Wildfield Village Secondary Plan
Caledon
Local Subwatershed Study (LSS)
Phase 2 Report
Impact Assessment

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Submitted by:

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1.0 Introduction

Wildfield Village is located within the Region of Peel, in the Town of Caledon, within the Region's Urban Boundary. The Wildfield Village Secondary Plan area was identified by the Region of Peel through their Settlement Area Boundary Expansion (SABE) Study as "New Community Area". The SABE Study informed the Region of Peel Official Plan, 2022, which designates the Secondary Plan Area as "2051 New Urban Area". In conformity, the Future Caledon Official Plan also designates the Secondary Plan Area as "2051 New Urban Area" and "New Community Area". These lands are intended to be developed for residential purposes including associated roads, infrastructure, utilities, institutional uses, retail, parks and open space.

1.1 Purpose

This Local Subwatershed Study (LSS) has been prepared by SCS Consulting Group Ltd. (SCS) and GEI Consultants Inc. (GEI) in support of the Secondary Plan for Wildfield Village. Per Town of Caledon correspondence (Cassie Schembri, Town of Caledon, March 28, 2024), the intent of the LSS is to "develop a sustainable development plan for the subject growth area in Caledon by protecting and enhancing the natural and human environments through the implementation of the direction, targets, criteria and guidance of the Region of Peel Scoped Subwatershed Study (SWS) prepared by Wood (2022). The LSS will confirm, refine and implement a Natural Heritage System (NHS) and the water resource management approach that will protect, rehabilitate, and enhance the natural and water-based environments within the Secondary Plan area, and the surrounding lands in the subwatershed."

This LSS has been prepared in accordance with the approved Terms of Reference dated August 23, 2024 (refer to **Appendix A1**). The LSS will address a range of environmental and servicing matters associated with the Wildfield Village Secondary Plan (WVSP) area, including the protection and management of surface water, groundwater, fluvial geomorphology, and terrestrial and aquatic resources. The LSS will also identify the NHS and municipal servicing needs, including stormwater management, sanitary and water servicing and site grading requirements.

The LSS serves to:

- Address the relevant natural features and functions identified in the Provincial Planning Statement (PPS; MMAH 2024), Region of Peel Official Plan, and Town of Caledon Official Plan;
- Provide the foundation for the layout of the Secondary Plan by defining and delineating elements such as the NHS, transportation and servicing networks, and the location of stormwater management (SWM) facilities;

- Follow the direction and guidance of the Region of Peel Scoped SWS (Wood., 2022) confirming targets and criteria based on site specific data obtained through the Secondary Plan level study; and,
- Define measures to protect and/or enhance the NHS.

The LSS will be completed in three phases as follows:

- Phase 1 – Characterization of Existing Conditions and Baseline Inventory
- Phase 2 - Analysis, Impact Assessment, Mitigation and Recommendations
- Phase 3 - Implementation, Monitoring and Adaptive Management

This report fulfills the requirements of the Phase 2 LSS. As the process proceeds, this report will be amended to include future Phase 3. The purpose of the current Phase 2 report is to introduce the land use plan and provide an assessment of the potential for impacts on natural heritage features and functions, as well as on groundwater and surface water that might result from the proposed development. The purpose is also to develop a Restoration and Enhancement Plan that enhances the retained NHS while mitigating and compensating for impacts on both the retained and created NHS. The Phase 2 LSS also introduces the stormwater management strategy which mitigates the potential impacts of the proposed land use.

1.2 Study Area

The WVSP area is approximately 358.1 hectares (ha) in size, and is located in the Town of Caledon, and the Region of Peel. The WVSP area is bound by Centreville Creek Road to the west, Mayfield Road to the south, the planned Highway 413 Transportation Corridor to the north and the limits of the Greenbelt Plan to the east, with the West Humber River beyond that. Refer to **Figure 1.1** in **Appendix A2** for the location of the Secondary Plan area. The Natural Heritage Study Area (NHSA) consists of the WVSP area plus the 120 m adjacent lands to study and assess natural heritage features.

Figure 1.2 (**Appendix A2**) shows the ownership for the WVPS area with approximately 57% of the lands owned by parties participating in the LSS and the Secondary Plan process.

1.3 Land Use Plan

Per the Planning Justification and Housing Assessment Report (PJR) prepared by SGL Planning and Design (2024), the proposed Land Use Plan reflects the Future Caledon Official Plan Town Structure and its identification of a Neighbourhood Centre, Urban

Corridors, as well as a network of collector roads. The Land Use Plan includes a mixed-use high-density Neighbourhood Centre at the intersection of Mayfield Road and Centreville Creek Road and three Urban Corridors, which are envisioned to develop with a mix of uses, mid-rise apartments, townhouses and neighbourhood-oriented uses. The majority of the WVSP area has been designated as Neighbourhood Area permitting various ground related housing types, parks and schools. The Land Use Plan also protects for a preliminary Natural Heritage System (NHS), as described in Section 2.5 of the Phase 1 LSS. Parks, schools and SWM facilities are shown as symbols. For additional land use information, refer to the PJR (SGL Planning, 2024).

The process of developing the proposed Land Use Plan was iterative with input from planners, engineers, ecologists and hydrogeologists. The plan was established based on a comprehensive review and analysis of planning, transportation, servicing and SWM needs while protecting for natural features and hazards within the NHS. Refer to the PJR (SGL Planning, 2024) and the Wildfield Community Transportation Study (WCTS) prepared by BA Group (2024) for the planning and transportation analysis, respectively.

Prior to approval of the Secondary Plan in June 2025, refinements were made to the final Land Use Plan, which differ from previously submitted versions. The final approved land use for the WVSP is provided here as **Figure 1.3** in **Appendix A2**. The extent and location of Natural Features and Areas and SWM facilities as shown on the approved Land Use Plan have been refined and finalized through this LSS.

1.4 Background Information

1.4.1 Reports

In preparation of the LSS, the following reports have been reviewed and referenced:

- Humber River Watershed Characterization Report (TRCA, 2023);
- Region of Peel Settlement Area Boundary Expansion Study (SABE), (2022);
- Scoped Subwatershed Study (SWS), Part A: Existing Conditions and Characterization (Final Report) Settlement Area Boundary Expansion, Region of Peel (Wood., 2022);
- Scoped Subwatershed Study (SWS), Part B: Detailed Studies and Impact Assessment (Final Report), Settlement Area Boundary Expansion, Region of Peel, (Wood., 2022);
- Scoped Subwatershed Study (SWS), Part C: Implementation Plan (Final Report), Settlement Area Boundary Expansion, Region of Peel (Wood., 2022).
- Approved Assessment Report: Toronto and Region Source Protection Area (CTC Source Protection Committee, 2022);
- Region of Peel Water and Wastewater Master Plan (2020);

- Technical Memorandum, Peel Scoped Subwatershed Study (SWS) – Groundwater "Areas of Concern" mapping (Oak Ridges Moraine Groundwater Programs (ORMGP), 2020);
- Final Report Humber River Hydrology Update (TRCA, 2018);
- Mayfield Road Improvements, Airport Road to Coleraine Drive – Class Environmental Assessment, Environmental Study Report (Stantec and the Region of Peel, April 2015)
- Humber River State of the Watershed Reports (TRCA, 2008);
- Humber River Watershed Plan (TRCA, 2008);
- Humber River Watershed Scenario Modelling and Analysis Report (TRCA, 2008);
- Listen to Your River: A Report Card on the Health of the Humber River Watershed (TRCA, 2007);
- Groundwater Modelling of the Oak Ridges Moraine Area (Kassenaar, J.D.C. and Wexler, E.J., 2006); and,
- The Physiography of Southern Ontario (Chapman and Putnam, 1984).

1.4.2 Policies, Guidelines and Legislation

The following policies, guidelines, and legislation have been reviewed with respect to preparing the LSS:

- Town of Caledon Official Plan (2024);
- Future Caledon Official Plan (2024);
- Ontario Regulation 41/24: Prohibited Activities, Exemptions and Permits (2024);
- Draft Town of Caledon Growth Management Phasing Plan and Financial Impact Assessment Presentation (2023);
- Municipal Consolidated Linear Infrastructure Environmental Compliance Approvals, Ministry of Environment, Conservation and Parks (MECP), (June 2023);
- Region of Peel Official Plan (2022);
- Approved CTC Source Protection Plan (CTC Source Protection Committee, 2022);
- A Place to Grow; Growth Plan for the Greater Golden Horseshoe (2020);
- Development Standards Manual, Town of Caledon, Version 5 (2019);
- Erosion and Sediment Control Guide for Urban Construction (TRCA, 2019);
- Technical Guidelines for Flood Hazard Mapping (TRCA and other Conservation Authorities, 2017);
- Wetland Water Balance Risk Evaluation (TRCA, 2017);
- Geotechnical Engineering Design and Submission Requirements (TRCA November 2017);

- Greenbelt Plan (May 2017);
- Wetland Water Balance Monitoring Protocol (TRCA, 2016);
- Crossings Guideline for Valley and Stream Corridors (TRCA, 2015);
- TRCA Master Environmental and Servicing Plan Guideline (TRCA, 2015);
- Evaluation, Classification, and Management of Headwater Drainage Features (HDF) Guidelines (CVC & TRCA, 2014);
- Hydrogeological Assessment Submissions- Conservation Authority Guidelines to Support Development Applications (Conservation Ontario 2013);
- Ministry of Municipal Affairs and Housing (MMAH) Supplementary Guidelines SG-6, Percolation Time and Soil Descriptions, (MMAH 2012)
- Stormwater Management Criteria, Toronto and Region Conservation Authority Version 1.0 (August 2012);
- Ministry of Natural Resources: Natural Heritage Reference Manual: Second Edition (OMNR 2010);
- TRCA/CVC Low Impact Development Stormwater Management Planning and Design Guide (2010);
- https://wiki.sustainabletechnologies.ca/wiki/Main_Page
- Peel Region Storm and Sanitary Sewer Use By-Law 53-2010 (Peel Region, 2010)
- Humber River Watershed Plan Implementation Guide (TRCA, 2008);
- Species at Risk in Ontario (SARO) List, regulation to the Endangered Species Act (ESA 2007);
- Channel Modification Design and Submission Requirements (TRCA, 2007);
- Belt Width Delineation Procedures (TRCA, 2004);
- Ministry of Environment (MOE) Stormwater Management Planning and Design Manual (March 2003);
- Technical Guide for River & Stream Systems: Erosion Hazard Limit (MNRF, 2002);
- The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority (TRCA, November 28, 2014).
- Ministry of Transportation (MTO) Drainage Management Manual (1997).

1.4.3 Base Mapping

The following data sets have been utilized in preparing the mapping utilized in the LSS:

- LiDAR 1.0 m Contours from Geohub, 2024
- Topographic Survey prepared by R-PE Surveying Ltd, October 2023
- Roads and Lot Fabric, Region of Peel
- Digital Imagery, First Base Solutions, 2002, 2013 and 2022.
- Watercourses, TRCA 2018

- TRCA Regulatory Mapping, 2024
- Humber River Hydrologic Catchments, Civica 2018
- Humber River Floodplain Mapping, Cole Engineering, May 2018
- Gao, C., Shirota, J., Kelly, R. I., Brunton, F.R., van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 207.
- Aerial photographs from 1960, 1976, and 1988, National Air Photo Library
- Digital imagery from 1954, University of Toronto Aerial Imagery Database (University of Toronto, 2024)
- Ministry of Environment, Conservation and Parks (MECP). Water Well Information System, Data Catalogue. Retrieved from: https://data.ontario.ca/dataset/well-records
- Ontario Geological Survey 2011. 1:250,000 scale bedrock geology of Ontario. Ontario Geological Survey. Miscellaneous Release---Data 126-Revision 1.
- Ontario Geological Survey. 2010. Surficial geology of Southern Ontario. Ontario Geological Survey. Miscellaneous Release--Data 128-Revised.
- Ontario Geological Survey. 2000. Quaternary geology, seamless coverage of the Province of Ontario. Ontario Geological Survey. Data Set 14---Revised.
- Ontario Ministry of the Environment, Conservation and Parks. 2021. Source Protection Information Atlas. Retrieved from: https://www.lioapplications.lrc.gov.on.ca/SourceWaterProtection/index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-CA
- Ontario Ministry of Natural Resources. 2024. Ontario Watershed Information Tool. Retrieved from: https://www.lioapplications.lrc.gov.on.ca/OWIT/index.html?viewer=OWIT.OWIT&locale=en-CA
- Gao, C., Shirota, J., Kelly, R. I., Brunton, F.R., van Haaften, S. 2006. Bedrock topography and overburden thickness mapping, southern Ontario. Ontario Geological Survey. Miscellaneous Release--Data 207.
- Armstrong, D.K. and Dodge, J.E.P. 2007. Paleozoic Geology Map of Southern Ontario. Ontario Geological Survey. Miscellaneous Release--Data 219.

1.4.4 Models

The following models have been utilized in the technical analysis completed as part of the LSS:

- Humber River Visual Otthymo Hydrologic Model (TRCA, 2018)
- Humber River Zone 2 HEC-RAS Hydraulic Model (TRCA, 2018)

The following reports contain the methodology and results for regional groundwater modelling, including the WVSP area, and have been referenced as part of the LSS:

- York Tier 3, results summarized in "Tier 3 Water Budget – Water Quantity Risk Level Assignment Study, Regional Municipality of York, Phase 1 Model Development Report," by Earthfx, dated February 2013.
- TRCA 2008 PRMS, results summarized in "Humber River Watershed, Scenario Modelling and Analysis Report," by TRCA, 2008.

1.4.5 Natural Heritage Resources

The following resources were reviewed for information relating to natural heritage features and species that may be found in the NHSA:

- The Ministry of Natural Resources and Forestry (MNRF) Land Information Ontario (LIO) database (2024);
- The Ministry of Natural Resources and Forestry (MNRF) Natural Heritage Information Centre (NHIC) database (MNRF 2024);
- Bird Studies Canada's Atlas of Breeding Birds of Ontario (BSC et al. 2006);
- Ontario Nature's Reptile and Amphibian Atlas (2020);
- Toronto Entomologists' Association's (TEA) Ontario Butterfly and Moth Atlases (2023, 2020);
- DFO Aquatic Species at Risk Mapping (2023); and,
- Other sources (e.g. watershed management plans, fisheries management plans).

The results of these background reviews are discussed in the following sections. This information assisted in defining the search effort and target species for studies on and immediately adjacent to the NHSA.

1.4.5.1 Land Information Ontario Natural Features Summary

Based on the MNRF Land Information Ontario (LIO) geographic database, no provincially significant wetlands or earth science areas occur on or within 120 m of the NHSA. However, the Gooseville Moraine Candidate Earth Science ANSI is located immediately north of the NHSA (north of Healey Road).

1.4.5.2 Natural Heritage Information Centre

The NHIC database (MNRF, 2024) was searched for records of provincially significant plants, vegetation communities and wildlife on, and in the vicinity of, the NHSA. The database provides occurrence database 1 km^2 area squares, with nine squares overlapping at least a portion of the NHSA.

Within these squares, the search revealed six records of species listed as threatened or endangered on the SARO list or Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species):

Species listed as threatened or endangered on the SARO list:

- Eastern Meadowlark (*Sturnella magna*) – Threatened;
- Bobolink (*Dolichonyx oryzivorus)* – Threatened; and,
- Redside Dace (*Clinostomus elongatus*) – Endangered.

Species listed as Special Concern on the SARO list or identified as an S1-S3 species:

- Wood Thrush (*Hylocichla mustelina*) – Special Concern;
- Eastern Wood- Pewee (*Contopus virens*) – Special Concern; and,
- American Brook Lamprey (*Lethenteron appendix*) – S3.

1.4.5.3 Ontario Breeding Bird Atlas

The Ontario Breeding Bird Atlas contains detailed information on the population and distribution status of Ontario birds (BSC et al. 2006). The data is presented on 100 km^2 area squares with two squares overlapping a portion of the NHSA (17PJ05 and 17NJ95). It should be noted that the NHSA may be a small component of the overall bird atlas squares, and therefore it is unlikely that all bird species are found within the NHSA. Habitat type, availability and size are all contributing factors in bird species presence and use.

A total of 122 species were recorded in the atlas squares that overlap with the NHSA. The following species of interest are noted:

Species listed as Threatened or Endangered on the SARO list:

- Acadian Flycatcher (*Empidonax virescens*) – Endangered;
- Prothonotary Warbler (*Protonotaria citrea*) – Endangered;
- Red-headed Woodpecker (*Melanerpes erythrocephalus*)--Endangered;
- Whip-poor-will (*Antrostomus vociferus*) – Threatened;
- Chimney Swift (*Chaetura pelagica*) – Threatened
- Bank Swallow (*Riparia riparia*) – Threatened;
- Eastern Meadowlark – Threatened and,
- Bobolink – Threatened.

Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species):

- Eastern Wood-Pewee – Special Concern;
- Wood Thrush – Special Concern;
- Common Nighthawk (*Chordeiles minor*) – Special Concern;
- Barn Swallow (*Hirundo rustica*)- Special Concern;
- Golden-winged Warbler (*Vermivora chrysoptera*) – Special Concern;
- Grasshopper Sparrow (*Ammodramus savannarum*) – Special Concern;
- Upland Sandpiper (*Bartramia longicauda*)-S2B; and
- Purple Martin (*Progne subis*) – S3B.

1.4.5.4 Ontario Nature's Reptile and Amphibian Atlas

The Ontario Reptile and Amphibian Atlas contains detailed information on the population and distribution status of Ontario herpetofauna (Ontario Nature 2020). The data is presented on 100 km2 area squares with two squares overlapping the NHSA (17PJ05 and 17NJ95). It should be noted that the NHSA are a small component of the overall atlas squares, and therefore it is unlikely that all herpetofauna species are found within the NHSA. Habitat type, availability and size are all contributing factors in herpetofauna species presence and use.

A total of 18 species were recorded in the atlas square that overlaps with the NHSA, of which three are salamander and lizard species, nine are frog and toad species, two are turtle species and four are snake species. Of these species, the following species of interest were noted:

Species of Conservation Concern (i.e., listed as Special Concern on the SARO List or identified as an S1–S3 species):

- Eastern Ribbonsnake (*Thamnophis saurita*) - Special Concern; and,

- Snapping Turtle (*Chelydra serpentina*) – Special Concern.

1.4.5.5 Ontario Butterfly and Moth Atlases

The Ontario Butterfly and Moth Atlases (Toronto Entomologists' Association 2020, 2023) contain detailed information on the population and distribution status of Ontario butterflies and moths. The data is presented on 100 km^2 area squares with two squares overlapping a portion of the NHSA (17PJ05 and 17NJ95). It should be noted that the NHSA is a small component of the overall atlas squares, and therefore it is unlikely that all butterfly and moth species are found within the NHSA. Habitat type, availability and size are all contributing factors in butterfly and moth species presence and use.

A total of 64 species were recorded in the atlas square that overlaps with the NHSA, of which 46 are butterfly species and 18 are moth species. Of these species, one Species of

Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species) was noted: Monarch (*Danaus plexippus*)- Special Concern.

1.4.5.6 Aquatic Species at Risk Distribution Mapping

Aquatic species at risk distribution mapping (DFO 2024) was reviewed to identify any known occurrences of aquatic SAR, including fish and mussels, within the subwatershed where the NHSA is located. One aquatic species at risk (Redside Dace) is present within the NHSA, located in the West Humber River east of the WVSP area but within the 120m adjacent lands. The West Humber River is expected to be considered occupied Redside Dace habitat.

1.4.5.7 West Humber River Fish Community

The Humber River Fisheries Management Plan (FMP; MNR and TRCA 2005) states that the West Humber River subwatershed is dominated by agricultural land-uses within a highly impermeable clay soil. The West Humber River subwatershed contains the least amount of riparian vegetation out of the entire Humber River watershed. Historically the West Humber River supported species such as American Brook Lamprey (Lethenteron appendix), Brassy Minnow (*Hydognathus hankinsoni*), Brook Trout (*Salvelinus fontinalis*), Mottled Scuplin (*Cottus bairdii*), Redside Dace (*Clinostomus elongatus*), Smallmouth Bass (*Micropterus dolomieu*), Stonecat (*Noturus flavus*) and Yellow Perch (*Perca flavescens*).

As of 2001, only 17 fish species were found within the watershed, with the fish community dominated by warmwater species. The FMP notes there is potential for the above noted species to still persist within the subwatershed. As illustrated on Figure 2 of the FMP (Stream Order for the Humber River Watershed), first and fourth order streams are found on the NHSA. No instream barriers are illustrated within the vicinity of the NHSA on Figure 10 (Instream Barriers in the Humber River Watershed) of the FMP.

Figure 22 of the FMP (Locations of the Aquatic Habitat Categories in the Humber River Watershed) of the FMP illustrates the portion of the West Humber River in the NHSA as intermediate riverine warmwater habitat. Small riverine warmwater habitat was also identified in reaches within the NHSA. The FMP notes that small riverine warmwater habitats have poor infiltration rates and minimal groundwater inputs, causing many of the reaches to dry up during the summer months or are reduced to standing pools of water.

1.4.5.8 Humber River Watershed Characterization Report

The Humber River Watershed Characterization Report (TRCA; 2023) Map 6 Watercourse and Headwater Drainage Feature Hydrology Function Classification identifies the West

Humber River in the NHSA as having Important hydrologic functions, while the majority of other reaches in the NHSA are shown as having Valued/Contributing hydrologic functions. A small number of reaches in the NHSA are identified as having Limited/Recharge hydrologic functions.

