Durham Watershed Planning Project – 2021 and 2022 Summary Report

Kawartha Conservation
2023

Discover · Protect · Restore

About Kawartha Conservation

Who we are

We are a watershed-based organization that uses planning, stewardship, science, and conservation lands management to protect and sustain outstanding water quality and quantity supported by healthy landscapes.

Why is watershed management important?

Abundant, clean water is the lifeblood of the Kawarthas. It is essential for our quality of life, health, and continued prosperity. It supplies our drinking water, maintains property values, sustains an agricultural industry, and contributes to a tourism-based economy that relies on recreational boating, fishing, and swimming. Our programs and services promote an integrated watershed approach that balance human, environmental, and economic needs.

The community we support

We focus our programs and services within the natural boundaries of the Kawartha watershed, which extend from Lake Scugog in the southwest and Pigeon Lake in the east, to Balsam Lake in the northwest and Crystal Lake in the northeast – a total of 2,563 square kilometers.

Our history and governance

In 1979, we were established by our municipal partners under the *Ontario Conservation Authorities Act*. The natural boundaries of our watershed overlap the six municipalities that govern Kawartha Conservation through representation on our Board of Directors. Our municipal partners include the City of Kawartha Lakes, Region of Durham, Township of Scugog, Township of Brock, Municipality of Clarington, Municipality of Trent Lakes, and Township of Cavan Monaghan.

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Executive Summary

The purpose of this report is to provide Durham Region with up-to-date information on water resources in the Lake Scugog drainage basin. This information will help municipal land use planners review Planning Applications more efficiently.

This report is accompanied by digital mapping files, and provides key findings and management recommendations on the following features of municipal interest:

Streams (e.g., surface water drainage features):

- there are 714 km of streams; these should be routinely checked in areas of land use change.

Coldwater streams (e.g., streams that have the potential to support sensitive life such as Brook Trout and Stoneflies):

- stream sensitivity potential was determined at 242 road-stream crossings; more efforts needed to confirm if these streams support sensitive life.

Wetlands (e.g., wet areas with vegetation, some of which could be provincially significant):

- there are 141km^2 of wetlands; recent provincial updates to legislation will likely results in a reduction in area of provincially significant wetlands.

Climate change impacts (e.g., anticipated changes in water quality and coldwater streams based on global warming):

- preliminary estimates indicate a decrease in water quality and sensitive areas in streams draining into Lake Scugog, from forecasted increased rainfall and air temperatures.

Significant groundwater recharge areas (e.g., lands that absorb lots of water and release it to creeks and wetlands).

- There are 153km^2 of significant groundwater recharge areas; these should be refined as necessary when changes to coldwater streams or wetlands are made.

Table of Contents

List of Figures

1.0 Introduction

To assist local planning authorities in meeting core provincial policy requirements, Kawartha Conservation and Durham Region completed a project in 2020 to address information gaps and centralize existing information (and in certain instances obtain new information).

Three summary reports were produced pertaining to the identification and mapping of the Water Resource System (Kawartha Conservation, 2020a), Key Natural Heritage Features (Kawartha Conservation, 2020b), and Watershed Plan Conformity (Kawartha Conservation, 2020c) within the shared jurisdictions of both agencies.

In 2021, Kawartha Conservation and Durham Region entered a 2-year ‘Watershed Planning’ project partnership to address key recommendations identified in the previous three reports to help make the review of *Planning Act* applications faster, more consistent, and more comprehensive.

The purpose of this 2-year project is to ensure that Durham Region has the most up to date information related to Water Resource Systems, Natural Heritage Systems, and Watershed Planning to assist with ongoing Municipal Conformity Review exercises and land use planning activities related to our Planning Services Partnership Memorandum of Understanding (MOU).

Deliverables from this project are:

- Verify the flow path of permanent and intermittent streams [Chapter 2.0].
- Confirm the status of permanent and intermittent streams, and coldwater habitats [Chapter 3.0].
- Evaluate and confirm the location of wetlands currently mapped as ‘unevaluated’ [Chapter 4.0].
- Integrate new climate change information into water quantity, water quality, and aquatic habitat assessments [Chapter 5.0].
- Address gaps in mapping of Ecologically Significant Groundwater Recharge Areas [Chapter 6.0].

The subsequent chapters in this report provide a summary of the 2-year (2021 and 2022) project activities related to addressing the itemized objectives listed above.

2.0 Verify the flow path of permanent and intermittent streams

Background

Permanent and intermittent streams (often called ‘watercourses’) are key hydrologic features as per provincial policy, and typically regulated features as per the *Conservation Authorities Act*.

- Permanent streams are defined in the Greenbelt Plan as: *“a stream that continually flows in an average year.”*

- Intermittent streams are defined in the Greenbelt Plan as: *“stream-related watercourses that contain water or are dry at times of the year that are more or less predictable, generally flowing during wet seasons of the year but not the entire year, and where the water table is above the stream bottom during parts of the year.”*

The OHN (Ontario Hydro Network) mapping layer, managed by the Ministry of Natural Resources and Forestry, is used for planning purposes. This layer provides a reasonable approximation of the location of permanent and intermittent streams across the province, but at the local level staff noted several inconsistencies in the layer and therefore undertook a verification process to ultimately increase the effectiveness of file review.

Verification was a desktop exercise (i.e., there was no ground-truthing component), and began in 2020. The ‘blue-line’ network totalling 769 km was edited (e.g., segments kept, added, or removed) by digitizing at a scale of between 1:500 and 1:1,500. Layers used included the most recent aerial imagery (2018) with the OHN stream layer and Digital Elevation Model (DEM) layer.

Verified streams included the following: (a) streams clearly visible on the aerial imagery but were not included on the existing OHN layer or DEM layer, and/or (b) streams that were included on the existing OHN layer that were confirmed through aerial imagery and DEM flow paths (including those not contiguously visible - continuity was inferred when DEM flow path was nearby).

At the end of that exercise, 89% (683 km) streams were verified. Non-verified streams represented (11%) 86 km and consisted of streams that are present on the base OHN layer but could not be seen on the aerial imagery nor on the DEM layer.

Verification continued in 2021, with the acquisition of more recent (2020) aerial imagery and Durham Region's All Digital Terrain Modelling (DTM) Lines 2020 dataset. The remaining 86km of 'non-verified' streams were verified (Figure 2.1). This included the removal of 55 km of streams, the majority of which were mapped as flowing through agriculture fields but are no longer clearly visible.

The updated 'blue-line' watercourse layer is managed by Kawartha Conservation and is named: '*KRCADURHAM_WRIS_Watercourse_Verified_20211209'* and can be accessed through the Natural Features category in our staff mapping tool. In addition, it has been sent to the province and Durham Region. It contains 714 km of perennial and intermittent streams.

Key Findings and Recommendations

- A new verified watercourse layer (updated November 2021) is an improvement on the provincial Ontario Hydro Network layer and contains approximately 714 km of perennial and intermittent streams.

- Recommend that repeated large-scale verifications should be again completed in 5-years time (e.g., 2026) as land use change progresses (e.g., land conversion into development or agriculture). In the meantime, verifications should include routine updating of small sections based on site-specific field visits that arise from planning and regulations file review activities.

References and Additional Resources

MNRF (Ministry of Natural Resources and Forestry). 2022. Ontario Hydro Network - Watercourse layer. Available online at Ontario GeoHub: https://geohub.lio.gov.on.ca/datasets/a222f2996e7c454f9e8d028aa05995d3/explore?location=50.580480%2C-84.745000%2C5.18

