



Elfrida Community Builders Group Inc.

Elfrida Subwatershed Plan

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Elfrida Subwatershed Plan

| Revision | Description | Author | Date | Quality Check | Date | Independent Review | Date |
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Elfrida Subwatershed Plan



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
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Executive Summary

The Elfrida lands proposed to be included as part of the City of Hamilton's (the City) urban area spans approximately 1,233 gross hectares and is generally bounded by Trinity Church Road to the west, Golf Club Road to the southwest/south, Hendershot Road to the southeast/east, Mud Street to the northeast, and existing urban area to the north. The Elfrida Community Builders Group have retained GeoProcess Research Associates Inc. (GeoProcess), Palmer Environmental Consulting Group, now part of SLR Consulting Ltd. (SLR), Landtek Limited (Landtek) and Stantec Consulting Ltd. (Stantec), "Consultant Team", to prepare a Subwatershed Plan (SWP) to support the proposed urban boundary expansion in Elfrida to ensure responsible environmental management is well-integrated into the land use planning fabric.

The overall purpose of the SWP is to characterize existing subwatershed conditions, identify opportunities and constraints for development, evaluate potential impacts of development on the health of the subwatersheds, and outline protective measures, mitigative methods and restoration opportunities, to help ensure features are protected and enhanced, where possible. This Phase 1 Report characterizes the existing natural environmental conditions, which include terrestrial ecology, aquatic ecology, fluvial geomorphology, surface water and hydrogeology. These efforts included both desktop and extensive field assessments of natural heritage features, watercourses, floodplains, subsurface conditions and evaluation of headwater drainage features for portions of the Twenty Mile Creek, Sinkhole Creek, Stoney Creek, Hannon Creek and Upper Davis Creek, which overlap the proposed Elfrida SWP Study Area (Study Area).

The Elfrida SWP Study Area is situated within the jurisdiction of two Conservation Authorities: the Niagara Peninsula Conservation Authority (NPCA) and the Hamilton Conservation Authority (HCA). Sinkhole Creek and Twenty Mile Creek are located within NPCA's jurisdiction. Stoney Creek, Hannon Creek, and Upper Davis Creek fall under the jurisdiction of HCA.

Terrestrial Natural Heritage Assessment

The terrestrial natural heritage assessment characterized existing terrestrial conditions, evaluated the significance of existing natural heritage features, and identified species, communities, and habitats of conservation concern. To support this assessment, field investigations of breeding birds, breeding amphibians, winter wildlife, vegetation, wetlands, and notetaking of incidental wildlife observations were undertaken to properly characterize the existing terrestrial natural heritage features within the Elfrida. Existing habitat was assessed under Significant Wildlife Habitat criteria and potential for additional Species at Risk that were not observed during field investigation was assessed. Terrestrial natural heritage features were mapped and delineated, giving context to what features would provide constraints to any future development.

Field investigation and analysis characterized the terrestrial and wetland systems within Stoney Creek Watershed, Twenty Mile Creek Watershed, and Sinkhole Creek Watershed as diverse but anthropogenically influenced communities, with a wide variety of species, both native and introduced, observed within the Study Area. A total of 322 vascular plants, 71 breeding bird species, 11 mammals, six amphibian species and one reptile species were recorded within the Study Area.



Ecological Land Classification results showed that the Study Area contained 64 distinct vegetation communities consisting of 23 unique community types alongside anthropogenic communities such as agricultural lands, residential lands, and hedgerows. Two wetland communities were recommended for future Ontario Wetland Evaluation System evaluation, indicating their potential to be considered provincially significant.

Fluvial Geomorphology

The fluvial geomorphic assessment was completed to characterize existing conditions, delineate erosion hazard limits, identify active erosion areas, and identify sensitive reaches that required further assessment to determine erosion thresholds to inform the future stormwater management erosion control criteria / strategy. To support this assessment, reaches were preliminarily delineated based on a desktop assessment and updated based on field observations. The field observations characterized the watercourses within the Study Area as low-gradient, low-energy systems that have been heavily modified by agricultural practices, with several functioning as channelized roadside ditches; few instances of active erosion were identified.

As part of the Phase 2 SWP, detailed geomorphic field sites recommended in this report are reviewed and refined, as appropriate. Data collected during the detailed assessments are applied to identify erosion thresholds in the form of a critical discharge. The thresholds are relied upon to complete an erosion exceedance analysis using post-development hydrologic modelling to evaluate the potential impact of the proposed land use plan on downstream receiving watercourses.

Fisheries, Aquatics & Headwater Assessment

Of the five subwatersheds assessed within the Study Area, watercourses were identified in three; Sinkhole Creek, Twenty Mile Creek and Stoney Creek. Headwater features requiring mitigation were classified within Hannon Creek using the Headwater Drainage Feature Assessment Methodology. No headwaters were identified within the Upper Davis Creek subwatershed.

Sinkhole Creek is considered to be a coolwater system predominantly composed of headwater features the majority of which were classified as not requiring management. Some of the existing aquatic habitat within the Sinkhole Creek subwatershed is characterized as marginal using the criteria of the Urban Hamilton Official Plan, with intermittent flows being conveyed through a poorly defined channel transecting agricultural lands. Other areas include a permanent flow regime and, although poorly defined, the existing channel conveys flow through dense vegetation often within linear wetland features. In these areas, groundwater upwelling was observed as were larger and deeper pool features that may provide refuge for fish during lower flow periods.

Twenty Mile Creek within the Study area is a warm-coolwater system. Of the eight branches identified within the Study area, six were classified as headwaters requiring no management, one was classified as a headwater that requires mitigation and parts of one branch classified as a watercourse. Within these reaches, the watercourse conveys flow within hedgerows and as a ditch feature adjacent to Fletcher Road and Golf Course Road. Permanent flow is typically conveyed through dense vegetation, with fragmented areas of open water where the canopy is better established. Fish were captured within portions of Twenty Mile Creek. This channel offers important habitat based on the criteria of the Urban Hamilton Official Plan.



Stoney Creek within the Study Area is classified as a coolwater system. The majority of the Stoney Creek subwatershed within the Study Area is composed of headwater drainage features that were classified as no management or that require mitigation. Portions of Stoney Creek suggests that flows are conveyed through emergent vegetation between agricultural fields, likely providing limited opportunity for fish habitat and is therefore best characterized as marginal habitat. There are three online ponds where previous assessments have captured Sunfish (*Lepomis* sp.), a warmwater species. Portions of Stoney Creek also include a straightened feature either transecting agricultural fields or acting as a roadside ditch that generally conveys flow through dense emergent vegetation. Within portions of the watercourse, a relatively resilient coolwater species (brook stickleback) has been captured as well as several warmwater species. The habitat provided by these reaches is considered marginal and may provide opportunity for remediation and enhancement.

Surface Water Assessment

Surface water quality measurements and samples were collected at three (3) stations within the Study Area. The water quality results obtained identified instances of Provincial Water Quality Objectives exceedances for parameters including dissolved oxygen and phosphorus. Dissolved oxygen concentrations in many samples collected at each sampling site were below the target threshold of 5 mg/L. Additionally, every sample collected exceeded the Ontario's Provincial Water Quality Objective total phosphorus limits.

Two Visual OTTHYMO models were created by Stantec to simulate existing conditions within the Study Area. One model did not include any of the existing stormwater management (SWM) controls, while the other included three (3) existing or currently being constructed external SWM controls upstream of the site. These SWM controls were derived from the SWM Reports provided by the City for adjacent urban developments.

Updated existing conditions peak flows for the 2-year through 100-year (12-hour AES Rainfall Distribution) and Regional Storm events have been determined at discrete locations within the Study Area. The peak flows without considering any existing SWM controls have been used to support the delineation of the existing flood hazard limits within, and immediately adjacent to, the Study Area. These peak flows were compared to the NPCA floodplain mapping model in HEC-RAS and were determined to represent current hydrologic conditions of the Study Area.

The hydraulic modeling for the major stream reaches within the study area was conducted using the most recent information including peak flow rates (from updated hydrologic modelling), detailed topographic survey and LiDAR data, hydraulic roughness, and detailed structure surveys. Updated peak flow rates for the Regulatory flood event (i.e., 100-year storm event within NPCA jurisdiction and the Regional storm event within HCA jurisdiction) were used in the HEC-RAS model to simulate the existing conditions.

Flood hazard limits were delineated against the updated DEM (combined detailed topographic survey and LiDAR surface) using the HEC-RAS computed water surface elevations for the Regulatory Storm.

The drainage conveyance capacity of sixty-nine (69) roadway crossings within the Study Area were also assessed. There are twenty-one (21) watercourse classified crossings, and forty-eight (48) surface drainage classified crossings. By present-day engineering design standards, three (3)



watercourse culverts and forty (40) of the surface drainage culverts are considered to be sufficient. While eighteen (18) watercourse culverts and eight (8) surface drainage culverts are considered to be deficient by current standards. More specifically, one (1) surface drainage culvert from Hannon Creek, eighteen (18) watercourse and surface drainage culverts from Twenty Mile Creek, twelve (12) watercourse and surface drainage culverts from Sinkhole Creek and twelve (12) watercourse and surface drainage culverts from Stoney Creek are considered sufficient.

Further hydrologic modelling is completed as part of Phase 2, to include a proposed conditions scenario to further inform future development planning and to establish appropriate stormwater management quantity control, extended detention and erosion control criteria.

Hydrogeological Assessment

Based on the hydrogeological assessment, using field data collected from across the Study Area and existing information available for the area, the following conclusions have been drawn.

The Study Area is located on the Haldimand Clay Plain which predominantly consists of poorly drained glaciolacustrine clay to silty clay overlying clay till. Bedrock underlying the site comprises primarily of the Eramosa Member of the Lockport Formation. Bedrock depth below existing ground level ranges between approximately 3.0 m in the north and west of the Study Area and approximately 8.0 m in the south of the Study Area. Results of the onsite drilling and test pitting program completed confirms the distribution of surficial soils across the Boundary Area to be largely accurate compared to existing surficial geology mapping.

The hydrostratigraphy (i.e., the vertical sequence and horizontal extent of aquifers and aquitards) in the overburden and bedrock generally follows geological horizons. The principal, shallower groundwater regimes are controlled by the till deposits, where finer grained overburden soils act as aquitards while 'sandier' units generally behave as aquifers of local potential.

Karst and karstic features are identified by the NPCA, HCA, Ministry of Natural Resources (MNR) and Corporation of the City within the Study Area, though are more notable to the north of the Study Area where the Eramosa Karst Area of Natural and Scientific Interest (ANSI) is situated adjacent. Karstic features are noted to include dry and groundwater-bearing conduits and should be anticipated within the dolostone bedrock, though no sinkhole or soil pipe development has been noted within the Eramosa Karst ANSI where overburden depths are greater than 2.8 m. Such conditions are only noted in the north and west within the Study Area and coincide with the three areas of karstic feature identified in this report.

Groundwater flow through the overburden deposits generally follows the existing topographical surface of the Study Area, moving in a southwestern direction, with a component of this flow being directed towards the various watercourses that occupy these lands. This localized interpretation of shallow groundwater flow is in general agreement with the surface water flow patterns mapped for the Study Area.

The location of High-Volume Recharge Areas throughout the Study Area generally correlate with alluvial and glaciolacustrine deposits outcropping at surface.



Unfactored infiltration rates established from field testing are reported to range between 13 mm/hour and 31 mm/hour respectively and are considered to be within the anticipated values for field-saturated hydraulic conductivity testing within the Study Area. The soil permeability in the horizontal direction is generally understood to be an order of magnitude higher than permeability in the vertical direction; subsequently, the vertical hydraulic conductivities for the subsurface deposits are estimated to be in the range of 10^{-6} m/s to 10^{-10} m/s.

Based on the testing results, there are no identified long-term trends (be it increasing or decreasing) in the concentrations of cobalt iron, silver or uranium in the groundwaters sampled. Throughout the Study Area, groundwater concentrations of these elements commonly exceed the Ontario's Provincial Water Quality Objective and is largely attributed to the natural dissolution of minerals associated with the geological deposits of the aquifer system underlying the Study Area.

Water balance calculations indicate that the annual volume of water infiltrating within the five primary watersheds within the Study Area ranges between approximately 2,081 m³ to 665,856 m³, for a total infiltration volume of 11,166,848 m³. Further discussion regarding water balance and low impact development mitigation measures are discussed in the Phase 2 SWP.

Environmental Constraints Mapping

A summary of the various existing constraints and minimum vegetation protection zones applied to natural heritage features (terrestrial and aquatic features) and hazard land features have been mapped throughout the Study Area. These constraints generally include the following:

- Coldwater / Warmwater watercourses
- Fish Habitat
- Locally and Provincially Significant Wetlands
- Woodlands
- Areas of Natural and Scientific Interest
- Habitat of Threatened & Endangered Species
- Meander Belt Limits
- Floodplain
- Sinkholes



Acronyms / Abbreviations

| | |
|---------|--|
| ANSI | Area of Natural and Scientific Interest |
| BAP | Biodiversity Action Plan |
| CAA | Conservation Authorities Act |
| CCIAP | Climate Change Impact Adaptation Plan |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| COSSARO | Committee on the Status of Species at Risk in Ontario |
| CVC | Credit Valley Conservation |
| DBH | Diameter at breast height |
| DEM | Digital Elevation Model |
| DFO | Fisheries and Oceans Canada |
| DO | Dissolved Oxygen |
| ECBG | Elfrida Community Builders Group |
| ELC | Ecological Land Classification |
| ESA | Endangered Species Act |
| GRIDS | Growth Related Integrated Development Strategy |
| ha | Hectares |
| HCA | Hamilton Conservation Authority |
| HDF | Headwater Drainage Features |
| IPZ | Intake Protection Zones |
| LIDs | Low-Impact Development |
| LIO | Land Information Ontario |
| MBW | Meander Belt Width |
| MECP | Ministry of the Environment, Conservation and Parks |
| MMP | Marsh Monitoring Program |
| MNR | Ministry of Natural Resources |
| MTO | Ministry of Transportation |
| NAI | Natural Areas Inventory |
| NEP | Niagara Escarpment Plan |
| NHIC | Natural Heritage Information Center |
| NPCA | Niagara Peninsula Conservation Authority |
| O. Reg. | Ontario Regulation |
| OBBN | Ontario Benthos Biomonitoring Network |
| OLS | Ontario Land Surveyor |



Elfrida Subwatershed Plan
Acronyms / Abbreviations

| | |
|----------|--|
| OLT | Ontario Land Tribunal |
| OSAP | Ontario Stream Assessment Procedure |
| OWES | Ontario Wetland Evaluation System |
| PPS | Provincial Policy Statement |
| PSW | Provincially Significant Wetland |
| PWQO | Ontario's Provincial Water Quality Objective |
| RGA | Rapid Geomorphic Assessment |
| RHOP | Rural Hamilton Official Plan |
| SAR | Species at Risk |
| SARA | Species at Risk Act |
| SARO | Species at Risk in Ontario |
| SC | Stoney Creek |
| SCA | Species Conservation Act |
| SGRA | Significant Groundwater Recharge Area |
| SIC | Sinkhole Creek |
| SPA | Source Protection Area |
| SPP | Source Protection Plan |
| SWH | Significant Wildlife Habitat |
| SWM | Stormwater Management |
| SWPA | Source Water Protection Areas |
| SWS | Subwatershed Study |
| SWP | Subwatershed Plan |
| The City | The City of Hamilton |
| TMC | Twenty Mile Creek |
| ToR | Terms of Reference |
| TRCA | Toronto and Region Conservation Authority |
| UBE | Urban Boundary Expansion |
| UFS | Urban Forest Strategy |
| UHOP | Urban Hamilton Official Plan |
| VO | Visual OTTHYMO |
| VPZ | Vegetation Protection Zone |
| WHPA | Well Head Protection Areas |
| WWIS | Water Well Information System |



1 Introduction

1.1 Background

The Elfrida Lands, which are subject to the proposed Secondary Plan, are generally “L” shaped and are located generally southeast within the boundaries of the City of Hamilton’s, in upper Stoney Creek. Elfrida consists of a total gross land area of approximately 1,233 hectares, inclusive of existing public roads that cross through the lands. It is approximately 5.3 kilometres wide in an east-west direction and 4 kilometres long in a north-south direction, at its deepest.

In November 2024, the Elfrida Community Home Builders Group (ECBG) filed a privately initiated urban boundary expansion application (the “UBE Application”), in accordance with the policies of the Provincial Planning Statement (2024). The UBE application is presently under appeal to the Ontario Land Tribunal, with appeal proceedings ongoing.

Despite the ongoing appeal of the UBE, the ECBG is committed to continuing to advance the planning policy framework for the Elfrida lands. The preparation of a Secondary Plan represents the next logical step in the process to facilitate the development of Elfrida. The proposed Secondary Plan contemplates the development of Elfrida with a mix of residential, mixed-use, commercial, open space and constraint/natural heritage system lands. A road structure is contemplated that builds on the existing road network on the abutting lands.

In support of the Secondary Plan, the ECBG retained GeoProcess Research Associates Inc. (GeoProcess), Palmer Environmental Consulting Group, now part of SLR Consulting Ltd. (SLR), Landtek Limited (Landtek) and Stantec Consulting Ltd. (Stantec), “Consultant Team”, to prepare the Elfrida Subwatershed Plan (SWP) and provide environmental direction for future land use planning considerations in the Study Area. This included a desktop review of natural heritage features, watercourses, floodplains, and headwater drainage features, as well as preliminary field surveys. The Consultant Team has prepared a preliminary characterization of the natural heritage and hazards in Elfrida. In support of this initiative, the Consultant Team has prepared a preliminary characterization of the natural heritage and hazards in Elfrida. These findings are summarized in the SWP, as outlined herein.

1.2 Purpose and Scope of the Subwatershed Plan

For the Elfrida lands and UBE to be considered for inclusion in the City’s Urban Boundary, the City requires a SWP to be completed to guide development and land use planning for the Elfrida Study Area. The purpose of the SWP is to characterize existing subwatershed conditions, identify opportunities and constraints for development, evaluate potential impacts of development on the health of the subwatersheds, and outline protective measures, mitigative methods and restoration opportunities, to help ensure features are protected and enhanced, where possible. The Consultant Team has coordinated to deliver the following key elements of the SWP, which can be broken down as follows:

- Project Management / Coordination: Stantec
- Terrestrial Ecology: GeoProcess / SLR



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1 Introduction

- Aquatic Ecology: GeoProcess / SLR
- Fluvial Geomorphology: GeoProcess / SLR
- Surface Water: Stantec
- Hydrogeology: Landtek

The SWP is intended to present an approach to manage potential impacts associated with development that will protect, rehabilitate, and enhance the environment within the Study Area limits. Some subwatersheds within the Study Area have existing downstream conditions and constraints beyond the identified Study Area, which shall be considered in the study objectives and ultimate targets.

The Elfrida SWP will:

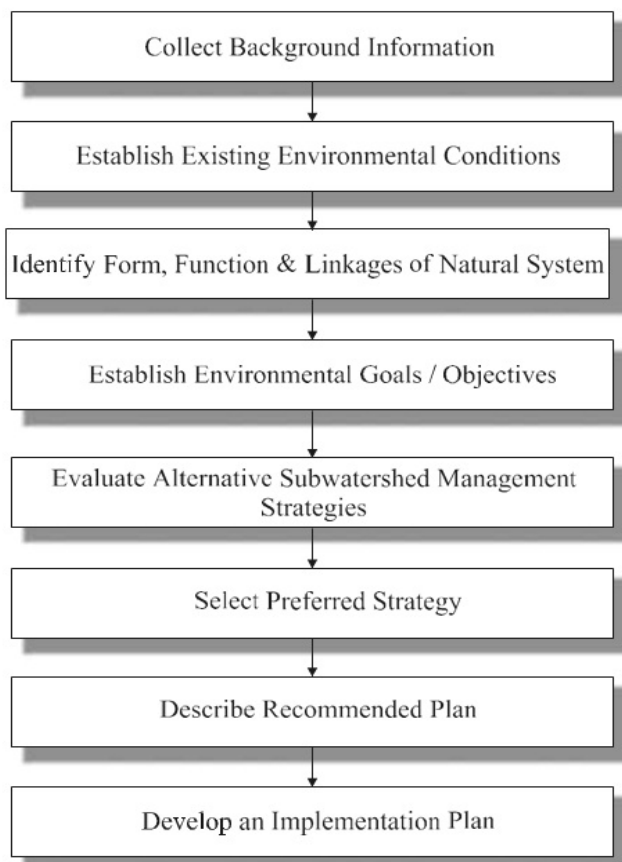
- Identify the location, extent, status, significance, and sensitivity of existing natural heritage features
- Identify sensitive areas and hazardous lands and appropriate management practices
- Identify lands where development may be permitted, and determination of how existing and future land uses can be integrated with and enhance natural features
- Provide direction on best management practice
- Provide direction on future infrastructure needs (from a drainage perspective)
- Implement strategies and requirements for environmental protection and monitoring
- Provide technical information to assist in the parallel development of a Secondary Plan

This report has been prepared to satisfy the requirements outlined in the Elfrida SWP Terms of Reference (ToR) and process described by the Ministry of the Environment, Conservation and Parks (MECP) Draft Subwatershed Planning Guide, dated January 2022, in accordance with relevant federal, provincial, and local municipal planning and environmental policy. The components of a Subwatershed Plan are illustrated on Figure 1.2.1 and the Elfrida SWP ToR, as prepared by the consultants, which was derived from the original ToR (C3-10-14), and is included in **Appendix A** for reference.

The structure of this document has been prepared to comprehensively deliver the Phase 1, Phase 2, and Phase 3 components of the Elfrida SWP, which are generally described as follows.



Figure 1.2.1 MECP Components of a Subwatershed Plan



(Ref: MECP Stormwater Management Planning & Design Manual, March 2003)

Phase 1 – Inventory and Mapping

The Elfrida SWP Phase 1 scope encompasses the inventory, mapping, and assessment of existing natural environmental conditions and hazards within the Study Area, as outlined in **Section 1.3**. Discipline-specific field assessments, including aquatic and terrestrial ecology, surface water, hydrogeology, and fluvial geomorphology, were conducted across various landownership types: lands owned by members of the ECBG, public rights-of-way, and non-participating properties where access permissions were granted. These assessments were undertaken to better characterize the existing natural environment.

As a result, the Phase 1 deliverable includes comprehensive data and analysis related to the Natural Heritage System (aquatic and terrestrial communities), surface water (hydrology and hydraulics), site geology, hydrogeology, and stream fluvial geomorphology. The methods, inventory findings, and results of Phase 1, along with recommendations for mitigation measures and targets aimed at preserving or enhancing existing natural environmental conditions, are summarized herein.

Phase 2 – Analysis

The Elfrida SWP Phase 2 scope includes confirmation of the extents and limits of existing natural environmental features, hazard lands and protection zones, and the delineation of appropriate development limits to inform the Secondary Planning process for the Study Area. The Phase 2



deliverable includes recommendations for the protection and enhancement of the natural system, assessment of potential development impacts, a master storm servicing strategy for lands within the Study Area, and the definition of environmental monitoring requirements and responsibilities.

Phase 3 – Implementation

The Elfrida SWP Phase 3 scope includes identifying roles, responsibilities, and funding expectations for implementing the recommendations made as part of the Phase 1 and Phase 2 deliverables.

Contingency plans to address enhancement and/or mitigation actions that fail to meet the goals and objectives of the SWP are also defined. Requirements for future planning and engineering submissions for subsequent stages of the development process are identified.

As the Elfrida SWP progressed, meetings were held with agency representatives from the City, Hamilton Conservation Authority (HCA), and the Niagara Peninsula Conservation Authority (NPCA) to help guide the disciplinary focus and inform the materials presented in this document. Meeting notes and other guiding agency correspondence are provided within **Appendix B**.

1.3 Subwatershed Plan Area

The Elfrida SWP has been prepared within the context of a defined Study Area, as previously identified in the UBE application submitted in April 2025.

The Study Area spans approximately 1,233 gross hectares (ha) and is generally bounded by Trinity Church Road to the west, Golf Club Road to the southwest/south, Hendershot Road to the southeast/east, Mud Street to the northeast, and the existing urban area to the north, as illustrated in Figure 1.3.1. This includes lands proposed for future urban development and is the primary focus for detailed environmental assessment and servicing strategy development. Prominent existing land uses within the Study Area include agricultural lands, natural open spaces, and localized rural residential uses.

The Study Area encompasses portions of five subwatersheds, including headwater and upper-reach segments of the Twenty Mile, Sinkhole, and Stoney Creek systems, with portions of Hannon Creek and Upper Davis Creek also considered. Twenty Mile Creek subwatershed is the main branch of the larger Twenty Mile Creek watershed. For simplicity, this report refers to this Main Branch as Twenty Mile Creek subwatershed. Further, in some report sections, the Twenty Mile Creek subwatershed has been divided into East and West Twenty Mile Creek subwatersheds, to reflect the two major subwatershed outflows at the Study Area boundary. Within the Study Area, subwatershed composition can be broken down as Twenty Mile Creek (28.0%), Sinkhole Creek (50.8%), Stoney Creek (18.0%), Hannon Creek (3.0%), and Upper Davis Creek (0.2%). The five subwatersheds within the Study Area can be referenced on Figure 1.3.1.

The broader landscape of the five subwatersheds extends beyond the Study Area limits, spanning approximately 237 km² and are situated within the upper reaches of the Niagara Peninsula and Hamilton watershed systems. A brief description of each of these five subwatersheds is provided below.



Twenty Mile Creek Subwatershed

Located in the southwestern portion of the Study Area, the Twenty Mile Creek subwatershed spans approximately 17,896 ha and represents the largest hydrologic unit intersecting the Study Area. It includes a diverse mix of agricultural tablelands, natural heritage features concentrated along unconfined valley corridors, and karst topography that influences both surface and subsurface hydrology. Several headwater tributaries originate within the Study Area, contributing to downstream flow regimes and supporting groundwater recharge functions. Portions of the subwatershed remain undeveloped, while others are actively farmed or used for rural residential purposes. The Elfrida SWP Study Area and the Twenty Mile Creek drainage area overlay 337 ha, accounting for 1.9% of the overall Twenty Mile Creek subwatershed.

Sinkhole Creek Subwatershed

The Sinkhole Creek subwatershed is situated in the central portion of the Study Area and covers approximately 1,836 ha. It is defined by its prominent karst landscape, including sinkholes, subsurface conduits, and groundwater discharge zones. Tributaries within this subwatershed are generally short and intermittent, with flow paths influenced by subsurface geology. Natural heritage features are concentrated around unconfined valleylands and karst formations, with adjacent lands primarily used for agriculture and rural residential purposes. The Elfrida SWP Study Area and the Sinkhole Creek drainage area overlay 642 ha, representing 34.0% of the overall Sinkhole Creek subwatershed.

Stoney Creek Subwatershed

The Stoney Creek subwatershed lies in the northeastern portion of the Study Area and encompasses approximately 2,103 ha. It includes several headwater drainage features and steep slopes that contribute to erosion sensitivity. Natural features are generally limited to unconfined valleyland areas. The Elfrida SWP Study Area and Stoney Creek subwatershed overlay 215 ha, representing 10.5% of the overall Stoney Creek subwatershed.

Hannon Creek Subwatershed

Located in the northwest corner of the Study Area, the Hannon Creek subwatershed is currently being assessed through the Upper Hannon Creek Master Drainage and Servicing Study (HCMDSS). It spans approximately 1,097 ha and includes regulated floodplains, urban drainage infrastructure, and riparian corridors. Tributaries in this subwatershed are more developed, with existing stormwater management (SWM) facilities and road crossings influencing flow patterns. Natural features are concentrated along unconfined valleylands, with surrounding land uses including agricultural fields, rural residential lots, and infrastructure corridors. The Elfrida SWP Study Area and Hannon Creek subwatershed overlay 36 ha, or 3.4% of the overall Hannon Creek subwatershed.

Upper Davis Creek Subwatershed

A small portion of the Study Area near the northwest corner of the site drains to the Upper Davis Creek subwatershed. In total, Upper Davis Creek spans approximately 725 ha, and includes mainly developed areas with residential land use and conservation areas. The portion within the Study Area drains to the subdivision to the north and is collected by urban drainage infrastructure. The Elfrida SWP Study Area and Upper Davis Creek subwatershed overlay 2 ha, or 0.3% of the overall Upper Davis Creek subwatershed.



Further information on the surface water modelling and drainage can be found in **Section 3.4**.

1.4 Subwatershed Plan - Land Ownership

At the time of this report's preparation, land ownership within the Study Area includes a mix of participating, cooperating, and non-participating landowners. Members of the ECBG are responsible for commissioning the Elfrida SWP and are identified as participating landowners. Collectively, the ECBG owns approximately 808 ha and represents 65.5% of the overall Study Area. Landowners not affiliated with the ECBG but who permitted field surveys and investigations on their properties are identified as cooperating landowners. Approximately 61.1 ha are owned by cooperating landowners, representing 5.0% of the overall Study Area. All other landowners and properties within the Study Area not part of the ECBG, or cooperating in field surveys, are identified as non-participating landowners, which account for approximately 363.9 ha and represents 29.5% of the overall Study Area. Land ownership and participation are illustrated in Figure 1.4.1; however, it should be noted that these figures are subject to change should additional landowners choose to join the ECBG and participate in the proposed Secondary Planning process.

1.5 How To Use This Subwatershed Plan

This document has been prepared to comprehensively present the Phase 1, Phase 2, and Phase 3 deliverables of the Elfrida SWP in a comprehensive, user-friendly format. The Elfrida SWP serves as a foundational step in the environmental planning process, as outlined by the MECP, particularly in areas where watershed-scale planning has not yet been completed. The study provides a comprehensive analysis of watershed conditions within the Study Area, including detailed assessments of surface water, groundwater, aquatic and terrestrial resources, fluvial geomorphology, and municipal storm servicing within the Study Area. These findings are intended to inform and support the development of the proposed future Secondary Plan for the Study Area.



2 Policy Context

2.1 Federal Context

2.1.1 Species at Risk Act

The federal Species at Risk Act, 2002 (SARA) was created to prevent wildlife species from becoming extirpated (i.e., extinct in Canada). SARA protects Species at Risk (SAR) and their critical habitats and contains provisions to help manage species of Special Concern to prevent them from becoming Endangered or Extinct. It includes prohibitions against killing, harming, harassing, capturing or taking species at risk, makes it illegal to destroy their critical habitats, and can impose restrictions on development and construction projects.

Species thought to be at risk in Canada are assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC is an independent body that reviews species based on a broad range of best available scientific data. The committee meets annually to review status reports on species suspected of being at risk and provides assessments to government and the public. The federal Cabinet then decides whether those species should receive legal protection under the SARA. These decisions are made after consultations with affected stakeholders and other groups. Once a species is added to the list of SAR and legally protected under the SARA, a recovery strategy must be developed. These recovery strategies detail the specific steps that need to be taken to protect the identified species.

The main limitation of SARA is that its legislative coverage extends only to federal lands while the Ontario Species Conservation Act, 2025 (SCA), previously the Ontario Endangered Species Act (ESA), covers public and private lands. In Ontario, SARA will take precedence for habitat protection and stewardship efforts for migratory birds and some aquatic species designated 'at risk'. The SCA takes precedence for most other SAR. Under Section 34(3) of the SARA, the Minister of the Environment must issue this order if of the opinion that the species is not adequately protected under provincial laws.

The provincial policy context for the replacement of the Endangered Species Act, 2007 with the Species Conservation Act, 2025 is described further in **Section 2.2.6**.

2.1.2 Fisheries Act

The Fisheries Act, 1985 (Government of Canada, 1985) is the main federal law governing fisheries in Canada and is administered by Fisheries and Oceans Canada (DFO). The Act was amended on November 27, 2024. The Fisheries Act provides for the management and control of fisheries, the conservation and protection of fish, the protection of fish habitat and pollution prevention. Projects that may impact fish, fish habitat, aquatic SAR, and aquatic invasive species may be subject to DFO review. The Fisheries Act prohibits causing the death of fish and the harmful alteration, disruption, or destruction (HADD) of fish habitat, unless authorized by the Minister of Fisheries and Oceans, and the Canadian Coast Guard. Conditions and circumstances for projects to be exempt from review are listed on DFO's Fish and Fish Habitat Protection Program website.

Following guidance and criteria provided on DFO's website regarding mitigation, waterbody types and codes of practice, proponents determine whether their projects in or near water will require review by



DFO. DFO review is requested through the submission of a 'Request for Review' (RfR) form. Following completion of their review, DFO can proceed in two ways: 1) issue a Letter of Advice indicating that the proposed work complies with the Fisheries Act or, 2) refer the project to the Regulatory Review Unit for project-specific review. If the project can avoid impacts to fish and fish habitat, project approval is not required. If impacts that cause the HADD of fish habitat that cannot be avoided or mitigated, proponents must apply for a Fisheries Act Authorization and may be required to develop a habitat offsetting or compensation plan.

2.2 Provincial Context

2.2.1 Planning Act / Provincial Planning Statement

The Planning Act, 1990 (PA) establishes the framework for land use planning in Ontario.

The 2024 Provincial Planning Statement (PPS) serves as a streamlined, province-wide land use planning policy framework. It replaces both the Provincial Policy Statement (2020) and A Place to Grow: Growth Plan for the Greater Golden Horseshoe (2019), while incorporating housing-supportive policies from both documents. Issued under the authority of Section 3 of the Planning Act, the PPS came into effect on October 20, 2024. The PPS provides direction on matters of provincial interest related to land use planning and development, including housing, transportation infrastructure, environmental protection, resource management, and economic growth.

The Province of Ontario (the Province) can delegate some planning authority to upper-tier municipalities (i.e. counties and regional/district municipalities, and planning boards) while retaining primary authority and control over the approval process for planning matters in Ontario. Under the Act, municipalities must conform to approved provincial policies as outlined in the PPS.

Municipalities and planning authorities must consider the policies of the PPS when making decisions on planning and land use proposals. Relevant policies applicable to the scope of the SWP are summarized herein.

PPS 2024 *Chapter 2: Building Homes, Sustaining Strong and Competitive Communities*, **Section 2.3: Settlement Areas and Settlement Area Boundary Expansions** provides the policy framework for managing growth within settlement areas and outlines the conditions under which settlement area boundary expansions may be considered. It emphasizes the importance of optimizing land and infrastructure use, supporting housing supply, and ensuring that expansions align with broader provincial planning objectives. Policy 2.3.2.1 specifically allows for boundary expansions outside of a municipal comprehensive review if seven criteria are met:

- The need to designate and plan for additional land to accommodate an appropriate range and mix of land uses
- If there is sufficient capacity in existing or planned infrastructure and public service facilities
- Whether the applicable lands comprise specialty crop areas
- The evaluation of alternative locations which avoid prime agricultural areas and, where avoidance is not possible, consider reasonable alternatives on lower priority agricultural lands in prime agricultural areas
- Whether the new or expanded settlement area complies with the minimum distance separation formulae



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2 Policy Context

- Whether impacts on the agricultural system are avoided, or where avoidance is not possible, minimized and mitigated to the extent feasible as determined through an agricultural impact assessment or equivalent analysis, based on provincial guidance
- The new or expanded settlement area provides for the phased progression of urban development

PPS *Chapter 3: Infrastructure and Facilities*, **Section 3.6: Sewage, Water and Stormwater**, and *Chapter 4: Wise Use and Management of Resources*, **Section 4.2: Water**, outline policies that aim to protect, improve, and restore the quality and quantity of water. These policies promote the use of watersheds as ecologically meaningful scales for long-term planning and sets the framework for avoiding or mitigating potential impacts on water systems. Planning authorities are directed to evaluate and prepare for climate change through watershed planning, ensure the efficient and sustainable use of water resources, and implement SWM practices that reduce volume and contaminant loads. Furthermore, development and site alterations may be restricted in or near hydrologically sensitive areas to safeguard water resources.

PPS 2024 *Chapter 4: Wise Use and Management of Resources*, **Section 4.1: Natural Heritage**, outlines the policies for preserving biodiversity and protecting natural heritage features and areas long term. This includes maintaining, restoring, or, where possible, improving the diversity and connectivity of natural features, and the long-term ecological function and biodiversity of natural heritage systems. It should be noted that natural heritage systems and features defined under *Section 4.1* are located within Ecoregions 6E and 7E. The Study Area is found in Ecoregion 7E, and therefore the natural heritage features described below are identified within Ecoregion 7E.

Under the policies of *Section 4.1*, development and site alteration shall not be permitted in:

- Significant wetlands
- Significant woodlands, significant valleylands, significant wildlife habitat, or significant areas of natural and scientific interest (ANSI), unless it has been demonstrated that there will be no negative impacts on natural features or their ecological functions
- Fish habitat or habitat of Endangered species and Threatened species, except in accordance with provincial and federal requirements
- Lands adjacent to natural heritage features and areas, unless the ecological function has been evaluated and it has been demonstrated that there will be no negative impacts on the features or their functions

Significant natural heritage features in Ontario, as defined by the PPS 2024, are the most ecologically and socially important components of the natural environment within a given region. These features are identified for their critical role in sustaining biodiversity, supporting essential ecological functions, and preserving the integrity and legacy of natural heritage landscapes for the benefit of current and future generations.

In addition to the natural heritage policies described above, PPS *Chapter 5: Protecting Public Health and Safety*, provides guidelines for the efficient use and management of land and infrastructure while protecting people, properties, and communities. **Section 5.1: General Policies for Natural and Human-Made Hazards** directs development away from areas of natural or human-made hazards to avoid creating or worsening risks to public health and safety. Development and site alterations are generally prohibited in hazardous areas, including lands prone to flooding or erosion, unless safe access has been demonstrated.



Section 5.2: Natural Hazards permits development and site alterations where minor impacts and natural hazards can be mitigated through flood proofing, protection works, access, wildlife fire assessment and mitigation, or other standards as approved by the Ministry of Natural Resources (MNR). Furthermore, **Section 5.3: Human-Made Hazards** requires that contaminated sites in land or water shall be assessed and remediated before any activities occur on these sites to prevent adverse effects. Where feasible, planning authorities should also support on-site and local re-use of excess soil while continuing to support the protection of human health and the environment.

In general, the PPS looks to provide a streamlined process for protecting natural heritage features and provides detailed guidance on collaboration with the Province, planning authorities, and Conservation Authorities. Collaboration is essential to mitigating the potential risks to public health, safety, and property damage arising from natural hazards.

Please refer to Figure 2.2.1 for an overlay of Provincial Planning Areas in the Elfrida SWP Study Area.

2.2.2 Greenbelt Plan

An amendment to the Greenbelt Plan took effect on July 1, 2017. The Greenbelt Plan was prepared and approved under the Greenbelt Act, 2005 and took effect on December 16, 2004. The Greenbelt Act sets out the main elements and objectives for the Greenbelt Area and requires planning decisions to conform to the Greenbelt Plan 2017.

The Greenbelt Plan incorporates and builds on other provincial plans, including the PPS, the Niagara Escarpment Plan 2017, and the Oak Ridges Moraine Conservation Plan. As discussed in **Section 2.2.1**, the PPS 2024 replaced the PPS 2020, and A Place to Grow: Growth Plan for the Greater Golden Horseshoe 2019. These changes were incorporated into the Greenbelt Plan in August 2024 under Amendment No. 4 to ensure continuity with the revised provincial planning policies.

The Study Area is situated immediately adjacent to lands designated by the Greenbelt Plan as Protected Countryside (along the south and easterly Study Area limits) and Specialty Crop Area lands (along the north Study Area limit). The Protected Countryside lands are intended to enhance our urban and rural areas and overall quality of life by promoting agricultural viability and protection, environmental protection, culture, recreation and tourism, settlement areas, infrastructure and natural resources and climate change. The Settlement Area lands “support and provide significant economic, social and commercial functions to Prime Agricultural Areas and Rural Lands”. The “Greenbelt Specialty Crop Lands” designation in Ontario refers to areas within the Greenbelt Plan specifically set aside for growing high-value specialty crops like tender fruits, grapes, and vegetables. These designations, which include the Niagara Peninsula Tender Fruit and Grape Lands, are based on factors like soil suitability and climate. The goal is to protect these areas and support the farmers and infrastructure that depend on them.

The Protected Countryside lands contain a Natural System that provides a continuous and permanent land base necessary to support human and ecological health in the greenbelt and beyond. The Natural System is made up of a Natural Heritage System and a Water Resources System that often coincide given ecological linkages between terrestrial and water-based functions.

Portions of the existing Natural Heritage System in Elfrida include core areas, water resources features and linkages that are connected to the downstream Protected Countryside. These areas need to be managed as a connected and integrated natural heritage system, given the functional inter-relationships



between them. Together, these systems will comprise and function as a connected Natural Heritage System. The Water Resource System is made up of both ground and surface water features and areas and their associated functions, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption.

The existing Natural Heritage System in Elfrida is not directly connected to the lands designated as Specialty Crop Areas. Under the Greenbelt Plan, Specialty Crop Areas are generally defined as areas within the agricultural land base where specialty crops are predominantly grown such as tender fruits (peaches, cherries, plums), grapes, other fruit crops, vegetable crops, greenhouse crops, and crops from agriculturally developed organic soil. Both the Niagara Peninsula Tender Fruit and Grape Area (NPTFGA) and Holland Marsh are listed as Specialty Crop Areas. Localized drainage from the existing Specialty Crop Area designation directs drainage/runoff from existing agricultural lands underneath Mud Street and into the Study Area. This localized drainage will be accommodated under both existing and future developed conditions within the Study Area.

2.2.3 Niagara Escarpment Plan

The Niagara Escarpment Plan (2017, Office Consolidation April 1, 2025) provides a comprehensive policy framework for the protection, conservation, and sustainable development of the Niagara Escarpment and its surrounding lands. The Niagara Escarpment Plan (NEP) aims to maintain the escarpment as a continuous natural environment by balancing ecological integrity, cultural heritage, agriculture, recreation, and compatible development, establishes several land use designations to guide development, conservation, and resource management within the NEP area. The Niagara Escarpment Plan is implemented in coordination with municipal planning, the Greenbelt Plan, and other provincial policies. If development is proposed within the NEP area, a permit under the Niagara Escarpment Planning and Development Act is required. The Elfrida lands are situated more than 800 m south/southeast of the NEP area and therefore the NEP policies and permitting requirements do not apply.

2.2.4 Eramosa Karst Area of Natural and Scientific Interest

The Eramosa Karst Provincial Earth Science Area of Natural and Scientific Interest (ANSI) is approximately 78 ha of land containing unique geological formations including dolines (sinkholes), soil pipes, karst windows, sinking streams, and caves, a portion of which is situated within the northwest limit of the Elfrida lands. As noted within Section 2.2.1, significant ANSIs are protected under the PPS, which prohibits development and site alteration within significant natural heritage features unless it can be demonstrated that there will be no negative impacts on the feature or its ecological functions. Restrictions also apply to adjacent lands, requiring an evaluation of ecological functions before any development can proceed.

2.2.5 Bill 150, Planning Statute Law Adjustments Act, 2023

On December 6, 2023, the Province passed Bill 150, Planning Statute Law Adjustments Act, which introduced the Official Plan Adjustments Act, 2023 and amendments to the Planning Act. The legislation was introduced following the Province's announcement of its intent to revisit decisions made under subsection 17(34) of the Planning Act, which had modified municipally adopted official plans in 12 municipalities, including the City of Hamilton, between November 2022 and April 2023.



As a result, Bill 150 reverses the majority of these Ministerial modifications, deeming them as never having been made, with only a limited number of changes retained. The legislation also amends the Planning Act to restrict legal remedies related to the reversals and requires municipalities to conform to the reinstated versions of their official plans.

For the City, the enactment of Bill 150 has direct implications for OPA 167 to the UHOP and OPA 34 to the RHOP. The legislation reverses provincial modifications that had expanded the City's urban boundary by approximately 2,200 hectares. As a result, the City's Council-adopted growth strategy, approved in 2022 through the GRIDS2 Municipal Comprehensive Review and based on accommodating growth within the existing urban boundary to 2051, was reinstated.

2.2.6 Species Conservation Act, 2025

In April 2025, the Province proposed to replace the Endangered Species Act, 2007 (ESA) with the Species Conservation Act, 2025 (SCA), which establishes a new framework for species classification, habitat protection, and regulatory oversight for Protected Species in Ontario. The SCA under Bill 5 received Royal Assent in June 2025, and came into effect March 30, 2026, effectively replacing the ESA. The SCA continues to identify and protect SAR, but with notable changes to listing procedures, habitat definitions, and recovery planning.

Species are assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) and may be classified as Extirpated, Endangered, Threatened, or of Special Concern. Under the new SCA framework, the provincial Cabinet now has authority to determine which species are added to the official list of protected species, either in alignment with or contrary to COSSARO's recommendations.

Habitat protection under the SCA is defined more narrowly than under previous legislation. For animal species, habitat includes dens, nests, or similar dwelling places that are occupied or habitually occupied, along with the immediate surrounding area used for breeding, rearing, staging, wintering, or hibernating. For vascular plant species, habitat is limited to the critical root zone surrounding the plant. The Lieutenant Governor in Council may prescribe additional habitat areas through regulation, using geographic boundaries or descriptive features.

The SCA prohibits the killing, harming, capturing, or taking of species listed as Extirpated, Endangered, or Threatened on the Protected Species in Ontario List. Activities that may affect listed species or their habitat are subject to either a registration process or a permit requirement, depending on the nature and impact of the activity. The registration-first approach allows certain activities to proceed without a permit if they meet prescribed conditions, while others require formal approval through a permit issued by the MECP.

The SCA does not require the development of recovery strategies or management plans for listed species. The legislation outlines a discretionary approach to species recovery and habitat management, with implementation guided by regulatory instruments and ministerial decisions. The Phase 2 SWP Report will identify potential impacts on species listed under the SCA within the Study Area and will provide recommendations for mitigation strategies to support species protection and habitat conservation.



2.2.7 Conservation Authorities Act

The Conservation Authorities Act (CAA) establishes the framework for the conservation, restoration, development, and management of natural resources within Ontario's watersheds. The MNR administers the Act and delegates the regulatory responsibilities of Conservation Authorities (CA) within their respective jurisdictions. As of January 2025, the MNR also has authority to issue permits and conduct reviews of Conservation Authority decisions on behalf of the Minister where activities are identified as supporting provincial priorities.

In 2017, amendments to the CAA were introduced through *Bill 139, Building Better Communities and Conserving Watersheds Act*. These amendments included re-enacting Section 28, which prohibits activities that straighten, alter, divert, or interfere with watercourses or wetlands without authorization. Additional amendments included permitting Conservation Authorities to issue approvals for such activities and cancelling permits under specified conditions and detailed the regulation making power related to natural resource management.

On April 1, 2024, further regulatory changes were implemented through Ontario Regulation (O. Reg.) 41/24, effectively replacing the former O. Reg. 97/04. This regulation consolidated existing regulations, introduced standardized definitions and permitting criteria, and introduced timelines and exemptions for certain activities. Notable changes include a reduction in the regulated area surrounding Provincially Significant Wetlands and the removal of "conservation of land" as a permitting consideration. More information on O. Reg. 41/24 is provided in **Section 2.2.8.1**.

The Study Area is located within the jurisdiction of the NPCA and the HCA. In accordance with Section 28(1) of the CAA, and pursuant to O. Reg. 41/24, these authorities regulate development activities, interference with wetlands, and alterations to shorelines and watercourses within their respective jurisdictions.

2.2.8 Clean Water Act

The Clean Water Act, S.O. 2006, Chapter 22, was created to protect existing and future sources of drinking water in Ontario. The Clean Water Act establishes the Conservation Authorities as the drinking water source protection authority for source protection area (SPA) in their respective jurisdiction. They are responsible for preparation, amendment and review of source protection plans and the regulation of drinking water threats.

2.2.8.1 Ontario Regulation 41/24 Prohibited Activities, Exemptions and Permits

In general, O. Reg. 41/24 prohibits development or site alteration to watercourses, wetlands, hazardous lands, and adjacent lands without prior written approval from NPCA and/or HCA. Permits may only be issued if the activity does not adversely affect flooding, erosion, dynamic beaches, or unstable soils and bedrock, and must also consider risks to human health, safety, and property. Notably, the regulation removed previous considerations related to pollution and conservation of land, and reduced the regulated area adjacent to Provincially Significant Wetlands from 120 m to 30 m.

The NPCA and HCA Regulated Areas under O. Reg. 41/24, and the extent that it covers both the Study Area and Boundary Area, is illustrated on Figure 2.2.2.



2.2.9 Ontario Water Resources Act

The Ontario Water Resources Act, R.S.O. 1990, c. O.40 was created to conserve, protect and manage Ontario's waters and for their efficient and sustainable use, to promote Ontario's long-term environmental, social and economic well-being. The Water Resources Act applies to both groundwater and surface water and provides several important regulations for water resource protection that the MECP administers.

The Act prohibits the discharge of polluting material in or near water resources; prohibits or regulates the discharge of sewage; enables the issuance of orders requiring measures to prevent, reduce or alleviate impairment of water quality; enables the designation and protection of sources of public water supply; regulates water takings in excess of 50,000 litres a day; regulated well drilling and construction; requires approval of water and sewage works; enables the Ontario Clean Water Agency to provide or operate water works or sewage works for municipalities; designates and regulates areas of public water or sewage services; and imposes a duty on corporate officers and directors to take all reasonable care to prevent the corporation from discharging materials into or near water that may impair water quality.

2.2.9.1 O. Reg 387/07 Water Taking and Transfers

O. Reg. 387/04 was made under the Ontario Water Resources Act to regulate Water Taking and transfers. The regulation manages water takings; regulates new or increased transfers of water from one Great Lake watershed to another; and retains exemptions for watering livestock or for domestic purposes, unless a new or increased transfer of 379,000 litres per day or more is established.

2.3 Local Context

2.3.1 City of Hamilton Official Plans

2.3.1.1 Rural Hamilton Official Plan

The RHOP was adopted by City Council on September 27, 2006, and brought into effect on March 7, 2012, except for policies schedules, maps, and appendices currently under appeal. In general, the RHOP outlines planning and land use policies for communities within the rural areas of the city. Under this plan, policies and rural settlement boundaries set limits for residential, non-farm, and non-resource-based growth to protect the local economy, support the conservation of cultural and natural heritage features, and provides housing for the farm community and rural residents.

In the context of this SWP, the Study Area is currently situated within the RHOP area. This boundary, relative to the Study Area, is generally defined by Trinity Church Road to the west, extending toward Rymal Road East, and then by Upper Centennial Parkway, continuing north to Mud Street, which marks the northeastern extent of the Study Area. Please refer to Figure 2.3.1(a) and 2.3.1(b) for land use designations under the UHOP and RHOP, respectively. Chapter B of the RHOP, Communities, and Chapter C, Section C.2.0 Natural Heritage Systems, include the relevant policies and guidance for the Study Area's current land use designations and limitations.

The City defines the urban boundary in Chapter B, under section B.2.0 Defining Our Communities, states that, *"the urban boundary which delineates the urban area from the rural area [...] is delineated through the Urban Hamilton Official Plan. It is the intent of the City of Hamilton to maintain a firm urban*



boundary. Lands shall not be removed from the boundaries of Rural Hamilton and added to the Urban Area [...]." This policy, approved in 2022, reflects the City's commitment to managing growth through intensification and the protection of agricultural and rural lands.

As described in **Section 2.2.5**, the Province passed Bill 150 in 2023, which reversed a previously imposed UBE and reinstated Hamilton's no-expansion policy. However, subsequent provincial reform to the PPS and Bill 185, now permit landowners to submit UBE applications at any time, without the requirement for a Municipal Comprehensive Review.

The RHOP aims to protect and enhance the natural heritage system through stewardship, education and awareness, land use planning policies, habitat restoration and management, and acquisition. Policy goals include protecting and enhancing biodiversity and ecological functions, conserving and where possible improving the distinct landscape and quality of life in natural heritage systems, and restoring and improving habitat connections and sustainable recreation activities.

According to the RHOP, Core Areas include key natural heritage features, hydrological features and provincially significant and local natural areas. Linkages are defined as the natural corridors that ecologically connect Core Areas. Both features are essential in connecting and preserving biodiversity and ecological functions in urban areas. The RHOP policies direct that Core Areas and Linkages are protected, and where possible enhanced. Projects that may affect Core Areas or Linkages require appropriate studies to assess potential impacts. These may include an Environmental Impact Statement (EIS), watershed study, or other assessments recognized by the RHOP. An EIS is typically required for proposals within Core Areas, while Linkages may be evaluated through a Linkage Assessment, which can be incorporated into an EIS where appropriate.

In general, new development and site alterations are not permitted within environmentally sensitive areas unless it can be demonstrated that there will be no negative impacts or the proposal complies with applicable provincial and federal requirements.

The natural heritage system within the Study Area is identified within Schedule B of the RHOP, (please refer to Figure 2.3.2). Under Section C.2.0 of the RHOP, the natural heritage systems identified on Schedule B consist of the Greenbelt Natural Heritage System, the Greenbelt Protected Countryside, and Core Areas within and outside of the Greenbelt Plan Area. The Core Areas and Linkages shown in Schedule B are considered general in nature, and minor changes to their boundaries may occur through EIS, watershed studies, or other approved studies accepted by the City without an amendment to the RHOP. It should be noted that the Study Area is located outside of the Greenbelt Plan Area.