The SABE (2022) classified drainage features within the NHSA as watercourses or HDFs, with HDFs categorized as swales or having a defined channel. However, the SABE recommended that management recommendations be identified through future studies.

1.4.5.9 Citizen Science Database

The iNaturalist (2024) database is a large citizen science-based identification and data collection app. It allows any citizen to submit observations to be reviewed and identified by other naturalists and scientists to help provide accurate species observations. As the observations can be submitted by anyone, and the records are not officially vetted, the data obtained from this tool should not be used as a clear indicator of species presence, and species may be filtered out based on habitat and target survey efforts.

This online database was examined to identify observations made within the NHSA that were research grade. The following species of interest are noted:

- Species listed as Threatened or Endangered on the SARO list:
    - Rapids Clubtail (*Phanogomphus quadricolor*) – Endangered
- Species of Conservation Concern (i.e., listed as Special Concern on the SARO list, or identified as an S1-S3 species):
    - Snapping Turtle (*Chelydra serpentina*) – Special Concern; and,
    - Barn Swallow – Special Concern

Four observations of Rapids Clubtail were noted east of the NHSA. Coordinates for Endangered species are obscured in iNaturalist; however, the observations are generally within 2 km of the NHSA. One observation of Barn Swallow was noted generally within 1 km southwest of the NHSA. One Snapping Turtle was observed nesting 2 km southwest of the NHSA along Goreway Drive.

The eBird (2024) database is a large citizen science-based project with a goal to gather bird diversity information in the form of checklists of birds, archive it, and share it to power new data-driven approaches to science, conservation and education. As the observations can be submitted by anyone, and the records are not officially vetted, the data obtained from this tool should not be used as a clear indicator of species presence, and species may be filtered out based on habitat and target survey efforts. This online database was examined to identify observations made within and adjacent to the NHSA. However, no significant species were found within the WVSP area or the NHSA.

1.4.5.10 Species at Risk Assessment Tool

Mapped natural heritage features on the landscape were cross-referenced with species-specific habitat requirements through GEI's Species at Risk Assessment Tool (SARAT) to determine potential Species at Risk (SAR) habitat in the NHSA. The SARAT includes all potential and known habitats for every species at risk listed under the ESA, and municipalities where these species are known to occur, where indicated in individual species assessment and/or recovery strategy reports.

1.4.6 Additional Data

Additional data is still required to supplement background information presented in the sections above. This includes both groundwater monitoring and surface water chemistry sampling. Monitoring of groundwater within the monitoring wells installed in the WVSP area will continue until summer of 2025. This will provide two years of monitoring across most of the participating lands, and one year of monitoring at Parcels 5 and 9 (refer to **Figure 2.1, Appendix A2**) that joined the study in the summer of 2024. The last round of surface water chemistry sampling will occur in the fall of 2025 for a wet and dry event. Flow monitoring will also continue into the fall of 2025.

2.0 Natural Heritage Features and Hazards

This section of the Phase 2 LSS assesses the potential impacts on the natural heritage features and functions that could result from the implementation of the proposed land use plan (**Figure 1.3, Appendix A2**), as well as climate change.

Impacts from land use changes will be considered in two categories:

- **Direct**: impacts associated with the removal or modification of natural features as a result of land use changes.
- **Indirect**: associated with impacts to less visible functions or pathways that could cause negative impacts to natural heritage features over time.

An analysis of existing natural features in the Natural Heritage Study Area (NHSA) was completed as part of the Phase 1 LSS, including an evaluation of their significance against criteria recommended in the Natural Heritage Reference Manual (NHRM; MNR 2010) and in the Significant Wildlife Habitat Criteria Schedules for Ecoregions 6E and 7E (MNRF 2015).

These analyses identified the following significant natural heritage features as present, on, or within 120 m, of the NHSA (**Figure 2.1, Appendix B1**):

- Significant Wetland;
- Significant Woodlands;

- Candidate Significant Valleyland;
- Fish Habitat;
- Habitat of endangered and threatened species (Redside Dace, Bobolink, Eastern Meadowlark and candidate SAR bat); and,
- Significant Wildlife Habitat including:
    - Seasonal Concentration Areas of Animals (Confirmed and Candidate Bat Maternity Colonies, Candidate Bald Eagle and Osprey Habitat and confirmed Turtle Overwintering Areas); and,
    - Species of Conservation Concern (Terrestrial Crayfish,Wood Thrush, and Barn Swallow).

A Natural Heritage System (NHS) is made up of a diversity of ecological components; not all those natural features and associated ecological functions merit a significance designation at a provincial scale. However, there are features that merit consideration as important at a local scale. The Phase 1 LSS characterization identified the following additional natural heritage features and functions in the NHSA which are addressed in this Phase 2 impact assessment (**Figure 2.1, Appendix B1**):

- Unevaluated and Other Wetlands;
- Other Woodlands.

Section 2.5 of the Phase 1 LSS identifies a preliminary NHS for the NHSA, comprised of retained natural heritage features and appropriate compensation for proposed natural features removal.

Within the Scoped SWS (Wood, 2022) for the SABE area, the following targets are recommended for the NHS. These targets will be explored through the LSS to support the identification and planning of the NHS. Targets for feature types are as follows:

- Natural cover: no net loss;
- Wetlands: no net loss of wetland cover; increase total wetland cover through NHS enhancements;
- Valley and Stream corridors: no net loss of ecological and hydrological functions; increase natural cover within these corridors through enhancements;
- Successional/Open Habitats: Maintain important existing successional / open habitats contiguous to other features and areas of the NHS; increase representation and quality of open country habitats across the landscape through NHS enhancement opportunities; strive to create at least one habitat area with a minimum size threshold of 5 ha;
- Aquatic: achieve 75% naturally vegetated watercourse length through protection, enhancement or restoration;
- Sand Barrens, Savannahs, Grasslands: protect these where they occur; and,

- NHS Enhancements: identify and distribute enhancement opportunities across the NHS to support a robust and sustainable system; increase natural cover by 30%.

These targets are reviewed in more detail, in the context of mitigation, compensation and restoration/enhancement in **Section 2.5**.

2.1 Potential Terrestrial Impacts

2.1.1 Woodlands

Two significant woodlands occur in the NHSA. One is a Cultural Woodland (CUW1) located adjacent to a Silver Maple Deciduous Swamp (SWD3-2; significant wetland) in the south-central portion of the NHSA. The other woodland, a Forest (FO) and Cultural Woodland (CUW) is associated with the West Humber River valley east of The Gore Road (**Figure 2.1, Appendix B1**). The majority of this woodland is within the Greenbelt Plan Area.

The CUW1/SWD3-2 was designated as significant due to it being greater than 0.5 ha in size, the proximity (within 30 m) to the adjacent wetland community and having confirmed significant species (Wood Thrush [Special Concern]) and significant wildlife habitat (bat maternity colonies). This significant woodland will not be altered and will be protected by a proposed minimum 10 m buffer from the dripline; this buffer width has been demonstrated to provide adequate root protection for woodland communities (Carolinian Canada, 2003), and native plantings within these buffers will help insulate significant woodlands against potential impacts of land use changes. To protect roots and prevent negative impacts to tree health, any required site grading is recommended to be limited within the minimum 10 m woodland buffer. Where grading cannot be avoided, additional mitigative measures such as tree protection hoarding, and timely restoration of impacted areas are recommended. A full impact evaluation of the recommended minimum VPZs for the identified significant natural heritage features is provided in **Table 14** (**Appendix B2**).

The other significant woodland (FO/CUW) occurs with the 120 m adjacent lands, in the south-east portion of the NHSA, and is associated with the valley surrounding the West Humber River. The FO/CUW was designated as significant due to being greater than 4 ha, the proximity (within 30 m) to a watercourse and having candidate significant species and communities (bat maternity colonies, Bald Eagle and Osprey habitats). The West Humber River also provides occupied habitat for Redside Dace. Most of this woodland is located within the Greenbelt Plan Area where it is afforded a 30 m buffer; the majority of this buffer also falls within the Greenbelt Plan Area.

As noted previously, woodland features within the NHSA are being retained and align with the SABE Scoped SWS target of ensuring no net loss of natural cover. Potential direct impacts to all retained woodland communities may include:

- Edge effects associated with the tree removal (e.g., sunscald, windthrow, increased light penetration); and,
- Impacts associated with site grading and machinery (e.g., tree root damage/loss; change in drainage to/from woodland, soil compaction, invasive species colonization, stress/dieback).

Indirect impacts because of disturbance within or immediately adjacent to the woodlands could include changes to drainage post-development (whereby overland flow contributions to woodland or its buffer are reduced or increased), noise and light disturbance, as well as the introduction of invasive and non-native plants along the disturbed margins of the development footprint.

Further design considerations to mitigate these direct and indirect impacts will be considered in site specific EIS work at the Draft Plan of Subdivision stage. These may include, but are not limited to the following:

- Tree protection fencing and Erosion and Sediment Control (ESC) measures should be installed adjacent to all retained trees at the edge of the buffer zone to mitigate against excessive disturbance caused by proposed vegetation removals, ground disturbance and dislodgement of sediment. This will also protect the integrity of the NHS and aide in preventing adverse effects from ground disturbance.
- Construction activities adjacent to the retained woodlands should be timed outside of the evening and early morning periods during the bat breeding seasons (March 15 to November 30). Some localized movement of wildlife out of these edge areas may still occur during the construction phase; however, refuge habitats exist within the broader landscape.
- New lighting should be directed away from woodlands to reduce impacts to wildlife. Fencing and other barriers should be considered to limit the effects of noise and light on wildlife, particularly adjacent to roadways.
- Construction equipment should be regularly cleaned to reduce the potential for transportation of invasive material within and outside of the site.
- To slow the spread of invasive species, such as Emerald Ash Borer (*Agrilus planipennis)* and American Beech scale insects (*Cryptococcus fagisuga*) and American Beech fungus (*Neonectria faginata*) (amongst others), all trees should be disposed of locally to reduce transportation to other local municipalities; and,
- Restore affected areas and naturalize adjacent buffers with native vegetation.

Provided recommended mitigation measures and minimum buffers are put in place, no negative impacts to significant woodlands and other woodlands are predicted.

2.1.1.1 Climate Change Impacts to Woodlands

Woodlands face several climate stressors that threaten their health and ecosystem services. The increase in the frequency and intensity of extreme weather events can damage urban trees, reduce canopy cover and lead to a loss of critical ecosystem goods and services such as air purification, water regulation, and cooling. Higher average temperatures and more frequent hot days over 30°C contribute to increased tree mortality, resulting in decreased shade and protection from heat. Additionally, rising temperatures and altered precipitation patterns cause shifts in eco-regions, which create conditions favorable for invasive species to thrive, further compromising woodland health. These impacts can collectively reduce the resilience of woodlands, diminishing their ability to mitigate climate change and support biodiversity.

A 10 m buffer is a commonly applied standard in many jurisdictions and is consistent with the TRCA Living City Policies. Although woodlands are no longer within TRCA's mandate, the buffer standard continues to be recognized as a best practice approach. The policy is designed to provide a protected transitional zone that helps reduce edge effects, support microclimate regulation, and protect wildlife habitat and hydrological functions (e.g., reduced runoff, improved water quality through filtering, increased infiltration, and groundwater recharge). These benefits remain relevant in the context of climate change, as they help maintain the ecological function and health of the woodland and its edge.

While larger buffers can offer added benefits in certain contexts, in this case, the 10 m minimum buffer is considered sufficient when combined with the site's existing natural features and its adjacency to the SWD3-2 PSW minimum 30 m buffer, which provides additional buffer to the majority of the woodland. These complementary measures can help address potential long-term stressors related to climate change.

By safeguarding the structural integrity and ecological functions of woodlands, these strategies can support the continued provision of vital ecosystem services, such as carbon storage, temperature regulation, and habitat for biodiversity. In turn, healthy, intact woodlands are better equipped to adapt to and mitigate the effects of climate change.

2.1.2 Wetlands

2.1.2.1 Wetland Characterization and Evaluation

GEI assessed all wetlands on participating lands with an area greater than 2 ha using the current Ontario Wetland Evaluation System (OWES) protocol (MNRF 2022) and determined that one wetland (wetland 8; SWD3-2 in the south-central portion of the NHSA; **Figure 2.1, Appendix B1**) met the criteria for significance. The OWES wetland evaluation reporting and mapping will be submitted under separate cover. Wetland characterization tables for wetlands on participating lands are provided in **Tables 1 – 13 (Appendix B2**).

All other wetland communities are either too small (<2 ha) to meet the OWES size criteria or were evaluated as other wetlands (non-significant). The following other wetland communities are identified within the NHSA, and numbered on **Figure 2.1** (**Appendix B1**):

- Cattail Mineral Shallow Marsh-MAS2-1 (wetlands 2,3,5,6,34)
    - Locally rare plant species: Pennsylvania Smartweed (*Persicaria pensylvanic*a; R3), Peach-Leaved Willow (*Salix amygdaloides*; R6) and Eastern Mannagrass (G*lyceria septentrionalis var. septentrionalis*; R2).
    - No calling amphibians or low species abundances reported.
    - Midland Painted Turtles (*Chrysemys picta*) were observed incidentally within wetland 3.
- Reed Canary Grass Mineral Meadow Marsh-MAM2-2 (wetland 4, 12, 13)
    - Locally rare plant species: Tall Beggarticks (*Bidens vulgata*; R1), Pennsylvania Smartweed, Common Bedstraw (*Galium aparine*; R4) and Peach-Leaved Willow
    - No calling amphibians or low species abundances reported.
- Reed Canary Grass Mineral Meadow Marsh/ Disturbed-MAM2-2/DIST (wetland 7)
    - Made up of common and secure (S5 and S4) vegetation species
    - No calling amphibians
- Mineral Meadow Marsh-MAM2 (wetland 14, 17)
    - Made up of common and secure (S5 and S4) vegetation species
    - No calling amphibians
- Reed Canary Grass Mineral Meadow Marsh/ Forb Mineral Meadow Marsh-MAM2-2/MAM2-10 (wetland 10_11)
    - Locally rare plant species: Tall Beggarticks, Pennsylvania Smartweed, Common Bedstraw, Peach-Leaved Willow and Sandbar Willow (Salix interior; R5)
    - No calling amphibians

Wetlands on non-participating lands consist of small (usually much smaller than 0.5 ha), secluded features in an agricultural and residential land use setting, generally comprised of Meadow Marsh and Shallow Marsh wetland types. These wetlands are assumed to be maintained on site until the appropriate level of work in future studies is completed, including evaluation under OWES.

2.1.2.2 Groundwater Impacts on Wetlands

The dependence of retained wetlands 8, 10_11, 33 and 34 (**Figure 2.1, Appendix B1**) on groundwater baseflow is minimal. Subsurface investigation has revealed that soils of low hydraulic conductivity predominate across the NHSA, and groundwater monitoring has indicated that prevalent vertical gradients are downward (i.e., recharge gradients) and lateral gradients are generally low in magnitude, similar to topographic slopes. Notable instances of apparent upward vertical gradients were observed at monitoring well MW28S/D. Based on the stratigraphy encountered at that monitoring well, it appears that the shale bedrock underlying the till may exhibit artesian conditions in some locations, depending on ground elevation. However, the potential seepage contributions to surface water remain attenuated by the low hydraulic conductivity of the intervening soils, and of the low transmissivity of the shale itself.

In combination, these factors indicate that the potential groundwater seepage to features is generally low. Therefore, impacts to wetlands from an annual infiltration deficit would be anticipated to be minor. Regardless, to mitigate any impacts from an annual infiltration deficit, infiltration targets for shallow seepage to retained wetlands has been provided below in Section 3.2.4.2. Provided the LIDs are designed and implemented to achieve these infiltration targets, the individual wetlands are predicted to generally achieve pre-development infiltration volumes. As such, it is anticipated that no indirect effects associated with groundwater contributions to the wetlands will occur if these mitigative measures are designed and implemented appropriately. Additional discussion on LID measures is provided in Section 4.4.1 as part of the overall SWM strategy for the WVSP area with specific information related to LID measures required for wetland water balance in Sections 4.4.1.1 and 4.4.1.2.

Changes to groundwater quality would be expected from human activities such as road salting, minor fuel and oil leaks, fertilizer application etc. Best management practices should be considered when applying salt, fertilizers etc. to minimize their application and limit changes to groundwater. Spills and leaks must be contained and remediated as soon as possible to limit damage to the environment. Provided that groundwater infiltration and best management practices can be achieved as predicted, no negative impacts to groundwater on local or significant wetlands are expected.

2.1.2.3 Surface Water Impacts on Wetlands

Wetlands in the NHSA are hydrologically supported by surface water inputs, such as direct precipitation, runoff, and interflow in the shallow weathered soils above the silt-clay till. Potential impacts to surface water contributions due to the proposed land use could include a degradation of surface water quality or change in water quantity contribution to support the health of the wetland systems. For example, the proposed development will result in increase in imperviousness across much of the NHSA and would also disrupt existing interflow patterns due to grading and the construction of services and building foundations (which may create alternate preferential flow paths). These effects would lead to an increase in peak storm flows and a general increase in overall runoff, which in turn may result in increased erosion.

Stormwater management design will therefore seek to mitigate erosion through the implementation of appropriate SWM facilities (to attenuate peak storm flows) and LID measures (to mitigate changes to overall runoff or recharge). These goals are especially important to meet within the catchment areas of features that are to be retained (i.e., wetlands 8, and 33, 34, 10_11). Refer to **Section 4.3**, below, for the feature-based water balance assessment for these wetlands, and **Section 4.4.1.1** for an overview of the LID strategy to mitigate impacts to retained wetlands.

The proposed development will also introduce sources of contaminants (e.g., road salt, oil and grease residues, heavy metals) from roadway runoff. To mitigate impacts of any quality concerns with surface water runoff into wetland features, all dirty, salt laden water from roads will be directed to end-of-pipe SWM facilities discharging directly to watercourses. Only "clean water" from roof areas, rear yards, open space and parks, will be captured and conveyed by Clean Water Collectors (CWC) to maintain water balance to wetlands and proposed wetland compensation areas. The "clean water" will be delivered to the features via the implementation of LID measures. The SWM strategy for the WVSP area, encompassing end-of-pipe SWM facilities and LID measures is further detailed in **Section 4.4**. Information regarding CWCs is provided in Section 5.4.2 below.

Provided that surface water volume and quality contributions to the significant and other wetlands are managed as per anticipated stormwater management approaches and LID Best Management Practices, no negative impacts to wetlands associated with surface water runoff are expected.

2.1.2.4 Proposed Wetland Relocation, and Removal and Compensation

Ten (10) other (non-significant) wetlands on participating lands are proposed for relocation or removal to accommodate the proposed land use plan (**Figure 1.3, Appendix A2**). No significant wetlands are proposed for removal. All wetland relocation/compensation will occur on site. It should be noted that only the participating portions of Wetlands 12, and 14 are proposed for removal/relocation.

The wetland characterization tables (**Tables 1 – 12; Appendix B2**) provide a summary of the wetlands and their functions that are proposed for removal. The wetlands proposed for relocation or removal (Wetlands 2, 3, 4, 5, 6, 7, part of 12, 13, part of 14 and 17, shown on **Figure 2.1, Appendix B1**) consist of wetland vegetation communities that are regionally and locally common and all plant species within these wetlands are regionally and locally common except for five locally rare species: Peachleaf Willow and Pennsylvania Smartweed present in rare abundance within MAS2-1 and MAM2-2 communities (wetlands 2, 3, 4, 5, 6 and 13), Eastern Mannagrass present occasionally in MAS2-1 communities (wetlands 2, 3, 5 and 6), Tall Beggarticks and Common Bedstraw present in rare abundance in MAM2-2 communities (wetlands 4 and 13). Opportunities for plant salvage and transplant within the NHS will be discussed in the Phase 3 LSS.

Amphibian breeding habitat was identified within MAS2-1 communities (wetlands 2, 3) for Wood Frog (*Lithobates sylvaticus*) and Gray Treefrog (*Dryophytes versicolor*). Amphibian breeding habitat was also identified within the MAM2-2 communities (wetland 4) for Wood Frog. In addition, turtle basking habitat for Midland Painted Turtle was identified within Wetland 3. All of these species are provincially ranked S5 (common and secure) or S4 (apparently common and secure). Species and abundances were not met to qualify as Significant Wildlife Habitat (SWH).

Terrestrial Crayfish (a species of conservation concern) was observed within Wetland 3 (2 chimneys), Wetland 14 (10 chimneys). As detailed in the Phase 1 LSS, GEI's opinion is that the significant wetland (SWD3-2; Wetland 8) provides more suitable habitat and is a better representation of Terrestrial Crayfish SWH compared to the smaller Wetlands 3 and 14. No other wildlife habitat was identified in these wetlands.

The wetlands proposed for relocation or removal and compensation are surface water fed.

The majority of wetlands proposed for removal on participating lands (wetlands 2, 3, 4, 5, 6, 7, part of 14, and 17) are planned to be compensated/relocated within Compensation Area 1 (CA1; 0.565 ha) (**Figure 2.3, Appendix B1**). CA1 is targeted to provide the same wetland vegetation type and amphibian habitat as per the wetlands being removed. Therefore, CA1 will target Cattail Mineral Marsh and Mineral Meadow Marsh habitat and amphibian habitat for wood frog and gray tree frog. The opportunity to salvage (seed, live stakes, sod mat) rare species within the wetlands that are being removed will be assessed based on the timing of wetland removal and construction. Within these wetlands, the following rare species are present: Peach leaf Willow, Pennsylvania Smartweed, Eastern Mannagrass, Tall Beggerticks and Common Bedstraw. Should wetland relocation be feasible for any of these wetlands then this plant material would be transferred to the relocated wetland.

