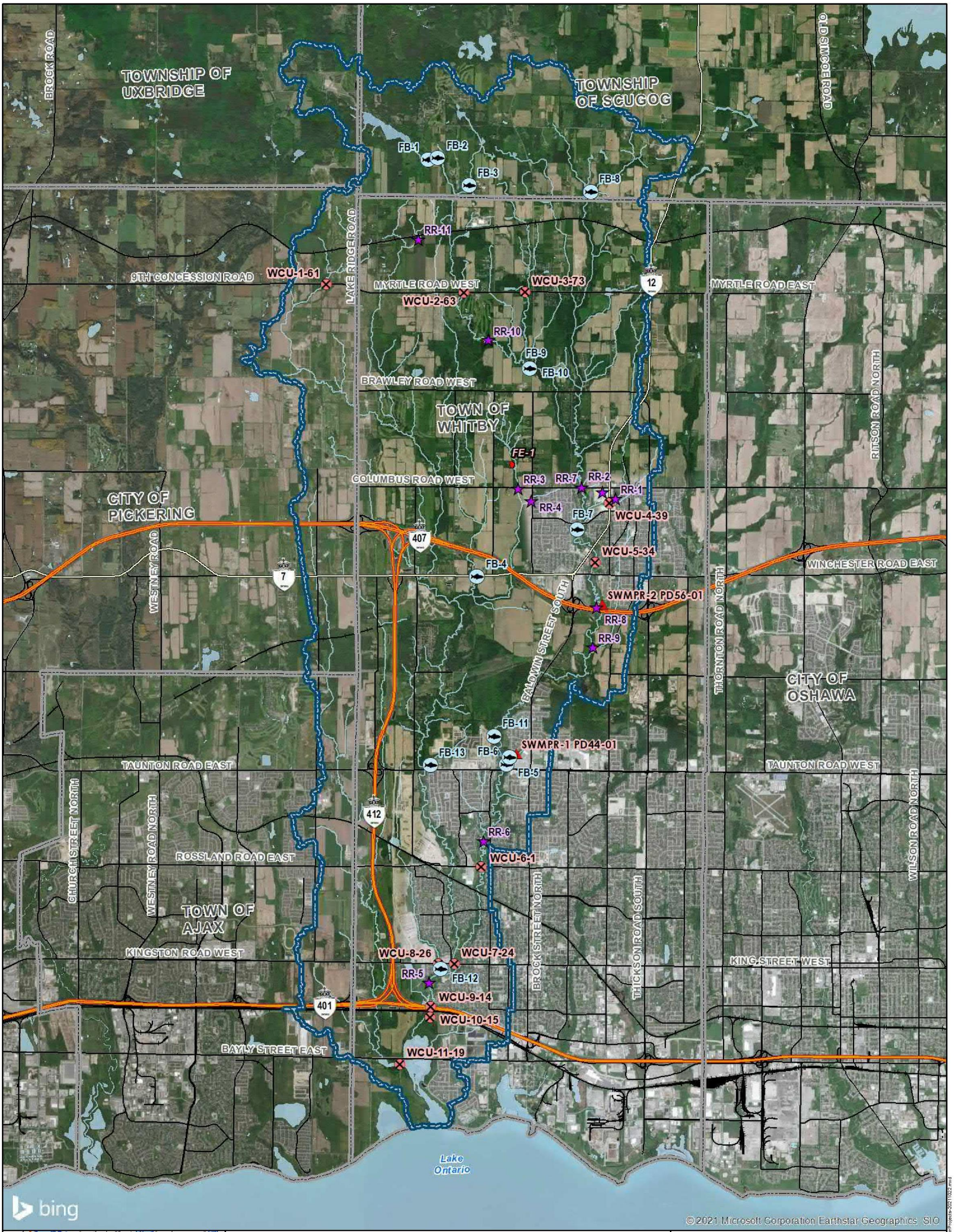
Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
SWMP – New	PDDW-05	West Whitby SP	■ Water Quality Control	■ TFP Whitby Development quality pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the *Planning Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A
SWMP – New	PDDW-06	West Whitby SP	■ Water Quality Control	■ Lazy Dolphin Site quality pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the Planning *Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A
SWMP – New	PDDW-07	West Whitby SP	■ Water Quality Control	■ Heathwood Lands quality pond	Developer	--	**Figure 8-2**	NA	■ To be addressed under the *Planning Act* ■ Assumes developers will complete land use concept and functional servicing including proposed SWMFs	A
LID - On-Site Control Area	BSP-OSCA-L1	Brooklin SP	■ Water Quantity & Quality Control	■ Treatment Train & LID	Developer	--	**Figure 8-2**	NA	■ Fourteen LID-OSCAs have been identified in the Brooklin Secondary Plan – Phase 3 Study – Their eventual number and location will be determined by Sub-Area Studies (SAS) at the Site Plan development stage	Not applicable
Watercourse Crossing Upgrades	WCU-1	Heber T4-1	■ Culvert upgrade – 25-yr design flow	■ 9th Concession Road – Rural Arterial –1.4 metre circular	Pickering	--	XS 6725 **Figure 8-3**	250		B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-2	Ashburn 2	■ Culvert upgrade – 50-yr design flow	■ Myrtle Road – B Urban Arterial –1.3 metre circular	Region	--	XS 6839 **Figure 8-3**	250		B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-3	Ashburn T1	■ Culvert Upgrade – 50-yr design flow	■ Myrtle Road – B Urban Arterial –1.9 metre circular	Region	--	XS 1913 **Figure 8-3**	500		B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-4 (CR-3)	Lynde T3 1	■ Culvert Upgrade – 50-yr design flow	■ Baldwin St. N – Urban Arterial – 1.5 metre circular	Region	--	XS 787 **Figure 8-3**	500		B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-5	Lynde 5	■ Bridge upgrade – 50-yr design flow	■ Cassels Rd. – Rural Arterial – 12.1 metre span x 2.7 metre rise	Whitby	--	XS 3670 **Figure 8-3**	1000		B – increasing hydraulic capacity

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Watercourse Crossing Upgrades	WCU-6	Lynde 4	■ Bridge upgrade – 50-yr design flow	■ Rossland Rd. W. – Rural Arterial – 15.6 metre span x 0.8 metre rise	Region	--	XS 3642 **Figure 8-3**	1500		B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-7	Lynde 3-1	■ Bridge Approach upgrade – 100-yr design flow	■ Dundas St. W. – Freeway – 18.6 metre span x 2.8 metre rise – require bridge approach, east of the structure, to be raised a maximum of 0.8 metre -over 110 metre of roadway approach.	Province	--	XS 605 **Figure 8-3**	750	■ Impacted by downstream crossing structures at CN/GO rail crossings and Jeffrey Street crossing. Upgrade necessity should be confirmed by more detailed study.	B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-8	Lynde T1-1	■ Culvert upgrade – 50-yr design flow	■ Dundas St. W. - Freeway ■ 2.9 metre CSP ellipse 156 metre long	Province	--	XS 245 **Figure 8-3**	750	■ Impacted by downstream crossing structures at CN/GO rail. . Upgrade necessity should be confirmed by more detailed study.	B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-9	Lynde 2-1	■ Bridge upgrade – 100-yr design flow	■ GO RAIL ■ Relief culverts ■ 13.1 metre span x 2.7 metre rise	Metrolinx	--	XS 3262 **Figure 8-3**	5000	■ Impacts two upstream structures	B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-10	Lynde 2-2	■ Bridge upgrade– 100-yr design flow	■ CN RAIL ■ Relief culverts ■ 12.8 metre span x 3.5 metre rise	CN	--	XS 3243 **Figure 8-3**	5000	■ Impacts three upstream structures	B – increasing hydraulic capacity
Watercourse Crossing Upgrades	WCU-11	Kinsale 1	■ Bridge upgrade – 100-yr design flow	■ Victoria Street – Type B Arterial –10.0 metre span x 2.3 metre rise	Region	--	XS 791 **Figure 8-3**	1500		B – increasing hydraulic capacity
Geomorphically Undersized Crossing	CR-1	L04-C1	■ Crossing Replacement	■ Future crossing replacement should remove piers and ensure crossing spans greater than bankfull width of the watercourse	Whitby	--	L-04 **Figure 8-4**	$200		A+
Geomorphically Undersized Crossing	CR-2	L04-C2	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel	Whitby	--	L-04 **Figure 8-4**	$200		B – increasing hydraulic capacity
Geomorphically Undersized Crossing	CR-3 (WCU-4)	L18-C3	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel.	Whitby	--	L-18 **Figure 8-4**	$200		A+

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Geomorphically Undersized Crossing	CR-4	L18 L19-C4	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel; replacement of gabion along the right bank with more naturalized bank protection	Whitby	--	L-18 and L-19 **Figure 8-4**	$200		A+
Geomorphically Undersized Crossing	CR-5	L20-C5	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel	Whitby	--	L-20 **Figure 8-4**	$200		A+
Geomorphically Undersized Crossing	CR-6	L20-C6	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel	Whitby	--	L-20 **Figure 8-4**	$200		A+
Geomorphically Undersized Crossing	CR-7	L20-C7	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel	Whitby	--	L-20 **Figure 8-4**	$200		A+
Geomorphically Undersized Crossing	CR-8	H19H20-C8	■ Crossing Replacement and Channel Restoration	■ Future crossing replacement should ensure crossing spans greater than bankfull width of the watercourse and create a defined low flow channel	Whitby	--	H-19 and H-20 **Figure 8-4**	$200		A+
Studies	S-3	Hydrologic Model Calibration	■ For Water Quantity	■ Using WSC streamflow gauges, supplemented by CLOCA. Calibrate and validate the hydrologic model used for streamflow estimation. There would be a large hydrogeologic component since infiltration/ recharge in the HVRA areas could be a major factor in appropriate modelling.	CLOCA	--	all	$150		Not applicable

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Guidelines	G-1	LID/BMP Guidelines	■ For Water Quality and Water Quantity	■ CLOCA/Whitby to upgrade/expand current development guidelines to include LID and BMP elements; with a focus on Water Balance and Infiltration methods	Whitby/ CLOCA	--	all	$50		Not applicable
Guidelines	G-2	Riparian and Natural Channel Restoration Guidelines	■ For Water Quality -	■ Compile, from existing guidelines, acceptable approaches/methods for channel restoration and identify, within the Lynde Creek Watershed, a detailed inventory of sites that need to be addressed	Whitby/ CLOCA	--	all	$50		Not applicable
Guidelines	G-3	Salt Management Plan	■ For Water Quality	■ Compile, from existing guidelines, acceptable approaches/methods for Road Salt Management, both on the roadway and at salt facilities, including identification of natural heritage sites that would be sensitive to salt loading	Whitby	--	TBD	$50	■ Policy SAL-10 in the CTC Source Protection Plan encourages: – The Planning Approval Authority (the Town of Whitby) to require a salt management plans where the application of road salt would be moderate or low drinking water threat as part of a complete application for development which includes new roads and parking lots – The municipality (the Town of Whitby) to require implementation of a salt management plan on unassumed roads and private parking lots greater than 200 square metres where the application of road salt is or would be a moderate or low drinking water threat	Not applicable
Monitoring	M-1	Streamflow	■ For Calibration	■ Develop and operate three streamflow gauges in the Ashburnham and Myrtle Tribs to assist in identifying hydrologic mechanisms for calibration purposes	CLOCA	Helps achieve Action Plan #8	TBD	$30		Not applicable

Category	Project ID #	Project Name	Project Type	Project Description	Implementing Agency	Linkage to 2012 Lynde Creek Watershed Plan Action Plans	Applicable Stream Reach ID # and Figure #	Cost Estimate (x$1000)	Comments	MCEA Schedule
Monitoring	M-2	Streamflow	■ For Heber Down Trib	■ Develop and implement two streamflow gauges on the Heber Down Trib to identify changes in flow regime	CLOCA	Helps achieve Action Plan #8	TBD	$20		Not applicable
Monitoring	M-3	Rainfall	■ For Calibration	■ Develop and implement a rainfall monitoring program for the upper portion of the watershed (Ashburnham, and Myrtle Tribs). Assume a minimum of four gauges	CLOCA	Helps achieve Action Plan #8	TBD	$50		Not applicable
Monitoring	M-4	Water quality	■ For impact assessment	■ Develop and implement a continuous water quality monitoring program for typical indicators (TSS, DO, P, COND). Two sites – one on Heber Down Trib and one near Lynde Creek outlet	CLOCA	Helps achieve Action Plan #8	TBD	$100		Not applicable



Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Fish Barrier
- Riparian Restoration Location
- Fen Enhancement Opportunity Area

Crossing Structure Priority

- High

SWMP Retrofit - Priority

- H > 100 ha

Crossing Structure Labels

WaCU-7 14 — Project ID; 2008 Inventory ID

29 — 2008 Inventory ID

SWMP Retrofit Labels

SWMPR-2 PD56-01 — Project ID; Inventory ID

N

Lynde Creek Watershed

Recommended Lynde Creek MDPU Projects - Aquatic and Terrestrial Related Projects

October 2021	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	Figure 8-1

AECOM

0 0.5 1 2 3 4
Kilometers

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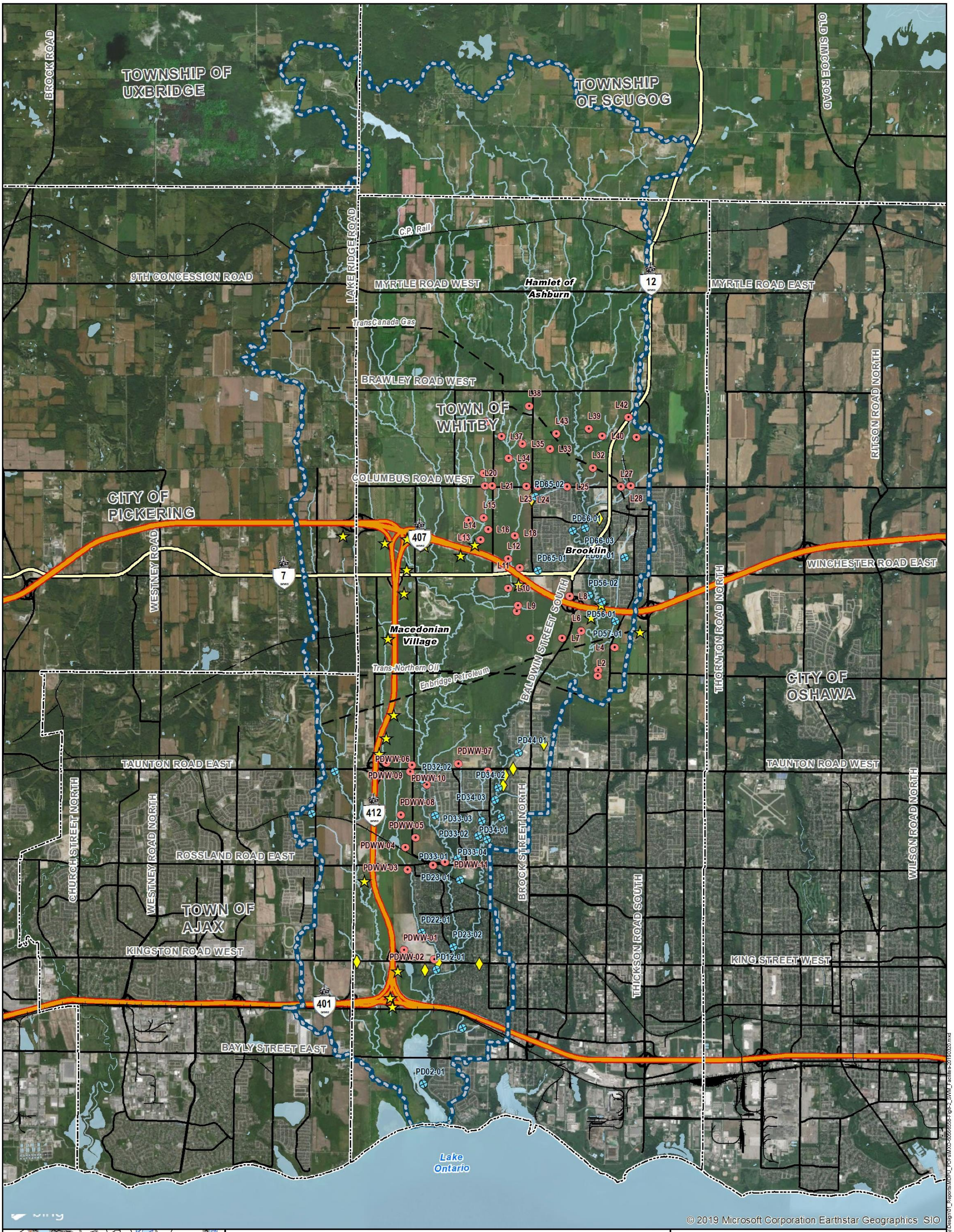
Map location: E:\PRJ\60566558_LyndeCreek\Design\01_Reports\MDPU_PDFs\MXD-60566558-Fig8-1_AqTerrProjects-20211022.mxd
Date Saved: 10/20/2021 4:38:58 PM



Legend

- Freeway
- Expressway / Highway
- Major Road
- Watercourse
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Existing OGS
- Existing Transportation SWM Pond
- Existing SWM Pond
- Proposed SWM Pond

Lynde Creek Watershed

Recommended Lynde Creek MDPU Projects – Stormwater Management Facilities (SWMP and LID-On-Site Control Areas)

May 2019	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	

AECOM

Figure 8-2

0 0.5 1 2 3 4
Kilometers

N

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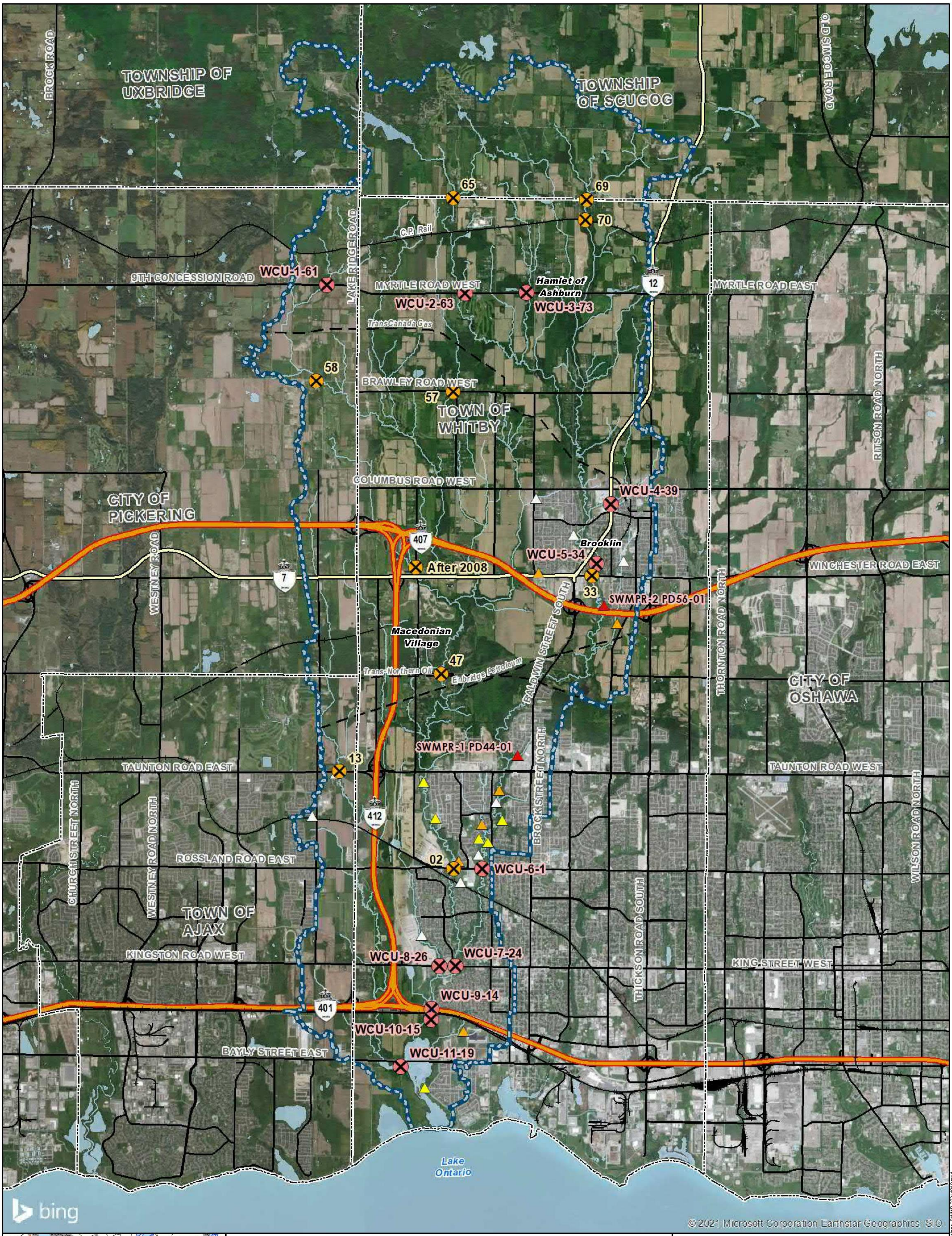

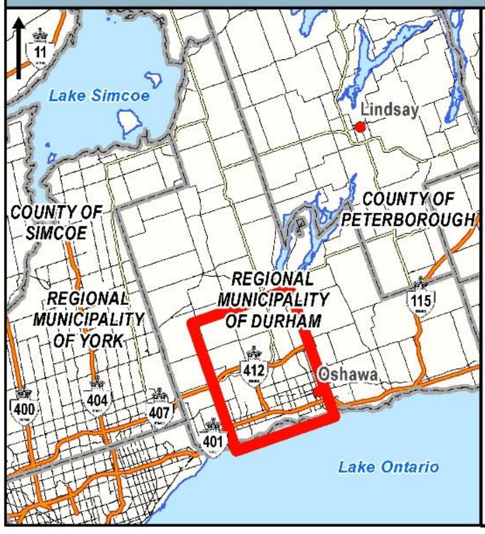

Legend

- Freeway
- Expressway / Highway
- Major Road
- Watercourse
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed

Crossing Structure Priority

- High
- Medium

SWMP Retrofit - Priority

- H > 100 ha
- 50 ha < M < 100 ha
- 10 ha < L < 50 ha
- NA

Crossing Structure Labels

WaCU-7 14 — Project ID; 2008 Inventory ID

29 — 2008 Inventory ID

SWMP Retrofit Labels

SWMPR-2 PD56-01 — Project ID; Inventory ID

N

Lynde Creek Watershed

Recommended Lynde Creek MDPU Projects – SWMP Retrofit and Watercourse Crossing Upgrades