Amendments to the RHOP are required for major refinements to the boundaries, including the removal or addition of Core Areas and Linkages. Where provincial direction for identifying Core Areas does not exist, the City is required to establish their own criteria and cooperation with agencies, stakeholders, and the public. This includes collaboration with the local Conservation Authorities to identify and implement strategies aligning with the PPS and RHOP policies.

Additional relevant land use and planning policies provided within the RHOP include Watershed Planning, Restoration, Remedial Action Plans, Tree and Woodland Protection, Non-Regulatory Natural Heritage System Management, and Water Resource policies. These policies reinforce the City's commitment to working with local Conservation Authorities, stakeholders, and other agencies to implement strategies that meet all legislative and ecological requirements.



2.3.1.2 Urban Hamilton Official Plan

Natural Heritage Policy Direction

The natural heritage policies outlined in the City's UHOP, adopted on July 9, 2009, and brought into effect on August 16, 2013, build upon the policy direction set forth in the PPS. The City's UHOP guides the planning and land use policies related to natural and cultural heritage, infrastructure, and community services on an urban wide basis. Chapter B of the UHOP, Communities, and Chapter C, Section C.2 Natural Heritage Systems, include the relevant policies and guidance for the Study Area to be considered as part of the City's Urban Boundary.

Chapter B of the City's UHOP outlines planning and policy directions that support complete communities within the City's urban boundary. This includes policies that support and promote the local economy, provide a range of housing opportunities for the growing population; provides and maintains community and emergency facilities; protects, and where possible, enhances cultural and natural heritage features, and ensures public safety through policy direction for contaminated sites, hazard lands, water and air quality.

Policies dedicated to protecting the City's natural heritage and green spaces are outlined in Chapter C, Section C.2.0 of the UHOP, and include:

- Protect water quality and quantity in accordance with Section C.2.0
- Hazard lands and their boundaries shall be identified, mapped, and regulated by the local Conservation Authorities
- Direct development outside of hazard lands and prohibit development or site alterations on or adjacent to hazard lands
- Permit development and site alterations on hazard lands where a Special Policy Area, such as the designation of a floodplain Special Policy Area, and any changes or modifications to the site-specific policies or boundaries applying to the floodplain Special Policy Area, must be approved by the Province prior to the City approving such changes or modifications
- Development and site alterations on or adjacent to hazard lands shall be regulated by the local Conservation Authority

The UHOP aims to protect and enhance the natural heritage system through stewardship, education and awareness, land use planning policies, habitat restoration and management, and acquisition. Policy goals were developed to guide the designation and management of natural heritage systems in the City's urban areas. These goals include protecting and enhancing biodiversity and ecological functions, conserving and where possible improving the distinct landscape and quality of life in natural heritage systems, and restoring and improving habitat connections and sustainable recreation activities.

For the purpose of this SWP, all subwatershed components have been evaluated against the UHOP to ensure the proposed boundary area assessment aligns with UHOP policies and supports the UBE application.

Subwatershed Plan Policy Direction

Under the UHOP, SWPs are to provide a comprehensive environmental planning framework that ensures the protection, enhancement, and restoration of natural heritage features, water quality, and hydrological functions.



The following UHOP policies outline requirements for preparing SWPs:

- Policy B.3.2.13 requires the preparation of SWPs prior to or concurrent with Secondary Plans for areas containing or adjacent to significant natural heritage features
- Policy B.3.2.14 specifies that SWPs must identify and evaluate Core Areas, Linkages, and key Natural Heritage Features, and provide recommendations for buffers, setbacks, and SWM
- Policy B.3.2.15 requires integration of ecological linkages and wildlife corridors into land use planning based on SWP findings
- Policy C.4.2.1 states that SWPs must assess surface water and groundwater systems, including recharge/discharge areas, and establish SWM criteria that maintain pre-development water balance
- Policy C.4.2.3 requires consideration of erosion control, floodplain management, and water quality protection in SWPs

Prior to initiating a SWP, Policy F.1.14 of the UHOP indicates that a ToR must be prepared and approved by the City. A ToR that established the scope, methodology, and deliverables associated with this SWP was prepared at study onset in 2023 and submitted to the City for review and comment on the following dates; however, a response was not received from the City during the course of this report development:

- September 15, 2023
- June 25, 2025
- July 23, 2025
- July 30, 2025
- August 27, 2025

A copy of the ToR and associated record of correspondence with the City is provided in **Appendix A** and **Appendix B**, respectively. The City ultimately provided a response to the ToR on April 2, 2026, which was after the field investigations, modelling and documentation had been prepared, as outlined herein. Responses to those City's comments are provided in **Appendix B**. We believe most of the City's comments have been addressed; however, further discussion regarding select comments are likely warranted following agency review of this document.

2.3.2 Hamilton Biodiversity Action Plan

As part of a proposed UBE, this project is being guided by the principles and objectives of the Hamilton Biodiversity Action Plan (BAP), a City-endorsed, multi-partner plan that identifies key actions to protect, enhance, and restore biodiversity across the city.

The BAP provides a framework for integrating biodiversity objectives into land use, development, and restoration activities. It sets out specific goals and key priorities, such as long-term protection and connection of natural areas, coordinated invasive species management, aquatic habitat restoration, and sustainable SWM. To advance its priorities, several actions are outlined within the BAP, including but not limited to developing watershed action plans, implementing Low Impact Development (LID) guidelines and enhancing connectivity between core natural areas.



Biodiversity holds particular significance due to the city's unique geography and natural features. Recognized as a regional biodiversity hotspot, the city is home to ecologically rich landscapes such as the Niagara Escarpment, mature Carolinian forests, the Dundas Valley, Cootes Paradise, and the Lake Ontario shoreline. These areas, along with extensive wetlands, woodlands, and watercourses in the rural landscape, support a wide range of species and ecological functions that are vital to the city's environmental integrity and long-term sustainability. It should be noted that the Study is located outside of the Niagara Escarpment.

In alignment with this, the SWP will help to identify key natural heritage features, ecological functions, and hydrological systems that support biodiversity within the Study Area. These findings will be used to guide further recommendations and considerations when adding the Study Area to the urban boundary and ensuring that important natural heritage features are protected in the planning process.

By integrating the SWP into development planning, new development and changes in land use will contribute to ecosystem resilience, improved water quality, and the long-term sustainability of both the city's residents and its wildlife.

2.3.3 City of Hamilton Climate Change Impact Adaption Plan

The City of Hamilton's Climate Change Impact Adaptation Plan (CCIAP) provides a critical framework for guiding land use decisions in the face of a changing climate. Developed using the International Council for Local Environmental Initiatives (ICLEI) Canada Building Adaptive and Resilient Communities (BARC) framework, the CCIAP is an evidence-informed, action-oriented strategy that identifies key vulnerabilities and outlines adaptive responses to reduce climate-related risks to infrastructure, ecosystems, and communities.

The CCIAP establishes guidelines that ensure future growth is resilient to climate impacts and supports watershed health. In the context of this SWP, the CCIAP emphasizes the importance of integrating climate resilience into planning processes. This includes protecting and enhancing natural systems such as wetlands, riparian zones, and groundwater recharge areas that provide essential ecosystem services and buffer against extreme weather events. The SWP supports this by identifying hydrological and ecological sensitivities, informing SWM, and ensuring that development is aligned with long-term adaptation goals. By embedding CCIAP's principles into the planning and design of new urban areas, this study will help foster a resilient built environment that supports both human and ecological health under future climate conditions.

2.3.4 City of Hamilton Urban Forest Strategy

The City of Hamilton's Urban Forest Strategy (UFS) outlines a long-term vision for sustaining and enhancing the city's tree canopy as a vital component of urban infrastructure and provides a framework for protecting, enhancing, and managing the City's urban forest, which is a critical component of watershed health and resilience. The strategy highlights the ecological and social value of urban trees, particularly in mitigating stormwater runoff, improving air quality, and maintaining biodiversity. The UFS sets a target of 30% canopy cover by 2041 and emphasizes the importance of trees and greenspaces for SWM, biodiversity, climate change mitigation, and community well-being.

Canopy cover, as defined by the UFS, refers to the proportion of land area covered by tree and shrub canopy when viewed from above and is measured using leaf-on satellite imagery. The UFS identifies that canopy cover of 30-40% is the minimum coverage required to support basic watershed and



ecological functions. In 2017, Hamilton's canopy cover was estimated at approximately 21.2%, indicating a notable gap between existing conditions and long-term policy objectives and highlighting the need for continued canopy expansion.

Developments provide a unique opportunity for street scaping and planting trees within built up areas and neighbourhoods. The UFS identifies development projects as critical mechanisms for increasing canopy cover, particularly in built-up areas where opportunities for tree planting and retention are limited. While the City requires tree planting in new residential developments, the UFS notes that a key challenge is translating high-level canopy targets into site-specific development outcomes. To address this, the Strategy emphasizes early integration of trees into site design, provision of adequate plantable space and soil volumes, and the use of area-specific canopy targets integrated into urban design guidelines. In the absence of specific tree protection by-laws, the City also encourages non-regulatory, collaborative approaches with developers and project managers to retain existing trees and design development around them, supporting equitable canopy growth and alignment with Official Plan objectives.

In the context of a proposed UBE, the UFS provides important direction for integrating urban forestry considerations into the early stages of land use planning. The SWP will assess existing vegetation cover, identify opportunities for canopy retention and expansion, and evaluate the role of forested areas in supporting watershed health and climate resilience. By incorporating UFS principles into the planning process, this study will ensure that development in the Study Area contributes to a greener, more livable urban environment while maintaining the integrity of the natural heritage system.



3 Overview of Existing Study Area Conditions

3.1 Terrestrial Natural Heritage Assessment

The Elfrida SWP Area is located in Ecoregion 7E (Lake Erie-Lake Ontario) of the Deciduous Forest Region, Niagara Forest Section, within the Mixedwood Plains Ecozone (Crins et al., 2009). Woodland cover in this ecoregion is largely deciduous, with some mixed forest cover as well. Common deciduous tree species in the region include sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), and black walnut (*Juglans nigra*). Common coniferous tree species include eastern hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*). Provincially rare tallgrass prairie and oak savannah communities are present as small fragments scattered across the ecoregion, but not in the current Study Area. Carolinian forests are also present in the ecoregion, although not represented in the Study Area.

Characteristic wildlife in the ecoregion includes white-tailed deer (*Odocoileus virginianus*), northern raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and Virginia opossum (*Didelphis virginiana*), northern cardinal (*Cardinalis cardinalis*), common yellowthroat (*Geothlypis trichas*), wild turkey (*Meleagris gallopavo*), snapping turtle (*Chelydra serpentina*), eastern gartersnake (*Thamnophis sirtalis sirtalis*), and American toad (*Anaxyrus americana*) (Crins et al., 2009).

Ecoregions are further divided into Ecodistricts based on common features such as physiography, vegetation, fauna, and land use. The Elfrida SWP Area is located within Ecodistrict 7E-5, the Niagara Ecodistrict. According to the Ecosystems of Ontario, Part 2: Ecodistricts, the Niagara Ecodistrict encompasses 361,785 ha (16.6% of the ecoregion and 0.4% of the province) (Wester et al., 2018). Approximately three-quarters of the land use in the ecodistrict is primarily pasture/cropland (75%) with deciduous forests (17%) scattered throughout and settlement and associated infrastructure accounting for 3%. Less than 1% of the ecodistrict includes protected areas (Wester et al., 2018).

A review of the MNR and Natural Heritage Information Center (NHIC) Natural Heritage Areas mapping tool identified approximately 29 ha of wooded areas and approximately 23.44 ha of wetlands within the Study Area. Two of these wetlands, comprising 10.85 ha of land, have been identified as Provincially Significant, while the remaining wetlands have either been evaluated as Non-Provincially Significant or are unevaluated. One ANSI was identified along the northwestern boundary of the Study Area, the Eramosa Karst, which is a provincially significant Earth Science ANSI. No Conservation Reserves, Provincial Parks, or other provincially designated conservation lands were identified in the Study Area. Agricultural lands occupy the vast majority of the Study Area.

The Study Area total 1,233 ha with 1,212 ha of land surveyed and 20.8 ha of additional land that was not able to be surveyed at the time of this report due to site access restrictions. Analysis of Ecological Land Classification (ELC) data collected by GeoProcess and SLR identified 91.8 ha (7.57%) natural cover by area for the Study Area, including:

- Forest/Woodland 18.3 ha (1.5%)
- Wetland 25.8 ha (2.13%)
- Meadow 9.8 ha (0.8%)
- Thicket 6.7 ha (0.55%)
- Hedgerow 30.9 ha (2.5%)



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- Pond 0.3 ha (0.02%)

In addition to natural cover, agriculture occupies approximately 941.9 ha (77.7%) of the Study Area. Approximately 179 ha (14.7%) is anthropogenic land use, including residential, commercial, transportation and utility infrastructure, and manicured greenspace.

The largest contiguous natural area is located in the northeast portion of the Study Area, in the treed swamp community north of Highway 20, between First Road East and Second Road East. This area is identified as both woodland and Provincially Significant Wetland by the MNR.

Future land use will be defined through the SWP.

3.1.1 Objective

The purpose of the Terrestrial Natural Heritage Assessment is to identify, characterize, and evaluate the significance of existing natural heritage features within the Study Area. This is accomplished through background review of available secondary materials (e.g., previously completed reports and studies), desktop-based assessments, and field data collection. The results of this assessment will identify constraints associated with natural heritage features for future development planning purposes. The terrestrial natural heritage constraints to development are determined based on guidance from the PPS (MMAH, 2024), the UHOP (City of Hamilton, 2022), the Greenbelt Plan, the Niagara Escarpment Plan, the HCA, and the NPCA.

3.1.2 Background

The Study Area spans five watersheds, including Hannon Creek, Upper Davis Creek, Twenty Mile Creek, Sinkhole Creek, and Stoney Creek (refer to Figure 1.3.1). These watersheds have individual natural heritage systems, made up of natural heritage features. Features within the Study Area that may be part of these natural heritage systems include Provincially Significant Wetland (PSW), ANSI, Significant Woodland, Significant Wildlife Habitat, woodlands ≥ 0.5 ha, wetlands ≥ 0.5 ha, and riparian corridors. Further, watershed planning objectives and strategies are in place to improve habitat and connectivity. The natural heritage and terrestrial resource objectives for the subject watersheds are summarized below.

Table 3.1.1: Watershed Natural Heritage Feature Objectives

| Watershed | Watershed Objectives |
|---|--|
| Twenty Mile Creek and Sinkhole Creek (subwatershed within Twenty Mile Creek) (NPCA, 2006) | <ul style="list-style-type: none">• Protect, enhance, reforest and restore woodlands and wildlife habitat in the watershed for the long-term• Protect, enhance and restore the stability, biodiversity, linkages, and ecological function between habitats that support terrestrial and aquatic species and communities• Preserve wetlands of provincial significance and conserve all other wetlands in the watershed |
| Upper Davis Creek (HCA, 2013b) | <ul style="list-style-type: none">• Establish and enhance riparian buffers along watercourses• Increase the urban tree canopy to provide linkages between adjacent natural areas and to contribute to the overall local natural heritage system• Increase natural cover in the subwatershed, working toward habitat targets as determined by Environment Canada's How |



| Watershed | Watershed Objectives |
|---------------------------|---|
| | Much Habitat is Enough Guidelines and the City of Hamilton UHOP and Vision 2020 Natural Heritage Goals |
| Hannon Creek (HCA, 2013a) | <ul style="list-style-type: none"> • Establish and enhance riparian buffers along watercourses • Maintain existing habitat and increase habitat where possible • Increase natural cover in the subwatershed, working toward habitat targets as determined by Environment Canada’s How Much Habitat is Enough Guidelines and the City of Hamilton UHOP and Vision 2020 Natural Heritage Goals |
| Stoney Creek | <ul style="list-style-type: none"> • No information on watershed targets or strategies available |

The information available through existing watershed reports and action plans, as well as the UHOP, was reviewed and used as background sources to inform the terrestrial natural heritage assessment.

3.1.3 Methods

3.1.3.1 Background Data Review

The characterization of terrestrial natural heritage included a desktop review of secondary sources including:

- Citizen science databases: eBird and iNaturalist
- Ecological Land Classification for Southern Ontario (Lee et al., 1998)
- Elfrida Subwatershed Study (SWS): Final Phase 1 Results (Aquafor Beech Ltd., 2018)
- Endangered Species Act (ESA) (2007)
- Fisheries and Oceans Canada (DFO) Aquatic Species at Risk Mapping (DFO, 2025)
- Google Earth Imagery (Google, 2024)
- Hamilton Natural Areas Inventory Project 3rd Edition (Hamilton Conservation Authority, 2014)
- Hannon Creek Subwatershed Stewardship Action Plan (Hamilton Conservation Authority, 2013a)
- Historical and contemporary Ortho imagery of the Study Area
- Land Information Ontario (LIO) database (MNR)
- List of the Vascular Plants of Ontario’s Carolinian Zone (Ecoregion 7E) (Oldham, 2017)
- Marsh Monitoring Program protocol (MMP and BSC, 2000)
- MECP Client’s Guide to Preliminary SAR Screening (2019)
- Natural Heritage Information Centre (NHIC) Biodiversity Explorer Database (MNR, 2024)
- Natural Heritage Reference Manual (Ontario Ministry of Natural Resources, 2010)
- Niagara Peninsula Conservation Authority Twenty Mile Creek Watershed Plan (NPCA, 2006)
- Ontario Breeding Bird Atlas (OBBA, 2001)
- Ontario Butterfly Atlas (Jones et al., 2025)
- Ontario Moth Atlas (Edwards et al., 2025)
- Ontario Reptile and Amphibian Atlas (Ontario Nature, 2020)
- Ontario Wetland Evaluation System Southern Manual 4th Edition (2022)



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- Significant Wildlife Habitat Criteria Schedules for Ecoregion 7E (Ontario Ministry of Natural Resources, 2015)
- Significant Wildlife Habitat Technical Guide (Ontario Ministry of Natural Resources, 2000)
- Species at Risk in Ontario (SARO) list (Government of Ontario)
- The East Escarpment Area Watershed Restoration Program (Hamilton Conservation Authority, 2015)
- The Physiography of Southern Ontario; Ontario Geological Survey (Chapman and Putnam, 1984)
- Twenty Mile Creek Watershed Plan (NPCA, 2006)
- Upper Davis Creek Subwatershed Stewardship Action Plan (Hamilton Conservation Authority, 2013b)
- Urban Hamilton Official Plan (City of Hamilton, 2013)
- What's Alive in Hamilton, Bird Checklist (Hamilton Conservation Authority, 2013c)

3.1.3.1.1 *Amphibians*

A desktop screening assessment for potential amphibian species was conducted for the Study Area. SAR with either federal or provincial status were considered. Following the MECP's Client Guide to Preliminary SAR Screening (2019), this screening was based on desktop air photo interpretation, a review of the NHIC, Hamilton Natural Areas Inventory (2014), Ontario Reptile and Amphibian Atlas (Ontario Nature, 2020), and citizen science databases (iNaturalist).

3.1.3.1.2 *Reptiles*

Specific field surveys for reptiles were not completed as part of this study; however, incidental observations were recorded during the many field days and hours of surveys that have been completed. A desktop screening assessment for potential reptile species was conducted for the Study Area. SAR with either federal or provincial status were considered. Following the MECP's Client Guide to Preliminary SAR Screening (2019), this screening was based on a review of the NHIC, Hamilton Natural Areas Inventory (2014), Ontario Reptile and Amphibian Atlas (Ontario Nature, 2020), and citizen science databases (iNaturalist).

3.1.3.2 **Field Investigations**

Terrestrial natural heritage field investigations were conducted by GeoProcess and SLR between 2023 and 2025. Site visit details are outlined in Table 3.1.2, while wildlife survey stations are illustrated in Figure 3.1.1.

Table 3.1.2 Summary of Terrestrial Natural Heritage Field Investigations and Weather

| Survey Type | Date(s) | Subwatershed | Surveyor(s) | Weather Information |
|--|--|---|---|--|
| Breeding Bird Surveys – Round 1 | May 29, 30, June 3, 4, 5, 6, 7, 10, 11, 12, 15, 2024 | Stoney Creek, Twenty Mile Creek, Hannon Creek, Sinkhole Creek | GeoProcess: LB, AM, EV, BT SLR: CH, MR, RC, JB | 10-16°C, light winds (0-3), no precipitation |
| Breeding Bird Surveys – Round 2 | June 17, 18, 19, 20, 21, 25, 26, 27, July 4, 5, 2024 | | | 12-20°C, light winds (0-2), no precipitation |



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| Survey Type | Date(s) | Subwatershed | Surveyor(s) | Weather Information |
|---|---|---|---|--|
| Breeding Bird Surveys – Round 3 | July 5, 2024, | Sinkhole Creek | SLR: MR | 28°C, light winds (0-2), no precipitation |
| Amphibian Calling Surveys – Round 1 | April 16, 17, 22, 25, 2025 | Stoney Creek, Twenty Mile Creek, Hannon Creek, | GeoProcess: LB, EV, BT, SD, AM, AJ, TS | 5-13°C, calm winds (0-1), no precipitation |
| Amphibian Calling Surveys – Round 2 | May 15, 16, 23, 24, 2024 May 12, 14, 2025, | Sinkhole Creek | SLR: GC, KL, JS, SH, CH, CP, FS | 11-21°C, light winds (0-2), no precipitation |
| Amphibian Calling Surveys – Round 3 | June 18, 26, 27, July 3, 2024 June 12, 24, 25, 2025 | | | 17-30°C, light winds (0-3), no precipitation |
| Winter Wildlife Surveys | January 30, February 10, 11, 12, 19, 21, 24, 2025 | Stoney Creek, Twenty Mile Creek, Sinkhole Creek | GeoProcess: LB, EV SLR: CH, LM | -15–4°C, varied winds (0-5), no precipitation, snow depth 5cm-10cm |
| Vegetation Community Classification - Spring | May 23, 29, 30, 31, June 6, 2024, | Stoney Creek, Twenty Mile Creek, Hannon Creek, | GeoProcess: EV, LB, SD, CZ SLR: CP, CH, DJ, JS, RS | 14-22°C, light winds (0-3), no precipitation |
| Vegetation Community Classification - Summer | August 21, 22, 24, 28, 2023 July 4, 8, 23, August 28, 2024, | Sinkhole Creek | | 15-28°C, light winds (0-3), no precipitation |
| Vegetation Community Classification - Fall | September 1, 5, 7, 13, 14, 19, October 11, 18, 2023 October 2, 3, 2024 | | | 15-25°C, light winds (0-3), no precipitation |
| Hedgerow Assessments | August 24, September 1, 5, 7, October 3, 4, 5, 6, 11, 18, 2023 May 23, June 6, July 4, 8, 23, August 7, 2024 | Stoney Creek, Twenty Mile Creek, Hannon Creek, Sinkhole Creek | GeoProcess: CZ, SD, AM SLR: CP, CH | 13-30°C, varied winds (0-4), no precipitation |
| Wetland Reconnaissance | July 31, 2025, | Stoney Creek, Twenty Mile Creek, Hannon Creek | GeoProcess: KL, EV | 20°C, calm wind (0-1), no precipitation |
| Incidental Wildlife Observations | Incidental wildlife observations were recorded during all field surveys; dates as above. | Stoney Creek, Twenty Mile Creek, Hannon Creek, Sinkhole Creek | GeoProcess, SLR: See staff listed above | See weather information above |

3.1.3.2.1 Vegetation and Wetlands

A three-season botanical inventory of floristic species present was completed during terrestrial ecological surveys and specifically alongside vegetation community classification following the ELC system for Southern Ontario (Lee et al. 1998). The table below includes the dates when surveys were completed by each team.

Table 3.1.3. Survey Dates for Botanical Inventories

| | GeoProcess | SLR |
|--|-------------------------|---|
| Spring Inventory (ephemerals focused) | May 29, 30, 31, 2024 | May 23, 2024 June 6, 2024 |
| Summer Inventory | August 21, 22, 24, 2023 | August 24, 28, 2023 July 4, 8, 23, 2024 August 28, 2024 |



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| | | |
|-----------------------|--------------------|---|
| Fall Inventory | October 2, 3, 2024 | September 1, 5, 7, 13, 14, 19, 2023 October 11, 18, 2023 |
|-----------------------|--------------------|---|

Vegetation community boundaries were first estimated using desktop analysis of available satellite imagery, aerial photography, and background information, and then further refined during field visits. A minimum polygon size of 0.5 ha was generally applied following guidelines of the ELC system, with any distinct plant communities smaller than 0.5 ha (e.g., wetland plant dominated areas) recorded as inclusions within larger surrounding polygons.

Field data collection included the completion of plant species list, a record of any disturbances, and a record of incidental wildlife for each polygon. Information collected during ELC surveys include dominant species cover, community structure, as well as any indicator species or other notable features. Percent tree cover, height and diameter and breast height (DBH) ranges were documented to define stand characteristics within treed polygons. Where necessary (e.g., determining moisture regime and hydric soils), a soil core was completed using a hand-held Dutch auger. Vegetation communities, where access was permitted, were fully inventoried. Visual surveys were completed for areas with adjacent access.

A comprehensive list of vascular plant species for the Study Area was compiled and provided in **Appendix C1**. Taxonomic nomenclature for plant species was based primarily on the NHIC species list for Ontario, which uses international standards for taxonomy and nomenclature. The NHIC species list was also referred to for information on conservation status, soil moisture preference (coefficient of wetness), and plant sensitivity (coefficient of conservatism) for all plant species recorded during the three-season botanical inventory. The Database of Vascular Plants of Canada (VASCAN) was referred to as an additional source to reflect the most recent nomenclatural changes for the recorded species.

Screening for potentially sensitive native plant species was based on conservation status records from Species at Risk in Ontario (SARO) and the federal SARA. Species assigned S-rank and coefficient of conservatism (C-value or CoC), provided within the NHIC species list, were also referenced. S-ranks are a subnational ranking that indicates the rarity and risk of extirpation of a species within a region, ranging from S1, which would indicate a critically imperiled species, to S5, which would indicate a regionally secure species. C-values indicate species sensitivity to disturbance and site fidelity using a numerical score of 0 to 10, with the most conservative or sensitive plant species receiving a score of 10 and the least conservative or sensitive plant species receiving a score of 0 (NHIC, 2025). Species were also screened against the Hamilton Natural Areas Inventory (HCA, 2014) to determine local rarity.

Through referencing the NHIC plant list, species were also identified for their coefficient of wetness (W-value or CoW), which indicates a species' affinity for soil moisture conditions (i.e., dry to wet/hydric soils). The scale for CoW ranges between 5 and -5, with 5 indicating species with low moisture tolerance, and -5 indicating species with high moisture tolerance. This value is significant when observing wetlands, which, by definition, will contain a large proportion of plants with high moisture tolerance.

Due to the sensitivity and potential constraints of wetlands, the project team conducted a robust characterization of the on-site wetland communities, where accessible. In many cases, the assessment included multi-season surveys of ephemeral and wetland plant species composition (potential rare and sensitive species), and investigation of subsurface soil conditions (for determination of potential organic soils) using a hand-held Dutch auger and soil probe. The Ontario Wetland Evaluation System (OWES)



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protocol using the 50/50 rule for wetland/upland plants was used for establishing wetland community boundaries where wetlands are found when greater than 50% of the plants are wetland species.

All unevaluated wetlands identified during the ELC process were screened to determine if a wetland is a candidate for potential future OWES assessment. OWES is used to evaluate a wetland's functions and values and determine whether it should be classified as Provincially Significant or not. Three primary criteria were evaluated to determine candidacy for future OWES assessment: size, species diversity, and habitat for SAR. Further descriptions and results of these assessments are found in **Section 3.1.4.2.2**.

3.1.3.2.2 Wildlife and Wildlife Habitat

Significant Wildlife Habitat (SWH) can be difficult to appropriately determine at the site-specific level, as the assessment must incorporate information from a wide geographic area and consider other factors such as regional resource patterns and landscape effects. To help with site level assessments, the MNR has developed the SWH Criteria Schedules for Ecoregion 7E (Ontario Ministry of Natural Resources, 2015). Proponents are responsible for conducting studies to identify potential candidate SWH while the planning authorities are ultimately responsible for confirming it. An exception to this is wintering deer yards, which are mapped and confirmed by MNR. Detailed identification and designation of SWH has not been completed for the City of Hamilton.

Confirmed SWH is considered a significant natural heritage feature in Provincial, Regional, and City Official Plan policies. SWH is defined by the MNR in the SWH Technical Guide (Ontario Ministry of Natural Resources, 2000) and the Natural Heritage Reference Manual (Ontario Ministry of Natural Resources, 2010) and includes the following broad categories:

- Habitats of Seasonal Concentration of Animals
- Rare Vegetation Communities or Specialized Habitats for Wildlife
- Habitats of Species of Conservation Concern
- Animal Movement Corridors

SLR and GeoProcess have screened for SWH for Ecoregion 7E, following the relevant criteria established by the Province (Ontario Ministry of Natural Resources, 2015). Upon completion of ecological field surveys, the screening included a review of observed site characteristics, collected field data and available habitat. This was supplemented by additional analysis, and examination of mapping (including air photography and ELC mapping) to determine if candidate SWH types exist and/or can be confirmed for the Study Area. The ecological field investigation data used included: amphibian calling surveys, breeding bird surveys, winter tracking surveys, ELC and floral inventory (methods have been described elsewhere), plus incidental observations.

The City of Hamilton Official Plan does not identify SWH. The most recent Natural Areas Inventory undertaken did not include any assessed areas within the Study Area (Hamilton Conservation Authority, City of Hamilton and the Hamilton Naturalist's Club (2014).

EBird (ebird.org/home) online database, which contains bird sightings from citizen birders, was reviewed for SAR and for wintering raptor data. EBird includes a large data set which is useful to identify patterns, ranges and records etc., but it is not a systematic survey (i.e. covers only where birders go) and has the potential to be inaccurate (i.e. birders could make a mistake).



3.1.3.2.3 Winter Wildlife

Winter wildlife surveys were completed following the Winter Wildlife Survey Protocol designed by GeoProcess and shared with SLR. The Protocol targets potential wildlife movement areas and records evidence of use by wildlife during snow covered conditions. The Protocol requires surveys to be completed between mid-December and early March when there is a minimum of 5 cm of snow of the ground. Where conditions allow, two rounds of surveys should be completed. Survey areas are to be predetermined through knowledge gained from previous site visits and desktop review and walked by surveyors. Evidence of wildlife activity (i.e. tracks, scat, visual sighting, nesting/roosting habitat, burrows, feeding areas, deer browse) is to be recorded.

Potential wildlife movement areas for the Study Area were identified by GeoProcess and SLR in 2024. These areas included linear features such as hedgerows, watercourses and headwater drainage features where they connected to larger natural areas. Incidental observations of wildlife movement outside of these areas were also recorded. Data collected through Winter Wildlife Surveys will be used in the determination of linkages and their function as wildlife movement areas.

Winter wildlife surveys were conducted for the Study Area between January 30 and February 24, 2025, to determine wildlife species, abundance, and diversity. Potential wildlife movement areas were all surveyed once. Insufficient snow cover resulted in unsuitable conditions to support a second round of surveys. Potential wildlife movement areas were surveyed using a travelling count approach, where species lists were compiled for each identified survey area. All evidence of winter wildlife was recorded using an observation code that detailed the species, direction of travel, observation type, habitat type, and observation number. Evidence of winter wildlife recorded included tracks, scat, browse, foraging/feeding, nesting/roosting, burrows, predation by bird/coyote, and auditory and visual observations.

3.1.3.2.4 Breeding Birds

Breeding bird surveys were conducted using a roving survey method whereby all of the areas of participating landowners in the Study Area were covered, focusing on large natural features, regenerating and early successional areas, and hedgerows. The point count method was also used as discussed below. All of lands were traversed by a breeding bird specialist such that the observer was within about 50 to 75 m or less of all parts of the site, except for active agricultural fields where the observer was generally within approximately 200 m of any part of the field. Surveys were conducted between sunrise and five hours after sunrise to coincide with the dawn chorus. Surveys were conducted under suitable weather conditions when wind speeds were less than 20 km/h and there was either no or limited precipitation. These conditions are as per the Ontario Breeding Bird Atlas 3 protocols for point counts (OBBA, 2021). The surveyors recorded all bird species and individuals seen and/or heard in the approximate location using site maps or used a similar method (i.e. traversing all patches of habitat, woodland, wetland, hedgerow and recording species and abundance per patch). Any individuals that were deemed late migrants were not included. Fly-overs were not recorded. Those individuals clearly not breeding but using the landscape (e.g. gulls resting on fields, herons foraging) were recorded as 'X' (i.e. not breeding). Numbers tabulated are maximum numbers of birds observed in either of the two rounds of surveys. SLR and GeoProcess conducted two rounds of breeding bird surveys for all habitats across the Study Area, more than ten days apart within the peak breeding season, with an additional third round for areas with suitable habitat for grassland bird SAR. Due to the size of the Study Area, surveyors required multiple days to cover the survey area once (refer to Table 3.1.4).



Table 3.1.4 Breeding Bird Survey Dates

| | SLR | GeoProcess |
|---------------------|--------------------------|---|
| First Round | June 3, 11, and 12, 2025 | May 29 and 30, June 3, 4, 5, 6, 7, 10, 15, 2025 |
| Second Round | June 25, 26 and 27, 2025 | June 17, 18, 19, 20, 21, 25, and July 4, 2025 |
| Third Round | July 5, 2025 | Not needed |

Additionally, eight point count stations, previously established and completed by Aquafor Beech in 2017 according to the Ontario Breeding Bird Atlas protocol were replicated by SLR and GeoProcess. Data collected by Aquafor Beech from these stations is available for comparison in the Aquafor Beech (2018) report. These point count stations were known as Stations 1 through 8 (Figure 3.1.1). Point counts surveys lasted a duration of 5 minutes and were typically completed at the beginning of the day to avoid higher levels of traffic noise. Point counts were done in addition to roving surveys and were completed for the purpose of being able to compare against previous data collected by others. Surveys completed by SLR and GeoProcess collected the most recent data and are both the most comprehensive and representative of current site conditions.

What's Alive in Hamilton, Bird Checklist 2013 was used to determine local bird status and rarity.

3.1.3.2.5 Amphibian Field Surveys

Amphibian surveys were completed following the Marsh Monitoring Program protocol (MMP and BSC, 2000). This required three visits between mid-April and the end of June under proper air and weather conditions.

The Great Lakes Marsh Monitoring Program (MMP) provides guidelines for the ideal windows of time for the three rounds of surveys: April 15 - 30 for round one, May 15 - 30 for round two, and June 15 - 30 for round three. Surveys were conducted with attention to these guidelines for timing, while adhering to MMP protocol regarding time of day and weather conditions.

Following MMP protocol surveys were conducted at least 30 minutes after local sunset and were completed before midnight. Surveys were only conducted on nights with adequate weather conditions, with light winds at most and an absence of rain. Air temperatures were 5°C or higher for round one, 10°C or higher for round two, and 17°C or higher for round three. Round one was completed April 16, 17, 22, and 23 of 2025. Round two was completed May 15, 16, 23, and 24 of 2024 and May 12 and 14 of 2025. Round three was completed June 18, 26, 27, and July 3 of 2024 and June 12, 24, and 25 of 2025.

Calling amphibians at each survey station were identified to species and assigned a calling code indicating the estimated number of individuals. Calling amphibians heard beyond the point count station were noted as heard outside of the station.

The amphibian calling codes used indicate four levels of calling, in increasing abundance:

- 0** — no calls
- 1** — individuals of one species can be counted, calls not simultaneous
- 2** — some calls of one species simultaneous, numbers can be reliably estimated
- 3** — full chorus, calls continuous and overlapping (not countable)



3.1.3.2.6 Species at Risk

A desktop review of SAR with the potential to occur within the Elfrida SWP boundary was undertaken as part of the Phase 1 SWP. The MECP Client’s Guide to Preliminary SAR Screening (2019) requires that this screening be based on a review of the NHIC database, which manages data about species of conservation concern, plant communities, and wildlife concentration areas in Ontario.

The NHIC Atlas is presented in a series of 1 km by 1 km squares and the Elfrida lands overlap the following squares: 17PH0282, 17PH0182, 17NH9582, 17NH9581, 17NH9580, 17PH0278, 17PH0178, 17PH0078, 17NH9978, 17NH9878, 17PH0279, 17PH0179, 17PH0079, 17PH0280, 17PH0180, 17PH0080, 17NH9980, 17PH0281, 17PH0181, 17PH0081, 17NH9981, 17PH0082, 17NH9982, 17NH9778, 17NH9678, 17NH9578, 17NH9478, 17NH9879, 17NH9779, 17NH9679, 17NH9579, 17NH9479, 17NH9880, 17NH9780, 17NH9680, 17NH9480, 17NH9881, 17NH9781, 17NH9681, 17NH9481, 17NH9882, 17NH9782, 17NH9682, 17NH9482).

Additional sources referenced following MECP guidelines include the DFO Aquatic SAR map, regional atlases recording species occurrence within the province (Ontario Breeding Bird, Butterfly, Moth, Reptile and Amphibian; Atlas Squares: 17NH98, 17NH97, 17PH08), as well as citizen science databases containing additional species occurrence data (i.e. iNaturalist and eBird).

Flora and fauna were surveyed through the field program that included ELC, three (3) season botanical studies, breeding bird surveys, breeding amphibian surveys, winter wildlife surveys, fish sampling surveys, and benthic invertebrate sampling surveys. The results of these surveys were compared to the list of potential SAR.

3.1.3.2.7 Woodland Assessments

Tree-dominated communities (i.e., cultural woodlands – CUW, forests – FO, treed swamps - SWD) were assessed for significance following the UHOP Significant Woodland criteria (2013). These criteria are outlined in Table 3.1.5.

Table 3.1.5 UHOP Significant Woodland Assessment Criteria

| Criterion | Description |
|-------------------------------|---|
| Size | Forest Cover (by planning unit) / Minimum patch size for significance (ha): < 5% / 1 ha 5-10% / 2 ha 11-15% / 4 ha 16-20% / 10 ha 21-30% / 15 ha Woodlands shall meet a minimum average width of 40 metres. |
| Interior Forest | Woodlands that contain interior forest habitat. Interior forest habitat is defined as 100 metres from edge. |
| Proximity/Connectivity | Woodlands that are located within 50 metres of a significant natural area (defined as wetlands 0.5 hectares or greater in size, ESAs, PSWs, and Life Science ANSIs). |
| Proximity to Water | Woodlands where any portion is within 30 metres of any hydrological feature, including all streams, headwater areas, wetlands, and lakes. |



| Criterion | Description |
|---------------------|--|
| Age | Woodlands with 10 or more native trees/hectare greater than 100 years old. |
| Rare Species | Any woodland containing Threatened, Endangered, Special Concern, provincially or locally rare species. |

According to the City, two of the criteria must be met to meet the test of significance. Characteristics of identified CUW and FO communities were therefore compared to the available criteria.

To determine the appropriate minimum patch size for significance, the City’s UFS (2020) was referenced. The percent canopy cover, by ward (planning unit), is outlined in this document. Portions of the Elfrida Lands fall within Ward 9 and Ward 11, which have canopy cover estimates of 16% and 16.5% respectively. Thus, as per the UHOP Significant Woodland criteria, the minimum patch size unit for significance is 10 ha. Outcomes of the woodland significance assessments are detailed in **Section 3.1.4**.

3.1.4 Results

3.1.4.1 Provincially Designated Natural Areas

Lower Twenty Mile Creek PSW and Sinkhole Wetland Complex is located south of Highway 20 and west of Hendershot Road. The Eramosa Karst Provincial Earth Science ANSI also exists within the Study Area, south of Blue Mountain Drive and straddling Fletcher Road. The ANSI exists within the hydro corridor and extends onto Parcel 27. There are no areas of Conservation Reserves, Provincial Parks, or other provincially designated lands within the Study Area and it is located outside of the Greenbelt Protected Countryside and Greenbelt Plan Area.

3.1.4.2 Vegetation and Wetlands

Vegetation community assessments were conducted by GeoProcess and SLR in 2023 and 2024 throughout the Study Area on lands with permitted access. Where access was restricted, visual surveys from adjacent lands along with air photos were used. Communities were assessed using ELC for Southern Ontario (Lee et al., 1998). Using the ELC protocol, communities are assessed based on vegetation and soils. Terrestrial communities are defined as upland areas where the water table is usually below the substrate surface and wetland plant species occupy ≤ 50% of total plant cover. Wetland communities are defined as areas with fluctuating water levels, water depth ≤ 2 m, predominance of hydrophytic plants (> 50% total species cover), and soil moisture regimes of generally ≥ 5 - 6. A total of 64 distinct vegetation communities were identified, consisting of 23 individual vegetation community types as well as anthropogenic, agricultural, and hedgerow communities, throughout the Study Area (Table 3.1.6). These communities are depicted in Figure 3.1.2. Detailed ELC for localized portions of the Study Area can be found in **Appendix C2**.

Core Areas and other landscapes identified through municipal planning processes (RHOP and UHOP) have been validated through field investigations and are represented where applicable based on the ELC communities identified in Figure 3.1.2. Consequently, certain features may differ from those originally identified in RHOP and UHOP due to refinements based on field verification of the existing ecological conditions and features on the landscape.



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Table 3.1.6 Summary of Vegetation Communities

| Polygon | ELC Code | Size (ha) | ELC Classification (1998 Manual) | Subwatershed |
|-----------|----------------|-----------|--|-------------------|
| Parcel 1 | FOD5-3 | 2.93 | Dry-Fresh Sugar Maple – Oak Deciduous Forest | Twenty Mile Creek |
| | SWT2-9 (incl.) | 0.13 | Gray Dogwood Mineral Thicket Swamp | |
| Parcel 2 | CUM1-1 | 0.49 | Dry-Moist Old Field Meadow | Twenty Mile Creek |
| Parcel 2 | CUT1-4 | 1.36 | Gray Dogwood Cultural Thicket | Twenty Mile Creek |
| | MAS2-1 (incl.) | 0.01 | Cattail Mineral Shallow Marsh | |
| | MAS2-1 (incl.) | 0.03 | Cattail Mineral Shallow Marsh | |
| Parcel 3 | MAM2 | 0.42 | Mineral Meadow Marsh | Twenty Mile Creek |
| Parcel 4 | CUW1 | 0.49 | Black Walnut Cultural Woodland | Twenty Mile Creek |
| Parcel 9 | MAM2 | 0.37 | Mineral Meadow Marsh | Sinkhole Creek |
| Parcel 9 | Pond (3) | 0.02 | Dug Pond | Sinkhole Creek |
| Parcel 9 | CUM1-1 | 0.20 | Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 9 | Pond (1) | 0.02 | Dug Pond | Twenty Mile Creek |
| Parcel 9 | Pond (2) | 0.06 | Dug Pond | Twenty Mile Creek |
| Parcel 9 | CUW1 | 0.59 | Sugar Maple Cultural Woodland | Twenty Mile Creek |
| Parcel 10 | FOD5-1 | 1.86 | Dry-Fresh Sugar Maple Deciduous Forest | Twenty Mile Creek |
| | SWD4-2 (incl.) | 0.15 | White Elm Mineral Deciduous Swamp | |
| Parcel 10 | MAM2-2 | 1.68 | Reed Canary Grass Mineral Meadow Marsh | Sinkhole Creek |
| Parcel 10 | CUW1 | 1.02 | Cultural Woodland | Sinkhole Creek |
| Parcel 10 | Pond (4) | 0.05 | Dug Pond | Sinkhole Creek |
| Parcel 12 | Pond (5) | 0.03 | Dug Pond | Twenty Mile Creek |
| Parcel 14 | FOD5-2 | 2.08 | Dry-Fresh Sugar Maple – Beech Deciduous Forest | Twenty Mile Creek |
| Parcel 14 | SWD3-2 | 0.47 | Silver Maple Mineral Deciduous Swamp | Twenty Mile Creek |
| Parcel 14 | MAM2-2 | 1.47 | Reed Canary Grass Mineral Meadow Marsh | Sinkhole Creek |
| | SWD2-2 (incl.) | 0.38 | Green Ash Deciduous Mineral Swamp | |
| | SWD2-2 (incl.) | 0.18 | Green Ash Deciduous Mineral Swamp | |
| Parcel 15 | MAM2-2/CUT1 | 0.51 | Reed Canary Grass Mineral Meadow Marsh Mineral Cultural Thicket | Twenty Mile Creek |
| Parcel 16 | MAM2-2/MAS2-1 | 2.61 | Reed Canary Grass Mineral Meadow Marsh/Cattail Mineral Shallow Marsh | Sinkhole Creek |
| Parcel 17 | MAS2-1 | 9.02 | Cattail Mineral Shallow Marsh | Sinkhole Creek |
| Parcel 17 | CUM1-1 | 1.77 | Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 20 | SWT/CUM | 0.45 | Thicket Swamp/Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 20 | MAM2 | 1.70 | Mineral Meadow Marsh | Sinkhole Creek |
| Parcel 20 | FOD9 | 1.09 | Fresh – Moist Oak – Maple – Hickory Deciduous Forest | Sinkhole Creek |
| Parcel 20 | FOD9 | 0.77 | Fresh – Moist Oak – Maple – Hickory Deciduous Forest | Sinkhole Creek |
| Parcel 20 | SWD | 0.50 | Deciduous Swamp | Sinkhole Creek |
| Parcel 20 | CUM1-1 | 0.24 | Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 22 | MAM2 | 0.81 | Mineral Meadow Marsh | Sinkhole Creek |
| Parcel 24 | CUM1-1 | 1.27 | Dry-Moist Old Field Meadow | Sinkhole Creek |



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| Polygon | ELC Code | Size (ha) | ELC Classification (1998 Manual) | Subwatershed |
|---------------|--------------------------|--------------|---|----------------|
| Parcel 25 | CUT1 | 0.83 | Mineral Cultural Thicket | Sinkhole Creek |
| Parcel 25 | MAS2-1 CUM1-1 (incl.) | 1.00 0.23 | Cattail Mineral Shallow Marsh Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 31 | MAM2-2 | 0.33 | Reed Canary Grass Mineral Meadow Marsh | Sinkhole Creek |
| Parcel 31 | CUT1 | 0.71 | Mineral Cultural Thicket | Sinkhole Creek |
| Parcel 35 | CUT1 | 1.44 | Mineral Cultural Thicket | Sinkhole Creek |
| Parcel 35 | MAS2-1 CUM1-1 (incl.) | 9.02 0.05 | Cattail Mineral Shallow Marsh Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 37 | FOD9-4 | 1.75 | Fresh – Moist Shagbark Hickory Deciduous Forest | Sinkhole Creek |
| Parcel 38A | FOD4-1 SWD3-1 | 1.29 0.14 | Dry – Fresh Beech Deciduous Forest Red Maple Mineral Deciduous Swamp | Sinkhole Creek |
| Parcel 38A | FOD4-1 | 0.49 | Dry – Fresh Beech Deciduous Forest | Sinkhole Creek |
| Parcel 38A | FOD4-1 | 1.34 | Dry – Fresh Beech Deciduous Forest | Sinkhole Creek |
| Parcel 38A/40 | SWD3-1 SWT (incl.) | 1.44 0.26 | Red Maple Mineral Deciduous Swamp Thicket Swamp | Sinkhole Creek |
| Parcel 38A | SWD3-1 | 0.92 | Red Maple Mineral Deciduous Swamp | Sinkhole Creek |
| Parcel 40 | CUT1 | 1.20 | Mineral Cultural Thicket | Sinkhole Creek |
| Parcel 45 | SWD4-1 | 0.60 | Willow Mineral Deciduous Swamp | Stoney Creek |
| Parcel 47 | Pond (6) | 0.05 | Dug pond | Stoney Creek |
| Parcel 58 | CUM1-1 | 0.88 | Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 64 | CUM1-1 | 0.90 | Dry-Moist Old Field Meadow | Sinkhole Creek |
| Parcel 64 | FOD9 | 2.54 | Fresh – Moist Oak – Maple – Hickory Deciduous Forest | Sinkhole Creek |
| Parcel 64.1 | CUM1-1 | 3.12 | Dry-Moist Old Field Meadow | Sinkhole Creek |

3.1.4.2.1 Hedgerows

Hedgerows can contain a mix of trees, shrubs or plants of interest and provide habitat and potential corridors for wildlife. The characterization and assessment of the hedgerows within the Study Area was completed to gather information on the dominant plant species, approximate size diameter at breast height (DBH) and representation of trees, general quality (e.g., presence/absence of non-native / invasive species) and to assess their function and general connection to the surrounding landscape. This included identifying if hedgerows provide connection to other natural heritage features including wetlands, woodlands, watercourses and Headwater Drainage Features (HDFs), and if they provide habitat opportunities for wildlife (e.g., suitable habitat for bats through the presence of snags). The locations and boundaries of hedgerows are depicted on Figure 3.1.2.

3.1.4.2.2 Vegetation Community Descriptions

Divided by subwatershed, survey findings and a description of each vegetation community listed in Table 3.1.6 are presented below. Additional areas (i.e., anthropogenic, agricultural, hedgerows) were also identified. The boundaries of communities and additional areas are depicted in Figure 3.1.2 and described in the following subsections.



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Distinct, but small vegetation communities with an area of less than 0.5 ha were identified where appropriate (based on professional opinion) as inclusions where they were abutting or within larger vegetation communities. Unique or sensitive areas of ecological interest less than 0.5 ha were also identified as ELC communities. The general approach for the identification and mapping of inclusions is described in the ELC for Southern Ontario field manual (Lee et al., 1998).

Stoney Creek Subwatershed

Results of the field investigations in this section identified five vegetation communities within the Stoney Creek subwatershed. The boundaries of these communities are depicted on Figure 3.1.2 and described in the following subsections.

Terrestrial System

Anthropogenic/Rural Property (ANTH)

Many of the properties have detached residential homes with manicured lawns, landscaping, and secondary buildings such as sheds and barns. Many of these communities were not accessed as they are situated on private property where access permissions had not been granted. Characterization of these areas is based on aerial photo interpretation and roadside surveys.

Agricultural (AG)

The majority of the Study Area supports actively managed cropland such as soybean, corn, and wheat.

Hedgerows (HR)

Many planted and regenerating hedgerows exist between agricultural fields. These features varied in species, maturity, and density but were commonly dominated by shrubs such as European buckthorn (*Rhamnus cathartica*), multiple hawthorn species (*Crataegus spp.*), grey dogwood (*Cornus racemosa*), and crabapple (*Malus sp.*) Additional tree species present include shagbark hickory (*Carya ovata*), American basswood (*Tilia americana*), oak species (*Quercus spp.*), black walnut (*Juglans nigra*), trembling aspen (*Populus tremuloides*), and ash species (*Fraxinus spp.*). Groundcover typically contained common cultural meadow species.

Wetland System

Willow Mineral Deciduous Swamp (SWD4-1)

A willow swamp community was identified in Parcel 45. This community was adjacent to a watercourse, with a canopy dominated by crack willow (*Salix fragilis*) and an abundance of cattails (*Typha spp.*), common reed (*Phragmites australis*), and reed canary grass throughout the ground layer. Panicked aster (*Sympyotrichum lanceolatum*), purple loosestrife (*Lythrum salicaria*), and tall goldenrod (*Solidago altissima*) were present in smaller quantities throughout the community. Soils within the community were composed of clay with mottles appearing at 20 cm.

Pond

A 0.05 ha shallow dug pond was identified in Parcel 47. The most abundant species present was lesser duckweed (*Lemna minor*), while emergent species such as rice cutgrass (*Leersia oryzoides*), Pennsylvania smartweed (*Persicaria pennsylvanica*), and reed canary grass (*Phalaris arundinacea*) were present around the pond edge. A few willow trees (*Salix sp.*) were also present along the edge of the pond.



Twenty Mile Creek Subwatershed

Results of the field investigations in this section identified 14 vegetation communities in the Twenty Mile Creek subwatershed. The boundaries of these communities are depicted on Figure 3.1.2 and described in the following subsections.

Terrestrial System

Anthropogenic/Rural Property (ANTH)

Many of the properties have detached residential homes with manicured lawns, landscaping and secondary buildings such as sheds and barns. Many of these communities were not accessed as they are situated on private property where access permissions had not been granted. Characterization of these areas is based on aerial photo interpretation and roadside surveys.

Black walnut cultural woodlands were identified in both Parcel 3 and Parcel 4. These communities have an abundance of black walnut (*Juglans nigra*) in the canopy, with a sparse subcanopy and understory and a ground layer of forb species such as tall goldenrod (*Solidago altissima*) and white avens (*Geum canadense*) in the ground layer. These communities showed strong evidence of cultural disturbance, such as the presence of introduced and horticultural species and manmade structures such as an old horse paddock in the woodland in Parcel 4 and an abandoned house in the woodland in Parcel 3. Soils in the community in Parcel 3 were composed of clay loam with faint mottling beginning at 35 cm. A soil core was not taken in Parcel 4 due to lack of access to the site; the community was assessed by visual survey only.

Agricultural (AG)

The majority of the Study Area supports actively managed cropland such as soybean, corn, and wheat.

A small cultural thicket plant community, 0.14 ha, was identified in Parcel 3. European buckthorn (*Rhamnus cathartica*) and hawthorn (*Crataegus spp.*) are the dominant and only species in the subcanopy, understory, and ground layers. No access was permitted on this property; the community was assessed by visual survey only.