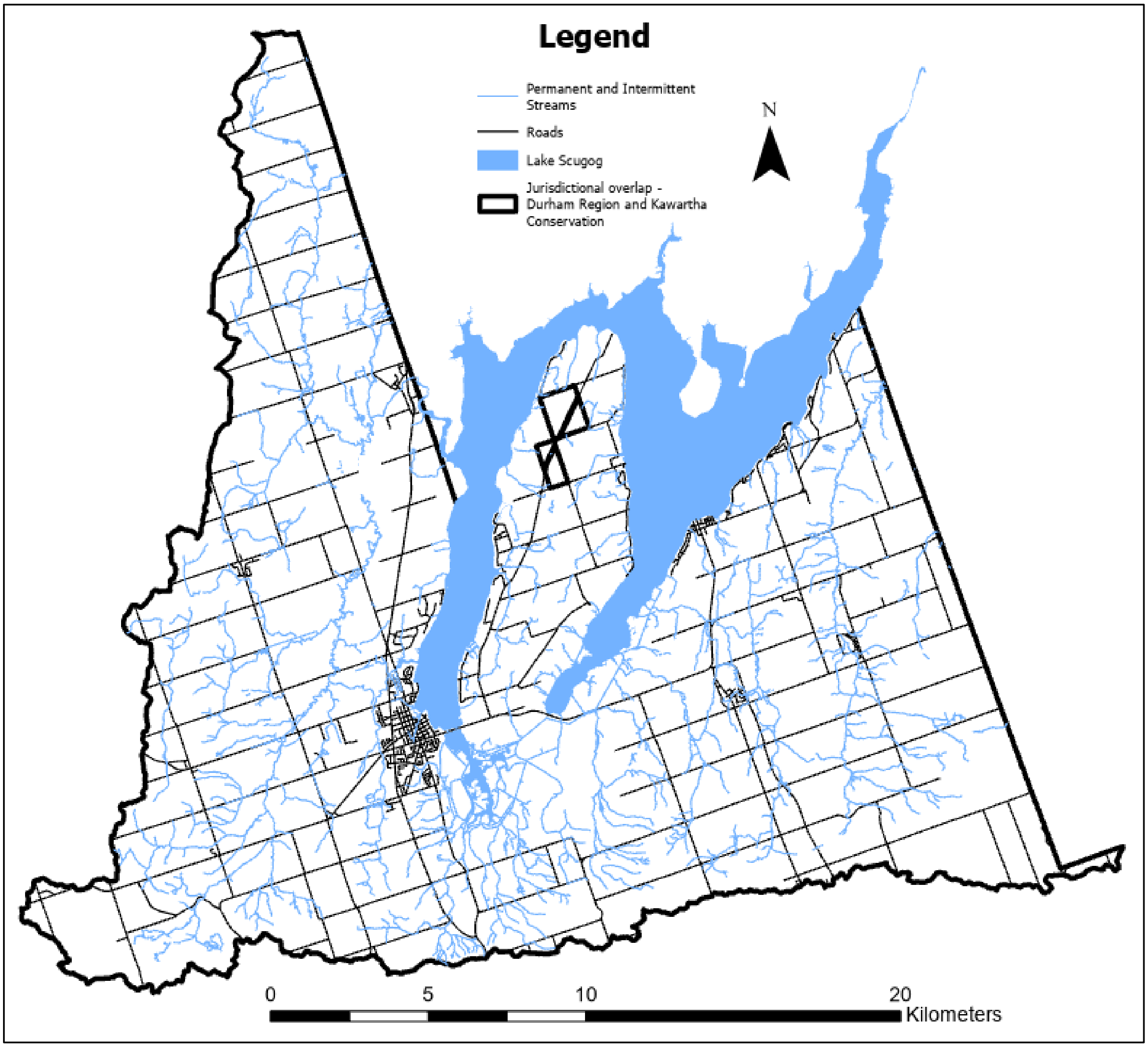

Figure 2.1. Location of permanent and intermittent streams.

3.0 Confirm the status of permanent and intermittent streams, and coldwater habitats

Background - Permanent and Intermittent Streams

The status (i.e., flow permanency) of permanent and intermittent streams was verified in 2021 through field visiting 242 road-stream intersections (representing 62% of 388 accessible road crossings) during low flow conditions in the summer to visually assess for stream permanence.

At each site, the watercourse flowing under the road was classified as permanent or intermittent based on the following criteria:

- Permanent: sites that were found to contain flowing water (obvious and continuous moving water).

- Intermittent: sites that were found to be dry (no water present at all) or had standing water in the culvert but not in the upstream or downstream channel.

117 sites (48% of total) were deemed permanent streams, whereas 125 sites (52% of total) were deemed intermittent streams (Table 3.1, Figure 3.1 and 3.2). Most intermittent sites were dry and located along small (e.g., 1st order) streams that flow directly into Lake Scugog or exist in the headwaters of the lake's major subwatersheds.

Data gaps remain in the south-central part of the study area, which includes several unnamed tributaries draining into Osler Marsh and the southern half of Scugog Island.

Table 3.1. Flow permanency classifications.

Flow Status	**Flowing**	**Standing**	**Dry**
Permanent	117 (48%)		
Intermittent		14 (6%)	111 (46%)

Figure 3.1 Representative photos of a permanent stream (above - Blackstock Creek), and intermittent stream (below – Layton River).

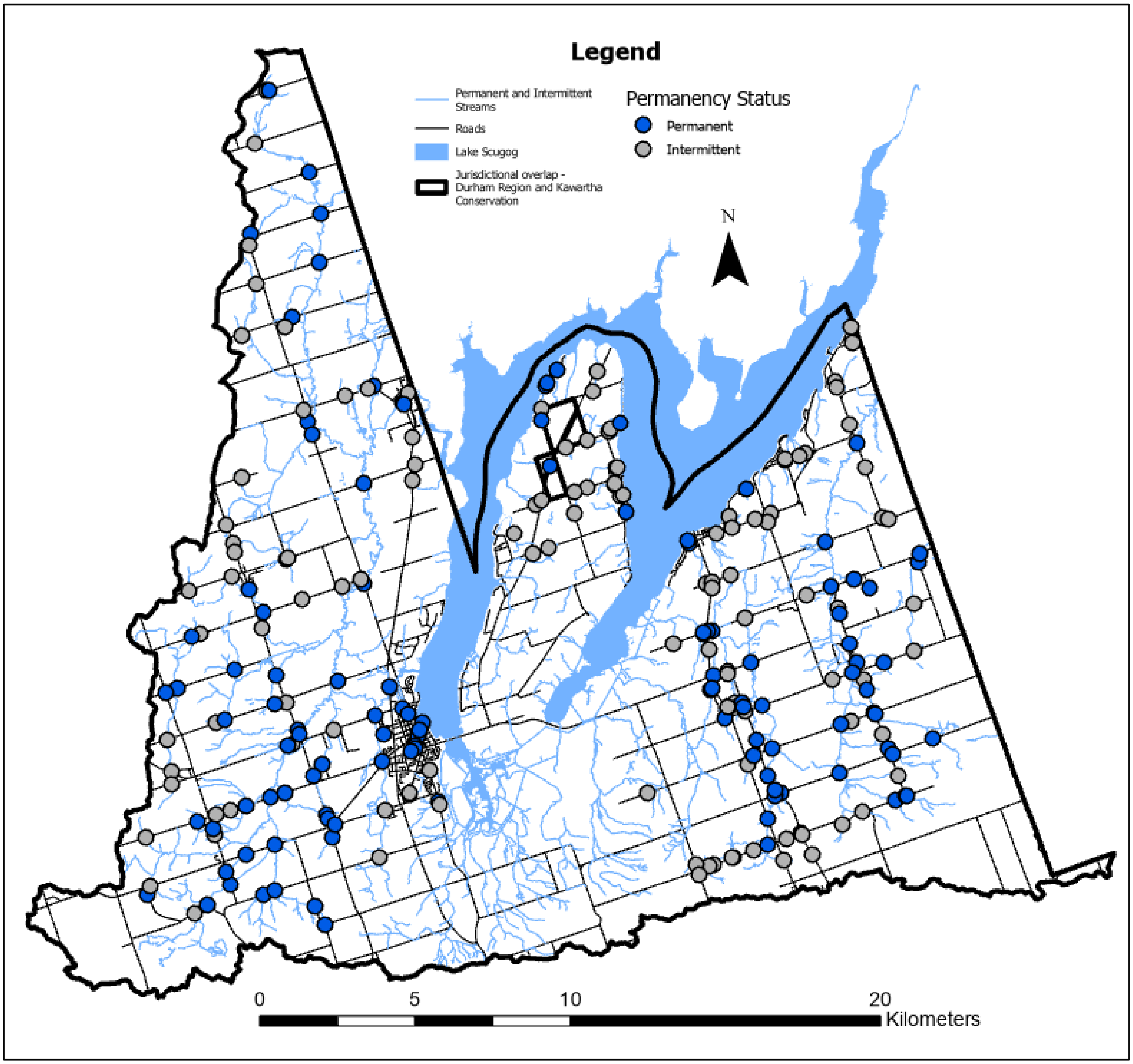

Figure 3.2. Location of permanent and intermittent streams as indicated by flow permanency sampling.

Background - Coldwater Habitats

Coldwater habitats are considered 'sensitive areas' as per the Greenbelt Plan and typically include permanent streams that support or are capable of supporting sensitive aquatic life (e.g., brook trout and stoneflies). The MNRF manages a provincial mapping layer called the Aquatic Resource Area (ARA) Line/Polygon layer that includes the locations of coldwater habitats (Figure 3.4).

To confirm the accuracy of the provincial ARA layer, in 2021 the same 242 sites were assessed regarding their capability of supporting coldwater life through classifying thermal regime. This is achieved by sampling water temperatures in the afternoon during low flow conditions and a 'heat wave' according to the protocol by Chu et al. (2009). Observed water temperatures are then compared with maximum daily air temperatures from a nearby climate station to determine the thermal classification of each site. Sites exhibiting of Coldwater, Cold-coolwater, and Coolwater thermal regime are considered as sensitive habitat.