October 2021	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 003	

AECOM

Figure 8-3

0 0.5 1 2 3 4
Kilometers

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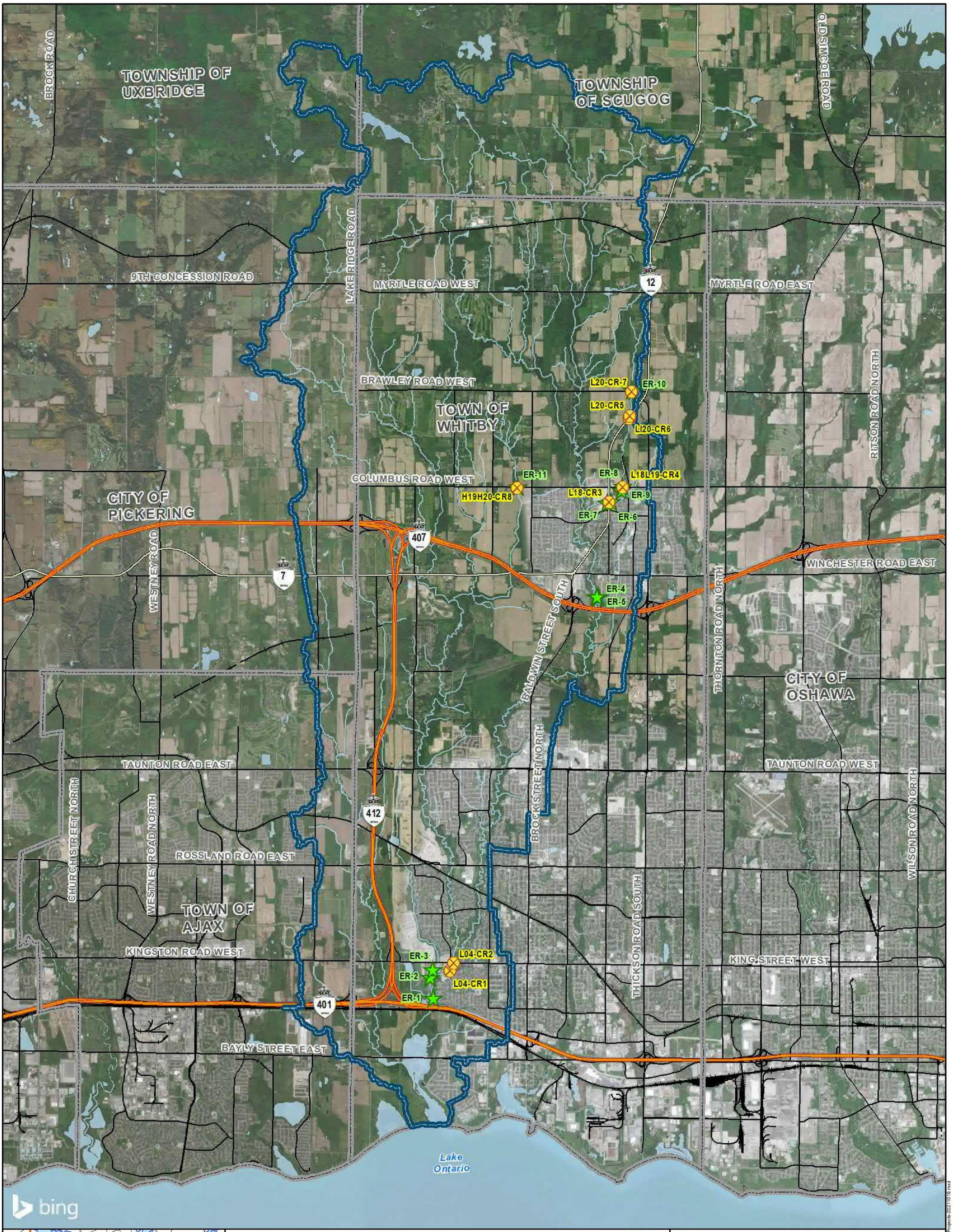

Legend

- Freeway
- Expressway / Highway
- Major Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary
- Lynde Creek Watershed
- Existing Geomorphically Undersized Culvert
- Existing Erosion Site

N

Lynde Creek Watershed

Recommended Lynde Creek MDPU Projects - Fluvial Related Projects

October 2021	1:74,300	Datum: NAD 83 Zone 17 Source: LIO, AECOM
P#: 60566558	V#: 001	

AECOM

Figure 8-4

0 0.5 1 2 3 4
Kilometers

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8.1 Alternative Master Drainage Plans

The approach to identifying alternative Master Drainage Plans, for EA purposes, has been simplified for the Lynde Creek Watershed by assuming that a preferred MDP will address watershed goals and objectives and that the pre-screening of SWM alternatives is part of the overall evaluation and selection process. These goals and objectives are summarized in **Table 8-1** and are to be implemented over time through the recommended projects (**Table 8-2**).

The following MDP alternatives have been identified and carried forward for evaluation:

1. Do Nothing;
2. Continued Implementation of the 1988 MDP; and
3. Implement the Tasks outlined in **Table 8-2** for the 2021 MDPU.

The evaluation of the three alternatives is presented in **Section 8.2**.

8.2 Evaluation and Selection of Preferred Master Drainage Plan

The alternatives, as identified in **Section 8.1,** were evaluated against the goals/objectives (i.e., criteria) previously established for the Lynde Creek MDP (See **Table 8-1**). For each alternative, a corresponding letter was assigned to indicate whether each met the individual objectives (N = No, and Y=Yes).

The objective of this approach is to show which alternative is, overall, the most effective in achieving the intended outcome (i.e., MDP goals/objectives). The evaluation was completed using professional judgement and was informed through the results of studies conducted during the EA process (e.g., Hydrologic Assessment, Hydraulic Assessment).

The results of the evaluation are provided in **Table 8-3**, indicating **Alternative 3 (2021 MDPU) is the preferred solution** as it best addresses the watershed goals/objectives when compared to “Do Nothing” and the “Continued Implementation of the 1988 MDP”. There are significant points of differentiation between the 1988 MDP and this 2021 MDPU. To summarize, in contrast to the 2021 MDPU, among others, the 1988 MDP does not include:

- A hydrogeologic/groundwater component that considered water balance and recharge/discharge areas;
- A review of the Natural Heritage Systems (terrestrial and aquatic) and its link to drainage;

Table 8-3: Alternative Evaluation – Achieve Goals and Objectives of the Lynde Creek Watershed (2021)

Area of Concern	Goal	Objective	Alternative 1 – Do Nothing	Alternative 2 – Continued Implementation of 1988 MDP	Alternative 3 – 2021 MDPU
Flood Hazard	Protect Life/Properties and Buildings	Floodplain delineation	N	Y	Y
Flood Hazard	Protect Life/Properties and Buildings	Watercourse crossing upgrade - improve capacity	N	Y	Y
Flood Hazard	Protect Life/Properties and Buildings	Floodproofing/berming	N	N	N
Flood Hazard	Protect Life/Properties and Buildings	Planning/Zoning-Control Land Development	N	N	Y
Flood Hazard	Protect Life/Properties and Buildings	Land Development - flow reduction through SWM BMP; LID [4.]	N	N	Y
Flood Hazard	Protect infrastructure-utilities/crossings	Bank stabilization	N	Y	Y
Flood Hazard	Protect infrastructure-utilities/crossings	Meander belt identification	N	N	y
Flood Hazard	Protect infrastructure-utilities/crossings	Land Development - flow reduction through SWM BMP; LID	N	N	Y
Streams and Related Habitat	Riparian aquatic restoration	Fish barrier removal	N	N	Y
Streams and Related Habitat	Riparian aquatic and terrestrial restoration	Riparian restoration	N	N	Y
Streams and Related Habitat	Riparian aquatic and terrestrial restoration	Thermal regulation-stream cover	N	N	Y
Streams and Related Habitat	Riparian terrestrial restoration	Wildlife crossing	N	N	Y
Streams and Related Habitat	Riparian terrestrial restoration	Bank stabilization	N	N	Y
Streams and Related Habitat	Minimize erosion impacts	Bank stabilization	N	N	Y
Streams and Related Habitat	Minimize erosion impacts	Meander belt identification	N	N	Y
Streams and Related Habitat	Improve water quality	SWM Pond retrofits	N	N	Y

Area of Concern	Goal	Objective	Alternative 1 – Do Nothing	Alternative 2 – Continued Implementation of 1988 MDP	Alternative 3 – 2021 MDPU
Streams and Related Habitat	Improve water quality	Salt Management Plan	N	N	Y
Streams and Related Habitat	Improve water quality	Land Development - water quality improvement through SWM BMP; LID	N	N	Y
Significant Natural Heritage	Identify and Protect Wetlands	Planning/Zoning-Control Land Development	N	N	Y
Significant Natural Heritage	Identify and Protect Wetlands	Mapping/Inventory	N	N	Y
Significant Natural Heritage	Identify and Protect Species at Risk	Planning/Zoning-Control Land Development	N	N	Y
Significant Natural Heritage	Identify and Protect Species at Risk	Mapping/Inventory	N	N	Y
Significant Natural Heritage	Identify and Protect Woodlands	Planning/Zoning-Control Land Development	N	N	Y
Significant Natural Heritage	Identify and Protect Woodlands	Mapping/Inventory	N	N	Y
Groundwater Recharge/Discharge	Identify and Protect Recharge/Discharge Areas	Planning/Zoning-Control Land Development	N	N	Y
Groundwater Recharge/Discharge	Identify and Protect Recharge/Discharge Areas	Land Development - water balance improvement through SWM BMP; LID	N	N	Y
Groundwater Recharge/Discharge	Identify and Protect Recharge/Discharge Areas	Mapping/Inventory	N	N	Y
			Not Preferred	Not Preferred	**Preferred**

- The application of geomorphologic techniques to assess watershed-wide potential for erosion;
- The identification of land development impacts; and
- SWM solutions to mitigate land development impacts.

Among the projects considered in this MDPU is the CN/Metrolinx Relief Culverts. Refer to **Section 8.3** for an overview of the project.

8.3 CN/Metrolinx Relief Culverts – Master Plan Approach No. 2 (Schedule B)

As per **Section 1.7**, the Lynde Creek MDPU is being carried out as a master plan. The MEA Municipal Class EA document outlines four approaches to the master planning process. At a minimum, Master Plans address Phases 1 and 2 of the Municipal Class EA process. When the MDPU was initiated, the Town of Whitby/CLOLCA were following Master Plan Approach #2, with the intent of obtaining full EA approval for the installation of CN/Metrolinx relief culverts.

The existing CN/Metrolinx Rail Corridor Lynde Creek culverts have hydraulic capacity limitations that contribute to upstream flooding and negatively impact on how the watershed functions. While there have been no major damages to existing property-structures to date, the Town has previously identified the need to update its floodplain mapping and investigate alternatives for addressing conveyance limitations and provide flood protection for a 1 in 100 year storm.

In 2016, The Town completed a Functional Feasibility Assessment to determine post-construction conditions at the CN/Metrolinx crossing of Lynde Creek, as well as identify potential solutions for improving hydraulic capacity at the site to address flooding upstream of Highway 401 and CN/Metrolinx crossings.

The Functional Feasibility Assessment (AECOM, 2016) considered various environmental and technical issues and reviewed the following four alternative solutions that can address the flooding problem:

Alternative 1: Do nothing – consider the impacts of not making hydraulic improvements (allow more stream flow to pass underneath the CN/Metrolinx structures) to the crossing;

Alternative 2: Install flood relief culverts beside the existing CN and GO structures;

Alternative 3: Replace the existing CN and GO structures; and

Alternative 4: Non-structural improvements – consider channel modifications or berms to control the floodplain.

The evaluation of alternative solutions to reduce residential flooding followed an EA evaluation framework and concluded that Alternative 2 – Install Flood Relief Culverts was the best solution at that time despite its significant capital cost (over $6.0M).

The Town in partnership with CLOCA have recently completed the Michael Boulevard Area Flood Mitigation Study (MIG 2020) that re-examined the CN/Metrolinx Relief Culverts, as well as other developed alternatives, to reduce or eliminate the risk of flooding and flood damages at a lower cost. The flood mitigation study recommends a Flood Protection Berm to "protect almost all of the homes currently at risk of flooding during the 100-yr return period storm event ", as well as a "Flood Proofing and Education Program". This study also followed the Municipal Class EA planning process. As such, the Town is no longer seeking EA approval for the proposed relief culverts through this MDPU study. The proposed relief culverts or other alternatives are identified in this MDPU as a water crossing upgrade (WCU-8 and WCU-9) as identified in **Table 8-2** and **Figure 8-3**. These projects could potentially move forward, dependent on further reviews of the hydraulics in the lower reaches of Lynde Creek based on the 2021/2022 floodplain mapping study of this area undertaken by CLOCA.

9. Master Drainage Plan Update: Preferred Undertaking

In keeping with the overall watershed goals, a comprehensive list of projects has been developed that, if implemented, achieve many of the goals and their objectives previously identified. The list of recommended MDPU projects summarizes the analysis in **Part B Technical – Sections 2** through **Section 5**. The recommended projects are spatially identified in **Figure 8-1**, **Figure 8-2, Figure 8-3** and **Figure 8-4.**

9.1 Flood Hazard Management

9.1.1 Watershed Improvement Project Listing

As identified in **Sections 3.0** and **4.0**, recommendations for the 2021 MDPU include:

- Address flood reduction in key flood vulnerable areas including upstream of Highway 401;
- Quantity control for land development upstream of Dundas Street including WWSP and BSP areas;
- Quality control for all land development projects with a special emphasis on thermal impact mitigation;

- Watercourse crossing improvements to meet design standards for clearance, freeboard and overtopping; and
- Streambank stabilisation and related natural channel design.