Hedgerows (HR)

Many planted and regenerating hedgerows exist between agricultural fields. These features varied in species, maturity, and density but were commonly dominated by shrubs such as European buckthorn (*Rhamnus cathartica*), multiple hawthorn species (*Crataegus spp.*), grey dogwood (*Cornus racemosa*), and crabapple (*Malus sp.*) Additional tree species present include shagbark hickory (*Carya ovata*), American basswood (*Tilia americana*), oak species (*Quercus spp.*), black walnut (*Juglans nigra*), trembling aspen (*Populus tremuloides*), and ash species (*Fraxinus spp.*). Groundcover typically contained common cultural meadow species.

Reed Canary Grass Mineral Meadow/Mineral Cultural Thicket (MAM2/CUT1)

This community was observed in Parcel 15 and is dominated by reed canary grass (*Phalaris arundinacea*) and European buckthorn (*Rhamnus cathartica*). It is located adjacent to and within a rural residential property.



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Gray Dogwood Cultural Thicket (CUT1-4)

This community type was observed in Parcel 2 and contains two Cattail Mineral Shallow Marsh (MAS2-1) inclusions dominated by cattails (*Typha spp.*) and panicled aster (*Symphotrichum lanceolatum*). The thicket contained an abundance of gray dogwood (*Cornus racemosa*) and tall goldenrod (*Solidago altissima*) along with reed canary grass, bird's-foot trefoil (*Lotus corniculatus*), and grass-leaved goldenrod (*Euthamia graminifolia*). The community contained clay soils with mottles appearing at 5 cm and gley at 55 cm.

Dry-Fresh Sugar Maple–Oak Deciduous Forest (FOD5-3)

This mature deciduous forest community was identified during field investigations in Parcel 1, east of Trinity Church Road and north of Gold Club Road. This community contains an abundance of sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), and American beech (*Fagus grandifolia*) in the canopy. Sugar maple, American beech, and basswood (*Tilia americana*) make up the sub-canopy, while the understory and ground layer contain very little vegetation. Soils within the community were composed of loamy clay with mottling at 45 cm, indicating a moderately moist moisture regime. A mapped watercourse runs along the northern edge of the forest community.

A Gray Dogwood Mineral Swamp Thicket (SWT2-9) inclusion is located at the northern edge of the FOD5-3 community and is 0.13 ha in size. The community is dominated by gray dogwood (*Cornus racemosa*) in the shrub layer and a few plants scattered in the understory including spotted jewelweed (*Impatiens capensis*), calico aster (*Symphotrichum lateriflorum*), and fowl manna grass (*Glyceria striata*).

Sugar Maple Cultural Woodland (CUW1)

This mid-aged woodland community was observed in Parcel 9 at the rear of a rural property where domesticated chickens and goats roam within the community. Sugar maple (*Acer saccharum*) and bur oak (*Quercus macrocarpa*) occur sparsely in the canopy layer, while young sugar maple is dominant in the sub-canopy. Introduced invasive species including European buckthorn (*Rhamnus cathartica*) and tatarian honeysuckle (*Lonicera tatarica*) are present in the understory, while Kentucky bluegrass (*Poa pratensis*) makes up most of the ground layer. Soils in this polygon were composed of clay, with 30 cm of silty loam in the upper layer.

Dry-Fresh Sugar Maple Deciduous Forest (FOD5-1)

A mature deciduous forest community with an abundance of sugar maple (*Acer saccharum*) in the canopy was identified in Parcel 10. Additional canopy species included basswood (*Tilia americana*), bur oak (*Quercus macrocarpa*), and American beech (*Fagus grandifolia*). The most abundant tree in the sub-canopy is American beech, with sugar maple, black maple (*Acer nigrum*), and white elm (*Ulmus americana*) present sparsely throughout. The understory is composed predominantly of European buckthorn (*Rhamnus cathartica*) and chokecherry (*Prunus virginiana*), while poison ivy (*Toxicodendron radicans*), tall goldenrod (*Solidago altissima*), zig-zag goldenrod (*Solidago flexicaulis*), and calico aster (*Symphotrichum lateriflorum*) make up most of the ground layer. The soil profile was composed of fresh silty loam with no mottles or gley present.

This community contained a White Elm Mineral Deciduous Swamp (SWD4-2) inclusion. The canopy is composed of white elm, basswood, and bitternut hickory (*Carya cordiformis*). Some areas appeared more thicket-like, with an abundance of European buckthorn, red osier dogwood (*Cornus sericea*), and



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riverbank grape (*Vitis riparia*) in groupings. Reed canary grass (*Phalaris arundinacea*), panicked aster (*Symphotrichum lanceolatum*), spotted jewelweed (*Impatiens capensis*), and sensitive fern (*Onoclea sensibilis*) are present within the ground layer. The soil profile was composed of moist clay loam with mottles appearing at 30 cm.

Dry-Fresh Sugar Maple–Beech Deciduous Forest (FOD5-2)

This mature deciduous forest community was identified in Parcel 14. The canopy and sub-canopy is abundant with sugar maple (*Acer saccharum*) and have a moderate amount of American beech (*Fagus grandifolia*), red oak (*Quercus rubra*), and basswood (*Tilia americana*) throughout. Additional sub-canopy species include ironwood (*Ostrya virginiana*) and black cherry (*Prunus serotina*). The understory is composed of young sugar maple, American beech, and chokecherry (*Prunus virginiana*). Species in the ground layer include western poison ivy (*Toxicodendron rydbergii*), riverbank grape (*Vitis riparia*), mayapple (*Podophyllum peltatum*), and calico aster (*Symphotrichum lateriflorum*). Soil in this polygon was very fresh loamy clay soil with no mottles or gley appearing in the core.

Wetland System

Reed Canary Grass Mineral Meadow Marsh (MAM2)

This community type was observed in one location within the Study Area: Parcel 3. This polygon was dominated by reed canary grass (*Phalaris arundinacea*) in the ground layer, with additional forb and grass species scattered sparsely throughout. Additional herbaceous species included barnyard grass (*Echinochloa crus-galli*), pale smartweed (*Persicaria lapathifolia*), yellow nutsedge (*Cyperus esculentus*), and fringed willowherb (*Epilobium ciliatum*). Evident mottling was present early in the soil profiles, indicating moist wetland soils.

Silver Maple Deciduous Swamp (SWD3-2)

A Silver Maple Deciduous Swamp occurs within the FOD5-2 community and leads to a drainage feature at the southern end. The canopy and sub-canopy contain silver maple (*Acer saccharinum*) most predominantly, as well as bur oak (*Quercus macrocarpa*), basswood, and white elm (*Ulmus americana*). Blue-beech (*Carpinus caroliniana*) and European buckthorn (*Rhamnus cathartica*) are present in the understory. Western poison ivy and calico aster make up much of the ground layer. Soils in this polygon were moist, with mottling appearing at 25 cm.

Pond

Two small dug ponds, 0.02 ha and 0.06 ha, were observed within Parcel 9. These ponds were dominated by common reed (*Phragmites australis ssp. australis*) and cattails (*Typha spp.*) at the edges with open water in the centre. Soils around the edges of the open water were composed of clay. Another small dug pond was in Parcel 12 with willow trees (*Salix sp.*) and some red osier dogwood (*Cornus sericea*) around the edges.

Sinkhole Creek Subwatershed

Results of the field investigations in this section identified 18 vegetation communities in the Sinkhole Creek subwatershed. The boundaries of these communities are depicted in Figure 3.1.2 and described in the following subsections. Portions of the Lower Twenty Mile Creek Wetland Complex PSW are



within the Study Area west of Second Road East and were delineated and classified as vegetation type where access was provided.

Terrestrial System

Anthropogenic/Rural Property (ANTH)

Many of the properties have detached residential homes with manicured lawns, landscaping, and secondary buildings such as sheds and barns. Many of these communities were not accessed as they are situated on private property where access permissions had not been granted. Characterization of these areas is based on aerial photo interpretation and roadside surveys.

Agricultural (AG)

The majority of the Study Area supports actively managed cropland such as soybean, corn, and wheat.

Hedgerows (HR)

Many planted and regenerating hedgerows exist between agricultural fields. These features varied in species, maturity, and density but were commonly dominated by shrubs such as European buckthorn (*Rhamnus cathartica*), multiple hawthorn species (*Crataegus spp.*), grey dogwood (*Cornus racemosa*), and crabapple (*Malus sp.*) Additional tree species present include as shagbark hickory (*Carya ovata*), American basswood (*Tilia americana*), oak species (*Quercus spp.*), black walnut (*Juglans nigra*), trembling aspen (*Populus tremuloides*), and ash species (*Fraxinus spp.*). Groundcover typically contained common cultural meadow species.

Dry – Moist Old Field Meadow (CUM1-1)

Areas of fragmented cultural meadow are spread throughout the Study Area in Parcels 9, 17, 20, 24, 25, 58, and 64. Canopy and subcanopy layers were limited and variable. The understory and ground cover species included a variety of non-native grasses such as smooth brome (*Bromus inermis*), common timothy (*Phleum pratense*), Kentucky bluegrass (*Poa pratensis*), reed canary grass (*Phalaris arundinacea*), and quack grass (*Elymus repens*). Additionally, herbaceous plants such as tall goldenrod (*Solidago altissima*), wild carrot (*Daucus carota*), common teasel (*Dipsacus fullonum*), white sweet-clover (*Melilotus albus*), tufted vetch (*Vicia cracca*), common milkweed (*Asclepias syriaca*), and bird's-foot trefoil (*Lotus corniculatus*), were typical of meadow areas. Soils in this community were mineral (silt loam). Anthropogenic disturbance within these cultural meadow communities included trails, dumping, and exotic and invasive species.

Mineral Cultural Thicket (CUT1)

Four areas of cultural thicket were observed across the Study Area in Parcels 25, 31, 35, and 40. Shrub species dominated the composition of this community and included European buckthorn (*Rhamnus cathartica*), common pear (*Pyrus communis*), scarlet hawthorn (*Crataegus coccinea*), and dotted hawthorn (*Crataegus punctata*). Tree species such as black walnut, Manitoba maple (*Acer negundo*), American basswood, shagbark hickory, American elm (*Ulmus americana*), and trembling aspen (*Populus tremuloides*) were also noted as a sparse canopy layer of this community. Woody vine species such as thicket creeper (*Parthenocissus inserta*) and riverbank grape (*Vitis riparia*) were also noted within cultural thicket communities. Groundcover and understory species were described as Canada goldenrod (*Solidago canadensis*), woodland strawberry (*Fragaria vesca*), and reed canary grass (*Phalaris arundinacea*) with additional typical cultural meadow species.



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The cultural thicket community west of Hendershot Road contained a small Reed-canary Grass Mineral Meadow Marsh (MAM2-2) inclusion within the southern limit of the feature, which was associated with an ephemeral drainage ditch.

Cultural Woodland (CUW1)

One cultural woodland community was observed east of Highway 56 and was associated with an abandoned rural residential property in Parcel 10. This community was dominated by tree species that provided less than 60% canopy cover. The shrub layer contained European buckthorn (*Rhamnus cathartica*), hawthorn species (*Crataegus spp.*), and black locust (*Robinia pseudoacacia*). The ground layer contained giant ragweed (*Ambrosia trifida*) and common cultural meadow species.

Dry – Fresh Beech Deciduous Forest (FOD4-1)

Three areas of FOD4-1, with one being classified as an inclusion based on its size, were identified in bands alternating with Red Maple Mineral Deciduous Swamp (SWD3-1) communities, within the PSW, west of Second Road East in Parcel 38A. This community was noted as supporting a canopy/subcanopy dominated by American beech (*Fagus grandifolia*) with sugar maple (*Acer saccharum*), and shagbark hickory (*Carya ovata*). Canopy dieback was observed due to beech bark disease and beech leaf disease. Understory species composition was composed of chokecherry (*Prunus virginiana*), green ash (*Fraxinus pennsylvanica*), sugar maple, and maple-leaved viburnum (*Viburnum acerifolium*). Groundcover vegetation establishment was sparse and supported running strawberry-bush (*Euonymus obovatus*), yellow trout-lily (*Erythronium americanum*), Jack-in-the-pulpit (*Arisaema triphyllum*), white trillium (*Trillium grandiflorum*), and beechdrops (*Epifagus virginiana*). Soils in this community were mineral (silt loam).

Dry – Fresh Sugar Maple Deciduous Forest (FOD5)

One FOD5 ecosite was noted within the Study Area east of Highway 56 in Parcel 68. Access to this community was not granted at the time of field surveys, so this community was not classified further than ecosite type. This deciduous forest community was dominated by sugar maple (*Acer saccharum*) with occasional red oak (*Quercus rubra*), and American basswood. The shrub layer contained European buckthorn (*Rhamnus cathartica*) and hawthorn species (*Crataegus spp.*). Due to access restrictions, a detailed shrub and ground layer inventory was not documented.

Fresh – Moist Oak – Maple – Hickory Deciduous Forest (FOD9-2)

Four of these forest communities were observed within the Study Area: one northeast of Rymal Road East and Upper Centennial Parkway and another within the southeastern extent of the Study Area north of Golf Club Road. This young to mid-aged forest community type supported a diverse canopy of red oak (*Quercus rubra*), bur oak (*Quercus macrocarpa*), American basswood (*Tilia americana*), shagbark hickory (*Carya ovata*), and Freeman's maple (*Acer x freemanii*). Subcanopy species included bur oak, shagbark hickory, trembling aspen (*Populus tremuloides*), American elm (*Ulmus americana*), and European beech (*Fagus sylvatica*). Understory species composition was composed of European buckthorn (*Rhamnus cathartica*), chokecherry (*Prunus virginiana*), grey dogwood (*Cornus racemosa*), green ash (*Fraxinus pennsylvanica*), and scarlet hawthorn (*Crataegus coccinea*). Groundcover vegetation establishment contained broad-leaved enchanter's nightshade (*Circaea canadensis*), yellow trout-lily, spotted geranium (*Geranium maculatum*), running strawberry-bush, woodland strawberry, devil's beggarticks (*Bidens frondosa*), common speedwell (*Veronica officinalis*), poison ivy



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(*Toxicodendron rydbergii*), and European buckthorn seedlings. Access was not granted to the parcel northeast of Rymal Road East and Upper Centennial Parkway in 2024.

Two FOD9 communities were noted north and south of the SWD inclusion east of Highway 56. Access to this community was also not permitted; therefore, species listed were observed from a distance. The canopy and subcanopy appeared to be dominated by bur oak and shagbark hickory with occasional dead ash species and scarce sugar maple. Understory species composition noted from the edge included European buckthorn, green ash, grey dogwood, and multiple hawthorn species. Groundcover vegetation noted from the edge included wild sarsaparilla (*Aralia nudicaulis*), spotted geranium, May-apple (*Podophyllum peltatum*), and panicked aster (*Symphotrichum lanceolatum*).

Fresh – Moist Shagbark Hickory Deciduous Forest (FOD9-4)

This mid-aged to mature forest community was identified adjacent to the eastern limit of the PSW, west of Second Road East in Parcel 37. This community was noted as supporting a canopy/subcanopy dominated by shagbark hickory (*Carya ovata*), sugar maple (*Acer saccharum*), white oak (*Quercus alba*), and red oak. Understory species composition was composed of chokecherry, black cherry (*Prunus serotina*), red oak (*Quercus rubra*), green ash (*Fraxinus pennsylvanica*), and sugar maple. Groundcover vegetation establishment was occasional and supported broad-leaved enchanter's nightshade, large-leaved aster (*Eurybia macrophylla*), Jack-in-the-pulpit, yellow trout-lily, running strawberry-bush, spotted jewelweed (*Impatiens capensis*), and spotted geranium. Soils in this community were mineral (silt loam).

Wetland System

Thicket Swamp (SWT)

One thicket swamp inclusion was identified along the western edge of the PSW, west of Second Road East in Parcel 40. This community was less than 0.5 ha and is therefore mapped as an inclusion. Permission to access this property had not been granted; therefore, this community was assessed to community series level.

One thicket swamp and cultural meadow complex was recorded east of Highway 56, south of Swayze Road. An additional thicket swamp / meadow complex was identified on the east side of Highway 56, just south of the hydro corridor in Parcel 20. Complexes occur where two or more vegetation communities are interspersed as a mosaic that is too complex to map as separate polygons (Lee et al., 1998).

Pond

Three pond / open aquatic features were observed on either side of Highway 56, surrounded by active agricultural fields. The pond west of Highway 56 in Parcel 9 had a perimeter of cattails (*Typha sp.*) and appeared to be natural, whereas the pond east of Highway 56 in Parcel 10 appeared to be dug and was surrounded by a band of cattails.

Deciduous Swamp (SWD)

One mature treed swamp inclusion was identified as not part of the PSW, east of Highway 56 in Parcel 20. Access to this community was not granted therefore species information is limited and community was not identified as ecosite type. The canopy and subcanopy appeared to be dominated by bur oak



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(*Quercus macrocarpa*) and shagbark hickory (*Carya ovata*) with occasional dead ash species (*Fraxinus* spp.). Understory and groundcover species were not visible from outside of the feature.

Green Ash Deciduous Mineral Swamp (SWD2-2)

Two green ash treed swamp inclusions were identified within the PSW west of Hendershot Road in Parcel 14. The sparse canopy and subcanopy consisted of green ash, most of which were dead or dying as a result of emerald ash borer (*Agrilus planipennis*) infestation. The understory was composed of reed-cannary grass (*Phalaris arundinacea*), invasive common reed (*Phragmites australis* ssp. *australis*), and narrow-leaved cattail (*Typha angustifolia*). Groundcover vegetation establishment was dense and supported large barnyard grass (*Echinochloa crus-galli*), fall panicgrass (*Panicum dichotomiflorum*) and Pennsylvania smartweed (*Persicaria pensylvanica*).

Red Maple Mineral Deciduous Swamp (SWD3-1)

This mid-aged to mature treed swamp community and inclusion were identified within the PSW, west of Second Road East in Parcel 38A. This community supported a canopy and subcanopy dominated by red maple (*Acer rubrum*) with less common canopy/subcanopy tree associates that included green ash (*Fraxinus pensylvanica*), American elm (*Ulmus americana*), and Freeman's maple (*Acer saccharinum* x *Acer rubrum*). Understory species composition consisted of grey dogwood (*Cornus racemosa*), shagbark hickory (*Carya ovata*), winterberry holly (*Ilex verticillata*), and black ash (*Fraxinus nigra*) saplings. Black ash was added to the SARO list in 2022 and is listed as Endangered under the SCA (Government of Ontario, 2007). Groundcover vegetation establishment was dense and supported spotted jewelweed (*Impatiens capensis*), fowl mannagrass (*Glyceria striata*), sensitive fern (*Onoclea sensibilis*), poison ivy (*Toxicodendron* spp.), paniced aster (*Symphotrichum lanceolatum*), and rice cutgrass (*Leersia oryzoides*). Soils in this community were mineral (silty clay) and saturated.

Mineral Meadow Marsh (MAM2)

This wetland feature exists west of Highway 56, in Parcel 22, surrounded by active agricultural fields. Cattail and reed-cannary grass establishment was dense, with occasional to abundant occurrences of a mixture of wetland species such as devil's beggarticks (*Bidens frondosa*), purple loosestrife (*Lythrum salicaria*), soft-stemmed bulrush (*Schoenoplectus tabernaemontani*), common woolly bulrush (*Scirpus cyperinus*), paniced aster, northern water-plantain (*Alisma triviale*), and more weedy common upland / cultural meadow species along the edges.

During surveys conducted in 2024, it was observed that the western limits of the feature had been ploughed, and the new limits were delineated by an OWES certified ecologist in June 2024. It should be noted that wetlands adjacent to active agricultural lands will change on an annual basis through farming practices as they expand/retreat depending on annual rainfall and ploughing activities.

Reed Canary Grass Mineral Meadow Marsh (MAM2-2)

Five reed canary meadow marshes were identified within the PSW and unevaluated wetlands throughout the Study Area. This community type was dominated by reed canary grass with narrow-leaved cattail (*Typha angustifolia*). Other wetland species in the ground layer included northern water-plantain (*Alisma triviale*), devil's beggarticks (*Bidens frondosa*), blunt spikerush (*Eleocharis obtusa*), Pennsylvania smartweed (*Persicaria pensylvanica*), yellow nutsedge (*Cyperus esculentus*), swamp milkweed (*Asclepias incarnata*), and purple loosestrife (*Lythrum salicaria*). Sparse canopy and subcanopy cover consisted of tree species such as bur oak (*Quercus macrocarpa*), American elm



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(*Ulmus americana*), and green ash (*Fraxinus pennsylvanica*), most of which were dead or dying due to damage caused by the emerald ash borer.

In 2024, moisture conditions within two reed-canary meadow marsh communities were drier than those observed during 2023 investigations. The limits of the meadow marsh MAM2-2(3) in Parcel 14 had reduced in size and was planted with soy in 2024. Similarly, the limits of the meadow marsh community within agricultural field southwest of Rymal Road East and Hendershot Road, in Parcel 31, had reduced in size as a result of drier conditions. The previous wetland feature limits were planted with soy in 2024. The revised feature limits were delineated by an OWES certified ecologist in July 2024 and are mapped in Figure 3.1.2. This can be expected and is often seen in areas where the limits of wet areas next to active farm fields can change over the years depending on annual rainfall fluctuations and farming activities.

Cattail Mineral Shallow Marsh (MAS2-1)

Four shallow marsh communities were observed within unevaluated and evaluated non-PSW within the Study Area, in Parcels 16, 17, 25, and 35. The vegetation assemblage of these communities was generally dominated by dense narrow-leaved cattail (*Typha angustifolia*) and mixed species. They also supported minor establishment of herbaceous species including devil's beggarticks (*Bidens frondosa*), purple loosestrife (*Lythrum salicaria*), Pennsylvania smartweed (*Persicaria pennsylvanica*), bittersweet nightshade (*Solanum dulcamara*), panicked aster (*Symphotrichum lanceolatum*), northern water-plantain (*Alisma triviale*), and large barnyard grass (*Echinochloa crus-galli*). Scattered woody species occurred in some cases (canopy, sub-canopy, understory) including black willow (*Salix nigra*), sandbar willow (*Salix interior*), green ash (*Fraxinus pennsylvanica*), and American elm (*Ulmus americana*).

The shallow cattail marsh east of Fletcher Road was surrounded by cultural meadow and cultural thicket communities.

Wetland Evaluation

Multiple wetlands are present throughout the Study Area, two of which have already been evaluated; the Lower Twenty Mile Creek PSW and Sinkhole Wetland Complex. The OWES is a science-based scoring system used in Ontario to evaluate the functions and values of wetlands, allowing for their relative ranking and the identification of PSWs. Wetland evaluation informs land-use planning decisions and can be used by Conservation Authorities to implement regulations. Information gathered from a wetland evaluation can provide a basis for considering management options. The evaluation recognizes the role of wetlands in maintaining natural processes and providing benefits to society. It assesses wetlands based on biological, social, hydrological, and special features. Unevaluated wetland communities within the Study Area were not assessed as part of this study but are recommended to be completed at the EIS stage.

To determine whether unevaluated wetlands in the Study Area should be considered candidates for future OWES assessment, three primary criteria were evaluated: size, species diversity, and habitat for SAR. Wetlands smaller than 0.5 hectares are generally considered too small to support significant ecological functions and were not considered candidates for OWES assessment. Wetlands with very low species diversity, particularly those dominated by non-native invasive species such as common reed (*Phragmites australis* ssp. *australis*) or reed canary grass (*Phalaris arundinacea*), were not considered candidates for future OWES assessment, regardless of size. Wetlands providing habitat for





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SAR, regardless of size or species diversity, were considered candidates for future OWES assessment.

Two wetland communities were visited in the Study Area. A summary of the findings and recommendations for future OWES assessment are provided in Table 3.1.7.

Table 3.1.7 Wetland Assessment Results

| Wetland, Size, and Watershed | Description | Recommendation | Photo |
|--|---|---------------------------------------|---|
| MAM2 0.42 ha Parcel 3 Twenty Mile Creek | A portion of this wetland was previously farmed and tilled (rutting present). It contains several wetland species including barnyard grass (<i>Echinochloa sp.</i>), pale smartweed (<i>Persicaria lapathifolia</i>), yellow nutsedge (<i>Cyperus esculentus</i>), and fringed willowherb (<i>Epilobium ciliatum</i>). One small upland pocket is included in it that contains Queen Anne's lace (<i>Daucus carota</i>), wild grape (<i>Vitis riparia</i>), cow vetch (<i>Vicia cracca</i>), ragweed (<i>Ambrosia sp.</i>), and common milkweed (<i>Asclepias syriaca</i>). There is also a transition area where wetland and upland vegetation is mixed. | Candidate for future OWES evaluation. |  |
| SWD4-1 0.60 ha Parcel 45 Stoney Creek | Wetland vegetation, including cattails (<i>Typha sp.</i>), reed canary grass (<i>Phalaris arundinacea</i>), and purple loosestrife (<i>Lythrum salicaria</i>), follows the watercourse and is riparian. The vegetated area is wider and includes upland species at edges, like common milkweed (<i>Asclepias syriaca</i>), bur oak (<i>Quercus macrocarpa</i>), and Queen Anne's lace (<i>Daucus carota</i>). Scattered willow trees (<i>Salix spp.</i>) are present along the riparian edge. | Candidate for future OWES evaluation. |  |

Botanical Inventories

A total of 322 vascular plants were recorded during the three-season botanical inventory and vegetation community classifications, as well as during hedgerow surveys (see **Appendix C1**). Of those 322 plants, 294 were identified to species. Of those 294 species, 185 (63%) are native to Ontario and 109 (37%) are introduced. The high percentage of non-native species reflects the history of human activity within the Study Area, and the fragmentation of many of the plant communities observed.

Invasive species such as European common reed (*Phragmites australis ssp. australis*) and reed canary grass (*Phalaris arundinacea*) have encroached on many wetland communities within the Study Area. In many of the terrestrial communities, invasive introduced species, including European buckthorn (*Rhamnus cathartica*) and Tatarian honeysuckle (*Lonicera tatarica*), are not uncommon.



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Three provincially rare species (S1-S3) were observed during field investigations. These species include pignut hickory (*Carya glabra*), shellbark hickory (*Carya laciniosa*), and honey locust (*Gleditsia triacanthos*). Pignut hickory and shellbark hickory are especially notable due to their high degree of fidelity to a specific habitat type. Both hickory species are listed as having a Coefficient of Conservatism of 9, which means that they have very little tolerance to habitat disturbance and are among some of the most conservative plant species.

Pignut hickory is also listed as rare in Hamilton in the 2014 Hamilton Natural Areas Inventory (NAI) Project 3rd Edition. One additional native species recorded within the Study Area is listed in the 2014 NAI as rare in Hamilton: scarlet hawthorn (*Crataegus coccinea*). Five native species that were found within the Study Area are listed as uncommon in Hamilton, including fireberry hawthorn (*Crataegus chrysocarpa*), large-thorned hawthorn (*Crataegus macracantha*), downy hawthorn (*Crataegus mollis*), great ragweed (*Ambrosia trifida*), and grove bluegrass (*Poa alsodes*).

Additionally, thirteen introduced species that are uncommon or rare in Hamilton were recorded

in the Study Area, including: spear saltbush (*Atriplex patula*), black mustard (*Brassica nigra*), winged euonymus (*Euonymus alatus*), osage orange (*Maclura pomifera*), Siberian crabapple (*Malus baccata*), Norway spruce (*Picea abies*), hawkweed oxtongue (*Picris hieracioides*), Austrian pine (*Pinus nigra*), European red raspberry (*Rubus idaeus ssp. idaeus*), Japanese lilac tree (*Syringa reticulata*), common lilac (*Syringa vulgaris*), little-leaved linden (*Tilia cordata*), and wayfaring viburnum (*Viburnum lantana*).

One plant SAR, black ash (*Fraxinus nigra*), was documented as occurring within the Study Area. Black ash is listed as Endangered in Ontario, and in Southern Ontario in particular, it has faced a large reduction in numbers since the introduction of the emerald ash borer.

3.1.4.3 Wildlife and Wildlife Habitat

Due to the highly agricultural character of the Study Area, and the relatively limited extent of natural features, limited representation of SWH has been identified.

SLR and GeoProcess has determined that there is Candidate or Confirmed SWH for the following:

- Seasonal Concentration Areas of Animals
- Bat Maternity Colonies – Candidate
- Habitat of Species of Conservation Concern
- Special Concern and Rare Wildlife Species, Eastern Wood-pewee – Candidate
- Special Concern and Rare Wildlife Species, Barn Swallow – Confirmed
- Special Concern and Rare Wildlife Species – Pignut Hickory – Confirmed
- Special Concern and Rare Wildlife Species – Shellbark Hickory – Confirmed
- Terrestrial Crayfish - Candidate

Confirmed SWH are mapped in Figure 3.1.3. A thorough assessment for each potential SWH in ecoregion 7E is also detailed in **Appendix C3**.

Bat Maternity Colonies

Woodlands (i.e. ELC codes FOD, FOM, SWD and SWM) within the Study Area might be candidate Bat Maternity Colony SWH, if, as the SWH criteria indicates, the woodland is 'located in mature deciduous



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or mixed forest stands greater than 10 per ha large diameter (>25 cm dbh) wildlife trees. A few woodlands with the Study Area may contain snag trees of sufficient number for big brown bat (*Eptesicus fuscus*) to meet the SWH criteria, and thus it is considered that there is limited potential habitat in the Study Area due to limited representation of mature forests.

All bat species, other than big brown bat, in Ontario are listed as Endangered and thus are covered under the SAR section of this report.

Special Concern and Rare Wildlife Species - Eastern Wood-Pewee (Special Concern)

As noted in the avian section, one or two territories of the Special Concern eastern wood-pewee were recorded within five woodlands or swamps (Figure 3.1.3). Despite its status as a Special Concern species, eastern wood-pewee is common in deciduous and mixed forests of many sizes throughout southern Ontario, particularly woodlands that have a closed canopy. For the purposes of screening SWH for this category, there is no direction provided by the MNR in the criteria regarding the abundance and/or representation of a Special Concern species to meet the threshold of confirmed SWH, in comparison to other SWH categories (e.g., Amphibian Breeding Habitat), where the criteria provide thresholds for abundance to qualify as SWH. The presence of a single territory of eastern wood-pewee would not automatically qualify an area as candidate habitat. However, in order to be conservative in a landscape with more limited woodland cover, woodlands (forest ELC communities) that contain pewee are considered Candidate SWH. Further assessment at the EIS stage may be needed to confirm the SWH status.

Note that there is one hedgerow where one eastern wood-pewee was observed which is not considered to be SWH; hedgerow habitat would be less functional, and it was assumed that the bird heard there had temporarily moved from the adjacent woodland (which contained singing pewee) or a second adjacent woodland that was just outside the Study Area.

Special Concern and Rare Wildlife Species – Pignut Hickory (S3) and Shellbark Hickory (S3)

Several individuals (of a variety of ages) of the rare pignut hickory (*Carya glabra*) were observed in swamp portions of three woodlands in the south portion of the Study Area, as well as one hedgerow in Parcel 28 [HR(4)] (Figure 3.1.3). Pignut hickory was most abundant (approximately 12 individuals) within inclusions in the community FOD5-3(1).

One or two young shellbark hickory (*Carya laciniosa*) were observed within one woodland (SWD4-2(1) (Figure 3.1.3).

S3 species are described as Vulnerable – Rare to uncommon, by the provincial Natural Heritage Information Centre (NHIC). Thus, these swamp inclusions and hedgerow have been considered confirmed SWH.

Terrestrial Crayfish

Two species of terrestrial crayfish (chimney or digger crayfish (*Fallicambarus fodiens*) and devil crayfish or meadow crayfish (*Cambarus diogenes*) can occur within or adjacent to wet meadow and edges of shallow marshes. Thus, there is potential for this species to occur in selected areas in the Study Area. Despite many field visits for a range of surveys, no chimneys (the main evidence used to indicate presence) were observed; thus, the likelihood of presence is considered low. Targeted surveys for



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terrestrial crayfish should be undertaken at the EIS stage of development in areas of suitable habitat to confirm their presence or absence.

Categories for Consideration Not Meeting SWH Criteria

Some analysis occurred for several categories of SWH as discussed below; however, none of these were considered SWH.

Raptor Wintering Area

There is a disturbed, anthropogenic early successional area with mature scattered trees of about 14 ha located southeast of Mud Street East and Upper Centennial Parkway (part of Parcel 49). Data from eBird has been used to look at the likelihood that this general area could potentially be SWH for wintering raptors. The following records from the Study Area for the potential SWH area for the listed species under the Ecoregion Schedule are provided:

- Rough-legged Hawk –1 (November 27, 2014)
- Red-tailed Hawk – 8 records of single or two birds between 2014 and 2024
- Northern Harrier –1 (February 7, 2015)
- Short-eared Owl –1 (February 7, 2015, the only winter record for the species in the Study Area)
- American Kestrel – 3 (single winter records between 2013 and 2016)

While the area has records indicating the presence of wintering raptors, the current use (i.e., last 10 years), abundance and the frequency of raptor use is not known. Habitat conditions Criteria Schedule for Ecoregion 7E suggests that the 'site must be used regularly (3 in 5 years) for a minimum of 20 days' each year presumably, and that it should be a minimum of 20 ha in size with at least 15 ha of old field or meadow. Neither of the latter conditions are met, thus the Study Area does not include candidate SWH. At the EIS stage, winter raptor surveys would be considered. Additionally, it should be noted that current conditions and representation of vegetation communities of this property are not well known as it is within a non-participating landowner property.

Special Concern and Rare Wildlife Species - Barn Swallow (Special Concern)

While numerous foraging individuals were observed in the Study Area, only one confirmed nesting location was observed at a building northwest of Highway 56 and Golf Club Road (Figure 3.1.3). Several active nests were observed within the barn. However, since this structure is not a natural feature, it is not deemed as SWH based on the criteria schedules for Ecoregion 7E (Ontario Ministry of Natural Resources and Forestry, 2015). It is recommended that this building is surveyed prior to any demolition or construction activities to confirm the presence of barn swallows. If this species is still present, appropriate steps are to be taken to ensure conformity to the applicable legislation and regulations, including the MBCA. This may include rescheduling proposed works until after August 31 or the last date the birds are observed, whichever is later (Environment and Climate Change Canada 2019). Furthermore, it is advised that a compensatory nesting structure be established within a protected area in close proximity to the existing building.



Special Concern and Rare Wildlife Species - Peregrine Falcon (Special Concern)

As noted previously one young peregrine falcon was observed in the Study Area. It may have been foraging over the lands, but no suitable habitat, nor nest of this species is known to be present in the Study Area. Thus, there is no SWH for this species in the Study Area.

Special Concern and Rare Wildlife Species – Great Egret (S3M)

A great egret (*Ardea alba*) was observed in the Study Area on October 3, 2024. Given the time of year and that no egret or heron colonies were observed in the Study Area, this bird is not a breeding individual. There are a small number of breeding colonies of this species in southern Ontario, however the species is known for ‘post-breeding wandering’ some distance from breeding colonies and is fairly regularly seen in late summer and early fall in other locations. Thus, the record does not confer SWH status to any habitat.

Special Concern and Rare Wildlife Species – Kentucky Warbler

Kentucky warbler is a very rare breeding bird in Ontario that breeds in very large patches of deciduous forest with a dense understory in a few locations in Carolinian Ontario. Its status in Hamilton (HCA et al., 2013) is that it is a migrant only and not known to breed. One Kentucky warbler was observed in the Study Area on October 3, 2024. This is considered to be a non-breeding individual as it was observed outside the breeding season in unsuitable breeding habitat and therefore does not lead to any SWH habitat identification.

Special Concern and Rare Wildlife Species – Grass Pickerel

This fish species has been recorded in NHIC data about 1 km outside the Study Area. There is an upstream portion of the watercourse which is situated within the Study Area. As there is no suitable habitat for the species in the upstream portion, it has not been considered SWH.

Open Country Breeding Bird Habitat

Over 30 savannah sparrows and over 10 vesper sparrows were observed across the Study Area. As noted previously, savannah sparrow is the most common songbird within active agricultural lands in southern Ontario (based on our professional experience) and according to the OBBA 2001-2005 (BSC, 2007) ‘in Ontario is the most common breeding bird in most meadows and pastures’. Vesper sparrow, while somewhat uncommon, is also to be expected in very large open fields. The observations were spread across the agricultural lands and were not concentrated in one or two locations. Areas where these species were observed are not considered SWH. This is primarily because the areas observed are not natural or semi-natural grasslands but active agricultural fields (as per direction in the criteria), thus the habitat is not appropriate. Additionally, using savannah sparrow as a driver of SWH is in our professional opinion not a useful approach due to the widespread abundance of the species.

3.1.4.4 Winter Wildlife

Survey conditions are provided in Table 3.1.8. All potential wildlife movement areas surveyed showed signs of use by several species, particularly coyotes, rabbits, and squirrels (Table 3.1.9).



Table 3.1.8. Winter Wildlife Survey Conditions

| Date (dd/mm/yyyy) | Temperature (°C) | Cloud Cover | Beaufort Wind Scale | Date of Last Snowfall (dd/mm/yyyy) | Average Snow Depth |
|-------------------|------------------|-------------|---------------------|------------------------------------|--|
| 30/01/2025 | -5 | 2/10 | 1-2 | 7+ days | 7-10 cm in snow drifts, >5 cm throughout |
| 10/02/2025 | -2 | 3/10 | 1-2 | 08/02/2025 | 22 cm throughout |
| 11/02/2025 | -11 | 9/10 | 0-1 | 10/02/2025 | 5-30 cm throughout |
| 12/02/2025 | -14 | 10/10 | 2-3 | 10/02/2025 | 20-30 cm in snow drifts, 5 cm throughout |
| 19/02/2025 | -15 | 0/10 | 1 | 16/02/2025 | 20-30 cm in snow drifts, >10 cm throughout |
| 21/02/2025 | -8 | 10/10 | 1 | 20/02/2025 | 48 cm in snow drifts, >20 cm throughout |
| 24/02/2025 | 4 | 5/10 | 4-5 | 20/02/2025 | 50 cm throughout |

Due to insufficient snow cover, only one round of surveys was completed in 2025 for the Study Area:

Evidence of various species were recorded during the survey period and abundances were estimated based on the number of species occurrences observed in the field (Table 3.1.7). Communities investigated include 1i, 1J, 2F, 4C, 5C, 7B, B10b, 10B, 11C, 11D, 13A, 13B, 14C, 14D, 23A, 23B, 23C, 25A, 38A, 38B, 47A, as shown on Figure 3.1.4. Detailed winter wildlife survey results for localized portions of the Study Area can be found in **Appendix C4**.

Table 3.1.9 Winter Wildlife Survey Results

| Common Name | Species Scientific Name | Evidence | Abundance | Survey Areas(s) |
|---------------------------|------------------------------|--|-----------|--|
| Coyote | <i>Canis latrans</i> | Tracks, scat, feeding | 101 | Throughout Study Area along/within hedgerows, and through agricultural fields. 1i, 1J, 2F, 4C, 5C, 7B, 10B, 11D, B13-14, 14A, 14C, 14D, 23A, 23B, 23C, 25A, 25B, 38A, 38B, 47A |
| Canada Goose | <i>Branta canadensis</i> | Tracks, scat, feeding | 21 | In agricultural fields adjacent to 7B |
| Eastern Cottontail | <i>Sylvilagus floridanus</i> | Tacks, scat, feeding, predation by carnivore | 45 | 1i, 10A, 11C, 11D, 13A, 13B, B13-14, 14C, 14D, 23A |
| Red Fox | <i>Vulpes vulpes</i> | Tracks | 1 | 14D |
| Mouse sp. | <i>Mus sp.</i> | Tracks | 2 | 14A, 14D |
| Vole sp. | <i>Microtus sp.</i> | Tracks, burrows, snow tunnels | 3 | 14A |
| Owl | <i>Strigiformes</i> | Evidence of predating small prey, owl pellet | 1 | In agricultural field south of 14C and PSW |
| Raccoon | <i>Procyon lotor</i> | Tracks, scat | 6 | B13-14, 47A |
| Raptor sp. | <i>Accipitridiformes</i> | Evidence of predating (raptor snow angels) | 7 | 5C, 14D, 25A |



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| | | | | |
|--------------------------------|--|---|-----|---|
| Rodent sp. | <i>Rodentia</i> | Tracks, scat, foraging and feeding, burrows | 29 | 1J, 5C, 10A, 10B, B10b, 14D, 23A, 25A, 47A |
| Songbird sp. | <i>Passeriformes</i> | Tracks, feeding | 33 | 4C, 5C, 10A, 10B, B10b, 13A, 14D, 23B |
| Squirrel – Gray and Red | <i>Sciurus carolinensis</i> <i>Sciurus vulgaris</i> | Tracks, scat, feeding and foraging | 110 | 1i, 1J, 2F, 4C, 5C, 10B, 11D, 13A, B13-14, 14A, 14D, 23A, 23B, 25A, 38A, 38B, 47A |
| Weasel sp. | <i>Mustela sp.</i> | Tracks | 6 | 13B, 14D |
| White-tailed Deer | <i>Odocoileus virginianus</i> | Tracks, browse | 6 | 1i, 14A, 14C, 14D, 47A |
| Wild Turkey | <i>Meleagris gallopavo</i> | Tracks | 2 | 14D |
| Unknown Mammal | <i>Unknown mammal</i> | Tracks, scat | 20 | 1i, 1J, 5C, 13A, 14D, 25A, 38A, 47A |

In some areas, the condition of snow cover impacted visibility of tracks due to large snow drifts. Specific observations such as evidence of predation, foraging, and nesting were recorded. The most common evidence of winter wildlife observed during surveys was tracks, followed by scat and evidence of feeding/foraging. Several hedgerows showed evidence of use as wildlife movement areas with either an abundance of observations for a single species or multiple species along the length of the hedgerow. These survey areas included: 1i, 1J, 2F, 4C, 7B, 13A, 13B, 14D, 23A, 38B, 47A.

Coyote tracks were abundant throughout the Study Area, showing movement within and between parcels and linkages. Evidence of squirrels was also common throughout, with their utilization of hedgerows for foraging and movement. Eastern cottontail rabbits were abundant in several areas with evidence of feeding and high concentrations of tracks and scat particularly in survey area 13B indicating possible residency. The surveys show that large mammals like coyotes and deer moved along, within and between natural features, while small mammals stayed within features when moving. As mentioned, fulsome descriptions of all wildlife evidence observed and their location within the Study Area are provided in **Appendix C4**.

All species directly and indirectly observed during the winter wildlife surveys are common to Ontario and Hamilton based on Hamilton Natural Areas Inventory (2014). Overall, these surveys confirmed the presence and general movement patterns of a variety of wildlife within the Study Area during the winter months.

3.1.4.5 Breeding Birds

A total of 71 breeding bird season species were recorded during breeding bird surveys within the Study Area. Eight species were observed foraging or otherwise considered non-breeders only. Evidence of breeding behaviours was observed for 62 species (**Appendix C5**). The most abundant nesting species across all habitat types were mourning dove (*Zenaida macroura*), song sparrow (*Melospiza melodia*), red-winged blackbird (*Agelaius phoeniceus*), American robin (*Turdus americanus*), European starling (*Sturnus vulgaris*), savannah sparrow (*Passerculus sandwichensis*), northern cardinal (*Cardinalis cardinalis*), rawn-headed cowbird (*Molothrus ater*), and horned lark (*Eremophila alpestris*). Agricultural fields and adjacent hedgerows are the dominant habitat within the Study Area, and this is reflected in the species that were most frequently recorded. Thus, the majority of birds observed are tolerant of habitat disturbance-and are frequently found in rural areas (fields, hedgerows, gardens, etc.). Many are both common and widespread species in southern Ontario.

Given the overall size of the Study Area and limited representation and small number and size of the woodlands within the local agricultural landscape, very few forest birds were recorded. For example, low



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numbers of territories of common forest species such as red-bellied woodpecker (*Melanerpes carolinus*) (five territories), eastern wood-pewee (*Contopus virens*) (five territories), and great-crested flycatcher (*Myiarchus crinitus*) (three territories) were observed. Several other forest species were observed in lower quantities including downy woodpecker (*Dryobates pubescens*), black-capped chickadee (*Poecile atricapillus*), and red-eyed vireo (*Vireo olivaceus*) and several forest area-sensitive species discussed in further detail below.

Few wetland specialists bird species (those that are almost exclusively found in wetland habitats) were recorded. Some species recorded in wetlands were either not wetland specialists or were upland species that may have been foraging in the edge of the wetland. Wetland specialists identified include mallard (*Anas platyrhynchos*), Virginia rail (*Rallus limicola*), yellow warbler (*Setophaga petechia*), common yellowthroat (*Geothlypis trichas*), and swamp sparrow (*Melospiza georgiana*).

Surveys conducted by Aquafor Beech in 2017 recorded a total of 33 bird species. These bird species were all recorded during SLR and GeoProcess 2025 surveys as well.

Area-sensitive Species

One to two individuals (except for brown creeper) of six forest area-sensitive species were observed. Area-sensitive species are not necessarily rare but rather require large areas of continuous habitat for breeding and foraging or are more productive in larger habitat. It is typical to observe a few of these species even when the woodlands being studied are small. The birds seen were not concentrated in any one forest area. The six forest area-sensitive species observed were: cooper's hawk (*Accipiter cooperi*), hairy woodpecker (*Dryobates villosus*), least flycatcher (*Empidonax minimus*), white-breasted nuthatch (*Sitta carolinensis*), brown creeper (*Certhia americana*), and American redstart (*Setophaga ruticilla*). Area-sensitive species are based on OMNR (2000).

Two grassland area-sensitive species were observed - bobolink (*Dolichonyx oryzivorus*) and savannah sparrow (*Passerculus sandwichensis*). Bobolink is a SAR and discussed further below. Savannah sparrow, despite being area-sensitive, is common in southern Ontario and often observed in open field habitats including both active and abandoned agricultural fields.

Rare and Species at Risk

Five SAR birds (four breeding) were observed within the Study Area (Figure 3.1.3 and Figure 3.1.5) as described below. These are species that are designated as Special Concern, Threatened or Endangered by the provincial government (O.Reg. 230/08 Government of Ontario, 2025) and are protected under the SARA and the Migratory Birds Convention Act.

Two locally rare (using HCA et al., 2013) were recorded within the Study Area. No provincially ranked rare birds with an SRank of S1 (Critically Imperiled), S2 (Imperiled), or S3 (Vulnerable) were recorded.

Bobolink (Threatened)

Eight male bobolinks were observed in a large hayfield area southwest of Mud Street and First Road East. This area supports habitat for this species which are often found in hayfields and other types of old field and meadow habitat. Sufficiently sized suitable habitat is not present within the remainder of the Study Area.



Eastern Meadowlark (Threatened)

At least one territory of eastern meadowlark was observed in a large hayfield area southwest of Mud Street and First Road East. This area supports habitat for this species which are often found in hayfields and other types of old field and meadow habitat, as well as sparsely vegetated early successional areas. Sufficiently sized suitable habitat is not present within the remainder of the Study Area.

Eastern Wood-Pewee (Special Concern)

One or two territories of the Special Concern eastern wood-pewee were recorded within five woodlands or treed swamps. Despite its status, this species is common in deciduous and mixed forests of many sizes, particularly those that have a closed canopy, throughout southern Ontario.

Barn Swallow (Special Concern)

Approximately 28 individual barn swallows were observed across the Study Area; some of these may have been family groups. Only one confirmed nesting location was found at a building northwest of Highway 56 and Golf Club Road. At least four active nests occurred here (on August 6, 2025). This species is typically found in rural landscapes and usually nests in buildings such as barns and can be seen foraging over adjacent wetlands, meadow and fields.

Targeted nest searches within buildings were not completed for all structures as access for surveying was restricted in some areas. Additional nesting habitat may be present in structures not surveyed where barn swallows could gain access (e.g. barns and other farm structures).

Peregrine Falcon (Special Concern)

One young Peregrine Falcon was observed in the Study Area on June 19, 2024. It may have been foraging over the lands, but no suitable habitat, nor nest of this species is known to be present in the Study Area. The species likely nested on a tall building in the adjacent urban area.

Locally Rare

Single individuals of two locally rare species (HCA et al., 2013) were observed - peregrine falcon, which is discussed above and ruffed grouse (*Bonasa umbellus*). An individual ruffed grouse was observed on June 3, 2025, near a small woodland near Harbinger Drive. Due to the marginal nature of the habitat where this individual was observed, a setting atypical for this species, which is predominantly associated with larger woodlands, the individual likely represents a non-breeding transient.

3.1.4.6 Amphibians

3.1.4.6.1 Amphibian Atlas Results

Fifteen amphibian (one historic record) species were identified in the desktop review for the Study Area that include the following:

- Mudpuppy
- Blue-spotted Salamander
- Jefferson Salamander, END
- Spotted Salamander



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- Eastern Red-backed Salamander
- Red-spotted Newt
- Wood Frog
- American Bullfrog
- Northern Leopard Frog
- Gray Tree Frog
- Green Frog
- Spring Peeper
- Western Chorus Frog
- American Toad

Historic Records

- Pickerel Frog (1938)

3.1.4.6.2 Amphibian Field Surveys

Forty-three survey stations were identified as potential amphibian breeding habitat for the Elfrida SWP Area (Figure 3.1.1). Stations were chosen based on a desktop review of aerial imagery, Land Information Ontario (LIO) data, and previous station locations used in the Elfrida SWS Final Phase 1 Report prepared by Aquafor Beech (2018). Of these 43 stations, 12 stations were in the Twenty Mile Creek watershed, 30 stations were in the Sinkhole Creek watershed, and 1 station was in the Hannon Creek watershed.

Three rounds of amphibian (frog and toad) calling surveys were completed for each station following the Marsh Monitoring Program protocol and nighttime air temperatures above 5°C for the first survey, above 10°C for the second survey, and above 17°C for the third survey.

Surveys were completed in both 2024 and 2025. Due to project initiation timing window constraints, the first round of surveys was missed in 2024. As such, surveys were again undergone in 2025, with all three rounds completed. The combined data from 2024 and 2025 surveys includes one set of data for round one, two sets of data for round two, and two sets of data for round three.

In 2024, amphibians were heard calling at 17 of the 43 survey stations. A total of five species were recorded during the surveys, with green frogs being the most abundant species. In 2025, amphibians were heard calling at 26 of the survey stations. Seventeen stations had no amphibians calling during all three rounds in 2025. A total of six species were recorded during the surveys, none of which are ranked as a SAR, and all are common within the City. Green frogs and spring peepers were the most abundant species followed closely by chorus frogs and American toads. During both the 2024 and 2025 surveys, no amphibians were heard during any of the rounds within 16 of the 43 stations. Table 3.1.8 provides a summary of the species heard throughout the Study Area and their respective stations and federal, provincial, and local status, while Table 3.1.9 summarizes the abundance of identified species between survey years.

Refer to **Appendix C6** for the full results of the combined data from both years of amphibian calling surveys.



Table 3.1.10 Amphibians Recorded During the Calling Surveys

| Common Name | Scientific Name | SRank | SARO | SARA | Hamilton Status | 2025 Survey Station(s)* |
|-----------------------|------------------------------|-------|------|------|-----------------|---|
| American Toad | <i>Anaxyrus americanus</i> | S5 | - | - | Abundant | TMC-3, TMC-5, TMC-6, TMC-7, TMC-11, TMC-12, SC-4, SC-9, SC3, SC7, SC8, SC19, SC20 |
| Western Chorus Frog | <i>Pseudacris triseriata</i> | S4 | NAR | - | Common | TMC-3, TMC-4, TMC-8, TMC-10, SC-1, SC-4, SC-9, SC15, SC16, SC20 |
| Gray Treefrog | <i>Dryophytes versicolor</i> | S5 | - | - | Abundant | TMC-9, TMC-10, TMC-12, SC3, SC7, SC16, SC19, SC20 |
| Green Frog | <i>Lithobates clamitans</i> | S5 | - | - | Abundant | TMC-6, TMC-7, TMC-8, TMC-10, SC-2, SC-2, SC-7, SC-9, SC1, SC3, SC7, SC8, SC10, SC11, SC19, SC20 |
| Northern Leopard Frog | <i>Lithobates pipiens</i> | S5 | NAR | - | Abundant | TMC-3, SC1, SC8, SC10 |
| Spring Peeper | <i>Pseudacris crucifer</i> | S5 | - | - | Abundant | TMC-8, TMC-9, TMC-10, TMC-11, SC1, SC-9, SC6, SC7, SC11, SC12, SC16, SC19, SC20 |

*Only amphibians heard calling within the stations were recorded in this table. Those heard calling from outside the station are not included.

Table 3.1.11 Amphibian Species Abundance Breakdown

| Year | Round | Spring Peeper | Chorus Frog | Green Frog | American Toad | Gray Tree Frog | Northern Leopard Frog |
|------|---------|------------------|-------------|------------------|-----------------|-----------------|-----------------------|
| 2024 | Round 2 | 5 | 0 | 27 + Full chorus | 1 + Full chorus | 6 | 3 |
| | Round 3 | 0 | 0 | 47 | 0 | 1 + Full chorus | 0 |
| 2025 | Round 1 | 15 + Full chorus | 21 | 2 | 3 | 0 | 3 |
| | Round 2 | 11 | 5 | 2 | 19 | 2 | 1 |
| | Round 3 | 1 | 0 | 27 | 0 | 9 | 0 |

*Round 1 in 2024 was not completed due to project timing windows.