Coldwater habitat conditions were found at 82 sites, representing 34% of all sites sampled (Table 3.2, Figure 3.3). The remaining 160 sites were not likely capable of supporting coldwater life, as they had thermal regimes of Warmwater or Cool-warmwater, were isolated (e.g., standing water only) or were dry.

When compared to the provincial ARA layer, thermal regime classifications matched relatively well. One notable exception is the presence of a significant number of coldwater thermal regime sites overtop the warmwater ARA layer in the northwest (i.e., headwaters of the Layton River) and north-central part (i.e., outlets of unnamed tributaries on the north half of Scugog Island) of the study area.

Data gaps remain in the south-central part of the study area, which includes several unnamed tributaries draining into Osler Marsh and the southern half of Scugog Island.

In 2022, all known coldwater habitats from thermal regime sampling (e.g., the 82 sites classified in 2021 as either Coldwater, Cold-coolwater, or Coolwater) were further evaluated to determine if they actually do support sensitive aquatic life – Stoneflies. Stoneflies are a coldwater habitat indicator aquatic organism. The presence of Stoneflies was targeted through kicking-and-sweeping the streambed as per Section 2 Module 1 of the Ontario Stream Assessment Protocol (Stanfield et al., 2017).

Table 3.2. Thermal regime classifications.

<table>
<tr><th>Thermal Class</th><th>Temperature Range (C)[1]</th><th>Number of Sites</th><th>Sensitive Sites (Coldwater)</th><th>Non-Sensitive Sites (Warmwater)</th></tr>
<tr><td>Coldwater</td><td><15.9</td><td>29 (12%)</td><td rowspan="3">82 (34%)</td><td rowspan="3"></td></tr>
<tr><td>Cold-coolwater</td><td>15.9 to 18.7</td><td>22 (9%)</td></tr>
<tr><td>Coolwater</td><td>18.7 to 22.1</td><td>31 (13%)</td></tr>
<tr><td>Cool-warmwater</td><td>22.1 to 25.3</td><td>27 (11%)</td><td rowspan="4"></td><td rowspan="4">160 (66%)</td></tr>
<tr><td>Warmwater</td><td>>25.3</td><td>8 (3%)</td></tr>
<tr><td>Standing</td><td>n/a</td><td>14 (6%)</td></tr>
<tr><td>Dry</td><td>n/a</td><td>111 (46%)</td></tr>
</table>

[1] temperature ranges defined as average plus one standard deviation from the nomogram for each category.

Stoneflies were found at 18% of sites (15 of 82) classified as coldwater from thermal regime sampling. When compared to the provincial ARA layer, sensitive habitats as indicated by 'Stonefly Present' sites were significantly less in distribution, particularly in the southwest part (i.e., Nonquon River) and east-central part (i.e., Blackstock Creek) of the study area. Further, there were some instances (3 sites) in reverse, where Stoneflies were found in non-sensitive warmwater streams as per the ARA layer.

Key Findings and Recommendations

- Field sampling in 2021, at 242 road-stream crossings, provided confirmation of the flow status of permanent and intermittent streams and location of sensitive habitats as indicated by coldwater temperatures.

- Field sampling in 2022, at 82 road-stream crossings, provided confirmation of the location of sensitive habitats as indicated by Stoneflies – a coldwater aquatic invertebrate. These data do not overlap well (significantly less distribution) with provincial sensitive coldwater habitat mapping layer.

- Recommend that further efforts be undertaken to confirm the location of sensitive coldwater habitats, given the apparent discrepancies in provincial versus local data. Priority should focus on detecting coldwater indicator aquatic organisms (e.g., Brook Trout, Stoneflies) across the study area, particularly at sites with data discrepancies, and working with MNRF to adjust provincial ARA layers as necessary through consultation.

References and Additional Resources

Chu, C., N. Jones, A. Piggott, and J. Buttle. 2009. Evaluation of a Simple Method to Classify the Thermal Characteristics of Streams Using a Nomogram of Daily Maximum Air and Water Temperatures. North American Journal of Fisheries Management. 29. 1605-1619.

MNRF (Ministry of Natural Resources and Forestry). 2022. Aquatic Resource Area Line Segment - Watercourse layer. Available online at Ontario GeoHub: https://geohub.lio.gov.on.ca/datasets/aquatic-resource-area-line-segment.

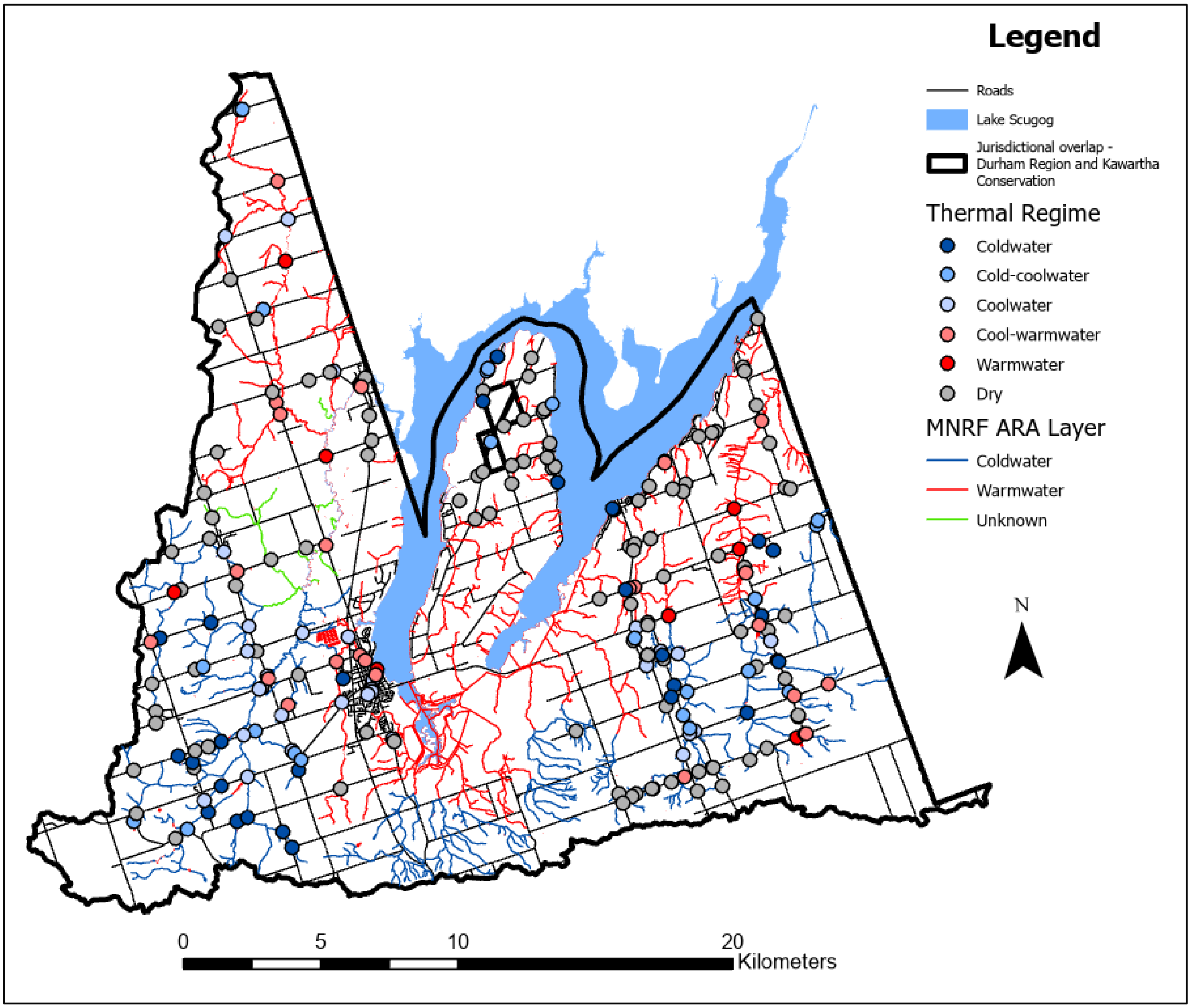

Figure 3.3. Location of sensitive habitats (blue) and non-sensitive habitats (red) as indicated by thermal regime sampling, and provincial mapping.