A portion of Wetland 12 and all of Wetland 13 (meadow marsh; 0.20 ha), on participating lands (see text below regarding wetland 13) and proposed for removal, are proposed to be compensated within Compensation Area 2 (CA2; 0.259 ha), (**Figure 2.3, Appendix B1**).

Wetlands on non-participating lands are shown on **Figure 2.2** (**Appendix B1**) with a 30 m buffer as 'Non-participant Natural Heritage Features and Buffers - For Further Study". Wetlands on non-participating lands but adjacent to participating lands have a recommended reduced buffer based on GEI's ability to characterize the wetlands from the property boundary, as detailed in **Table 14** (**Appendix B2**). Natural heritage features on non-participating lands are not proposed for removal and therefore do not have compensation areas identified. Removals and compensation for these features will be determined based on appropriate field surveys when those lands develop. One exception is the owner of Parcel 17 who granted access to GEI to assess the small portion of Wetland 13 located on their lands. GEI conducted the wetland assessment on October 28, 2025 and mapped the wetland limit with a sub-meter GPS. The portion of the wetland on Parcel 17 was found to be consistent with that on adjacent Parcel 14 (i.e. Reed Canary Grass Mineral Meadow Marsh MAM2-2). The owner of Parcel 17 noted they wish to remove their portion of Wetland 13 concurrently with the remainder of the wetland, and as such GEI has accounted for the compensation of the entirety of Wetland 13 in Compensation Area 2 (**Figure 2.2).** Should TRCA wish to stake the remainder of Wetland 13 in the spring, GEI will attend the staking exercise.

By implementing the wetland compensation/relocation described in detail in **Sections 2.5.4.3** and **2.5.4.4**, there are no negative impacts expected because of wetland removals. Additional details and a fulsome restoration and enhancement plan will be provided in the Phase 3 LSS. With the proposed plan, there will be no net loss of wetland cover and the wetland relocation and/or compensation areas will provide an overall increase in wetland cover within the NHS, aligning with the SABE Scoped SWS targets.

2.1.2.5 Wetland Buffers

It is recommended that a proposed minimum 30 m buffer be maintained for significant wetlands to support their continued function and maintain water quality (TRCA, 2014; MNRF, 2012). The significant wetland (Wetland 8; **Figure 2.1, Appendix B1**) in the NHSA is afforded a minimum 30 m buffer, noting that buffer adjustments may be examined at subsequent stages of development. A full impact evaluation of the recommended minimum VPZs for the identified significant natural heritage features is provided in **Table 14** (**Appendix B2**).

Additional retained wetlands within the NHSA (Wetlands 10_11, 33, 34; **Figure 2.1, Appendix B1**) are considered other (non-significant) wetlands. These features consist of wetland vegetation communities that are regionally and locally common and all plant species within these wetlands are regionally and locally common except for five locally rare species: Peachleaf Willow and Pennsylvania Smartweed present in rare abundance within MAS2-1, MAM2-10 and MAM2-2 communities (wetlands 10_11, 34), Sandbar Willow present in rare abundance in MAM2-10 communities (wetland 10_11), Eastern

Mannagrass present occasionally in MAS2-1 communities (wetland 34), Tall Beggarticks and Common Bedstraw present in rare abundance in MAM2-10 and MAM2-2 communities (wetlands 10_11). Opportunities for plant salvage and transplant within the WVSP NHS will be discussed in the Phase 3 LSS.

Amphibian breeding habitat was identified within Wetland 33 for American Toad (*Anaxyrus americanus*), Wood Frog and Green Frog (*Lithobates clamitans*) by listening from the edge of a participating property. Amphibian breeding habitat was identified within Wetland 34 for Wood Frog and Western Chorus Frog (*Pseudacris triseriata*). All of these species are provincially ranked S5 (common and secure) or S4 (apparently common and secure). However, species and abundances were not met to qualify as Significant Wildlife Habitat (SWH). Additionally, turtle over-wintering SWH was identified within Wetland 34. These other (non-significant) wetlands are afforded a minimum 10 m buffer, as is generally recommended best practice (TRCA, 2014). Buffer adjustments may be examined at subsequent stages of development. As detailed in **Table 14** (**Appendix B2)**, wetlands on non-participating lands but adjacent to participating lands (Wetlands 12, 14, 21, and 44) have a recommended reduced buffer (5 m) based on GEI's ability to characterize the wetlands from the property boundary, and acknowledgement that these features are located within an area anticipated for future development and are likely to be removed as part of those plans subject to future study.

The wetland buffers are proposed to be planted with native trees and shrubs which will provide enhanced protection to these wetlands. A minimum 10 m buffer will also be applied to each Compensation Area (**Figure 2.2, Appendix B1**). Any required site grading and LID measures will be permitted within the new buffer. The application of the aforementioned wetland buffers is anticipated to both protect features by mitigating any adverse impacts to the features and enhance the existing NHS.

2.1.2.6 Climate Change Impacts to Wetlands

Climate stressors can also threaten wetland function and resilience. The increase in extreme weather events, such as heavy rainfall and flooding, can disrupt wetland hydrology, causing erosion, habitat degradation, and altering surface water contributions. Rising temperatures and altered precipitation patterns can lead to shifts in vegetation communities, favoring invasive species, which can outcompete native plants and reduce habitat quality. In the NHSA, wetlands are primarily supported by surface water inputs, such as direct precipitation, runoff, and interflow through shallow soils. Proposed development may increase impervious surfaces, disrupt existing interflow patterns, and impact surface water quality. To mitigate these impacts, stormwater management (SWM) facilities, erosion control, and LID measures will be implemented to attenuate peak flows, maintain water quality, and support groundwater recharge. These design considerations will help maintain hydrological balance, prevent erosion, and ensure wetlands can continue to provide critical ecosystem services.

Wetlands are important for both mitigating climate change by sequestering carbon and reducing greenhouse gas emissions, and adapting to its impacts by providing flood protection, storm buffering, drought resilience, and habitat preservation. These multifunctional ecosystems play a crucial role in supporting environmental stability and community resilience in the face of climate change. By safeguarding the surface water and groundwater contributions to these wetlands, these strategies enhance climate resilience.

Wetland relocation and compensation can support wetland resilience to climate change by maintaining or enhancing the critical ecological functions these ecosystems provide. The proposed relocation of non-significant wetlands aims to allow wetland systems to continue to regulate water flow, reduce flood risks, and support biodiversity, which are essential in adapting to climate variability and increased extreme weather events. By incorporating wetland relocation within designated areas, opportunities exist to create habitats that are more resilient to climate stressors, such as flooding and drought.

2.1.3 Significant Wildlife Habitat

As identified in the Phase 1 LSS, candidate and confirmed SWH features were identified within the NHSA. The majority of SWH will be protected with appropriate minimum vegetated buffers and as such no impacts are anticipated. These include:

Within the Developable Area:

- Turtle Overwintering Area within MAS2-1 (wetland 34) will be protected by a minimum 10 m vegetated buffer.
- Bat Maternity Colonies within SWD3-2/CUW1 will be protected with a minimum 30 m wetland vegetated buffer.
- Habitat for Species of Conservation Concern including Terrestrial Crayfish (within SWD3-2 [wetland 8], protected by a minimum 30 m vegetated buffer), Wood Thrush (within SWD3-2/CUW1, protected by a minimum 30 m wetland vegetated buffer and minimum 10 m woodland vegetated buffer) and Barn Swallow (within barn structures along Centreville Creek Road, to be removed outside active breeding window and mitigated with Habitat Replacement Structures located in the NHS).

A full impact evaluation of the recommended minimum VPZs for these identified significant natural heritage features is provided in **Table 14** (**Appendix B2**).

Within the Greenbelt Plan Area:

- Candidate Bat Maternity Colonies within the FOD/CUW associated with the Humber River valley will be protected by minimum 30 m woodland buffers.
- Candidate Bald Eagle and Osprey Nesting, Foraging and Perching Habitat within the Humber River corridor will be protected by a minimum 30 m woodland buffer.
- Candidate Seeps and Spring within the Humber River corridor will be protected by a minimum 30 m buffer; and,
- Candidate Habitat for Species of Conservation Concern including Marsh Bird Breeding Habitat, Wood Thrush and Eastern Wood-Pewee within the Humber River corridor will be protected by minimum 30 m woodland and wetland buffers.

Indirect impacts to terrestrial crayfish SWH (SWD3-2; Wetland 8) could include a potential drop in the water table from a reduction in groundwater discharge to this wetland feature. However, as noted in Section 2.1.2.2 dependance of the wetland on groundwater is minimal and therefore these indirect impacts are not anticipated based on site conditions.

Wetland SWD3-2 (Wetland 8) is generally supported by surface water input such as precipitation, runoff and seasonal thaw. Wetland 8 is intended to be retained post-development. The lack of pronounced gullies in the areas upgradient of this feature indicates that runoff reaches this feature largely via sheet flow or by interflow through the weathered soils above the underlying silt-clay Halton till. To maintain the hydrological function of SWD3-2, pre-development surface water runoff volumes must be maintained to the retained wetland and post to pre groundwater balance is required at a catchment level. As set out in **Section 4.3**, a feature-based water balance has been completed for retained participating wetlands including SWD3-2 which has identified that the augmentation of clean surface water to the wetland under post development conditions is required. **Section 4.4.1.1** provides targets for runoff volumes and information regarding the LID measures required to augment surface water to the retained wetland and crayfish SWH. **Section 3.2.4** provides the infiltration targets for groundwater balance and **Section 4.4.1.3** provides information regarding LID measures as it relates to mitigation of impacts to groundwater.

Wetland SWD3-2 will be further protected by a minimum 30 m Significant Wetland buffer. By vegetating this buffer, important foraging habitat can also be created which will be an improvement compared to the current agricultural land. The buffer will also provide protection to the wetland and SWH from sedimentation and surface water runoff.

Provided that surface water volume contributions to SWD3-2 are managed as anticipated using stormwater management approaches and LID Best Management

Practices, no negative impacts to Terrestrial Crayfish SWH and Wetland 8 are anticipated.

2.1.3.1 Climate Change Impacts to Significant Wildlife Habitat

The protection of SWH within the NHSA, supported by appropriate vegetated minimum buffers, plays a crucial role in supporting climate resilience. By preserving habitats for species like turtles, Terrestrial Crayfish, and Wood Thrush, these measures help maintain biodiversity and ecosystem stability, which are essential for adaptive capacity in the face of climate change. The recommended minimum buffers provide safeguards against disturbances, protecting SWH from sedimentation, runoff, and hydrological changes, impacts that may be exacerbated in the future under changing climate regimes. Vegetated buffers further enhance climate resilience by stabilizing soil, filtering pollutants, and creating additional foraging and nesting habitats, which can improve overall ecosystem health. Collectively, these strategies assist SWH in adapting to climate stressors, sustaining critical ecosystem services and supporting broader environmental resilience.

2.1.4 Candidate Significant Valleyland

A Candidate Significant Valleyland occurs for the valley surrounding the West Humber River. This feature is located inside the Greenbelt Plan Area and is afforded the following minimum buffers:

- Preliminary Long Term Stable Top of Slope + 15 m;
- Significant Woodlands + 30 m; and,
- Fish Habitat + 30 m.

As this feature is located within the Greenbelt Plan Area, no impacts to the Candidate Significant Valleyland are anticipated. This aligns with the SABE Scoped SWS target by ensuring no net loss of the valleyland's ecological and hydrological functions.

2.1.4.1 Climate Change Impacts to Candidate Significant Valleyland

Valleylands provide important climate adaptation and mitigation related ecosystem services that enhance environmental resilience. They help mitigate climate change by sequestering carbon in their vegetation and soils and maintaining biodiversity, which supports ecological stability. Valleylands also play a critical role in climate adaptation by mitigating floods through their natural floodplain functions, reducing erosion with stabilizing vegetation, and regulating water flow to maintain groundwater recharge. Their vegetation helps moderate temperatures and provides shade, reducing heat stress in surrounding areas. Valleylands also serve as ecological corridors, enabling wildlife to move and adapt to changing habitats. Additionally, they filter pollutants from surface runoff, maintaining water quality and protecting aquatic ecosystems. These combined functions make valleylands vital for supporting resilient communities and ecosystems in the face of climate change.

2.2 Potential Aquatic Impacts

2.2.1 Direct Fish Habitat

The Phase 1 LSS identified direct fish habitat for the West Humber River located in the southeast portion of the NHSA which is identified as occupied Redside Dace habitat. The river is characterized as intermediate riverine warmwater fish habitat (TRCA, 2005).

Headwater drainage feature H12AS1 (**Figure 2.1**, **Appendix B1**) was also identified as providing direct seasonal fish habitat, due to the observation of one Brook Stickleback in April 2024 in an isolated pool. This feature is ploughed through in the spring and had ephemeral flow in April 2024, but was dry in May 2024, and supports seasonal warmwater fish species. This HDF is proposed for removal, and compensation will aim to enhance fish habitat through the creation of wetland habitat that will be designed to provide a net ecological gain through thermal mitigation from shading, improved water quality due to settling of sedimentation, and provision of extended baseflow to downstream habitat. This is anticipated to improve fish habitat compared to existing conditions (degradation from agricultural activities such as ploughing through the feature, as well as the use of fertilizers resulting in pollution).

Despite fish community sampling surveys in May 2024, no fish were observed in watercourse H5S1/S2/S3/S4-1 located in the southeast portion of the NHSA. The watercourse exhibited intermittent flow and was dry in August 2024. Due to the proximity and connection to the West Humber River and unobstructed passage under The Gore Road and Mayfield Road, it is acknowledged that this feature has potential to provide seasonal fish habitat.

As part of the NHS, the Tributary of the West Humber River and H5S1/S2/S3/S4-1 will both be protected by a minimum 15 m warm water fish habitat buffer (MNR 2010), intended to mitigate negative impacts to water quality from adjacent land uses. Buffers with native vegetation can also contribute to bank stability and thermal regulation. A full impact evaluation of the recommended minimum VPZs for the identified significant natural heritage features outside the Greenbelt Plan Area is provided in **Table 14** (**Appendix B2**). The West Humber River will be protected by a minimum 30 m Greenbelt fish habitat. The West Humber River will be further protected by the buffers for adjacent features including the stable top of slope (minimum 15 m buffer), and significant woodland (minimum 30 m buffer). Overall, this aligns with the SABE Scoped SWS targets by preserving the ecological and hydrological functions of these stream corridors, ensuring no net loss, and enhancing natural cover, aiming to achieve 75% naturally vegetated watercourse length.

Additional potential indirect effects on fish habitat downstream that could occur from the proposed development include:

- Impaired fish habitat and/or negative impacts on aquatic biota (e.g., fish and benthic invertebrates), including deteriorated health or mortality, due to erosion and sediment from site alteration and development;
- Mortality or health impacts due to accidental spills of toxic materials during or post-construction;
- Short-term dewatering may be required related to the construction of subsurface utilities;
- Alterations in watercourse water balance (e.g., timing and volume of flows) and associated negative impacts on fish habitat functions; and,
- Long-term impairment of watercourse quality (including chemical contaminants, suspended solids and temperature) due to surface runoff from the proposed development.

The following mitigative measures should be considered in subsequent development applications to prevent or minimize negative effects on fish and fish habitat:

- Establishment of erosion and sediment control (ESC) measures along the limit of the NHS that should be monitored during construction and where deficiencies are identified, ESC measures must be repaired immediately to prevent adverse impacts to receiving features;
- Preparation and implementation of a spill prevention and response plan to prevent or minimize the potential for spills of potentially toxic materials during construction;
- Groundwater mitigation measures, as discussed in **Section 3.2.5** below;
- Surface water quality and quantity impact mitigation measures, as discussed in Section 3.1.4 and 3.2.6; and,
- Considerations of fencing and/or thorny barrier plantings should also be contemplated in subsequent site plan designs to limit human disturbance.

Positive impacts to fish habitat are anticipated as a result of the creation of wetland habitat compared to existing conditions within actively managed agricultural fields.

2.2.1.1 Surface Water Impacts to Fish Habitat

Fish habitat within the NHSA was identified for H5S1/S2/S3/S4-1. Surface water level measurements (i.e., staff gauge SG1 located at H5S2) and other field observations indicate that this feature is intermittent.

The increase in imperviousness due to development is expected to generally increase the quantity of runoff. The stormwater management design will need to attenuate flows to prevent excessive erosion or flooding in these areas. However, by attenuating flows while also accommodating a larger overall volume of runoff, there is potential that the duration of flows in these features may also increase relative to pre-development conditions. This would typically result in a benefit to fish habitat. Perennial streams, such as the West Humber River, would not be affected by these changes as they are already water-bearing year-round.

Potential impacts associated with the proposed development include erosion and sedimentation due to construction activities, and accidental spills during construction. A formal Erosion and Sediment Control (ESC) Plan, as well as a spill prevention and response plan, will be required to demonstrate that construction activities will not have negative impacts on downstream fish habitat.

Provided that surface water volume and quality contributions to the watercourses can be managed as anticipated utilizing stormwater management approaches and mitigation measures outlined above, negative impacts to fish habitat associated with surface water are not anticipated.

2.2.1.2 Groundwater Impacts to Fish Habitat

The potential for groundwater impacts to fish habitat is expected to be limited. This is because, for the identified fish habitat within the NHSA (H5S1/S2/S3/S4-1), groundwater contributions are minor in comparison to surface water contributions due to the low hydraulic conductivity of the Halton till soil materials.

The West Humber River, due to the depth of its incised channel potentially intersecting strata more conductive than the overlying silt-clay Halton Till, may receive larger volumes of groundwater discharge. However the rate of discharge is controlled by hydraulic gradients, which in turn are related to groundwater levels. Reduced infiltration and construction of structures that induce drainage (e.g., services, foundation drains) have the potential to result in a lowering of the water table; however, within the WVSP area this is not likely to be significant because the Halton Till is of such low hydraulic conductivity that the reduced infiltration will not likely result in measurable lowering of water levels.

To mitigate any impacts to the water balance and changes in groundwater recharge, infiltration targets have been proposed for the general WVSP area and for specific catchments, as detailed in **Section 3.2.4**.

Section 4.4.1.3 outlines and recommends that stormwater management designs incorporate LID measures (e.g., infiltration galleries, soak-away pits, etc.) to meet the proposed infiltration targets. Additional Water Balance analysis and development of a

LID strategy on a site-by-site basis will be required in support of Draft Plan of Subdivision applications.

Where deep structures (e.g., along the urban corridor, or trunk sewers and other infrastructure) may intersect higher conductivity materials at depth or may induce larger drawdowns (>2 to 3 m) due to long-term drainage, assessments should be conducted to determine whether mitigation measures are necessary (e.g., waterproof subsurface structures to avoid reliance on drainage; clay collars for linear infrastructure).

Changes to groundwater quality would be expected from human activities such as road salting, minor fuel and oil leaks, fertilizer application, etc. Best management practices should be considered when applying salt, fertilizers etc. to minimize their application and limit changes to groundwater. Spills and leaks must be contained and remediated as soon as possible to limit damage to the environment.

Considering the identified infiltration targets and mitigation measures outlined above, negative impacts to fish habitat associated with groundwater are not anticipated.

2.2.2 Indirect Fish Habitat

The HDFs within the NHSA were generally ephemeral and provide indirect fish habitat, except for H12AS1 which had ephemeral flow and provided direct fish habitat as discussed in Section 2.4.5 of the Phase 1 LSS. It is important to acknowledge that as with any guidelines, the HDF Guidelines (CVC and TRCA 2014) are intended to have flexibility to best reflect additional considerations regarding the site-specific nature of features, such as impairment related to surrounding active agriculture (i.e., siltation due to ploughing up to the edge or through the feature and pollution due to fertilizers), compensation for wetlands, and compatibility with land uses. As such, there are situations where recommendations were made for an alternative management recommendation based on site-specific understanding of these additional factors. These HDFs are proposed for removal with replication of their functions expected to be achieved through LIDs or wetland compensation.

Within the NHSA, generally all of the HDFs on participating properties have a Management Recommendation of Mitigation based on the anticipated ability to replicate functions through the provision of baseflow and on-site compensation of wetland habitat. The remaining HDFs have a Management Recommendation of No Management Required and can be removed without mitigation. All HDFs on non-participating lands associated with wetlands will require further study before a HDF management recommendation is provided.

As noted in the HDF Guidelines (CVC and TRCA 2014), Mitigation management allows for the replication of the function of the HDF to:

- Replicate or enhance functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream;
- Replicate on-site flow and outlet flows at the top end of system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage); and
- Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or LID stormwater options. Any HDFs designated as ‘Mitigation’ that are proposed for removal are required to have their functions replicated. This will be achieved through SWM facilities and LID infrastructure that will convey flows to the appropriate receiving tributary, as well as HDF wetland compensation and alluvium deposits. Further details are provided in **Sections 2.5.4.3** and **2.5.4.4**.

Additional details on the SWM facilities and LID measures are provided in Section 4.4 as part of the overall SWM Plan for the WVSP area. Additional required studies may include a HDF Wetland Compensation Plan with appropriate planting plan drawings, a water availability assessment, construction phasing plan and monitoring plan. Future Study requirements will be provided in the Phase 3 LSS.