During the first round of surveys from April 16-23, 2025, five species were heard across 13 stations: spring peepers, chorus frogs, green frogs, American toads, and northern leopard frogs. Spring peepers were the most abundant species with approximately 15 individuals heard, as well as a full chorus (call code level three) at station TMC-8. This was the only station and the only species in 2025 where a full chorus was heard. Chorus frogs were the second most abundant with approximately 21 individuals heard.

In 2025, the second round of surveys took place from May 12-14, 2025, and six species were heard across 17 stations: spring peepers, chorus frogs, green frogs, gray treefrogs, northern leopard frogs, and American toads. American toads were the most abundant with approximately 19 individuals heard followed by spring peepers with approximately 11 individuals heard.



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In 2024, the second round of surveys took place from May 15-24, 2024, with five species heard: spring peepers, green frogs, gray treefrogs, northern leopard frogs, and American toads. During this round, full choruses of both green frogs and American toads were heard at station TMC-7.

During the third round of surveys on June 12 and 25, 2025, three species were heard: green frogs, gray treefrogs, and spring peepers. Green frogs were the most abundant, with an approximate total of 27 individuals heard at ten stations. One spring peeper and four of the nine gray treefrogs were heard at separate stations. In 2024, the third round of surveys took place from June 18 - July 3, 2024, with two species, green frogs and gray treefrogs, heard. A full chorus of gray treefrogs was heard at station TMC-9.

Stations with the highest number of individuals heard in 2024 include TMC-7, TMC-9, SC1, SC3, SC19, and SC20. In 2025, stations with the highest number of individuals heard include TMC-8, SC6, SC19, and SC20.

In 2025, the station with the highest diversity was station SC20 with five species heard over the three rounds. Stations TMC-10 and SC19 had the second highest diversity with four species heard at each station over the three rounds. In 2024, the stations with the highest diversity were TMC-10 and SC1 with three species heard over the two rounds.

3.1.4.7 Reptiles

Fourteen reptile species were identified in the desktop review for the Study Area. Twelve of the 14 species were recorded in the last 40 years. The species include the following:

Turtles:

- Snapping Turtle, SC
- Midland Painted Turtle
- Northern Map Turtle, SC
- Blanding's Turtle, THR
- Red-eared Slider (Invasive)

Snakes:

- Northern Ribbonsnake
- Dekay's Brownsnake
- Eastern Gartersnake
- Northern Watersnake
- Eastern Milksnake
- Smooth Greensnake
- Northern Ringnecked snake

Historic Records (Greater than 75 years old)

- Red Bellied Snake (1928)
- Gray Ratsnake (1938)



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Three of those species are recorded to be at risk federally and/or provincially, and one species (red-eared slider) is non-native.

Two eastern gartersnakes were observed in two separate locations during field surveys and were recorded as incidental wildlife observations. One was seen in Parcel 59 along the breeding bird transect and the other was seen in Parcel 3 near the fish monitoring station TM02. Eastern gartersnakes are common within Ontario and Hamilton and considered not at risk at a provincial or federal level.

No turtles were observed during any of the field visits. Potential foraging and basking habitat occurs in the pond located in Parcel 47. Potential nesting sites could potentially occur along roadsides in areas that are proximate to aquatic habitat; however, no evidence of nesting was observed.

3.1.4.8 Species at Risk

The results of the SAR screening are shown below in Table 3.1.10 (a thorough assessment of potential SAR can be found in **Appendix C7**). As noted above, the NHIC squares include 1 km by 1 km squares that cover areas extending beyond the Elfrida lands. As such, observations of SAR within these squares do not necessarily represent observations within the boundaries of the Study Area. Special Concern SAR and uncommon species observed during field visits are depicted in Figure 3.1.3 and Threatened and Endangered SAR observed during field visits are depicted in Figure 3.1.5.

Table 3.1.12 Desktop SAR Screening Results

| Species | | Status | | |
|---------------------------------------|-----------------------------------|---------------|------|------|
| Common Name | Scientific Name | S_Rank | SARO | SARA |
| Birds | | | | |
| Bank Swallow ^{4,5} | <i>Riparia riparia</i> | S4B | THR | THR |
| Barn Swallow ^{1,2,4,5} | <i>Hirundo rustica</i> | S4B | SC | THR |
| Bobolink ^{1,2,4,5} | <i>Dolichonyx oryzivorus</i> | S4B | THR | THR |
| Canada Warbler ⁴ | <i>Cardellina canadensis</i> | S5B | SC | THR |
| Chimney Swift ^{2,4,5} | <i>Chaetura pelagica</i> | S3B | THR | THR |
| Common Nighthawk ^{4,5} | <i>Chordeiles minor</i> | S4B | SC | SC |
| Eastern Meadowlark ^{1,4,5} | <i>Sturnella magna</i> | S4B, S3N | THR | THR |
| Eastern Whip-poor-will ⁵ | <i>Antrostomus vociferus</i> | S4B | THR | THR |
| Eastern Wood-pewee ^{1,2,4,5} | <i>Contopus virens</i> | S4B | SC | SC |
| Golden-winged Warbler ⁴ | <i>Vermivora chrysoptera</i> | S3B | SC | THR |
| Grasshopper Sparrow ^{4,5} | <i>Ammodramus savannarum</i> | S4B | SC | - |
| Horned Grebe ⁴ | <i>Podiceps auritus</i> | S1B, S3N, S4M | SC | - |
| Least Bittern ⁵ | <i>Botaurus exilis</i> | S4B | THR | THR |
| Lesser Yellowlegs ⁴ | <i>Tringa flavipes</i> | S3S4B, S5M | THR | - |
| Peregrine Falcon ^{4,5} | <i>Falco peregrinus</i> | S4 | SC | - |
| Red-headed Woodpecker ^{1,5} | <i>Melanerpes erythrocephalus</i> | S3 | END | END |
| Rusty Blackbird ⁴ | <i>Euphagus carolinus</i> | S4B, S3N | SC | SC |
| Short-eared Owl ^{1,5} | <i>Asio flammeus</i> | S4? B, S2S3N | THR | SC |
| Upland Sandpiper ¹ | <i>Bartramia longicauda</i> | S2B | - | - |
| Wood Thrush ^{1,4,5} | <i>Hylocichla mustelina</i> | S4B | SC | THR |
| Amphibians and Reptiles | | | | |
| Blanding's Turtle ⁷ | <i>Emydoidea blandingii</i> | S3 | THR | - |
| Eastern Milksnake ^{1,7} | <i>Lampropeltis triangulum</i> | S4 | NAR | SC |
| Eastern Ribbonsnake ² | <i>Thamnophis saurita</i> | S4 | SC | - |



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| Species | | Status | | |
|--|--|----------|------|------|
| Common Name | Scientific Name | S_Rank | SARO | SARA |
| Ambystoma Hybrid pop.1 ⁷ | Unisexual <i>Ambystoma</i> (Jefferson Salamander dependent population) | S2 | END | END |
| Midland Painted Turtle ^{1,7} | <i>Chrysemys picta marginata</i> | S4 | - | SC |
| Northern Map Turtle ⁷ | <i>Graptemys geographica</i> | S3 | SC | SC |
| Snapping Turtle ^{1,7} | <i>Chelydra serpentina</i> | S4 | SC | SC |
| Insects | | | | |
| Mottled Duskywing ⁶ | <i>Erynnis martialis</i> | S2 | END | - |
| Monarch ^{2,6} | <i>Danaus plexippus</i> | S4B, S2N | SC | END |
| West Virginia White ⁶ | <i>Pieris virginiensis</i> | S3 | SC | - |
| Plants | | | | |
| Butternut ^{1,2} | <i>Juglans cinerea</i> | S2? | END | END |
| Green Dragon ¹ | <i>Arisaema dracontium</i> | S3 | SC | - |
| Spotted Wintergreen ¹ | <i>Chimaphila maculata</i> | S2 | THR | THR |
| Fish and Molluscs | | | | |
| Grass Pickerel ^{1,3} | <i>Esox americanus</i> | S3 | SC | - |
| Round Pigtoe ² | <i>Pleurobema sintoxia</i> | S1 | END | - |
| Threehorn Wartyback ² | <i>Obliquaria reflexa</i> | S1 | THR | THR |

Species in **bold** found in detailed field surveys (or habitat identified)

Sources: ¹NHIC Database, ²iNaturalist, ³DFO Aquatic SAR Map, ⁴eBird Database, ⁵Ontario Breeding Bird Atlas, ⁶Ontario Butterfly Atlas, ⁷Ontario Reptile and Amphibian Atlas

S Rank – Subnational (Provincial) Conservation Status from S1 (Critically Imperilled) to S5(Secure)

SC – Special Concern, THR – Threatened, END – Endangered

The list of species encountered during the field program was referenced with SARO and the federal SARA, to determine any confirmed Endangered, Threatened, Special Concern or SAR species occurring within the Study Area.

The majority of species identified in the screening were not found during more detailed flora and fauna surveys. As noted above, the NHIC squares include 1 km by 1 km squares which overlap the Elfrida lands but also include areas beyond them. Specific habitat for all screened species is not present in the Elfrida lands, and records include rare sighting as well as common ones, therefore they do not represent the typical species use of the Elfrida lands

Using the results from the desktop SAR screening and observations from the field, all species with confirmed presence within or the potential to occur based on available habitat within Study Area are discussed below.

Barn Swallow (*Hirundo rustica*)

The barn swallow is ranked 'S4B' (breeding population apparently secure) in Ontario and is listed as Threatened by SARA and SARO. The barn swallow is a migratory songbird with distinct shiny dark blue feathers on its back and upper wings, and reddish colouring on its forehead, breast, and throat, with colouring more vibrant on males. This species primarily builds its nests on man-made structures, including barns, bridges, and ledges, and as such tends to live in close association with humans. Although a common bird species, the barn swallow population has been in decline in Ontario in recent years. Barn swallows are aerial insectivores, and as such are threatened by practices such as pesticide use, which can diminish insect populations. Additional threats to the species include habitat loss, predation, and loss of access to historic nesting sites.



More than twenty migrating barn swallows were observed in Parcel 9 during a spring vegetation survey on May 31, 2025. Additionally, barn swallows were observed during both round one and round two of breeding bird surveys in several locations within the Study Area. Barn swallows and most were observed foraging. One building contained confirmed barn swallow nests.

Black Ash (*Fraxinus nigra*)

Black ash is ranked 'S4' (apparently secure) in Ontario and was added to the SAR List in Ontario (SARO) on January 26, 2022, where it is listed as Endangered. Since 2018, COSEWIC has listed black ash as Threatened in Canada, citing its vulnerability to the invasive emerald ash borer, which lays eggs in ash trees, ultimately destroying the tree's vascular system when the larvae hatch and feed on the wood of the tree.

Black ash is a medium-sized tree that prefers wet habitats. It can be distinguished from other ash species by its sessile leaflets and bark, which is scaly when mature and corky or bumpy in texture when young.

Black ash was observed in the Red Maple Mineral Deciduous Swamp (SWMD3-1) polygon that can be found in Figure 3.1.2.

Bobolink (*Dolichonyx oryzivorus*)

The bobolink is ranked 'S4B' (breeding population apparently secure) in Ontario and is listed as Threatened under both the federal and provincial SARA. COSEWIC lists the bobolink as Special Concern, which refers to species with characteristics that make them particularly sensitive to human activities or natural events. This species is a medium-sized songbird with sexually dimorphic colouring- female bobolinks are light beige to yellowish in colour year-round, while male bobolinks are mostly black with a white back and yellow collar during the summer breeding season. Threats to the bobolink include agricultural practices in the breeding zones and over-wintering areas in South America, habitat loss and fragmentation.

Several breeding individuals were recorded during breeding bird surveys and the details are provided in **Section 3.1.4.5** of this report. Additionally, this species was observed incidentally during the headwater drainage feature assessment in Parcel 47 on May 16th, 2024.

Eastern Meadowlark (*Sturnella magna*)

The eastern meadowlark is ranked 'S4B, S3N' in Ontario, meaning that the breeding population is apparently secure while the nonbreeding population is considered vulnerable. This species is listed as Threatened under SARO and SARA. A medium-sized songbird with bright yellow colouring on its breast, the eastern meadowlark breeds in fields and grasslands and is threatened by development and habitat fragmentation. Although it is still a common species, the eastern meadowlark population is declining in Ontario.

An eastern meadowlark was observed incidentally during a headwater drainage feature assessment in Parcel 47 on May 16, 2024, as well as in Parcel 4 during a spring vegetation survey on May 31, 2024. Three recently fledged young eastern meadowlarks were also observed in hedgerow 51 during round two of breeding bird surveys. These observations are in the area indicated on Figure 3.1.5.



Eastern Wood-pewee (*Contopus virens*)

This species is ranked 'S4B' (breeding population apparently secure) in Ontario and is listed as Special Concern under SARO and SARA. The eastern wood-pewee is a small, grayish-brown flycatcher that inhabits forests and woodlands, with a preference for woodland edges and forest clearings. Threats to this species include habitat loss and fragmentation, declining insect populations, and predation.

Eastern wood-pewees were observed within the Study Area during both round one and round two of breeding bird surveys in five woodlands and one hedgerow. These observations are identified on Figure 3.1.5.

Monarch (*Danaus plexippus*)

The monarch is ranked 'S4B, S2N' in Ontario, meaning that the breeding population is apparently secure while the nonbreeding population is imperiled within the province. This species is listed as Special Concern under SARO and Endangered under SARA. The monarch is a large butterfly with orange and black wings in their adult form. Monarch caterpillars can be distinguished by their black, white, and yellow striping, and will only feed on milkweed species (*Asclepias spp.*).

The Ontario SAR Evaluation Report for Monarch (COSSARO, 2020) identified habitat degradation and pollution as the most significant risk to monarchs in Ontario. Specifically, they note that increased use of herbicides and conversion of agricultural lands to more intensive cropping are the most significant risk. They further note that low-risk threats include residential and commercial development on the presence of milkweed and road mortality.

A monarch was observed in Parcel 4 during a spring vegetation survey conducted on May 31, 2024.

Peregrine Falcon (*Falco peregrinus*)

The peregrine falcon is ranked 'S4' (apparently secure) in Ontario and is listed as Special Concern under SARO. A large bird of prey, this species can be recognized by its grey to blue-grey back and wings and its white, buffy underside. Adult peregrine falcons have a distinctive black-capped head resembling a helmet and a darkened malar stripe resembling a moustache, which extends from the base of the beak down the side of the face.

A recently fledged young peregrine falcon was observed during round two of breeding bird surveys in hedgerow 23 on June 19, 2024.

Species with a potential to occur within the Study Area:

Butternut (*Juglans cinerea*)

The butternut is listed as 'S2?' (imperiled) in Ontario and is considered Endangered under both the SARO and federal SARA. Butternut can be found in the sunny clearings and edges of deciduous forests, and prefers moist, well-draining soils. It can also be found along streams and in floodplains. This species is shade intolerant and readily hybridizes with several exotic *Juglans* species, including the Japanese walnut (*Juglans ailantifolia*) and the Persian walnut (*Juglans regia*).

Once a widespread canopy tree species in southern Ontario, the butternut has been in decline since the introduction of the non-native butternut canker (*Sirococcus clavigignenti-juglandacearum*) to Ontario in the 1990s. Most butternut trees in Ontario are infected with this fungus, with surviving trees few and far



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between. Trees that persist despite infection are potential sources for genetic disease resistance or tolerance and are crucial for the recovery of the population.

A hybrid species with a butternut parent was recorded in hedgerow 10A on October 4th, 2023, during hedgerow assessment surveys. The presence of a hybrid species within the Study Area implies that butternut is likely present nearby, if not within the Study Area itself.

Eastern Milksnake (*Lampropeltis triangulum triangulum*)

The eastern milksnake is ranked 'S4' (apparently secure) in Ontario and is listed as Special Concern by COSEWIC and under SARA. This species is a long, slender non-venomous snake with distinct patterning of alternating red or brown blotches outlined in black.

The eastern milksnake has a variety of suitable habitat types, including fields, swamps, open woodlots, and even rural pastures and hayfields. In the winter, the eastern milksnake hibernates in communal dens underground. This species is still widespread throughout Ontario and Quebec, however its distribution covers some of the most highly populated and agricultural areas in the country, subjecting the eastern milksnake to the effects of human encroachment. These effects include high levels of road mortality and habitat loss and fragmentation, including loss of winter habitat. Persecution by humans is another significant threat.

During the desktop SAR Screening conducted on September 4, 2025, this species was found to have potential to occur within the Study Area. Potential snake habitat exists in various parcels throughout the Study Area, including old fill, abandoned houses and outbuildings, and rubble in hedgerows. No individuals were observed.

Grass Pickerel (*Esox americanus vermiculatus*)

Grass pickerel is ranked 'S3' (vulnerable) in Ontario and is listed as Special Concern under SARA. A smaller subspecies of the redbfin pickerel, the grass pickerel is the smallest member of the Pike family (*Esocidae*) in Ontario. Like other members of the Pike family, this species is known for its distinct, long, cylindrical body and forked tail. Grass pickerel is found in wetlands, ponds, and warm, slow-moving streams with clear water and extensive aquatic vegetation.

The greatest threat to this species is habitat loss and alteration. Grass pickerel are sensitive to changes in water level, transparency, and temperature, as well as loss of aquatic vegetation. Development, agricultural activities, or any other anthropogenic activity that can impact grass pickerel habitat poses a threat to the survival of this species.

Grass pickerel are found in the Twenty Mile Creek watershed downstream of the Study Area and are on record as being present in streams less than a kilometre beyond the Study Area boundary.

Midland Painted Turtle (*Chrysemys picta marginata*)

The midland painted turtle is ranked 'S4' (apparently secure) in Ontario and is listed as Special Concern under SARA as well as by COSEWIC. This species is a small to medium-sized freshwater turtle with a smooth, dark olive to black carapace. Yellow to red markings can be found on the outer edges of the carapace, as well as along their extremities. The plastron of this species ranges from brilliant yellow to cream in colour.



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One of the largest threats to this species includes habitat loss and fragmentation. Midland painted turtles spend most of their life in water and wetlands, and the extreme reduction in wetlands in southern Ontario especially has impacted the species. Road mortality, particularly of mature females, is devastating to most turtle species in Ontario due to their slow maturation rates and high mortality rates.

During the desktop SAR Screening conducted on September 4, 2025, this species was found to have potential to occur within the Elfrida SWP boundary. Potential foraging and basking habitat for turtle species occurs in the pond located in Parcel 47.

Short-eared Owl (*Asio flammeus*)

The short-eared owl is ranked 'S4? B, S2S3N' in Ontario, meaning that the breeding population is apparently secure while the nonbreeding population is ranked between imperiled and vulnerable. This species is listed as Threatened under SARO and listed as Special Concern under SARA. The short-eared owl is medium-sized owl with mottled brown feathers and small feather tufts on its head which can sometimes resemble ears. Short-eared owls also have large, round faces and distinct yellow eyes. The preferred habitat for this species is open areas, including grasslands and marshes, where it can hunt for small mammals like voles, mice, and shrews. Threats to the species include habitat loss and alteration, loss of nesting and winter habitat, and second-hand consumption of toxins used for rodent control.

A short-eared owl was observed beyond the border of Parcel 42 on April 17, 2025, during round 1 of amphibian surveys but is considered non-breeding as there is no adjacent suitable breeding habitat.

Snapping Turtle (*Chelydra serpentina*)

The snapping turtle is listed as Special Concern under SARO and COSEWIC, as well as under the SARA. It is ranked 'S4' (apparently secure) in Ontario and is still present throughout much of Central and Southern Ontario. These animals spend most of their time in water, and travel overland most often during nesting season, often using gravelly roadsides for nest sites.

This species is threatened by a combination of factors, including its slow maturity rate and road mortality. Predation, particularly of eggs, and habitat fragmentation are also large threats to the survival of the snapping turtle. Snapping turtles are present in the Twenty Mile Creek subwatershed, making their presence within the Study Area a possibility. Potential foraging and basking habitat for turtle species occurs in the pond located in Parcel 47.

3.1.4.9 Woodland Assessments

Fourteen, tree-dominated communities (cultural woodlands, forests, and deciduous swamp inclusions) were documented throughout the Study Area. UHOP Significant Woodland criteria were applied to these communities to determine the significance levels, as development policies vary between Significant Woodlands and Other Woodlands. Following the analysis, nine of the woodlands were deemed significant, while the remaining five were deemed Other Woodlands. Significant Woodlands included the following communities: FOD9(1), FOD9(2), FOD4-1(1), FOD4-1(2), FOD4-1(3), FOD9-4(1), FOD5-1(1) and FOD5-1(2) with SWD4-2(1) inclusion, FOD5-2, and FOD5-3. Other Woodlands included the following communities: CUW1(5), FOD9(4), CUW1(3), CUW (1), and CUW1(2) (see Figure 3.1.2. and Appendix C2 for community locations). It is important to note that some of the non-wetland, tree-dominated communities were on non-participating lands. As such, assessments were completed based on roadside surveys, surveys from adjacent properties, and aerial photography interpretation. These



communities will need to be field verified when lands are accessible, which may impact developability. The full assessment of these communities can be found in **Appendix C8**.

3.1.4.10 Landscape Connectivity

Landscape connectivity is a concept that considers the degree of connectedness of natural features and habitats when a landscape has been subject to some degree of human development. These connections (i.e., linkages) can be aquatic in nature, such as watercourses or headwater drainage features, or land based, such as hedgerows or tableland woodlots. These linkages, and the connectiveness they provide, are especially relevant to southern Ontario, south of the Canadian Shield, where most land has been altered through agricultural practices or the construction of manmade structures (including roads).

A highly connected landscape is one where there is generally a higher percentage of natural cover (i.e., woodlands, wetlands) to start, and there are many large natural corridors that link the natural areas together. These landscapes enable higher biodiversity and higher genetic diversity due to increased species mobility. On the contrary, landscapes with low connectivity result in lower biodiversity and lower genetic diversity due to the isolation of natural features.

While some wildlife, like northern raccoon and striped skunk, can readily cross landscape connectivity barriers (e.g., agricultural fields, roadways, etc.), there are many species that cannot or find it very difficult to do so (e.g., herptiles, insects, etc.). It is worth noting that the science of landscape connectivity is somewhat imprecise, and it is not always clear as to which species within a landscape use or require linkage corridors, and under which circumstances. Consequently, it is important to assess the ecological function of existing linkages within a landscape and to promote increased connectivity through the enhancements of existing linkages or the creation of new linkages, where possible.

Within the RHOP (Schedule B), Core Natural Heritage Features have been identified. Within the Study Area and the surrounding lands, these features are interspersed throughout a highly agricultural landscape. A large linkage corridor, running east-west, has also identified within this Schedule. Through field investigations, these Core Natural Heritage Features and linkage corridor were investigated, where possible, as were features that could provide potential landscape connectivity. The Core Natural Heritage Feature boundaries were preliminarily delineated in the field to reflect current conditions, and the identified linkage corridor was determined to largely align with an existing hydro corridor. Aquatic and terrestrial features (i.e., drainage features and hedgerows) that could provide potential linkage functions were also identified and studied. A formal evaluation of these potential linkages and opportunities for new linkage corridors within the Study Area will be discussed in Phase 2 of the SWP, to assist in the future land use planning portion of the process.

3.1.4.11 Valleylands

The designation of Significant Valleylands is usually undertaken by the planning authority and/or the relevant Conservation Authority (in this case HCA and NPCA). Criteria recommended by the Province for Significant Valleyland designation include prominence as a distinctive landform, extent of naturalness, importance of its ecological functions, restoration potential, and historical and cultural values.

The City provides the following definitions in their UHOP:



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- **Valleylands:** Means a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year
- **Significant Valleyland:** Means a natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year which is ecologically important in terms of features, functions, representation or amount and contributing to the quality and diversity of an identifiable geographic area or natural heritage system

No Valley Lands or Significant Valleylands are found in the Study Area. All aquatic systems within the Study Area are generally situated within unconfined corridors.

3.1.5 Conclusions and Recommendations

The terrestrial natural heritage assessment characterized existing terrestrial conditions, evaluated the significance of existing natural heritage features, and identified species, communities, and habitats of conservation concern. To support this assessment, field investigations of breeding birds, breeding amphibians, winter wildlife, vegetation, wetlands, and notetaking of incidental wildlife observations were undertaken to properly characterize the existing terrestrial natural heritage features within the Elfrida SWP Area. Existing habitat was assessed under SWH criteria and potential for additional SAR that were not observed during field investigation was assessed. Terrestrial natural heritage features were mapped and delineated, giving context to what features would provide constraints to any future development.

Field investigation and analysis characterized the terrestrial and wetland systems within Stoney Creek subwatershed, Twenty Mile Creek subwatershed, and Sinkhole Creek subwatershed as diverse but anthropogenically influenced communities, with a wide variety of species, both native and introduced, observed within the Study Area. A total of 322 vascular plants, 71 breeding bird species, 11 mammals, six amphibian species and one reptile species were recorded within the Study Area. ELC results showed that the Study Area contained 64 distinct vegetation communities consisting of 23 unique community types alongside anthropogenic communities such as agricultural lands, residential lands, and hedgerows. Three wetland communities were recommended for future OWES evaluation, indicating their potential to be considered provincially significant.



3.2 Fluvial Geomorphology

3.2.1 Objective

The objective of the fluvial geomorphology assessment was to characterize existing geomorphic conditions within and immediately downstream of the Study Area based on a combination of desktop and field assessments. This characterization addresses the Stream Morphology and Channel Erosion sections of the ToR, which include:

- Background review of existing documents related to the Study Area, including topography, physiography, and geology maps of the Study Area
- Reach delineation for all watercourses in the Study Area
- Site reconnaissance and characterization for watercourse and protection-level HDF reaches identified on participating lands
- Characterization of erosion processes
- Hazard delineation and erosion setbacks for all confined and unconfined reaches in the Study Area
- Detailed geomorphic assessments to inform erosion threshold analysis (completed as part of the Phase 2 SWP)
- Erosion threshold and exceedance analysis to inform erosion control design targets for any proposed SWM facilities in the Study Area (completed as part of the Phase 2 SWP)

3.2.2 Background

The morphology of unaltered watercourses is governed by the combination of flow regime (hydrology and climate), the characteristics and mobility of sediment within the watershed (surficial geology), and the channel slope and confinement (topography). Vegetation and land use also influence channel morphology. Over long-time scales, watercourses tend towards semi-stable (“quasi-equilibrium”) conditions governed by these forcing factors. Quasi-equilibrium may be disrupted by changes in the forcing factors (e.g., climate change or land use change), as well as by direct anthropogenic modification of the channel.

The Study Area is located within the Haldimand Clay Plain physiographic region (Chapman and Putnam 1984). Surficial geology comprises glaciolacustrine clay and silt, with localized exposures of Halton Till in the upper headwaters of the Stoney Creek and Sinkhole Creek subwatersheds. Materials comprising the watercourse bed and banks within the Study Area reflect local surficial geology, generally consisting of silt and clay.

3.2.3 Subcatchment Characterization

The Study Area is composed of six subwatersheds: Hannon Creek, East Twenty Mile Creek, West Twenty Mile Creek, Sinkhole Creek, Upper Davis Creek and Stoney Creek. Within the Study Area, the Hannon Creek subwatershed does not contain mapped watercourses; only HDFs are present. The Upper Davis Creek subwatershed contains neither HDFs nor watercourses, while the remaining subwatersheds include both HDFs and watercourses.



Land use within the Study Area is predominantly agricultural. As a result, watercourses have been heavily modified (e.g., channelized, realigned) to facilitate drainage, irrigation and optimize opportunities for cultivation. These modifications have resulted in a less natural form that is largely governed by anthropogenic activity. Active farming frequently extends to the edge of each watercourse, limiting the presence of riparian vegetation that otherwise enhances channel morphology and stability. The watercourses are particularly sensitive to changes in subcatchment area or land use, a result of relatively minor catchment areas either primarily or entirely contained within the Study Area.

3.2.4 Reach Delineation and Desktop Characterization

A watercourse may transition between different morphologies due to changes in geology, slope, valley type, sediment sources, anthropogenic influences, and/or discharge. As such, it is common to subdivide a watercourse into reaches that are generally homogenous in relation to these characteristics. Reaches function as management units that are expected to respond to changes in forcing factors in a manner distinct from adjacent reaches. Reaches within the Study Area were delineated based on changes in the following:

- Channel planform and morphology
- In-channel and riparian vegetation
- Flow, due to tributary inputs
- Anthropogenic modifications

Reaches were delineated for all drainage features in the Study Area based on the above-noted criteria and a desktop review of available data such as aerial imagery, LiDAR data, geologic/physiographic information and previous studies and reports. Reach breaks were subsequently verified in the field for participating lands. Reaches located within non-participant lands may require field confirmation through future planning studies to confirm desktop-level findings presented in this report.

The reach naming convention references the prefixes “TMC”, “SC”, “SIC”, indicating “Twenty Mile Creek”, “Stoney Creek” and “Sinkhole Creek” subwatersheds, respectively, with numbering progressing from downstream to upstream. A reach map is illustrated on Figure 3.2.1, with more detailed mapping provided in **Appendix D1**. All references to channel “left” and “right” banks assume that the viewer is looking downstream.

3.2.5 Channel Characterization from Field Observations

3.2.5.1 Geomorphic Characterization

As previously discussed, the Study Area is dominated by HDFs that were generally characterized as shallow swales, commonly actively farmed. HDFs were first differentiated from watercourses based on available mapping and subsequently verified in the field as part of the HDF assessment. Drainage features on non-participating parcels were classified as watercourses. These classifications should be reviewed and refined as field observations become available.

Field reconnaissance to characterize existing fluvial geomorphic conditions on a reach basis for participating lands within the Study Area was conducted over multiple site visits. SLR staff visited the Sinkhole Creek subwatershed on September 26, 2023, October 5, 2023, August 24, 2023, May 16, 2024, March 19, 2025, May 9, 2025, and July 30, 2025; additional incidental observations were also



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made along watercourse reaches during HDF field work. GeoProcess staff visited the Twenty Mile Creek subwatershed on October 16, 2023, and the Stoney Creek subwatershed on October 17, 2023, with additional incidental observations made during the HDF field work. Given the poorly defined nature of watercourses within the Study Area, standardized rapid assessment protocols, such as the Ontario Ministry of the Environment (2003) Rapid Geomorphic Assessment (RGA) protocol, were not applied. The RGA protocol was developed to assess well-defined, permanent watercourses in urbanized watersheds and was deemed inappropriate for the poorly defined, low-order watercourses present within the Study Area. Instead, field investigations served to verify reach boundaries and document general characteristics.

Data collection included representative bankfull channel dimensions (where applicable), observed floodplain characteristics, riparian vegetation conditions, and bed and bank composition. Evidence of anthropogenic modifications, including excavation/maintenance activities and any infrastructure, was also documented. Selective measurements of bed and bank shear strength were collected using a Torvane and a penetrometer to better understand the resistance characteristics of observed channel boundary materials. Georeferenced photographs were collected to document representative channel characteristics.

Existing conditions are described on a subwatershed basis below. Table 3.2.1 provides a summary of general watercourse reach characteristics. A photographic record of existing conditions at the time of assessment is included in **Appendix D2**.

- **Hannon Creek:** The upstream reaches of the Upper Hannon Creek subwatershed, which are the only portions of Upper Hannon Creek located within the Study Area, are classified as low-constraint HDFs. These reaches are characterized by their ephemeral nature and generally have moderate channel definition, with instances of localized erosion observed near the northwest corner of the Study Area. The surrounding land use is predominantly agricultural, resulting in a substrate of fine material and topsoil, with some gravels and cobbles noted along the channel bed, and a riparian zone that was commonly devoid of vegetation or heavily modified by agricultural activity.
- **West Twenty Mile Creek:** The West Twenty Mile Creek subwatershed contains two main tributaries: 1-TMC1 and 1-TMC2. At the time of assessment, 1-TMC2 appeared to have been recently excavated, leaving exposed soil along the disturbed bed and banks. Reaches 1-TMC1a and 1-TMC1b were characterized as low-gradient, low-energy channelized ditches. Reach 1-TMC1d was characterized as a low-gradient agricultural swale with considerable in-channel vegetation. Reach 1-TMC1c was similar to 1-TMC1d but was narrower and lacked in-channel vegetation. Approximately mid-reach, a tile drain failure had resulted in localized ground subsidence. Surface water from the watercourse was being captured by the depression, creating a diversion into the subsurface, failed tile drain system. Downstream of the tile drain, Reach 1-TMC1c was dry during the field visit (October 16, 2023). Most HDFs within the watershed were poorly defined and lacked distinct banks, except for sections that passed through forested areas (e.g., hedgerows) between agricultural fields. Due to their location within cultivated lands, most HDFs had little to no in-channel or riparian vegetation; evidence of tilling through the feature itself was also observed. The dominant substrate observed was clay and silt, with localized presence of gravel.
- **East Twenty Mile Creek:** East Twenty Mile Creek subwatershed contains one main tributary, 4-TMC1a. At the time of assessment on October 16, 2023, Reach 4-TMC1a was characterized



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as a low-gradient, low-energy channelized ditch. Vegetation encroachment within the channel was dense and consisted predominantly of emergent plant species. Both the bed and bank materials consisted primarily of clay and silt. Channel banks were generally steep, with minor evidence of localized erosion observed. Flow was absent during the site visit. Multiple culvert crossings provide connections between Golf Club Road and adjacent private residences. The HDFs within this subwatershed were predominantly poorly defined with no distinct banks. Reflecting the agricultural land use, many features had little to no in-channel or riparian vegetation. Evidence of anthropogenic modification included tire tracks and plow marks within and adjacent to HDFs. The dominant substrate was a mixture of clays and gravel.

Sinkhole Creek: The headwaters of the Sinkhole Creek subwatershed are almost entirely within the Study Area. Most features within this subwatershed were classified as HDFs, with a watercourse identified east of Hwy 56. Nearly all flow within the Sinkhole Creek subwatershed drains to the east and southeast to Reach 1-SIC1, which exits the Study Area through a concrete box culvert located approximately 1 km northeast of the Hendershot Road and Golf Club Road intersection. Several HDFs in the northeast portion of the subwatershed exit the Study Area independently of Reach 1-SIC1, presumably via culverts below Hendershot Road. Both watercourse and HDF reaches commonly exhibited poor channel definition, with the exception of the furthest downstream Reaches 1-SIC1 and 1-SIC2. These reaches exhibited localized sections of defined channel, which were intermittently observable among dense emergent aquatic vegetation. Cover within the remainder of the poorly defined watercourse and HDF reaches consisted of a mix of dense emergent aquatic vegetation and sparse, grassy riparian vegetation. Substrate was primarily clay and silt. Siltation, likely caused by agricultural runoff, contributed to the lack of channel definition. Evidence of anthropogenic modification included tire tracks alongside and through several features, stockpiled substrate adjacent to recently dredged features, and multiple dilapidated crossings. Reaches that could not be accessed due to non-participating landowners were characterized using observations gathered along property boundaries and public right-of-way (i.e., roadways and utility corridors), from surrounding reaches that were accessible, and desktop assessments.

- **Stoney Creek:** Stoney Creek subwatershed contains two main tributaries: 3-SC1/5-SC and 3-SC2. The assessed reaches included 3-SC1c, 3-SC1b, and 3-SC2; 3-SC1a could not be accessed due to a lack of landowner participation, nor could many of the reaches upstream of and including 5-SC1. Reach 3-SC1 was identified as a watercourse based on observations made from accessible lands, but it was not possible to adequately characterize Reach 5-SC1 based on field observations. For this reason, Reach 5-SC1 was excluded from the geomorphic assessment and the HDF assessment, as were the inaccessible reaches further upstream.

Based on observations that could be documented from accessible lands, the reaches were characterized as low-gradient, low-energy, channelized ditches. Dense in-channel vegetation (dominated by emergent species) was observed along the upstream portion of Reach 3-SC1c (west of First Road East); the downstream section (east of First Road East) was less densely vegetated. 3-SC1b was heavily vegetated, with localized tree cover. 3-SC2 was heavily vegetated throughout its length. The bed and bank materials along all of the reaches consisted primarily of clay and silt; 3-SC1c contained trace components of gravel, likely sourced from the adjacent roadway, while 3-SC1b included zones of organic material along the bed.

In general, channel banks were characterized as stable along each of the reaches, with minor areas of localized erosion observed within Reach 3-SC1b. Bank profiles were generally steep



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within 3-SC1c and 3-SC2, whereas those along 3-SC1b were gentler. Flow was present in all assessed reaches on October 17, 2023, although water levels were low. Multiple culvert crossings were noted along 3-SC1c, providing connections between Mud Street and private residences. HDFs in this subwatershed had been tilled recently and exhibited varying degrees of channel definition. Riparian vegetation was limited, as crops generally extended to the features. The dominant substrate was silt, with secondary components of clay and gravel. These HDFs were subject to anthropogenic modification due to the agricultural setting.

To characterize existing geomorphic conditions along sections of watercourse downstream of the Study Area, “windshield surveys” were conducted within the rights-of-way of major road crossings. General channel conditions were documented with notes and representative photos. Previous studies and publicly available satellite imagery accessed via Google Earth were also reviewed. The downstream reaches were generally characterized as low-gradient, low-energy systems similar to the conditions within the Study Area. Road crossings commonly resulted in localized backwater conditions, with only minor instances of localized erosion observed. Anthropogenic modifications for agricultural purposes were also common throughout downstream reaches, with backwater impoundments and straightened channels frequently observed in satellite imagery.

Table 3.2.1 General Watercourse Reach Characteristics

| Reach | Typical Bankfull Dimensions | | Typical Wetted Dimensions | | Substrate | | Riparian Vegetation* | Notes* |
|--------------------------|-----------------------------|-------------|----------------------------|----------------------------|---------------------|-------------------------------|---|--|
| | Width (m) | Depth (m) | Width (m) | Depth (m) | Bed | Bank | | |
| Twenty Mile Creek | | | | | | | | |
| October 16, 2023 | | | | | | | | |
| 1-TMC2 | 3.6 | 0.63 | 1.9 | 0.19 | Clay, with organics | Clay, till/clay in excavation | Shrubs and trees along east bank. In-channel vegetation d/s of excavation. | U/s portion of reach has been excavated. Unstable banks are susceptible to erosion. |
| 1-TMC1b | 4.8 | 0.8 | 2.3 | 0.32 | Clay, with organics | Clay | Shrubs on both banks. Trees along north bank. Heavy emergent in-channel vegetation. | Denser in-channel vegetation near u/s limit. |
| 1-TMC1a | 4.8 | 0.15 | 1.55 | 0.11 | Clay, with organics | Clay, some sand from road | Grasses and reeds/sedges along both banks. Emergents and algae in channel. | N/A |
| 1-TMC1d | 1.8-2.7 | 0.15 - 0.72 | 0.8 – 1.4 | 0.07 – 0.18 | Silt | Clay | Grasses along both banks. Emergents and algae in channel. | Minor bank erosion noted. |
| 1-TMC1c | 1.2-1.4 | 0.15-0.50 | U/S: 0.37-0.65 D/S: Dry | U/S: 0.03-0.08 D/S: Dry | Clay | Clay and silt | Grasses/sedges in upstream channel. Limited vegetation in downstream channel. | Mid-reach, a broken tile drain captures flow to subsurface. Channel was dry downstream of broken tile drain. |
| 4-TMC1a | 4.6 | 0.7 | Dry | Dry | Clay and silt | Clay and silt | Grasses along banks. In-channel | ~0.4m of accumulated |



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| Reach | Typical Bankfull Dimensions | | Typical Wetted Dimensions | | Substrate | | Riparian Vegetation* | Notes* |
|-------------------------|-----------------------------|-----------|---------------------------|-----------|---------------------------------------|---------------------------------------|---|---|
| | Width (m) | Depth (m) | Width (m) | Depth (m) | Bed | Bank | | |
| | | | | | | | emergent vegetation. | sediment/cattails u/s of d/s culvert caused by in-channel metal debris. |
| Stoney Creek | | | | | | | | |
| October 17, 2023 | | | | | | | | |
| 3-SC1c | 2.95-4.4 | 0.6-1.05 | 0.9-1.95 | 0.1-0.12 | Clay and silt, trace gravel from road | Clay and silt, trace gravel from road | Grasses on south bank. Submerged, floating, and thick emergent in-channel vegetation. | No bankfull indicators. Ditch geometry was referenced for representative dimensions. |
| 3-SC1b | 5.0 | 0.37 | 3.3 | 0.11 | Clay and silt. Some organics | Clay and silt | Grasses along banks at u/s end. Scattered trees at d/s end. Heavy emergent vegetation at u/s end. | Sediment deposition on lateral bar (left bank) near d/s end. |
| 3-SC2 | 3.3- 4.6 | 0.31-0.51 | 1.5- 3.0 | 0.06-0.15 | Clay and silt | Clay and silt | Reeds/sedges along both banks. In-channel emergent vegetation. | N/A |
| Sinkhole Creek | | | | | | | | |
| March 19, 2025 | | | | | | | | |
| 1-SIC2 ¹ | 1.3-4.5 | N/A | 3-5 | 1.5 | Silt clay mud | | Grassy and herbaceous, trees, and cropped fields. | Several wider sections with pooled water at sharp bends; wetted dimensions were estimated from property boundary during spring conditions and bankfull widths were measured from imagery. |
| October 5, 2023 | | | | | | | | |
| 1-SIC1 | 1.4-5.5 | 0.2-0.8 | 0.3-3.5 | 0.07-0.4 | Silt clay mud, organic matter | | Varied between grassy and herbaceous meadow, trees, and cropped fields. | Turbid standing water; dense in-channel vegetation. |
| 1-SIC3 ¹ | Channel not discernable | | ~2 | N/A | Silt clay mud | | Grassy and herbaceous. | Turbid standing water. |
| 1-SIC4 | 3.6-4.8 | 0.2 | Dry | Dry | Silt clay mud | | Agricultural field, variable buffer with short grassy vegetation. | Poor channel definition, flow path identified by bare, dry cracked mud. |

1. No access, characterization completed from edge of adjacent property

*u/s = upstream / d/s = downstream



3.2.5.2 Erosion Characterization

Field investigation results generally classified the watercourse reaches as low-gradient, low-energy systems with minimal erosion. Similarly, assessed HDFs generally consisted of shallow swales with minimal erosion that were commonly actively farmed. Although erosion was observed at hedgerows in response to changes in riparian vegetation, these areas of minor erosion were not considered to be representative of reach-scale conditions. Furthermore, the isolated erosion does not currently pose a risk to infrastructure or property and was not deemed sufficient to warrant ongoing monitoring or specific mitigation measures.

Field observations documented along Reach 1-TMC2 and Reach 1-SIC6 identified recent excavation activities, with exposed soil along the channel bed and banks that would be susceptible to erosion (Table 3.2.2 and Figure 3.2.1).

Broadly, drainage features within the Study Area may be sensitive to changes in flow regime due to the lack of a defined channel cross-section and exposed bed material consisting of seasonally cultivated soil (e.g., Reach 1-SIC4). In a post-development condition, as land use transitions from active agricultural cultivation to urban residential development, changes in surface drainage patterns and flow conditions may result in lateral and vertical erosion. Subsequent planning phases should consider opportunities to restore riparian vegetation along retained reaches to enhance the form and function of these features, while also helping to moderate rates of erosion. Further discussion of riparian restoration opportunities is provided in the Phase 2 SWP.

Table 3.2.2 Inventory of Active Erosion Sites

| ID Code | Reach | Priority | Issues and Concerns |
|---------|--------|----------------------------------|---|
| BE1 | 1-TMC2 | Low – no adjacent infrastructure | Channel banks had been excavated without erosion/sediment control. Likelihood of bank erosion is high in the medium term until disturbed areas are stabilized by vegetation growth. |
| BE2 | 1-SIC6 | Low – no adjacent infrastructure | Drainage feature had been excavated, and unconsolidated substrate was piled adjacent to flow path. Remobilization of piled material and bank erosion is possible in these areas. |

3.2.5.3 Detailed Assessments of Sensitive Reaches

At the time of this Phase 1 report, preliminary SWM facility locations had not been identified within the Study Area. Therefore, the selection of detailed geomorphic field site locations was based on accessibility, erosion sensitivity (stability) and locations that are likely to receive drainage from future SWM facilities. Additional selection criteria included:

- Reaches that had been recently modified
- Reaches with localized instances of exposed channel bank materials
- Reaches where localized erosion was observed
- Reaches displaying sections of defined channels that are more suitable for stormwater erosion control exceedance analyses

Based on the above-noted criteria, a total of nine sites have been selected for detailed geomorphic assessment within the Study Area, as shown in Figure 3.2.1. One additional detailed geomorphic



assessment site was selected on Hannon Creek, downstream of the Study Area. The Hannon Creek site – situated within Mount Albion Conservation Area – is located on Reach HC2, a medium-constraint reach identified in the Upper Hannon Creek Master Drainage Plan Municipal Class EA (AECOM 2017).

The detailed assessments, which are described in the Phase 2 SWP, involve the following activities:

- Detailed geomorphic survey of channel centreline (longitudinal profile) and representative cross-sections. Cross-sections capture bankfull dimensions, wetted width/depth and key inflection points.
- Qualitative characterization of riparian conditions, and bed and bank composition at each cross-section.
- Modified Wolman's (1954) pebble count at cross-sections with coarse-grained substrate (i.e., gravel or larger size class).

The purpose of the detailed assessments is to determine erosion thresholds and inform a stormwater erosion control exceedance analysis, as described in the Phase 2 SWP.

3.2.6 Erosion Hazards

Erosion hazard limits define areas that are subject to lateral erosion, typically within a 100-year planning horizon. Erosion hazards may be due to a combination of fluvial and hillslope erosional processes. Delineation of erosion hazards is an important component of a SWP, as it is used to inform constraint limits for future development. Erosion hazards are delineated on a reach scale based on a review of existing and historical conditions and consideration of valley form.

3.2.6.1 Confined and Unconfined Hazard Delineation

Section 5.2 of the PPS (MMAH, 2024), issued under the Planning Act (1990), outlines areas of provincial interest with respect to natural hazards (i.e., flooding, erosion, unstable soils). The MNR Technical Guide - Rivers and Streams: Erosion Hazard Limit was prepared to outline standardized procedures for the delineation and management of erosion hazards in the Province of Ontario (MNR, 2002). The guide differentiates the applicability of riverine erosion hazard protocols based on two generalized landform systems: confined and unconfined systems. The erosion hazard limit associated with unconfined systems consists of the meander belt plus an erosion access allowance. For confined systems, the erosion hazard limit is governed by geotechnical considerations, including the stable slope allowance and an applicable toe erosion allowance (i.e., channel migration component), as well as an erosion access allowance.

Within the Study Area, all watercourse reaches have been classified as unconfined. Therefore, the erosion hazard limit is based on the meander belt, as described in **Section 3.2.6.2**.

3.2.6.2 Unconfined Systems: Meander Belt

The meander belt is generally defined as the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. Following the Toronto and Region Conservation Authority (TRCA) (2004) Belt Width Delineation Procedures document, the meander belt was delineated for mapped watercourse reaches and protection-level HDF reaches within the Study Area. Drainage features on non-participating parcels were classified based on up- and down- stream conditions and observations from right-of-way or property boundaries, supplemented with desktop information. Where



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right-of way or property boundary access was not possible, drainage features on non-participating parcels were classified as watercourses. Their inclusion in the meander belt mapping represents a conservative approach given that these reaches could not be field verified. Meander belt dimensions for these features should be reviewed and, as appropriate, refined with field verification through subsequent studies undertaken as part of future planning applications.

Typically, meander belts are delineated referencing the lateral extent of governing meander bends along a reach over the available historical record (minimum period of 25 years). Given the historically modified and channelized nature of reaches within the Study Area, however, an empirical modelling approach was employed.

The recommended preliminary meander belt dimensions for the Study Area were calculated using the TRCA equation, which was developed based on a dataset of meandering watercourses in southern Ontario (TRCA, 2004). This method uses 2-year return period flow, channel gradient, and drainage area as inputs. The equation is as follows:

$$W_b = -14.827 + 8.319 * \ln(\gamma * Q * S * A_d) + 2 * 8.63$$

Where γ is the specific weight of water ($\text{kg/m}^2\text{s}^2$), Q is the existing 2-year return period flow (m^3/s) provided by Stantec (2025), S is the channel gradient (m/m) as determined from a LiDAR-derived DTM (MNR, 2021), A_d is drainage area (km^2) provided by Stantec (2025), and W_b is the meander belt width (m). Basing channel gradients on LiDAR-derived elevations was deemed appropriate, despite LiDAR not penetrating water, because water depths were so shallow in the LiDAR-defined drainages in the Study Area that the beds are reasonably well represented. Furthermore, energy gradients are best estimated from water surfaces in the absence of reliable bankfull indicators.

The TRCA equation is considered more appropriate than those that reference bankfull channel dimensions, since bankfull indicators within the Study Area are either not well-defined or have been heavily impacted by anthropogenic activities.

A 20% factor of safety was then applied to the calculated preliminary meander belt width (MBW) to obtain the final MBW.

The meander belt concept as a management tool is most applicable to watercourses dominated by fluvial processes. Small, low-gradient watercourses and HDFs may have less energy to drive erosive processes, including lateral adjustment. Nevertheless, headwater features are not static and have the potential to adjust over time, particularly in the context of land use change. Under the TRCA/ Credit Valley Conservation (CVC) HDF protocol management recommendations, protection-level HDFs require protection (or enhancement) of the existing feature and its riparian zone corridor in-situ and thus a corridor width must be established for these features. The UHOP for warmwater watercourses specifies a minimum width Vegetation Protection Zone (VPZ) of 15 m. To ensure a conservative approach, a minimum preliminary MBW of 30 m, based on the VPZ, was applied to all watercourses and protection-level HDFs in the Study Area. After applying the 20% factor of safety, this resulted in a minimum recommended MBW of 36 m.

MBW results were then reviewed within the context of field observations, recent aerial/satellite imagery and topographic mapping to ensure that the dimensions were appropriate for existing channel conditions. The final MBWs recommended for watercourses and protection-level HDFs range from 36 to 59 m. Final recommended MBWs are provided in Table 3.2.3 and are shown in Figure 3.2.1, with more detailed mapping provided in **Appendix D1**.



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Table 3.2.3 Meander Belt Widths

| Reach | Preliminary Belt Width (m) | 20% Factor of Safety (m) | Final Belt Width (m) |
|-----------|----------------------------|--------------------------|----------------------|
| 1-SIC1 | 48 | 9 | 57 |
| 1-SIC2 | 46 | 9 | 55 |
| 1-SIC3 | 49 | 10 | 59 |
| 1-SIC4 | 32 | 7 | 39 |
| 1-SIC5 | 31 | 6 | 37 |
| 1-SIC6 | 30* | 6 | 36 |
| 1-SIC7 | 30* | 6 | 36 |
| 1-SIC8 | 30* | 6 | 36 |
| 1-SIC3-1a | 30* | 6 | 36 |
| 1-SIC3-1c | 30* | 6 | 36 |
| 1-SIC3-1f | 30 | 6 | 36 |
| 1-SIC3-1g | 30* | 6 | 36 |
| 1-SIC3-1i | 34 | 6 | 40 |
| 1-SIC3-1j | 34 | 6 | 40 |
| 1-SIC3-1k | 34 | 6 | 40 |
| 1-SIC3-1l | 30* | 6 | 36 |
| 1-SIC4-1a | 30* | 6 | 36 |
| 1-SIC4-1b | 30* | 6 | 36 |
| 1-SIC4-1c | 30* | 6 | 36 |
| 3-SC1a | 41 | 8 | 49 |
| 3-SC1b | 40 | 8 | 47 |
| 3-SC1c | 32 | 6 | 38 |
| 3-SC2 | 30* | 6 | 36 |
| 5-SC1 | 30* | 6 | 36 |
| 5-SC1-2a | 30* | 6 | 36 |
| 5-SC2 | 29 | 7 | 36 |
| 5-SC2-1a | 30* | 6 | 36 |
| 5-SC2-1c | 30* | 6 | 36 |
| 5-SC3 | 30* | 6 | 36 |
| 5-SC3-1a | 30* | 6 | 36 |
| 1-TMC1a | 45 | 9 | 54 |
| 1-TMC1b | 44 | 9 | 52 |
| 1-TMC1c | 30* | 6 | 36 |
| 1-TMCd | 30* | 6 | 36 |
| 1-TMC1a | 45 | 9 | 54 |
| 1-TMC1b | 44 | 9 | 52 |
| 1-TMC1c | 30 | 6 | 36 |
| 1-TMC1d | 30* | 6 | 36 |
| 1-TMC2 | 30* | 6 | 36 |
| 4-TMC1a | 39 | 8 | 47 |
| 5-TMC1 | 30* | 6 | 36 |
| 5-TMC2 | 30* | 6 | 36 |

* A minimum preliminary belt width of 30 m was used, resulting in a final width of 36 m.



3.2.7 Study Area Erosion Impact Mitigation

3.2.7.1 Erosion Thresholds

Erosion and deposition are natural processes that are necessary for the maintenance of channel form and function. Changes in land use can result in changes in the magnitude and duration of surface runoff produced by precipitation events, which can result in increased or decreased rates of erosion.