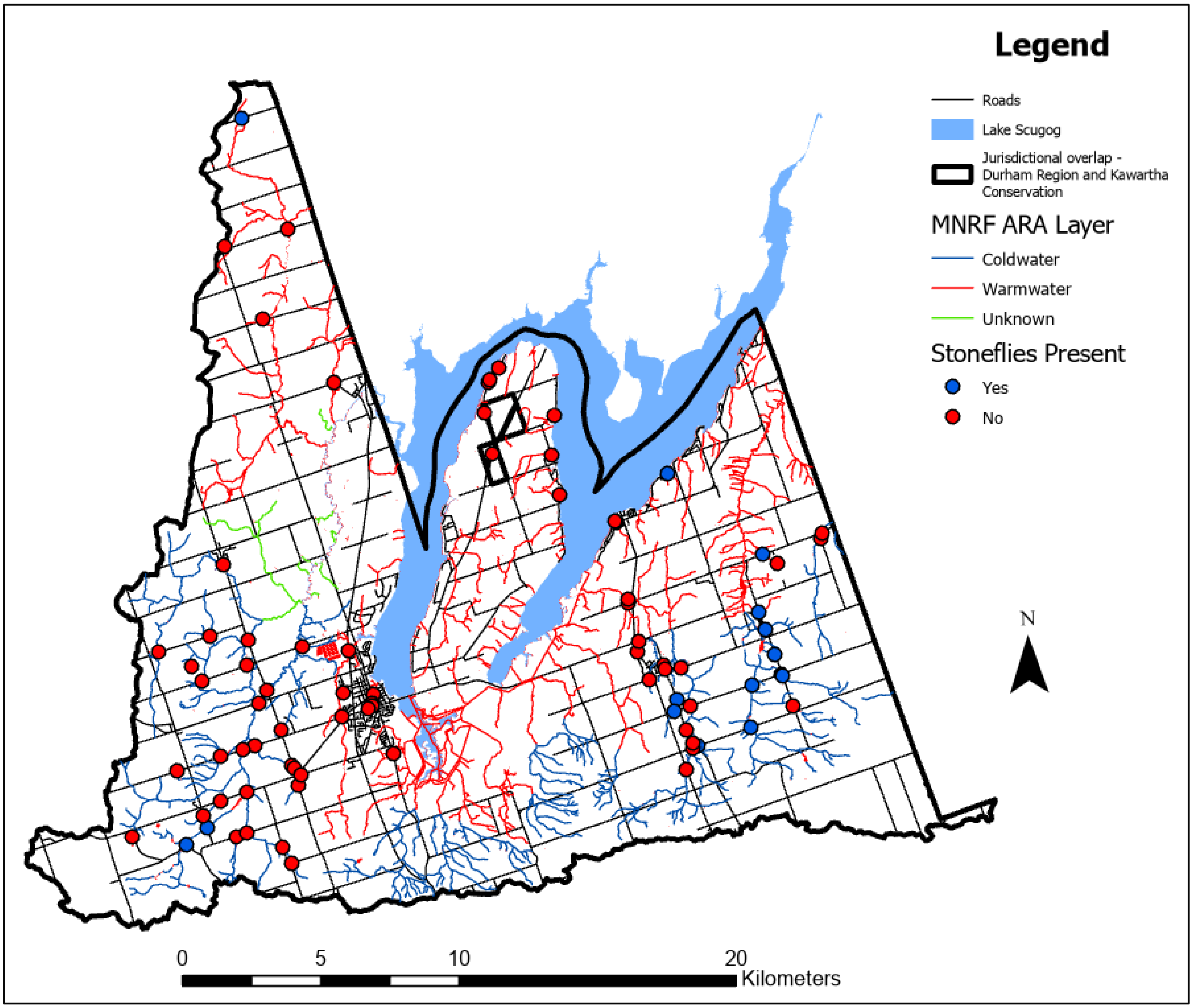

Figure 3.4. Location of sensitive habitats (blue) as indicated by Stonefly sampling, and provincial mapping.

4.0 Evaluate and confirm the location of wetlands currently mapped as 'unevaluated'

Background

2021 activities focused on consolidating our existing wetland mapping information. These data are a compilation of information from three primary sources administered by the province and Kawartha Conservation.

- Province: wetland information managed by MNRF is generated through two primary sources, including:
    - Southern Ontario Land Resources Information System (SOLRIS): a compilation of data from numerous sources including provincial base data (woodland/wetland perimeters, hydrology, built up areas, Ontario road network), satellite imagery and digital elevation models. Computer modelling, visual interpretation with high resolution aerial photos and field validation were used to create a seamless inventory for Southern Ontario (MNRF, 2015).
    - Wetland Evaluation System: through the Ontario Wetland Evaluation System (OWES) process, aerial imagery was utilized in combination with ground-truthing to evaluate the status of Wetlands according to a defined protocol (MNRF, 2014). Large or high priority Wetlands were inventoried through this system and classified as either 'provincially significant' or 'evaluated non-provincially significant' (these are often referred to as locally significant).
- Kawartha Conservation: Ecological Land Classification (ELC) methodology was used to interpret land cover as shown in 2018 aerial imagery, according to a community-series level of detail (Lee et al., 1998).

These data indicate that there are approximately 141 km^2 of wetlands in the jurisdictional overlap. However, a significant portion of these remain unevaluated (59 km^2, or 42% of total) and thus have not been 'ground-truthed' to confirm or deny their existence and boundaries (Figure 4.1). A priority for Kawartha Conservation is to determine an approach to confirm the location of these unevaluated wetlands using standardized procedures and in partnership with the province and local landowners.

The following wetlands were identified as priority for evaluation (Figure 4.1):

- Wetland A: the Unevaluated/ELC wetlands extending south from Scugog Line 6 Road to Regional Rd. 21 have the potential to be complexed into the Nonquon Provincially Significant Wetland #7 connecting to the north.

- Wetland B: the Unevaluated/ELC wetlands extending west from Simcoe Street along Cragg Road have the potential to be complexed into the Nonquon Provincially Significant Wetland #7 connecting to the east.

- Wetland C: the Unevaluated/ELC wetland complex extending along Pine Point Road and Mississauga's Trail on Scugog Island have the potential to be either complexed into separate but hydrologically connected wetlands, or evaluated as one large stand-alone wetland.

2022 activities focused on a 'desktop screening' evaluation of Wetland C (a large contiguous tract of unevaluated wetland), to determine whether it could potentially be deemed significant as per the scoring criteria in the OWES methodology. The desktop screening OWES scoring record can be found in Appendix A.

Partway through this process (October to December, 2022), the province announced updates to the Wetland Evaluation System. The changes came into effect on January 1, 2023 and include:

- the addition of new guidance related to re-evaluation of wetlands and updates to mapping of evaluated wetland boundaries;

- changes made to better recognize the professional opinion of wetland evaluators and the role of local decision makers (e.g., municipalities); and,

- other housekeeping edits to ensure consistency with the above changes throughout the [OWES] manual.

Results from the desktop screening evaluation indicate that Wetland C would have been deemed a Provincially Significant Wetland using existing OWES evaluation methodology, but would not be deemed Provincially Significant when applying the updated (i.e., January 2023 onwards) methodology.