As per TRCA’s ecological compensation guidelines (2023; Sections 1.3, 2.0, 3.3) the following documentation is required for wetland compensation reporting, part of which is addressed in this Phase 2 LSS:

- Characterize the impacted ecosystem (Phase 2 LSS);
- Describe the proposed compensation location and rationale for the selected compensation location (Phase 2 LSS);
- Demonstrate that compensation is required, as avoidance, minimization and mitigation are not feasible (Phase 2 LSS);
- Replace the same level of lost ecosystem structure and function in proximity to where the loss occurs (Phase 2 LSS);
- Identify whether on-site compensation, offsite compensation and/or cash-in-lieu will be provided (Phase 2 LSS);
- Replicate ecosystem structure and replicate land base (Phase 2 LSS);
- Establish agreements through the planning process (e.g. conditions of draft plan approval for a subdivision or site plan agreement) that provide the commitments for wetland compensation (size, ecosystem type) and timing for installation and or provision of cash-in-lieu funds;

- Detailed design drawings;
- Construction phasing plan; and
- Monitoring plan.

The replication of HDF functions will assist in maintaining flow conditions and provide sediment and allochthonous (agricultural organic debris) contributions to downstream reaches. HDF compensation through wetland creation and enhancement will provide additional shading, improved water quality, and extended baseflows. Together, these measures help fish habitat maintain their ecological functions and support aquatic biodiversity.

2.2.3 Climate Change Impacts to Fish Habitat

Climate change may impact direct and indirect fish habitats in the NHSA through increased water temperatures, altered flow patterns, and intensified extreme weather events, which can cause erosion, sedimentation, and habitat degradation. The increase in impervious surfaces due to development can further alter runoff patterns and reduce groundwater infiltration. The above noted proposed mitigative measures aim to minimize these impacts and enhance climate resilience. Protective buffers assist in regulating water temperature, improve water quality, and stabilize banks. ESC plans, spill prevention measures, and LID measures will further reduce risks from construction activities, such as sedimentation and pollution, further supporting healthy fish habitat that is better able to withstand changing climate conditions. Refer to Section 4.4 for the proposed SWM strategy including LID measures.

2.3 Potential Impacts to Species at Risk

Each property will be responsible for preparing and submitted an Information Gathering Form to the MECP at the Draft Plan of Subdivision stage to demonstrate how direct and indirect impacts to Endangered and Threatened species will be mitigated. The following sections provide an overview of the potential impacts to Species at Risk resulting from the proposed WVSP.

2.3.1 Redside Dace

The West Humber River located in the southeast portion of the NHSA provides occupied habitat for Redside Dace. As shown on **Figure 2.2, Appendix B1**, the West Humber River and its valley are protected within the Greenbelt and NHS.

Potential impacts to Redside Dace occupied habitat could occur during construction as it relates to erosion or sedimentation being conveyed to downstream habitats, and/or accidental spills. Unmitigated, this could cause negative effects on Redside Dace habitat, mortality and health effects.

Recommended Mitigation/Management measures include ESC measures and providing setbacks to development. ESC measures will be used throughout construction, and spill prevention and response measures will be implemented to avoid negative effects due to accidental spills during construction. Regulated habitat for Redside Dace is the Meander belt plus 30 m surrounding the occupied reach. The preliminary Meander Belt plus 30 m is shown on **Figure 2.2, Appendix B1**. This area generally falls within the Greenbelt Plan Area; however, will need to be confirmed based on future study as to be set out in the Phase 3 LSS. Any works within this area will need to adhere to MNRF's Guidance for Development Activities in Redside Dace Protected Habitat (MNRF, 2016).

Stormwater Management criteria for SWM facilities that discharge near Redside Dace occupied habitat include the MNR RSD construction guideline requirements (e.g., 24 C, 7 mg/L DO, 25 mg/L TSS). Thermal mitigation is required in accordance with MNR's Thermal Mitigation Checklist. The design for the SWM facilities is recommended to address thermal mitigation requirements through the following measures: Average permanent pool depth of 3 m;

- Bottom-draw, reverse-slope outlet with invert located 2.5 m below the permanent pool elevation;
- Energy transfer from warm surface water runoff to cool sub-surface storm sewers upstream from the pond (including buried inlet pipe and concrete outlet pipe);
- Low impact development measures (e.g., downspout disconnection) to promote infiltration within the development area (minimizing the amount of runoff to the pond). Consequently, storm runoff from rainfall events in the range of 5 to 10 mm is expected to be eliminated or significantly reduced;
- Vegetation plantings at the inlet, around the pond and at the outlet (including within the rip rap lined spillway) to provide shading of surface waters;
- Pond orientation to reduce solar inputs and increase exposure to prevailing winds for cooling;

Provided thermal mitigation is carried out as recommended, no negative impacts to Redside Dace are anticipated.

2.3.2 Candidate SAR Bats

No bat SAR were identified within the NHSA participating ownerships during the acoustic monitoring. Habitat for bat SAR may be present within the well forested West Humber River valley in the south-east portion of the NHSA.

There is no setback requirement prescribed by MECP for SAR bats; however, the woodland features are within the Greenbelt Plan Area and will be protected by a minimum 30 m buffer.

While the features that may provide candidate SAR bat habitat are not anticipated to be altered, the following are best practices that should be followed to protect SAR bats within the NHSA:

- Any tree removals within the NHSA should be completed outside of the bat active window (approximately April 1 – September 30); and
- New lighting should be directed away from candidate SAR bat habitat to minimize disturbance.

Provided these mitigation measures are carried out as recommended, no negative impacts on candidate SAR bats are anticipated.

2.3.3 SAR Birds

Both Bobolink and Eastern Meadowlark are designated as Threatened on the SARO list and receive protection under the ESA (2007). Eastern Meadowlark and Bobolink were observed in suitable habitat (hayfields) located within the NHSA east of The Gore Road on non-participating lands. No suitable habitat for these species occurs on participating lands in the NHSA.

Impacts to Bobolink and Eastern Meadowlark will be addressed with MECP through the Information Gathering Form (IGF) process during the Draft Plan of Subdivision stage for these lands. Any proposed removal of this habitat will require permit registration with MECP under clause 17(2)(b) of the ESA accompanied by appropriate habitat compensation. Under O. Reg. 830/21 Part IV, Bobolink and Eastern Meadowlark may be exempt, with compensation options including cash-in-lieu payments to the Species at Risk Conservation Fund. Requirements for creating or enhancing habitat are outlined in Section 17. Following habitat creation or enhancement, the proponent must develop a Bobolink and Eastern Meadowlark management plan in accordance with Section 16. Additionally, for five years, at least three annual surveys must be conducted to confirm the species' presence and assess fledgling success, as stipulated in Section 14.

Barn Swallow are Special Concern on the SARO List. Farm buildings which currently provide nesting habitat near Centreville Creek Road are proposed to be removed which will result in loss of breeding habitat for the species. Habitat removals will occur outside of the Barn Swallow active season (beginning of May to end of August) to avoid adverse impacts. Replacement habitat structures for Barn Swallow will be installed in the NHS.

Provided these mitigation measures are carried out as anticipated, no negative impacts to Eastern Meadowlark, Bobolink, or Barn Swallow are anticipated.

2.3.4 Candidate Rapids Clubtail

Rapids Clubtail (*Phanogomphus quadricolor*) was identified through background review and may be present along the West Humber River. This species prefers large streams and rivers with wooded shorelines and riffle and pool features.

The West Humber River and its valley are within the Greenbelt Plan Area and well protected though the following minimum buffers:

- Significant Woodlands +30 m;
- Fish Habitat + 30 m; and;
- Candidate Significant Valleyland + 15 m from Long Term Stable Top of Slope.

Provided these mitigation measures are carried out as recommended, no negative impacts on potential Rapids Clubtail are anticipated.

2.4 Magnitude and Longevity of Impacts to the NHS

As part of the assessment of impacts on natural heritage features and functions, the magnitude (extent of an impact) and longevity (associated with duration of an impact) were also considered as it applies to each of the natural heritage features discussed above in Sections 2.1 through 2.3.

Proposed land use changes adjacent to the NHS includes change from active agriculture (row crops) to predominantly "Neighbourhood Area", with a small area of "Urban Corridor" in the southeast corner.

Specific potential impacts of adjacent land uses, and recommended mitigation include:

1. **Disturbance from People and Pets Entering the NHS**

   People and pets have potential to enter the NHS, resulting in vegetation trampling, wildlife disturbance. Recommended mitigation includes thorny barrier plantings at the outside of buffer edges, as well as educational signage and/or homeowner brochures.

2. **Artificial Light**

   Artificial light can disrupt wildlife behavior, particularly for nocturnal animals. Artificial light can also negatively impact insects who are attracted to light and become trapped and thereby impact groups such as birds and bats who feed on insects. Recommended mitigation includes shielded fixtures that reduce spill light into natural heritage features, as well as the use of timers and low-intensity lighting.

3. **Invasive Species**

Residential areas can be a source of invasive species spreading into nearby natural areas. Common causes include disturbed edges next to natural features, due to vegetation removal and unauthorized trails, people and pets unintentionally bringing in invasive seeds, as well as garden escapes. Recommended mitigation includes thorny barrier plantings at the outside of buffer edges, as well as educational signage and/or homeowner brochures.

Overall, the magnitude of impacts on natural heritage features within the NHSA, including Wetlands, Woodlands, SWH, Fish Habitat (direct and indirect), Valleylands and SAR habitat has been assessed as minimal. With the implementation of recommended mitigation measures and compensation, there are no negative impacts predicted.

Similarly, the longevity of impacts will be mitigated through pre-construction, during-construction, and post-construction mitigation measures, appropriate monitoring, and adaptive management, which will make the long-term protection of the NHS a top priority. This will be fully detailed within the Management and Implementation Plan, and the Adaptive Management and Monitoring Plan, which are key deliverables of the Phase 3 LSS. In general, it is anticipated that most impacts to features and their functions will be mitigated, resulting in a minimal impact, or else limited to construction phases with mitigation measures in place to minimize the longevity of these impacts. Some examples of efforts to limit the magnitude and longevity of impacts due to land use change will include:

- Erosion and Sediment Controls – these should be established so that sediment is not entering wetland features or downstream watercourses. These measures are intended to prevent the release of debris, sediment or deleterious substances which could have long-term impacts on the aquatic ecosystem. Both magnitude and longevity of potential impacts are mitigated in this scenario; and,
- Wetland Ecohydrology Monitoring – as the proposed land use plan requires some wetland feature relocation and removal, mitigating the magnitude and longevity of the feature relocation and removal will be reliant on successful implementation of the proposed relocation and compensation. This will require developing a post-construction monitoring program that assesses the hydroperiods of the created wetlands, water volumes, and wetland vegetation establishment, and identifying adaptive management techniques to maintain the created wetlands.

The examples above are just a subset of methods of reducing magnitude and longevity impacts to natural heritage features and functions. By implementing the mitigative measures outlined in the previous sections and incorporating the implementation, management and adaptive management recommendations that will be detailed in the Phase 3 LSS, it is expected that the NHS will be a robust system with adequate protection and restoration to enhance the longevity of retained and compensated features and functions.

2.5 Mitigation, Compensation, and Restoration/Enhancement Opportunities

The NHS, conceptual compensation, restoration and ecological enhancements are founded upon a sound technical understanding of the extent and quality of natural heritage features and functions observed within the NHSA. The overall goal of the proposed NHS is to establish a healthy and diverse ecosystem that enhances and complements the native vegetation coverage and strengthens its ecological resilience. The goals of the LSS were established through the SABE Scoped SWS (Wood, 2022), the PPS and Future Caledon Official Plan.

The NHS has been designed to align with the SABE Scoped SWS targets (Wood, 2022) by ensuring no net loss of natural cover, wetlands, and valley and stream corridor functions while actively enhancing these features. Enhancement opportunities will be distributed throughout the NHS to create a resilient and sustainable system, with an overarching target of increasing natural cover by 30%, as detailed in **Section 2.5.2.2**. Woodland cover will be retained within the NHS, while wetland cover will be expanded through compensation and relocation efforts, contributing to overall NHS enhancements. Additionally, identified stream corridors, including H5S1/S2/S3/S4-1, will be vegetatively buffered to support the aquatic target of achieving 75% naturally vegetated watercourse length, thereby enhancing ecological and hydrological functions. Valleyland cover will also be preserved and retained, as these features lie outside the NHSA, ensuring no net loss.

In addition to the SABE SWS targets, the following recommendations are also being considered through this LSS to maintain, restore, and enhance existing conditions:

- Provide natural vegetative cover across the entire created NHS and all NHS buffers;
- Achieve an overall measurable net gain in native vegetation community type and species diversity (flora and fauna);
- Provide habitat for certain life stages of various bird and small and medium sized mammal species;
- Mitigate removal of wetlands through relocation and by providing appropriate areas for wetland compensation and by increasing ecological functions within created wetland features;
- Map abundance of Category 1 invasive species (i.e., *Rhamnus cathartica, Phragmites australis ssp. australis*) within retained natural features;

- Invasive species management (risk) assessment to determine whether it is ecologically, socially, and economically viable to manage a given invasive species population;
- Where invasive species risk assessment identifies invasive management, for a given species, carry out invasive management as per Ontario Invasive Plant Council best management practices;
- Explore salvage and transplant of native species within removed features into created features and or retained feature buffers, where feasible; and,
- Consider best management practices for road crossings of watercourses to support movement of amphibian, reptile, small and medium sized mammals under road crossings.

As discussed throughout Section 2.0, a key mitigation measure for the protection of features within the NHS are minimum buffers or Vegetation Protection Zones (VPZs). These minimum buffer recommendations are made based on established best practices, the form of the feature, functions, sensitivity, and location within the NHS, as well as the extent and nature of the proposed land use changes. These recommended buffers apply to both retained and compensation features within the NHSA. Final buffers will be established as part of the site-specific application process/ Draft Plan of Subdivision stage.

To facilitate the NHS, some feature compensation will be required as described in **Section 2.5.4**, below. Recommendations for these compensation areas are provided in the subsequent sections, and additional details will be provided in the Phase 3 LSS.

The proposed mitigation, compensation, and restoration/enhancement opportunities are anticipated to support climate change resilience by maintaining and enhancing ecosystem functions within the NHS. The creation of natural vegetative cover, wetland compensation, and invasive species management is expected to improve habitat quality, stabilize hydrological processes, and enhance biodiversity, making the system more adaptive to climate variability and extreme weather events. These efforts collectively promote a healthier, more robust natural heritage system capable of withstanding and adapting to the impacts of climate change.

2.5.1 Ecological Offsetting Policy Considerations

Ecological offsetting is a mitigation strategy that is often considered to achieve a net ecological benefit to projects, subject to the approval of the planning authority. This compensation strategy quantifies the loss of natural features to provide compensation through habitat re-creation or an alternative through a consultation process. Ecological offsetting approaches are typically applied as a last resort (after avoidance and mitigation have been considered). In this case, ecological offsetting is proposed to achieve additional ecological benefit by meeting and/or exceeding the replication requirement.

As per O. Reg. 41/24, the TRCA no longer has planning jurisdiction over natural heritage features and instead regulates natural hazard features only. This includes flood and erosion risks that relate to the alteration of rivers, streams, valleys, and wetlands, and consideration of the regulation and permitting requirements that will impact these features will be incorporated into the feature compensation design.

The Town of Caledon is responsible for administering the in-force Town of Caledon OP (2018) and the Region of Peel's OP (2022).

The Town does not have ecological offsetting guidance available. Within the Draft Caledon Official Plan (2024), Section 13.9.2 outlines that ecosystem replication and compensation may be considered in limited circumstances as per the SABE, only after consideration is given to preceding steps in the net gain mitigation hierarchy. Replication of features may also be considered through a LSS in "circumstances where retaining the feature in-situ in an urbanizing landscape matrix will result in an impact to its form or function that cannot be reasonably mitigated" (Section 13.9.9 of the Draft Caledon Official Plan, 2024a).

The Region of Peel OP notes the following policy considerations for ecological compensation in Section 2.14.30:

> "Support the appropriate use of ecosystem compensation guidelines by the local municipalities and other agencies in accordance with the policies of this Plan subject to federal and provincial policy requirements and provided that development or site alteration will not result in negative impacts to the natural features or ecological functions of the Greenlands System. Where ecosystem compensation is determined to be an acceptable mitigation option, it should be applied to achieve a no net loss and if possible, a net gain, in natural heritage feature area or function."

TRCA has also developed a 'Guideline for Determining Ecosystem Compensation' (TRCA, 2023) which highlights best practices for the compensation of features and their functions. This guiding document could be considered when finalizing compensation efforts during detailed design.

One of the main goals for ecological compensation will be to target a net gain for the Town's NHS. This concept is not fully defined within the Town of Caledon OP (2018); however, net gain should be measured at "relevant timescales" for the project, recognizing that actions to restore and offset actions may lead to short-term adverse effects before it is achieved (IUCN, 2021). The TRCA's compensation guidelines Section 1.3 also notes:

> "Compensation outcomes should strive to fully replace the same level of lost ecosystem structure and function in proximity to where the loss occurs and, where possible, achieve an overall gain."

The SABE SWS also outlines two types of ecosystem compensation; Like-for-Like Compensation is where the same habitat type is created, and Alternative Habitat Compensation is where alternative habitat types are created. The SABE outlines that compensation should be the last option within the mitigation hierarchy and opted for when compensation presents an improved condition for the system.

The following sections outline high-level natural feature compensation considerations for the wetland and fish habitat removal, with details on how the principles of net ecological gain will be achieved by providing ecosystem structure and function. Natural feature compensation requirements should be further reviewed at later design stages.

The preparation of preliminary restoration, and monitoring and adaptive management plans will be discussed in the Phase 3 LSS.

2.5.2 NHS Goals and Targets

Goals and objectives have been established for the WVSP at a subwatershed level based on the most current information and approaches for subwatershed level studies within the Town of Caledon, specifically as it relates to the SABE Local SWS (Wood et al., 2022).

The goals for the SABE NHS include the following, as outlined in the Part A Scoped SWS:

- Develop a system (NHS) that balances policy direction, emerging science and natural heritage planning best practices;
- Establish a robust, connected and ecologically resilient system (NHS) for the long-term benefit of environmental and public health, well-being and safety; and,
- Provide opportunities and direction for the enhancement of the NHS to establish a sustainable system in a changing landscape matrix and that supports climate change resilience.

2.5.2.1 SABE NHS Targets

The Scoped SWS (Wood, 2022) also recommends targets for the NHS within the SABE area. A review was completed to address how targets could be met:

Natural cover: no net loss – this will be achieved within the WVSP area through feature retention (**Section 2.5.3**) and restoration, enhancement, and feature compensations (**Section 2.5.4**);

- Wetlands: no net loss of wetland cover; increase total wetland cover through NHS enhancements and ecosystem offsetting (**Section 2.5.4**);
- Valley and Stream corridors: no net loss of ecological and hydrological functions; increase natural cover within these corridors through enhancements (**Section 2.5.4.5**discusses compensatory and restoration measures that are recommended to support the conceptual anastomosing channel and conceptual meandering watercourse relocation; these watercourse corridors will be enhanced through natural vegetation – this will result in approximately 645 m of improved ecological and hydrological function compared to H5S4-1 and H5S4A);
- Aquatic: achieve 75% naturally vegetated watercourse length through protection, enhancement or restoration – this will be achieved as 100% of the conceptual watercourse/HDF layout will be naturally vegetated; the stream corridor, associated wetlands, and riparian buffers will yield approximately 1.04 ha of natural corridor area; and
- NHS Enhancements: identify and distribute enhancement opportunities across the NHS to support a robust and sustainable system; increase natural cover by 30% - this LSS will achieve a 37.7% increase in natural cover as shown on **Figure 2.4** (**Appendix B1**) and detailed below.

The SABE SWS also sets a target to maintain important successional habitats; no important successional habitats were identified within the Study Area. In addition, the SABE recommends the LSS “strive” to create at least 5 ha of successional habitat; this target will not be achievable within the participating properties of the Study Area, however, there is habitat available associated with the Greenbelt Plan Area to the east of the Study Area. Additional efforts will be made to incorporate successional and open habitats into restoration, compensation and buffer planting.

2.5.2.2 Linkage and Enhancement Targets

The SABE SWS outlines conceptual linkages intended to act as to maintain ecological connections to allow the NHS to remain connected across the landscape.

Preliminary linkages and enhancements that were identified as part of the SABE NHS on Drawing D2-10. There are four types of linkages described in the SABE; major landscape linkages, local landscape linkages, feature/site-scale linkages, and conceptual linkages. These linkage types are further defined by their “Minimum Vegetated Widths” (MVWs) and/or “Permeable Landscape Zones” (PLZ).

GEI prepared a letter report titled "Wildfield Village Local Subwatershed Study – Natural Heritage Comment, Linkages and Enhancements" (**Appendix B3**) which provided a review of the SABE conceptual linkages (L06 and L07), which included an analysis of additional feature/site-scale linkage potential associated with Watercourse/HDF WT2(1)1-1 which could be enhanced at the north end of the tributary to provide additional linkage to the eastern Greenbelt Plan Act. This is located within non-participating lands, so further studies would be required as part of future site-specific development applications for these lands. As this is recommended as a site/feature specific linkage, no MVW or PLZ is required.

The linkage from the south-central woodland/wetland is not shown on the Land Use Schedule. As discussed, and agreed upon with the Town, overall connectivity within the Natural Environment System will be explored through the future CSSS and Draft Plan of Subdivision for the subject property through SWM ponds, trails, parks, LIDs, and/or other compatible land uses that provide pervious land uses to support linkage to the south-central woodland/wetland.