Appropriate SWM techniques can typically mitigate the impacts associated with land use change by reducing the magnitude of post-development storm events. Surface runoff is collected and detained in SWM facilities, then released at a controlled flow rate. The total volume of post-development runoff can also be mitigated through the implementation of low-impact development techniques (LIDs). The overall objective of these management tools is to match, to the extent possible, pre-development and post-development flow conditions in the receiving watercourse.

Erosion thresholds represent the instream hydraulic parameter by which pre- and post-development flow conditions are compared. An erosion threshold defines the theoretical hydraulic conditions under which sediment is entrained and transported within the channel. Specifically, the threshold represents a depth, velocity, or discharge at which sediment of a particular size class (usually the median or average grain size material) may potentially be entrained. This does not necessarily imply that systemic erosion (i.e., widening or degradation of the channel) will occur if the threshold is exceeded; it simply indicates flow conditions at which sediment entrainment (i.e., initiation of motion) is likely to occur.

The erosion threshold is determined based on the channel's bed and bank material properties, the channel geometry, and the hydraulic conditions. Erosion thresholds provide an understanding of resiliency, describing the channel's inherent ability to accommodate changes to the flow and/or sediment regime. The thresholds provide guidance and targets that can be used to evaluate proposed land use changes (e.g., urbanization).

Erosion thresholds are established within the Phase 2 SWP Report. Erosion thresholds have been applied to identify critical discharges for the erosion exceedance analysis.

3.2.7.2 Erosion Exceedance Analysis

An erosion exceedance analysis has been completed as part of the Phase 2 SWP. The exceedance analysis utilizes pre- and post-development hydrographs provided by Stantec, at discrete locations, to compute the Cumulative Erosion Index (CEI), Cumulative Effective Work Index (CEWI) and Time of Exceedance (TE) for all detailed geomorphic field site locations. This analysis evaluates the potential for increased erosion under various proposed land use conditions and stormwater control scenarios. Should a risk of erosion potential be identified through the analysis, mitigation options are identified and recommended. The overall objective of the exceedance analysis is to confirm that the applied SWM criteria avoids increasing erosion potential in the receiving (downstream) system above observed existing condition rates.

The 2011 Stoney Creek and Battlefield Creek Flood and Erosion Control Class Environmental Assessment evaluated erosion risks within Stoney Creek downstream of the Niagara Escarpment. The Class EA highlighted numerous active erosion areas between the CNR Rail line and South Service Road and identified the reach between Queenston Road and the Battlefield Creek confluence as being most sensitive to changes in flow.



While results of the 2011 Class EA were considered in preparing this report, reaches downstream of the Niagara Escarpment are not considered representative of existing geomorphic conditions within the Study Area. Changes to land use within the Study Area are not expected to significantly impact erosion potential downstream of the Escarpment, as the contributing drainage area to that portion of Stoney Creek is approximately five times larger than that within the Study Area. Designing and implementing on-site SWM controls through site-specific erosion exceedance analyses further limits the potential for downstream impacts. The Phase 2 SWP erosion exceedance analysis has therefore focused on the reaches identified in **Section 3.2.5.3**.

3.2.8 Conclusions and Recommendations

The fluvial geomorphic assessment was completed to characterize existing conditions, delineate erosion hazard limits, identify active erosion areas, and identify sensitive reaches that required further assessment to determine erosion thresholds to inform the future SWM erosion control criteria / strategy. To support this assessment, reaches were preliminarily delineated based on a desktop assessment and updated based on field observations. The field observations characterized the watercourses within the Study Area as low-gradient, low-energy systems that have been heavily modified by agricultural practices, with several functioning as channelized roadside ditches; few instances of active erosion were identified.

As part of the Phase 2 SWP, detailed geomorphic field sites recommended in this report are reviewed and refined, as appropriate. Data collected during the detailed assessments are applied to identify erosion thresholds in the form of a critical discharge. The thresholds are relied upon to complete an erosion exceedance analysis using post-development hydrologic modelling to evaluate the potential impact of the proposed land use plan on downstream receiving watercourses.



3.3 Fisheries, Aquatics & Headwater Assessment

3.3.1 Objective

The purpose of the fisheries, aquatic and headwater assessment is to characterize the existing aquatic features within the Study Area using secondary source information and field investigations. This information is necessary to identify potential constraints to development associated with aquatic habitat features as guided by the UHOP and other relevant policy.

3.3.2 Background

As described in **Section 1.3**, the Study Area contains portions of the Sinkhole Creek, Twenty Mile Creek, Stoney Creek, Hannon Creek, and Upper Davis Creek subwatersheds (Figure 1.3.1). The Hannon Creek and Upper Davis Creek subwatersheds have no watercourses within the Study Area, and as such are assessed only as headwaters (i.e., not subject to fish community, benthic, stream temperature or aquatic habitat characterization). The watercourses and headwater features within the Study Area are generally small, with a maximum Strahler stream order of 3. All watercourses have seen a high degree of anthropogenic influence, principally from agriculture. Secondary source information suggests that the Study Area is composed of a cool or warmwater fishery that is seasonally limited in their distribution by intermittent flow regimes (Minns and Wichert 2005; Aquafor Beech Ltd. 2018).

3.3.3 Methods

To characterize the reaches within the Study Area, a background review was completed, and five field methodologies were applied during site investigations; stream temperature monitoring, headwater drainage features assessments, aquatic habitat assessments, fish community assessments and benthic community assessments.

3.3.3.1 Background Data Review

The characterization of fisheries, aquatics and headwaters included a desktop review of the following secondary source information:

- COSEWIC information regarding Grass Pickerel (COSEWIC, 2005 and 2014)
- The Twenty Mile Creek Watershed Plan (NPCA, 2006)
- The City of Hamilton Stormwater Management Master Plan (City of Hamilton, 2006)
- The Urban Hamilton Official Plan (City of Hamilton, 2013a)
- The Hannon Creek Sub-Watershed Stewardship Action Plan (HCA, 2013b)
- The Upper Davis Creek Sub-Watershed Stewardship Action Plan (HCA, 2013c)
- The East Escarpment Area Watershed Restoration Program (HCA, 2015)
- The Elfrida SWS: Phase 1 Final Results (Aquafor Beech Ltd., 2018)
- The NPCA Water Quality Monitoring Report (NPCA, 2019)
- Hamilton Region Source Water Protection Assessment Report (Hamilton Conservation Authority and Halton Conservation, 2022)
- Natural Heritage Information Centre Biodiversity Explorer Database (MNR, 2024)



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- Ontario Ministry of Natural Resources (MNR) online aquatic resource mapping tool (MNR, 2025)
- DFO Aquatic SAR Mapping
- Historical and contemporary Ortho imagery of the Study Area

3.3.3.2 Field Investigations

Field investigations were completed on participating lands within the Study Area on the dates indicated within Table 3.3.1. Data was collected at locations where there were known data gaps or to supplement previous assessments, as determined by the review of secondary source information. Where possible, multiple data were collected at individual stations to provide fulsome observations of physical and biological characteristics (i.e., fish community assessments, benthic invertebrate sampling, aquatic habitat characterization and continuous water temperature data) to support the identification of potential constraints associated with aquatic habitat.

Table 3.3.1 Summary of Aquatic Field Investigation Effort

| Date | Surveys Conducted | Surveyors |
|-----------------------------------|---|--|
| September 26, 2023 | Aquatic Habitat Characterization | J. Davey (SLR) |
| October 25, 2023 | Benthic invertebrate sampling | J. Davey and K. Tyler (SLR) |
| May 15, 16, 17 and 23, 2024 | Headwater Drainage Feature Assessments | L. Barnett and T. Muller (GeoProcess) |
| August 29, 30, and 31, 2024 | Headwater Drainage Feature Assessments | D. Hock (GeoProcess) |
| June 25, 2024 | Aquatic Habitat Characterization and Fish Community Assessment (electrofishing) | P. Anderson and E. Veres (GeoProcess) |
| July 26, 2024 | Fish Community Assessments (electrofishing) | J. Davey and L. McLennan (SLR) |
| November 12, 2024 | Benthic invertebrate sampling | D. Francis and S. Henry (SLR) |
| March 19, 21, 25, 26 and 27, 2025 | Headwater Drainage Feature Assessments | E. Veres and L. Barnett (GeoProcess); J. Davey and M. Robinson (SLR) |
| April 1, 2025 | Headwater Drainage Feature Assessments | E. Veres and L. Barnett (GeoProcess) |
| July 29, 2025 | Temperature Loggers Deployed | B. Tessaro and P. Anderson (GeoProcess) |
| May 9, 2025 | Aquatic Habitat Characterization | J. Davey (SLR) |
| May 27, 2025 | Headwater Drainage Feature Assessments | E. Veres and T. Synard (GeoProcess); |
| August 6, 2025 | Headwater Drainage Feature Assessments | E. Veres (GeoProcess) |
| October 23, 2025 | Aquatic Habitat Assessment | M. Shin (GeoProcess) and D. Francis (SLR) |

Aquatic habitat was characterized within the Study Area using a modified Ontario Stream Assessment Procedure (OSAP) rapid assessment for channel structure and supplemented with a characterization of riparian habitat, substrate, channel morphology and channel dimensions. Reconnaissance was completed at all watercourses, and rapid assessments were completed at five reaches (two within Twenty Mile Creek, two within Sinkhole Creek and one within Stoney Creek) determined to be representative of each respective watercourse. Ponds within the Study Area were assessed in the field in terms of their function as aquatic habitat. Watercourse crossings were evaluated in the field in terms of their potential to be physical impediments to fish passage (i.e., impediments unrelated to flow limitations).



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Headwater Drainage Features Assessments were informed by a review of historical and contemporary imagery, LiDAR topographic data, and the 2018 Aquafor Beech Final Phase 1 SWS (Aquafor Beech Ltd., 2018). Potential features identified during the background review were evaluated in the field using the rapid methodology outlined within the Evaluation, Classification and Management of Headwater Drainage Features Guidelines (hereafter, the 'HDF Guidelines') (TRCA and CVC, 2014), supplemented by professional judgement. Several potential features could not be accessed due to a lack of landowner participation. All potential features on participating lands within the Study Area were evaluated.

Fish community assessments were completed using the OSAP single pass electrofishing sampling surveys (MNR, 2017) and supplemented with dip netting (where electrofishing was not feasible). Sampling was completed in alignment with the requirements of a scientific fish collection permit obtained from the MNR (License No. AYGU-2024-FWCA-00711). Fish community assessments were completed at six stations; two within Sinkhole Creek, three within Twenty Mile Creek and one within Stoney Creek.

Benthic macroinvertebrate community characterization was completed using standard stream sampling methods from the Ontario Benthos Biomonitoring Network (OBBN) stream (travelling kick and sweep transect method) or wetland (jab and sweep) sampling methods.

3.3.4 Results

3.3.4.1 Watercourses, Stream Temperature and Thermal Regimes

The Study Area is an L shape, bounded by Trinity Church Road to the west, Golf Club Road to the south and Hendershot Road/Second Road East to the east. Its northern border follows the hydro corridor between Trinity Church Road and Regional Road 56 where the border turns north and continues along Upper Centennial Parkway to Mud Street, where the border turns east until reaching the eastern border at Second Road East.

Reaches delineated within the five sub watersheds in the Study Area as part of the HDF Assessment were applied to the aquatic assessment. These reaches are shown within Figure 3.3.2.

Four continuous surface water monitoring stations were installed on July 29, 2025, to collect continuous water temperature and level data within Sinkhole Creek (SC-01), Stoney Creek (STC-01), and Twenty Mile Creek (TMC-01, TMC-02). The stations were selected with consideration of the aquatic habitat and fish community sampling sites. No stations were installed in Hannon Creek or Upper Davis Creek due to there being no identified watercourses.

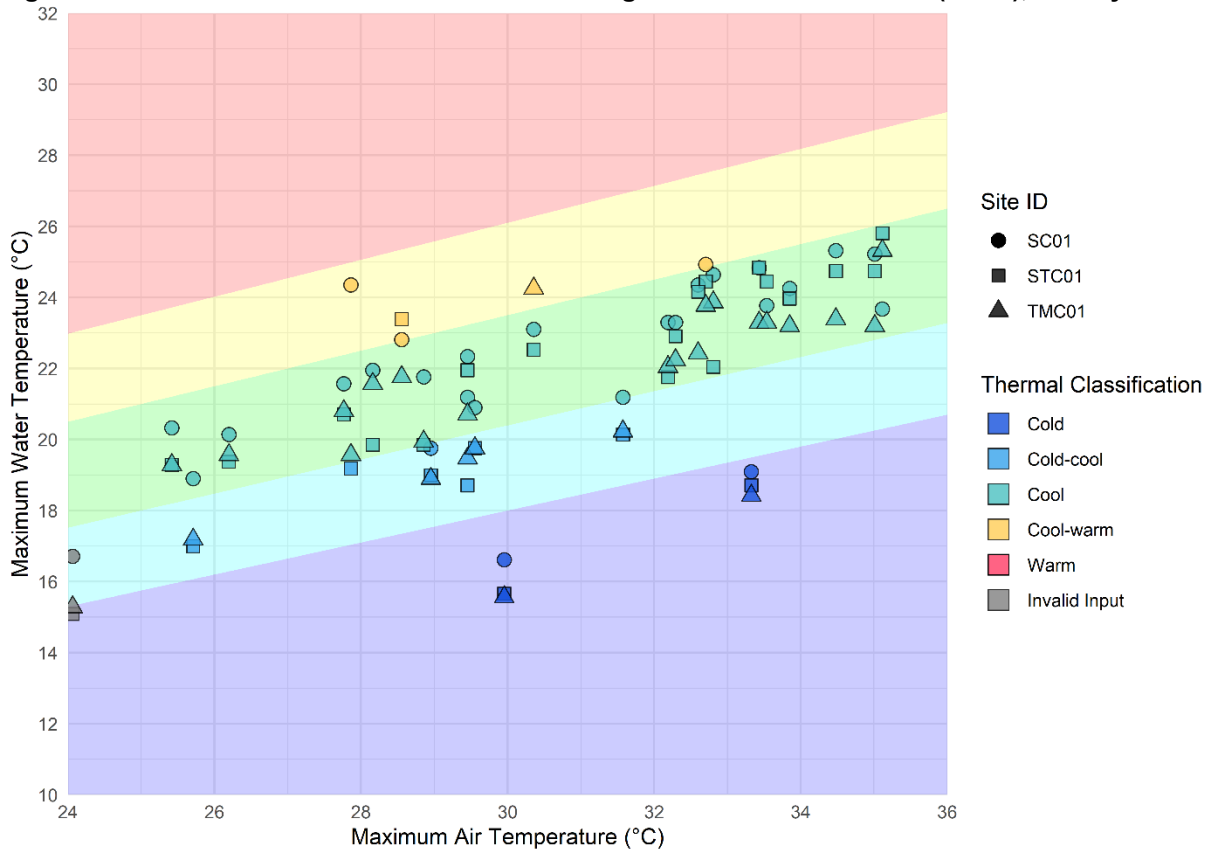
Following the methodology outlined by Stoneman and Jones (1996) and revised by Chu (2009), continuous water temperature measurements (collected between July 1 and August 31, from 16:00 to 18:00) and single measurements of maximum air temperature during the summer months are plotted on a nonogram to classify the subject watercourses as coldwater, coolwater, and/or warmwater systems.

Currently, continuous water temperature data is only available for the period of July 29 to December 4, 2025. Discrete water temperature samples are also available for October 25, 2023, June 28, 2024, September 6, 2024, September 24, 2025, and November 21, 2024. This dataset is insufficient to classify thermal regime following the methodology of Stoneman and Jones (1996) revised by Chu (2009). Data collection efforts are therefore ongoing to provide a complete dataset for thermal regime classification by October 2026. In the interim, thermal regimes have been estimated using the



preliminary results of monitoring as presented within the nomogram in Figure 3.3.1 and secondary source information.

Figure 3.3.1 Stream Thermal Classification Nomogram for Sinkhole Creek (SC01), Stoney Creek



(ST01) and Twenty Mile Creek (TMC01) based on the methodology of Chu et al. (2009)

3.3.4.1.1 Sinkhole Creek

At the Study Area, Sinkhole Creek is a third order stream that conveys flows eastwardly towards its confluence with Twenty Mile Creek approximately 6 km downstream. Four of the five headwater branches of Sinkhole Creek originate within the Study Area, with one branch (1-SIC3) collecting surface drainage from the development west of Swayze Road before which is discharged from a headwall located west of Regional Road 56 and south of Rymal Road. The mainstem of Sinkhole Creek leaves the Study Area through a box culvert at Hendershot Road. Two watercourses were identified within Sinkhole Creek, the mainstem of Sinkhole Creek itself, located between Reach 1-SIC4 and 1-SIC1, and Branch 1-SIC3 of Sinkhole Creek.

The MNR online aquatic resource mapping tool (MNR, 2025) identifies Sinkhole Creek as a warmwater system. No data was available from the NPCA to describe the thermal regime of Sinkhole Creek within the Study Area. The previous SWS characterized the stream as coolwater (Aquafor Beech Ltd., 2018).



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One continuous temperature data logger was installed at Sinkhole Creek (SC01). Between July 30, 2025, and December 4, 2025, the highest stream temperature recorded during the monitoring period was 25.3 °C at 17:15 when the corresponding air temperature was 33.0 °C (August 10, 2025). Using the approach of Chu (2009), the watercourse is classified as a warm-coolwater stream.

The secondary source information and the incomplete empirical dataset suggest that Sinkhole Creek is best characterized as a coolwater stream.

3.3.4.1.2 *Twenty Mile Creek*

Seven branches of Twenty Mile Creek are present along the Southern portion of the Study Area. Only one of these branches, 1-TMC1 (including a portion of its sub-branch, 1-TMC2) has been classified as a watercourse based on the HDF Assessments. Branch 1-TMC1 is a third order stream that partially originates in the rural and agricultural lands west of the Study Area and leaves the Study Area through an open box culvert at Golf Club Road approximately 225 m east of Fletcher Road.

No background data from the NPCA or the MNR is available to describe the thermal regime of Twenty Mile Creek at the Study Area. The previous SWS characterized the stream as warm-coolwater (Aquafor Beech Ltd., 2018).

Two continuous temperature data loggers (TMC-01, TMC-02) were installed in Branch 1-TMC1, one of which, Station TMC-02, was excluded from the analyses as the temperature logger was outside of the water for the majority of the sampling period. Between July 30, 2025, and December 4, 2025, the highest stream temperatures recorded at site TMC-01 during the monitoring period was 24.25 °C at 16:15, at which time air temperature reached 24.5 °C (August 17, 2025). Using the approach of Chu (2009), the watercourse is classified as a coolwater stream.

The secondary source information and the incomplete empirical dataset suggest that Twenty Mile Creek is best characterized as a coolwater stream.

3.3.4.1.3 *Stoney Creek*

Stoney Creek is a third order stream at the Study Area that generally conveys flows north and eastwardly. Two branches of the Creek are present within the Study Area that form a confluence east of First Road East before leaving the Study Area at a culvert conveying flows beneath Second Road East, south of Mud Street.

No background data from HCA or the MNR is available to describe the thermal regime of Stoney Creek at the Study Area. The previous SWS characterized the stream as coolwater (Aquafor Beech Ltd., 2018).

One continuous temperature data logger was installed at Stoney Creek (STC-01). Between July 30, 2025, and December 4, 2025, the highest stream temperature recorded during the monitoring period was 27.37 °C at 13:00, when the corresponding air temperature was 34.26 °C (August 11, 2025). Using the approach of Chu (2009), the watercourse is classified as a coolwater stream.

The secondary source information and the incomplete empirical dataset suggest that Stoney Creek is best characterized as a coolwater stream.



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3.3.4.1.4 *Hannon Creek*

No watercourse was identified within the Hannon Creek subwatershed.

3.3.4.1.5 *Upper Davis Creek*

No watercourse was identified within the Upper Davis Creek subwatershed.

3.3.4.2 **Headwater Drainage Feature Assessment**

The following sections detail the HDF management recommendations proposed for the Study Area. The management recommendations generally align with the HDF Guidelines; however, technical reasoning for an alternative management recommendation based on professional judgement is provided for some features.

In accordance with the TRCA and CVC Headwater Drainage Feature (HDF) classification guidelines, four distinct management recommendations have been established. Each recommendation is outlined below, along with the corresponding management implications for its respective classification (TRCA and CVC, 2014).

- **Protection:** Features that provide critical ecological functions, including breeding habitat for amphibians, perennial headwater drainage feature functions, permanent fish habitat, and habitat for Species at Risk. These features are typically associated with permanent systems containing wetlands and forested riparian zones. Features classified as protection cannot be relocated and require complete protection and/or enhancement.
- **Conservation:** Applies to features that provide critical ecological functions, such as intermittent fish habitat or amphibian breeding habitat. These features are typically associated with wetlands or forested riparian zones. Recommended management for features classified as conservation include maintenance and/or enhancement of the feature and the associated corridor. Relocation may be permitted, provided that the ecological functions of the feature and its corridor are preserved or improved.
- **Mitigation:** Applies to features that contribute indirectly to fish habitat or provide supporting ecological functions. These features are often located within meadow environments or areas with limited vegetative cover. Features classified as mitigation are more flexible in terms of management recommendations. These features and their associated functions can be relocated or replicated and enhanced through lot-level conveyance strategies and Low Impact Development (LID) measures.
- **Recharge:** Applies to features situated in areas with sandy or gravel soils where no observable flow is present (i.e., dry or standing water), with or without defined channels. With these features, management recommendations include ensuring the water balance is maintained through appropriate mitigation measures.
- **Maintain or Replicate Terrestrial Linkage:** Applies to features with no observable flow that serve as important wildlife corridors or linkages between natural features. Examples include forest communities that connect two headwater drainage features. For these features, corridors between features should be maintained. If relocation is necessary, then the corridor should be replicated and enhanced in a new location.
- **No Management:** Applies to features exhibiting little or no flow, lacking ecological functions such as wildlife habitat, fish habitat, or corridor connectivity. These features do not warrant management intervention.



3.3.4.2.1 Sinkhole Creek

Most of the Sinkhole Creek HDFs exist as agricultural swales, which, through surface evaluation, adhere to conventional flow regimes of higher recorded flows following spring freshet and spring rains, and lower flow, standing water, and eventually dry conditions by late spring into summer. Similar to the main branch of Sinkhole Creek, no surface evidence was observed that indicated the presence of groundwater and surface water interactions (i.e., iron staining, bubbling, upwellings, or indicator vegetation). HDF segments located to the west of Regional Road 56, or those identified in the upstream half of the subwatershed (within the Study Area), were found to dry out earlier than those located within the eastern or downstream half of the subwatershed. The HDFs connected to the Regional Road 56 culverts, which collects upstream drainage from the commercial properties along Portside Street (located outside of the Study Area), were found to contain at least standing water or minimal flow during the Visit 2 site investigation.

Many of the HDF segments west of Regional Road 56 are assessed as no management required due to their limited hydrologic functions and dry conditions in late spring (Figure 3.3.2). However, certain feature segments are assessed as mitigation, conservation, and protection due to either important hydrologic function or important riparian characteristics such as the presence of wetlands and/or woodlands.

At a site-specific level, influence from existing tile drainage was noted at the downstream extent of segment 1-SIC4-1f, with flow being captured into a large concrete manhole. From a review of the province's tile drainage records (OMAFRA, 2024), it appears that areas to the west of Regional Road 56 and north of Golf Club Road are recorded as being tile drained. Separately, several of the smaller HDF segments were recorded as originating from the base of the retaining wall that extends westwards from Regional Road 56 to the south of Dolomiti Court. These features were observed with standing water in early spring but were mostly dry by the second field visit.

East of Regional Road 56, management recommendations varied from no management required to protection due to varying conditions in hydrologic and ecological functions along the subwatershed (Figure 3.3.2).

A summary of the hydrological and ecological functions, management recommendations, and any professional interpretations for the HDFs within Sinkhole Creek is provided in **Appendix E2** and can be viewed in Figure 3.3.2. For mapping that displays individual HDF labeling and the corresponding management recommendation colour coding, please refer to **Appendix E3**.

3.3.4.2.2 Twenty Mile Creek

Within the Twenty Mile Creek, HDFs are predominantly situated within agricultural lands. The features have hydrological regimes characterized by high flows following the spring freshet or rainfall events, then followed by low-flow or dry conditions. HDFs were evaluated across the subwatershed, with key management recommendations based on functional characteristics and location within the watershed.

Most HDF segments across the Twenty Mile Creek subwatershed were found to have limited hydrologic and ecological function and were accordingly assessed as no management required. Among these HDFs are segments associated with agricultural fields and smaller, isolated drainage features. Mitigation level management was applied to segments that exhibited a higher degree of hydrologic



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and/or ecological functions, such as features that connect wetlands and/or woodlands to larger watercourses, or those observed to have flowing water during Visit 1 and dry conditions during Visit 2.

The highest level of management (protection) was assigned to segment 5-TMC2, located northeast of the intersection of Regional Road 56 and Golf Club Road. The feature has a surrounding riparian populated with densely wooded areas (FOD5-1) and a wetland complex (SWD4-2), which provide essential hydrologic, ecological, and terrestrial habitat functions. The feature was also observed to have flowing water during Visit 1 and standing water during Visit 2, providing valued hydrological function. Segment 5-TMC-1 was assessed as protection, as the feature is positioned downstream of 5-TMC-2.

A summary of the hydrological and ecological functions, management recommendations, and any professional interpretations for the HDFs within Twenty Mile Creek is provided in **Appendix E2** and can be viewed in Figure 3.3.2. For mapping that displays individual HDF labeling and the corresponding management recommendation colour coding, please refer to **Appendix E3**.

3.3.4.2.3 Stoney Creek

Within the Stoney Creek subwatershed, HDF management recommendations are primarily influenced by connectivity to important natural features and observed hydrological function. Several features, particularly those found within agricultural fields near the southern border of the subwatershed, were found to have limited or contributing hydrological and ecological functions and were assessed as no management required or mitigation.

In the northern portion of the subwatershed, two HDFs that convey drainage from a wetland feature into Stoney Creek (segment 4-SC1 and 4-SC2) were assessed as conservation. The riparian area surrounding these HDFs represents potential stepping-stone habitat between upstream and downstream ecologically significant areas, and the hydrological function of both features is considered valued.

A summary of the hydrological and ecological functions, management recommendations, and any professional interpretations for the HDFs within Stoney Creek is provided in **Appendix E2** and can be viewed in Figure 3.3.2. For mapping that displays individual HDF labeling and the corresponding management recommendation colour coding, please refer to **Appendix E3**.

3.3.4.2.4 Hannon Creek

Consistent with other subwatersheds in the Study Area, the HDFs that populate the Hannon Creek subwatershed are predominantly situated within agricultural fields. Flow present within some of these features during Visit 1 typically receded shortly after the spring freshet, and standing or no water was observed during Visit 2. The HDF assessment indicates that these features have limited or contributing hydrological and ecological functions, resulting in a recommendation of no management required or mitigation.

Segment 2-HC-1, located at the downstream extent of the Hannon Creek subwatershed, was observed to have valued hydrological function and wetland riparian vegetation. Correspondingly, the segment was assessed as conservation.

A summary of the hydrological and ecological functions, management recommendations, and any professional interpretations for the HDFs within Hannon Creek is provided in **Appendix E2** and can be



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viewed in Figure 3.3.2. For mapping that displays individual HDF labeling and the corresponding management recommendation colour coding, please refer to **Appendix E3**.

3.3.4.2.5 Upper Davis Creek

No HDFs were found within the Upper Davis Creek subwatershed area.

3.3.4.3 Aquatic Habitat

3.3.4.3.1 Sinkhole Creek

Two watercourses were identified within Sinkhole Creek and assessed in terms of their aquatic habitat; the mainstem of Sinkhole Creek, located between Reach 1-SIC4 and 1-SIC1, and Branch 1-SIC3 of Sinkhole Creek. Four online ponds were also determined to be present based on a review of aerial imagery and secondary source information (Aquafor Beech Ltd., 2018). Two of the ponds, identified along Reach 1-SIC8 and Reach 5-SIC2, are located within lands permitted for survey, while the remaining two are located within lands where site access was not permitted.

At Reach 1-SIC4, the confluence of the two western headwater branches merge to form the mainstem of Sinkhole Creek. The reach typically conveyed diffused flow through emergent vegetation. Substrate was primarily clay and silt, and riparian vegetation was principally composed of cropland with aquatic plants and grasses present within 10 m of the channel except where it traversed hedgerows. Channel banks were poorly defined with no notable observations of erosion. Siltation was prevalent in the channel due to its low gradient and adjacent agricultural lands. Where discernible, bankfull channel width and depth were 3.6 to 4.8 m and 0.2 m, respectively. During the midsummer site visit, the channel conveyed minimal flow and was dry during site visits in the fall, however substantial flow was observed during the Spring where wetted depths were 0.1 to 0.2 m with an average width of 0.75 m.

Branch 1-SIC3 of Sinkhole Creek enters the Study Area through a culvert located south of Rymal Road that conveys flow beneath Regional Road 56. Similar to the main branch of Sinkhole Creek (e.g., Reaches 1-SIC1 to 1-SIC4), diffused flow paths through dense vegetation were prevalent. No discernible riffle-pool morphology was observed, and the channel is generally poorly defined. Siltation was common within the channel, and no significant bank erosion was observed. Riparian conditions within the branch were discontinuous, transitioning between areas of isolated natural habitat (linear wetlands or isolated woodlands) and agricultural fields where the only riparian vegetation, if present, was grass species. Substrate was principally composed of silt, clay and organic materials. Bankfull channel dimensions were not discernible.

Assessments of Reach 1-SIC2 and Reach 1-SIC1 were limited to sites where access was permitted. At these locations, the reach conveyed flow through localized sections of defined channel between areas of dense vegetation where water was conveyed as diffused flow. Substrate was predominantly clay and silt and organic materials. In specific areas within 1-SIC2 and 1-SIC1, instances of deep pools with bankfull depths up to 0.8 m and bankfull widths of 2 m were observed as were sites with evidence of groundwater upwelling (e.g., watercress, iron staining and lower water temperatures relative to upstream). These areas may provide refuge during periods of low flow to resident fish. Bankfull widths and depths in Reach 1-SIC 2 and 1-SIC1 varied between 1.4 and 5.5 m and 0.2 and 0.8 m, respectively. Wetted widths during the Spring site visit averaged 0.75 m, while wetted depths generally ranged between 0.1 and 0.2 m.



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Four ponds are identified in Sinkhole Creek. Two of the ponds, identified along Reach 1-SIC8 and Reach 5-SIC2, are located within lands permitted for survey, while the remaining two are located within lands where site access was not permitted. At Reach 1-SIC8 is a wetland ecosite featuring very little open water. From onsite investigations the 1-SIC8 pond feature exhibited limited open water in the spring and was dry in late July. A dense band of vegetation exists around the perimeter of the 1-SIC8 pond area, restricting movement from upstream to downstream during all times of the year. At Reach 5-SIC2, a small online pond exists within a large woodland feature. In 2024, the pond contained water during the spring and was dry in late July. During field investigation in October 2025, the pond was found to contain standing water and fish activity within the pond was noted. The 5-SIC2 pond is completely shrouded in a high canopy following spring leaf-out and was covered in a layer of duck weed during October 2025. During the July 2024 and October 2025 field investigations, the inlet and outlet channels to the pond were found to be dry.

Four crossings were assessed within Sinkhole Creek, three located at Regional Road 56 (SHC 4, SHC 5, and SHC 6) and one at Hendershot Road (SHC 14). None were determined to be physical impediments to fish passage, although passage could be impeded for larger bodied fish during periods of low flow. Culvert crossing labels are provided on Figure 3.4.6.

3.3.4.3.2 *Twenty Mile Creek*

One watercourse within Twenty Mile Creek was delineated within the Study Area, consisting of Reach 1-TMC1 and its tributary Reach 1-TMC2. The six other branches of Twenty Mile Creek, as well as the reaches upstream of 1-TMC1 and 1-TMC2, were classified as headwater features. No ponds were identified within the Twenty Mile Creek subwatershed in the Study Area.

Reach 1-TMC2 of West Twenty Mile Creek is an anthropogenically modified feature, as evidenced by excavation of the channel during a site visit in Fall 2023 and the straightened planform. Where excavation had not occurred, the channel typically conveyed diffused flow through dense instream vegetation. Intermittently, when the channel passed through areas with more dense canopy cover from trees, discernible bed and banks were observed and the channel had a plain bed morphology. Although the channel was susceptible to erosion where excavation was completed, minimal erosion was observed. Rather, siltation was common as a consequence of the low gradient and adjacent agricultural lands. Dominant bed materials were clay and silt. Typical bankfull widths and depths were 3.6 m and 0.63 m, while wetted widths and depths were 1.9 m and 0.19 m, respectively. During field visits at low flow periods the channel remained wetted.

Reach 1-TMC1 of West Twenty Mile Creek originates within the agricultural and rural lands west of the Study Area. Upstream of the reach's confluence with Reach 1-TMC2, in Reach1-TMC1c and d, the channel transects agricultural fields and has a riparian buffer consisting of grasses and herbaceous species directly adjacent to the watercourse abutted against cropland. These reaches have a low gradient and typically convey diffused flow through dense vegetation. Bankfull channel width ranged between 1.2 m and 2.7 m, and bankfull depth ranged between 0.15 m and 0.72 m. A failed tile drain system may contribute to seasonal drying of Reach 1-TMC1.

Downstream of Reach1-TMC2, within Reach 1-TMC1b, the channel conveys flows through a wooded hedgerow where bed and banks had been excavated, and the channel had a plain bed morphology. Dominant substrate in the channel was clay and silt, with localized pockets of gravel observed. Instream vegetation remained prevalent, although there were isolated areas where less vegetation was present due to the mature canopy shading the watercourse. Bankfull channel width and depth were



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approximately 4.8 m and 0.8 m. Water remained present within the reach throughout the majority of the growing season but was absent during the late Fall.

Downstream of Fletcher Road, within Reach 1-TMC1a, flow is conveyed through a straight channel directly adjacent to Fletcher Road and Golf Club Road. The channel had a low gradient and plain bed morphology and has been aligned to convey flow as a roadside ditch. Bed material consisted predominantly of clay and silt, with some sand deposits on the bank likely sourced from the adjacent road. Grasses and sedges with some trees composed the riparian buffer with emergent vegetation and filamentous algae observed in the channel. Bankfull width was approximately 4.8 m and depth was 0.2 m. Water remained present within the reach throughout the growing season, suggesting a permanent flow regime.

Two crossings were assessed within Twenty Mile creek, one beneath Fletcher Road (Figure 3.4.6; ID 20MC-W 10) and the other conveying flows out of the Study Area beneath Golf Club Road (Figure 3.4.6; ID 20MC-W13). Neither crossing had physical characteristics that would cause fish passage concerns, although low flows may seasonally limit passage.

3.3.4.3.3 *Stoney Creek*

One watercourse was delineated within the Stoney Creek subwatershed in the Study Area, which included two branches. 3-SC2 is a minor branch conveying flow eastwardly towards its confluence with 3-SC1 and the main branch includes Reaches 3-SC1a-d and 5-SC1. Reaches 5-SC1 and Reach 3-SC1a were not assessed in the field as they were not within participating lands.

Five ponds were identified within the Stoney Creek subwatershed, four of which were located within Reach 5-SC1 and consequently could not be assessed in the field. The fifth is connected to a headwater drainage feature (Reach 4-SC1) that is a tributary to Reach 3-CS1c.

Reach 5-SC1 was not assessed in the field due to having no access. Aerial imagery and secondary source information (Aquafor Beech Ltd., 2018) show that the watercourse originates nearby to Highland Road, east of Upper Centennial, and at its upper limits conveys flow through a straightened channel within a linear wetland dominated by Phragmites and Cattails. Some canopy cover is provided by instream vegetation and isolated trees, and bed material was documented to consist principally of clay and silt. Beyond the wetland, riparian vegetation is composed of meadow until the channel enters an abandoned golf course approximately halfway between Mud Street East and Highland Road. Within the abandoned golf course, the watercourse passes through a series of three online ponds. Riparian conditions of the watercourse within the abandoned golf course vary considerably and include meadow, wetland and forest. Bankfull dimensions for Reach 5-SC1 were previously measured at the upper limits of the Reach as being 1.9 m in width and 0.3 m in depth. The downstream limit of the reach is the point where the watercourse turns eastwardly along Mud Street East. The flow regime within the watercourse was previously characterized as permanent.

Reach 3-SC1 is composed of three sub-reaches; 3-SC1a, 3-SC1b and 3-SC1c. All reaches retained flow during the Fall of 2023 and 2025, suggesting a permanent flow regime.

Reach 3-SC1c is a low gradient channel best described as a roadside ditch that conveys flow along the south side of Mud Street East. Bed materials were principally clay and silt, and banks were protected from erosion. Flow was conveyed through dense emergent instream vegetation in the channel. Riparian vegetation was lacking on the left side of the channel due to the road and was composed of sparse



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trees and meadow to the right. No groundwater indicators were observed within the Reach. A headwater tributary to Reach 3-SC1c, Reach 4-SC1, seasonally connects a pond at the upper limit of the reach to Stoney Creek.

Reach 3-SCb begins where the watercourse turns southwardly, away from Mud Street east, into the agricultural lands east of First Road East. Like the majority of Stoney Creek in the Study Area, the channel has been artificially straightened and conveys flow through dense rooted emergent vegetation. The riparian community consists of meadow with sparse trees and wetland habitats. Bed materials were principally clay and silt, and banks were protected from erosion. Bankfull width and depth were 4.6 m and 0.7 m. No groundwater indicators were observed within the Reach.

The majority of Reach 3-SCa was not assessed in the field as it was not accessible. Aerial imagery and secondary source information suggest that the channel conveys flow through dense submergent vegetation, with some emergent and woody debris also present (Aquafor Beech Ltd., 2018). The riparian community consists of a narrow strip of meadow and wetland abutting against cropland, with almost no mature trees providing shade. Bankfull width at the site was previously measured as 6.2 m (Aquafor Beech Ltd., 2018).

Reach 3-SC2 is a branch of Stoney Creek that forms a confluence with Reach 3-SC1b. The Reach principally conveys flow through a linear wetland with dense emergent vegetation. Riparian vegetation adjacent to the linear wetland consists of cropland, with some areas of meadow and scrub also observed. Bed material principally consisted of clay, silt and organics, and banks were protected from erosion. Bankfull width and depth of the channel were 6.12 m and 0.7 m. No groundwater indicators were observed within the Reach.

Two crossings were assessed within Stoney Creek, one beneath First Road E (Figure 3.4.6; ID SC 5) and the other conveying flows out of the Study Area beneath Second Road E (Figure 3.4.6; ID SC 22). Neither crossing had physical characteristics that would cause fish passage concerns, although low flows may seasonally limit passage.

3.3.4.3.4 Hannon Creek

No watercourses were found within the Study Area within the Hannon Creek subwatershed. Therefore, no aquatic habitat characterization was completed for this subwatershed.

3.3.4.3.5 Upper Davis Creek

No watercourses were found within the Study Area within the Upper Davis Creek subwatershed. Therefore, no aquatic habitat characterization was completed for this subwatershed.

3.3.4.4 Fish Communities

Fish community sampling was conducted at two locations in Sinkhole Creek, three locations in Twenty Mile Creek and one in Stoney Creek (Figure 3.1.1.). No fish community sampling was conducted for the Hannon or Upper Davis subwatersheds due to their being no watercourses present.

Table 3.3.2. Fish Community Sampling Dates (2024)

| Subwatershed | Station # | Sampling ID | Sampling Date |
|--------------|-----------|-------------|---------------|
| Sinkhole | 1 | 1 | July 26, 2024 |



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| | | | |
|-------------------|----|------|---------------|
| Sinkhole | 2 | 2 | July 26, 2024 |
| Twenty Mile Creek | 1 | TM01 | June 25, 2024 |
| Twenty Mile Creek | 2 | TM02 | June 25, 2024 |
| Twenty Mile Creek | 3 | TM03 | June 25, 2024 |
| Stoney Creek | 21 | ST02 | June 25, 2024 |

Fish collection methods including backpack electrofishing and dip netting followed the OSAP single-pass electrofishing survey methodology. Prior to the completion of sampling, fish collection permits were obtained from the MNR (License No. AYGU-2024-FWCA-00711), and sampling was completed in accordance with permit requirements. Collected fish were identified and measured by total length. All collected fish were monitored for health then replaced immediately back into their reaches. A catch summary per station can be seen within Table 3.3.3.

3.3.4.4.1 Sinkhole Creek

Sinkhole Station 1 is located within Reach 1-SIC4 (Figure 3.1.1). The site is within a narrow, linear wetland (ELC unit MAM2) that held standing water during the summer. The channel has a low gradient with clay and silt as the dominant bed material. Riparian conditions are wetland within 10 m of the channel banks and cropland beyond 10 m. Wetland vegetation was also present within the channel. Two warmwater species, Bluntnose Minnow (*Pimephales notatus*) and Pumpkinseed (*Lepomis gibbosus*) were captured at Sinkhole Station 1 (Table 3.3.3.).

Sinkhole Station 2 is located within Reach 1-SIC2 (Figure 3.1.1). Similar to Sinkhole Station 1, the channel occupied a linear wetland (ELC unit MAM2-2). Channel conditions at this site were better suited to fish habitat than at Sinkhole Station 1, with bankfull depths of up to 0.8 m within the channel and evidence of groundwater discharge. The channel had a low gradient with plain bed morphology and substrate consisted principally of organics, silt and clay. Two warmwater species, Bluntnose Minnow and Common Shiner (*Luxilus cornutus*), and one coolwater species, Brook Stickleback (*Culaea inconstans*) were captured at Sinkhole Creek Station 2 (Table 3.3.3.).

Work completed in 2016 identified five species as being present within pond habitat in Sinkhole Creek (Aquafor Beech Ltd., 2018); Brook Stickleback, Central Mudminnow (*Umbra limi*), Creek Chub (*Semotilus atromaculatus*), and Fathead Minnow (*Pimephales promelas*) and an unidentified sunfish (*Lepomis*) species (Table 3.3.3.). Sampling was intended to be replicated within the two ponds previously assessed within Sinkhole Creek (one at Reach 1-SIC8 and one within Reach 5-SIC2), however the features were dry and therefore unable to be assessed.

The fish captured within Sinkhole Creek are characteristic of warm to coolwater systems. Species captured are either intermediately tolerant or tolerant to environmental perturbations and changes in water temperature and turbidity (Eakins, 2025).

3.3.4.4.2 Twenty Mile Creek

Twenty Mile Creek Station 1 is located within Reach 1-TMC1 at the road right of way of Golf Club Road, east of Fletcher Road (TM01; Figure 3.1.1). This site was characterized as low gradient plain bed habitat and had abundant emergent vegetation. Substrate consisted of fines and riparian vegetation consisted of mature trees directly adjacent to the watercourse abutting against agricultural lands to the north and road to the south. At this station, one warmwater and one coolwater species were captured: Fathead Minnow and Central Mudminnow (Table 3.3.3.).



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Twenty Mile Creek Station 2 was also located within Reach 1-TMC1, west of Fletcher Road (TM02; Figure 3.1.1). This site was similar to at Twenty Mile Creek Station 1, in that it had plain bed morphology, a low gradient and substrate consisting of clay and silt. Riparian conditions consisted of scrubland directly adjacent to the watercourse with cropland beyond 10 m. The site had less instream vegetation than at Station 1. No fish were captured at Twenty Mile Creek Station 2.

Twenty Mile Creek Station 3 was located within Reach 1-TMC1, east of Trinity Church Road (TM03; Figure 3.1.1). At this station the watercourse was poorly defined, partially occupying cropped land and a linear wetland where flow was diffused through emergent vegetation. The channel had a low gradient and equivalent substrate to Twenty Mile Creek Station 2. No fish were captured at Twenty Mile Creek Station 3.

The fish community of Twenty Mile Creek within the Study Area was assessed in 2016 at the same station locations (Aquafor Beech Ltd., 2018). Fish community composition was equivalent, however in 2016 fish were captured further upstream at Twenty Mile Creek Stations 2 and 3.

The fish captured within Twenty Mile Creek are characteristic of a warm to coolwater system. Species captured are either intermediately tolerant or tolerant to environmental perturbations and changes in water temperature and turbidity (Eakins, 2025).

3.3.4.4.3 Stoney Creek

Stoney Creek Station 2 was located within Reach 3-SC1b (ST02; Figure 3.1.1). The sampling station was partially within a hedgerow that provided overhead cover and partially within an open area where dense instream vegetation was prevalent. Bed material consisted of clay, silt and organics, and the channel had a plain bed morphology. At this station, one coolwater fish was captured, Brook Stickleback (Table 3.3.3.).

The stream fish community of Stoney Creek within the Study Area was assessed in 2016 at the same station location (labeled as ST02 within the 2018 SWS), and two additional stations within inaccessible areas; a stream station within Reach 3-SC1b (ST01) and a pond station within Reach 5-SC1 (ST-Ponds; Aquafor Beech Ltd., 2018). At ST01, four species were captured: Central Mudminnow, Fathead Minnow, Brook Stickleback and an unknown Sunfish species (*Lepomis* sp.). At ST02, where sampling was repeated in 2024, two species were captured: Brook Stickleback (which were also captured in 2024) and Fathead Minnow. Within the ponds connected to Reach 5-SC1 (ST-Ponds), only one species of fish was captured: Green Sunfish (*Lepomis cyanellus*).

The fish captured within Stoney Creek are characteristic of warm to coolwater systems. Species captured are either intermediately tolerant or tolerant to environmental perturbations and changes in water temperature and turbidity (Eakins, 2025).

3.3.4.4.4 Hannon Creek

No fish sampling was completed within the Hannon Creek subwatershed.

3.3.4.4.5 Upper Davis Creek

No fish sampling was completed within the Upper Davis Creek subwatershed



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Table 3.3.3. Fish Sampling Results

| Scientific Name | Common Name | Environmental Tolerance Threshold* (Tolerant, Intermediate, Sensitive) | Thermal Preference* | Number of Fish Captured | | | | | |
|----------------------------|-------------------|---|---------------------|-------------------------|------------|---------------------|---------------------|---------------------|-----------------|
| | | | | Sinkhole 1 | Sinkhole 2 | Twenty Mile Creek 1 | Twenty Mile Creek 2 | Twenty Mile Creek 3 | Stoney Creek 12 |
| <i>Culaea inconstans</i> | Brook Stickleback | Intermediate | Coolwater | 0 | 16 | 0 | 0 | 0 | 1 |
| <i>Lepomis gibbosus</i> | Pumpkinseed | Intermediate | Warmwater | 1 | 3 | 0 | 0 | 0 | 0 |
| <i>Luxilus cornutus</i> | Common Shiner | Intermediate | Coolwater | 0 | 3 | 0 | 0 | 0 | 0 |
| <i>Pimephales notatus</i> | Bluntnose Minnow | Intermediate | Warmwater | 2 | 0 | 0 | 0 | 0 | 0 |
| <i>Pimephales promelas</i> | Fathead Minnow | Tolerant | Warmwater | 0 | 0 | 3 | 0 | 0 | 0 |
| <i>Umbra limi</i> | Central Mudminnow | Tolerant | Coolwater | 0 | 0 | 4 | 0 | 0 | 0 |
| TOTALS | | | | 3 | 22 | 7 | 0 | 0 | 1 |

*Eakins 2025



3.3.4.5 Benthic Communities

Benthic macroinvertebrate sampling was completed at six stations (One within Sinkhole Creek, Three within Twenty Mile Creek and one within Stoney Creek) on October 25, 2023 (fall event), and June 6, 2024 (spring event) (Figure 3.1.1). Additional samples were collected on November 12, 2024, for a segment of aquatic habitat located within Reach 1-Sic3-1M of Sinkhole Creek (Figure 3.1.1).

3.3.4.5.1 Data Analysis

Sample collection utilized standard methods as outlined within the OBBN Protocol Manual (Jones, Sommers, Craig, & Reynaldson, 2005). Three subsamples from each station were collected using a 500 µm mesh kick net for three-minute timed ‘travelling kick and sweep’ samples. Samples were subsampled until at least 100 specimens were found (or until no other specimen could be found within the sample) (Barb Elliot, personal communications, 2025). The teaspoon method involves processing teaspoon sized samples instead of larger volumes (i.e. bucket method – outlined by David et al., 1998). Samples were then sent to a qualified taxonomist (Barbara Elliot, Ausus Consulting) to be tabulated and sorted to the OBBN 27-group level.

Results were summarized using: Total Taxa (Total Richness), Total Specimens, Dominant Taxa and Percent Taxa, Simpson and Shannon-Wiener Diversity Index and Percent Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies; %EPT) and Ephemeroptera, Plecoptera, and Trichoptera (EPT Index) (Government of Canada, 2024; Jones et al., 2007). A summary of each of these benthic analysis metrics is provided in Table 3.3.4. and the below text.

Taxa Richness

Taxa richness indicates the diversity of taxa, or in this case OBBN groups, within the sample. Although Taxa Richness is a commonly referenced metric, it is considered a coarse indicator of stream condition and should be considered alongside other metrics to fully evaluate long-term water quality and habitat conditions.

Percent EPT (%EPT) and EPT Index

%EPT reflects the composition of the benthic community within specific groups (Ephemeroptera, Plecoptera, and Trichoptera) that are considered to be sensitive to habitat quality (i.e., a higher percentage indicates more sensitive groups). High %EPT typically occurs in areas where there is good water quality and benthic habitat.

Similar to %EPT, EPT Index reflects the habitat quality using the sensitive groups. Instead of reflecting a proportion out of 100 (i.e., percentage), the index represents the richness of those sensitive group (Ephemeroptera, Plecoptera, and Trichoptera) pooled together divided by the total number of individuals. Since these are based on sensitive groups, water quality is considered better as EPT index increases.



Simpson's Diversity and Equitability and Shannon-Wiener Diversity Index

The Simpson's Diversity and Equitability index is related to the proportion of total organisms contributed by each taxon. Simpson's Diversity can be reported as the Index (D) or its complement (1-D). The equation for the Simpson's Diversity Complement is:

$$D = 1 - \left(\sum \frac{n}{N} \right)$$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

The Shannon-Weiner Diversity Index is related to the proportion of species richness (or in this case, group richness) within an area and the evenness. The equation is:

$$H' = - \sum_{i=1}^s x_i \cdot \ln x_i$$

s = total number of species in community

i = species in community

x = proportion of each species in community

For both Simpson's Diversity Complement (1-D) and Shannon-Wiener's Diversity Index), diversity and evenness are low when the benthic community is dominated by a few OBBN groups, and higher when the number of organisms is more evenly distributed across numerous groups. High diversity and low equitability or high diversity with high equitability indicates good environmental conditions, while the opposites can indicate stresses on the system. Both indices were used to provide complementary analysis of biodiversity, with one providing information on dominance (Simpson's) and the other on evenness (Shannon's).

3.3.4.5.2 Results

The metrics calculated for the benthic invertebrates collected at each monitoring station are summarized below. It should be noted that certain sampling stations were only sampled once due to dry conditions. Even in these cases, metrics were used to provide snapshots of the water quality in these systems. Table 3.3.4. provides the 2023 and 2024 benthic invertebrate analysis results within the Study Area.



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Table 3.3.4 Summary Benthic Macroinvertebrate Sampling

| | Fall 2023 | | | | | Spring 2024 | | | | | Fall 2024 |
|---------------------------------------|--------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------|--------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------|--------------------------|
| | Sinkhole Creek Station 1 | Twenty Mile Creek Station 1 | Twenty Mile Creek Station 2 | Twenty Mile Creek Station 3 | Stoney Creek Station 1 | Sinkhole Creek Station 1 | Twenty Mile Creek Station 1 | Twenty Mile Creek Station 2 | Twenty Mile Creek Station 3 | Stoney Creek Station 1 | Sinkhole Creek Station 2 |
| Sampling ID | Sic1 | TM01 | TM02 | TM03 | ST02 | Sic1 | TM01 | TM02 | TM03 | ST02 | Sic 2 |
| Total Number of Organisms | 328 | 397 | 698 | 331 | 18 | 216 | 451 | 549 | 147 | - | 254 |
| Taxa Richness | 13 | 13 | 9 | 17 | 7 | 12 | 8 | 7 | 11 | - | 6 |
| % EPT | 14.94 | 15.62 | 2.90 | 1.21 | 0 | 0.93 | 2.66 | 1.15 | 6.12 | - | 0.79 |
| EPT Index | 0.15 | 0.16 | 0.03 | 0.01 | 0 | 0.01 | 0.03 | 0.01 | 0.06 | - | 0.01 |
| Simpson's Diversity Complement | 0.70 | 0.69 | 0.48 | 0.43 | 0.75 | 0.71 | 0.40 | 0.31 | 0.52 | - | 0.12 |
| Shannon-Wiener Diversity Index | 1.52 | 1.58 | 1.02 | 1.18 | 1.61 | 1.48 | 0.92 | 0.64 | 1.19 | - | 0.33 |



Sinkhole Creek: Station 1

Within Sinkhole Creek station 1, taxa richness was found to be moderately high during the fall 2023 and spring 2024 sampling events (13 OBBN groups in fall 2023, 12 OBBN groups in the spring 2024). In terms of sensitive benthic biota, Sinkhole Creek displayed a relatively high percentage of EPT (14.94%) during the fall 2023, versus only 0.93% of EPT during the Spring 2024 sample. An abundant amount of pollution tolerant Chironomidae were found during both sampling events. In terms of diversity calculations, Simpson's diversity was considered moderately high (Fall 2023 – 0.70, spring 2024 – 0.71), with the benthic community being comprised of multiple groups during both the spring and fall (Oligochaeta -aquatic earthworms, Isopoda - sowbugs, Coleoptera - beetles, Hemiptera – true bugs, Anisoptera - dragonflies, Ephemeroptera - mayflies, Zygoptera - damselflies, Chironomidae - midges, Amphipoda - scuds and Hirundinea - leeches). However, relative abundance and distribution of OBBN groups, as outlined by the Shannon-Weiner was found to be low in both seasons, with sow bugs, true bugs and midges making up the majority of the benthic community. Diversity metrics were similar between seasons (refer to Table 3.3.4.).