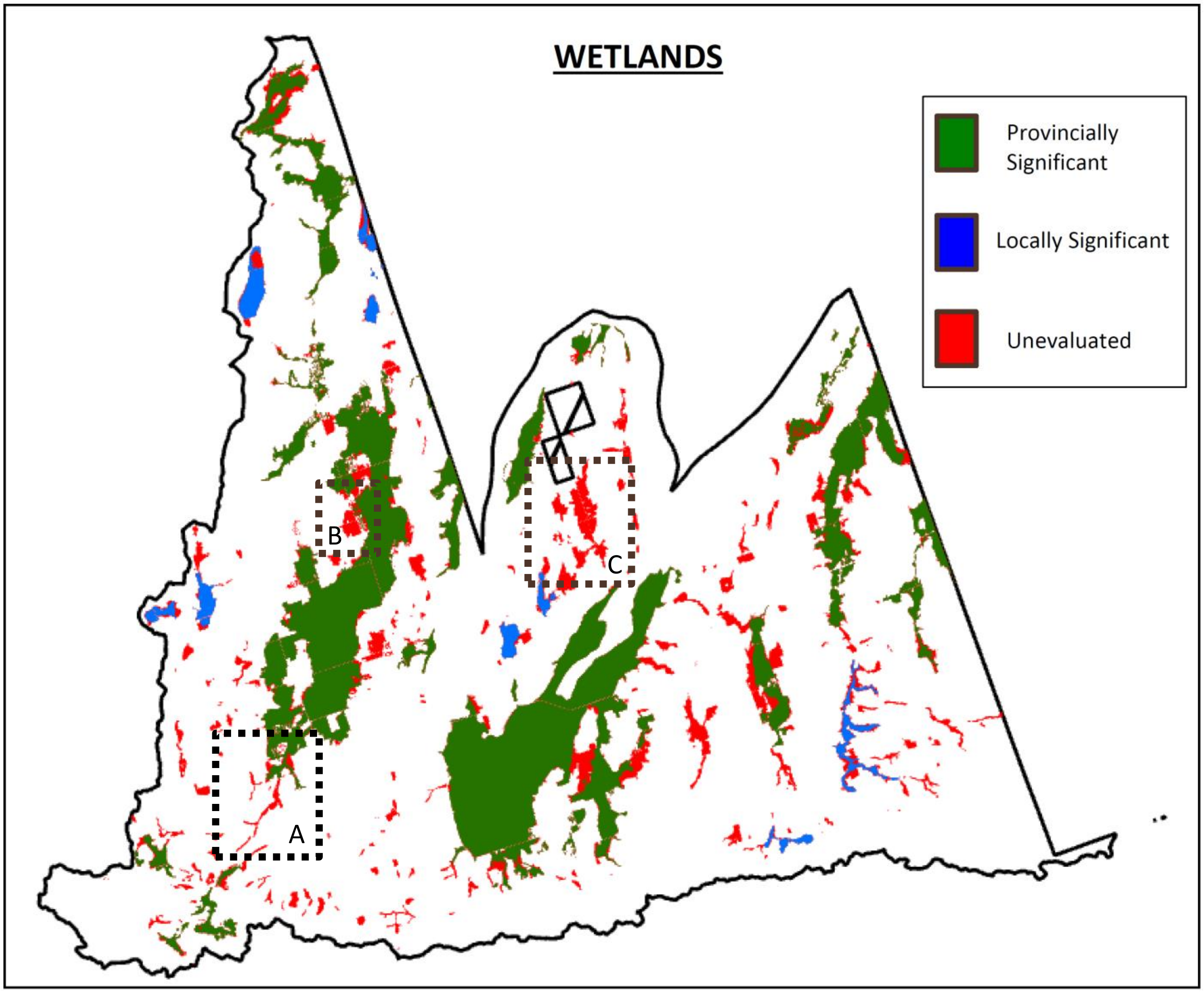

Figure 4.1. Location of wetlands, including Evaluated (Provincially Significant, and Locally Significant) and Unevaluated wetlands. Dashed boxes refer to priority wetlands for evaluation.

Figure 4.2. Candidate Wetland C, showing unevaluated potential wetlands (red and orange) and confirmed wetlands (green).

The OWES has two key components that have been removed that dramatically change the score achieved by Wetland C, including the inability to 'complex' small wetlands into one large wetland (i.e., score as one unit hydrologically connected wetlands within 750m) and the removal of scoring for habitat for species of conservation concern and/or habitat of species of conservation concern. The following provides additional information related to each component.

- Complexing:
    - Wetland C has a total area of 192.52 hectares with a large swamp being complexed in on the southwest side of the core wetland area. The area of the complexed swamp is 44.9 hectares.
    - Without complexing this large area would not be included in the evaluation, reducing any size related values in the scoring. Areas where the grades would be reduced include: Size (Biological Component), Total Size (Social Component), and values that are calculated within other components that use the size of the wetland to determine the value of the wetland (e.g., Section 2.0 Social Component, Section 2.1 Economically Valuable Products, Section 2.1.1 Wood Products, etc.).
- Species of Conservation Concern:
    - Section 4.0 Special Features Component contains the relevant sections for the inclusion of species at risk, including: Section 4.1.2.1 Reproductive Habitat for Endangered or Threatened Species and 4.1.2.2 Traditional Migration or Feeding Habitat for an Endangered or Threatened Species. These are the key sections in the evaluation that greatly impact the final score and the potential for significance.
    - For this desktop evaluation no reproductive habitat was included due to the lack of site visits and documented proof of breeding species at risk. Even without reproductive habitat, the presence of migratory species (from the following sources: Ontario Breeding Bird Atlas Data, E-bird Data, and the Ontario Herpetological Atlas) raises the score enough to make this wetland significant.

- With migratory Threatened or Endangered Species included the Special Features Score is 478. When this component is removed, the score drops to 178.

- The Special Features Component bestows significance on a wetland when scores are over 200, so clearly the removal of the species at risk scores is important for determining Provincial Significance.

Key Findings and Recommendations

- Wetland mapping from all sources has been consolidated (2021) and includes 141 km^2, classified as evaluated Provincially Significant, evaluated Locally Significant, and non-evaluated.

- Provincial updates to the Ontario Wetland Evaluation System take effect on January 1, 2023. After undertaking a 'desktop screening' evaluation of an unevaluated wetland on Scugog Island, it is apparent that the updates (specifically the removal of Complexing, and Habitat for Endangered or Threatened Species components in the scoring system) will have profound consequences for the status of existing and potential Provincially Significant Wetlands.

- Recommend that large-scale verifications in locations of wetlands should be completed in 5-years time (e.g., 2026) as land use change progresses (e.g., land conversion into development or agriculture). In the meantime, verifications should include routine updating of small sections based on site-specific field visits that arise from planning and regulations file review activities.

References and Additional Resources

Environmental Registry of Ontario. 2022. Proposed updates to the wetland evaluation system – Decision Summary. Available online at: https://ero.ontario.ca/notice/019-6160#comments-received.

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MNRF (Ministry of Natural Resources and Forestry). 2014. Ontario Wetland Evaluation System, Southern Manual. Third Edition. Version 3.3. Available online at: https://www.ontario.ca/page/wetlands-evaluation#section-2.

MNRF (Ministry of Natural Resources and Forestry). 2015. Southern Ontario Land Resource Information System (SOLRIS) Version 2.0: Frequently Asked Questions. Available at: https://www.sse.gov.on.ca/sites/MNR-PublicDocs/EN/CMID/SOLRIS%20v2.0%20-%20FAQ.pdf

MNRF (Ministry of Natural Resources and Forestry). 2022. Wetlands layer. Available online at: https://geohub.lio.gov.on.ca/datasets/5216a770ef684d2fae8bcc13ee9c4357/explore.

5.0 Integrate new climate change information into water quantity, water quality, and aquatic habitat assessments

Background

2021 activities focused on obtaining the latest climate change modelling projections and consolidating datasets for key parameters that could affect water resources (water quality, quantity, and sensitive habitats) within the Lake Scugog basin.

A particularly useful reference that provides the most recent climate change projection analyses for this area is the Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region (Delaney et al., 2020). It provides a range of future weather projections for the Township of Scugog (centred around the Town of Port Perry) based on high-emission and low-emission greenhouse gas scenarios, for key climate change parameters including: Mean Temperature, Maximum Temperature, Minimum Temperature, Extreme Heat, Extreme Cold, Total Precipitation, Extreme Precipitation, Dry Days, Growing Season, Agricultural Variables, and Ice and Snow.

The following are key climate change predictions for the Township of Scugog area as outlined in Delaney et al. (2020):

- *Increase in mean air temperature by 5.2°C.*
- *Increase in extreme hot days by 16.6 days.*
- *Decrease in extreme cold days by 33.3 days.*
- *Increase in total precipitation by 27%.*
- *Increase in extreme precipitation by 29 mm (in one day).*

2022 activities focused on undertaking preliminary scenario-based modelling approach using the most up-to-date climate projections to better understand anticipated future changes in nutrient loading (phosphorus and nitrogen) into Lake Scugog, and the status of sensitive coldwater streams in the Lake Scugog watershed.

Background: Nutrient Loading

To ensure that Lake Scugog continues to provide high-quality recreational and environmental services, the Lake Scugog Environmental Management Plan (LSEMP) was first initiated in 2004 to (1) characterize key environmental components in the Lake Scugog watershed, and (2) to provide recommendations that would enhance the integrity, resilience, and health of these components. For the initial LSEMP project, the water quality of Lake Scugog and its major tributaries was monitored for 5 years.

According to the LSEMP nutrient inputs from rivers and streams were the main driving force at 56.5% of total phosphorus (TP) and 66.6% of all total nitrogen (TN) (Kawartha Conservation, 2010). Loadings from rivers and streams are based on two main factors: the concentration of the contaminants, and the amount of water moving through the systems. Changes (either increase or decrease) of any of the two will change the loading value.

The goal of this section is to provide an updated nutrient loading for Lake Scugog tributaries by using historical volumes with recent (2016-2021) water quality information. We will compare phosphorus and nitrogen loadings from recent years to results in the LSEMP report (Kawartha Conservation, 2010).

Water quality and quantity datasets are required to assess each scenario. Average annual volumes were extracted from the LSEMP report. Water quality dataset were compiled from historical LSEMP tributary surveys for the following years: 2004-2008 and 2016-2021. Note that due to the COVID Pandemic, the tributary sampling campaign for 2020 was incomplete and thus was omitted. Climate projections for Durham Region were taken from the Ontario Climate Consortium (Delaney et al., 2020).

Generally, precipitation (rain, snow, and ice) accounts for 16.7% of all water inflows in the Lake Scugog watershed, which contributes to ~19% and ~28% of all phosphorus and nitrogen inputs (Kawartha Conservation, 2010).

For the Region of Durham, it is expected that precipitation will increase in amount, intensity, and seasonal pattern of when it falls (Delaney et al., 2020). It is expected that the Township of Scugog will experience an increase in total precipitation by 27% by 2071-2100 under the stabilization climate scenario (where we employ a range of technologies and strategies to reduce greenhouse gas emissions).