The SABE also provided recommendations for enhancements to the NHS; a feasibility assessment was completed for these as part of the "Wildfield Village Local Subwatershed Study – Natural Heritage Comment, Linkages and Enhancements" letter report (**Appendix B3**). It is recommended that floodplain enhancements associated with the watercourse east of Gore Road could be recommended through the LSS; however, as this is a non-participating property, future site-specific investigations would be required. Similarly, Provincial NHS enhancements to the Greenbelt Plan Area are outlined, and while feasible, are not within participating lands; future studies will be required.

GEI has reviewed other opportunities for restoration and enhancement within the Study Area to focus on improving ecological health and resiliency of both retained and compensation features. High level recommendations for these are outlined below in **Section 2.5.4**.

2.5.2.3 Local Subwatershed Study Goals

The overall goal of the NHS is to establish a healthy and diverse ecosystem that enhances and complements the native vegetation coverage and strengthens its ecological resilience.

The following ecological targets are being considered through this LSS to maintain, restore, and enhance existing conditions:

- Provide vegetative cover across the entire created NHS and all NHS minimum buffers.

  - As per the Natural Cover mapping exercise (**Figure 2.4, Appendix B1**) when excluding buffers and including the Greenbelt agricultural lands located immediately east of the NHSA, there is a 37.7% increase in natural cover post development (15.88 ha) when compared to existing conditions (11.53 ha);
- Achieve an overall measurable net gain in native vegetation community type and species diversity (flora and fauna);
- Provide habitat for certain life stages of various bird and small and medium sized mammal species;
- Facilitate wetland relocation/compensation and mitigate removal of wetlands by providing appropriate areas for wetland relocation/compensation and by increasing ecological functions within created wetland features;
- Compensate for the proposed removal of ephemeral warm water fish habitat (HDF H12A1) with wetland compensation;
- Map abundance of Category 1 invasive species within retained natural features. This is expected to be carried out in the Environmental Impact Study (EIS) for each draft plan of subdivision;
- Invasive species management (risk) assessment to determine whether it is ecologically, socially, and economically viable to manage an identified Category 1 invasive species population. This is expected to be carried out following detail design in the construction stage prior to conveyance to the Town;
- Where invasive species risk assessment identifies invasive management, for a given Category 1 invasive species, carry out invasive management as per Ontario Invasive Plant Council best management practices. This is expected to be carried out following detail design in the construction stage prior to conveyance to the town; and,
- Explore salvage and transplant of native species within removed features into created features and or retained feature buffers, where feasible.

The goals and targets, as reviewed in **Section 2.5.2**are reflected in the following sections that review strategies for retained and compensation features within the Study Area.

2.5.3 Retained Features and Minimum Feature Buffers

Two natural heritage features will be retained on the landscape, shown on **Figures 2.1 and 2.2** (**Appendix B1**):

1. The south-central woodland and wetland complex (Wetland 8, 33, 34; SWD3-2/CUW1/MAS2-1/SA).
   - This feature is designated as a significant woodland (SWD3-2/CUW1) and a provincially significant wetland (SWD3-2; Wetland 8) with a nearby cattail marsh (MAS2-1; Wetland 34) non-significant wetland and an unevaluated shallow water feature (Wetland 33).

- It provides habitat for several important species, including Wood Thrush, overwintering turtles, and terrestrial crayfish.
- These features are primarily reliant on surface water inputs so it will be important to maintain runoff to these features in the post-development condition.

2. The H5S1/S2/S3 watercourse and adjacent wetlands (Wetlands 10_11, MAM2-2/MAM2-10) identified in the southeast corner of the NHSA.

   - The watercourse is a tributary of the West Humber River and includes riparian habitat comprised of a non-significant meadow marsh (MAM2-2/MAM2-10), a cultural meadow (CUM1) and a Buckthorn thicket (THDM2-6).
   - The feature is identified to have intermittent flow and has the potential to provide seasonal fish habitat.
   - These features are primarily reliant on surface water inputs so it will be important to maintain runoff to these features in the post-development condition.

The natural features within the developable area will be protected with designated buffers, including proposed minimum 10 m buffers for a significant woodland, minimum 10 m buffers for local (non-significant) wetlands, minimum 5 m buffers for local (non-significant) remnant wetlands on non-participant lands that area located adjacent to participating lands and have therefore be characterized (these features are anticipated to be removed when the properties participate), minimum 30 m buffers for a significant wetland, and minimum 15 m for warm water fish habitat. Additionally, any Significant Wildlife Habitat (SWH) identified within these features will be safeguarded through the protection of the associated natural features and their minimum buffers. A detailed natural heritage features minimum Vegetation Protection Zone impact assessment is provided in **Table 14** (**Appendix B2**).

Features identified within the Greenbelt Plan Area, including a significant woodland, significant valleyland, SWH and fish habitat will be generally afforded a minimum 10 to 30 m buffer.

Natural feature buffers are recommended to be planted with native vegetation that are suitable based on soil texture, soil moisture, aspect and topography. Buffer plantings should consider the need for protection from sunscald and windthrow (treed communities) and for barrier planting to deter future residents from creating their own trails into the natural features.

2.5.3.1 Net Gain in Ecological Function

To increase function of retained features, through increasing biodiversity both invasive management and retained feature buffer native vegetative planting is recommended. For invasive management this consists of conducting a risk evaluation of each Category 1 (aggressive) invasive species, based on their abundance with retained features to identify the management strategy (eradicate, control, contain) to target for a given species in each retained area that can be reasonably attained.

The ELC vegetation cards were reviewed for retained features to identify general abundance of Category 1 species for a given vegetation type (not for individual vegetation polygons). Please see **Section 2.2.2**for further details. At the next planning stage, it is recommended that the ecological consultant conduct an invasive species grid abundance survey, for each species, within the retained features. This detailed survey would then be used to update the LSS risk evaluation for Category 1 species and identify locations on the ground where a given management approach (eradicate, control, contain) would be targeted.

Buffer plantings will help to protect the retained features, as well as increase the plant species diversity and size of the features. Wildlife enhancements, such as brush piles, bat boxes, and native fruit-bearing vegetation are recommended to provide habitat for a variety of wildlife species. It is anticipated that these measures will improve native biodiversity and habitat quality within these features, and support ecosystem resilience.

2.5.4 Proposed Feature Removals and Relocation and/or Compensation

2.5.4.1 Proposed Wetland Removals

As detailed in **Section 2.1.2.5**, to facilitate the proposed land use plan, ten (10) other (non-significant) wetlands (Wetlands 2, 3 ,4, 5, 6, 7, part of 12, 13, part of 14 and 17; **Figure 2.1, Appendix B1**), totaling 0.747 ha are proposed for removal and on-site relocation and/or compensation. It should be noted that only the participating portions of Wetlands 12, and 14 are proposed for removal/relocation. Future study is required for wetlands on non-participating lands to establish removals and relocation and/or compensation potential.

These wetlands are small (ranging between 0.019 ha and 0.149 ha), isolated pockets of wetland vegetation communities that are both regionally and locally common. The plant species within these wetlands reflect this trend, with all being regionally and locally common except for five locally rare species, which occur in low abundance. While some of these wetlands provide amphibian breeding habitat (Wetlands 2, 3 and 4) and turtle basking habitat (Wetland 3), all identified species are provincially ranked as S5 (common and secure) or S4 (apparently common and secure). Additionally, amphibian and turtle species composition and abundance do not meet the criteria for designation as SWH. Given their small size, lack of connectivity to larger wetland systems, and the predominance of common species, these wetlands are proposed for removal.

2.5.4.2 Proposed Wetland Relocation and/or Compensation

The TRCA considers wetland relocation to be the intact salvage of hydric soil and native wetland vegetation and transplant into graded wetland areas that will receive suitable hydrological inputs to maintain wetland processes. Wetlands dominated by aggressive invasive species are not appropriate candidates for wetland relocation, as the transport of invasive species is prohibited under Section 7 of the Invasive Species Act (2015). Relocation may be possible if the percent cover of Category 1 invasive species is low (10% or less). At the EIS stage, an invasive species grid abundance survey is recommended to be completed for each Category 1 species to identify the percent of cover. Therefore, based on the completed ecological field surveys only Wetlands 2, 5, 12 and 14 may be suitable for relocation. Conversely, wetlands dominated by invasive plants, such as Wetlands 3, 4, 6, 7, 13 and 17, may not be candidates for relocation and wetland compensation is to be implemented. These wetlands are dominated by Category 1 (aggressive) invasives species such as Canada Thistle (*Cirsium arvense*) and Purple Loosestrife (*Lythrum salicaria)*. As a result, prior to relocation these invasive species within the wetlands are to be disposed of as per Ontario Invasive Plant Council's best management practices.

In cases where relocating a wetland is not feasible, compensation becomes necessary to demonstrate no net loss. As detailed in **Section 2.1.1**, the Town of Caledon and Region of Peel do not provide specific ecological compensation ratios. TRCA recommends a 1:1 compensation ratio for non-treed (swamp) wetlands. To help achieve a net ecological gain, a 2% increase in area of wetland compensation will be provided.

Wetland relocation and/or compensation areas will be constructed in close proximity to the removal locations, aligning with best practices for feature removal offsetting and compensation. As per TRCA requirements, compensation wetlands need to be established and functional prior to the removal of the existing wetlands, and a monitoring report outlining the success of the wetland compensation will be required as part of the approval process.

Two wetland relocation/compensation areas are identified for the WVSP area (**Figure 2.2**, **Appendix B1)**. Compensation Area 1 is located in the northwest portion of the study area where reach H1S1 meets Centreville Creek Road. An existing MAM2-2/DIST community is located adjacent to Compensation Area 1, and both surface water and groundwater monitoring were conducted near this location. SG22 was installed at the upstream end of the culvert where H1S1 meets Centreville Creek Road and nested well NW18S/D was installed southeast of this location, where infiltration test GP3 was also completed. Meadow marsh (MAM) communities tend to establish in low-lying areas with poor drainage where precipitation events create frequent flooded conditions with shallow water depths which evaporate over time. Water level and volumetric flow monitoring at SG22 showed near-consistent shallow standing water at the culvert, with water levels and flow rates highly dependent on precipitation trends. The borehole logs for NW18S/D indicate native soils in this area consist of clay and silt glacial till to a depth of 3 m, under which sandy silt glacial till was encountered, followed by more clay and silt glacial till. The infiltration test completed at GP3 was inconclusive, but the soils encountered were classified as "compacted, structureless, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.". The infiltration test may have been inconclusive due to low permeability or high water table. All evidence discussed above indicates that the native soils around Compensation Area 1 are suitable to provide standing water conditions for wetlands, since they limit drainage of surface water.

Compensation Area 2 (identified on **Figure 2.2**, **Appendix B1**) is located in the southeast corner of the study area along reach H5S2. Existing MAM2-2 and MAM2-10 communities are located along H5S2, SG1 was installed within H5S2, and nested well BH38S/D was installed adjacent to H5S2. Water level and flow monitoring at SG1 showed water levels of up to approximately 0.5 m above ground surface after precipitation events, and then water levels quickly returned to 0 m. Borehole logs of BH38S/D indicate the native soils in the area consist of clay and silt glacial till, sandy silt glacial till, and sand and silt glacial till. Based on the above evidence, the native soils around Wetland Compensation Area 2 are expected to be suitable to provide standing water conditions for wetlands, since they limit drainage of surface water.

Refer to **Sections 4.3** and **4.4.1.2** below for information regarding the feature-based surface water balance analysis for compensation wetlands. It is anticipated both wetland relocation and/or compensation areas can receive sufficient volumes of clean water to sustain diverse water depths, promoting the successful development of a range of wetland vegetation community types. Given the feasibility of maintaining appropriate hydrological conditions and the compatibility of the soil composition with wetland function, the proposed compensation strategy is expected to be effective.

2.5.4.3 Compensation Area 1: Wetland Relocation and Compensation

Compensation Area 1 is shown on **Figure 2.2** (**Appendix B1**) and is 0.565 ha in size and provides area for wetland relocation and compensation (including three small HDF wetlands) for the following features:

1. Other wetlands (Wetlands 2, 3, 4, 5, 6) = 0.427 ha; and
2. HDF wetlands (part of Wetlands 14 [HDF H7S1], 7 [HDF H1S1-1], 17 [HDF H1S1-3]) = 0.124 ha.

As noted earlier, a 2% increase in compensation area is provided to help achieve a net gain. Therefore, the total compensation area for Compensation Area 1 is 0.565 ha.

Two native vegetative communities are targeted for wetland compensation, as they are the two wetland vegetation communities proposed for removal:

- Mineral shallow marsh (MAS2) communities consist of less than 25% cover of trees and shrubs with a hydrophytic emergent macrophyte cover greater than 25%. Water is expected to be standing through most of the growing season and substrates can range from bedrock to mineral to organic.
- Mineral Meadow Marsh (MAM2): Mineral soils seasonally flooded that later become moist to dry, features dominated by grasses/sedges intolerant to prolonged flooding, less than 25% cover of both emergent vegetation and trees/shrub.

Compensation Area 1 will be fed by a Clean Water Collector (CWC) that will convey flow from the downstream end of H1S3 through the proposed residential subdivision and outlet at the compensation area, before discharging to the culvert at Centreville Creek Road. Refer to **Sections 4.3** and **4.4.1.2** below for the feature-based water balance and mitigation measures for the new compensation wetland.

The main goal of the Compensation Area 1 design will be to achieve a net gain in overall function of the wetland community and HDF H1S1 compared to existing conditions. The wetlands proposed for relocation or compensation are small and isolated features within active agricultural fields, some of which provide breeding amphibian and turtle basking habitat.

A net ecological gain is proposed to be achieved through the following:

1. Provide an increase in total wetland habitat area as well as contiguous wetland area;
2. Help mitigate changes to hydrology (slower release from the wetland);
3. Provide an increase in wetland plant species diversity;
4. Thermal mitigation via shading from wetland buffers planted with native trees and shrubs;
5. Enhance the functions of H1S1 (provision of baseflow, insects, organic materials, as well as coarse sediment supply via alluvium deposits in the wetland outlet reach).
6. Wildlife enhancements such as brush piles, native wildflowers, amphibian breeding habitat and turtle basking habitat are recommended to support a diverse range of species. These features can be designed to provide essential shelter, nesting sites, and foraging opportunities, benefiting birds, mammals, amphibians, and pollinators.

By enhancing wetland habitat complexity and contiguous area, Compensation Area 1 is anticipated to improve ecological function and overall resilience, preserve biodiversity, maintain essential ecosystem services, and provide an overall net benefit compared to existing conditions.

2.5.4.4 Compensation Area 2: Fish Habitat and Wetland Compensation Area

Compensation Area 2 is shown on **Figure 2.2** (**Appendix B1**) and is 0.259 ha in size and provides compensation area for the following features:

1. Other wetlands (portion of #12 and all of #13) = 0.208 ha with 2% area increase; and,
2. Ephemeral seasonal fish habitat (HDF H12A1; 512 m in length) = 0.051 ha wetland compensation (1 square meter of compensation area for each linear meter of HDF H12A1).

One native vegetative community is targeted for wetland compensation, which is the same vegetation community proposed for removal:

- Mineral Meadow Marsh (MAM2): Mineral soils seasonally flooded that later become moist to dry, features dominated by grasses/sedges intolerant to prolonged flooding, less than 25% cover of both emergent vegetation and trees/shrub.
- The seasonal fish habitat function of HDF12A1 will be replicated with a marsh (MA) community type.

A CWC is proposed to feed Compensation Area 2 with cool clean stormwater. Refer to **Sections 4.3** and **4.4.1.2** below for the feature-based water balance and mitigation measures for the new compensation wetland.

The hydrologic functions of H12A1 will be replicated by continuing to convey flows via CWC to the appropriate downstream habitat within the WVSP area and further downstream at Culvert #9 at Mayfield Road. The main goal of the Compensation Area 2 design is to achieve a net gain in overall function of the wetland community and fish habitat (HDF H12A1) compared to existing conditions. The wetlands proposed for removal are small and isolated features within active agricultural fields, that do not provide breeding amphibian habitat. HDF H12A1 is ploughed through ephemeral swale that provides direct seasonal fish habitat (one Brook Stickleback observed in an isolated pool).

A net ecological gain is proposed to be achieved through the following:

1. Creating fish habitat compensation wetland area (MA) to enhance direct fish habitat in Tributary H5S1/S2/S3 that is connected to the same branch (i.e. within approximately 400m of the fish observation at H12A1) and that is known to support fish at nearby Mayfield Road Culvert (Culvert #9);
2. Improve direct fish habitat (in-stream and riparian vegetation, insects, organic materials, as well as coarse sediment through alluvium deposits in the wetland

outlet reach) compared to existing conditions of H12A1 which is ploughed-through and planted with row crops;
3. Help mitigate changes in hydrology (slower release from the wetland);
4. Improved water quality due to settling of sedimentation;
5. Provide an increase in total wetland habitat area as well as contiguous natural area (i.e., CA2 is adjacent to other existing and created wetlands as well as the relocated watercourse, as further outlined below in **Section 2.5.4.5**);
6. Provide an increase in wetland plant species diversity;
7. Thermal mitigation via shading from wetland buffers planted with native trees and shrubs; and,
8. Wildlife enhancements such as brush piles and native wildflowers are recommended to benefit birds, small mammals, and pollinators.

By enhancing wetland and fish habitat complexity and contiguous area, Compensation Area 2 is anticipated to improve ecological function and overall resilience and provide an overall net benefit compared to existing conditions.

The proposed location of Compensation Area 2, adjacent to a stream corridor, aligns with the SABE Scoped SWS target by enhancing natural cover within these corridors and improving the ecological and hydrological functions of the H5S1/S2/S3 watercourse, ensuring no net loss. Additionally, this will contribute to the overall goal of increasing natural cover in the NHS by 30%.

2.5.4.5 Proposed Relocation of Watercourse H5S4-1 and Watercourse/HDF H5S4A

TRCA and the Town indicated during the meeting on July 21, 2025, that they were supportive of the relocation of TRCA-identified watercourse H5S4-1 and HDF/watercourse H5S4A, as conceptually shown on **Figure 2.2** (**Appendix B1**). TRCA noted that the relocated watercourse would not need to match the linear distance of the existing reach but would need to enhance the quality of the watercourse/HDF habitat.

The distance of the existing watercourse/HDFs proposed for relocation is as follows:

1. H5S4-1 = 185 m
2. H5S4A (participating lands only) = 560 m
3. Total = 745 m

The conceptual watercourse/HDF relocation is shown in the southeast corner of the WVSP area, refer to **Figure 2.2** (**Appendix B1**). Although only a conceptual layout, it has potential to provide approximately 645 m of compensation reach length, broken down as follows:

1. Conceptual anastomosing channel = 400 m (due to multiple connected reaches; as

per GEI's preliminary analysis); and
2. Conceptual Watercourse Relocation with Meander = 245 m.
3. Total = 645 m

The conceptual watercourse/HDF relocation area including the channel width and buffers, outside of the existing and proposed wetland buffers, is approximately 1.04 ha with an average width of approximately 40 m. Additional conveyance channels are included in the conceptual design shown on **Figure 2.2** (**Appendix B1**).

As further outlined in **Section 4.4** below, a proposed SWM facility will discharge treated stormwater flows to the realigned watercourse. The pre-development catchment area draining to the SWM facility will be maintained to the extent possible under post development conditions, thus increasing runoff volumes to the watercourse due to the changes in impervious surfaces while maintaining existing peak flows to the downstream reach.

The main goal of the Watercourse/HDF relocation design is to rehabilitate and enhance the features, to achieve a net gain in overall quality and function of the reaches compared to existing conditions. Under existing conditions, the reaches do not provide a high level of natural heritage function.

The reaches proposed for relocation are characterized as follows:

Watercourse H5S4-1

- Flows through a narrow hedgerow (approximately 12 m wide) comprised of scattered small shrubs and cultural meadow vegetation surrounded by agricultural fields;
- The feature was identified by TRCA as a watercourse with a well-defined channel;
- Little to no variability in substrate was observed, and bed material consists of silt, clay, and organic material;
- Riparian vegetation consists of a hedgerow and cultural meadow (Hawthorn (Crataegus spp.), Malus spp. and Manitoba Maple (Acer negundo) with Reed-canary grass (Phalaris arundinacea) and Perennial Rye (Lolium perenne).
- The feature lacked instream vegetation due to seasonal flow conditions and generally contained the same species identified in the riparian area;
- Intermittent flow; and,
- Indirect fish habitat.

Watercourse/HDF H5S4A

- Flows through a mosaic of cultural meadow and fallow vegetation surrounded by agricultural fields;

- The feature was identified by TRCA as a watercourse/HDF consisting of localized defined channels (with swales in the remaining areas);
- Substrate consisted predominantly of organic material, silt, and clay;
- Riparian vegetation occurs as a mosaic of vegetation associated with varying degrees of past disturbance including cultural meadow type species (Goldenrods) and fallow -type species (Lamb's Quarters (Chenopodium album) and Scentless Chamomile (Tripleurospermum inodorum)). These weedy species are more typically associated with agricultural fields than with true cultural meadows.
- The feature lacked instream vegetation due to seasonal flow conditions and generally contained the same species identified in the riparian area;
- Intermittent flow; and,
- Indirect fish habitat.