The specific projects associated with flood hazard management are identified in **Table 8-2.**

9.2 Streams and Related Habitat

9.2.1 Watershed Improvement Project Listing

As identified in **Sections 2.5**, **2.7** and **2.8**, the recommendations for the 2021 MDPU are as follows:

- Brook trout spawning surveys to confirm important spawning areas, especially in the Brooklin Community Secondary Plan area;
- Institute LID measures in land development to maintain groundwater discharge areas associated with Oak Ridges Moraine and Iroquois Beach that support Brook trout spawning and associated coldwater habitat;
- Provide cooling trenches and bottom-draw outlet conversions on stormwater management facilities to improve water quality for Brook trout, Redside dace and associated coldwater fish species;
- Water quality data collection (e.g., stream temperature, turbidity, benthic community, etc.) before and after construction of stormwater management facility retrofits to determine relative success of retrofit activities;
- Landowner consultation and incentives to convert mowed grass areas adjacent to watercourses to healthy riparian zones containing native, long grasses, shrubs and trees;
- Landowner consultation and incentives to prevent cattle access to watercourses;
- Replace undersized culverts with adequately sized culverts capable of conveying bankfull flows and providing dry passage for wildlife. Incorporate low-flow channels into culverts where feasible;
- Recommend natural channel design for erosion sites and fish barrier sites;
- Restore agricultural land between fen and natural corridor into a succeeding woodland to increase vegetation protection buffer for the fen community and increase land connectivity located northeast of the intersection of Columbus Road and Cochrane Street;

- Complete Ontario Wetland Evaluation System (OWES) evaluation for fen community and connecting wetland communities (i.e., within 750 metres of each other) located on private land in the Brooklin Community Secondary Plan Area to determine significance status and add additional protection;
- Install recreational bridges where motorized vehicles cross watercourses;
- Consultation with affected municipalities, stakeholders and Indigenous communities (e.g., Scugog Island First Nation) pursuant to potential 2019 changes to the *Fisheries Act*, *Canadian Environmental Assessment Act* and *Navigation Protection Act* as a result of Bill C-68 and Bill C-69;
- Consultation with government and conservation groups (e.g., Ontario Soil and Crop Improvement Association (Species at Risk Farm Incentive Program), Community Stream Steward Program, Trout Unlimited Canada, naturalist groups) to identify resources to support implementation of study recommendations;
- Barrier removal projects should be accompanied by assessment of potential impacts on the spread of Aquatic Invasive Species (AIS), in conjunction with consultation with CLOCA and Fisheries and Oceans Canada (DFO). Consult CLOCA on forthcoming Fish Barrier Assessment Methodology; and
- Implementation of a Stormwater Management Strategy for existing and proposed development as determined through Whitby and CLOCA SWM Guidelines. These guidelines will include:
  - A Water Balance Assessment for new development
  - Stormwater quality treatment for existing and new land development areas
  - Stormwater quantity treatment for existing and new land development areas upstream of Dundas Street.

The specific projects associated with streams and related habitats are identified in **Table 8-2**.

9.3 Significant Natural Heritage Feature Restoration and Enhancement

9.3.1 Watershed Improvement Project Listing

As identified in **Sections 2.7** and **2.8**, recommendations for the 2021 MDPU are as follows:

- Restore agricultural land between fen and natural corridor into a succeeding woodland to increase vegetation protection buffer for the fen community and increase land connectivity located northeast of the intersection of Columbus Road and Cochrane Street;

- Complete Ontario Wetland Evaluation System (OWES) evaluation for fen community and connecting wetland communities (i.e., within 750 metres of each other) located on private land in the Brooklin Community Secondary Plan Area to determine significance status and add additional protection;
- Install recreational bridges where motorized vehicles cross watercourses;
- Consultation with affected municipalities, stakeholders and Indigenous communities (e.g., Scugog Island First Nation) pursuant to potential 2019 changes to the *Fisheries Act*, *Canadian Environmental Assessment Act* and *Navigation Protection Act* as a result of Bill C-68 and Bill C-69; and
- Consultation with government and conservation groups (e.g., Ontario Soil and Crop Improvement Association (Species at Risk Farm Incentive Program), Community Stream Steward Program, Trout Unlimited Canada, naturalist groups) to identify resources to support implementation of study recommendations.

The specific projects associated with significant natural heritage feature restoration and enhancements are identified in **Table 8-2**.

9.4 Groundwater Recharge/Discharge

9.4.1 Watershed Improvement Project Listing

As identified in **Section 5** recommendations for the 2021 MDPU are as follows:

- Contributing to the hydrogeologic component of a Hydrologic Model Calibration study;
- Continued identification and definition of recharge/discharge areas through mapping and inventory; and
- Development of groundwater monitoring programs to assist in LID implementation.

The specific projects associated with groundwater recharge/discharge are identified in **Table 8-2**.

9.5 Climate Change

Ontario has recently developed a Climate Change Action Plan. As a commitment of the Action Plan, the province has released a guide entitled Considering Climate Change in the Environmental Assessment Process (October 2017). The guide includes MECP's expectations regarding climate change and EA studies/processes. **Table 9-1** provides a qualitative assessment of how this study's impacts on climate change (mitigation) and impacts of climate change on the MDPU projects' (adaptation) have been considered.

Table 9-1: Climate Change Considerations

Consideration	Review of Project
Climate Change Mitigation	■ Implement natural heritage restoration and enhancement projects with emphasis on increased vegetation and tree cover.
Climate Change Adaptation	■ Improve hydraulic capacity of undersized creek water crossings to remediate flooding risk (e.g., CN/Metrolinx Relief Culverts).

In addition, the MDPU and select projects also support the 2012 Lynde Creek Watershed Plan Climate Change Monitoring/Adaptive Management Strategy (Action Plan No. 20) by reporting baseline data of existing conditions, specifically for assessing indicators of climate change (e.g., precipitation, surface runoff, infiltration).

10. Identification of Recommended Mitigation Measures – Construction Projects

Impacts related to the reconstruction of the proposed watershed improvement projects will be limited to the duration and location of construction. Based on the individual projects and proposed construction techniques, construction is expected to have varying environmental effects. By incorporating proper best management practices and construction techniques, adverse construction related effects can be minimized. In order to address the effects, the following approach was taken:

- **Avoidance:** The first priority to prevent the occurrence of negative or adverse environmental effects associated with construction of the proposed projects;
- **Mitigation:** Where adverse environmental effects cannot be avoided, it will be necessary to develop appropriate measures to eliminate, or reduce to some degree, the negative effects associated with construction; and,
- **Compensation:** In situations where appropriate mitigation measures are not available, or significant net adverse effects will remain following the application of mitigation measures, compensation measures may be required to counter balance the negative effect through replacement in kind, or provision of a substitute or reimbursement.

The following mitigation measures are recommended to ensure that any disturbances are managed by the best available methods. These measures form commitments for managing known or potential environmental and social/cultural impacts. **Table 10-1** provides a high level overview of the potential impacts associated with the proposed projects and the recommended mitigation measures required to reduce these effects. Impacts will be further confirmed and developed for individual watershed improvement projects during subsequent Class EA planning phases and detailed design.

Table 10-1: Proposed Mitigation Measures

Category	Potential Impacts	Mitigation Measures
Natural Environment	Vegetation Protection Buffers and Loss of Tree Cover	■ Future developments will need to incorporate and maintain vegetation protection zones (i.e., buffers) to certain natural heritage features from development as prescribed by the various planning documents within the Lynde Creek Watershed (See **Table 2-16**). Buffers may be adjusted or developed based on detailed site-specific investigation through completion of an EIS. ■ Restore disturbed areas/habitat to existing or better conditions. ■ Minimize tree and vegetation removal. ■ All trees to be saved shall be clearly marked. ■ Trees/vegetation that must be removed should be replaced after construction. ■ Protect mature and mid-aged trees along the edge of construction; prepare tree preservation plan, as required.
Natural Environment	Removal/Pruning of Mature Tree Limbs	■ Restrict the pruning and removal of tree limbs and branches to those that are required for construction, as required.
Natural Environment	Breeding Birds	■ In accordance with the *Migratory Birds Convention Act*, any tree trimming or site clearing should take place between August 1 and April 31. ■ Should tree or site clearing be scheduled from May 1 to July 31, comprehensive breeding bird surveys will be required.
Natural Environment	Fish and Wildlife	■ Ensure that outlet locations create or enhance habitats for fish and wildlife. ■ Review MTO's Environmental Guide for Wildlife Mitigation (2015) regarding advice on the design and implementation of different types of wildlife crossing structures when considering incorporation of wildlife crossings structures in either existing or future road crossings, in consultation with CLOCA.
Natural Environment	Groundwater Resource Management	■ The extent of water-taking required will be confirmed through the completion of the hydrogeological investigations prior to the start of preliminary design. ■ Follow PTTW requirements and EASR requirements.
Natural Environment	Surface Water Protection	■ Prior to dewatering effluent discharge, if required, periodically analyze the quality of the discharge water, including comparison to PWQO and local sewage by-laws. ■ Disperse pumped groundwater, treated construction water and/or compound runoff via existing vegetated drainage swales or storm sewers when it is periodically required.

Category	Potential Impacts	Mitigation Measures
Natural Environment	Source Water Protection	■ Consult the Source Protection Authority to confirm whether there are any prescribed drinking water threats, including applicable source protection policies associated with the watershed improvement projects during subsequent Class EA planning phases and detailed design. ■ Where an activity associated with the proposed project poses a risk to drinking water, it should be documented and discussed as to how the project adheres to or has regard to applicable policies in the CTC Source Protection Plan.
Natural Environment	Geomorphically Undersized Crossings	■ Works within existing and new development to replicate the natural flow regime (e.g., Low Impact Development – Stormwater retention). ■ Channel crossing should address the potential for in-channel erosion without impacting the local channel adjustment processes. ■ Crossings should extend greater than bankfull width and not impact natural sediment transport processes or channel velocity.
Natural Environment	Erosion	■ Implement Low Impact Development and Stormwater Management best practices to replicate more natural flow conditions. ■ Maintain or restore channel connection within the floodplain. ■ Maintain appropriate bankfull width dimensions throughout the watercourse. ■ Restore and maintain the riparian corridor with the addition of native plans, shrubs and trees. ■ Undertake erosion control works on reaches currently experiencing active erosion.
Natural Environment	Excess Soil Management	■ These activities will be completed in accordance with the MECP's current guidance document titled "Management of Excess Soil – A Guide for Best Management Practices" (2014) available online (http://www.ontario.ca/document/management-excess-soil-guide-best-management-practices). ■ Since the removal or movement of soils may be required, appropriate tests to determine contaminant levels may need to be undertaken. If the soils are contaminated, the proponent must determine how and where they are to be disposed of, consistent with Part XV.1 of the Environmental Protection Act (EPA) and Ontario Regulation 153/04, Records of Site Condition. If contaminated sites are present, the ministry's York-Durham District Office should be contacted for further consultation.