Using precipitation chemistry values from the LSEMP monitoring periods 2004-2008 (i.e., 29.7 µg/L for TP and 1.3 µg/L of TN), and total precipitation amounts from Delaney et al. (2020), we can expect an increase in nutrient loadings from the atmosphere. We can expect an increase of 20-35% in atmospheric loadings of phosphorus by 2071 and 24-41% for total nitrogen (Table 5.1).

Table 5.1. Total precipitation amount (mm), TP and TN loadings from increased precipitation amount from climate change modelling. Percentage increase in loading (compared to 2004-2008) is also shown.

	Total (mm)	Loading (kg/yr)		Percent Increase	
Time Period	**Precipitation**	**TP**	**TN**	**TP**	**TN**
2004-2008	882	1784	76		
2011-2014	1059	2139	94	20	24
2041-2070	1132	2287	100	28	32
2071-2100	1205	2434	107	36	41

For the baseline years (1971-2000), precipitation fell mostly in the fall months (~28%), followed by summer and winter (24%) and lastly, spring (23%) (Delaney et al., 2020). This is expected to change, where precipitation will fall less in the winter and fall months and more in the spring and summer months. By 2071, we can expect a 45.8% increase in precipitation for the spring months (when compared to the baseline). Results from Delaney et al. (2020) suggest earlier spring-like temperatures and increased amounts falling as rain (as opposed to snow).

Five tributaries were chosen for this study, they are Blackstock Creek, Cawker's Creek, William's Creek, Fingerboard Creek, and the Nonquon River (Table 5.3; Figure 5.1). For the recent period of 2016-2021, all streams will exceed the interim TP Provincial Water Quality Objective of 30 µg/L for streams and rivers. Exceeding this limit will cause excessive plant growth in rivers (MOE, 1994).

For some streams, nutrient (TN and TP) concentrations have decreased since the 2004-2008 period, these were found at Blackstock Creek (TP = 32%, TN = 29%) and Williams Creek (TP = 80%) (Table 5.3). Other streams (Cawker's Creek, Fingerboard Creek, and Nonquon River) have seen an increase in nutrient concentrations, with the exception of TN for the Nonquon River, which decreased ~35% (Table 5.2).

Table 5.2. Average total phosphorus (TP) and total nitrogen (TN) concentrations (µg/L) and loadings ($kg/km^2/yr$) per watercourse and per time period, i.e., historic = 2004-2008 and recent = 2016-2021. Drainage areas and average volumes were taken from the LSEMP report.

Watercourse			Historic (2004-2008)				Recent (2016-2021)			
	km^2	Million m^3	µg/L		$kg/km^2/yr$		µg/L		$kg/km^2/yr$	
	Drainage Area	**Average Volume**	TP	TN	TP	TN	TP	TN	TP	TN
Blackstock Creek	37.9	10.5	70.2	2842.2	19.5	790	47.5	2009	13.2	556.6

Cawker's Creek	10.4	3.7	68.7	3641.7	24.6	1303.2	79.3	2487.2	28.2	884.9
Fingerboard Creek	12.7	3.6	31.1	2318.5	8.8	656.4	116.6	3338.6	33.1	946.4
Nonquon River	184.7	73.6	32.9	1495.6	13.1	596.1	43.3	976.9	17.3	389.3

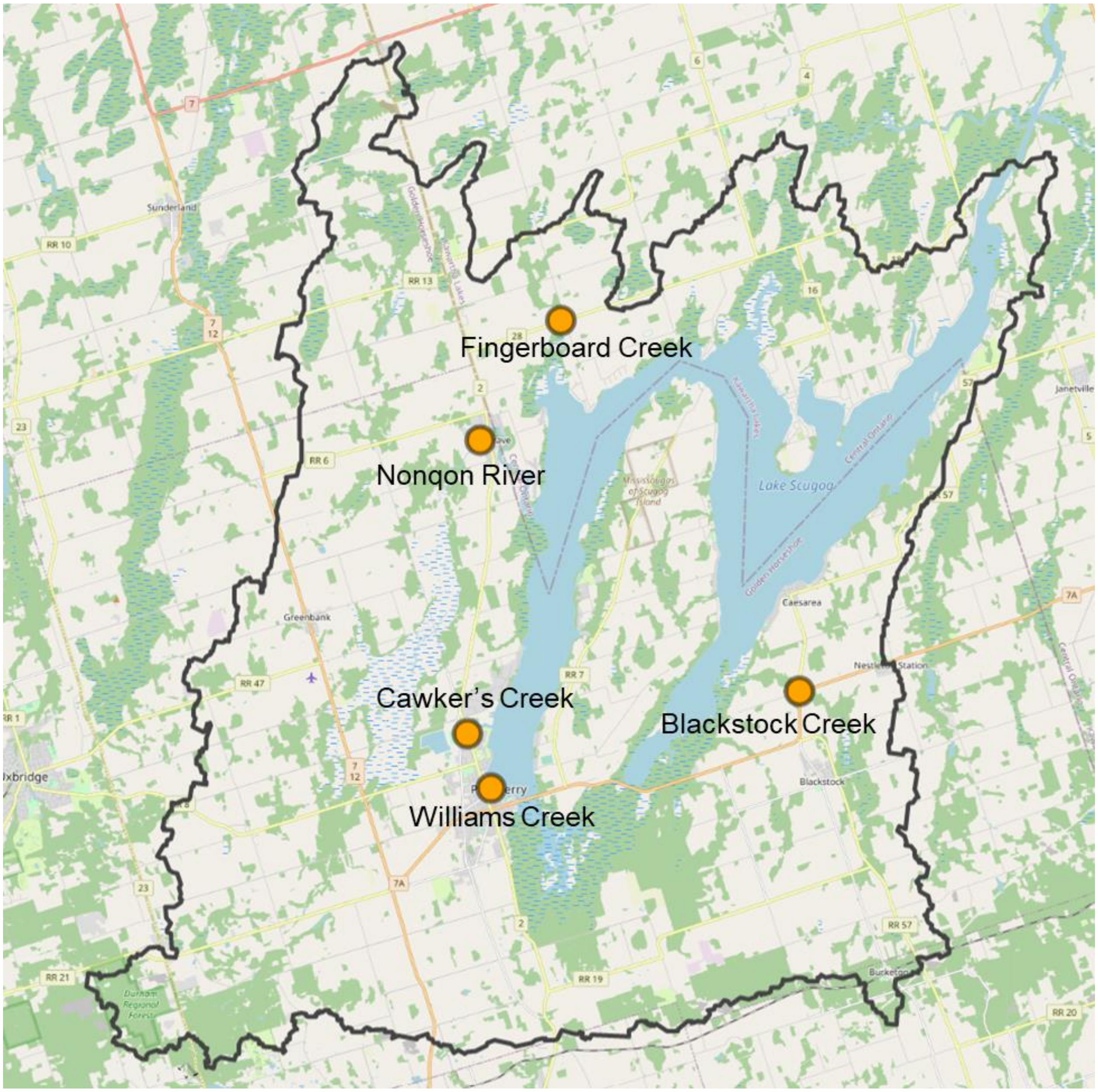

Figure 5.1. Site locations of key selective major streams in the Lake Scugog watershed.

It is expected that changes in precipitation amount and pattern will influence stream flows. Tan and Gan (2015) found that climate change is expected to increase the mean annual streamflow in southern Ontario. Given that precipitation amounts will fall more frequent during the spring and summer, streamflow is expected to follow the same pattern, where higher flows would occur during those periods. In the Lake Simcoe watershed, an increase of 2.7-5.9 % in precipitation resulted in an increase in total phosphorus loadings by 53.3-21.2% by 2061-2069 (Crossman et al., 2013).

In the Township of Scugog area, it is expected that there will be an increase in dry days (from 146 to 208 days), consecutive dry days (18 to 23 days), and days above 30°C (from 7.6 to 55 days) in the 2071-2100 period (Delaney et al., 2020). Higher air temperatures will lead to more evaporation, leading to a concentration effect for nutrients in streams. Previous reports, also suggest that increased temperatures will leave to higher summertime concentrations of contaminants (Booty et al., 2005; Crossman et al., 2013; Mehdi et al., 2015; Coffey et al., 2018; Paul et al., 2019). Results from Crossman et al. (2013) in the Lake Simcoe watershed confirm that reduced summer precipitation and increasing temperatures will lead to higher (25%, by 2071–2100) TP concentration during the project summer months.