The proposed channel relocation incorporates the following restoration and enhancement components, to provide a net ecological gain:

1. An enhanced, natural channel design, incorporating an anastomosing channel type, with a stable form (inspired by anastomosing rivers). Anastomosing channels are often low-energy, stable streams, which form in finer sediments. The existing sediment character is proposed to be maintained, and energy is proposed to be dissipated through increased hydraulic roughness across multiple, vegetated flow paths.
2. More substantial riparian vegetation (increased riparian width and increased species diversity), providing additional thermal mitigation from shade. The riparian vegetation increases roughness, which also promotes sediment deposition and maintains long-term stability.
3. Proximity to other existing and created natural heritage features (created wetlands, existing wetlands, existing Tributary – H5S1/S2/S3).
4. A transitional channel at the downstream extent of the anastomosing channel, which outlets to the downstream, single thread meandering channel system. The transitional channel would incorporate energy dissipation measures and avoid headcutting/knickpoint formation.
5. Enhanced sediment supply through well-placed alluvial deposits. These would be placed within or adjacent to the single thread channel, and would be intended to periodically flush out sediment, such as during high flow events.

Therefore, the proposed design will need to incorporate channel naturalization, wetland creation, and riparian enhancement through vegetation planting. These measures will improve aquatic and terrestrial habitat within the relocated reaches and provide a net ecological gain.

2.6 Policy Conformity

One of the goals of the LSS is to address the proposed land use changes in the context of applicable planning policies and to clearly identify how requirements are met or exceeded. The following is a summary linking the conclusions of the above impact assessment to conformity and/or consistency with land use plans and applicable policies, including the PPS, provincial legislation, Regional and Local Municipal Official Plans, and federal legislation. This LSS addresses alignment, conformity and consistency with the following policies outlined in Section 2.6.1 through 2.6.7:

2.6.1 Fisheries Act, 1985

The Fisheries Act prohibits the death of fish by means other than fishing (subsection 34.4 (1)) and the harmful alteration, disruption or destruction of fish habitat (HADD; subsection 35. (1)). A HADD is defined under the Fisheries Act as “any temporary or permanent change to fish habitat that directly or indirectly impairs the habitat’s capacity to support one or more life processes” (DFO 2019).

The West Humber River, H5S1/S2/S3/S4-1 and H12A1 (**Figure 2.1**, **Appendix B1**) provide direct fish habitat. The West Humber River and H5S1/S2/S3/S4-1 are anticipated to be protected or enhanced, respectively. No negative impacts are expected to fish habitat as the West Humber River is protected in the Greenbelt with feature minimum buffers (30 m for fish habitat, 30 m for significant woodlands, 15 m from stable top of slope). HDF H12A1 is proposed to be removed and compensated through wetland creation that is aimed to improve aquatic habitat conditions for fish species (refer to **Section 2.5.4**).

Some HDFs that provide indirect fish habitat are proposed for removal (H1S1, H4S1/S2, H5S4B, H5S4-2, H3S1A, H3S1; **Figure 2.1, Appendix B**). The functions of these features are anticipated to be replicated through the SWM strategy, as well as through wetland compensation areas. Any potential impacts to fish habitat are anticipated to be mitigated through the measures discussed in Section 2.5.4.

2.6.2 Migratory Birds Convention Act, 1994

The federal Migratory Birds Convention Act prohibits the killing, capturing, injuring, taking or disturbing of migratory birds (including eggs) or the damaging, destroying, removing or disturbing of nests. Tree removals will be undertaken outside of the core breeding period, which is approximately April 1 to August 31. In rare circumstances where this window cannot be avoided, a nest search is recommended, and a buffer will be marked off surrounding any active nests that must be maintained until activity in the nest has ceased. The Migratory Birds Convention Act applies at all times, even outside of the peak breeding period.

2.6.3 Federal Species at Risk Act (2002) and Provincial Endangered Species Act (2007)

Eastern Meadowlark and Bobolink were observed in suitable habitat (hayfields) located within the NHSA east of The Gore Road on non-participating lands. No suitable habitat for these species occurs on participating lands in the NHSA. Impacts and habitat removals, as needed, will occur through engagement with MECP and approved permits in accordance with section 17(2) of the ESA and O. Reg. 183/21.

Barn Swallow nesting habitat was identified within several farm structures along Centreville Creek Road. Habitat will be removed outside the active breeding bird window and replaced with habitat structures.

Candidate SAR bat habitat may be present within the woodlands associated with the Humber River valley at the southern portion of the NHSA. The woodlands are located in the Greenbelt Plan Area and will be afforded a minimum 30 m buffer.

Redside Dace occupied habitat is identified in the West Humber River located in the southeast portion of the NHSA. This habitat occurs within the Greenbelt Plan Area and is protected with a minimum 30 m fish buffer and 15 m stable top of slope buffer.

The Species at Risk Act and Endangered Species Act protect all threatened, endangered and extirpated listed species, which are legally protected from harm or harassment, and their associated habitats are legally protected from damage or destruction, as defined under the Acts. For all future site-specific development, additional efforts may be required to demonstrate compliance with the Species at Risk Act and Endangered Species Act.

2.6.4 Provincial Planning Statement (PPS, 2024)

The Provincial Planning Statement (2024) is the guiding document providing policy direction on matters of Provincial interest related to land use and development. Section 3(5) of the Planning Act requires that all decisions that affect planning matters be consistent with the PPS, which is issued under the Act. The following PPS features were identified and considered in the NHSA: Significant Woodlands (Section 2.1.1), Significant Wetlands (Section 2.1.2), Significant Wildlife Habitat (Section 2.1.3), Direct and Indirect Fish Habitat (Sections 2.2.1 and 2.2.2, respectively) and Habitat for Threatened and Endangered Species (Section 2.3). As described in these sections, provided the recommended mitigation and compensation are achieved, with anticipated stormwater management, no negative impacts to these features are expected. The NHS is expected to meet the intent of the policies of the PPS.

2.6.5 Ontario Regulation 41/24: Prohibited Activities, Exemptions and Permits

O. Reg. 41/24 allows Conservation Authorities to implement Section 28 of the Conservation Authorities Act, 1990 (amended 2024), which states under Section 28(1) that:

28 (1) No person shall carry on the following activities, or permit another person to carry on the following activities, in the area of jurisdiction of an authority:

1. Activities to straighten, change, divert or interfere in any way with the existing channel of a river, creek, stream or watercourse or to change or interfere in any way with a wetland.
2. Development activities in areas that are within the authority's area of jurisdiction and are,
    i. hazardous lands,
    ii. wetlands,
    iii. river or stream valleys the limits of which shall be determined in accordance with the regulations,
    iv. areas that are adjacent or close to the shoreline of the Great Lakes-St. Lawrence River System or to an inland lake and that may be affected by flooding, erosion or dynamic beach hazards, such areas to be further determined or specified in accordance with the regulations, or v. other areas in which development should be prohibited or regulated, as may be determined by the regulations. 2017, c. 23, Sched. 4, s. 25.

Pursuant to O. Reg. 41/24, any interference with or development in or on areas stated in the Conservation Authorities Act (e.g., hazardous lands, wetlands, river or stream valleys) requires permission from the Conservation Authority. The Conservation Authority may issue permits under Section 28.1 and may attach conditions on the permits per Section 9(1) of the Regulation. This will apply to any alteration within the regulated area of TRCA, including any wetland removals and compensation.

O. Reg 41/24 also identifies the following limits for river or stream valleys to define subparagraph 2 iii of subsection 28 (1) of the Act:

2 (1) For the purposes of subparagraph 2 iii of subsection 28 (1) of the Act, river or stream valleys include river or stream valleys that have depressional features associated with a river or stream, whether or not they contain a watercourse, the limits of which are determined as follows:

1. Where the river or stream valley is apparent and has stable slopes, the valley extends from the stable top of the bank, plus 15 metres, to a similar point on the opposite side.

2. Where the river or stream valley is apparent and has unstable slopes, the valley extends from the predicted long term stable slope projected from the existing stable slope or, if the toe of the slope is unstable, from the predicted location of the toe of the slope as a result of stream erosion over a projected 100-year period, plus 15 metres, to a similar point on the opposite side.
3. Where the river or stream valley is not apparent, the valley extends,
    i. to the furthest of the following distances:
        A. 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, and
        B. 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, and
    ii. an additional 15-metre allowance on each side, except in areas within the jurisdiction of the Niagara Peninsula Conservation Authority.

As part of the Phase 1 LSS, erosion hazard limits were delineated for all watercourses within the WVSP. Limits for watercourses consist of the meander belt for features situated within an unconfined valley, and the toe erosion allowance and corresponding stable top of slope for features situated within a confined valley. Within the Subject Lands, a final erosion hazard limit of 15 m, was delineated for feature H5S1/2/3, which exists in an unconfined valley setting. Future study will be required for non-participating lands east of The Gore Road.

The land use plan and post-development NHS are in alignment with this regulation; no significant wetlands will be impacted. Permits will be required from the Conservation Authority (TRCA) to facilitate the alteration and compensation of the regulated wetlands and relocation of watercourses/HDFs within the NHSA.

2.6.6 Region of Peel Official Plan (2022)

Region of Peel's OP (RPOP) outlines policies to guide growth and development in the Region. The Regional Greenlands System is based on natural heritage features and areas and the linkages among them.

As per Section 2.14 of the RPOP, development and site alteration is not permitted in Core Areas; however, refinements to the Greenlands System may be permitted through an approved development plan as per Section 2.14.10. Greenland System features are shown in Schedule C-1 ("Greenlands System") and Figure 7 ("Regional Greenlands System- Core Areas, Natural Areas and Corridors and Potential Natural Areas and Corridors").

In general, it would be expected that any impact shall be mitigated through restoration and enhancement or compensation.

Within the NHSA, the West Humber River and the downstream portion of one of its tributaries are identified as part of the Core Area of the Greenlands System as per Schedule C-2 ("Core Area of the Greenlands System"). This area is generally within the Greenbelt and will not be impacted. One small area extends beyond the Greenbelt on non-participating lands and appears to be associated with the Preliminary Long Term Stable Top of Slope (GEI) and will need to be further assessed as part of subsequent Draft Plan of Subdivision level studies for the non-participating lands.

Section 5.6.20 of the ROP outlines policies for 'Designated Greenfield Areas' – this is inclusive of specific provisions for the 2051 New Urban Area (Section 5.6.20.14). Within ROP Designation Greenfield Areas, Secondary Plans are required to make appropriate considerations for the protection, restoration and enhancement of a natural heritage system (5.6.20.14.16d) and should ensure the protection of the natural heritage system and water resource system as informed by a subwatershed study that integrates water and stormwater management (5.6.20.16.16(e)).

A detailed subwatershed study is required to "further implement the direction, targets, criteria and recommendations of broader scale watershed or scoped subwatershed planning studies in consultation with the Region and conservation authorities" (5.6.20.16.17(f)).

A natural heritage system is required to be identified in conformity with the objectives and targets of the detailed subwatershed study which shall meet or exceed targets and criteria identified by the Region in consultation with the conservation authorities and relevant agencies (5.6.20.16.17(g)).

These features have all been delineated and assessed by GEI through the LSS process by expanding on the findings of the Scoped SWS completed as part of the SABE and will meet the SABE targets for no net loss of natural cover or natural heritage features including wetland, woodland and valley and stream corridor, and natural cover targets for aquatic systems and total enhancement areas, as outlined in **Section 2.5.2**. This LSS has evaluated the ecological form and functions of Core Areas, NACs, and PNACs and determined that land use change impacts will be mitigated through buffering, restoration and enhancement, or compensation as outlined in **Section 2.5** above.

2.6.7 Caledon Official Plan (2018)

To implement new secondary plans, an official plan amendment (OPA) is required to the Town of Caledon Official Plan. Secondary plans require a subwatershed study or comprehensive environmental impact study and management plan prepared in accordance with an approved term of reference. The subwatershed study should include a consideration of cumulative environmental impacts from existing and planned development and considerations that avoid or minimize impacts, strategies to meet environment targets and objectives to protect, improve, restore and enhance the natural environment system (Section 5.5.9.2).

This LSS has identified existing conditions within the NHSA and has evaluated the impacts of the proposed land use concept on the existing system while providing mitigative and enhancement opportunities to improve the overall NHS.

Within the NHSA, the following features of the Town of Caledon's Ecosystem Framework for Environmental Protection Areas (EPAs) were identified:

Natural Core Areas:

- Significant Woodlands (SWD3-2/CUW1 [south-central area], FOD/CUW [associated with the West Humber River valley]);
- Significant Wetland (SWD3-2);
- Candidate Habitats of Endangered Species (bat SAR associated with the West Humber River valley);
- Habitat of Endangered and Threatened Species (Bobolink and Eastern Meadowlark on non-participating lands east of The Gore Road);
- Fish Habitat:
  - The West Humber River; H12AS1; H5S1/S2/S3/S4-1;
- Significant Wildlife Habitat:
  - Seasonal Concentration Areas of Animals (Confirmed Bat Maternity Colonies within SWSD3-2/CUW1, Candidate Bat Maternity Colonies within West Humber River corridor; Over-Wintering Turtle Habitat within wetland 34);
  - Specialized Wildlife Habitat (Candidate Seeps and Spring within West Humber River corridor; Candidate Bald Eagle and Osprey Nesting, Foraging and Perching Habitat within West Humber River corridor; and
  - Species of Conservation Concern (Terrestrial Crayfish within SWD3-2, Wood Thrush within SWD3-2/CUW1, Barn Swallows within farm structures along Centreville Creek Road, Candidate Marsh Bird Breeding Habitat within the West Humber River corridor and Candidate Wood Thrush and Eastern Wood-Pewee within the West Humber River Corridor).

Natural Corridors:

- Valley and Stream Corridor (The West Humber River).

Supporting Natural Systems:

- Other woodlands (CUW1 south of Mayfield Road); and
- All other wetlands.

Through this LSS, a fulsome impact assessment has been completed and determined that based on the proposed mitigation, compensation, and enhancements, there are no negative impacts anticipated to the features listed above.

The LSS is also expected to identify minimum buffers based on “existing conditions and sensitivities, and the anticipated impacts” (Section 13.9.4). Minimum buffers were addressed in alignment with the OP through **Sections 2.1, 2.2** and **2.3** of this LSS (**Table 14, Appendix B2**). Final buffer widths within New Community Areas and New Employment Areas will be confirmed as part of site-specific development applications, through a detailed EIS, and may include increases or decreases to the buffer widths identified through the secondary planning process (Section 13.9.6).

2.7 Natural Hazards

Natural hazards, including both erosion and flood hazards, have been identified for the WVSP area as detailed in the Phase 1 LSS. Additional study will be required at the Draft Plan of Subdivision stage to confirm erosion hazards for non-participating lands and confirm flood hazards for the West Humber River for non-participating lands east of The Gore Road. The preliminary NHS utilized in preparation of the proposed Land Use Plan (**Figure 1.3, Appendix A2**) encompasses these hazards, in addition to the associated development setbacks as outlined in Section 2.5 of the Phase 1 LSS. Additionally, **Figure 2.1, Appendix A2,** displays the hazard limits associated with features within the WVSP.

Implementation of the proposed Land Use Plan (**Figure 1.3, Appendix A2**) will not require modification to any flood hazards as there are no proposed watercourse crossings or grading proposed within the floodplain. As outlined in Section 2.2.2, all HDFs designated as ‘Mitigation’ are anticipated to be removed and will have their functions replicated through SWM and LID infrastructure. As discussed, and agreed upon by TRCA (P. Corresp. D. Chekol (TRCA) and A. Keeping (SCS) July 31, 2024), the flood storage associated with these HDFs does not need to be replicated under post-development conditions.

3.0 Groundwater

3.1 Geological and Hydrogeological Assessment

A summary of the Phase 1 LSS findings for groundwater and hydrogeology is provided below in the form of a description of the hydrogeological conceptual site model for the WVSP area. For full details on the WVSP area characterization, please refer to the Phase 1 LSS.

The WVSP area is characterized by uniformly-sloped lands dissected by a parallel-to-dendritic pattern of shallow headwater drainage features extending through active agricultural fields (see **Figures 3.1** and **3.2 Appendix C1**). In a few locations (notably in the southeastern portion of the Site, such as at H5S1 and H5S2) the drainage features are more deeply-incised and are considered watercourses due to the presence of distinctive bed and banks.

Based on observations made during subsurface investigation as part of the Phase 1 LSS and in comparison, with existing published sources (Ontario Geological Survey, 2010; Kassenaar and Wexler, 2006) the hydrostratigraphy of the WVSP area is generally characterized as follows:

- Weathered (Halton) Till, up to 1.5 m thick
- Halton Till, a silt-clay till ranging in thickness from 4 m to over 6 m
- Newmarket Till, a silt-sand till varying in thickness from 1.3 m to over 4 m, though was absent in some locations in the south-central portion of the WVSP area
- Georgian Bay Formation, which is shale where it has been encountered within the WVSP area and has been identified as shallow as 3.4 mbgs (meters below ground surface) but generally not encountered during drilling (typical borehole depths around 6.6 mbgs).

Single well response testing conducted during the Phase 1 LSS indicated that the overburden materials are of low hydraulic conductivity, with the Newmarket Till being slightly more conductive than the Halton Till. The test results indicate the following geometric means of horizontal hydraulic conductivities:

- Halton Till: 2.4×10^{-8} m/s
- Newmarket Till: 1.9×10^{-7} m/s

Hydraulic conductivity in the weathered till layer was not directly tested but due to the development of microfissures from freeze-thaw and wet-dry cycles, it is expected that it is higher than that of the Halton Till by at least a factor of ten.

Groundwater level measurements across much of the WVSP area indicate that groundwater levels approach ground surface during periods of high moisture surplus (i.e., winter and spring) and decline over the warmer months of the year due to losses by evapotranspiration. This pattern of fluctuation is typical of upland till-dominated sites in southern Ontario and is reflective of a hydrology dominated by surface water processes. An interpolated groundwater contour surface is provided in **Figure 3.3** (**Appendix C1**).

Lateral groundwater gradients generally follow the topographic slope of the WVSP area, indicating that the lateral component of groundwater flow is similar to that of surface water drainage, which is mainly toward the southeast except for the northwestern portion of the WVSP area (e.g., catchment area of H1S1 through H1S3 on **Figure 3.1, Appendix C1**) where it is southwest.

Vertical groundwater gradients are generally downward, indicating that the WVSP area is a recharge area. However, the rate of recharge is moderated by the low hydraulic conductivity of the Halton Till. Based on average vertical gradients and hydraulic conductivities in the Halton Till, the average annual rate of deep recharge (i.e., water that passes downward through the Halton Till aquitard) was estimated to be approximately 45 mm/year across the WVSP area.

In one location, BH28D (**Figure 3.2, Appendix C1**), artesian groundwater levels were occasionally observed. This was inferred to be due to some anomaly (e.g., fracture pattern) in the shale of the Georgian Bay Formation, in which BH28D is partially screened. The occurrence of artesian water levels was not accompanied by apparent seepage or flow at surface in the adjacent headwater drainage feature (H5S4-2), indicating that the layer of Halton Till overlying the shale provides a significant degree of resistance to flow.

Within the WVSP area, surplus water (i.e., water not taken up by evapotranspiration) primarily becomes runoff, with a smaller proportion infiltrating. However, the bulk of infiltrated water does not ultimately reach the regional groundwater system but flows laterally through the weathered till layer and emerges nearby as runoff at low-lying headwater drainage features and wetlands. As such, the bulk of the surface water features within the WVSP area are considered to be surface water dominated because they are primarily fed by runoff and secondarily through interflow (i.e., precipitation that recently infiltrated in the upland immediately surrounding the feature) during freshet and following stormwater events. Groundwater influence on wetlands within the WVSP area is primarily associated with the retention of precipitation within the subsurface due to the low hydraulic conductivity of the underlying soils, which prevent drainage.

A water balance assessment was completed for the pre-development condition as part of the Phase 1 LSS and it indicated that the bulk of precipitation occurring within the WVSP area is taken up by evapotranspiration (62.2% of precipitation). Infiltration, which includes both deep recharge as well as interflow, takes up approximately 13.5% of precipitation. Runoff takes up the remaining 24.3% of precipitation.

In the Settlement Area Boundary Expansion report (the "SABE", Wood, 2022), some areas within the southern part of the WVSP were identified as "Ecologically Significant Groundwater Recharge Areas" (ESGRAs). However, based on the findings of field investigations conducted during this LSS, it was determined that the areas previously identified as ESGRAs are not particularly unique in terms of their importance for the maintenance of hydrological conditions of off-site habitats. Therefore, the Phase 1 LSS established that no ESGRAs exist within the WVSP.

3.1.1 Dewatering Assessment

The Land Use Plan is described in **Section 1.3** above and is illustrated on **Figure 1.3 (Appendix A2)**. It includes urban corridors for mixed-use development, a neighborhood area for residential development, collector roads, elementary schools, parks, environmental features and Stormwater Management (SWM) facilities. However, detailed information (e.g., final grades, building footprints, road/servicing alignments etc.) are not currently available, so the following assumptions were made to assess potential short-term construction dewatering requirements and potential impacts:

- Site servicing could extend approximately 3 to 5 m below grade for storm or sanitary sewers. 100 m of trench is assumed to be dewatered at a time.
- Residential basements could extend about 3 m below grade. It is assumed that a typical residential block could be 50 m wide, 200 m long, and basement areas could cover 70% of each block.
- Deeper basements or multiple underground levels may occur within the urban corridors, requiring excavations extending as much as 6 to 7 m below grade. It is assumed these urban corridor blocks could be 100 m wide and 200 m long, and basement areas could cover 70% of each block.
- Perimeter and sub-floor drains for buildings are assumed to be about 0.3 m deeper for the permanent dewatering assessment.
- SWM facilities are assumed to extend about 3 to 4 m below grade with plan dimensions up to 200 m by 200 m in size.

The following data was used in the preliminary dewatering assessments:

- Based on the subsurface conditions at the site as characterized through the LSS field investigation, the site is generally underlain by 5 to 6 m of low permeability clay and silt glacial till (Halton Till), followed by very dense silt and sand glacial till.