Category	Potential Impacts	Mitigation Measures
Natural Environment	Contamination of Soils Through Spills and Leaks	■ Contamination of soils through spills and leaks can be avoided by ensuring that fuel storage, refuelling and maintenance of construction equipment are handled properly and not allowed in or adjacent to watercourses. ■ Contingency plans will be prepared before construction begins for the control and clean-up of a spill, should one occur. ■ The MECP Spills Action Centre must be contacted if a spill occurs.
Social/ Cultural Environment	Archaeology and Built Heritage Resources	■ As required under the EA process, determine individual project's potential impact on archaeological, cultural heritage resources. Current recommendations for Schedule B projects are listed below: – Archaeological resources: screen the project with the MHSTCI "Criteria for Evaluating Archaeological Potential" and "Criteria for Evaluating Marine Archaeological Potential" to determine if an archaeological assessment is needed. If determined there is archaeological potential, then an archaeological assessment should be undertaken by an archaeologist licenced under the *OHA.* – Built Heritage and Cultural Heritage Landscapes: determine potential impacts to cultural heritage resources by completing the MHSTCI "Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes". If potential or known heritage resources exist, MHSTCI recommends that a Heritage Impact Assessment (HIA) be completed by a prepared by a qualified professional to assess potential project impacts. – Consult MHSTCI regarding individual watershed improvement projects during subsequent Class EA planning phases and detailed design to confirm requirements.
Social/ Cultural Environment	Short-Term Construction Related Impacts (Traffic and Access)	■ During the course of construction, there may be temporary disruption to traffic for select projects. The following measures will be employed to ensure that impacts are eliminated or minimized: – Prepare and follow the Construction Traffic Management Plan and provide advanced notification signage – Temporary access will be made available to residents/businesses if the access is severed for an extended period of time – Provide advanced notification of upcoming construction to affected property owners – Regular community project updates, including construction project manager contact information

Category	Potential Impacts	Mitigation Measures
Social/ Cultural Environment	Noise, Vibration and Dust	■ Construction operations to occur during day shift, where possible. ■ Adhere to municipal noise by-laws, where possible. ■ Use of low noise equipment during construction, where possible. ■ Ensure construction equipment is in good working order. ■ Implement a vibration, noise and dust monitoring and response program along with limits. ■ Dust control by use of non-chloride dust suppressants, spraying water, and street sweeping. ■ Install hoarding (fencing) around the perimeter of all construction compounds. ■ Complete preconstruction condition surveys of buildings along construction area.

10.1 Proposed Construction Monitoring

Contract tender documents will address the mitigation measures in an explicit manner and ensure that compliance with contract documents is maintained. Experienced field inspectors will also be on-site during construction to ensure that all contract specifications are followed and do not unnecessarily impact the environment.

10.2 Post Construction Monitoring

The proposed projects are not expected to result in negative impacts following construction. A post-construction monitoring plan will be developed and implemented to ensure that any disturbances have been property restored (e.g., grading, seeding and planting) and the projects (e.g., stormwater management retrofits) are operating as planned. Post-construction monitoring details will be developed during detailed design for subsequent project Class EA planning phases.

11. Consultation

11.1 Notices

The MEA MCEA document requires mandatory points of contact to facilitate public consultation. For Schedule B projects there are two mandatory points of contact during Phase 2 of the Municipal Class EA process. Notifications were distributed over the course of the Study at key project milestones (Notice of Study Commencement, Notice of Public Information Centres No's 1 and 2, and Notice of Completion). The following sub-sections hereafter describe the purpose and method for distributing each notice and are included in **Appendix E1.**

11.1.1 Notice of Study Commencement

The purpose of the Notice of Commencement was to introduce the Lynde Creek MDPU Study. This included identifying the Study's need and justification and Municipal Class EA process (i.e., Schedule B requirements – Master Plan Approach #2) and the two planned Public Information Centres (PICs) over the course of the Class EA process. The Notice provided Study Team contact information for potential inquiries, input, or to request to be added to the study's mailing list.

The Notice of Study Commencement was published in " Week this Whitby", as well as posted on the Town's website. Agencies, stakeholders and members of the public on the contact list were sent the Notice of Commencement via mail/regular mail and where required, by email.

Indigenous communities were provided a separate notice letter. This included a formal request to indicate whether they were interested in participating in engagement activities. Refer to **Section 11.4** for more information regarding engagement with Indigenous Communities.

11.1.2 Notice of PIC No. 1

The purpose of the Notice of Public Information Centre (PIC) No.1 was to notify the public, stakeholders, agencies and Indigenous communities about the first of two planned PICs. The Notice of PIC #1 provided details, including date, location, time, format and focus of what was to be presented at the first PIC. Study Team contact information was included for potential inquiries, input, or to request to be added to the study's mailing list.

The Notice for the first PIC was published on the Town's website and in two editions of "Whitby this Week" on May 23 and May 31, 2018. All members of the public with an interest in the study; agencies, Indigenous communities, stakeholders and members of the public on the contact list were invited via email and where no email was provided, regular mail to participate in the PIC. In addition, property owners located within the immediate area where CN and GO rail lines cross Lynde Creek (north of Highway 401) in southwest Whitby, were also notified by regular mail as part of the Lynde Creek CN/Metrolinx relief culverts project (see **Section 8.3**).

11.1.3 Notice of PIC No. 2

The purpose of Notice of PIC No.2 was to notify the public, stakeholders, agencies and Indigenous communities of the second PIC. Similar to PIC No.1, all members of the public with an interest in the study; agencies, Indigenous communities, stakeholders and members of the public on the contact list were invited via email and where no email was provided, regular mail to participate in the PIC. In addition, property owners located within the immediate area where CN and GO rail lines cross Lynde Creek (north of Highway 401) in southwest Whitby, were also notified by regular mail as part of the Lynde Creek CN/Metrolinx relief culverts project (see **Section 8.3**).

The Notice of PIC No. 2 included date, location, time, format and focus of what was to be presented. Study Team contact information was included for potential inquiries, input, or to request to be added to the study's mailing list. This notice was published on the Town's website and in two editions of "Whitby this Week" on October 4, 2018 and October 10, 2018.

11.1.4 Notice of Study Completion

The purpose of the Notice of Study Completion was to notify the public, stakeholders, agencies, and Indigenous communities of the completion of the planning process and opportunity to review of the MDPU. Similar to previous notifications, all members of the public with an interest in the study; agencies, Indigenous communities, stakeholders and members of the public on the contact list were notified by email, except where email was not provided or a request was made to be contacted by regular mail.

The notice was first issued on August 25, 2022. The notice was published on the Town's website and in two editions of "Whitby this Week". The notice specified the 30 day public review period and locations to review the Master Plan Project File documenting the MDPU planning process.

11.2 Public Consultation

For the Lynde Creek MDPU Study, two Public Information Centres (PIC) were held during Phase 2 (Alternative Solutions) of the Municipal Class EA process.

11.2.1 Public Information Centre No.1

The first PIC was held on June 5, 2018 from 6:00 PM to 8:00 PM at the Town of Whitby. Overall, there were 26 attendees that signed in at PIC #1, excluding Study Team members. The purpose of Public Information Centre (PIC) 1 was to:

- Introduce the Lynde Creek Master Drainage Plan Update (MDPU) Municipal Class Environmental Assessment (EA) Master Plan including background-previous watershed planning;
- Provide an overview of the Study's planning process including problem/opportunity statement;
- Present an assessment of existing conditions (e.g., natural heritage, fluvial geomorphology, hydrology-hydraulics, and stormwater management) within the watershed including study area problems being addressed (e.g., flooding, erosion and future land use);
- Present the CN/Metrolinx Relief Culverts project (Municipal Class EA Schedule B requirements) that is being satisfied under the Lynde Creek Master Drainage Plan Update; and,
- Gather public input and discuss next steps in the planning process.

Participants were invited to speak one on one with Study Team members and view the information display boards and associated fact sheets. **Table 11-1** summarizes the issues and feedback from participants as identified through one on one conversation with Study Team members and submitted comments sheets. The main issues/feedback identified from PIC #1 included:

1. Overall support for study, including areas of focus and CN/Metrolinx Relief Culverts;
2. Need to address localized problems identified by participants - flooding, erosion, MTO Highway 412 corridor ATV usage (temporary bridges) and bank stability; and,
3. Look at opportunities to improve active transportation linkages as part of the proposed CN/Metrolinx Lynde Creek relief culverts.

Figure 11-1: PIC No. 1

A summary of PIC No. 1, including submitted comment sheets is included in **Appendix E2.**

Table 11-1: Summary of Comments and Responses (PIC No.1)

Theme	Comment	Response
Problem/ Opportunity Statement – support for Study	1. Participants indicated they agreed with the problem / opportunity statement. 2. My concern would be more about the quality of water entering Lynde Creek. 3. As we continue to expand our urban lifestyle into the existing infrastructure, we need to keep vigil to ensure the wildlife and flora and fauna are minimally impacted.	1. Noted. 2. Being addressed through this study. 3. Being addressed through this study.
Existing Conditions – localized problems	1. Two participants indicated their concern regarding the impact of additional impervious land use created by the proposed development on the property located at Raglan Street & Giffard Street in Whitby. Both indicated this is already a stressed erosion area and will get worse with improvements to the infrastructure. 2. Consider landfill runoff, soil preservation, and endangered wildlife. 3. There are significant blockage and erosion problems on the section of Lynde Creek that flows through my property. As a minimum, resources should be allocated to deal with blockage/erosion issues on the section of Lynde Creek that flows through my property (shown as stressed area on fluvial geomorphology board) 4. In my opinion, resources should be allocated to purchase floodplain, wetland zoned areas from owners who do not have the resources to manage them. Clearly this will not happen if they are valued the same as hazard lands. 5. ATV / motorcycles are negatively impacting Lynde Creek in Highway 410 corridor (e.g., building temporary bridges)	1. Being addressed through this study. 2. Study Team to review area around closed landfill. 3. Site specific information – may be included in list of recommended improvement projects. 4. Noted. 5. Noted. Study to address Lynde Creek issues in MTO Corridor management area.

Theme	Comment	Response
CN / Metrolinx Culverts	1. Representatives from Jeffrey Street townhouses Condo Board that back onto Lynde Creek noted past flooding close to rear yards and indicated support for the project. 2. Promote active transportation/walking trails along Lynde Creek and connection to Lake Ontario Waterfront Trail. Add an additional culvert for multi-use path to provide north/south connection under Highway 401. 3. Is this cost effective? It will probably help.	1. Noted. 2. Town to review if relief culverts can be designed to accommodate future multi-use path at Highway 401 / CN/GO Lynde Creek crossing (dependent on Town agreeing to overall trail linkage concept). 3. Noted. The Town has recently initiated a separate EA study that is looking at other alternatives in addition to the proposed relief culverts with the objective of finding a lower cost solution.
Additional Information Requested	1. I live on Garrard Road, just outside the study area, but have a substantial amount of groundwater and must be constantly vigilant in the power goes out. Participant would like a solution, such as storm sewers to address this (currently no storm sewers on Garrard Road). 2. I would like to stay informed about proposed retention ponds on old land fill site on Garden Street.	1. Not being address through this study (Town municipal servicing issue). 2. Added to contact list.

11.2.2 Public Information Centre No. 2

The second PIC (Community Open House) was held on October 11, 2018 from 6:00 PM to 8:00 PM at the Town of Whitby. Overall, there were 29 attendees that signed in. The purpose of PIC No. 2 was to:

- Provide an update on the Lynde Creek Master Drainage Plan Update (MDPU) Municipal Class Environmental Assessment (EA) Master Plan, including feedback from the first open house;
- Present the completed impact assessments (i.e., natural heritage, fluvial geomorphology, hydrologic, hydraulic);
- Present the recommended Whitby Lynde Creek MDPU strategies, including associated watershed management projects; and,
- Gather public input and discuss next steps in the planning process

Figure 11-2: PIC No. 2

Similar to PIC No. 1, participants were invited to speak one on one with Study Team members and view the information display boards and associated fact sheets. **Table 11-1** summarizes the issues and feedback from participants as identified through one on one conversation with Study Team members and submitted comments sheets. The main issues/feedback identified from PIC #1 included:

1. Need to address localized problems identified by participants, including flooding, local drainage and erosion;
2. Overall support for the recommended projects, including proposed CN/Metrolinx Lynde Creek relief culverts and the potential for active transportation linkages; and,
3. Concerns with natural heritage features and associated recommended projects (e.g., stream riparian restoration 30 metres on side of watercourse) on agricultural lands and reduced development potential if lands are designated urban in the future.