Increased temperature will also result in increased decomposition (Evans et al., 2005) by microbes and a reduction of dissolved oxygen concentration in Lake Scugog and its tributaries. Many important biotas, e.g., Brook Trout and Walleye, require a certain level of dissolved oxygen to grow and thrive, where colder water tends to hold more dissolved oxygen than warmer water. Modelled climate change scenarios for New Brunswick found that an increase of 2°C results in a decrease of dissolved oxygen by 0.4 mg/L (El-Jabi et al., 2014). Results from Jane et al. (2021) have confirmed that increased water temperature from climate change has deoxygenated over 300 lakes across the temperature region. In combination with increased flushing (from increased precipitation) of contaminants, e.g., nutrients and organic matter, and increased temperature, algae-blooms are expected to increase (more nutrients and better-growing conditions), leading to increase decomposition and reduction of dissolved oxygen concentrations.

Higher inputs (amount and duration) of rainfall on the landscape will reduce the clarity of Lake Scugog and its tributaries through increase erosion. Long-term monitoring of three streams in Alberta found that increased in precipitation (and streamflow) lead to increased erosion among stream banks which results in a reduction of water clarity by 17.2% (Rostami et al., 2018).

Like many other parts of Ontario, the Region of Durham will experience a rapidly changing climate in the future. It is expected that precipitation will fall increasing during the spring and summer months as intensive rain events occur, that winters will be warming, and that summer will be longer and dryer (Delaney et al., 2020). These changes will drive loadings from streams and precipitation to increase across the watershed, possibly leading to further degradation of water quality across Lake Scugog and its streams.

<u>Background: Sensitive Coldwater Habitats</u>

Given that climate change is anticipated to cause significant changes in weather patterns as compared to baseline conditions, these changes are also likely to cause changes in aquatic habitat conditions across our watersheds.

As exemplified by Dove-Thompson et al., (2011), sensitive coldwater habitats are particularly vulnerable:

> *"Because fish are cold-blooded, increases in water temperature will affect their distribution, growth, reproduction, and survival. The habitat and productivity for coldwater species, such as [brook trout], may decline substantially with increased air and water temperatures. Climate change is projected to greatly reduce the distribution of many brook trout populations throughout Ontario."*

In an effort to characterize the potential magnitude of impacts to coldwater streams from climate change, the current distribution of coldwater streams in the watershed is being assessed through field studies. As summarized in Chapter 3.0, the locations of likely coldwater habitat can be confirmed through a sampling approach as per Chu et al., (2009) by taking spot water temperature values in the summer, in the afternoon, during low flow conditions, in a heat-wave. These values, which represent the 'maximum water temperature' of each respective stream, are then compared against the maximum air temperatures for that same day to determine the 'thermal regime' of a site/stream. Thermal regime in the categories of: Coolwater, Cold-coolwater, and Coldwater are all considered 'coldwater habitat' and are therefore likely to contain sensitive coldwater aquatic organisms such as brook trout.

Chu et al. (2009) established a relationship between thermal regimes, and maximum water temperatures and maximum air temperatures (Figure 5.2), as expressed by the following equations:

- *Warmwater, cool-warmwater boundary: y = 0.4087x + 12.787*
- *Coolwater, cool-warmwater boundary: y = 0.3304x + 11.904*
- *Coolwater, cold-coolwater boundary: y = 0.287x + 10.17*
- *Coldwater, cold-coolwater boundary: y = 0.1565x + 11.165*

In order to provide a preliminary assessment of changes in aquatic habitat distribution from climate change, water temperatures obtained in 2021 were first standardized to 30°C for comparison purposes following the methodology outlined in Stanfield (2003), and thermal regimes were re-calculated based on the equations above. Subsequently, air temperatures were increased to 35°C (an increase of 5°C, representing the average air temperature increase expected as per Delaney et el., 2020) and thermal regime was again re-calculated for each site.

The comparisons yielded an approximate loss of 11 sites (7%) of coldwater streams habitat (Table 5.3). The losses came from the Cold-coolwater, and Coldwater category which, given that these are our coldest streams, are also likely representative of a loss of our best brook trout coldwater habitats. Generally, these data provide a confirmation at the local level that rising air temperatures will cause a transition to more warmwater habitats at the expense of sensitive coldwater streams.

Table 5.3. Summary comparison of thermal regimes.

Thermal Regime Classification	30°C Standardized Air Temperature (# of sites)	35°C Standardized Air Temperature (# of sites)	Degree of Change (# of sites)
Coldwater	**29 (25%)**	**26 (22%)**	**-3 (3%)**
Cold-coolwater	**20 (17%)**	**12 (10%)**	**-8 (7%)**
Coolwater	**25 (21%)**	**28 (24%)**	**+3 (3%)**
Cool-warmwater	29 (25%)	12 (10%)	-17 (15%)
Warmwater	14 (12%)	39 (33%)	+25 (21%)
TOTAL	117 (100%)	117 (100%)	
% Coldwater Streams	**74 (63%)**	**66 (56%)**	**-11 (7%)**

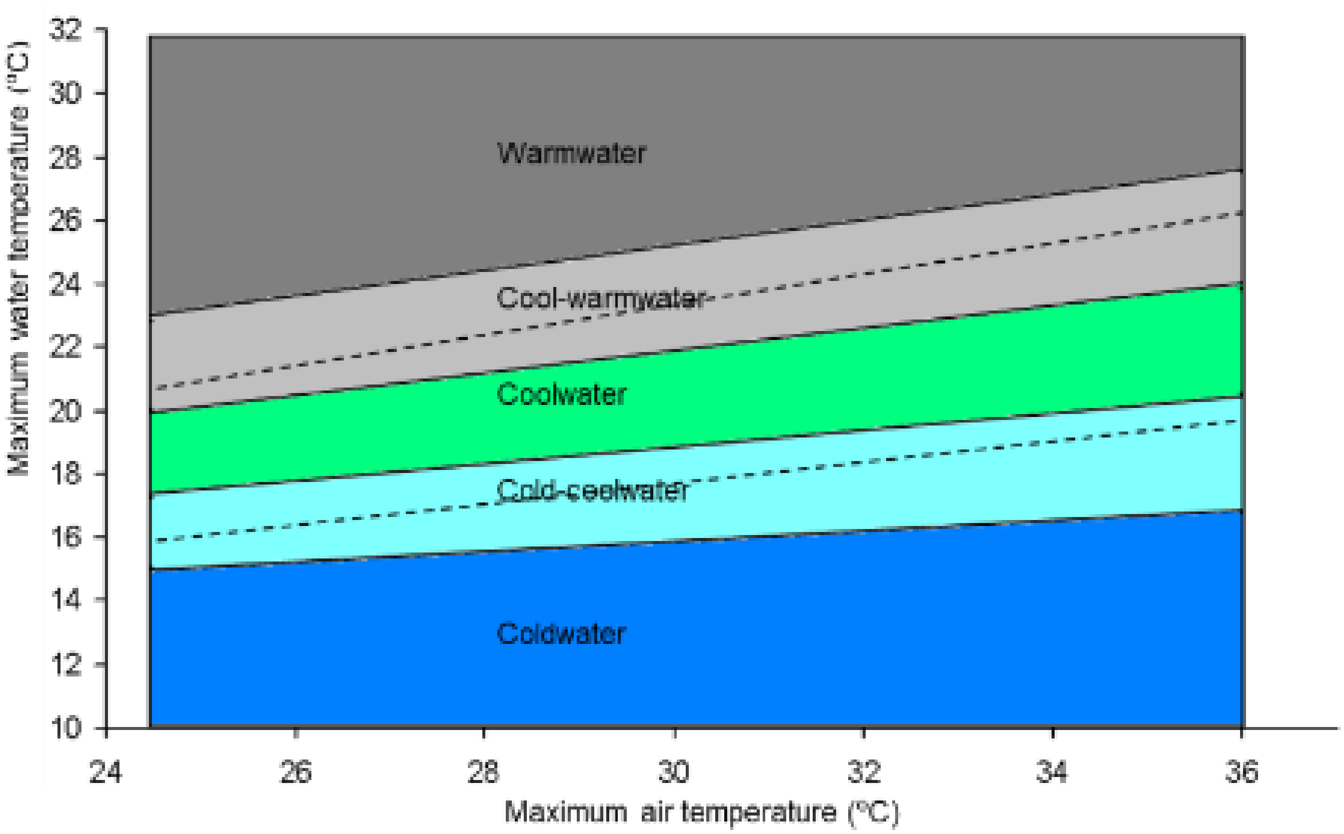

Figure 5.2. Thermal regime classifications for southern Ontario streams as developed by Chu et al., (2009).

<u>Key Findings and Recommendations</u>

- Climate change will alter water quality and quantity regimes in the Lake Scugog watershed. Preliminary analyses indicate a 28 to 41% increase in nutrient loadings over the next 20 to 80 years from projected increases in precipitation.

- Climate change will alter the existence of sensitive habitats in Lake Scugog tributaries. Preliminary analyses indicate a reduction of 7% of coldwater sites from projected increases in air temperature.