- Rising head tests measured hydraulic conductivity values in the following ranges:
  - Halton Till (surficial, silt-clay till):
    - 2.5×10^{-9} m/s to 7.8×10^{-7} m/s
    - Geometric Mean: 2.4×10^{-8} m/s
  - Newmarket Till (older, silt-sand till)
    - 7.2×10^{-8} m/s to 5.6×10^{-6} m/s
    - Geometric Mean: 1.9×10^{-7} m/s
- For shallow excavations (e.g., residential blocks, SWM ponds, servicing) a hydraulic conductivity of 5×10^{-8} m/s was used, corresponding to the surficial Halton Till; for deeper excavations (e.g., urban blocks) a hydraulic conductivity of 5×10^{-7} m/s was used, corresponding to the deeper Newmarket Till which may be intersected by those deeper excavations.
- Seasonal high groundwater levels were as high as 0.2 m below existing grade. During summer and early fall (typical construction season), the groundwater table typically ranges from about 0.5 to 2.5 m below grade. To provide a conservative assessment, it was assumed that groundwater levels were 0 mbgs (i.e., at existing ground surface).

3.1.1.1 Construction Dewatering

For preliminary purposes, the short-term construction dewatering assessment is based on open cut excavations. To excavate under dry conditions, the groundwater level is anticipated to be lowered at least to a minimum of approximately 0.5 m below the proposed excavation depth. Additional dewatering capacity may be required to maintain dry conditions within the excavation during and following significant precipitation events. The values below are preliminary estimates to support the impact assessment which are very conservative, and detailed analysis for dewatering will be required in future phases of site development.

The Radius of Influence (ROI) for construction dewatering is estimated based on the empirical Sichardt Equation. This equation is used to predict the distance at which the drawdown resulting from pumping is negligible. This equation is empirical and was developed to provide representative flow rates using the steady state flow dewatering equations, as discussed below.

It is noted that in steady state conditions, the radius of influence of pumping will extend until boundary flow conditions are reached and provide sufficient water inputs to the aquifer, such as surface water bodies, more productive aquifers, or, as may be the case with soils of low hydraulic conductivity, until a new equilibrium is formed with infiltration and runoff/interflow processes. As a result, though some variability may be expected, the radius of influence calculated using Sichardt equation is considered to be suitable for the purposes of this impact assessment. It is also noted that conservative assumptions have been made, such as selecting a practical maximum groundwater level (i.e., groundwater level at surface) and a hydraulic conductivity that is higher than indicated by the results of *in situ* testing, so the estimated radius of influence is also expected to be conservative.

The ROI of pumping (dewatering) for radial flow is calculated based on the Sichardt equation, which is described as follows:

$$R_0 = 3000\ (\mathrm{H} - \mathrm{h})\sqrt{\mathrm{K}}$$

Where:

K	= Hydraulic Conductivity (m/s)
H	= Static Saturated Head (m)
h	= Dynamic Saturated Head (m)
R_0	= Radius of Influence (m)

For input into the Sichardt equation, a hydraulic conductivity of 5.0 x 10^{-7} m/s was used for urban blocks and 5.0 x 10^{-8} m/s was used for servicing, residential blocks and SWM ponds. These values were obtained by applying a moderate factor of safety to the hydraulic conductivity estimates obtained through investigation conducted in the Phase 1 LSS for the Halton Till (2.4x10^{-8} m/s, applied to shallow excavations) and Newmarket Till (1.9x10^{-7} m/s, applied to deeper excavations such as urban corridor blocks). Drawdowns used in the calculations are summarized in **Table 3.1** (**Appendix C2)** and are based on an assumption that static groundwater levels are at ground surface.

The resulting radius of influence estimates range from approximately 2.3 m to 15.9 m. The radius of influence and potential drawdown for each type of excavation is summarized in **Table 3.1 (Appendix C2)** with calculations provided in **Appendix C3**.

The Equivalent Well Radius method was used to obtain a flow rate estimate for the proposed site servicing and is expressed as follows:

$$Q = \frac{\pi K(H^2 - h^2)}{\ln R_O / r_s} + 2\left[\frac{xK(H^2 - h^2)}{2L}\right]$$

Where:

Q	= Rate of pumping (m^3/s)
x	= Length of excavation (m)
L_0	= Length of influence (m) ($L_0 = \frac{R_0}{2}$)
K	= Hydraulic conductivity (m/s)
H	= Head beyond the influence of pumping (static groundwater elevation) (m)

h = Head above base of aquifer at the excavation (m)
R_0 = Radius of influence (m)
r_s = Equivalent well radius (m)

To estimate dewatering for the long, narrow excavations associated with site servicing, the entire equation above is used which accounts for linear flow along the length of the trench and radial flow at both ends of the trench. For dewatering flows associated with larger excavations with lower aspect ratios (i.e., shorter length relative to width), only the first term in the equation is used as these types of excavations can more adequately be represented by flow to an equivalent well: such excavations include those for residential blocks, urban blocks, or SWM facilities.

Based on the assumptions provided previously, the results of the dewatering rate estimates are summarized in **Table 3.2** (**Appendix C2**).

The total construction dewatering flow rates include a factor of safety of 2.0 to account for seasonal fluctuations in the groundwater table and variation in hydrogeological properties beyond those encountered during the field investigation. A 10 mm rain event was included to account for a typical precipitation event that could occur during construction. The selection of a 10-mm event is based on review of the Richmond Hill climate normals, which indicate that over 80% of rainfall events are 10 mm or less. The dewatering estimates could be more or less, depending on the actual area and depth excavated at a time for each location.

It is noted that as of July 1, 2025, amendments to O.Reg. 63/16 have come into force which will remove volume limits such that essentially all construction dewatering activities would be managed under the EASR program, with PTTW being reserved for limited circumstances which are not expected to apply at WVSP (e.g., release of construction dewatering discharge within a Wellhead Protection Area “A”).

Generally, construction dewatering is not expected to cause impacts to the natural environment because of the temporary nature of the dewatering. The relatively small zones of influence will mean that most dewatering activities will not result in drawdown influence at sensitive receptors (e.g., wetland areas). Where construction dewatering does occur near a sensitive wetland area and drawdown or water quantity related impacts are expected to result, the dewatering activity can be planned so that discharge water is released back into the same catchment to maintain water levels. This level of impact assessment and mitigation planning would be best conducted at the time of site plan or detailed design.

It is reiterated that the dewatering estimates are for the impact assessment only, additional analysis based on the detailed design must be carried out to support future work within the WVSP area.

3.1.1.2 Post Construction Dewatering and Basement Drainage

The Town of Caledon engineering standards do not specify a minimum clearance between basement slabs and the seasonal high groundwater table. Based on the groundwater monitoring data provided in the Phase 1 LSS, seasonal high groundwater levels typically range from 0.6 to 0.2 m below existing grade. Unless more than 3 m of grade raise is undertaken at the site, most basements in the proposed development would extend below the seasonal high groundwater level, and in most cases below the prevailing groundwater table throughout the year. Similarly, subsurface infrastructure (e.g., watermains, sewers) have the potential to form preferential flow paths due to disturbance of soils along their length, potentially leading to groundwater drainage and lowering of the overburden water table.

Where basement levels and any perimeter subdrains are kept above the seasonal high groundwater level (with a typical clearance of at least 0.5 to 1.0 m to account for long-term yearly variations) or where basement levels are fully waterproofed (i.e. no drains) and designed to resist hydrostatic pressures, no permanent dewatering would be anticipated. Installation of sewers and watermains with trench plugs or clay collars can also limit long-term dewatering and groundwater drainage.

A preliminary assessment is completed below for potential permanent dewatering rates, should basement levels be constructed below the groundwater table. The following additional assumptions are made for the purposes of providing an assessment:

- For most of the residential development areas, low density development is anticipated (e.g., single-detached dwelling units, townhouses), but building dimensions are unknown. Lot sizes of 20 m wide by 30 m long were assumed for a typical detached residential dwelling.
- For larger buildings in the urban corridor, with potentially one or two underground levels, it is still assumed these urban corridor blocks could be 100 m wide and 200 m long, and basement areas could cover 70% of each block.
- Rainfall events are not included for permanent dewatering because there is no open excavation.

The ROI estimation for permanent dewatering from basement drains follows the same procedure discussed previously for construction dewatering. Estimation details are provided in **Appendix C3**, and the ROIs and potential drawdowns are summarized in **Table 3.3** (**Appendix C2**) for different potential permanent dewatering locations. The ROI estimates indicate zones of influence extending generally less than 16 m from the proposed structures.

The estimates were carried out using the methodology previously discussed (see **Appendix C3**), and are summarized in **Table 3.4** (**Appendix C2**). For a single detached dwelling, the estimated drainage rates are up to 3,862 L/day, whereas for a larger building constructed in the urban corridor (e.g., apartment or mixed use building with below ground parking) estimated long term drainage rates may be up to 161,762 L/day.

These rates are based on pre-development groundwater levels: it is likely that in the post-development condition, groundwater levels will decline in response to the increased imperviousness, regularity of grading, and disturbance of the subsurface (i.e., installation of services and foundation drains). In the long-term, average rates of foundation drainage are likely to be far less than indicated above and for shallow basements would likely only occur following heavy precipitation and during spring freshet. For comparison, 3,862 L/d corresponds to a sump pump (assumed flow 20 Lpm) running for approximately 2 hours in a day. It is also well below the capacity of typical weeping tile piping as would be constructed under OBC. As such, based on the information available at this stage, foundation drains are expected to be a suitable means of mitigating groundwater pressures at shallow basements. For additional discussion of foundation drainage and an assessment of potential impacts on groundwater, see Section 3.1.3.

It is reiterated that the dewatering estimates are for the impact assessment only, and additional analysis based on detailed design must be carried out to support future work within the WVSP area.

Generally, long-term drainage of groundwater into SWM facilities will be relatively limited because of the low hydraulic conductivity of the Halton Till. Estimated seepage rates are in the range of 15,000 L/d per hectare of SWM facility (see **Appendix C2, Table 3.2**: estimate based on a SWM facility 200 m by 200 m in dimension). For perspective, this is a similar order of magnitude to the rate of evapotranspiration (approximately 550 mm/year over a 1-ha area is 15,100 L/d). Regardless, to limit potential impacts due to long-term drainage at SWM facilities, it is recommended that they be designed with liners to minimize groundwater ingress unless future investigation (e.g., at site plan or detailed design) provides additional study (i.e., detailed water balance and/or flow calculations) to indicate that the drainage quantities for an unlined pond would not have an impact on the local hydrogeology. In cases where the requirement for a liner remains, they shall be designed to resist hydrostatic uplift through the use of appropriate restraints (e.g., ballast, burial).

3.1.2 Regulatory Considerations for Water Taking

On July 1, 2025, amendments to O.Reg. 63/16 came into force which made all construction dewatering activities subject to the Environmental Activity and Sector Registry program, with a few exceptions (i.e., dewatering activities that release discharge water to the natural environment within a WHPA-A will continue to require a PTTW). Dewatering activities involving the taking of less than 50,000 L/d would not be required to register to EASR.

Therefore, it is expected that a PTTW will not be required for construction dewatering activities conducted within the WVSP. Where dewatering rates exceed 50,000 L/d, EASR would be required: this may be the case in construction dewatering for urban corridor blocks, low to medium density residential (where constructed as blocks) and stormwater management facilities. Servicing and single detached dwelling construction are not expected to require EASR but this should be confirmed through further study at future stages in the development process (e.g., site plan, detailed design).

Per O. Reg. 63/16, construction dewatering activities registered to EASR (i.e., exceeding 50,000 L/d) must be conducted in accordance with a report prepared by a Qualified Person (i.e., licensed engineer or geoscientist). This report must meet the terms of reference laid out in O. Reg. 63/16, including the completion of various impact assessments with respect to the natural environment, water users, and other receptors. The report must also include suitable mitigation, monitoring and contingency measures to be implemented to address the potential impacts. Based on the information and site observations collected during this LSS, no major obstacles have been identified that would preclude the development and implementation of appropriate plans to mitigate impacts associated with dewatering. However, the preparation of these plans will be completed at a later stage in the development process (i.e., detailed design, site plan).

It is recommended that the dewatering reports consider the "TRCA Technical Guidelines for the Development of Environmental Management Plans for Dewatering," dated September 2013. During future development stages, an ecologist may need to be retained to review the ROIs and estimated water taking rates previously described, relative to the potential NHS on or near the WVSP area. A Natural Heritage Evaluation may be required, along with consultation with TRCA to determine if an Environmental Management Plan (EMP) is required for construction dewatering.

As of July 1, 2025, due to revisions to O.Reg. 387/04, foundation drainage for a building whose primary purpose is residential use only requires a PTTW if the drainage rate equals or exceeds 379,000 L/d. Buildings of other uses will require a PTTW where foundation drainage exceeds 50,000 L/d.

Based on the assessment provided in Section **3.1.1**, the long-term drainage from residential buildings in the WVSP area is expected to be below 379,000 L/d. As a result, the impacts associated with long-term dewatering of structures must be addressed through the development approvals process as there appears to be no approvals requirement specifically required for the water-taking activities themselves. A preliminary impact assessment related to long-term dewatering is provided in the following sections.

It is noted that the discharge from foundation drains is typically conveyed to either the local stormwater system (either via an overland flow route from sump pump discharge or via a direct connection with a stormwater service) or to a third pipe foundation drain collector. Under the Consolidated Linear Infrastructure – Environmental Compliance Approval (CLI-ECA) framework, direct connection of a foundation drain collector to the storm sewer is only approvable by the municipality if the discharge is of precipitation rather than groundwater. Hydrogeologically, the drainage from shallow basements on-site would be considered to be the drainage of precipitation because the upland hydrology is controlled by surface water processes, and flows collected by foundation drains would primarily be water from precipitation that infiltrated locally (i.e., in the immediate vicinity of the structures). This would therefore make the foundation drains eligible for direct connection to storm sewers and those connections would be approvable by the municipality under the CLI-ECA framework.

As such, foundation drains for shallow basements (e.g., townhouses, single detached dwelling) may be connected to either the storm sewer or a “third pipe” foundation drain collector. However, deep basements (i.e., urban corridor structures), especially where they intersect deeper strata such as the Newmarket Till or the bedrock, may be considered to draw groundwater and therefore may not be eligible for direct connection to the stormwater system. This should be evaluated in more detail at a later stage in the design process based on additional study and on the details of the proposed designs and the hydrogeological conditions at those sites.

3.1.3 Potential Impacts to the Natural Environment

The potential impacts discussed below must be assessed in more detail and addressed during future phases of development. The West Humber River lies outside the anticipated zones of influence of dewatering, therefore impacts to the West Humber River from short term construction dewatering are not expected. Furthermore, the water taken during construction dewatering would likely be discharged to surface within the same catchment from which it was taken, therefore eventually being returned to the West Humber River.

Most surface water features in the WVSP area are fed by surface water and would not be impacted by water-taking occurring during construction dewatering. Features that are supported by groundwater (i.e., have access to shallow groundwater) may have the potential to be impacted by water-taking during construction dewatering if the zone of influence intersects the feature and results in water level drawdown at the feature. However, due to the temporary nature of dewatering as well as the relatively low hydraulic conductivity of geological materials within the WVSP area, it is likely that impacts will not occur due to these water-takings.

Updated construction dewatering impact assessments should be provided at each phase of development (e.g., Draft Plan of Subdivision, Site Plan) noting the additional details that are available at the respective stages of design. Recommendations for appropriate monitoring and mitigation plans to reduce or prevent the impacts should also be updated or provided at each stage.

Apart from water-taking during construction dewatering, there may also be potential water quality impacts related to the management of discharge. Generally, these can be mitigated through the implementation of erosion and sediment control plans during construction. Details of these systems would be specified by the discharge report prepared in accordance with O.Reg. 63/16, which would be completed at later stages in design (e.g., Site Plan).

Post-construction (i.e., long-term) dewatering may have impacts on features that are supported by groundwater. In the case of servicing (e.g., sewers), trench collars can be provided to mitigate the development of the preferential flow paths that may cause this kind of dewatering. Deep basements (e.g., in the urban corridor) can be constructed as waterproof structures to minimize dewatering but the need for this should be established by future studies (i.e., at Site Plan) based on the exact details of those developments and their relation to sensitive features.

For shallow basements (e.g., townhouses, single detached dwellings) waterproofing is not practical nor expected to be necessary. Foundation drainage is a practical solution for protecting basements from potential high groundwater because the soils are of very low hydraulic conductivity. The impact of these foundation drains vis-à-vis the natural environment must be considered in two modes: potential impacts to deep recharge and potential impacts to interflow.

The maintenance of interflow is mainly of importance to local (i.e., on-site) wetland areas that may receive or rely on shallow groundwater that occurs in the shallow weathered till layer. However, the effects of this impact can be mitigated by the placement of appropriate LID measures to enhance groundwater recharge in areas adjacent to the features in question. Target recharge quantities for these LID measures are provided in **Section 3.2.4** below. If these facilities are placed adjacent to the features that they are intended to support, then foundation drains will not be able to intercept these flows nor impact the receiving features. It is also noted that the support provided by these LID measures would be a supplement to the features as their hydrology is dominated by surface process (i.e., runoff, direct precipitation) and only secondarily supported by groundwater, which is mainly available due to runoff being retained in these low-lying areas by the underlying soils of low hydraulic conductivity.

Deep recharge is mainly important because it provides water to deeper hydrostrata and the regional hydrogeological system. This has potential implications for features further off-site, especially where the deeper hydrostrata are more conductive and support higher rates of lateral flow. In the case of the WVSP area, the deeper stratigraphy is not highly conductive but is relatively more conductive than the surficial Halton Till (i.e., Newmarket Till has hydraulic conductivity in the order of 10^{-7} m/s approximately 10 times that of Halton Till). The WVSP area proposes extensive areas to be built out with dwellings with single-level basements and shallow foundation drains. However, deep recharge is not expected to be impacted by the proposed foundation drains. This is because the deep recharge is governed by the vertical gradient through the Halton Till. Reviewing the hydrographs for nested monitoring wells across the WVSP area (see Appendix C11 in Phase 1 LSS), it is noted that during times of low groundwater levels, the vertical gradient is similar to or greater than it is when groundwater levels are high. This indicates that lowered groundwater levels are not likely to reduce the rate of deep recharge through the Halton Till. The important element in maintaining deep recharge is to ensure that post-development infiltration at least matches the deep recharge quantity, rather than necessarily matching the total pre-development infiltration quantity. Infiltration targets for the maintenance of deep recharge are discussed in **Section 3.2.4** of this report.

Based on this analysis, it is considered unnecessary for the post-development infiltration targets to account for post-development long-term drainage, on the condition that the bulk of the catchment-specific infiltration can be provided in locations adjacent to the intended receptor (i.e., a constructed compensation wetland area or a wetland area that is to be retained) where the infiltrated water is not likely to be subsequently intercepted by foundation drains. Therefore, the stormwater management design, informed by the water balance assessment(s) for applicable features, should generally seek to maintain the water balance of the wetlands/features that are to be retained, thus mitigating any impact. Refer to Sections 3.5.3 and 4.4.1 for further information on the water balance mitigation and LID measures, respectively. The details of basement designs and the LID measures will be determined through subsequent design stages (e.g., draft plan, site plan).

Consultation between different technical experts such as natural heritage / ecology teams and hydrogeologists are recommended during future design stages to make sure the appropriate long-term groundwater conditions are understood and accounted for. For example, if constructed wetlands are designed based on current groundwater levels, but drained basements are to be constructed that will reduce infiltration (and hence interflow) in the catchment area, this must be understood and incorporated into / accounted for in the design and appropriate mitigation measures (e.g., installation of LID measures near the affected features) included as applicable. Infiltration targets for such mitigation measures are proposed in Section 3.2.4. However, it is noted that during future development stages more detailed studies are required to assess the potential changes to the water balance of sensitive features, the spatial area of impact, and any potential environmental effects or impacts to the natural heritage system, as well as to confirm mitigation requirements.

Overall, it is expected that the proposed development will not have a significant impact on the general trend in groundwater flow directions on-site. The WVSP area is dominated by the Halton Till aquitard, and the direction of groundwater flow in aquitards is largely determined by topography. Site grading design is expected to maintain general drainage patterns and to minimize cut-fill balance. As such, the post-development topography is expected to be similar to the existing topography and groundwater flow directions will similarly be retained in the post-development condition.

3.1.4 Potential Impacts to Future Servicing Infrastructure

If any construction dewatering occurs after site servicing is completed and the groundwater is discharged into the storm or sanitary sewer infrastructure instead of to the land surface, the water-taker will need to verify that the expected flows can be safely conveyed by the servicing infrastructure and in accordance with all relevant criteria and by-laws. If not, an appropriate discharge plan will need to be prepared and implemented to limit potential impacts to receivers.

Where drained basements are constructed with an outlet to a storm sewer, there will be increased permanent flows to the sewers and SWM facilities. The designer will need to check if the increased permanent flows will impact the design or function of the infrastructure and accommodate the flows within the design accordingly. Similar considerations apply in the design of a “third pipe” system with a dedicated drain for foundation drainage (i.e., foundation drain collector).

Service trenches typically contain granular bedding and granular backfill around the pipes. The granular material is more permeable compared to the clay and silt glacial till encountered at the WVSP area. This can create a French drain effect, where groundwater is drawn into the granular material and conveyed along the pipe alignments, potentially lowering the groundwater table or creating issues with internal soil erosion (also referred to as “piping”). The need for trench plugs, anti-seepage collars, or similar methods should be explored as part of future design stages.