The analytical results for Sinkhole Creek represent an aquatic system that is in fair to poor condition. Based on the results, spring runoff may result in higher pollution levels in the spring. The considerable difference in EPT% during the spring and fall visits may suggest that water quality is lower during the spring months, and more stable in the fall. This seasonal water quality trend is further corroborated as the spring-time benthic samples were heavily dominated by sow bugs and midges, whereas the fall benthic results displayed higher levels of sensitive individuals including mayflies.

Sinkhole Creek: Station 2

Given that Sinkhole Creek station 2 was only sampled once, these results only provide a snapshot of the water quality and habitat characteristics. Within Sinkhole Creek station 2, taxa richness was low with only six groups being found during the fall 2024 sampling event. In terms of sensitive benthic biota, Sinkhole Creek in 2024 displayed an extremely low percentage of EPT (0.79%) (1 individual). In fall 2024, diversity values at this station were low (Simpson's: 0.12, Shannon-Wiener: 0.32), with one taxon (Chironomidae – Midges) dominating the benthic community.

Overall, the analytical results for the station at Sinkhole Creek station 2 represents an aquatic system that is in fair to poor condition given the low diversity, evenness and %EPT.

Twenty Mile Creek: Station 1

Within Twenty Mile Creek station 1 (TM01), taxa richness was found to be relatively low during the spring (only 8 OBBN groups) and moderately high in the fall (13 OBBN groups). Similar to Sinkhole Creek, Twenty Mile Creek (Station 01) displayed a relatively high percentage of EPT (15.62%) during the fall, versus only 2.66% of EPT during the spring sample. Simpson's diversity was calculated as being low during the spring (0.40), with a benthic community dominated by one filterer group (Bivalvia – Clams), but, increased during the fall (0.69) with several groups dominating the benthic community. Similar to the Simpson's diversity calculations, Shannon-Weiner diversity was lower in the spring (0.91) and higher in the fall (1.57) with an increase in the number of OBBN groups during the fall months.

Overall, the results indicate that Twenty Mile Creek station 1 ranges from poor to fairly poor conditions, and similar to Sinkhole Creek, with seasonal water trends, that are poorer in the spring months and comparatively better in the fall.



Twenty Mile Creek: Station 2

Within Twenty Mile Creek station 2 (TM02), taxa richness was found to be low during the spring (only 7 OBBN groups) and moderate in the fall (9 OBBN groups). Twenty Mile Creek station 2 displayed a comparatively low percentage of EPT in both the 2023 Fall (2.89%) and 2024 Spring (1.14%) sampling results. Simpson's diversity was calculated as being low to moderate during both the spring (0.31) and fall (0.48) seasons. Similar to the Simpson's diversity calculations, Shannon-Weiner diversity was low in the spring (0.64) and higher in the fall (1.01).

The analytical results for Twenty Mile Creek station 2 represents an aquatic system that is in poor to very poor condition. The taxa richness was found to be comparatively low to that of other monitoring stations results, with a very low % EPT in both the spring and fall. This station presented some of the lowest diversity scores (Simpson's: 0.48 and 0.31 in the fall and spring, respectively). This means that this station has the highest total number of organisms while representing a very small number of groups.

The analytical results for Twenty Mile Creek station 2 represents an aquatic system that is in poor to very poor condition. The taxa richness was found to be comparatively low to that of other monitoring stations results, with a very low % EPT in both the spring and fall. This station presented some of the lowest diversity scores (Simpson's: 0.48 and 0.31 in the fall and spring, respectively). This means that this station has the highest total number of organisms while representing a very small number of taxa. The HBI scores for both seasons were two of the highest of any sampled area within the Study Area, indicating a strong likelihood of severe organic pollution, especially in the fall.

Twenty Mile Creek: Station 3

Within Twenty Mile Creek station 3 (TM03), taxa richness was found to be moderately high during the spring (11 OBBN groups) and the highest of all sampled stations in the Study Area, during the fall (17 OBBN groups). Twenty Mile Creek station 3 displayed a comparatively low percentage of EPT in the 2023 Fall (1.21%) and slightly higher in the 2024 Spring (6.12%) sampling results. Diversity was identified as being moderate (Simpson's: 0.43 – Fall 2024, 0.52 – Spring 2024, Shannon-Weiner: 1.18 – Fall, 1.19 – Spring). This indicates that although the station was dominated by one group (Gastropoda – snails and limpets), other groups (ex. beetles, midges, mayflies, damselflies) still represented a fair share of the total organisms.

Overall, the results indicate that Twenty Mile Creek station 3 ranges from poor to fairly poor conditions, with water quality conditions being marginally better in the fall than in the spring. During both seasons, one group dominated the benthic macroinvertebrate community, including leeches in the spring sampling results, and snails and limpets in the fall. Generally, predators such as leeches, should decrease in periods of disturbance; however, certain species of leeches are moderately tolerant of pollution and low oxygen conditions, and their presence in large numbers may indicate low dissolved oxygen caused by organic pollution (Voshell & Reese, 2002). For the elevated levels of snails and limpets, their functional feeding group is Shredders and Scrapers, which are both typically elevated in the fall season with more abundant leaf litter (shredders) and higher sunlight due to canopy loss promotes algae growth on rocks and other stream substrates (scrapers) (Merritt & Cummins, 2007).



Stoney Creek: Station 1

Due to generally dry conditions, sampling was not completed in the spring of 2024 for Stoney Creek. The following results summary is based on the 2023 fall results only.

Within Stoney Creek in 2023, taxa richness was found to be low (only 7 OBBN groups) with very few individuals were found during the fall 2023 sampling (Total = 18 individuals). No individuals from the EPT group were identified at the station. However, as mentioned previously, this sampling station was considered a wetland and %EPT cannot be used individually to assess water quality as these groups may not occupy wetlands (slow moving, low oxygen) as frequently as stream systems (fast flowing, higher oxygen). Therefore, richness and diversity metrics are the primary metrics used in this evaluation.

Diversity values at this station were moderate in fall 2023 (Simpson's: 0.75, Shannon-Wiener: 1.61). Diversity was considered moderate to high as a similar proportion of each OBBN group was found during sampling.

Based on the 2023 fall sample, the benthic analysis results indicate that the portion of Stoney Creek within the Study Area exhibits generally poor to fair water quality conditions.

Hannon Creek

No benthic macroinvertebrate sampling was completed for the Hannon Creek subwatershed.

Upper Davis Creek

No benthic macroinvertebrate sampling was completed for Upper Davis Creek subwatershed.

3.3.5 Conclusions and Recommendations

Of the five subwatersheds assessed within the Study Area, watercourses were identified in three; Sinkhole Creek, Twenty Mile Creek and Stoney Creek. Headwater features requiring mitigation were classified within Hannon Creek using the HDF Assessment Methodology. No headwaters were identified within the Upper Davis Creek subwatershed.

Sinkhole Creek is a coolwater system predominantly composed of headwater features the majority of which were classified as not requiring management. The habitat within Reach 1-SIC4, upstream of the confluence with Branch 1-SIC3, is characterized as marginal using the criteria of the UHOP (City of Hamilton, 2013), with intermittent flows being conveyed through a poorly defined channel transecting agricultural lands. Within Branch 1-SIC3, Reach 1-SIC2 and Reach 1-SIC1, the flow regime is permanent and, although poorly defined, the channel conveys flow through dense vegetation often within linear wetland features. In these areas, groundwater upwelling was observed as were larger and deeper pool features that may provide refuge for fish during lower flow periods. This channel is considered important using the criteria of the UHOP (City of Hamilton, 2013).

Twenty Mile Creek within the Study area is a warm-coolwater system. Of the eight branches identified within the Study area, six were classified as headwaters requiring no management, one was classified as a headwater that requires mitigation and parts of one branch, TMC1, were classified as a watercourse. Specifically, two reaches within this branch, Reach 1-TMC1a and Reach1-TMC1b are considered a watercourse. Within these reaches, the watercourse conveys flow within hedgerows and



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as a ditch feature adjacent to Fletcher Road and Golf Course Road. Here, permanent flow is typically conveyed through dense vegetation, with fragmented areas of open water where the canopy is better established. Fish were captured within Reach 1-TMC1a in 2024 (Station Twenty Mile Creek 1). This channel offers important habitat based on the criteria of the UHOP.

Stoney Creek within the Study Area is as a coolwater system. The majority of the subwatershed within the Study Area is composed of headwater drainage features that were classified as no management or that require mitigation. Reach 5-SC1, 5-SC2 and 5-SC3 were not assessed in the field and in the interim are considered a watercourse. A desktop analysis suggests that Reach 5-SC3 and 5-SC2 convey flow through emergent vegetation between agricultural fields, likely providing limited opportunity for fish habitat and is therefore best characterized as marginal habitat. Within Reach 5-SC1 are three online ponds where previous assessments have captured Sunfish (*Lepomis sp.*), a warmwater species. This suggests that Reach 5-SC1 may be considered important based on the criteria of the UHOP (City of Hamilton, 2013). The watercourse downstream of Reach 5-SC1 (i.e., Reach 3-SC1c, 3-SC1b, 3-SC1a and 3-SC2) is a straightened feature either transecting agricultural fields or acting as a roadside that generally conveys flow through dense emergent vegetation. Within the watercourse, a relatively resilient coolwater species (brook stickleback) has been captured as well as several warmwater species. The habitat provided by these reaches is considered marginal and may provide opportunity for remediation.



3.4 Surface Water Assessment

3.4.1 Objective

The Phase 1 SWP includes an existing conditions surface water assessment of lands situated within the Study Area with the intent of accomplishing the following:

- Supplemental characterization of the existing surface water quality through the Study Area
- Discretize existing drainage patterns and subcatchment areas within the Study Area, to produce peak flow estimates for discrete events (2-year to 100-year and Regional Storm)
- Establish existing conditions peak flow targets for SWM water quantity controls
- Establish a baseline (existing conditions) hydrology model to inform the flood hazard mapping and future conditions hydrology model development
- Prepare an updated hydraulic model (HEC-RAS), using the revised peak flow data, to delineate updated flood hazard mapping and associated buffers throughout the Study Area
- Assess the available hydraulic capacity of existing municipal culvert crossings throughout the Study Area against current Ministry of Transportation (MTO) Engineering Standards

3.4.2 Background

As outlined in **Section 1.3**, and shown on Figure 1.3.1, the Study Area overlaps six subwatersheds including Stoney Creek, Hannon Creek, Upper Davis Creek, West Twenty Mile Creek, East Twenty Mile Creek, and Sinkhole Creek. The topography of the Study Area and the drainage boundaries of the six subwatersheds can be found in Figure 3.4.1. These subwatersheds are hydrologically connected to lands within the Study Area and form part of the future Secondary Plan for the Study Area. They are within the upper reaches of the Niagara Peninsula and Hamilton Watershed systems, ultimately discharging to Lake Ontario through downstream tributaries. The physiography of the Study Area consists of two physiographic regions, the extents of which can be seen on Figure 3.4.2. The prominent existing land uses within the Study Area consist of agricultural and natural open spaces with localized residential and commercial uses.

The Study Area was discretized into subcatchments. The subcatchment identification nomenclature is based on the subwatershed they are within. Table 3.4.1 below provides a summary of the subcatchment identification nomenclature, and Figure 3.4.3 identifies the delineation of the subcatchments.

Table 3.4.1 Subcatchment Nomenclature

| Subwatershed | Series |
|------------------------|--------|
| Sinkhole Creek | 100 |
| West Twenty Mile Creek | 200 |
| East Twenty Mile Creek | 300 |
| Stoney Creek | 400 |
| Hannon Creek | 500 |
| Upper Davis Creek | 600 |

The following sections describe the field collected water quality monitoring data and the existing hydrologic, hydraulic, and flood hazard conditions within and adjacent to the Study Area.



3.4.3 Surface Water Monitoring

In support of the subwatershed management strategy, surface water quality data has been collected and assessed along the edges of the Study Area. Sampling was performed between October 2023 and November 2024. The data collection methodology is explained in **Section 3.4.3.1** and results are discussed in **Section 3.4.3.2**.

3.4.3.1 Data Collection Methods

Surface water quality data was collected at three locations, one for each creek, within the Study Area. Twenty Mile Creek is identified as '20MC', Sinkhole Creek as 'SHC', and Stoney Creek as 'SC.' Monitoring locations are shown on Figure 3.4.4. Details of the monitoring stations are summarized in Table 3.4.2.

During the sampling program, there was one dry-weather sampling event and four additional discrete sampling days. On each of these days, samples were collected at three discrete locations, with three samples taken at each location. The five days of sampling took place between October 2023 and November 2024.

The sampling days of October 25, 2023, September 6, 2024, and September 24, 2024, occurred during rain events. The September 24, 2024, sampling took place under wet weather conditions, with an additional 21.9 mm of precipitation in the five days prior to the 23.1 mm of rainfall on the day of sampling. The sampling dates of October 25, 2023, and September 6, 2024, had had drier conditions with only 6.5 mm and 0 mm of precipitation, respectively in the previous five days. However, rainfall did occur on both sampling days with 5.4 mm recorded on October 25, 2023, and 5.9 mm on September 6, 2024.

On June 28, 2024, a dry weather sample was collected as there was no rain event during the day of sampling or in the previous 24 hours. Samples taken on November 21, 2024, occurred after a rain event, with 14.6 mm of precipitation occurring in the last 24 hours before sampling.

Table 3.4.2. Summary of Surface Water Monitoring Stations

| Station ID | Location Description | Coordinates | Hydraulic Control Infrastructure | Monitoring Dates |
|------------|---|-----------------------------|----------------------------------|---|
| 20MC | Upstream end of a concrete culvert passing under Golf Club Road. | 43.161273 N, 79.811126 W | Open-bottom Box Culvert | October 25, 2023, June 28, 2024, September 6, 2024, September 24, 2024, November 21, 2024 |
| SHC | Upstream end of a concrete culvert passing under Hendershot Road. | 43.159491 N, 79.761534 W | Open-bottom Box Culvert | October 25, 2023, June 28, 2024, September 6, 2024, September 24, 2024, November 21, 2024 |
| SC | Upstream end of a concrete culvert passing under Second Road E. | 43.183414 N, 79.750677 W | Open-bottom Box Culvert | October 25, 2023, June 28, 2024, September 6, 2024, September 24, 2024, November 21, 2024 |

Water quality samples were collected by Stantec field staff directly into pre-labelled laboratory supplied sample bottles from a depth of approximately 5 cm below the water surface (wherever possible). A field duplicate was collected from a different station during each monitoring visit. Water quality sample collection was performed according to approved methods for grab sampling including sample vial



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labeling, sample storage in cooler to avoid thermal sample integrity breaches and completion of Chain-of-Custody sample submission documentation. Water quality samples were delivered in iced insulated coolers to Bureau Veritas (BV) located in Mississauga, Ontario. BV is an accredited laboratory by the Standards Council of Canada (SCC). BV has an in-house QA/QC program to govern sample analysis, including duplicates. Surface water quality samples were analyzed for RCap-Surface Water, Total Suspended Solids (TSS), total kjeldahl nitrogen (TKN), and biochemical oxygen demand (BOD). Detection limits used for the laboratory analysis are well below Ontario's Provincial Water Quality Objective (PWQO) limits (MECP, 1994).

At the time of water quality sample collection, in-situ water quality measurements were taken using a YSI multi-parameter device at each surface water quality sampling location. These in-situ water quality measurements consist of temperature and dissolved oxygen.

3.4.3.2 Field Collected Data

This section provides a summary of the water quality parameters measured in samples collected from three sampling locations throughout the Study Area. The laboratory Certificates of Analysis provided by BV are provided in **Appendix F1**.

3.4.3.2.1 *Twenty Mile Creek Water Quality Results*

Table 3.4.3 is a water quality summary of general constituents and nutrients from samples collected at the Twenty Mile Creek station.

The temperature values observed at the Twenty Mile Creek sampling location were below the PWQO exceedance target of 30°C. The highest temperature sampled was 20.2°C on September 6, 2025, at 14:15 and the lowest temperature was 5.8°C on November 21, 2024, at 8:30.

The pH values observed at the Twenty Mile Creek sampling dates were within the PWQO range of 6.5 – 8.5. The highest pH value was 8.06 on October 25, 2023, at 17:15 and the lowest pH value was 7.73 on September 24, 2024, at 9:30.

Every sample taken at the Twenty Mile Creek sampling location exceeded the total phosphorus PWQO limit of 0.03 mg/L. The total phosphorus concentrations from all the dates ranged from 0.067 - 0.22 mg/L. The sample date of November 21, 2024, at 8:30 had the highest observed value of 0.22 mg/L.

Dissolved Chloride values ranged from 110 to 240 mg/L. The lowest value was observed on November 21, 2024, at 8:30 and the highest values were observed on October 25, 2023, at 17:15 and June 28, 2024, at 13:15.

The samples taken from the Twenty Mile Creek location all resulted in relatively low concentrations of dissolved oxygen (DO) with ten out of thirteen samples below the target concentration. Dissolved oxygen concentrations are aimed to be greater than 5 mg/L and the samples taken from the Twenty Mile Creek ranged from 0.2 – 10.7 mg/L. The lowest concentration of DO was observed on October 25, 2023, at 17:15 and the highest concentration of DO was observed on November 21, 2024, at 8:30.



Table 3.4.3. Twenty Mile Creek Water Quality Summary

| Parameters | | Temperature (°C) | DO (mg/L) | pH | Dissolved Chloride (Cl-) (mg/L) | Nitrate + Nitrite (N) (mg/L) | Total Phosphorus (mg/L) | Total Suspended Solids (mg/L) |
|--------------------------------|-------|------------------|-----------|-----------|---------------------------------|------------------------------|-------------------------|-------------------------------|
| Regional Detection Limit (RDL) | | - | - | - | 1 | 0.1 | 0.004 | 1 |
| Water Quality Objectives | | - | > 5.0 | 6.5 – 8.5 | - | - | 0.03 | - |
| Morning | | | | | | | | |
| Date | Name | | | | | | | |
| 6/28/2024 9:30 | 20MC1 | 15.3 | 1* | 7.84 | 220 | <0.10 | 0.18* | 4 |
| 9/6/2024 10:45 | 20MC1 | 18.6 | 1.6* | 7.94 | 190 | <0.10 | 0.16* | 45 |
| 9/24/2024 9:30 | 20MC1 | 19 | 3.7* | 7.73 | 160 | <0.10 | 0.15* | 2 |
| 11/21/2024 8:30 | 20MC1 | 5.8 | 10.7 | 7.83 | 110 | 0.6 | 0.22* | 38 |
| Afternoon | | | | | | | | |
| Date | Name | | | | | | | |
| 6/28/2024 13:15 | 20MC2 | 17.3 | 1.9* | 7.84 | 240 | <0.10 | 0.17* | 5 |
| 9/6/2024 14:15 | 20MC2 | 20.2 | 4* | 7.95 | 210 | <0.10 | 0.2* | 16 |
| 9/24/2024 12:30 | 20MC2 | 19 | 3.9* | 7.85 | 170 | <0.10 | 0.14* | 3 |
| 11/21/2024 13:15 | 20MC2 | 7.1 | 10.5 | 7.79 | 120 | 0.69 | 0.17* | 28 |
| Evening | | | | | | | | |
| Date | Name | | | | | | | |
| 10/25/2023 17:15 | 20MC | 14 | 0.2* | 8.06 | 240 | <0.10 | 0.07* | 11 |
| 6/28/2024 16:20 | 20MC3 | 18.5 | 2.4* | 7.83 | 230 | <0.10 | 0.16* | 3 |
| 9/6/2024 14:15 | 20MC3 | 20 | 2.9* | 7.9 | 210 | <0.10 | 0.19* | 25 |
| 9/24/2024 16:00 | 20MC3 | 19.3 | 3.8* | 7.83 | 170 | <0.10 | 0.18* | 34 |
| 11/21/2024 16:45 | 20MC3 | 7.5 | 10.4 | 7.96 | 130 | 0.68 | 0.15* | 26 |

* = Value exceeds the indicated standard

3.4.3.2.2 Sinkhole Creek Water Quality Results

Table 3.4.4 is a water quality summary of general constituents and nutrients from samples collected at the Sinkhole Creek location. It is noted that five sampling days took place and four of 5 days had three samples taken.

The temperature values observed at the Sinkhole Creek sampling location were below the PWQO exceedance target of 30°C. The highest temperature sampled was 22.3°C on June 28, 2024, at 13:45 and the lowest temperature was 5.9°C on November 21, 2024, at 9:00.



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The pH values observed at the Sinkhole Creek sampling dates were within the PWQO range of 6.5 – 8.5. The highest pH value was 8.31 on October 25, 2023, at 16:10 and the lowest pH value was 7.76 on September 24, 2024, at 10:10.

Every sample taken at the Sinkhole Creek sampling location exceeded the total phosphorus PWQO limit of 0.03 mg/L. The total phosphorus concentrations from all the dates ranged from 0.071 - 0.22 mg/L. The sample date of November 21, 2024, at 15:45 had the highest observed value of 0.22 mg/L.

Dissolved Chloride values ranged from 64 to 220 mg/L. The lowest value was observed on November 21, 2024, at 15:45 and the highest value was observed on June 28, 2024, at 10:15 and 13:45.

The samples taken from the Sinkhole Creek location all resulted being close to the targeted concentrations of dissolved oxygen (DO) with three out of thirteen samples below the target concentration. Dissolved oxygen concentrations are aimed to be greater than 5 mg/L and the samples taken from the Sinkhole Creek ranged from 3.3 – 12.2 mg/L. The lowest concentration of DO was observed on September 24, 2024, at 10:10 and the highest concentration of DO was observed on June 28, 2024, at 9:30.

Table 3.4.4. Sinkhole Creek Water Quality Summary

| Parameters | | Temperature (°C) | DO (mg/L) | pH | Dissolved + Chloride (Cl-) (mg/L) | Nitrate | | Total Suspended Solids (mg/L) |
|--------------------------------|------|---------------------|--------------|------|--|--------------------------|-------------------------------|--|
| | | | | | | Nitrite (N) (mg/L) | Total Phosphorus (mg/L) | |
| Regional Detection Limit (RDL) | | - | - | - | 1 | 0.1 | 0.004 | 1 |
| Water Quality Objectives | | > 5.0 | 6.5 – 8.5 | - | - | - | 0.03 | - |
| Morning | | | | | | | | |
| Date | Name | | | | | | | |
| 6/28/2024 10:15 | SHC1 | 19.7 | 7.3 | 8.02 | 220 | <0.10 | 0.082* | 11 |
| 9/6/2024 11:45 | SHC1 | 18.5 | 3.6* | 8.04 | 96 | <0.10 | 0.08* | 22 |
| 9/24/2024 10:10 | SHC1 | 19.5 | 3.3* | 7.76 | 99 | 0.12 | 0.18** | 34 |
| 11/21/2024 9:00 | SHC1 | 5.9 | 10.1 | 7.87 | 74 | 0.37 | 0.16 | 82 |
| Afternoon | | | | | | | | |
| Date | Name | | | | | | | |
| 6/28/2024 13:45 | SHC2 | 22.3 | 11.8 | 8.12 | 220 | <0.10 | 0.08* | 8 |
| 9/6/2024 14:45 | SHC2 | 20.1 | 5.8 | 8.06 | 93 | <0.10 | 0.071* | 16 |
| 9/24/2024 13:00 | SHC2 | 19.8 | 5.67 | 7.84 | 98 | <0.10 | 0.16* | 38 |
| 11/21/2024 12:15 | SHC2 | 6.1 | 10.8 | 7.91 | 66 | 0.51 | 0.21* | 100 |
| Evening | | | | | | | | |
| Date | Name | | | | | | | |
| 10/25/2023 16:10 | SHC | 15.4 | 10.6 | 8.31 | 130 | <0.10 | 0.041* | 8 |
| 6/28/2024 9:30 | SHC3 | 22.4 | 12.2 | 8.15 | 220 | <0.10 | 0.074* | 9 |
| 9/6/2024 16:45 | SHC3 | 20.2 | 5.3 | 8.06 | 94 | <0.10 | 0.072* | 16 |
| 9/24/2024 16:15 | SHC3 | 19.9 | 4.2* | 7.89 | 100 | <0.10 | 0.15* | 33 |
| 11/21/2024 15:45 | SHC3 | 6.9 | 8.5 | 7.84 | 64 | 0.56 | 0.22* | 79 |

* = Value exceeds the indicated standard



3.4.3.2.3 Stoney Creek Water Quality Results

Table 3.4.5 is a water quality summary of general constituents and nutrients from samples collected at the Stoney Creek location. It is noted that five sampling days took place and four of 5 days had three samples taken.

The temperature values observed at the Stoney Creek sampling location were below the PWQO exceedance target of 30°C. The highest temperature sampled was 21.4°C on September 6, 2024, at 15:10 and the lowest temperature was 6.1°C on November 21, 2024, at 9:30.

The pH values observed at the Stoney Creek sampling dates were within the PWQO range of 6.5 – 8.5. The highest pH value was 8.07 on June 28, 2024, at 4:45 and the lowest pH value was 7.73 on September 6, 2024, at 17:10.

Every sample taken at the Stoney Creek sampling location exceeded the total phosphorus PWQO limit of 0.03 mg/L. The total phosphorus concentrations at all the dates ranged from 0.041 - 0.33 mg/L. The sample date of September 6, 2024, at 12:10 had the highest observed value of 0.39 mg/L.

Dissolved Chloride values ranged from 80 to 230 mg/L. The lowest value was observed on November 21, 2024, at 9:30 and the highest value was observed on June 28, 2024, at 10:45.

The samples taken from the Stoney Creek location all resulted in relatively low concentrations of dissolved oxygen (DO) with seven out of thirteen samples below the target concentration. Dissolved oxygen concentrations are aimed to be greater than 5 mg/L and the samples taken from the Stoney Creek ranged from 0.2 – 10.3 mg/L. The lowest concentration was observed on September 6, 2024, at 12:10 and 15:10. The highest concentration of DO was observed on November 21, 2024, at 16:15.

Table 3.4.5. Stoney Creek Water Quality Summary

| Parameters | | Temperature (°C) | DO (mg/L) | pH | Dissolved Chloride (Cl-) (mg/L) | Nitrate + Nitrite (N) (mg/L) | Total Phosphorus (mg/L) | Total Suspended Solids (mg/L) |
|--------------------------------|------|---------------------|--------------|-----------|---------------------------------------|------------------------------------|----------------------------|----------------------------------|
| Regional Detection Limit (RDL) | | - | - | - | 1 | 0.1 | 0.004 | 1 |
| Water Quality Objectives | | - | > 5.0 | 6.5 – 8.5 | - | - | 0.03 | - |
| Morning | | | | | | | | |
| Date | Name | | | | | | | |
| 6/28/2024 10:45 | SC1 | 17.3 | 6.8 | 7.8 | 230 | <0.10 | 0.19* | 13 |
| 9/6/2024 12:10 | SC1 | 18.9 | 0.2* | 7.77 | 120 | <0.10 | 0.39* | 290 |
| 9/24/2024 10:40 | SC1 | 19.2 | 3* | 7.83 | 100 | <0.10 | 0.13* | 4 |
| 11/21/2024 9:30 | SC1 | 6.1 | 9.4 | 7.75 | 80 | 1.8 | 0.33* | 74 |
| Afternoon | | | | | | | | |
| Date | Name | | | | | | | |
| 6/28/2024 14:00 | SC2 | 18.9 | 6.9 | 7.8 | 220 | <0.10 | 0.19* | 39 |
| 9/6/2024 15:10 | SC2 | 21.4 | 0.2* | 7.74 | 120 | <0.10 | 0.23* | 73 |
| 9/24/2024 13:30 | SC2 | 19.2 | 3.4* | 7.79 | 100 | <0.10 | 0.12* | 7 |
| 11/21/2024 8:30 | SC2 | 6.4 | 9.6 | 7.97 | 92 | 1.36 | 0.24* | 58 |
| Evening | | | | | | | | |



| Parameters | | Temperature (°C) | DO (mg/L) | pH | Dissolved Chloride (Cl-) (mg/L) | Nitrate + Nitrite (N) (mg/L) | Total Phosphorus (mg/L) | Total Suspended Solids (mg/L) |
|------------------|------|---------------------|--------------|------|---------------------------------------|------------------------------------|----------------------------|----------------------------------|
| Date | Name | | | | | | | |
| 10/25/2023 4:45 | SC | 16 | 7.22 | 8.07 | 210 | <0.10 | 0.041* | 15 |
| 6/28/2024 17:00 | SC3 | 19.2 | 4.5* | 7.75 | 210 | <0.10 | 0.16* | 10 |
| 9/6/2024 17:10 | SC3 | 21 | 0.3* | 7.73 | 120 | <0.10 | 0.29* | 180 |
| 9/24/2024 16:30 | SC3 | 19.4 | 2.9* | 7.79 | 110 | <0.10 | 0.11* | 6 |
| 11/21/2024 16:15 | SC3 | 6.7 | 10.3 | 7.9 | 92 | 1.05 | 0.19* | 49 |

* = Value exceeds the indicated standard

3.4.4 Hydrological Model

To model the existing hydrological conditions, a hydrology model was created using Visual Otthymo v6.2 (VO). This modeling software was selected due to its well-known accuracy at modelling large rural drainage basins.

Two hydrology models were developed to reflect development conditions:

1. Conditions with SWM Infrastructure - Reflects conditions including all known (at the time of writing) existing or proposed-and-approved SWM infrastructure. This model includes three RouteReservoir commands to represent the SWM controls in the upstream, external subcatchments. The flows generated by this model provide an existing conditions baseline for future phases.
2. Conditions without SWM Infrastructure - Reflects conditions excluding all known (at the time of writing) existing SWM infrastructure. The flows generated from this model were used for the purposes of floodplain mapping and the roadway crossing assessment.

Otherwise, all subcatchment parameters and flow patterns between the two models are the same.

3.4.4.1 Subcatchment Delineation

Subcatchments within the Study Area have been discretized to a level of detail considered appropriate for SWP planning purposes, and to provide flows at relevant locations to support the floodplain mapping. Section 3.4.5 provides further details on the hydraulic modelling.

To delineate subcatchment boundaries, a flow accumulation model¹ was created using two sources of survey data. The area within the Elfrida study limits was surveyed, and the topographic plan (A.T. McLaren Ltd., 2024) can be found in **Appendix F2.**, and Figure 3.4.1 shows the topography of the Study Area and surrounding area. Publicly available LiDAR data was used for any external lands included in the model, and was retrieved from Ontario's Geohub website. The LiDAR data was

¹ The Spatial Analyst extension for ArcGIS Pro v3.4.1 was used to generate the flow accumulation model.



converted from the CGVD2013 vertical datum to CGVD28:78 to match the survey data, and then the two datasets were combined into one Digital Elevation Model (DEM).

Once the flow accumulation model was complete, the lands contributing to each subwatershed were delineated, and any external drainage was identified. Subsequently, each subwatershed was delineated into subcatchments, with consideration given to important flow change locations (i.e. confluences and roadways) for hydraulic modelling and culvert capacity calculations. This resulted in 82 subcatchments, of which 66 are internal and 16 are external. Subcatchments remain grouped into their associated subwatershed series throughout this report, as explained in **Section 3.4.2**. The location of these subcatchments can be found in Figure 3.4.3.

3.4.4.2 Design Storm Selection and Model Parameters

Design storm files used in the hydrology models apply the 4-hour Chicago distribution to the 25mm event, and the 12-hour Atmospheric Environment Service (AES) distribution to the 2-year through 100-year events. A climate change scenario for the 100-year event has also been modelled to inform future phases. The climate change scenario has not been used in the floodplain mapping (discussed in Section 3.4.5). It is proposed that climate change may be accounted for in future development through over-control by increasing the volumes provided in proposed SWM facilities to offset increases in runoff due to climate change, controlling future climate change flows back to existing conditions. The 12-hour AES distribution is applied by the NPCA in their floodplain mapping of Sinkhole Creek (NPCA, April 2006) and Twenty Mile Creek (NPCA, August 2007) and was selected for consistency.

The 12-hour duration was selected over shorter design storm options due to the slower runoff response and longer travel times of the primarily rural watersheds. As provided in the City of Hamilton Standards (Comprehensive Development Guidelines and Financial Policies Manual (2019)), the Mount Hope Intensity-Duration-Frequency curves were used to generate the design storms. The 48-hour Hurricane Hazel storm has also been applied to the model as the Regional Storm for the Study Area.

The hydrology model was run for the 25mm event, 2-year through 100-year events, and the Regional Storm, as described above, for every subwatershed and subcatchment within the proposed future Elfrida Secondary Plan Area.

The majority of subcatchments within the Study Area are rural with imperviousness levels less than 20% and were modelled using the NasHyd command. Exceptions are listed below:

- **Subcatchments 121 & 124:** Both these subcatchments include commercial type land uses including gravel parking lots, resulting in an imperviousness of 28% and 29% respectively. However, based on satellite imagery, these subcatchments still do not have characteristics of an urban subcatchment (i.e. no storm sewer, all impervious area flows to pervious area). Therefore, these subcatchments, while having impervious percentages greater than 20%, are still modelled using NasHyd commands.
- **Subcatchment 441:** This subcatchment includes commercial land use including a paved parking lot and rooftop, resulting in an impervious percentage of 45%. There is evidence from satellite imagery that a storm sewer system exists within the subcatchment. This subcatchment was modelled with a StandHyd.

The SCS curve number (CN) approach was selected to estimate runoff. SCS CN and initial abstraction (IA) for Study Area subcatchments were calculated on an area-weighted basis using background shapefiles including land use, ecological land classification and underlying hydrological soils data. The



land use can be seen in Figure 3.4.5. Time-of-concentration (Tc) and time-to-peak (Tp) were calculated either using Bransby Williams or Airport method depending on calculated value of runoff coefficient for each unique subcatchment area. Bransby Williams equation is applied when runoff coefficient is calculated to be more than 0.40 and Airport equation is applied when runoff coefficient was found to be less than 0.40. See **Appendix F3** for a summary of key existing conditions input model parameters for Study Area.

Upstream subcatchments are routed to downstream flow nodes using the channel routing within VO. Lengths and slopes of the channels were approximated in the GIS flow accumulation model, and select cross-sections were approximated from the HEC-RAS model and assigned to channel routing features based on drainage area and the survey data. Route channel lengths and slopes can be found in **Appendix F3**.

3.4.4.3 External Subcatchments

The subcatchments external to the site are in various stages of development. Table 3.4.6, below, provides a summary of the assumptions related to site condition which informed the modelling parameters for the external subcatchments.

Table 3.4.6. Assumptions Effecting External Subcatchment Parameters

| Subcatchments | Assumptions (Based on satellite imagery) |
|------------------------------------|---|
| 10, 12, 43, 44, 45 | Existing Urban – StandHyd These subcatchments are currently urban subcatchments and are modelled as such. |
| 11, 42 | Proposed Urban – StandHyd These subcatchments are in the process of being developed and therefore are modelled as fully developed. |
| 20, 21, 22, 23, 30, 31, 32, 40, 41 | Existing Rural – NashHyd These subcatchments are currently rural subcatchments and no development plans were provided for these areas. |

Subcatchments 11, 42, and 43 were derived from drainage areas to SWM facilities described in the following reports:

- Subcatchment 11 is derived from the drainage area to “SWM FACILITY 2 (WET POND)” in Figure 2A, from Part 1 of 3 of the *Stormwater Management Report for Summit Park Swayze Lands – City of Hamilton (Glanbrook), A.J. Clarke and Associated Ltd.* (October 2017).
- Subcatchment 42 is derived from the drainage area to “EAST POND” in Figure 2, from *Stormwater Management Report, Felker Neighbourhood – Phase 1 – City of Hamilton, Pitura Husson Limited* (April 2011).
- Subcatchment 43 is derived from the drainage area to “EXISTING POND” in Drawing No. SWM 2, from *Highgate Meadow Estates Plan of Subdivision, Storm Water Pond Retrofit to Quality/Quantity Pond – City of Hamilton (Stoney Creek), The Odan/Detech Group Inc.* (March 2009).

Percent impervious values of subcatchments 11, 42 and 43 are sourced from their respective SWM reports, however the impervious area of subcatchment 43 was increased to better reflect satellite imagery. Subcatchment 43 was updated further to include the pond block area, as it was not previously included in the calculations performed for “EXISTING POND” in 2009.



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In the model including SWM infrastructure, three SWM facilities were modelled using the RouteReservoir command. The location of these RouteReservoirs is provided on the Schematic included in **Appendix F4**. The methodology used to determine their respective Discharge-Storage curve is explained below:

- RouteReservoir NHYD 874 (located in subcatchment 11) was sized using the VO sizing tool to reflect all SWM infrastructure described within Part 1 of 3 of the *Stormwater Management Report for Summit Park Swayze Lands – City of Hamilton (Glanbrook), A.J. Clarke and Associated Ltd.* (October 2017). Outflows provided in the report for the 25mm, 5-, 25- and 100-year events were used as target flows for each event. It is noted in the report that the final pond in the treatment train will provide additional quantity control to all incoming flows.
- Subcatchment 42 contains RouteReservoir command NHYD 872, while subcatchment 43 contains RouteReservoir command NHYD 873. The Discharge-Storage curves for NHYD 872 and 873 were taken directly from the VO output included in the SWM reports mentioned above.

3.4.4.4 Flow Results

The hydrology model was run for the 25mm event, 2-year through 100-year events, and the Regional Storm, as described above, for every subwatershed and subcatchment within the proposed future Elfrida Secondary Plan Area. These flows can be referenced in **Appendix F4**.

Some peak flow rates were prorated to accommodate flow change locations within the hydraulic model. Subcatchments where prorating was required include 451, 443, 430, 410, and 120. The peak flow was reduced by the ratio of area draining to a given flow change location within a subcatchment, to the total area of that subcatchment. Peak flows from RouteChannel commands were considered when necessary. These flows and their appropriate hydraulic model flow change location can be found in **Appendix F4**.

Detailed hydrological model input parameter calculations are provided in **Appendix F3**. The existing conditions hydrologic model schematic and detailed output files are included in **Appendix F4**.

3.4.4.5 Flow Comparison

The flows generated by the VO hydrologic model were compared to background hydrology documentation and regional regression analysis to verify their validity. While consistently higher, the VO flows are comparable to these analyses. However, these analyses were deemed unreliable due to flow gauges being distant from the Study Area, and the data was insufficient or of the incorrect scale to apply to the Boundary Area. Therefore, the most applicable background documentation was determined to be the NPCA floodplain mapping exercise performed in 2006. This modelling covers 78.8% of the Study Area and at the time of analysis this was the only downstream floodplain mapping provided.

Therefore, it was decided that it is preferable to maintain a conservative model rather than precisely match data that may be unreliable and lead to underestimations of peak flows.

3.4.4.5.1 NPCA Floodplain Mapping Comparison

NPCA policy defines the flood hazard as the 100 year flood event. The 100-year event flows generated from the model without SWM infrastructure were compared to the flows (100-year event) generated in the NPCA Floodplain Mapping Analysis for Sinkhole Creek (NPCA, April 2006) and Twenty Mile Creek (NPCA, August 2007). Key nodes which can be easily compared are included below in Table 3.4.7, with



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a more detailed table provided in **Appendix F4**. VO nodes can be located using the schematic provided in **Appendix F4** and Figure 3.4.3, while the NPCA IDs can be found in the Floodplain Mapping Analysis for the Sinkhole Creek (NPCA, April 2006) and Twenty Mile Creek (NPCA, August 2007).

NPCA catchments are more expansive than those used in the VO model, therefore some of the NPCA flows were prorated to match the drainage areas of the VO nodes and provide a more accurate comparison. For larger catchment proration, Equation 8.31 is provided in the MTO Drainage Management Manual (1997) and was used to calculate the flows presented in the table below.

Equation 8.31:

$$Q_2 = Q_1 * (A_2 / A_1) ^ 0.75, \text{ where:}$$

$$Q_2 = Q_1 \left(\frac{A_2}{A_1} \right)^{0.75}$$

Q_2 = prorated area peak discharge [m³/s],

Q_1 = total area peak discharge (downstream) [m³/s],

A_2 = prorated area [m²],

A_1 = total area [m²]

Table 3.4.7: Existing Conditions 100-year Peak Flow Summary – Comparison (Study Area)

| VO Node | NPCA ID | VO Flow - Model Without SWM Infrastructure (m3/s) | NPCA Prorated flow – 2006 or 2007 report (m3/s) |
|---------|----------|---|---|
| 1300 | SiCk-6 | 9.25 | 6.84 |
| 1400 | SiCk-7 | 7.91 | 5.86 |
| 1201 | J-Si-6/7 | 20.13 | NA |
| 1000 | J-Si-4/5 | 25.47 | 19.40 |
| 2000 | TwCk 44 | 9.51 | 5.16 |
| 3000 | TwCk 38 | 4.97 | 2.33 |

No nodes from Stoney Creek are shown because Stoney Creek is part of the Hamilton Conservation Authority (HCA). No existing floodplain mapping analysis from the HCA was reviewed prior to the writing of this report.

Peak flow rates resulting from the VO model are comparable to the NPCA Floodplain Mapping Analysis (2006, 2007), however the VO model peak flow rates are consistently higher. The following explanations are attributed to this finding:

- The NPCA floodplain mapping assumes a hydrologic soil group type B for the entire Study Area. The VO model used mostly soil group type C with some D, in accordance with the Government of Ontario’s *Soil Survey Complex* (March 2023), which is also generally consistent with the subsurface investigations completed as part of the Phase 1 Report. This adjustment in soil group results in higher peak flow rates from the site and is the most significant contributor to the higher peak flow rates.
- NPCA assumes undeveloped conditions throughout the Study Area. However, many external subcatchments have been developed since NPCA’s modelling, and some internal subcatchments also have an increased imperviousness compared to the NPCA floodplain mapping conditions. This has a particular impact on the flows to node 1300 above.



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- NPCA calculated the initial abstraction (IA) differently than Stantec. The method used by Stantec is recommended in the VO manual for determining the initial abstraction, which was established following a literature review. This has a greater effect on the smaller storm events, however, can still impact the results of the 100-year event.
 - NPCA: $IA = 0.2 \cdot S$
 - VO Model: if $CN \leq 70$, $IA = 0.075S$
if $CN > 70 \leq 80$, $IA = 0.10S$
if $CN > 80 \leq 90$, $IA = 0.15S$
if $CN > 90$, $IA = 0.2S$

The NPCA models have lumped the entire Study Area draining to Twenty Mile Creek and Sinkhole Creek into parts of five subcatchments. The VO model has discretized these subcatchments into 82 subcatchments. The size of the subcatchments affects time of concentration and thus peak flow estimates and therefore contributes to the differences between the VO and NPCA flows.

Considering the above, it is assumed that while the flows established as part of this floodplain mapping are greater than those presented by NPCA in 2006 and 2007, they are representative of the current conditions and latest site information.

During Phase 2 of the SWP, these flows will be used in conjunction with the future conditions hydrology analysis to determine the need for additional SWM requirements. The implementation of LID strategies will also be determined in Phase 2, drawing upon the pre-development water balance targets summarized in **Section 3.5**.

3.4.5 Hydraulic Model

Hydraulic modelling and associated floodplain mapping were undertaken to define the flood hazard along the major stream reaches within the Study Area. The major stream reaches were considered to include defined watercourses or HDF's identified for "conservation" and "protection". The purpose of this section of the report is to summarize the 1-dimensional hydraulic model development for the study reaches, including creating a georeferenced model, defining cross section geometry using detailed topographic survey and LiDAR data, coding of structures, and defining detailed model parameters.

The hydraulic modelling for this SWP includes five watercourses. Characteristics of these watercourses are summarized in Table 3.4.8.

Table 3.4.8: Characteristics of the Modelled Watercourses

| Name of Watercourse | Description | Total Length (m) |
|--------------------------|--|------------------|
| Sinkhole Creek | Main Sinkhole Creek from approximately 1.7 km west of Regional Road 56 to just downstream (i.e., east) of Hendershot Road | 7106 |
| Sinkhole Creek Tributary | Tributary of Sinkhole Creek running north of Highway 20 from approximately 125 m east of First Road E to just downstream (i.e., east) of Second Road E | 1215 |



| Name of Watercourse | Description | Total Length (m) |
|----------------------------------|--|-------------------------|
| East Twenty Mile Creek Tributary | Tributary of Twenty Mile Creek from immediately upstream (i.e., west) of Highway 56, running along Golf Club Road and extending downstream (i.e., south) of Golf Club Road | 789 |
| West Twenty Mile Creek Tributary | Main Twenty Mile Creek from immediately east of Trinity Church Road to just downstream (i.e., south) of Golf Club Road | 2280 |
| Stoney Creek | Stoney Creek from immediately downstream (i.e., north) of Highland Road E to just downstream (i.e., east) of Second Road E | 3812 |

3.4.5.1 Hydraulic Model Selection

The hydraulic modelling for this SWP was conducted using the latest available release of the non-proprietary software HEC-RAS (version 6.6), which was developed and is frequently updated by the Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers in Davis, California.

HEC-RAS has the ability to perform several river analysis functions including steady flow water surface profile computations, as well as one- and two-dimensional unsteady flow simulations. The one-dimensional method is generally considered to be conservative and has historically been the standard method for flood hazard mapping. The selection of HEC-RAS 1D also aligns with existing floodplain models through the area within the NPCA boundaries.

3.4.5.2 Survey Work

Field surveying was completed in summer and fall 2023 to collect ground elevation as well as structure geometry necessary for modeling. The survey was completed in NAD83 CSRS 2010 epoch, UTM Zone 17N and fixed vertically to CGVD28:78. The Topographic Plans associated with this survey can be found in **Appendix F2**. Publicly available LiDAR data was used for any external lands included in the model and was retrieved from Ontario’s Geohub website. The LiDAR data was converted from the CGVD2013 vertical datum to CGVD28:78 to match the survey data, and then the two datasets were combined into one Digital Elevation Model (DEM). The LiDAR data represents topographic information only and does not include any structures.

Within the study limits, various hydraulic structures were surveyed of which, 29 were included in the hydraulic model. The collected data for the structures generally included opening characteristics including shape and dimensions as well as invert and obvert elevations. Additionally, monitoring was conducted and field photos were captured for 13 out of these 29 structures, including three culverts along the Main Sinkhole Creek, one culvert along the Sinkhole Creek Tributary, two culverts along the West Twenty Mile Creek Tributary, two culverts along the East Twenty Mile Creek Tributary, and five culverts along the Stoney Creek.

3.4.5.3 Digital Elevation Model

The Digital Elevation Model (DEM) for the Study Area was created by combining LiDAR and survey data into one elevation surface. The horizontal coordinate system for the LiDAR is NAD 1983 CSRS UTM Zone 17N and the vertical coordinate system is CGVD2013. The LiDAR data was converted to CGVD28:78 datum before the two datasets were combined.



3.4.5.4 Hydraulic Model Development

The DEM discussed in **Section 3.4.5.3** was used to create the georeferenced HEC-RAS model. The channel reach centerline for the model was aligned with the thalweg (lowest point of successive cross-sections along the channel) of the reaches based on LiDAR, survey data, and aerial imagery.

Following the definition of the channel centreline, cross-section locations were determined. Cross-sections were initially cut perpendicular to the anticipated flow path extending beyond the channel into the floodplain, with spacing varying along the reach depending on location. Cross-sections were added at pinch points along the watercourses or inflection points in the channel bottom and upstream and downstream of hydraulic structures to capture any flow restrictions in the model. Since the cross-sections were geo-referenced, the base terrain file was applied to each section, which included both LiDAR and survey data.

The bank stations at each cross-section were generally placed at the high points in the proximity of the flow path (i.e., reach centreline) or where a significant change in the cross-sectional slope was noticed to capture the change in conveyance between the main channel and the overbank sections.

Variations in cross-section geometry and structures required additional measures to accurately model the channel hydraulics. This included adding obstructions, levees, and/or ineffective flow areas at various locations throughout the reach. Ineffective flow areas were located upstream and downstream of structures, landforms, and overbank areas where water will pond, but velocities will be close to or equal to zero. These areas can be considered ineffective in conveying flow and thus defined as ineffective flow areas. Blocked obstructions were used to define areas of the cross-sections that will be permanently blocked by obstructions (i.e., building, abutments, etc.) located upstream and/or downstream of the cross-sections. Obstructions decrease flow area and add wetted perimeter when the water comes in contact with them. Levees were used at some locations to ensure that low areas behind high ground such as hills or berms were isolated from the floodplain and were not considered as active flow areas. Levees were generally placed at high points in cross sections where the water would have to overtop before spilling into the low-lying offline storage areas; this ensured the model was only accounting for flow where it would reasonably occur, producing more accurate flood elevations.

3.4.5.4.1 Structure Modeling

As part of this SWP, thirty-two hydraulic structures² were modelled in HEC-RAS. A summary table including Structure ID, Reach Name, HEC-RAS Cross-section ID, Opening Characteristics including shape and dimensions as well as invert and obvert elevations, and Source of the Information is provided in **Appendix F5**.

Four cross-sections were placed around each structure to accurately compute the energy losses. The two bounding cross-sections were placed immediately upstream and downstream of structure locations. They represent the natural ground (main channel and floodplain) just outside of the structure limits and

² Thirty-two (32) hydraulic structures, of which twenty-nine (29) were surveyed, were modelled in HEC-RAS as part of the floodplain mapping, see **Appendix F5** for further details.



allow for flow contraction and expansion to occur. The two cross-sections outside of these bounding sections were placed far enough away to allow flow to become fully effective.

Ineffective flow areas were placed at the bounding sections of the structures, using approximately 1:1 contraction and 2:1 expansion ratio from the face of the structure. Upstream of the structures, the elevations of these ineffective flow boundaries were generally set at the spill point in the road, at which point flow will no longer be ineffective through these areas as flow overtops the road. Downstream of the structures, the ineffective flow elevations were set to 0.3 m below the upstream ineffective flow elevations (i.e., the spill points), as per the literature.

The expansion and contraction coefficients were set to 0.5 and 0.3, respectively, around the structures for two sections on the upstream side and one section on the downstream side.

3.4.5.4.2 Manning’s Roughness Coefficient

The Manning’s roughness coefficients for the main conveyance channels and the floodplain areas were estimated using reference tables included in Technical Guidelines for Flood Hazard Mapping (2017). Generally, the reaches within the Study Area are fairly straight natural channels with no deep pools and bankfull depths lower than 2 m. Therefore, a Manning’s roughness coefficient of 0.035 was assumed to represent the roughness of the main channel at the majority of the cross-sections.

Within the Study Area, some sections of the Sinkhole Creek run through marsh, swamp, and treed areas. The reach sections through these areas are generally natural channel with some weeds and stones. Therefore, a Manning’s roughness coefficient of 0.045 was assumed to represent the roughness of the main channel through these areas.

The Manning’s n values for the overbank and floodplain areas varied and were based on land use mapping and aerial imagery. Shapefiles were created in RAS Mapper through importing land use files from external sources or delineating these areas based on aerial imagery. Manning’s values were then assigned to each specific land use then applied directly to the cross-sections, creating accurate, horizontally varied Manning’s values. The Manning’s values were determined to be within an acceptable range based on literature and confirmed via aerial imagery. Manning’s n values used in the model are summarized in Table 3.4.9.

Table 3.4.9: Manning’s Roughness Coefficients Selected in HEC-RAS

| Description | Manning’s n Value |
|---|--------------------------|
| Main Channel: | |
| • Natural Channel – clean, straight, shallow, no rifts or deep pools, with limited stones and weeds | 0.035 |
| • Natural Channel – clean, shallow, with stones and weeds | 0.045 |
| Undeveloped Areas: | |
| • Floodplain – Forest/Deciduous Forest/Mixed Forest | 0.100 |
| • Floodplain – Treed/Thicket Swamp | 0.080 |
| • Floodplain – Marsh | 0.080 |
| • Floodplain – Open Water/Water | 0.080 |



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| | |
|--|-------|
| • Floodplain – Hedge Rows | 0.100 |
| • Floodplain – Tilled (Cultivated) | 0.040 |
| • Floodplain – Tree Plantation | 0.100 |
| • Floodplain – Pasture, No Brush | 0.035 |
| • Floodplain – Pasture and Brush | 0.045 |
| • Floodplain – Undifferentiated (Mixed Land Cover) | 0.050 |
| Developed Areas: | |
| • Floodplain – Pervious Built-up Area | 0.040 |
| • Floodplain – Impervious Built-up Area | 0.030 |
| • Floodplain – Transportation/ROW | 0.020 |
| • Floodplain – Aggregate | 0.025 |

3.4.5.4.3 **Boundary Conditions**

Normal depth was used as the boundary condition at the downstream ends of the hydraulic models. Per the literature, normal depth boundary condition uses Manning's equation to estimate a stage for each computed flow and can only be used as a downstream boundary condition for an open-ended reach.