- Recommend the continuation of water quality, quantity, and sensitive habitat monitoring in the Lake Scugog watershed. Further, reinstate water quality monitoring in precipitation (both snow and rain) in our existing climate monitoring stations to help track atmospheric inputs of contaminants into the Lake Scugog watershed, and deploy autosamplers (with water level loggers) to capture inputs during extreme events.

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6.0 Address gaps in mapping of ecologically significant groundwater recharge areas

Background

Activities included working closely with Durham Region and participating conservation authorities on a Working Group, to help refine an approach for determining the location of Ecologically Significant Groundwater Recharge Areas (ESGRAs). These areas are important components of a functioning water resources system.

The Growth Plan for the Greater Golden Horseshoe defined ESGRAs as *"areas of land that are responsible for replenishing groundwater systems that directly support sensitive areas like coldwater streams and wetlands."*

Durham Region retained external consultant support to help delineate ESGRAs for the entire municipal boundary, which includes our areas of interest. They are currently finalizing the process for modelling, defining, and mapping ESGRAs on the landscape to conform to provincial standards.

In 2021 staff attended several meetings, led by Durham Region and consultants, and provided advice on behalf of the Working Group. The results were a draft ESGRA mapping layer for consideration by the Working Group. In 2022, the ESRGA layer was finalized.

Key Findings and Recommendations

- Ecologically Significant Groundwater Recharge Areas have now been finalized and mapped, and include 153 km^2 (31%) within the study area.

- Recommend refining mapping, as opportunities become available, on a five-year basis coinciding with large-scale updating of location of coldwater streams and wetland features.

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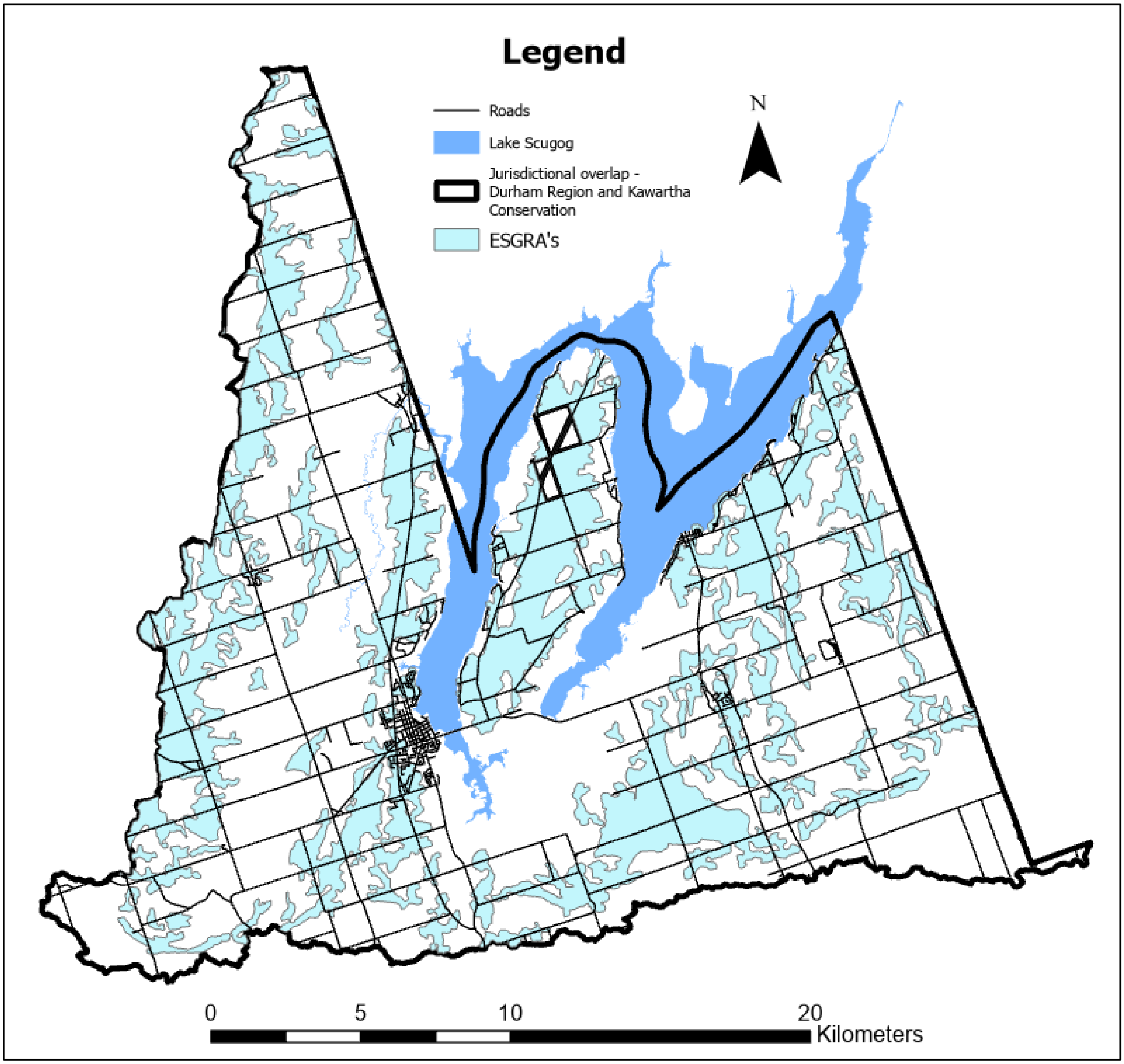

Figure 6.1. Proposed ESGRAs mapping.

7.0 Summary of key findings and recommendations

The following is a summary of key findings and recommendations for each chapter in the report.

Verify the flow path of permanent and intermittent streams

- A new verified watercourse layer (updated November 2021) is an improvement on the provincial Ontario Hydro Network layer and contains approximately 714 km of perennial and intermittent streams.

- Recommend that repeated large-scale verifications should be again completed in 5-years time (e.g., 2026) as land use change progresses (e.g., land conversion into development or agriculture). In the meantime, verifications should include routine updating of small sections based on site-specific field visits that arise from planning and regulations file review activities.

Confirm the status of permanent and intermittent streams, and coldwater habitats

- Field sampling in 2021, at 242 road-stream crossings, provided confirmation of the flow status of permanent and intermittent streams and location of sensitive habitats as indicated by coldwater temperatures.

- Field sampling in 2022, at 82 road-stream crossings, provided confirmation of the location of sensitive habitats as indicated by Stoneflies – a coldwater aquatic invertebrate. These data do not overlap well (significantly less distribution) with provincial sensitive coldwater habitat mapping layer.

- Recommend that further efforts be undertaken to confirm the location of sensitive coldwater habitats, given the apparent discrepancies in provincial versus local data. Priority should focus on detecting coldwater indicator aquatic organisms (e.g., Brook Trout, Stoneflies) across the study area, particularly at sites with data discrepancies, and working with MNRF to adjust provincial ARA layers as necessary through consultation.

Evaluate and confirm the location of wetlands currently mapped as 'unevaluated'

- Wetland mapping from all sources has been consolidated (2021) and includes 141 km^2, classified as evaluated Provincially Significant, evaluated Locally Significant, and non-evaluated.

- Provincial updates to the Ontario Wetland Evaluation System take effect on January 1, 2023. After undertaking a 'desktop screening' evaluation of an unevaluated wetland on Scugog Island, it is apparent that the updates (specifically the removal of Complexing, and Habitat for Endangered or Threatened Species components in the scoring system) will have profound consequences for the status of existing and potential Provincially Significant Wetlands.

- Recommend that large-scale verifications in locations of wetlands should be completed in 5-years time (e.g., 2026) as land use change progresses (e.g., land conversion into development or agriculture). In the meantime, verifications should include routine updating of small sections based on site-specific field visits that arise from planning and regulations file review activities.

Integrate new climate change information into water quantity, water quality, and aquatic habitat assessments

- Climate change will alter water quality and quantity regimes in the Lake Scugog watershed. Preliminary analyses indicate a 28 to 41% increase in nutrient loadings over the next 20 to 80 years from projected increases in precipitation.

- Climate change will alter the existence of sensitive habitats in Lake Scugog tributaries. Preliminary analyses indicate a reduction of 7% of coldwater sites from projected increases in air temperature.

- Recommend the continuation of water quality, quantity, and sensitive habitat monitoring in the Lake Scugog watershed. Further, reinstate water quality monitoring in precipitation (both snow and rain) in our existing climate monitoring stations to help track atmospheric inputs of contaminants into the Lake Scugog watershed, and deploy autosamplers (with water level loggers) to capture inputs during extreme events.

Address gaps in mapping of ecologically significant groundwater recharge areas

- Ecologically Significant Groundwater Recharge Areas have now been finalized and mapped, and include 153 km^2 (31%) within the study area.

- Recommend refining mapping, as opportunities become available, on a five-year basis coinciding with large-scale updating of location of coldwater streams and wetland features.