A summary of the second open house, including submitted comment sheets, is included in **Appendix E3.**

11.3 Agency and Stakeholder Consultation

The key review agencies and affected Municipalities identified for the Lynde Creek MDPU are as follows:

- Ministry of the Environment, Conservation and Parks
- Ministry of Heritage, Sport, Tourism and Culture Industries
- Ministry of Natural Resources and Forestry
- CN Rail
- Metrolinx – GO Transit
- The Regional Municipality of Durham
- Township of Scugog
- City of Pickering
- Town of Ajax
- City of Oshawa

Table 11-2: Summary of Comments and Responses (PIC No. 2)

Theme	Comment	Response
Existing Conditions – localized problems	1. Concern regarding ponding in existing floodplain, including poor drainage and fish being trapped. Resident offered to send photos of the Lynde Creek "in flood". Requested data from the study and would like to know any future plans for the properties adjacent to the floodplain. 2. Work completed on Highway 412 has caused significant localized flooding on their property. Video documenting this has been previously provided to Town.	1. Comments noted. The study team contacted resident regarding Lynde Creek flooding photos to review. Photos were sent electronically to the study team as a follow-up to one-on-one discussion. Resident noted areas of erosion on the outer bend of the creek's meander and concern regarding existing and future water levels/flooding. 2. Comments noted. The study team will review drainage/flooding in the area resident has identified. The City is aware of reported drainage issues related to the 407/412 construction. The MDPU will discuss this in more detail.
Recommended Future Potential MDPU Projects	1. Two attendees noted active transportation improvements should be incorporated with the proposed CN/Metrolinx relief culverts. Suggest adding an additional slightly larger culvert to accommodate active transportation users. Photos were also submitted following the Open House showing the existing space under Highway 401 at Lynde Creek and existing active transportation corridor crossings in Oshawa and Quebec that have employed box culverts. 2. What is the connection between the MDPU and Jeffery Street Park Development that is already underway? Were setbacks taken into consideration? 3. Long term maintenance costs for stormwater management ponds should be discussed in the MPDU. 4. Improve vegetation in groundwater recharge areas	1. Comments noted. Town will need to confirm with CLOCA future plans for lands south of proposed culverts where connections to other trails could be made further south. The planned Gordon Street overpass would provide a connection to the lakefront; however it is many years away from being built. 2. Under a separate process, a permit for development activities at the Jeffrey Street Park was issued by CLOCA in 2018, including a new pedestrian crossing of Lynde Creek. The permitted design was reviewed to ensure that there would be no negative impact on flood levels from the associated site grading or the bridge crossing structure itself. 3. Estimated costs for recommended stormwater management pond retrofits will be included in the MDPU.

Theme	Comment	Response
	5. Attendee noted that they will send photos of property to confirm their obligations with regard to overall recommendations.	4. The study team recognizes the benefits of this and will consider it as a possible watershed management tool. 5. Comments noted. The study seam will review any photos received in the future and respond, as required.
Other – Land Use	1. Review future land use for City of Pickering (area of Ninth Concession and Lake Ridge)	1. The study team will review the future land use map against the Pickering Official Plan.
Additional Information Requested	1. Cross reference of MDPU recommendations and map locations. 2. A figure showing stream reach identification numbers 3. Request for electronic copy of the display boards	1. The list of recommended projects will be cross referenced in the final MDPU. 2. A figure showing stream reach identification numbers will be included in the MDPU. 3. Individuals who requested display boards will be sent a copy of the link to the display boards. Display boards can be found on the Town's website: www.whitby.ca/en/townhall/currentstudies.asp

Other agencies kept informed of the study are as follows:

- Ministry of Transportation
- Department of Fisheries and Oceans Canada
- Environment Canada
- Transport Canada
- Ministry of Infrastructure
- Ministry of Municipal Affairs & Housing
- Aboriginal Affairs and Northern Development Canada
- Indian and Northern Affairs Canada
- Ministry of Aboriginal Affairs
- Canadian Pacific Railway
- Durham Region Police Services
- Durham Regional Emergency Medical Services
- Whitby Fire Department
- Ontario Provincial Police
- Ministry of Agriculture, Food & Rural Affairs
- School Boards
- Utility and Telecommunication companies

The agencies and stakeholders were notified in accordance with the Municipal Class EA requirements, as required. The complete list of agencies and stakeholders are identified in **Appendix F1**. **Table 11-2** provides an overview of the comments received during Phases 1 and 2 of the Municipal Class EA process. Complete correspondence can be found in **Appendix F2**.

11.4 Indigenous Consultation

The following Indigenous communities have been notified throughout the study, as per the requirements of the Class EA process:

- Curve Lake First Nation[1];
- Hiawatha First Nation[1];
- Alderville First Nation[1];
- Mississauga of Scugog First Nation[1];
- Copy to Karry Sandy McKenzie, Williams Treaties Claims Co-ordinator[1];
- Chippewas of Rama First Nation;
- Nation Hurrone-Wendat; and
- Six Nations Council.

Note: 1 Indigenous communities identified as potentially affected.

Table 11-3: Summary of Agency and Stakeholder Comments and Responses

Agency / Organization	Date Received / Method	Comment	Response
The Bigileri Group	■ March 7, 2018 ■ Email	■ Requested more information regarding the Study, including how it will impact the Brooklin Community Secondary Plan area.	■ Study has only recently been initiated. ■ Recent changes to Town and Region Official Plans will form part of the MDPU.
Cardinal Environmental Consulting Services Ltd. Consulting Engineers	■ March 13, 2018 ■ Email	■ Requested to be added to the Study's contact list.	■ Contact list updated.
Active Transportation & Safe Roads Advisory Committee (ATSRAC) – Town of Whitby	■ March 14, 2018 ■ Email	■ In response to the Notice of Commencement, ATSRAC requested to be added to the Study's contact list ■ Identified interests regarding active transportation. There are several existing active transportation routes within the Lynde Creek Watershed boundaries.	■ Contact list updated.
Sabourin Kimble & Associates Ltd.	■ March 16, 2018 ■ Email	■ Requested Terms of Reference and completion date for the study.	■ The Master Plan Project File will be posted for the 30 day review period during early 2019. ■ Added to Study's contact list.
Ministry of the Environment, Conservation and Parks (MECP)	■ April 11, 2018 ■ Email	■ In response to the Notice of Commencement, the MECP provided a response letter providing guidance regarding the ministry's interests in the Municipal Class EA process.	■ Comments noted. The draft Master Plan Project File will be forwarded to the MECP prior to issuance of the Notice of Completion for review/comment.
Ministry of the Environment, Conservation and Parks (MECP)	■ April 29, 2019 ■ Email	■ Provided comments on the Draft MDPU, including project specific comments relating to the proposed CN/Metrolinx Relief Culverts.	■ All comments addressed in final MDPU report ■ Notified MECP that the Town is no longer seeking EA approval for the proposed relief culverts through this MDPU study. The project is identified in this MDPU as a water crossing upgrade item. ■ Draft Notice of Completion will be provided for review prior to issuance.
Ministry of the Environment, Conservation and Parks (MECP)	■ February 25, 2022 ■ Email	■ Provided comments on the draft Notice of Completion. ■ Will provide any additional comments on the MDPU report during the public review period.	■ Comments addressed for the Notice of Completion. ■ MECP will be provided the Notice of Completion with a link to the final MDPU report.
Canadian Environmental Assessment Agency (CEAA)	■ April 16, 2018 ■ Email	■ In response to the Notice of Commencement, the CEAA provided a response letter indicating the project is not a federal environmental assessment and therefore, CEAA can be removed from the study's contact list.	■ Contact list updated – CEAA removed.
City of Pickering	■ April 19, 2018 and May 29, 2018 ■ Email	■ Requests to be added to the study's contact list.	■ Contact list updated.
Infrastructure Ontario (IO)	■ April 20, 2018 ■ Email	■ In response to the Notice of Commencement, IO provided a response letter regarding IO's interest in the EA process; particularly, if the study is proposing to use lands under the control of the Ministry of Infrastructure.	■ Comments noted. Should any of the recommended projects require access to or from lands under the Ministry's control, IO should be consulted in the early stages of the project.
Ministry of Transportation (MTO)	■ April 25, 2018 ■ Email	■ In response to the Notice of Commencement, MTO requested to be kept informed as the study area contains provincial highways.	■ Contact list updated.
Miller Planning Services	■ May 3, 2019 ■ Email	■ Requested to be added to the study's contact list.	■ Contact list updated.
Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI)	■ May 29, 2018 ■ Email	■ In response to the Notice of PIC No. 1, MHSTCI provided a response letter providing guidance regarding the Ministry's interest in the Municipal Class EA process (i.e., archaeological resources, built heritage resources, and cultural heritage landscapes).	■ Given the large study area, an inventory of natural heritage resources and archaeological works will be undertaken in the future, as required, prior to the implementation of the individual projects identified in this MDPU (**Table 8-2**).

Agency / Organization	Date Received / Method	Comment	Response
Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI)	■ April 30, 2019 ■ Email	■ MHSTCI confirmed the approach to include a commitment for the recommended MDPU projects regarding future screening for archaeological potential, built heritage and cultural heritage resources. ■ Provided comments regarding the proposed CN/Metrolinx Relief Culverts Schedule B undertaking.	■ Where ground disturbance is anticipated, screening for archaeological potential, built heritage and cultural heritage resources will be completed, as required and in consultation with MHSTCI. Should it be determined through the screening that there is potential for impacts, the appropriate studies will be completed and submitted to the Ministry. ■ Notified MHSTCI that the Town is no longer seeking EA approval for the proposed relief culverts through this MDPU study. The proposed relief culverts project is identified in this MDPU as a water crossing upgrade item.
CN Rail	■ June 6, 2018 ■ Email	■ In response to the Notice of Commencement and request for initial comments regarding the 2016 Functional Feasibility Study (AECOM), CN confirmed via email on June 6, 2018 their agreement of Option 2 – relief culverts as being recommended under the Lynde Creek MDPU as a Schedule B project. ■ CN indicated the Kingston subdivision and will need to be trenchless (no open cut) as per one of the options noted in the 2016 Feasibility Study. Geotechnical report should be reviewed at this location to determine the preferred option. ■ Requested a copy of the geotechnical report in addition to a meeting to discuss requirements and documentation prior to approval.	■ Comments noted. ■ As per **Section 8.3**, the Town in partnership with CLOCA have initiated a separate Class EA study that includes re-examining the relief culverts.
Department of Fisheries and Oceans Canada (DFO)	■ September 27, 2018 ■ Email	■ In response to the Notice of Open House No.2, DFO indicated that they do not require notifications for administration purposes.	■ Removed from receiving future notifications.
Township of Scugog	■ October 4, 2018 ■ Email	■ In response to the Notice of Open House No.2, the Township of Scugog requested to be kept informed of the MDPU. ■ Would also like to know how study impacts Scugog (partially located within the Lynde Creek Watershed).	■ Added to contact list. ■ AECOM provided a link to display boards from Open House No.2. Township of Scugog will be provided a link to the electronic copy of the MDPU report with receipt of the notice of completion.
The Regional Municipality of Durham	■ October 9, 2018 ■ Email	■ Provided comments on the draft boards for Open House No. 2.	■ Comments addressed.
The Regional Municipality of Durham	■ April 29, 2019 ■ Email	■ Provided overall, project specific and policy comments on the Draft MDPU report.	■ All comments addressed in final MDPU report.
The Regional Municipality of Durham	■ July 14, 2022 ■ Email	■ Indicated previous comments were addressed.	■ The Region will be provided the Notice of Completion with a link to the final MDPU report.
Enbridge Pipelines Inc.	■ October 18, 2018 ■ Email	■ In response to the Notice of Open House No.2, Enbridge requested to send notifications to the following email: est.reg.crossing@enbridge.com	■ Study contact list updated accordingly. ■ Future notifications will be sent via the email provided.
Ministry of Natural Resources and Forestry (MNRF)	■ October 23, 2018 ■ Email	■ In response to the Notice of Open House No.2, MNRF requested to be added to Study's contact list. ■ Correspondence noted the numerous significant natural areas and species at risk within the study area.	■ Added to contact list. ■ Requests for terrestrial natural heritage information that are not publically available were requested from the MNRF on April 10, 2018 and a response was received from the MNRF on August 1, 2018.
Toronto and Region Conservation Authority	■ May 15, 2019 ■ Email	■ Provided comments on the Draft MDPU with regard to the vulnerable areas identified under the Clean Water Act, 2006 and in the CTC Source Protection Plan. ■ Requested to be consulted in the future regarding potential impacts on drinking water prior to implementation of the recommended environmental assessment projects.	■ All comments addressed in Final MDPU. ■ Future Schedule B projects identified in Table 8-2 may not proceed to implementation until the project-specific EA. requirements are fulfilled. This includes consulting the source protection authority regarding potential impacts on drinking water.

A copy of the letters/notifications distributed to the above communities can be found in **Appendix G1. Table 11-4** provides a summary of the correspondence received during Phases 1 and 2 of the Municipal Class EA process. Refer to **Appendix G2** for the complete correspondence.