The average bed slope in the vicinity of the boundary condition location has been used as an estimate for the friction slope. The following table lists the downstream boundary condition (i.e., estimated friction slopes) used in this study for the various watercourses.

Table 3.4.10: Downstream Boundary Conditions

| Name of Watercourse | Friction Slope |
|----------------------------|----------------|
| Sinkhole Creek | 0.0028 |
| Sinkhole Creek - Tributary | 0.0024 |
| Twenty Mile Creek - East | 0.0020 |
| Twenty Mile Creek - West | 0.0024 |
| Stoney Creek | 0.0010 |

3.4.5.5 **Hydraulic Model Results**

The hydraulic models were run for the Regulatory storm event. The Sinkhole Creek, Sinkhole Creek Tributary, East Twenty Mile Creek Tributary, and West Twenty Mile Creek Tributary are located within the NPCA jurisdiction while Stoney Creek is part of the HCA jurisdiction. NPCA policy states: “the Niagara Peninsula Conservation Authority defines the flood hazard as the *100 year flood* event,” while the HCA policy states: “the flooding hazard limit (or ‘regulatory floodplain’) for watercourses within most of the HCA watersheds is defined based on the Hurricane Hazel flood event standard (the Regional Storm), with the exception of the numbered watercourses in Stoney Creek where the 100-year flood frequency event is used to determine the floodplain.” The Study Area lands within HCA jurisdiction do



not overlap with the numbered watercourses in Stoney Creek³. Therefore, the Regulatory flood event in the Study Area is the 100-year storm event for areas within NPCA jurisdiction and the Regional storm event (i.e., Hurricane Hazel) for areas within HCA jurisdiction.

Regulatory flow rates at various flow change locations along the reaches were derived based on the results of the hydrologic model discussed in **Section 3.4.4**. The detailed results for the subject watercourses are provided in **Appendix F6**.

3.4.6 Regulatory Floodplain

Updated Regulatory floodplain limits throughout the Study Area were created using the hydraulic model results. Figures were produced to show the updated inundation limits and are presented in **Appendix F7**. As noted above, the Regulatory flood event in the Study Area is the 100-year storm event for areas within NPCA jurisdiction and the Regional storm event (i.e., Hurricane Hazel) for areas within HCA jurisdiction.

3.4.7 Municipal/Provincial Roadway Crossings

An assessment of the existing municipal and provincial roadway culverts within the Study Area has been undertaken to determine if culvert/bridge upgrades would be necessary to satisfy current engineering standards. The City and MTO rely upon MTO Drainage Design Standards, which identify design storms to be used for culvert/bridge sizing and the necessary associated freeboards based on roadway classification. A total of 68⁴ existing municipal/provincial crossings were surveyed within or immediately adjacent to the Study Area (refer to Figure 3.4.6).

Municipal roads in/around the Study Area are classified as rural arterial. As such, in accordance with MTO standards, the following design standards apply depending on whether or not the crossing is considered to be conveying a 'watercourse' or 'surface drainage'.

Table 3.4.8. Design Flows Return Period for Watercourses, Bridges and Culverts by Roadway Classification

| Watercourse Crossing (WC-1) Requirements | | | |
|--|--|-------------------------------|--------------------|
| Functional Road Classification | Return Period of Design Flows | | |
| | Design Flow | | Check Flow |
| | Total Span less than or equal to 6.0 m | Total Span greater than 6.0 m | |
| Rural Arterial, Collector Road | 25-yr | 50-yr | 115% of the 100-yr |

³ Hamilton Conservation Authority (HCA). 2025. HCA Subwatersheds SWP [Dataset], Conservation Ontario. <https://hca-open-data-camaps.hub.arcgis.com/maps/camaps::hca-subwatersheds-swp/about>. Accessed October 2025

⁴ With respect to the crossing assessment, the sixty-eight (68) crossings which were surveyed were modelled in either HEC-RAS or Culvert Master to determine whether they met current capacity and conveyance standards.



MTO Standard WC-1, Design Flows (Bridges & Culverts) identifies the minimum Design Flows for the sizing of bridges and culverts for flow conveyance on Regulated and non-Regulated Watercourses. It also identifies the requirement for accommodating the Regulatory Flow on Regulated Watercourses, and for determining the maximum allowable increase in flood elevations upstream of a bridge or culvert. This standard provides the hydrologic basis for all watercourse crossing standards. In accordance with MTO Standard WC-2 (Freeboard & Clearance at Bridge Crossings) and MTO Standard WC-7 (Culvert Crossings on a Watercourse), the minimum freeboard imposed by design for freeways and rural arterial roads is 1.0 meter, measured from the minor design flow high water level to the edge of the travelled lane on the upstream side of the culvert. Furthermore, in accordance with MTO Standard WC-13 (Relief Flow (Bridges and Culverts)), the maximum depth over the roadway should be less than 0.30 m for the Regulatory Storm and the product of the velocity x depth should be less than 0.8 m²/s for the Regional Storm.

Table 3.4.9. Design Flows Return Period for Culverts (not on a watercourse) by Roadway Classification

| Surface Drainage (SD-1) Requirements | | |
|---|-------------------------------|-------------|
| Functional Road Classification | Return Period of Design Flows | |
| | Design Storm | Check Storm |
| Freeway, Urban Arterial | 10-yr | 100-yr |
| Rural Arterial, Collector Road | 10-yr | 100-yr |

In accordance with MTO Standard SD-13 (Design Flows and Freeboards for Culverts not on a Watercourse), the minimum freeboard to the top of sub-grade upstream of the culvert shall be 0.30 meters for the minor system design flow. There is no minimum freeboard associated with the major system design flow (only must demonstrate hydraulic conveyance without overtopping the roadway).

Flows to the culverts/bridges were determined using the VO “without SWM infrastructure” model (as discussed in previous sections) at all locations, while the culvert hydraulics were modelled in CulvertMaster or through the HEC-RAS models developed for flood hazard mapping. Information on the HEC-RAS models can be found in **Appendix F5** and **Appendix F6**, while culvert/bridge capacity assessment information and CulvertMaster reports can be found in **Appendix F8**. Results of each bridge/culvert assessment and whether the conveyance capacity and associated freeboards satisfy the criteria listed above are provided in the tables below. Three of the nineteen watercourse culverts meet each criterion of freeboard and velocity when modelled.

Table 3.4.10. Assessment of Bridges/Culverts at Watercourses

| Rural Arterial, Collector Road (Total Span less than or equal to 6.0 m) | |
|--|---------------------------------------|
| Crossing I.D. | Conveyance Capacity Compliance |
| 20MC-W2 | No |
| 20MC-W10 | No |
| 20MC-13 | No |
| 20MC-E3 | No |
| 20MC-E9 | No |
| 20MC-E13 | No |
| SHC 4 | Yes |
| SHC 5 | Yes |
| SHC 6 | Yes |
| SHC 10 | No |



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| Rural Arterial, Collector Road (Total Span less than or equal to 6.0 m) | |
|--|---------------------------------------|
| Crossing I.D. | Conveyance Capacity Compliance |
| SHC 14 | No |
| SC 2 | No |
| SC 5 | No |
| SC 6 | No |
| SC 8 | No |
| SC 11 | No |
| SC 12 | No |
| SC 22 | No |
| SC 23 | No |

Table 3.4.11. Assessment of Bridges/Culverts Collecting Surface Drainage

| Crossing I.D. | Storm Event | |
|----------------------|---------------------------------------|--------------------|
| | Rural Arterial, Collector Road | |
| | Design Storm | Check Storm |
| HC 1 | Yes | No |
| HC 2 | Yes | Yes |
| 20MC-W1 | Yes | Yes |
| 20MC-W3 | Yes | Yes |
| 20MC-W4 | Yes | Yes |
| 20MC-W5 | Yes | Yes |
| 20MC-W6 | Yes | Yes |
| 20MC-W7 | Yes | Yes |
| 20MC-W8 | Yes | Yes |
| 20MC-W9 | Yes | Yes |
| 20MC-W11 | Yes | Yes |
| 20MC-W12 | No | No |
| 20MC-W14 | No | Yes |
| 20MC-W15 | Yes | Yes |
| 20MC-W16 | Yes | Yes |
| 20MC-E4 | Yes | Yes |
| 20MC-E5 | Yes | Yes |
| 20MC-E6 | No | Yes |
| 20MC-E7 | Yes | Yes |
| 20MC-E8 | Yes | Yes |
| 20MC-E10 | No | No |
| 20MC-E11 | Yes | Yes |
| 20MC-E12 | No | No |
| 20MC-E14 | Yes | Yes |
| 20MC-E15 | Yes | Yes |
| SHC 1 | Yes | Yes |
| SHC 2 | No | Yes |
| SHC 3 | Yes | Yes |
| SHC 7 | Yes | Yes |
| SHC 8 | Yes | Yes |
| SHC 9 | Yes | Yes |
| SHC 11 | Yes | Yes |
| SHC 12 | Yes | Yes |
| SHC 13 | No | Yes |
| SHC 15 | Yes | Yes |
| SHC 16 | Yes | Yes |
| SC 1 | Yes | Yes |
| SC 3 | Yes | Yes |



| Crossing I.D. | Storm Event Rural Arterial, Collector Road | |
|-------------------|---|-------------|
| | Design Storm | Check Storm |
| SC 4 ¹ | N/A | N/A |
| SC 7 | No | No |
| SC 9 | Yes | Yes |
| SC 10 | Yes | No |
| SC 13 | Yes | Yes |
| SC 14 | Yes | Yes |
| SC 15 | Yes | Yes |
| SC 16 | Yes | Yes |
| SC 17 | Yes | Yes |
| SC 18 | Yes | Yes |
| SC 19 | Yes | Yes |
| SC 20 | No | Yes |
| SC 21 | Yes | Yes |

¹Crossing is outside of Study Area

The culvert/bridge summary provided herein is intended to illustrate the conveyance capacity of all existing hydraulic crossings in public right-of-way areas within and immediately adjacent to the Study Area in Elfrida. Twelve of the fifty-one surface drainage culverts modelled did not meet both the design and check storm freeboard criteria.

In Phase 2, the sizing of preliminary watercourse and headwater drainage feature crossings considers the requirements for terrestrial (mammals, reptiles and amphibian passage), aquatic (fish passage), fluvial geomorphic and surface water conveyance needs (hydraulic sizing). Watercourse crossing sizing requirements shall be optimized at the future planning and detailed design stages when existing roadway improvements and development applications are further advanced.

3.4.8 Conclusions/Recommendations

- Surface water quality measurements and samples were collected at three stations within the Study Area on five separate sampling days with four of those days taking three samples during the monitoring period (Appendix F1). The water quality results obtained from the Stantec monitoring identified instances of PWQO exceedances for parameters including dissolved oxygen and phosphorus. DO concentrations in many samples collected at each sampling site were below the target threshold of 5 mg/L. Additionally, every sample collected by Stantec, the total phosphorus exceeded the PWQO limits.
- Two Visual OTTHYMO models were created by Stantec to simulate existing conditions within the Study Area (**Appendix F4**). One model did not include any SWM controls, while the other included three (3) existing or currently being constructed external SWM controls upstream of the site. These SWM controls were derived from the SWM Reports for those developments. External subcatchments 10, 11, 12, 42, and 43 are considered to be fully built out in the existing conditions model.
- Updated existing conditions peak flows for the 2-year through 100-year (12-hour AES Rainfall Distribution) and Regional Storm events have been determined at discrete locations within the Study Area. The peak flows of the Regulatory Event without considering any existing SWM controls have been used to support the delineation of flood hazard limits within, and immediately adjacent to, the Study Area. These peak flows were compared to the NPCA floodplain mapping model in HEC-RAS and were determined to represent current hydrologic conditions of the Study Area.



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- The hydraulic modeling for the major stream reaches within the study area was conducted using the most recent information including peak flow rates (from updated hydrologic modelling), detailed topographic survey and LiDAR data, hydraulic roughness, and detailed structure surveys. Updated peak flow rates for the Regulatory flood event (i.e., 100-year storm event within NPCA jurisdiction and the Regional storm event within HCA jurisdiction) were used in the HEC-RAS model to simulate the existing conditions.
- Stantec has prepared updated existing conditions flood hazard mapping for the Study Area (**Appendix F7**). Flood hazard limits were delineated against the updated DEM (combined topographic and LiDAR surface) using the HEC-RAS computed water surface elevations for the Regulatory Storm.
- Stantec has assessed the conveyance capacity of sixty-nine (69) roadway crossings within the Study Area (Appendix F8). There are twenty-one (21) watercourse classified crossings, and forty-eight (48) surface drainage classified crossings. By present-day engineering design standards, three (3) watercourse culverts and forty (40) of the surface drainage culverts are considered to be sufficient. While eighteen (18) watercourse culverts and eight (8) surface drainage culverts are considered to be deficient by current standards. More specifically, one (1) surface drainage culvert from Hannon Creek, eighteen (18) watercourse and surface drainage culverts from Twenty Mile Creek, twelve (12) watercourse and surface drainage culverts from Sinkhole Creek and twelve (12) watercourse and surface drainage culverts from Stoney Creek are considered sufficient.
- Further hydrologic modelling is completed as part of Phase 2, to include a proposed conditions scenario to further inform future development.



3.5 Hydrogeological Assessment

3.5.1 Objective

The investigation program was designed to collect the necessary data to develop a conceptual understanding of existing hydrogeological conditions within the Study Area. This data was then used to assess potential impacts from future development activities to the six primary hydrogeological systems within the Study Area:

- East Twenty Mile Creek Subwatershed
- Hannon Creek Subwatershed
- Sinkhole Creek Subwatershed
- Stoney Creek Subwatershed
- Upper Davis Creek Subwatershed
- West Twenty Mile Creek Subwatershed

The hydrogeological assessment aims to meet the following objectives:

- Characterize existing hydrogeological conditions within the six subwatersheds, including physiography, geology, groundwater levels and flow systems, groundwater recharge and/or discharge areas and areas of potential aquifer vulnerability.
- Provide data pertaining to relationships between local watercourses and the groundwater systems, specifically where watercourses are receiving groundwater inputs from or losing streamflow to (i.e., discharge and recharge conditions) the subsurface.
- Protect, restore, or enhance the function of groundwater flow systems within the Study Area, and groundwater discharge areas (i.e., watercourses and wetlands).
- Protect, restore, or enhance groundwater quality, particularly in potentially vulnerable aquifer systems.
- Establish pre-development infiltration targets to maintain or improve existing groundwater recharge function under the post-development condition.

3.5.2 Background

3.5.2.1 Source Water Protection Requirements

The MECP introduced the Clean Water Act as a means of ensuring the protection of drinking water sources within the Province of Ontario. The Clean Water Act requires that a detailed Assessment Report be prepared for each municipal drinking water system, with this Assessment Report incorporating numerous components as outlined in the document "*Technical Rules: Assessment Report, Clean Water Act, November 16, 2009*". This legislation provides a basic framework for communities to follow in developing an approach to protecting their municipal water supplies, with the key components of this approach being as follows:

- Identify and assess risks to the quality and quantity of municipal drinking water sources and determine which risks are significant and require immediate action, which risks need monitoring to ensure they do not become significant, or which pose low to negligible risk. This information is presented in a detailed Assessment Report, with the content of this report consisting of (i) the defining of Well Head Protection Areas (WHPA) for groundwater drinking water sources and



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Intake Protection Zones (IPZ) for surface water drinking water sources, (ii) completion of a vulnerability assessment for each WHPA, and (iii) identification of drinking water issues and threats

- Develop a Source Protection Plan (SPP) that sets out how the risks will be addressed
- Carry out the SPP through existing land use planning and regulatory requirements
- Perform ongoing monitoring and reporting to measure the effectiveness of the actions taken to protect drinking water sources and ensure that they are protected in the future

As per the Hamilton-Halton Source Protection Plan (HHSPP) (2022), there are no municipally operated water supply wells located within the Study Area and, subsequently, no WHPAs that extend into the boundaries of the Study Area.

Areas of significant groundwater recharge in the Study Area were mapped based on the information provided in the Hamilton Source Protection Assessment Report (2015) and the Niagara Peninsula Source Protection Assessment Report (2013). The Assessment Reports contain Significant Groundwater Recharge Area (SGRA) mapping for the Hamilton Region and Niagara Peninsula Source Protection Areas (SPA) and includes the lands in the Study Area.

A total of five Source Water Protection Areas (SWPA) for groundwater protection occur within the Study Area boundary and account for approximately 20% of the Study Area. These SWPA correlate with areas identified by the NPCA as Highly Vulnerable Aquifers (HVA), where the HVA is defined by the NPCA as being of a “*medium vulnerability*”. The HVAs are associated with Sinkhole Creek and Twenty Mile Creek (east and west watersheds) within the centre and south of the Study Area.

The details of the SWPAs and HVAs within the Study Area are provided in Table 3.5.1.

Table 3.5.1 Source Water Protection Areas within the Study Area

| Location | Details |
|--|---|
| Between Trinity Church Rd. and Fletcher Rd. | Niagara Peninsula Significant Groundwater Recharge Area Score 6 Highly Vulnerable Aquifer Score 6 |
| Between Fletcher Rd. and Upper Centennial Pky. | Niagara Peninsula Significant Groundwater Recharge Area Score 0-6 Highly Vulnerable Aquifer Score 0-6 |
| Between Upper Centennial Pky. and Hendershot Rd. | Niagara Peninsula Significant Groundwater Recharge Area Score 0-6 Highly Vulnerable Aquifer Score 0-6 |
| Between Rymal Rd. East and Highland Rd. East. | Niagara Peninsula Significant Groundwater Recharge Area Score 0-6 Highly Vulnerable Aquifer Score 0-6 |
| Between Highland Rd. East. And Mud Street East | Hamilton Region Significant Groundwater Recharge Area Score 0 Highly Vulnerable Aquifer Score 0 |

SGRAs in these SPAs were delineated by identifying areas where groundwater is recharged by a factor of 1.15 or greater of the average recharge rate for the SPA, per the technical methodology recommended by the MECP and MNR (NPSPA, 2013). The SGRA areas situated within the Study Area are presented on Figure 3.5.1.



3.5.2.2 Water Balance Requirements

The protection of pre-development recharge rates is a fundamental mechanism to maintaining watershed health. Factors influencing recharge rates include:

- Greater volumes of runoff from the increase in impervious surfaces resulting from development is likely to contribute to decreased stability and health of stream corridors.
- The loss in groundwater recharge function from increasing impervious cover that contributes to the lowering of groundwater levels.
- The maintaining of infiltration volumes associated with vulnerable aquifer systems to support and maintain the overall groundwater recharge function of the sub-watersheds.
- The maintenance of groundwater recharge function, in combination with preservation of Natural Heritage Systems and the implementation of SWM practices, to mitigate runoff impacts.

Therefore, the objective of the water balance assessment will be to assign pre-development infiltration volumes to the various subwatersheds of the Study Area, establishing targets from which future post-development conditions must match or exceed.

3.5.3 Methods

To effectively protect, restore or enhance the form and function of a hydrogeological system, detailed investigation is required to identify the aquifer units of the system within the Study Area and to establish an understanding of how the system interacts with local groundwater sustained features.

The tasks undertaken to achieve the objectives of the hydrogeological investigation were as follows:

- Desktop-level review of existing geological and hydrogeological conditions throughout the Study Area using published information sources, with this information used to develop a conceptual model of the hydrogeological system.
- Drilling of 35 boreholes and excavation of 12 test pits to supplement the findings of the desktop-level review and, subsequently, refine the geological and hydrogeological aspects of the conceptual model.
- The installation of 27 groundwater monitoring wells (either as a single-stage or nested monitoring well).
- Installation of 14 drive-point piezometers into the watercourses that flow through the Study Area to assess the hydraulic relationship between the shallow groundwater system and these features (i.e., identification of vertical hydraulic gradients beneath the watercourse substrates and evaluate recharge /discharge function of the watercourse).
- Combined manual (discrete) and automated (continuous) (i.e., Levelogger) measurements of groundwater levels, continuing for an ongoing period of 12 months (March 2025 to March 2026) to capture seasonal fluctuations in levels within the various aquifer units and surface water features.
- Perform in-situ permeability testing of the surficial and subsurface soils by means of Guelph Permeameter Testing, with these data being used to estimate rates of infiltration across the Study Area for use in the water balance and to assess the potential for LID opportunities.
- Collection of groundwater samples from pre-determined monitoring well locations for water quality analysis.
- Completion of a pre-development water balance using the Thornthwaite and Mather method to evaluate the existing groundwater recharge function of the Study Area.



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- Using the dataset correlated by the desktop and field investigations, provide a comprehensive analysis and discussion of these data and a subsequent assessment of the potential hydrogeological constraints to development within the Study Area. The results of this assessment will provide the foundation for the development of a pre-, during, and post-development hydrogeological monitoring program

This section summarises the methodologies and practices adopted for collecting the dataset required to complete the hydrogeological investigation of the Study Area. The major components of the investigation included:

- test pit excavations
- drilling and installing monitoring wells
- installing drive-point piezometers
- performing groundwater level monitoring
- performing hydraulic response and infiltration testing.

These components are discussed in more detail in the following sections, with locations of all exploratory holes presented on Figure 3.5.2.

3.5.3.1 Test Pit Excavations

From April 28 to 29, 2025, 12 test pits (TP1 to TP12) were excavated in identified SGRAs and non-SGRAs throughout the Study Area to an assumed depth of 1.5 m below ground surface (bgs). The subsurface conditions in the test pits were identified by visual and tactile examination of the materials exposed on the sides and bottom of the test pits. The groundwater conditions in the open test pits were observed on completion of excavating.

The soils encountered within the test pits excavated across the site generally consisted of topsoil overlying native clayey silt, silt and clay, traces of sand soil to the depths of exploration (3.0 m bgs). Guelph Permeameter tests were carried out in the silt till layer.

3.5.3.2 Borehole Drilling

A total of thirty-one boreholes (boreholes BH1 to BH31) were drilled between November 4, 2024, and January 30, 2025. The boreholes were drilled using a Dietrich D-50 track mounted drill rig equipped with continuous flight, solid stem augers to depths of between approximately 2.8 m and 10.7 m bgs. Full time supervision of drilling and soil sampling operations was carried out by a representative of Landtek.

Borehole stratigraphy was logged using the American Society for Testing and Materials (ASTM) guideline for the description and identification of soils. All soil samples were transported to a Canadian Council of Independent Laboratories (CCIL) certified laboratory and visually examined to determine their textural classification. Moisture content testing was carried out on all samples.

Borehole logs are presented in **Appendix G1**, and their locations presented on Figure 3.5.2. The borehole logs contained descriptions (where relevant and possible) of soil type, texture, colour, structure, consistency, plasticity, moisture content, and other visual and olfactory observations.



3.5.3.3 Monitoring Well and Drive-Point Piezometer Installations

Twenty-seven boreholes were completed as monitoring wells, consisting of new/sealed, 50 mm polyvinyl chloride (PVC) screen with No.10 slots threaded onto a matching riser. The screens and risers were pre-threaded including O-ring seals such that no glues or solvents were used to connect the pipe sections. The annular space between the PVC well and the borehole was backfilled to approximately 0.3 m above the top of the screen section with sand pack, and then with bentonite to existing ground level. A J-Plug lockable air-tight cap was installed on the riser.

The monitoring well installation details are presented on the respective borehole logs provided in **Appendix G1**. The locations of these boreholes are shown on Figure 3.5.2. A summary of the monitoring well installation details are presented in Table 3.5.2.

Table 3.5.2 Monitoring Wells Construction Details

| Monitoring Well ID | Easting* 17T (NAD83) | Northing* 17T (NAD83) | Well Depth (mbgs) | Stick-up (m) | Screened Interval (m) | Screened Material |
|--------------------|----------------------------|-----------------------------|----------------------|-----------------|--------------------------|----------------------------------|
| BH/MW1 | 595507.4 | 4780166.5 | 6.0 | 1.02 | 3.0-6.0 | Silty Clay Till |
| BH/MW2S | 595904.5 | 4780260.0 | 6.0 | 0.99 | 3.0-6.0 | Clayey Silt Till |
| BH/MW2D | 595904.5 | 4780260.0 | 10.0 | 1.08 | 7.0-10.0 | Silty Clay/Limestone |
| BH/MW3 | 596343.3 | 4780857.7 | 6.0 | 1.10 | 3.0-6.0 | Silty Clay |
| BH/MW4 | 596072.3 | 4779870.8 | 6.0 | 0.83 | 3.0-6.0 | Clayey Silt Till/Silty Clay Till |
| BH/MW5 | 597091.6 | 4779792.4 | 5.9 | 1.01 | 2.9-5.9 | Clayey Silt/Silt |
| BH/MW6 | 597288.5 | 4780442.6 | 3.0 | 0.94 | 1.5-3.0 | Silty Clay Till |
| BH/MW7S | 598075.0 | 4780130.6 | 6.0 | 1.02 | 3.0-6.0 | Silty Clay/Limestone |
| BH/MW7D | 598075.0 | 4780130.6 | 9.0 | 0.85 | 6.0-9.0 | Limestone |
| BH/MW9 | 597382.0 | 4779474.0 | 6.0 | 0.83 | 3.0-6.0 | Clayey Silt/Silt |
| BH/MW10 | 598293.1 | 4779156.8 | 4.0 | 1.09 | 2.5-4.0 | Clayey Silt |
| BH/MW11 | 598444.7 | 4779853.0 | 2.9 | 1.13 | 1.4-2.9 | Clayey Silt/Clayey Silt Till |
| BH/MW14 | 599077.7 | 4779384.1 | 4.0 | 1.08 | 2.5-4.0 | Clayey Silt Till |
| BH/MW15 | 599169.9 | 4779818.9 | 6.0 | 1.15 | 3.0-6.0 | Silty Clay Till |
| BH/MW16 | 599752.0 | 4779289.6 | 6.0 | 1.03 | 3.0-6.0 | Silty Clay Till |
| BH/MW18S | 600009.1 | 4778648.4 | 3.8 | 0.83 | 2.3-3.8 | Silty Clay Till |
| BH/MW18D | 600009.1 | 4778648.4 | 9.0 | 1.01 | 6.0-9.0 | Limestone |
| BH/MW19 | 600494.3 | 4778978.9 | 5.2 | 1.09 | 2.2-5.2 | Silty Clay Till |
| BH/MW20 | 600517.5 | 4779788.1 | 6.0 | 0.80 | 3.0-6.0 | Silty Clay Till |
| BH/MW21 | 599784.3 | 4780213.8 | 6.0 | 0.81 | 3.0-6.0 | Silty Clay Till |
| BH/MW22 | 600685.5 | 4780749.8 | 6.0 | 0.78 | 3.0-6.0 | Silty Clay Till |
| BH/MW24 | 600851.3 | 4781167.1 | 7.6 | 1.01 | 4.6-7.6 | Silty Clay Till |
| BH/MW25 | 601216.8 | 4781474.5 | 4.5 | 1.14 | 3.0-4.5 | Silty Clay Till |
| BH/MW27 | 600625.3 | 4782343.1 | 6.0 | 0.97 | 3.0-6.0 | Silty Clay Till |
| BH/MW28 | 600301.4 | 4782031.8 | 5.7 | 0.98 | 2.7-5.7 | Silty Clay/Silty Clay Till |
| BH/MW30S | 599992.1 | 4781299.8 | 6.0 | 1.08 | 3.0-6.0 | Silty Clay Till |
| BH/MW30D | 599992.1 | 4781299.8 | 9.1 | 1.03 | 6.1-9.1 | Silty Clay Till |

masl = metres above sea level
mbgs = metres below ground level
m = metres

A total of 14 drive-point piezometers, identified as PZ1 to PZ4, PZ6, and PZ7 to PZ15, were driven into the beds of the various watercourses that flow through the Study Area. Their installation was



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undertaken to identify related vertical hydraulic gradients and evaluate groundwater recharge/discharge function.

The piezometers were installed to evaluate whether the respective water bodies' function as a groundwater recharge feature (i.e., contributes water to subsurface), discharge feature (receives water from the subsurface), or a combination of both.

Each drive-point piezometer is constructed of a 0.31 m long stainless-steel screen (25 mm diameter) that is connected to a 0.31 or 0.62 m long, 25 mm diameter steel riser pipes. Landtek personnel drove the drive-point piezometers into the substrate using a sledgehammer in accordance with standard procedure.

A summary of the construction details for the drive-point piezometers installation is presented in Table 3.5.3. The locations of the piezometers are presented on Figure 3.5.2.

Table 3.5.3 Piezometers Construction Details

| Piezometer ID | Easting* (NAD83) | Northing* (NAD83) | Depth (mbtp) | Stick-up (m) | Depth (mbgs) |
|----------------------|-------------------------|--------------------------|---------------------|---------------------|---------------------|
| PZ1 | 595744.0 | 4780027.0 | 1.37 | 0.92 | 0.45 |
| PZ2 | 595749.0 | 4779927.0 | 0.89 | 0.40 | 0.44 |
| PZ3 | 596485.4 | 4779579.7 | 1.37 | 0.79 | 0.63 |
| PZ4 | 597851.0 | 4779393.0 | 1.37 | 1.02 | 0.35 |
| PZ6 | 598732.8 | 4779900.0 | 1.37 | 0.65 | 0.72 |
| PZ7 | 599393.4 | 4780257.7 | 1.37 | 0.80 | 0.57 |
| PZ8 | 599745.0 | 4778746.0 | 1.37 | 0.92 | 0.45 |
| PZ9 | 600130.6 | 4779465.9 | 1.37 | 0.95 | 0.42 |
| PZ10 | 600778.0 | 4779569.0 | 1.37 | 0.70 | 0.67 |
| PZ11 | 601529.0 | 4781940.0 | 1.37 | 0.64 | 0.73 |
| PZ12 | 600650.0 | 4780621.0 | 1.37 | 1.02 | 0.35 |
| PZ13 | 599933.5 | 4780969.8 | 1.37 | 0.89 | 0.48 |
| PZ14 | 600614.0 | 4782357.7 | 1.37 | 0.79 | 0.58 |
| PZ15 | 600904.4 | 4779978.3 | 1.37 | 0.75 | 0.62 |

masl = metres above sea level
mbtp = metres below top of pipe
mbgs = metres below ground level
m = metres

3.5.3.4 Groundwater Level Monitoring

Each of the installed monitoring wells was initially developed to remove any sediment that may have been introduced during installation and to establish representative hydraulic properties of the formation within which the respective wells were installed to screen. The monitoring wells were developed using an electric well pump and Waterra tubing with foot valves. Each well was developed until a visible decrease in turbidity and steady flow was observed.

On completion of the monitoring well development works, a datalogger was installed in each of the monitoring wells and drive point piezometers in the Study Area. The dataloggers were programmed to record groundwater level readings in the monitoring wells and piezometers at 60 minutes intervals for the previously defined 12-month period to determine seasonal fluctuations, to be downloaded at



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intervals. A barologger was also installed at a pre-determined location within the Study Area for barometric pressure correction.

Groundwater levels in the monitoring wells and drive-point piezometers were measured using a combination of automated and manual measurement techniques. The automated measurement of water levels occurred using a Solinst Edge Levelogger® (Levelogger), a device consisting of a pressure transducer and datalogger suspended in the water column of each monitoring well and drive-point piezometer. The Leveloggers record total pressure (atmospheric+ height of water column) and were programmed to record groundwater levels readings in the piezometer, at 60 minutes intervals for a period of 12 months (one year) to determine seasonal fluctuations, to be downloaded at intervals. The resulting dataset required correction using atmospheric pressure data collected from a separate Solinst Barologger® (suspended in one of the monitoring wells and above the water level).

Manually measured water levels were obtained using a battery-operated Heron™ water level meter equipped with an electrode connected to a metric-graduated polyethylene tape. The water level measurements were recorded in metres to the nearest 0.01 m and converted to Geodetic elevations using surveyed elevation data. The manual water level data were also used to calibrate and check the accuracy of the data recorded by the Leveloggers.

Hydrographs presenting the groundwater level fluctuations observed in the monitoring wells over the investigation period are provided in **Appendix G2**.

3.5.3.5 Groundwater Sampling and Water Quality Testing

Groundwater sampling was carried out during two field monitoring events in September 2025. Groundwater samples were collected using a low-flow peristaltic pump with dedicated tubing for each monitoring well. This method minimizes the velocity of the formation water entering the well screen, as the drawdown is kept to a minimum (i.e., less than 10 % of the initial water column height) by adjusting the pumping rate.

Water quality parameters were monitored and recorded in the field every three minutes until either stabilization was observed or until twenty-four minutes passed, whichever came first, using a calibrated YSI ProDSS (Digital Sampling System) multiparameter, digital water quality meter. Parameters monitored included pH, ORP, conductivity, dissolved oxygen, temperature and turbidity and, prior to sampling, three consecutive rounds of parameters were observed to be stabilized (within 10%).

Once groundwater sampling commenced, groundwater samples were collected in laboratory-supplied containers and stored in iced coolers, with the samples being maintained at temperatures between 0°C and 10°C until their delivery to the laboratory, at which time the samples were transferred to laboratory ownership. The sample transfer process followed standard chain-of-custody protocols.

The groundwater samples were analyzed for the following parameters:

- Petroleum Hydrocarbons (PHC) F1-F4
- Volatile Organic Compounds (VOC)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Metals and Hydride-forming Metals, and other inorganic parameters



Field filtering was conducted for all samples analysed for dissolved metals using a dedicated 0.45 µm cartridge filter for each sample.

3.5.3.6 Hydraulic Response Testing

Hydraulic conductivity tests were completed in each of the installed monitoring wells to determine the horizontal hydraulic conductivity of the subsurface deposits and estimate groundwater flow velocities and potential groundwater contributions to the local watercourses and/or karst features.

The tests involved the extraction of a volume of groundwater to displace the water level. A Solinst Edge Levellogger® (Levellogger), programed at two-second intervals, was used to record the water level response during the tests.

The rising head test data was then analyzed using AqteSolve Professional Version 4.5 software package developed by Glenn M. Duffield of HydroSOLVE Inc. applying the Hvorslev analysis solutions, depending on the hydrogeological condition.

Results of the hydraulic response testing are presented in **Appendix G3**.

3.5.3.7 Infiltration Testing

Guelph Permeameter testing was carried out in 12 test pits (identified as test pits TP1, TP3, TP4, TP8, TP9, TP11, TP13, TP16 to TP19, and TP21) to assess the infiltration conditions of the native near surface soils. Attempts to complete the testing at four test pit locations (identified as test pits TP3, TP4, TP13 and TP18) could not be completed successfully due to the presence of wet ground conditions at surface and/or saturated soils conditions within the testing depth range. The Guelph Permeameter testing was undertaken concurrently to the test pitting exercise being undertaken for the investigation.

From April 28 to 29, 2025, Landtek field staff supervised the completion of in-situ infiltration testing using a Guelph Permeameter in each of the completed test pits. The test pits were completed within the proposed infiltration bed footprint ranges. Field-saturated hydraulic conductivity (K_{fs}) was measured using a Guelph Permeameter (Model 2800K1) within these test pits. The locations of the test pits are presented on Figure 3.5.2 and the results of the Guelph Permeameter testing are presented in **Appendix G3**.

In line with best practices, the infiltration testing conducted conformed to the methodology laid out in the NVCA Stormwater Technical Guide, dated December 2013. The method used on site is summarized below:

- A Guelph Permeameter test was used to determine the saturated hydraulic conductivity in the vertical direction. One infiltration test was completed in each test pit per the native soil type encountered on site.
- The testing did not occur during a precipitation event nor within 24 hours of a significant rainfall event, and the temperature was above freezing.
- One grain-size sample was taken at the depth of each test pit in which an infiltration test was performed to analyze particle size.
- The saturated hydraulic conductivity was converted to infiltration rates using the approximate relationships provided within Table 7.1 of Appendix C of *“Low Impact Development Stormwater Management Planning and Design Guide,”* (Dated 2010, by Credit Valley Conservation (CVC))



and Toronto and Region Conservation Authority (TRCA)) and applying the appropriate factor of safety based on Table 7.2 in Appendix C of the CVC Design Guide.

In-situ permeability testing of the native soil was performed at an assumed depth of 1.5 m bgs, where conditions were suitable (i.e., above the water table) using a Guelph Permeameter. This data was used to complete a pre-construction assessment of the soil suitability for future LID SWM practices.

3.5.4 Subsurface Characteristics

3.5.4.1 Geology and Hydrogeology

The geology of the Study Area is generally consistent and comprises of low permeability, glaciolacustrine clay and silt deposits overlying dolostone. An extract of the superficial geology map for the area, Map P.993 “*Quaternary Geology, Grimsby Area*” is provided as Figure 3.5.3, for reference.

Feenstra (1975) describes the clay and silt deposits as “...*proglacial Lake Warren*...” deposits, a recent lake that predates Lake Ontario and formed a vast lake-plain to the south of the Niagara Escarpment. Chapman and Putnam (1984) identify the clay deposits as part of the ‘Haldimand Clay Plain’, which covers most of the Niagara Peninsula beyond the Niagara Escarpment. The deposits consist predominantly of interbedded clays and silts, that are noted to cover, in part, the Niagara Falls Moraine.

The Niagara Falls Moraine is described by Feenstra (1975) as a “...*gently sloping ridge*...” that crosses the Study Area from the area of Highland Road East in the east of the Study Area to south of Rymal Road East in the west of the Study Area. The Niagara Falls Moraine comprises of low-permeability clays and clayey silts associated with the Halton Till.

The ridge associated with the Niagara Falls Moraine behaves topographically as a surface water divide between streams and creeks flowing northwards towards Lake Ontario, and those streams and creeks that form the upper reaches of Twenty Mile Creek and flow in a southwesterly direction.

The thickness of the low permeability clay ranges from 2.0 m to 3.0 m around Highland Road East near Centennial Parkway, to greater than 10 m along Highway 20 near 2nd Road East.

The underlying dolostone is identified by the MECP as a Regional Aquifer. The dolostone is of the Guelph Formation in the south and the Eramosa Member of the Lockport Formation in the north, with both Formations being of Silurian age. The Eramosa Member is described by Feenstra (1975) as “...*light brown to black*...” in colour and is “...*thin to moderately layered*”. It is known to be both fossiliferous and bituminous (Armstrong and Carter, 2010).

Four geological cross-sections, identified as Sections A-A' to D-D', have been generated for the Study Area using the exploratory hole dataset and are presented as Figures 3.5.4 to 3.5.7, respectively. The locations of the cross sections are presented on Figure 3.5.2. Bedrock surface elevations determined by the borehole drilling works completed within the Study Area are presented on Figure 3.5.8.

3.5.4.2 Karst Hazards

A karst hazard is defined by the Ministry of Municipal Affairs and Housing “*Provincial Planning Statement, 2024*” (PPO) as a ‘hazardous site’. A hazardous site is described by the PPO as “...*property or lands that could be unsafe for development and site alteration due to naturally occurring hazards*.”



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These may include unstable soils (sensitive marine clays [leda], organic soils) or unstable bedrock (karst topography)."

The NPCA regulates karsts and karstic conditions within their watershed, within which the majority of the Study Area is situated. The HCA regulates these conditions in a very limited watershed in the west of the Study Area, abutting Trinity Church Road to the west and the hydro corridor to the north.

The NPCA's Hazardous Sites Policy, 2022 states "*The potential for catastrophic failures in some areas of unstable soil and unstable bedrock warrant site specific studies to determine the extent of these hazardous sites, and therefore the appropriate limits of the hazard and regulation limits. The regulated area will be based on the conclusions and recommendations of such studies, to the satisfaction of NPCA. Accordingly, the limits for hazardous lands, such as leda clays, organic soils and karst formations, shall be determined on a site-specific basis according to the Ministry of Natural Resources Technical Guide for Hazardous Sites (1996) and Understanding Natural Hazards (2001).*"

The MNR document "*Hazardous Sites Technical Guide*" 1996, provides methods for identifying and assessing hazardous sites. These methods include the review of existing information, initial Study Area inspection using aerial photography, visual inspection, subsurface investigation, analysis, and reporting.

This assessment has been completed using the following methods:

- Review of publicly available information
- Review of aerial photographs
- Site inspections
- Reporting

The information gathered by the ground investigation has been used in conjunction with the desk-based review to address potential natural karst hazards in accordance with the definitions provided by the PPS and the NPCA Hazardous Sites Policy, as previously detailed.

The following information has been reviewed for this assessment;

- Aerial photography from 1934, 1954, 1965, 1995, 2005, 2009, 2012, 2015, 2017 to 2024
- County Map of the Township of Glanford, 1875
- Ontario Division of Mines Map P0993 "*Quaternary Geology of the Grimsby Area*", 1975
- Ontario Division of Mines Map P0536 "*Drift Thickness, Grimsby Sheet*", 1969
- Ontario Geological Survey Map P2401 "*Bedrock Topography Series, Grimsby Area, Southern Ontario*", 1981
- Ontario Division of Mines Map M2343 "*Palaeozoic Geology, Grimsby*", 1976
- MECP Water Well Records
- Ontario Geological Survey Borehole Records
- Hamilton Conservation Authority "*Eramosa Karst Conservation Area Master Plan*", Draft, October 2024
- Buck, M., Worthington, S.R.H. and D.C. Ford, "*Evaluation of the Eramosa Karst in Stoney Creek, Ontario as a Candidate for an Earth Science Area of Natural Scientific Interest*", 2003
- Harrington and Hoyle Ltd "*Twenty Mile Creek Fluvial Geomorphology Study*", September 1999



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- SNC-Lavalin “*Hamilton Groundwater Resources Characterization and Wellhead Protection Partnership Study*”, April 2006
- Terra-Dynamics Consulting Inc. “*Geologic Hazard Mapping Study, Karst Topography, Phase 1, NPCA Watershed Area*”, April 2006
- Niagara Peninsula Conservation Authority “*Updated Assessment Report – Niagara Peninsula Source Protection Area*”, October 2013

The Study Area is located on the Haldimand Clay Plain, which predominantly consists of poorly drained glaciolacustrine clay to silty clay overlying clay till (Chapman and Putnam, 1984 & Feenstra, 1975). Bedrock underlying the site comprises primarily of the Eramosa Member of the Lockport Formation. Bedrock depth below existing ground level ranges between approximately 3.0 m in the north and west of the Study Area and approximately 8.0 m in the south of the Study Area.

A review of the aerial photographs available have determined there to have been no changes in land use, with the primarily agricultural land use dating back to least 1934. The County Map of 1875 also shows the area to be of agricultural land, albeit in hand-drawn form. All watercourses and natural surface drainage features are clearly defined on the aerial photographs.

The Eramosa Karst Conservation Area is situated to the northwest of the Study Area, In the watershed of the Hamilton Conservation Authority. The Eramosa Karst has been defined by the Ministry of Natural Resources as an ANSI and is considered a Provincially significant earth science ANSI. Though most of the Eramosa Karst is located outside of the Study Area, a small section of the structure and associated development offset does cross the boundary in the vicinity of the HydroOne corridor, in the west of the Study Area. The extents of the Eramosa Karst feature within the Study Area, as defined by the HCA, is presented on the Natural Hazard Constraints Figure 4.1.1.

One known sinkhole is present within the western limits of the Study Area, situated within the Hannon Creek subwatershed. This sinkhole and the associated spring were originally mapped by Terra-Dynamics in 2001 as part of their wider watershed study for the NPCA. One additional, minor sinkhole is also noted in the north of the Study Area. The locations of both sinkholes were observed and noted during multiple site visits undertaken between November 2024 and May 2025 and are presented on the Natural Hazards Constraints Figure 4.1.1.

Review of the aerial photographs and documents identified no further, obvious presence of karst structures or karstic features within the Study Area. Buck *et al.* (2003) reported there to be no sinkhole or soil pipe development within the Eramosa Karst Conservation Area where overburden depths were measured to be “...*greater than 2.8 m*”. Such conditions within the Study Area are only noted in the north and west.

This corresponds to those sinkholes and karst features already reported within the Study Area and correlates with the noted absence of such features in the central, south, and southeastern sections of the Study Area, where bedrock is encountered at depths of up to 8.0 below ground level.

The absence of such features at the surface may not necessarily imply that dissolution or karstic features are not present within the deeper bedrock. Karst conduits are also known to be present within karstic areas and may be only 10 cm to 20 cm high. The potential for such features generally warrants a more detailed investigation, as is required by the NPCA for development within identified ‘hazard’ (i.e., karstic or potentially karstic) areas.



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As prescribed by the NPCA's Hazardous Sites Policy, development and site alteration limitations are not permitted within a 50 m setback distance from any identified karst feature within areas defined as 'hazardous sites', unless it can be demonstrated that there are no adverse impacts to the identified hazard with respect to:

- The control of flooding
- Erosion
- Dynamic beaches
- Pollution
- The conservation of land

The NPCA does permit of development or site alteration on or within 50 metres of an existing karst structure, but on condition that the following concerns are addressed to the satisfaction of the NPCA:

- Storm water drainage
- Utilities
- Groundwater contamination
- Flooding

3.5.5 Local Water Supplies

Water well information for the province of Ontario is managed by the MECP, who requires that a licensed water well contractor complete a well record and submit to the MECP when a new well is constructed in the province of Ontario. Information from these well records is stored and managed in the Water Well Information System (WWIS), which contains information pertaining to well construction, lithology, static and pumped water levels, water-bearing zones, and water use. Well records also contain well location information such as UTM coordinates, and municipal address information such as lot, concession and township.

Well records for the Elfrida SWP Study Area were obtained from the MECP WWIS online database. A total of 333 water well records were found within the Study Area as of September 2025.

Based on a review of the information contained in the well records, 325 of the 333 wells located within the Study Area are completed in the bedrock and two wells are completed in overburden deposits. The well records also indicate that 291 of 333 wells located within the Study Area were constructed for domestic water use, and that the water quality is classified by the well records as being predominantly "fresh".

Other groundwater well uses reported in the WWIS include 'limited commercial', 'irrigation', 'livestock' and 'industrial', though no further details are provided.

3.5.6 Groundwater Levels

Groundwater or water seepages were not encountered during the field drilling operations and all exploratory boreholes remained dry after their completion. Wet or saturated soils were encountered, particularly in the clayey silt tills, and were noted to be variable across the Study Area. This is typical for glacio- and glaciolacustrine soil horizons, where soil permeability is equally as variable. In addition, over the monitoring period, the installed drive-point piezometers remained dry.



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Table 3.5.4 presets the manual groundwater level measurements obtained from the monitoring wells over the investigation period.