Table 11-4: Summary of Indigenous Comments and Responses

Indigenous Community	Comment	Response
Nation Hurrone-Wendat	■ In response to the Notice of Commencement and request regarding potential involvement in this study, Nation Hurrone-Wendat indicated via email on April 8, 2018 they would like to stay informed and involved in the MDPU with respect to archaeological work.	■ Nation Hurrone-Wendat will be notified by the Study Team of any archaeology study or work that is completed as part of this Study.
Chippewas of Rama First Nation	■ In response to the Notice of Commencement and Notice of PIC No.1, Chippewas of Rama First Nation indicated they forwarded the notification to Karry Sandy McKenzie, Williams Treaties First Nation Process Co-ordinator/Negotiator.	■ Comments noted. The Study Team will contact Ms. McKenzie, if required during the EA process.
Chippewas of Rama First Nation	■ In response to the Notice of Community Open House No. 2, Chippewas of Rama First Nation indicated no concerns or comments regarding the Lynde Creek MDPU at this time. Notify Chippewas of Rama First Nation of any future projects that may potentially impact their traditional territories.	■ Comments noted.
Mississaugas of Scugog Island First Nation (MSIFN)	■ In response to the Notice of Commencement and request regarding potential involvement in this study, MSIFN indicated via email on April 27, 2018 they would like to stay informed and involved. This includes information sharing in all aspects of the study and direct engagement and consultation with the Study Team. The study area falls within the Williams Treaties Clause 2 lands. ■ Provided updated contact information for future correspondence.	■ The Study Team requested to meet with MSIFN to discuss MSIFN's interest in the study, including any concerns and to share work completed to date. Meeting was held on August 22, 2018. ■ MSIFN will be provided a digital copy of the Project File, as well as be notified of future archaeological studies associated with the recommended projects. ■ Contact list updated.

In addition to the above correspondence, one meeting was held with the Mississaugas of Scugog Island First Nation (MSIFN) on August 22, 2018 to share and review work that has been completed to date and identify potential impacts concerning this study. MSIFN is primarily interested-concerned about environmental-ecological integrity including biodiversity and negative impacts from urbanization (e.g., loss of cold water streams).

As per the August 22, 2018 meeting minute action items, MSIFN was provided relevant Transportation Association Canada (TAC) Salt Management guidelines-information. **Appendix G2** contains the complete meeting minutes, including follow-up correspondence.

Part D: Implementation

12. Master Drainage Plan Update Implementation and Monitoring Strategy

12.1 Implementation Plan

The Implementation Plan comprises **Table 8-2** and related figures:

- **Figure 8-1** Recommended Lynde Creek MDPU Projects – Aquatic and Terrestrial;
- **Figure 8-2** Recommended Lynde Creek MDPU Projects – Stormwater Management Facilities;
- **Figure 8-3** Recommended Lynde Creek MDPU Projects – SWMP Retrofit ; Major Relief Culvert and Watercourse Crossing Upgrades; and
- **Figure 8-4** Recommended Lynde Creek MDPU Projects – Fluvial Geomorphology.

The Implementation Plan provides a framework for Planning Act Development Application(s) for future development within the Secondary Plan Areas through Sub-Area Studies (SAS) as well as guidance to the Town and CLOCA in addressing natural heritage, flooding and erosion issues.

12.2 Monitoring Strategy

The following strategies apply to Land Development as well as to the implementation of works related to the Natural Heritage System maintenance and improvements.

12.3 Erosion and Sediment Control Planning (Construction)

Future construction activities taking place in study area will require clearing of vegetation, topsoil stripping and earth grading that leaves exposed soils vulnerable to wind and water erosion. Stringent sediment and erosion control measures will need to be implemented to ensure that the adjacent natural heritage system is not negatively impacted by construction practices. Sediment release due to construction activities is not only detrimental to the health of the receiving environment but will also result in costly future maintenance work of the existing downstream drainage infrastructure.

Prior to construction, comprehensive erosion and sediment control (ESC) plans must be submitted to the Town and CLOCA detailing the methods that will be used to prevent the release of sediment laden runoff from the construction site. There are extensive sediment and erosion control guidelines available that describe the design considerations, application and function, implementation procedures, maintenance procedures and removal procedures for a wide variety of sediment and erosion control measures for construction sites. The following is a list of existing guidelines currently used in Ontario:

- MNRF Technical Guideline: Erosion and Sediment Control;
- Environmental Guide for Erosion and Sediment Control During Construction of Highway Projects (MTO 2015); and
- Erosion and Sediment Control Guidelines for Urban Construction (December 2006 – GGH-CAs).

The Erosion and Sediment Control Guidelines for Urban Construction (December 2006) is the guideline to develop the most effective ESC plans for the Town; these guidelines must be consulted before submission of an ESC plan. The comprehensive checklists provided in these guidelines are specifically designed to assist developers, contractors and inspectors with developing and implementing effective ESC plans.

Typical sediment and erosion control best management practices currently in use today include but are not limited to:

- Sediment traps, dewatering traps;
- Sediment control fencing;
- Check dams;
- Inceptor swales and ditches;
- Temporary stabilization measures of exposed soils (e.g., erosion control matting, seeding, hydro seeding, and mulches);
- Construction mud matts; and
- Protecting surface inlets with filter cloth.

In order for these measures to be truly effective, they will need to be monitored regularly by the contractor to ensure that these measures are maintained in proper working order throughout the construction phase and until the site has become fully stabilized.

12.3.1 Erosion and Sediment Control Inspection

Approved sediment and erosion control plans are to be monitored at the start of construction and throughout the construction phase by the Town (or their designated site inspector) until the site has become fully stabilized. The contractor will be required to perform routine (minimum once a week) sediment and erosion control inspections to ensure that the sediment and erosion control measures are maintained and functioning as intended.

Sediment and erosion control measures shall be inspected:

- Prior to forecasted rainfall events to ensure that the measures are in proper working condition;
- During rainfall events to observe in situ performance; and
- After rainfall events to identify measures that may require immediate repair or maintenance.

The following provides examples of thresholds for when maintenance work is required:

- Once sediment accumulation in sediment traps, sedimentation basins, dewatering traps, catchbasins among others occupies 60% of the available volume a cleanout will be required;
- If sediment accumulation depths behind silt control fencing, granular berms, etc. exceeds 300 mm the sediment must be removed; and
- Filter fabric protection of surface inlets and discharge points to be checked and replaced regularly (i.e., after heavy rainfall events).

The inspection reports will verify that the sediment and erosion control measures are in place and properly maintained. In the event that the proposed ESC plans are not operating as intended corrective measures shall be taken immediately.

12.3.2 Erosion and Sediment Control Monitoring

In addition to weekly inspections the contractor shall also be responsible for submitting regular water quality monitoring reports. As explained above, the inspections will verify and ensure that sediment and erosion control measures are in place and maintained. The water quality testing will ensure that the sediment and erosion control measures are performing and preventing the release of sediment laden water into the receiving watercourses.

The water quality parameter to be measured is Total Suspended Solids (TSS) and samples shall be required during and after rainfall events applying the following criteria:

- Storm fall events greater than 10 mm (verify rainfall volume with on-site rain gauges); and
- Take discrete water quality samples of stormwater runoff leaving the site at all outlets regardless of where they outlet during and after rainfall events.

The measured TSS concentrations will provide municipal staff with an indication of how the concentrations compare to typical TSS concentrations for construction sites with similar soil types. Threshold concentrations will be established to trigger when municipal staff need to perform independent inspections. Through site inspections it can be determined whether the sediment and erosion control measures are in need of maintenance, are improperly installed or whether additional measures need to be added to the existing treatment train to lower TSS concentrations to acceptable levels.

12.4 Monitoring Parameters

For the Study Area, two types of monitoring programs are proposed:

1. Performance assessments of SWM facilities; and
2. Watershed effectiveness assessment to ensure MDP objectives are met, during the ongoing establishment of NHS and Erosion Control projects.

A major component of a MDP or SAS is SWM. It usually results in the construction and operation of built works such as stormwater ponds, conveyance features and infiltration facilities. These facilities are typically designed to meet some receiving water objectives such as: flood control, channel erosion control, water quality protection / improvement, habitat protection, and protection of biota, including fish. Thus, monitoring may involve both water quality and quantity monitoring that may be in stream or at other locations.

In-stream monitoring parameters can be both specific constituents or surrogates. The specific parameters are typically related directly to the objective or use being protected, whereas, for stormwater facilities, indirect parameters or surrogates are often used as indicators when monitoring system performance. In other words, different parameters will have to be identified and monitored to evaluate the system effectiveness in-stream and performance in the facility. The effectiveness is measured by comparing the monitoring results to the targets established for the parameters for each objective. **Table 13-1** illustrates this point. Monitoring in a watershed for the facility and watercourse elements will take advantage of the common elements for all objectives (i.e., rain, flow, water quality, and toxicity data). Objective specific data will have to be collected for erosion control, and aquatic habitat and biota.

Table 12-1: Monitoring Parameters for SWM Objectives

Objectives	Flood Control	Channel Erosion Control	Water Quality Improvement	Habitat/Biota Protection
System Element: SWM Facility	Rainfall, peak flow rate, water level, flood flow routing, draw down time	Rainfall, flow rate and duration, water level	Pollutant removal efficiency; sediment accumulation; temperature	Discharge water quality, toxicity
System Element: Watercourse	Peak flow rate, water level, property damage	Flow rate and duration, water level, bank erosion, channel modifications stable, velocity, bed substrate, bank recession, down cutting of channel, bank vegetation	Water quality improved? PWQO met? Subwatershed targets met?	Habitat parameters / indices (including physical parameters), toxicity, macro invertebrate indices / fish health indices, biomonitoring

12.5 Performance Assessment Monitoring for SWM Facilities

12.5.1 Objectives

The performance assessment monitoring objectives are as follows:

- Determine whether performance of control facility meets design objective;
- Can facility be assumed from developer?; and
- What level of continued monitoring and maintenance are needed?

Following construction, each facility should be inspected and compared to the design by municipal staff to ensure compliance and a monitoring policy should be implemented. The facility should be monitored for compliance for a minimum period of two years under the ownership of the developer starting once the development has been assumed by the Town. A monitoring report should be provided to the Town and Conservation Authority twice per year for the two year period. Responsibility for and ownership of facilities would be assumed by the Town after a period of three consecutive years of monitoring that confirms the targets and objectives have been met. Should the monitoring show non-compliance, the developer would be responsible for implementing the contingency plan / remedial measures and continued monitoring, until the monitoring confirms compliance for three consecutive years.

12.5.2 Analysis

Operations Monitoring

- Compare infiltration, flood control and quality control pond hydraulics to design specifications for flow splitting, volume controlled, drawdown time and released flow rates. Compare total capture to expected volumetric control level. Compare quantity control hydrology to what was expected as the modelled performance. May need to apply models for some analysis steps. Calculate removal rate efficiency of parameters and compare to established targets.

Maintenance Monitoring

- Observe or measure sedimentation in channels, sediment build-up in ponds, berm erosion, litter build-up, clogging of inlet and outlet structures, free operation of moveable control elements, health of wetland plants, pond security and gratings, etc.

12.5.3 Action Plan / Remedial Action

The Action Plan/Remedial Actions are as follows:

- Facility functioning as designed – Town assumes facility from developer;
- Modify pond hydraulics – continue monitoring until facility meets targets and can be assumed from developer;
- Maintain pond;
- Replant aquatic plants;
- Remove sediment buildup; retrofit additional controls in pond or upstream in drainage area – continue monitoring until facility meets targets and can be assumed from the developer; and
- Modify design and / or targets for future similar cases.

12.6 Monitoring Program - NHS

The monitoring program for natural heritage features within proximity to areas that will be developed shall be undertaken by a developer within the minimum two year period beginning once development has been assumed by the Town. After a period of three consecutive years of monitoring that confirms that the targets and objectives of each facility have been met, all monitoring shall be assumed by the Town. It is recommended that monitoring adhere to the timelines and protocols identified for each natural heritage component listed below, but will be required for a minimum of two years following construction completion.