Table 3.5.4 Groundwater Monitoring Data

| MW ID | Date | Total Depth (mbgs) | Water Strike (mbgs) * | Water Level (mbtp) | Water Level (mbgs) | Water Level (masl) | Ground Elevation (masl)** |
|-------|-----------|--------------------|--------------------------|--------------------|--------------------|--------------------|---------------------------|
| MW1 | 19-Mar-25 | 6.0 | 5.0 | 2.46 | 1.44 | 211.66 | 213.1 |
| | 22-Apr-25 | | | 2.57 | 1.55 | 211.55 | |
| | 5-May-25 | | | 2.43 | 1.41 | 211.69 | |
| | 10-Jun-25 | | | 2.61 | 1.59 | 211.51 | |
| | 14-Jul-25 | | | 3.18 | 2.16 | 210.94 | |
| | 21-Aug-25 | | | 3.81 | 2.79 | 210.31 | |
| | 11-Sep-25 | | | 4.41 | 3.39 | 209.71 | |
| MW2S | 19-Mar-25 | 6.0 | None | 1.54 | 0.55 | 212.55 | 213.1 |
| | 22-Apr-25 | | | 1.77 | 0.78 | 212.32 | |
| | 5-May-25 | | | 1.56 | 0.57 | 212.53 | |
| | 10-Jun-25 | | | 1.9 | 0.91 | 212.19 | |
| | 14-Jul-25 | | | 2.2 | 1.21 | 211.89 | |
| | 21-Aug-25 | | | 3.68 | 2.69 | 210.41 | |
| | 11-Sep-25 | | | 4.57 | 3.58 | 209.52 | |
| MW2D | 19-Mar-25 | 10 | 7.8 | 9.01 | 7.93 | 205.17 | 213.1 |
| | 22-Apr-25 | | | 9.03 | 7.95 | 205.15 | |
| | 5-May-25 | | | 9.11 | 8.03 | 205.07 | |
| | 10-Jun-25 | | | 9.11 | 8.03 | 205.07 | |
| | 14-Jul-25 | | | 9.44 | 8.36 | 204.74 | |
| | 21-Aug-25 | | | 10.01 | 8.93 | 204.17 | |
| | 11-Sep-25 | | | 10.24 | 9.16 | 203.94 | |
| MW3 | 19-Mar-25 | 6.0 | None | 2.09 | 0.99 | 217.01 | 218 |
| | 22-Apr-25 | | | 1.85 | 0.75 | 217.25 | |
| | 5-May-25 | | | 1.89 | 0.79 | 217.21 | |
| | 10-Jun-25 | | | 1.85 | 0.75 | 217.25 | |
| | 14-Jul-25 | | | 2.03 | 0.93 | 217.07 | |
| | 21-Aug-25 | | | 2.24 | 1.14 | 216.86 | |
| | 11-Sep-25 | | | 2.37 | 1.27 | 216.73 | |
| MW4 | 19-Mar-25 | 6.0 | None | 1.33 | 0.5 | 209.8 | 210.3 |
| | 22-Apr-25 | | | 1.57 | 0.74 | 209.56 | |
| | 5-May-25 | | | 1.38 | 0.55 | 209.75 | |
| | 10-Jun-25 | | | 1.72 | 0.89 | 209.41 | |
| | 14-Jul-25 | | | 1.97 | 1.14 | 209.16 | |
| | 21-Aug-25 | | | 3.48 | 2.65 | 207.65 | |
| | 11-Sep-25 | | | 4.71 | 3.88 | 206.42 | |
| MW5 | 19-Mar-25 | 5.9 | None | 1.62 | 0.61 | 214.39 | 215 |
| | 22-Apr-25 | | | 1.64 | 0.63 | 214.37 | |
| | 5-May-25 | | | 1.48 | 0.47 | 214.53 | |
| | 10-Jun-25 | | | 1.75 | 0.74 | 214.26 | |
| | 14-Jul-25 | | | 1.86 | 0.85 | 214.15 | |
| | 21-Aug-25 | | | 3.27 | 2.26 | 212.74 | |
| | 11-Sep-25 | | | 4.6 | 3.59 | 211.41 | |
| MW6 | 19-Mar-25 | 3.0 | None | 1.44 | 0.5 | 213.8 | 214.3 |
| | 22-Apr-25 | | | 1.46 | 0.52 | 213.78 | |
| | 5-May-25 | | | 1.32 | 0.38 | 213.92 | |
| | 10-Jun-25 | | | 1.65 | 0.71 | 213.59 | |
| | 14-Jul-25 | | | 1.8 | 0.86 | 213.44 | |
| | 21-Aug-25 | | | 1.93 | 0.99 | 213.31 | |



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| MW ID | Date | Total Depth (mbgs) | Water Strike (mbgs) * | Water Level (mbtp) | Water Level (mbgs) | Water Level (masl) | Ground Elevation (masl)** |
|-----------|-----------|--------------------|--------------------------|--------------------|--------------------|--------------------|---------------------------|
| MW7S | 11-Sep-25 | 6.0 | None | 2 | 1.06 | 213.24 | 211 |
| | 19-Mar-25 | | | 5.41 | 4.39 | 206.61 | |
| | 22-Apr-25 | | | 5.67 | 4.65 | 206.35 | |
| | 5-May-25 | | | 5.77 | 4.75 | 206.25 | |
| | 10-Jun-25 | | | 5.74 | 4.72 | 206.28 | |
| | 14-Jul-25 | | | 6.5 | 5.48 | 205.52 | |
| | 21-Aug-25 | | | 6.99 | 5.97 | 205.03 | |
| 11-Sep-25 | 7 | 5.98 | 205.02 | | | | |
| MW7D | 19-Mar-25 | 9.0 | None | 7.09 | 6.24 | 204.76 | 211 |
| | 22-Apr-25 | | | 7.45 | 6.6 | 204.4 | |
| | 5-May-25 | | | 7.51 | 6.66 | 204.34 | |
| | 10-Jun-25 | | | 7.59 | 6.74 | 204.26 | |
| | 14-Jul-25 | | | 8.07 | 7.22 | 203.78 | |
| | 21-Aug-25 | | | 8.24 | 7.39 | 203.61 | |
| | 11-Sep-25 | | | 8.54 | 7.69 | 203.31 | |
| MW9 | 19-Mar-25 | 9.0 | None | 3.05 | 2.22 | 212.38 | 214.6 |
| | 22-Apr-25 | | | 2.48 | 1.65 | 212.95 | |
| | 5-May-25 | | | 2.44 | 1.61 | 212.99 | |
| | 10-Jun-25 | | | 2.36 | 1.53 | 213.07 | |
| | 14-Jul-25 | | | 2.69 | 1.86 | 212.74 | |
| | 21-Aug-25 | | | 3.24 | 2.41 | 212.19 | |
| | 11-Sep-25 | | | 3.73 | 2.9 | 211.7 | |
| MW10 | 19-Mar-25 | 4.0 | None | 2.09 | 1 | 208.4 | 209.4 |
| | 22-Apr-25 | | | 2.38 | 1.29 | 208.11 | |
| | 5-May-25 | | | 2.47 | 1.38 | 208.02 | |
| | 10-Jun-25 | | | 2.57 | 1.48 | 207.92 | |
| | 14-Jul-25 | | | 3.04 | 1.95 | 207.45 | |
| | 21-Aug-25 | | | 5.02 | 3.93 | 205.47 | |
| | 11-Sep-25 | | | 5.01 | 3.92 | 205.48 | |
| MW11 | 19-Mar-25 | 2.9 | None | 2.03 | 0.9 | 211.3 | 212.2 |
| | 22-Apr-25 | | | 2.03 | 0.9 | 211.3 | |
| | 5-May-25 | | | 2.09 | 0.96 | 211.24 | |
| | 10-Jun-25 | | | 2.09 | 0.96 | 211.24 | |
| | 14-Jul-25 | | | 2.24 | 1.11 | 211.09 | |
| | 21-Aug-25 | | | 3.35 | 2.22 | 209.98 | |
| | 11-Sep-25 | | | 4.07 | 2.94 | 209.26 | |
| MW14 | 19-Mar-25 | 4.0 | None | 1.35 | 0.27 | 209.53 | 209.8 |
| | 22-Apr-25 | | | 1.49 | 0.41 | 209.39 | |
| | 5-May-25 | | | 1.63 | 0.55 | 209.25 | |
| | 10-Jun-25 | | | 1.68 | 0.6 | 209.2 | |
| | 14-Jul-25 | | | 1.84 | 0.76 | 209.04 | |
| | 21-Aug-25 | | | 3.64 | 2.56 | 207.24 | |
| | 11-Sep-25 | | | 4.65 | 3.57 | 206.23 | |
| MW15 | 19-Mar-25 | 6.0 | None | 6.55 | 5.40 | 203.30 | 208.7 |
| | 22-Apr-25 | | | 6.37 | 5.22 | 203.48 | |
| | 5-May-25 | | | 6.55 | 5.40 | 203.30 | |
| | 10-Jun-25 | | | 6.47 | 5.32 | 203.38 | |
| | 14-Jul-25 | | | 6.64 | 5.49 | 203.21 | |
| | 21-Aug-25 | | | 7.52 | 6.37 | 202.33 | |
| | 11-Sep-25 | | | 7.15 | 6.00 | 202.25 | |
| MW16 | 19-Mar-25 | 6.0 | None | 2.20 | 1.17 | 206.73 | 207.9 |
| | 22-Apr-25 | | | 2.05 | 1.02 | 206.88 | |
| | 5-May-25 | | | 1.98 | 0.95 | 206.95 | |
| | 10-Jun-25 | | | 2.30 | 1.27 | 206.63 | |



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| MW ID | Date | Total Depth (mbgs) | Water Strike (mbgs) * | Water Level (mbtp) | Water Level (mbgs) | Water Level (masl) | Ground Elevation (masl)** |
|-------|-----------|--------------------|--------------------------|--------------------|--------------------|--------------------|---------------------------|
| | 14-Jul-25 | | | 2.87 | 1.84 | 206.06 | |
| | 21-Aug-25 | | | 3.35 | 2.32 | 205.58 | |
| | 11-Sep-25 | | | 3.65 | 2.62 | 205.28 | |
| MW18S | 19-Mar-25 | 4.0 | None | 1.83 | 1.00 | 209.5 | 210.5 |
| | 22-Apr-25 | | | 2.84 | 2.01 | 208.49 | |
| | 5-May-25 | | | 1.37 | 0.54 | 209.96 | |
| | 10-Jun-25 | | | 1.53 | 0.70 | 209.8 | |
| | 14-Jul-25 | | | 1.80 | 0.97 | 209.53 | |
| | 21-Aug-25 | | | 3.42 | 2.59 | 207.91 | |
| MW18D | 11-Sep-25 | 9.0 | none | 4.51 | 3.68 | 206.82 | 210.5 |
| | 19-Mar-25 | | | 2.92 | 1.91 | 208.59 | |
| | 22-Apr-25 | | | 1.47 | 0.46 | 210.04 | |
| | 5-May-25 | | | 2.87 | 1.86 | 208.64 | |
| | 10-Jun-25 | | | 3.00 | 1.99 | 208.51 | |
| | 14-Jul-25 | | | 3.74 | 2.73 | 207.77 | |
| MW19 | 21-Aug-25 | 5.2 | None | 4.75 | 3.74 | 206.76 | 210.3 |
| | 11-Sep-25 | | | 5.34 | 4.33 | 206.17 | |
| | 19-Mar-25 | | | 5.22 | 4.13 | 206.17 | |
| | 22-Apr-25 | | | 3.77 | 2.68 | 207.62 | |
| | 5-May-25 | | | 3.37 | 2.28 | 208.02 | |
| | 10-Jun-25 | | | 3.79 | 2.70 | 207.60 | |
| MW20 | 14-Jul-25 | 6.0 | None | 4.15 | 3.06 | 207.24 | 209.3 |
| | 21-Aug-25 | | | 5.89 | 4.80 | 205.50 | |
| | 11-Sep-25 | | | 6.26 | 5.17 | 205.13 | |
| | 19-Mar-25 | | | 2.10 | 1.30 | 208.00 | |
| | 22-Apr-25 | | | 1.66 | 0.86 | 208.44 | |
| | 5-May-25 | | | 1.82 | 1.02 | 208.28 | |
| MW21 | 10-Jun-25 | 6.0 | None | 1.79 | 0.99 | 208.31 | 208.8 |
| | 14-Jul-25 | | | 2.39 | 1.59 | 207.71 | |
| | 21-Aug-25 | | | 3.06 | 2.26 | 207.04 | |
| | 11-Sep-25 | | | 3.41 | 2.61 | 206.69 | |
| | 19-Mar-25 | | | 6.85 | 6.04 | 202.76 | |
| | 22-Apr-25 | | | 6.35 | 5.54 | 203.26 | |
| MW22 | 5-May-25 | 6.0 | None | 6.33 | 5.52 | 203.28 | 211.6 |
| | 10-Jun-25 | | | 5.90 | 5.09 | 203.71 | |
| | 14-Jul-25 | | | 6.32 | 5.51 | 203.29 | |
| | 21-Aug-25 | | | 6.69 | 5.88 | 202.92 | |
| | 11-Sep-25 | | | 6.18 | 6.00 | 202.55 | |
| | 19-Mar-25 | | | 2.7 | 1.92 | 209.68 | |
| MW24 | 22-Apr-25 | 7.6 | None | 2.06 | 1.28 | 210.32 | 215.1 |
| | 5-May-25 | | | 2.14 | 1.36 | 210.24 | |
| | 10-Jun-25 | | | 2.05 | 1.27 | 210.33 | |
| | 14-Jul-25 | | | 2.54 | 1.76 | 209.84 | |
| | 21-Aug-25 | | | 3.07 | 2.29 | 209.31 | |
| | 11-Sep-25 | | | 3.43 | 2.65 | 208.95 | |
| MW25 | 19-Mar-25 | 4.5 | None | 2.24 | 1.23 | 213.87 | 210.1 |
| | 22-Apr-25 | | | 1.76 | 0.75 | 214.35 | |
| | 5-May-25 | | | 1.84 | 0.83 | 214.27 | |
| | 10-Jun-25 | | | 1.73 | 0.72 | 214.38 | |
| | 14-Jul-25 | | | 2.24 | 1.23 | 213.87 | |
| | 21-Aug-25 | | | 2.81 | 1.80 | 213.30 | |
| | 11-Sep-25 | | | 3.15 | 2.14 | 212.96 | |
| | 19-Mar-25 | | | 3.16 | 2.02 | 208.08 | |
| | 22-Apr-25 | | | 1.25 | 0.11 | 209.99 | |



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| MW ID | Date | Total Depth (mbgs) | Water Strike (mbgs)* | Water Level (mbtp) | Water Level (mbgs) | Water Level (masl) | Ground Elevation (masl)** |
|-------|-----------|--------------------|----------------------|--------------------|--------------------|--------------------|---------------------------|
| | 5-May-25 | | | 2.04 | 0.90 | 209.20 | |
| | 10-Jun-25 | | | 2.37 | 1.23 | 208.87 | |
| | 14-Jul-25 | | | 2.93 | 1.79 | 208.31 | |
| | 21-Aug-25 | | | 3.41 | 2.27 | 207.83 | |
| | 11-Sep-25 | | | 3.82 | 2.68 | 207.42 | |
| MW27 | 19-Mar-25 | 6.0 | 4.5 | 1.24 | 0.27 | 205.23 | 205.5 |
| | 22-Apr-25 | | | 1.2 | 0.23 | 205.27 | |
| | 5-May-25 | | | 1.27 | 0.30 | 205.20 | |
| | 10-Jun-25 | | | 1.34 | 0.37 | 205.13 | |
| | 14-Jul-25 | | | 1.98 | 1.01 | 204.49 | |
| | 21-Aug-25 | | | 2.23 | 1.26 | 204.24 | |
| | 11-Sep-25 | | | 2.47 | 1.50 | 204.00 | |
| MW28 | 19-Mar-25 | 5.7 | None | 1.82 | 0.84 | 206.96 | 207.8 |
| | 22-Apr-25 | | | 1.49 | 0.51 | 207.29 | |
| | 5-May-25 | | | 1.49 | 0.51 | 207.29 | |
| | 10-Jun-25 | | | 1.41 | 0.43 | 207.37 | |
| | 14-Jul-25 | | | 1.76 | 0.78 | 207.02 | |
| | 21-Aug-25 | | | 2.41 | 1.43 | 206.37 | |
| | 11-Sep-25 | | | 2.79 | 1.81 | 205.99 | |
| MW30S | 19-Mar-25 | 6.0 | None | 2.09 | 1.01 | 214.29 | 215.3 |
| | 22-Apr-25 | | | 1.62 | 0.54 | 214.76 | |
| | 5-May-25 | | | 1.72 | 0.64 | 214.66 | |
| | 10-Jun-25 | | | 1.63 | 0.55 | 214.75 | |
| | 14-Jul-25 | | | 2.17 | 1.09 | 214.21 | |
| | 21-Aug-25 | | | 2.78 | 1.70 | 213.60 | |
| | 11-Sep-25 | | | 3.22 | 2.14 | 213.16 | |
| MW30D | 19-Mar-25 | 9.1 | None | 4.24 | 3.21 | 212.09 | 215.3 |
| | 22-Apr-25 | | | 3.57 | 2.54 | 212.76 | |
| | 5-May-25 | | | 3.53 | 2.50 | 212.8 | |
| | 10-Jun-25 | | | 3.40 | 2.37 | 212.93 | |
| | 14-Jul-25 | | | 3.70 | 2.67 | 212.63 | |
| | 21-Aug-25 | | | 4.16 | 3.13 | 212.17 | |
| | 11-Sep-25 | | | 4.52 | 3.49 | 211.81 | |

[*] water strike/groundwater seepage

masl = metres above sea level

mbtop = metres below top of pipe

mbgs = metres below ground level

m = metres

** R. A. McLaren, O. L. S. – 2024.

It is noted from the groundwater monitoring dataset collected that groundwater levels being recorded are at shallower depths (i.e., higher elevations) than the depth at which groundwater was noted to have been either struck or identified as wet/saturated soils. Stable groundwater levels are also noted in monitoring wells where shallow soils were initially dry on completion of drilling.

These results are indicative of a primarily piezometric groundwater condition that is known to be present across the Hamilton area, with groundwater being encountered at depth and either permeating through the soils at the base of the monitoring well or rising up from the depth of groundwater strike in the installed groundwater monitoring well.



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A groundwater regime is considered piezometric when its pressure (i.e., its 'piezometric head') determines the groundwater resting level to be above the point at which groundwater is encountered in the ground (i.e., the height the water would rise in a monitoring well versus groundwater strike). This phenomenon is associated with confined, locally limited groundwater-yielding aquifers, generally comprising of sandier and siltier seams within the glacial till deposits encountered across the Study Area.

As the piezometry of groundwater levels is directly controlled by the permeability and/or porosity of the superficial soils and the source-water pressure head, the resulting piezometric groundwater levels are also variable. Consequently, this will present a general groundwater flow direction with apparent, localized diversions where piezometric levels are reduced or increased by respective drops or increases in groundwater pressures.

A deeper groundwater regime is also associated with the underlying dolostone bedrock and yields a piezometric condition as groundwater is controlled within the bedrock mass by the variable and confining fracture network associated with the dolostone. As such, groundwater levels may be recorded in monitoring wells at depths that are shallower than what is required to excavate to encounter it.

High groundwater contours based on groundwater level measurements recorded in March 2025 are presented on Figure 3.5.9, with hydrographs of the groundwater data presented in Appendix G2 for each respective groundwater monitoring well.

The hydrograph dataset available to date for both monthly readings and installed dataloggers indicates the groundwater levels across the Study Area, though at different elevations, respond in a similar manner, showing a general trend in elevation increase during the seasonally wetter period between April and May. Fluctuations in piezometry are generally in the order of 1.0 m to 2.0 m, though are noted very locally to be between 2.0 m to 3.0 m and are clearly defined in the peaks and troughs of the contours.

It is also noted that the datalogger dataset corroborates the corresponding dataset for the manual groundwater readings, providing confidence in the accuracy of the datasets representation of groundwater conditions within the Study Area.

Based on the investigation dataset, the fluctuations in groundwater are principally controlled by the superficial geology, being the naturally variable permeability and confining nature of the glacial deposits, rather than by groundwater recharge within the Study Area. This is corroborated by the limited area of groundwater recharge previously discussed and is confirmed further by the relative similarities in the behaviour of groundwater responses between nested shallow and deep monitoring wells, as is presented on the hydrographs in **Appendix G2**.

3.5.7 Groundwater Flow and Surface Water Interaction

The direction of horizontal groundwater flow through the Study Area subsurface was determined by using the groundwater elevations recorded in all onsite monitoring wells. The water table elevation contours lines were completed by triangulation with linear interpolation and are presented on Figure 3.5.9. The horizontal hydraulic gradient across the site was calculated to be approximately 0.004 m/m in a southwesterly direction.

Areas of significant groundwater recharge in the Study Area were mapped based on the information provided in the Hamilton Source Protection Assessment Report (2015) and by the NPCA's Source



Protection Assessment. These reports provide SGRA mapping data for Hamilton and the wider Niagara Peninsula SPA and includes the Study Area.

SGRAs in these source protection areas were delineated by identifying areas where groundwater is recharged by a factor of 1.15 or greater of the average recharge rate for the source protection area, per the technical methodology recommended by the MECP and MNR (NPSPA, 2013). SGRA mapping also considers site-specific factors affecting recharge rates, such as topography, surface cover, and soil texture. Recharge rates in the wider area of the Niagara Peninsula SPA are reported as being generally low and are primarily the response to overburden soils consisting of fine-textured clay and silt, glacio- and glaciolacustrine deposits.

Recharge rates detailed by the more locally prevalent Hamilton Region SPA vary significantly due to changes in the geology. The local but dominant influence of coarser grained (i.e., sandier) soils and fractured dolostone above the escarpment results in higher recharge rates in these areas. It is noted that groundwater inputs to onsite surface water features appear to be limited, as indicated by the absence of groundwater in the drive-point piezometers installed in wetland areas and creeks. These results are also corroborated by lower surface water flow rates and limited areas of surface water ponding noted during drier periods, particularly during the summer months. This is likely the result of the generally “*poorly defined*” channels and valley systems reported across the Study Area and the associated disconnect with the deeper groundwater regimes identified from the groundwater monitoring well and piezometer dataset.

As previously noted, SGRAs cover approximately 20% of the Study Area (Figure 3.5.1). Average recharge rates for surface water catchment areas were determined as part of the Niagara Peninsula SPA Water Availability Study for the Twenty Mile Creek Watershed Plan Area. Average recharge rates for these surface water catchment areas in the Study Area range from 45 mm/year to 51 mm/year (Aqua Resource and NPCA, 2009).

3.5.8 Infiltration Potential

To evaluate the potential for post-development infiltration strategies, soil permeability (Guelph Permeameter) testing was undertaken across a representative range of shallow soil types encountered across the Study Area. The testing was undertaken at pre-determined locations at a depth of 1.5 m below ground level.

The soils encountered within the test pits excavated across the Study Area generally consisted of topsoil overlying native clayey silt, silt and clay, traces of sand soil to the testing depths, with the Guelph Permeameter testing being undertaken predominantly within silty clay to clayey silt till strata.

In-situ hydraulic response (hydraulic conductivity) testing was also completed at selected monitoring wells in November 2025 and used to determine horizontal hydraulic conductivities within the Study Area. Graphical results of the horizontal hydraulic conductivity analyses are presented in **Appendix G3**. The results are summarized in Table 3.5.5.



Table 3.5.5 Horizontal Hydraulic Conductivity Results

| Monitoring Well | Hydraulic Conductivity | Screened Material |
|-----------------|--------------------------|-------------------|
| MW2D | 4.2×10^{-6} m/s | Limestone |
| MW3 | 4.0×10^{-9} m/s | Silty Clay Till |
| MW5 | 4.2×10^{-8} m/s | Clayey Silt |
| MW6 | 1.0×10^{-7} m/s | Silty Clay Till |
| MW7D | 1.6×10^{-5} m/s | Limestone |
| MW9 | 4.2×10^{-8} m/s | Clayey Silt/Silt |
| MW16 | 5.3×10^{-8} m/s | Silty Clay Till |
| MW18 | 1.2×10^{-6} m/s | Limestone |
| MW20 | 6.0×10^{-8} m/s | Silty Clay Till |
| MW22 | 5.2×10^{-9} m/s | Silty Clay Till |
| MW24 | 7.4×10^{-9} m/s | Silty Clay Till |
| MW25 | 6.8×10^{-8} m/s | Silty Clay Till |
| MW27 | 5.5×10^{-7} m/s | Silty Clay Till |
| MW28 | 2.5×10^{-8} m/s | Silty Clay Till |
| BH/MW30S | 2.2×10^{-9} m/s | Silty Clay Till |
| BH/MW30D | 1.7×10^{-9} m/s | Silty Clay Till |

The horizontal hydraulic conductivity of the subsurface soils that characterize the Study Area ranged from 1.5×10^{-5} m/s to 1.7×10^{-9} m/s. The soil permeability in the horizontal direction is generally understood to be an order of magnitude higher than permeability in the vertical direction; subsequently, the vertical hydraulic conductivities for the subsurface deposits are estimated to be in the range of 10^{-6} m/s to 10^{-10} m/s.

Based on the field-saturated vertical hydraulic conductivity testing results obtained from the Guelph Permeameter (1.2×10^{-7} m/s to 7.8×10^{-9} m/s; **Appendix G3**), the infiltration rates before applying any factor of safety corrections range between 13 mm/hour to 31 mm/hour. From extensive experience in the area, these values fall within the ranges anticipated for field-saturated hydraulic conductivity testing within the Study Area. Incorporating a factor of safety of 2.5, a design infiltration rate of 5 mm/hour to 13 mm/hour is obtained, which is considered by the City of Hamilton and the MECP as being less than ideally suitable for LID features or structures.

The variations in ranges for infiltration and hydraulic conductivities are as expected for glacial deposits in the Hamilton area, principally being the result of the variability in silt and sand fractions of the deposits and the associated, more permeable seams within the glacial deposit stratigraphy.

3.5.9 Groundwater Quality

The results of the analyzed groundwater samples collected from all monitoring wells within the Study Area were compared to the Provincial Water Quality Objectives (PWQO).

All analyzed parameters were reported within their respective PWQO guideline limits, except for total cobalt, iron, silver, and uranium. The results are summarised in Table 3.5.6.



Table 3.5.6 Laboratory Analysis Results

| Monitoring Well | Parameter | PWQO |
|-----------------|---------------|--|
| MW3D | Total Cobalt | 0.0019 mg/L* (Guideline = 0.0009 mg/L) |
| MW3D | Total Iron | 0.863 mg/L* (Guideline = 0.3 mg/L) |
| MW4 | Total Cobalt | 0.0048 mg/L* (Guideline = 0.0009 mg/L) |
| MW4 | Total Silver | 0.0001 mg/L* (Guideline = 0.0001 mg/L) |
| MW4 | Total Uranium | 0.0067 mg/L* (Guideline = 0.005 mg/L) |
| MW10 | Total Cobalt | 0.0023 mg/L* (Guideline = 0.0009 mg/L) |
| MW10 | Total Uranium | 0.0078 mg/L* (Guideline = 0.005 mg/L) |

[*] Exceedance

Based on the testing results and experience in groundwater testing in the vicinity of the Study Area, there appear to be no identified long-term trends (be it increasing or decreasing) in the concentrations of cobalt iron, silver or uranium in the groundwaters sampled that would indicate anything other than a natural background.

Experience gathered from an extensive range of investigations, both across the Hamilton area and throughout the Study Area, has established groundwater concentrations of these elements to commonly exceed the PWQO. This is largely attributed to the natural dissolution of minerals associated with the superficial and bedrock geology of the aquifer systems underlying the Study Area.

3.5.10 Pre-Development Water Balance Targets

The objective of the water balance assessment is to establish pre-development infiltration targets to preserve and/or enhance existing groundwater recharge function in each of the subwatersheds that occupy the Study Area (i.e., East Twenty Mile Creek, Hannon Creek, Sinkhole Creek, Stoney Creek, Upper Davis Creek, and West Twenty Mile Creek) under the post-development condition. The water balance analysis accounts for the various components of the hydrologic cycle: precipitation, evapotranspiration, runoff, and infiltration, which ultimately recharges the underlying aquifer systems.

3.5.10.1 Methodology

Within the hydrologic cycle, the flow of water into and out of a system is described through a simplified water balance equation, as follows:

$$P = ET + S + R + INF \quad \text{Equation 1}$$

Where:

- P = precipitation
- ET = evapotranspiration
- S = change in groundwater storage
- R = runoff
- INF = infiltration (groundwater recharge)

Equation 1 may be further simplified by ignoring the change in groundwater storage (S), which trends over time to zero. The various components of the hydrologic cycle may be estimated through calculations or based on measurements made in the field. Precipitation (P) is typically a measured value. The calculation of evapotranspiration (ET) is dependent on measured air temperatures, with the



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calculation of infiltration (INF) and runoff (R) being based on P and ET values. The difference between P and ET represents the water surplus (WS) that is available for infiltration and runoff to occur:

$$WS = P - ET \quad \text{Equation 2}$$

Where WS calculates INF after applying an infiltration factor (IF),

$$INF = WS \times IF \quad \text{Equation 3}$$

And the value for R is the subtraction of INF from the WS,

$$R = WS - INF \quad \text{Equation 4}$$

For this assessment, ET is calculated using the soil moisture balance model by Thornthwaite and Mather. In the Thornthwaite and Mather model, monthly potential evapotranspiration (PET) is calculated based on the measured average monthly daily temperature (T_a) and a heat index (H_i) value assuming 12 hours of daylight in a day and 30 days in a month, as follows:

$$PET = 16 \times \left(\frac{10T_a}{H_i} \right)^\alpha \quad \text{Equation 5}$$

Where T_a is taken as 0 degrees Celsius for months with negative temperatures, and H_i , the heat index is estimated as,

$$H_i = \sum_{i=1}^{12} \left(\frac{10T_a}{5} \right)^{1.514} \quad \text{Equation 6}$$

For α

$$\alpha = 0.49 + (0.0179 \times H_i) - (0.0000771 \times H_i^2) + (0.000000675 \times H_i^3) \quad \text{Equation 7}$$

An adjustment value is then multiplied with the PET values, after Thornthwaite and Mather, representing the average number of daylight hours per month at the latitude of the subject lands and providing the Adjusted Potential Evapotranspiration (PET_{adj}).

The calculated Actual Evapotranspiration (AET) is,

$$AET = PET_{adj} - \Delta S \quad \text{Equation 8}$$

Where ΔS is the change in storage for the month, calculated as,

$$\Delta S = S_{mc} \times e^{\left(\frac{APWL}{S_{mc}} \right)} \quad \text{Equation 9}$$

Where:

S_{mc} = soil moisture capacity

APWL = accumulated potential water loss, calculated for $\Delta P < 0$ as $APWL = -\sum_{i=0}^{12} PET_i$, and for $\Delta P > 0$ by rearranging equation 8; with $\Delta P =$ net precipitation = $P - PET_{adj}$



WS is derived by subtracting AET from the monthly precipitation,

$$WS = P - AET \quad \text{Equation 10}$$

And the infiltration and runoff calculated per Equation 3 and 4 above.

Each subwatershed is broken down into a series of sub-areas based on topographic, soil type, and land cover characteristics. The overall infiltration factor (IF) for a sub-area represents the sum of infiltration factors assigned by Stantec to each of the previously mentioned subwatershed characteristics (i.e., topography, soil type, land use) based on interpretations of the published values presented in MOE (2003). **Appendix G4** provides the MECP breakdown of infiltration factors associated with topography, soil type and land cover. As per Equation 3, the IF is then multiplied against the WS for a given sub-area to provide a calculated value of INF. The sum of all sub-area INF associated with the subwatershed then represents the overall pre-development infiltration target for that subwatershed.

Topography in the sub-areas is classified as rolling based on calculated slope averages, with soil types varying from silty clay to clayey silt (i.e., fine-textured glaciolacustrine deposits). Land cover, based on ELC mapping, varies from urban lawn (i.e., manicured lands), pasture/shrub lands, mature forest, and shallow rooted row crops (i.e., agricultural lands). Based on these parameters, infiltration factors ranged from 0.30 to 0.45 in the sub-areas (where a value of 1.00 indicates that the full WS volume infiltrates).

Under pre-development conditions, the percentage of area covered in each subwatershed by impervious surfaces was estimated to range from 3.0% to 7.1%.

The Hamilton Airport Climate Station (HCS) provided long-term monthly average (1981-2010) air temperature and precipitation data for use in the water balance analysis. Located approximately 11.5 km to the west of the Study Area, Stantec assumes that the monthly average precipitation and air temperatures recorded at the station is reflective of the precipitation and air temperature fluctuation trends that have historically occurred at the Study Area.

3.5.10.2 Results

Table 3.5.7 provides a summary of the pre-development infiltration rates and volumes calculated for each of the subwatersheds that occupy the Study Area, with this information being presented graphically in Figure 3.5.10. The detailed pre-development water balance calculations for each subwatershed is provided in **Appendix G4 (Tables G4-1 to G4-6)**.



Table 3.5.7 Pre-Development Infiltration Targets

| Subwatershed | Precipitation | | Evapotranspiration | | Runoff | | Infiltration | |
|------------------------|----------------------|------------|----------------------|------------|----------------------|------------|----------------------|------------|
| | (m ³ /yr) | (mm/yr) | (m ³ /yr) | (mm/yr) | (m ³ /yr) | (mm/yr) | (m ³ /yr) | (mm/yr) |
| East Twenty Mile Creek | 1,350,536 | 906 | 778,717 | 523 | 417,964 | 281 | 153,854 | 103 |
| Hannon Creek | 326,304 | 906 | 190,590 | 529 | 98,382 | 273 | 37,333 | 104 |
| Sinkhole Creek | 5,819,088 | 906 | 3,361,349 | 524 | 1,791,883 | 279 | 665,856 | 104 |
| Stoney Creek | 1,948,760 | 906 | 1,099,889 | 512 | 634,691 | 295 | 214,181 | 100 |
| Upper Davis Creek | 18,128 | 906 | 10,684 | 534 | 5,362 | 268 | 2,081 | 104 |
| West Twenty Mile Creek | 1,704,032 | 906 | 989,876 | 527 | 518,629 | 276 | 195,526 | 104 |
| Study Area | 11,166,848 | 906 | 6,431,105 | 522 | 3,466,911 | 281 | 1,268,831 | 103 |

Annual infiltration volumes within each of the subwatersheds are estimated to range from roughly 2,081 m³ to 665,856 m³, equating to annual infiltration rates of 100 mm/year to 104 mm/year. Overall, the estimated annual volume of infiltration occurring throughout the Study Area is 11,166,848 m³, equating to an annual infiltration rate of 103 mm. These annual infiltration rates are in agreement with rates assigned for clayey silt deposits (100 mm/year) as presented in Appendix C of the City of Hamilton (2023) Guidelines for Hydrogeological Studies and Technical Standards for Private Services and the MOEE (now MECP) (1995) Hydrogeological Technical Information Requirements for Land Development Applications (100 to 125 mm/year).

3.5.11 Conclusions

Based on the hydrogeological assessment, using field data collected from across the Study Area and existing information available for the area, the following conclusions have been drawn:

- The Study Area is located on the Haldimand Clay Plain which predominantly consists of poorly drained glaciolacustrine clay to silty clay overlying clay till. Bedrock underlying the Study Area comprises primarily of the Eramosa Member of the Lockport Formation. Bedrock depth below existing ground level ranges between approximately 3.0 m in the north and west of the Study Area and approximately 8.0 m in the south of the Study Area. Results of the onsite drilling and test pitting program completed by Stantec confirms the distribution of surficial soils across the Boundary Area to be largely accurate compared to existing surficial geology mapping.
- The hydrostratigraphy (i.e., the vertical sequence and horizontal extent of aquifers and aquitards) in the overburden and bedrock generally follows geological horizons. The principal, shallower groundwater regimes are controlled by the till deposits, where finer grained overburden soils act as aquitards while ‘sandier’ units generally behave as aquifers of local potential.
- Karst and karstic features are identified by the NPCA, HCA, MNR and Corporation of the City within the Study Area, though are more notable to the north of the Study Area where the Eramosa Karst ANSI is situated adjacent. Karstic features are noted to include dry and groundwater-bearing conduits and should be anticipated within the dolostone bedrock, though



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3 Overview of Existing Study Area Conditions

no sinkhole or soil pipe development has been noted within the Eramosa Karst ANSI where overburden depths are greater than 2.8 m. Such conditions are only noted in the north and west within the Study Area and coincide with the two areas of karstic feature identified in this report.

- Groundwater flow through the overburden deposits generally follows the existing topographical surface of the Study Area, moving in a southwestern direction, with a component of this flow being directed towards the various watercourses that occupy these lands. This localized interpretation of shallow groundwater flow is in general agreement with the surface water flow patterns mapped for the Study Area.
- The location of High-Volume Recharge Areas (HVRA) throughout the Study Area generally correlates with alluvial and glaciolacustrine deposits outcropping at surface.
- Infiltration rates established from field testing range between 13 mm/hour and 31 mm/hour, respectively, and are within the anticipated values for field-saturated hydraulic conductivity testing within the Study Area. The soil permeability in the horizontal direction is generally understood to be an order of magnitude higher than permeability in the vertical direction; subsequently, the vertical hydraulic conductivities for the subsurface deposits are estimated to be in the range of 10^{-6} m/s to 10^{-10} m/s.
- Based on the testing results, there are no identified long-term trends (be it increasing or decreasing) in the concentrations of cobalt iron, silver or uranium in the groundwaters sampled. Throughout the Study Area, groundwater concentrations of these elements commonly exceed the PWQO and is largely attributed to the natural dissolution of minerals associated with the geological deposits of the aquifer system underlying the Study Area.
- Water balance calculations indicate that the annual volume of water infiltrating within the subwatersheds of the Study Area ranges between approximately 2,081 m³ to 665,856 m³, for a total infiltration volume of 11,166,848 m³. Further discussion regarding water balance and low impact development mitigation measures are discussed in the Phase 2 SWP.



4 Environmental Constraints Mapping/Buffers

As the Study Area is projected to become part of the City's urban boundary through an UBE application, the 2013 UHOP was used as the guiding document when determining appropriate vegetation protection zone widths for natural heritage features. In addition to this, the Study Area falls within HCA and NPCA jurisdictions and consequently the conservation authorities' policies and regulations were taken into account when determining vegetation protection zone widths. As depicted on Figure 4.1.1, the Study Area abuts, but does not extend into, the Greenbelt Protected Countryside and Specialty Crop Area land use designations and, as such, Greenbelt policies and associated vegetation protection zones do not apply.

As per Section 2.5.10 of the UHOP, the following vegetation protection zone widths are to be applied:

- *Coldwater Watercourse and Critical Habitat* – 30 m on each side of the watercourse, measured from the bankfull channel
- *Warmwater Watercourse and Important and Marginal Habitat* – 15 m on each side of the watercourse, measured from the bankfull channel
- *Provincially Significant Wetlands* – 30 m measured from the boundary of the wetland
- *Unevaluated/Locally Significant wetlands* – a minimum 15 m measured from the boundary of the wetland
- *Significant Woodlands* – 15 m measured from the edge (drip line) of the feature
- *Woodlands* – 10 m measured from the edge (drip line) of the feature
- *ANSIs* – 15 m for Life and Earth Science ANSIs
- *Significant Habitat of Threatened or Endangered Species and Significant Wildlife Habitat* – determined through Environmental Impact Statements, dependent on the sensitivity of the feature; and, where applicable, subject to the *Endangered Species Act*, or future *Species Conservation Act*
- *Significant Valleylands* – as required by the relevant Conservation Authority

As per HCA policy Section 3.1.7.c (2011) of the Planning and Regulation Policies and Guidelines; and NPCA policy Section 8.2.3.1 (2024) of the Policies for Planning and Development document, the following vegetation protection zone widths have been identified:

- Unevaluated/Locally Significant wetlands – a minimum 15 m and up to 30 m measured from the boundary of the wetland

As noted in previous sections, the following natural features were identified within the Study Area:

- Warmwater watercourses (which range from warmwater to coolwater)
- Provincially Significant Wetlands
- Unevaluated and locally significant wetlands
- Significant woodlands
- Other woodlands
- Significant Wildlife Habitat
- Significant Habitat of Threatened and Endangered Species



- An Earth Science Area of Natural and Science Interest (Eramosa Karst Provincial Earth Science ANSI)

As per Section 3.1.7.c of the HCA's Planning and Regulation Policies and Guidelines document (2011) and Section 8.2.3.1 of the NPCA's Policies for Planning and Development in the Watersheds of the NPCA document (2024) the following vegetation protection zone widths have been identified:

- *Wetlands* – 30 m measured from the boundary of the wetland
- Hazard Lands – 50 m from the boundary of hazardous feature (example: sinkholes)
- Applicable vegetation protection zones are detailed in the sections below

4.1 Aquatic Environment

Based on initial water temperature data, and supporting field information, Sinkhole Creek and Stoney Creek are coolwater systems whereas Twenty Mile Creek is a warm-coolwater system using the criteria of Stoneman and Jones (1996) and revised by Chu (2009). No watercourses were identified in the study area within the Hannon Creek or Upper Davis Creek subwatersheds and therefore thermal regime was not evaluated. The UHOP provides guidance regarding VPZs for warmwater and coldwater systems, but not coolwater systems. For the Study Area, watercourses were therefore classified based on the criteria for Critical, Important and Marginal habitat from the UHOP. The UHOP states that Important and Marginal Habitat (i.e., protection HDFs, open agricultural watercourses) require a 15 m VPZ, whereas Critical Habitat require a 30 m VPZ. Important habitats are defined within the UHOP as fish habitats which are moderately sensitive to development and, although important to the fish population, are not considered critical (e.g., feeding areas, open water habitats of lakes). Marginal Habitats have low productive capacity or are highly degraded, and do not currently contribute directly to fish productivity. Critical habitats mean those fish habitats which have high productive capacity, are rare, highly sensitive to development, or have a critical role in sustaining fisheries (e.g. spawning or nursery areas for some species and ground water recharge areas). The majority of habitat in the Study Area was determined to be Marginal Habitat except for the downstream limits of Sinkhole Creek and Twenty Mile Creek and the ponded section of Stoney Creek being which has been classified as Important Habitat. Fish habitat VPZs are outlined in Figure 4.1.1.

4.2 Wetlands

PSWs, locally significant wetlands, and unevaluated wetlands were identified through background review of available LIO data and other sources. Through air photo interpretation and field survey verification (where applicable), the boundaries of these features were updated and mapped to reflect current conditions, confirmed through field investigations, where accessible. In some locations, existing mapped wetlands were part of an upland / wetland complex and therefore these areas were further ground-truthed to differentiate between upland and wetland areas. Where applicable, vegetation community mapping included ELC "inclusion" polygons. Following the boundary revisions and complexing, vegetation protection zones of 30 m and 15 m were applied to the PSWs and locally significant wetland communities respectively (as per UHOP policies). Unevaluated wetlands were also identified within the Study Area, and these wetland community boundaries were ground-truthed and confirmed by OWES-certified ecologists, where accessible (i.e., participating properties). Mapping of wetland boundaries is based on a combination of reviewing LIO mapping and aerial photography interpretation, as well as field confirmation with a hand-held GPS. No wetland boundaries have been surveyed by an Ontario Land Surveyor (OLS), which is expected to be completed with the conservation



authorities and applicable agencies at future stages of the project. Where not accessible (i.e., non-participating properties), aerial and drone imagery were utilized to determine approximate feature boundaries. A minimum 15 m vegetation protection zone was then applied to these communities, as per UHOP policies (as reflected in Figure 4.1.1).

Additionally, the HCA (HCA, 2011) and NPCA (NPCA, 2024) policies and regulations (Section 3.1.7.c and Section 8.2.3.1 respectively), identify a wetland vegetation protection zone of 30 m, regardless of the wetland classification. Given the changes to Conservation Authority's mandates (i.e., focus on hazards), the application of these policies will need to be reviewed and discussed further as the approval process advances, and site-specific applications proceed. Final vegetation protection zones for locally significant and unevaluated wetlands are anticipated to be confirmed at the EIS stage and will be determined based on the ecological functions for these areas. For the purposes of the Phase 1 study and mapping, a conservative approach was taken, and a 30 m vegetation protection zone has been applied to all locally significant and unevaluated wetlands (see Figure 4.1.1) in consideration of conservation authority policies. For planning purposes, a 15 m minimum vegetation protection zone has been applied to locally significant and unevaluated wetlands (also depicted on Figure 4.1.1) as this is the minimum vegetation protection zone identified in the applicable UHOP policies (with the understanding that Conservation Authority's may require up to a 30 m minimum vegetation protection zone pending the findings of future site-specific studies). A reduced vegetation protection zone for unevaluated and locally significant wetlands could potentially be determined during future stages of the development review and approval process. In consideration of wetland size (based on UHOP proximity / connectivity criteria for assessment of woodland significance, which references wetland significant natural areas as a minimum of 0.5 ha, see Table 3.1.5), unevaluated wetland communities that did not meet the UHOP wetland size criterion of 0.5 ha (and were not part of a larger wetland / woodland complex), were not always mapped as constraints as those small areas were considered wetland features of low function (e.g., cattail, phragmites in agricultural lands, along ditches). Wetland inclusions were not prescribed a 30 m Conservation Authority minimum vegetation protection zone / 15 m minimum vegetation protection zone. The inclusions were prescribed the minimum vegetation protection zone of the larger natural features that they were contained within (e.g., a wetland inclusion within a significant woodland was prescribed a 15 m significant woodland minimum vegetation protection zone). Subject to further site-specific study for a more detailed assessment of ecological features and functions, locally significant wetlands and unevaluated wetlands, shown on Figure 4.1.1, may be candidate areas for potential compensation, in consultation with the agencies.

4.3 Woodlands

Woodland communities (i.e., cultural woodlands and forests, per ELC) within the Study Area were assessed for significance using the UHOP's Significant Woodland criteria (see Section 3.1.3.2.7). These criteria are based on woodland size, interior woodland habitat, woodland proximity and connectivity to significant natural areas, woodland proximity to water, woodland age, and the presence of rare species within woodlands. Details related to the criteria can be found in Sections 3.1.3.2.7 and 3.1.4.9 and the formal assessment of the woodlands within the Study Area can be found in **Appendix C8**.

As per the UHOP, woodlands must meet two or more of the criteria to be deemed significant. Thus, communities within the Study Area that met two or more of the criteria were classified as significant, while those communities that met one or less of the criteria were characterized as "other", non-significant woodlands.



Similar to the approach with wetlands, the mapping of woodland boundaries is based on a combination of review of LIO mapping, aerial photo interpretation, and field confirmation with a hand-held GPS where accessible (i.e., participating properties). No woodland boundaries have been surveyed by an Ontario Land Surveyor (OLS), which is expected to be completed with the agencies at future stages of the development review and approval process. Where not accessible (i.e., non-participating properties), aerial and drone imagery were utilized to determine approximate feature boundaries. As per UHOP Section 2.5.10, a 15 m vegetation protection zone was applied to the significant woodlands, and a 10 m vegetation protection zone was applied to “other”, non-significant woodlands. Subject to further site-specific study for a more detailed assessment of ecological features and functions, woodlands identified as “other” may be candidate areas for potential compensation, in consultation with the agencies. Further details pertaining to potential compensation frameworks for these “other” woodlands (i.e., the completion of General Vegetation Inventory assessments and development of Tree Management Plans) will be outlined in the Phase 2 SWP Report.

A 15 m vegetation protection zone was established for the FOD9 forest within Parcel 64. While it did not meet the criteria of a Significant Woodland (outlined in **Section 3.1.3.2.7**), based on the field surveys completed to date, the dominant composition of mid-aged native tree species, and relative size of the woodland within the Study Area, it was determined that this “other” woodland warranted enhanced mitigation. Thus, a 15 m buffer was applied to maintain the form and function of the woodland..

4.4 Earth Science ANSI

As illustrated on Figure 2.2.1 an Earth Science ANSI, the Eramosa Karst Provincial Earth Science ANSI, is located on and adjacent to the Study Area (associated with Upper Davis Creek subwatershed). As per Section 2.5.10 of the UHOP a 15 m vegetation protection zone was applied to this feature. It should be noted, however, that immediately north of the Study Area boundary residential, commercial, educational, and recreational development has been permitted and therefore development may be permitted assuming that all applicable policies and guidelines are met. A more detailed site specific karst analysis can be conducted by the landowner to assess the type of development permitted within and/or adjacent to the Eramosa Karst Provincial Earth Science ANSI or identified karst features to support future planning/development approvals.

Due to the presence of the identified ANSI, visual screenings were completed while on accessible parcels to document any potential evidence of hazardous sites (i.e., sinkpoints, caves, sinkholes, fissures, and springs). Evidence of two sinkholes were noted within the Study Area (depicted in Figure 4.1.1). As per Section 2.3.1.d.iii of the HCA’s Planning Regulation Policies and Guidelines (2011), development and/or site alteration shall not be permitted within a setback distance of 50 m from the boundary a hazardous site. Consequently, a 50 m setback has been applied to these features and is illustrated in Figure 4.1.1.

4.5 Threatened and Endangered Species

Significant habitat of Threatened and Endangered Species was also recorded within the Study Area. Bobolink and eastern meadowlark, species identified as Threatened on the SARO list, were documented within the Stoney Creek subwatershed (see Figure 3.1.5). Individuals were observed in hayfields that were being actively farmed. Currently, under Ontario Regulation 242/08, Section 4.1, habitat removal is permitted, subject to MECP consultation and registry or permitting requirements. Prior to development within these parcels; however, additional breeding bird surveys are recommended



to determine if these species are still present. If these species are present, the requirements of the legislation that is in force at that time, now the SCA, 2025, will apply and the appropriate steps are to be taken to ensure conformity to the applicable legislation and regulations.

Butternut and black ash, species listed as Endangered within Ontario, were also documented within the Study Area. The identified butternut was determined to be a hybrid individual within Hedgerow 10A. Although not protected under the *Endangered Species Act*, the presence of a hybrid individual implies that a pure butternut could be present nearby, if not within the Study Area itself. The presence of black ash was confirmed and identified within the Sinkhole Creek PSW complex. The community in which the black ash is found is part of the PSW and will be retained and will be protected through the 30 m PSW vegetation protection zones and 15 m Significant Woodland vegetation protection zones associated the communities within the upland and woodland complex.

One short-eared owl was observed in the Study Area (Figure 3.1.3) flying back and forth across SecondRoad East near property 42 on April 17, 2025. The date of observation is around the time that a short-eared owl could be either a migrant or an early breeding individual. Additional surveys should be completed prior to development to confirm presence or absence in the Study Area.

4.6 Significant Wildlife Habitat

Significant Wildlife Habitat for one Special Concern species (Eastern Wood-Pewee) was confirmed within Study Area. Breeding individuals of Eastern Wood-Pewee were observed in various woodlands and hedgerows throughout the Study Area. Woodlands in which the Eastern Wood-Pewee were documented will be retained and protected (as they qualify as significant woodlands) with applicable vegetation protection zones (15 m for significant woodlands and, where applicable, 10 m for woodlands deemed not significant). It is important to note that a barn structure was identified within the Twenty Mile Creek subwatershed, which was found to have several active Barn Swallow nests. Although this man-made structure was not deemed to be SWH, it is recommended that if the barn be scheduled for demolition as part of future development, that additional breeding bird surveys occur to determine if this Special Concern species is still present. If so, it is recommended that a compensation habitat structure be built within the natural heritage system of the subwatershed prior to the barn's removal.

It should be noted that SAR bat surveys and surveys for determining bat SWH were not completed as part of the SWP. Rather, a SWH screening was completed based on the known representation of woodlands in the Study Area. Related surveys for the determination of presence/absence (i.e., acoustic monitoring, bat exit surveys) may need to be completed on a parcel-by-parcel basis, where applicable, at the time of proposed development. This would be applicable to wooded communities (i.e., hedgerows, thickets, cultural woodlands, and "other" woodlands proposed for compensation) or potential roosting/overwintering structures that are slated for removal. Acoustic monitoring would not be expected to be required for woodland areas to be protected. Bat habitat associated compensation requirements will be dependent on survey findings and, if required, will be determined via consultation with the MECP, which will be subject to the SCA and supporting regulations.

All terrestrial and aquatic natural heritage features (and their associated vegetation protection zones) discussed above are shown on Figure 4.1.1. It is important to note that although woodland and wetland feature boundaries were determined by certified ecologists, where accessible and based on the methods described in this study, formal natural feature staking's will need to occur on a parcel-by-parcel basis with the appropriate agencies (i.e., the City, the NPCA, the HCA) at the time of proposed



development to determine the precise ecological development limits. Further to this, it is critical to note that the final determination of vegetation protection zones may be subject to additional field surveys and more detailed assessment of features and functions and the proposed adjacent land uses, whereby lesser buffers or variable buffer widths may be appropriate.

4.7 Hazard Lands

Hazard Lands, which include meander belt widths and floodplains, have also been considered in the assessment of development constraints throughout the Study Area. Meander belt width determinations and delineations along the unconfined systems of the Study Area are discussed in Section 3.2.6.2 and detailed in Figure 3.2.1 and **Appendix D1** (also present in Figure 4.1.1). Updated existing conditions floodplain mapping is discussed in Section 3.4.6 and also detailed in Figure 3.2.1 (as well as Figure 4.1.1). Regulation allowances for both the meander belt widths and the floodplains differ between conservation authorities. As per Ontario Regulation 41/24, *Prohibited Activities, Exemptions and Permits* (2024):

Where the river or stream valley is not apparent, the valley extends:

To the furthest of the following distances:

- The distance from a point outside the edge of the maximum extent of the flood plain under the applicable flood event standard to a similar point on the opposite side
- The distance from the predicted meander belt of a watercourse, expanded as required to convey the flood flows under the applicable flood event standard to a similar point on the opposite side
- An additional 15-metre allowance on each side, except in areas within the jurisdiction of the Niagara Peninsula Conservation Authority where this is no additional allowance

NPCA's Policies for Planning and Development in the Watershed of the Niagara Peninsula Conservation Authority (2024), on the other hand states:

Where the river or stream valley is not apparent, the valley extends to the furthest of the following distances:

- The distance from a point outside the edge of the maximum extent of the floodplain under the applicable flood event standard to the similar point on the opposite side
- The distance from the predicted meander belt of a watercourse, expanded as required to convey the flood flows under the applicable flood event standard to a similar point on the opposite side

Consequently, no regulation allowance has been applied to the meander belt widths and floodplain limits in the Twenty Mile Creek and Sinkhole Creek which fall within NPCA's jurisdiction. In the Hannon Creek, Upper Davis Creek, and Stoney Creek subwatersheds, which fall within the HCA's jurisdiction, a 15 m regulation allowance has been applied to the greater of the floodplain or meander belt width limit, where applicable. These hazard limits and applicable allowances are shown in Figure 4.1.1.



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4 Environmental Constraints Mapping/Buffers

Table 4.7.1 summarizes the various vegetation protection zones and allowances applied to natural heritage features (terrestrial and aquatic features) and hazard land features in the Study Area.

Table 4.7.1. Natural Heritage (Terrestrial and Aquatic) & Hazard Land Feature VPZ Summary

| Feature | Present in Accessible Portions of the Study Area (Y/N) | Vegetation Protection Zone (2013 UHOP) | Allowances and buffers (NPCA/HCA) |
|--|--|---|---|
| Coldwater Watercourses | N ¹ | 30 m on each side of the watercourse, measured from the bankfull channel | NPCA: 30 m on permanent watercourse, but can be reduced to 15 m (note: NPCA does not provide buffers based on thermal regime) HCA: 30 m on each side of the watercourse, measured from the bankfull channel (note: 2025 draft HCA policies do not provide buffers) |
| Fish Habitat (Critical Habitat) | N | 30 m on each side of the watercourse, measured from the bankfull channel | NPCA: N/A HCA: N/A |
| Warmwater Watercourses | Y | 15 m on each side of the watercourse, measured from the bankfull channel | NPCA: 15 m on an intermittent watercourse HCA: 15 m on each side of the watercourse, measured from the bankfull channel |
| Fish Habitat (Important or Marginal Habitat) | Y | 15 m on each side of the watercourse, measured from the bankfull channel | NPCA: N/A HCA: N/A |
| Provincially Significant Wetlands | Y | 30 m, measured from the boundary of the wetland | NPCA: 30 m, measured from the boundary of the wetland HCA: 30 m, measured from the boundary of the wetland |
| Locally Significant / Unevaluated Wetlands | Y | 15 m, measured from the boundary of the wetland, unless an EIS recommends a more appropriate vegetation protection zone | NPCA: 30 m, measured from the boundary of the wetland HCA: 30 m, measured from the boundary of the wetland |
| Significant Woodlands | Y | 15 m, measured from the edge (drip line) of the significant woodland | NPCA: N/A HCA: N/A |
| Other Woodlands | Y | 10 m, measured from the edge (drip line) of the woodland | NPCA: N/A HCA: N/A |
| Area of Natural and Scientific Interest | Y | 15 m | NPCA: N/A HCA: 50 m from the boundary of hazardous sites |
| Significant Valleylands | N | As required by the relevant conservation authority | NPCA: 15 m from top of slope (stable), 15 m from long-term stable top of slope (unstable) HCA: 15 m from top of slope (stable), 15 m from long-term stable top of slope (unstable) |
| Habitat of Threatened & Endangered Species | Y ² | To be determined by EIS in consultation with the MECP | N/A |
| Significant Wildlife Habitat | Y ³ | To be determined by EIS | N/A |
| Meander Belt | Y | N/A | NPCA: Meander belt width limit HCA: Meander belt width limit, plus 15 m |



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4 Environmental Constraints Mapping/Buffers

| Feature | Present in Accessible Portions of the Study Area (Y/N) | Vegetation Protection Zone (2013 UHOP) | Allowances and buffers (NPCA/HCA) |
|------------|--|--|--|
| Floodplain | Y | N/A | NPCA: Floodplain limit HCA: Floodplain limit, plus 15 m |

¹ The thermal regime of watercourses within the Study Area are still being assessed with temperature loggers. Watercourse classifications may be revised in the future.

² Community in which Black Ash is located is protected with Provincially Significant Wetland and Significant Woodland vegetation protection zones. The identified Bobolink and Eastern Meadowlark habitat is to be re-examined at the EIS stage. If still present, compensation may be required in the form of a cash-in-lieu payment to the Species Conservation Fund (through the newly proposed Species Conservation Act) or through the development and implementation of a Bobolink/Eastern Meadowlark Management Plan (as per Part IV of Ontario Regulation 830/21).

³ Communities in which Eastern Wood-Pewee were breeding are protected with Significant Woodland and Woodland vegetation protection zones. Due to the low numbers of breeding individuals observed, larger vegetation protection zones have not been recommended. The identified barn with nesting Barn Swallow should be re-examined at the EIS stage. If active nesting is still occurring, it is recommended that a compensation structure be built within the subwatershed.

In general, the Natural Heritage and Hazard Land Features - and their associated vegetation protection zones and allowances - suggest a robust network of features running east-west through the central portion of the Study Area, which is reflective of current City of Hamilton Official Plan Schedule mapping. The development limit of this network of features is largely governed by flooding hazards, with natural heritage features and their associated vegetation protection zones playing a lesser role. Outside of this central network of features; however, natural features and hazard lands are more dispersed and isolated in nature. In these instances, floodplain hazards and natural heritage features and their vegetation protection zones play a more equivalent role in determining the development limits. The outermost development constraints of the discussed features are outlined in Figure 4.1.1.

Connectivity of natural heritage features throughout the landscape is encouraged by the City, the NPCA, and the HCA, as connectivity promotes biodiversity via wildlife movement corridors. In addition to this, the City, the NPCA, and the HCA are mindful of climate change and its potential future effects on the landscape. Further evaluation of landscape connectivity (via a linkage assessment) and the potential future impacts of climate change on the Study Area and surrounding lands will be considered in Phase 2 of the planning process.



5 References

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|------------------------------|---|
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5 References

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