12.6.1 Terrestrial

Ecological monitoring is described as "*a measurement or estimation of change in an indicator's status over time*" (Busch and Trexler, 2003). The monitoring provides data on the feature of interest. Data on the ecosystem are measured against targeted, measurable objectives set out in the beginning of the monitoring program. If the data collected at a given point in time of the monitoring match the goals and objectives then the success of the project objective are on track. If these data do not match, then some form of mitigation, remedial action or adjustment is required (Ecological Engineering 2000).

The focus of the terrestrial monitoring program is to detect potential changes in the quality and quantity of wildlife habitat, species richness and diversity, wetland and woodland features and functions, local landscape connectivity and wildlife movement, and habitat enhancement and restoration. The overall objective is the preservation, maintenance and enhancement of the environment.

12.6.1.1 Vegetation Communities

Monitoring changes in vegetation community composition and boundaries will assist in detecting changes as a result of natural succession, plantings (see below), and potential impacts as a result of development.

The use of the standardized Ecological Land Classification (ELC) system allows for the review and monitoring of vegetation community composition and boundaries over time. This approach has been used in a number of similar studies in which the extent of vegetation communities has been monitored using field surveys and / or aerial photography. Field surveys should follow the ELC system protocols (Lee *et al.*, 1998), as well as the most current Municipal/CA Environmental Impact Statement (EIS) protocols.

12.6.1.2 Woodlands

Woodland monitoring should consist of a series of standard permanent monitoring plots following a standard protocol. Standard protocol includes the establishment and monitoring of several permanent monitoring quadrants within the ESA / ANSI and compensation areas should development be within proximity to these areas. Post-construction monitoring shall evaluate the various strata within the woodlands, and shall include tree and shrub tallies, health assessments, signs of disturbance, and percent cover of herbaceous species present (which includes abundance indices and a list of invasive species present). This monitoring should be conducted in concert with wildlife monitoring (see below) and during a time that allows for capture of early spring flowering ephemerals (during May).

12.6.1.3 Enhancement

Within the study area, there are opportunities for enhancement of existing features to improve the overall state of the natural condition. It is recommended that enhancements occur along existing stream riparian areas with consideration of the following enhancement options:

1. **Native Plantings** – native to Ontario plantings with guidance from Town and CLOCAA staff are recommended bolster the diversity of existing riparian edges, improve shoreline substrate retention and improve overall cover to facilitate wildlife movement. Areas where native plantings are targeted will need to ensure plants are selected considering soil, moisture, sun, wind and surrounding vegetation conditions.
2. **Removal of Invasive Plants** – Enhancement through removal of invasive plants will increase biodiversity and promote establishment of native plants increasing wildlife use in an area. Especially for areas which contain invasive plants including common reed (*Phragmites australis*), reed canary grass (*Phalaris arundica*) and common buckthorn (*Rhamnus cathartica*).

   Removal of the common reed and reed canary grass could be undertaken by the following methods:

   a) Mowing, followed by a prescribed burn or herbicide application;
   b) Compression/Rolling, followed by a prescribed burn or herbicide application;
   c) Cutting plants to less than 10 cm in height, removing the biomass and covering the area with tarps or heavy duty geotextile fabric (woven plastic fabric);
   d) Application of herbicides either glyphosate and imazapyr, provided no standing water is not present; and
   e) The area should then be replanted with native species including: shrubs such as sandbar willow, gray dogwood and red-osier dogwood as well as grasses such as cattail species.

   In order to avoid a subsequent invasion, the cut plant materials should be placed into thick plastic bags which are left in the sun to kill viable seeds and rhizomes. After which the materials can either be burned or disposed of per municipal guidelines. All workers boots and clothing should be cleaned prior to re-use. Treatments should be repeated annually for three years until the patch has been completely eliminated.

Removal of common buckthorn could be undertaken by cutting stems to the ground combined inoculation of glyphosate. Repeated treatments prior to seed would be required. This treatment must be followed by replanting the area with native species.

12.6.1.4 Wildlife

Wildlife monitoring is recommended to consist of breeding bird surveys, as well as amphibian monitoring. These two groups of species are fairly readily monitored and are sensitive to changes in habitats and potential impacts of development. Standard monitoring protocols are in use throughout southern Ontario and can be used to track changes in species overtime.

- **Birds:** The Ontario Breeding Bird Atlas and the most current municipal/agency Environmental Impact Statement (EIS) protocols should be used to monitor breeding birds at strategic locations in the Study Area.
- **Amphibians:** Early spring call surveys following the standard Marsh Monitoring protocol should be conducted at strategic wetland areas.

12.6.2 Streams

12.6.2.1 Fluvial Geomorphology

As land use changes within the watershed, there are several monitoring program recommendations that can be made to evaluate changes and / or issues along the watercourses potentially due to development. It is proposed that with future development within the Study Area and subsequent changes to flow, that monitoring of channel morphology occur.

Field surveys should be completed once every five years to assess channel migration and planform adjustment on a larger scale and should include the insertion of erosion pins at each location. Key to this effort will be landowner permission to access all of the monitoring sites. These data will prove invaluable in assessing the effects of urbanization on the stream network and will allow for the identification of changes to channel width, depth, cross-sectional area, riffle and inter-pool gradients, and lateral migration of the watercourse. These variables should not increase or decrease in excess of 20%, but baseline data should be analyzed by a qualified fluvial geomorphologist and based on the results, the proposed thresholds may be modified. If significant adjustments are identified then they will be further investigated by the fluvial geomorphologist to determine the cause and consultation with stakeholders will occur.

12.6.2.2 Fisheries

A number of post-construction monitoring activities are recommended to be carried out for this project, particularly with respect to the aquatic environment. Due to the nature of the Study Area and the work that is being undergone, monitoring tasks will be used to determine the potential effects of the Project on the health of the fisheries habitat within the Study Area. Downstream monitoring will be conducted to assess a number of factors, including any changes in riparian vegetation growth, stream temperature, suspended sediment amounts, and biodiversity as a result of construction activities. The proposed methods that will be utilized are described below along with the most current municipal/agency Environmental Impact Statement (EIS) protocols ensuring that investigations are conducted during the appropriate season.

12.6.2.3 Riparian Vegetation

Ecological Land Classification (ELC) mapping as well as site specific monitoring of success of restoration / enhancement planting is proposed. Riparian vegetation monitoring will be incorporated with the terrestrial monitoring program described above. This program is considered adequate to determine if the desired increase in riparian vegetation is occurring.

12.6.2.4 Stream Temperature

Stream temperature monitoring should occur to determine success of maintaining or improving water temperatures. The methodology used should combine those detailed in the Department of Fisheries and Oceans "Method to Determine the Thermal Stability of Southern Ontario Trout Streams" (DFO 1996) and the Stream Thermal Characteristics Classification Methods (Chu et al. 2009). The methodology will involve recording stream temperature at scheduled intervals (typically 15 minutes) using data loggers that have been installed at selected locations throughout the watercourses. The data are then plotted on a nomogram which uses the temperature data from July 1st to August 31st, when the daily maximum air temperature is typically above 24.5°C. On these days, the corresponding daily maximum water temperature as measured between 16:00 and 18:00 is plotted against the corresponding daily maximum air temperatures. The data are plotted against ranges of five thermal classifications (Cold, Cold-Cool, Cool, Cool-Warm, Warm) to determine the thermal classification of the watercourse. A monitoring system as described above will allow measurement of the success of control measures (riparian vegetation and SWM) in maintaining and / or improving stream temperatures.

12.6.2.5 Suspended Sediment

A monitoring program is required to confirm the success of SWM initiatives to control suspended solids to the intended levels.

12.6.2.6 Biodiversity

Biodiversity monitoring is recommended for fish and benthic invertebrate communities within the Study Area. Both species richness (number of species) and evenness (distribution of individuals across species) must be incorporated in the measure of biodiversity. Simple biodiversity indices such as those developed by Shannon and Weaver and Simpson are recommended for both the fish and benthic invertebrate communities. While not solely a measure of biodiversity the Hilsonhoff Index should also be used to analyze the benthic invertebrate community, the results of this index can provide an overall assessment of water quality through benthic community species richness. Fish community sampling should be completed following the Multiple Pass Survey method as detailed in Section 3, Module 1 of the Ontario Stream Assessment Protocol (OSAP) (Stanfield et al. 2007). The Multiple Pass method requires the use of block nets and offers the greatest probability of capturing all species within a site. The benthic community should be sampled following the Ontario Benthos Biomonitoring Network (OBBN) Transect Travelling Kick and Sweep collection method (Jones et al. 2007). The collection of fish and benthic invertebrates following these two methodologies will result in data sets which will allow for trend over time assessment of the aquatic community.

12.7 Monitoring Program – Hydrology/Hydrogeology

12.7.1 Stream Flow

It is recommended that continued support of the Water Survey of Canada streamflow monitoring system be continued. Streamflow measurements will allow the calculation of annual peak flow rates as development progresses within the Study Area. Peak flow rates will determine if the Implementation Strategy has been successful. If peak flow rates increase, modifications may be required to the outlet works of the stormwater management facilities. In addition, continuous streamflow measurements will allow the determination of flow duration curves, baseflows, and annual runoff volumes. It is also recommended that streamflow monitoring of headwaters be implemented as part of the calibration process recommended for the hydrologic model update.

12.7.2 Hydrogeology – Groundwater Monitoring

Changes to the groundwater regime are usually difficult to observe and quantify. Groundwater contributions to existing streams are an important factor in their ecological health and function. Therefore, for stream reaches where there is currently an observed or interpreted groundwater discharge, future monitoring should be done as an overall measure of stream health. This would focus on stream flow and the aquatic habitat function of the reach. This report provides a water balance assessment and presents LID measures that provide mitigation for the effects of future development.

Because year to year variations in the condition and function of these tributaries are expected, the tracking and comparison of long term observations to both historical observations and predicted changes will enable a determination of the overall success of the management plan. Should significant variations occur, that affect the health and function of the tributaries, opportunities for implementing alternative mitigation measures can then be explored.

In addition to the stream / habitat monitoring, the water table elevation should also be monitored. Groundwater wells should be monitored at least semi-annually during periods of high and low water table (after spring melt and in late summer). As there are relatively large seasonal and year to year fluctuations in the water table, monitoring data should be compiled to create baseline data to evaluate future groundwater fluctuations in the Study Area related to development. In order to achieve this monitoring program, the wells will have to be maintained in place and unaltered during the development (construction) process.

12.7.3 Further Hydrogeologic Analysis

Sub-Area Studies will have identified hydrogeologic features within the BSP study area. Further analysis related to the hydrogeological components of the system to be addressed prior to development include:

- A water balance evaluation, at the scale of each proposed development that addresses potential impacts to groundwater quantity and quality;
- A characterization of all hydrologic features illustrated on the constraint mapping and their functions;
- A description of the relationship and interdependence of these features and functions;
- Site-specific soil and groundwater investigations to assess the potential for groundwater recharge and infiltration. This will assist in identifying appropriate Best Management Practices / Low Impact Development; and

- Define other lot level measures that could be implemented, assess the relative benefits of these measures with respect to groundwater quantity and quality.

12.8 Monitoring Program - Water Quality (baseline and post-construction)

The water quality monitoring program is to be based upon targets for TSS controls for suspended solids. Parameters to be included in the monitoring are:

- Chloride;
- Total Phosphorus;
- Metals (cadmium, copper and zinc);
- Nitrates;
- Total Suspended Solids;
- Dissolved oxygen;
- Conductivity; and
- Water temperature and pH.

The monitoring of temperature is based primarily upon fisheries protection**.**

The remaining water quality parameters are to be monitored in-stream and can be linked to streamflow monitoring to provide a representation of overall effectiveness of the management strategy. It is recommended that water quality be monitored along regular sections of the stream corridor, as well as downstream of stormwater management ponds.

The monitoring program should include nine rainfall events for the first year (to collect baseline information and establish event mean concentrations), followed by three rainfall events per year for each consecutive year. It is recommended to use automated flow-weighted samplers for monitoring of rainfall events at the two main stations. A temperature probe should be used to record water temperature at regular intervals (15 to 30 minutes). Other statins may be monitored using grab samples. Three dry weather events should also be monitored by collection and analysis of grab samples in each year including the first year.

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