3.1.5 Potential Impacts to Land Stability and Settlement

For construction dewatering and long-term drainage, settlement of the soil within the radius of influence must be calculated based on the increase in effective stress from reducing the pore water pressures. Settlement has the potential to damage buried utilities, building foundations, or cause subsidence in adjacent lands. The settlement must be assessed in reports during future development stages, and if concerns are noted, mitigation measures must be provided.

Generally, dewatering-induced settlement is not expected to be significant because of the substantial natural fluctuation in groundwater levels, which indicates that changes in effective stress caused by development will be within the historical range. However, this may not be applicable to deep foundations associated with the urban corridor. As such, a project-specific analysis would be required to be undertaken at a later stage (e.g., site plan or detailed design) when the details of those buildings are known. Again, dewatering related impacts associated with deep foundations for urban corridor buildings can generally be mitigated by waterproofing the foundations but a project-specific impact analysis based on the details of the development design may indicate that waterproofing is not necessary and that other mitigation measures would be effective.

Another cause of significant dewatering-related settlement is due to pumping of fines through a dewatering or drainage system (i.e., ground loss by internal soil erosion). Future reports supporting site development should provide recommendations on filtering techniques or other methods to ensure soil is not conveyed through the dewatering systems. Low-density dwellings (e.g., townhouses, single-detached units) with basements below seasonal high groundwater and relying on foundation drainage should consider the use of appropriate granular material as backfill around weeping tile and filter fabrics to limit internal soil erosion and in turn mitigate issues related to ground loss.

3.2 Water Balance and Groundwater Recharge

3.2.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. The water balance equates the precipitation (P) over a given area to the sum of the change in groundwater storage (ΔS), evapotranspiration/evaporation (ET), surface water runoff (R) and infiltration (I) using the following equation:

$$\mathrm{P} = \Delta S + I + ET + R$$

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). For example, runoff occurs at a higher percentage during periods of snowmelt when the ground is frozen or during intense rainfall events.

Precise measurement of the water balance components is difficult, and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important inputs to the water balance calculations.

- **Precipitation (P):** For the purposes of approximating the annual precipitation at the WVSP area, the monthly rainfall between 1981 and 2010 was used based on Environment Canada historical weather data for the Richmond Hill, Ontario weather station (Climate ID 6157012, Latitude 43°52' N, Longitude – 79°27' W, Elevation 240 metres), which is located about 19.5 km east of the WVSP area.
- **Change in Storage (ΔS):** Although there are groundwater storage gains and losses on a short-term basis, for the purposes of this water balance calculation the net change in groundwater storage on a long-term basis is assumed to be zero. This is because this water balance is calculated to provide the average annual water balance over an indefinite period of time, which requires that the system be assumed to be at steady state (i.e., zero change in storage). This is a suitable assumption because the physical environment is considered to remain more or less unchanged over the long-term for both the pre-development condition and the post-development condition (once established).
- **Evapotranspiration/Evaporation (PET):** The evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. Evaporation occurs from a hard surface (such as flat rooftops, asphalt, gravel parking areas, etc.).
- **Water Surplus (R + I):** The amount of precipitation in excess of evapotranspiration and changes in storage is referred to as the water surplus. The water surplus is divided into two parts: as surface or overland runoff (R) and the infiltration into the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to underlying aquifers (referred to as percolation, deep recharge or net recharge) and a second component that moves laterally through the near surface soil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short distance and time following precipitation.

3.2.2 Regional Climate

The average temperature and precipitation data was taken from Environment Canada Richmond Hill station 1981 to 2010. The annual information is presented below:

- Average Annual Precipitation: 895.2 mm
- Average Annual Temperature: 7.9°C

It is noted that the above are average values, which are representative in a regional context. The intent of the water balance calculation is to provide an estimate of average annual runoff and recharge. Seasonal and annual variations of these values are to be expected. The long-term groundwater recharge and discharge rates are determined by these average values.

3.2.3 Approach and Methodology

An annual water balance was calculated according to the methodology provided by Thornthwaite and Mather (1957). This methodology involves monthly estimates of soil-moisture balance to determine the pre- and post-development infiltration volumes. The detailed water balance calculation is provided in **Appendix C4**, and the approach and results of this calculation are described in this and subsequent sections of the report.

The Thornthwaite and Mather calculation process is a standard approach to calculating water balance and involves utilization of available climate data, characterization of the site (vegetative cover, soil conditions), and reference to tables provided within the Thornthwaite and Mather water balance manual (1957).

The Thornthwaite and Mather (1957) water balance method generally operates on the following assumptions:

- No moisture surplus occurs in months when soil moisture storage is below its maximum capacity.
- During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. In months where soil moisture reaches its maximum, the excess is considered to be moisture surplus, which is available to become either runoff or infiltration.
- During "dry months", changes in soil moisture are determined according to the guidance provided by Thornthwaite and Mather (1957), in which the soil moisture storage (i.e., the quantity of water that is stored in the soil) is calculated based on the accumulated potential water loss.
- In turn, the actual evapotranspiration for a given month is taken to be:
    - For cool months (temperature less than -1°C): 0 mm
    - For wet months (where there is excess precipitation over potential evapotranspiration): the difference between precipitation and potential evapotranspiration
    - For dry months (where precipitation is less than potential evapotranspiration): the sum of precipitation and the absolute value of the change in soil moisture storage.

The calculations were conducted in general accordance with the Thornthwaite and Mather (1957) method, with the following notable exceptions:

- Heat Index and Unadjusted Daily Potential Evapotranspiration were computed based on formulae given in Lorente (1961).
- The division of moisture surplus into recharge and runoff is determined based on the infiltration factors specified in the Stormwater Management Planning and Design Manual (MOE, 2003), which involves selection of components based on soil, topography and vegetation cover.
- Whereas Thornthwaite and Mather provides a monthly water balance, accounting for snow storage, snowmelt runoff, and other seasonal processes which re-distribute moisture surplus throughout the year, the water balance calculations provided here are annual and do not provide those distributions.
- Impervious areas were accounted for by assuming a constant evaporation rate of 15% of annual precipitation, with the remaining 85% of precipitation being considered as runoff.
    - The proportion of impervious area in each catchment area was calculated based on the proposed land use plan (**Figure 1.3**, **Appendix A2**).

As noted above, certain site conditions and material properties must be accounted for in the water balance calculation process. For the post-development water balance, the following characteristics were used in these calculations (for pre-development, please refer to Section 2.3.4 of the Phase 1 LSS):

- The maximum soil moisture storage was determined based on guidance provided by Thornthwaite and Mather (1957), which accounts for both soil type and vegetative cover.
- Soil: Based on grain-size analyses, the surficial Halton Till of the WVSP area is typically in excess of 40% clay with relatively low sand content. Under the Canadian Soil Classification System (Soil Classification Working Group, 1998), such soils are classified as “clay”.
    - Cover: Three types of cover are anticipated on pervious areas in the post-development condition:
        - Grassed: for residential lawns, yards and other open space
        - Treed: for retained areas with wooded cover
        - Wetland: for retained or proposed compensation wetland areas.
    - Soil Moisture Storage Capacity: Thornthwaite and Mather (1957) provide a soil moisture storage capacity for each combination of soil and cover type. For the post-development case, the following were used:
        - Grassed with clay soils: 75 mm soil moisture capacity
        - Treed with clay soils: 350 mm soil moisture capacity
        - Wetland with clay soils: 200 mm soil moisture capacity (wetlands taken to be similar to shrub/pasture cover).
- For the purposes of infiltration factor selection, the following conditions were chosen:

- Soil factor: 0.15
  - Rationale: the surficial till soils of the Site typically contain greater than 40% clay, indicating potentially “impervious” conditions, but weathering of shallow soils indicates slightly elevated permeability. Therefore 0.15 is a modification of the “tight impervious clay” selection of 0.1.
- Topographic Factor: 0.15
  - Rationale: the slope across the WVSP is relatively uniform, typically between 10 and 16 m/km, which indicates an intermediate value between “Rolling Land” and “Hilly Land”, for which the MECP provides factors of 0.2 and 0.1, respectively.
- Vegetative Cover: 0.1 or 0.2
  - Rationale: the vast majority of the WVSP area in the post-development condition will be landscaped land, which is taken to be “cultivated” land (factor of 0.1) but additional calculations have been made to account for the areas that will retain wooded cover (factor of 0.2)

The water balance (**Appendix C4**) provides calculations on a catchment-by-catchment basis.

3.2.4 Water Balance Targets

3.2.4.1 Deep Recharge

The results of the pre-development and post-development water balance calculations are presented in detail in **Appendix C4**. The major components of the water balance are summarized below as site wide annual averages for the WVSP area:

- Infiltration:
  - Pre-Development: 121.0 mm, 427,864 m^3
  - Post-Development: 34.9 mm, 123,535 m^3
  - Change: 71.1% decrease
- Runoff:
  - Pre-Development: 217.1 mm, 768,709 m^3
  - Post-Development: 618.3 mm, 2,186,889 m^3
  - Change: 185% increase

- Evapotranspiration
  - Pre-Development: 557.1 mm, 1,969,159 m^3
  - Post-Development: 242.0 mm, 855,954 m^3
  - Change: 56.5% decrease

It is noted that these estimates assume no mitigation, such as the implementation of LID measures to enhance on-site infiltration.

The results of the water balance calculations indicate that the proposed development has the potential to cause significant changes to all three major components of the water balance. The bulk of these changes is related to the construction of impervious surfaces and structures in place of existing pervious, vegetated areas. Such changes reduce evapotranspiration because evapotranspiration is largely driven by vegetation and by the evaporation of water that is held in surficial soils. The increase in impervious surface area also promotes runoff at the expense of infiltration.

Impacts to evapotranspiration can be reduced through landscaping, such as by planting more deeply-rooted plants (e.g., trees, shrubs, and tallgrass) to increase soil moisture storage and by limiting the increase in impervious surfaces (e.g., widening of driveways, paving of backyards, construction of large outbuildings). At residential properties, the use of rain barrels may allow for the collection of some potential runoff to be retained for use in watering plants, gardens, and lawns, which would ultimately result in a conversion of some runoff to evapotranspiration.

Impacts associated with increased runoff are largely mitigated by conventional stormwater management, which provides capacity to attenuate peak flows and delivers flows to natural drainage channels in such a way that mitigates risk of flooding and erosion.

Impacts associated with decreased infiltration can be mitigated by implementation of LID measures (e.g., infiltration galleries, bio-swales) to promote infiltration (refer to **Section 4.4.1**). These measures can also, to a degree, mitigate increases in runoff but the effectiveness will be limited by the natural hydrogeological conditions (i.e., shallow groundwater levels, surficial soils of low hydraulic conductivity).

To mitigate impacts to infiltration that may be caused by the development, the WVSP area should achieve a target annual infiltration rate of 45 mm/year. The purpose of this general, site-wide target is to maintain pre-development quantities of deep recharge and, in turn, minimize impacts to the regional hydrogeological system. This general target infiltration rate is based on the assessment provided in the Phase 1 LSS report, which analyzed site-specific data (groundwater levels, vertical gradients, and hydraulic conductivity of Halton Till) to estimate the average annual rate of deep groundwater recharge that occurs through the Halton Till aquitard. It also closely corresponds to the estimated rate of groundwater recharge for the WVSP area as published by the TRCA in the 2008 "Humber River Watershed, Scenario Modelling and Analysis Report".

Based on the results of the water balance calculations (see **Appendix C4**), the post-development-site-wide average infiltration rate is 34.9 mm/year. Therefore, to achieve the general infiltration target of 45 mm/year, mitigation measures are required to provide an equivalent enhanced recharge of 10.1 mm/year across the WVSP area. Development-specific infiltration targets must be confirmed or further refined based on pre- and post-development water balance calculations at the Draft Plan of Subdivision stage.

3.2.4.2 Shallow Seepage for Wetlands

As outlined above in Section 3.2.4.1, a site wide infiltration target of 10.1 mm/year has been established for the WVSP area to maintain deep recharge. In areas where sensitive on-site features are to be retained or where compensation wetlands are intended to be constructed, infiltration targets must be higher to support the maintenance of shallow seepage (i.e., interflow in the thin surficial layer of weathered till) that supports those features. As such, infiltration targets have been established for shallow seepage to these wetlands as follows.

For catchments requiring additional infiltration to maintain shallow seepage to wetlands, the following provides a summary of the expected post-development infiltration requirements (see **Table 3.1** below). These targets are provided for the maintenance of hydrogeological function at groundwater-supported features.

Table 3.1 – Feature-Specific Infiltration Targets for the Maintenance of Retained Wetland and Compensation Features

Wetland/ Compensation Area	Catchment Location	Net Area[1]	Pre-Development Recharge Volume	Post-Development Recharge Volume	Feature-Specific Infiltration Target[2]
10_11 and CA2	38.04.20	53.45	64,348	17,488	40,294
8, 33, and 34	38.04.10	3.33	4,009	1,226	2,510
43	38.04.11	27.99	33,695	9,157	21,100
CA1	36.10.1	4.54	5,459	1,793	3,419

1-Net Area is the catchment area that is tributary to the wetland feature(s) in the pre-development condition but excludes the wetland areas themselves and their buffers.
2-This amount is exclusive of the infiltration target that applies to the gross development area of the WVSP (i.e., the "general" infiltration target), which is intended to make up the deficit between post-development recharge and the average annual deep recharge rate of 45 mm/year (or 45 m^3/hectare/year, see Section **Error! Reference source not found.**).

Development-specific infiltration targets for wetlands must be confirmed or further refined based on pre- and post-development water balance calculations at the Draft Plan of Subdivision stage. The surface water balance for these features is provided in Section 4.3 below.

3.2.5 Potential Impacts to the Natural Environment

Urban development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (e.g., roads, parking lots, driveways, rooftops). Impervious surfaces prevent infiltration of water into the underlying soils and the removal of the vegetation reduces the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 15% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (nearly two-thirds of precipitation). So, the net effect of the urbanization of the site is that most of the precipitation that falls onto impervious surfaces increases the surplus water resulting in more direct runoff from developed areas and reduced natural infiltration.

In conjunction with increased runoff, there is a reduction in infiltration to the shallow groundwater system. A reduction in infiltration can potentially lead to changes in hydroperiod at local wetland features and impacts to deeper aquifers through reductions of deep recharge. The analysis presented above (Section 3.2.4) provides both general (i.e., site-wide) and feature-specific (wetland) infiltration targets that, if met, are expected to mitigate potential impacts to deep recharge and to local wetland features where such features are retained or constructed as compensation areas.

Changes to groundwater flow patterns are not expected because in aquitard environments such as in the WVSP area, gradients are predominantly governed by topography. Area grading is expected to preserve the general topography and surface drainage pattern of the WVSP area; therefore, groundwater flow patterns are not expected to be significantly affected. Groundwater flow patterns can also be maintained by mitigating the development of preferential flow paths associated with linear infrastructure (i.e., sewers, watermains) by installing trench plugs (or clay collars) during service construction.

Infiltration targets have been specified for the general WVSP area and for select areas where wetlands on-site are intended to be retained (see Sections 3.2.4.1 and 3.2.4.2, respectively). To adhere to the performance criteria under the CLI-ECA, LID measures will be implemented to achieve these infiltration targets. The details of these mitigation measures must be defined in future design phases.

It is recognized that infiltration at the WVSP area may be challenging, based on the low infiltration rates and the high groundwater table. However, it is also noted that the estimated pre-development rate of deep recharge is 45.0 mm/year, which is only approximately 10.1 mm/year above the unmitigated post-development recharge rate (34.9 mm/year), so the maintenance of deep recharge is expected to be achievable. Additional feature-specific targets are applicable to retained wetland features or compensation areas for wetlands that will be removed (see **Table 3.1**). These targets are generally higher than the general infiltration target and, in that sense, may be more difficult to achieve because of the high groundwater levels on-site. However, it is also noted that the purpose of these feature-specific targets is to maintain hydroperiod and interflow seepage to the features: if high groundwater levels prevent the contribution of infiltration through engineered structures, then it suggests that high groundwater levels also persist at the features themselves, which in turn indicates that the target may be relaxed because the end goal has been achieved. As such, when designing infiltration structures intended to meet the feature-specific infiltration targets, the requirement to maintain the usual clearance (i.e., 1.0 m) above seasonal high groundwater levels may be waived.

It is noted that the WVSP area is not within a Significant Groundwater Recharge Area (SGRA) under the Source Protection Plan. Though the SABE (Wood, 2022) indicated that an area in the southern part of WVSP was identified as Ecological Significant Groundwater Recharge Areas (ESGRAs), analysis in the Phase 1 LSS (see Sections 3.1.5 and 3.5) demonstrated that, based on the predominance and very low hydraulic conductivity of the Halton Till across the WVSP area, these identified ESGRAs are not significant or unique in terms of providing groundwater recharge for the support of habitats or other ecological features.

Surface water features planned to be maintained on site include (**Figure 2.3**, **Appendix B1**):

- Wetland 8 (SWD3-2, Silver Maple Mineral Deciduous Swamp)
- Wetland 33 (SA, Shallow Aquatic)
- Wetland 34 (MAS2-1, Cattail Mineral Shallow Marsh, Mowed)
- Wetland 10_11 (MAM2-2, Reed Canary Grass Mineral Meadow Marsh and MAM2-10, Forb Mineral Meadow Marsh)

Based on the data available from the Phase 1 LSS, which included the staff gauges and nested monitoring wells to measure gradient, surface flow, and potential groundwater-surface water interaction, the hydrology of these features, in addition to that of off-site

Wetland 43, is considered to be dominated by surface water processes and supported by groundwater due to the shallow depth to groundwater which is retained in the surficial soils of low hydraulic conductivity. If development causes reduced infiltration or the lowering of the groundwater table over time, impacts to the features are not expected as they do not primarily rely on groundwater discharge. As outlined in Section 4.4 below, the stormwater strategy has been developed to maintain the availability of runoff to these features post-development, in a way that maintains the pre-development flow pattern (e.g., distributed flow versus point outlet) and runoff volumes (refer to Section 4.4.1.1). Additionally, the implementation of infiltration type LIDs to maintain shallow seepage to these wetlands will ensure that any potential impacts to the natural environment will be mitigated.

Wetlands located on participating lands that are planned to be removed but compensated with constructed wetlands include (see **Figure 2.3 Appendix B1**):

- Wetlands 2, 3, 5 and 6 (MAS2-1)
- Wetlands 4, 7, and 17 (MAM2-2)

Similar to the features that are to be retained, the hydrology of these features is interpreted to be dominated by surface water processes and supported by groundwater due to access to shallow groundwater retained in the surficial till soils. The occurrence of water in these features is understood to be mainly due to the combination of topography, which focuses runoff and interflow from the surrounding areas into these depressions, and the Halton Till soils, which limits seepage outflows and allows for periods of prolonged water retention. Site-specific groundwater level data, both at the existing wetland locations and the proposed compensation area, should be considered when establishing grades for the constructed wetlands. Refer to Section 4.4.1.2 for additional information regarding LID measures for compensation area wetlands.

3.3 Groundwater and Surface Water Quality

Depending on land use, runoff from urban developments may contain a variety of dilute contaminants such as suspended solids, chloride from road salt, oil and grease, metals, pesticide residues, phosphorous, bacteria and viruses. For groundwater, generally most contaminants, except for the dissolved constituents such as nitrogen and salt, are attenuated by filtration during groundwater flow through the soils.

LID measures or end treatments such as oil/grit separators or wet ponds will mitigate surface water quality impacts from development by removing total suspended solids and other contaminants in runoff prior to infiltration. The proposed SWM strategy for the WVSP area, including LID measures and end-of-pipe SWM facilities, is discussed in Section 4.1.

Runoff from residential developments (e.g., rooftops, landscaped areas) is typically considered “clean” and should be prioritized for infiltration where infiltration is required to maintain groundwater recharge. Infiltration-based practices could potentially be permitted for impervious areas such as roads and driveways for the low-density residential neighbourhood areas, but this must be confirmed during future design stages with the Town and TRCA. Infiltration of runoff from commercial areas may require pre-treatment prior to infiltration or may not be permitted for infiltration depending on the end use, which will be determined in future design stages.

If only clean or pre-treated runoff will be infiltrated, the groundwater quality will not be degraded and will not impact the West Humber River, on-site wetlands being maintained or created, or other nearby environmental features.

3.4 Water Supply Wells

The potential impacts discussed below must be assessed in more detail and addressed during future phases of development.

As discussed previously in the Phase 1 LSS, the WVSP area is not located within a Well Head Protection Area Zone A to D or Q1/Q2, Intake Protection Zone, Significant Groundwater Recharge Area, Oak Ridges Moraine, or the Niagara Escarpment.

Development in the WVSP area is not expected to impact the quality or quantity of groundwater taken from active municipal wells given that the radius of influence is estimated to be less than 15 m from the excavation for the worst-case short term and permanent dewatering scenario (refer to Section 3.1.1 above). The nearest active municipal wells are approximately 6.4 km east and/or 9.4 km northwest of the WVSP area.

Since the WVSP is not within a WHPA Q2, impacts to municipal wells for groundwater quantity are not expected even if the water balance cannot be maintained due to lower permeability soils and a high groundwater table.

LID measures are expected to be implemented on site where possible. If only clean or pre-treated runoff will be infiltrated, the quality of groundwater available to nearby domestic wells is not likely to be impacted. The low-permeability silt and clay till deposit (Halton Till) across the WVSP area also limits the amount of water infiltrating deeper below grade as recharge and helps reduce the potential for contamination entering the deeper drinking water aquifers.

It is noted that areas within the north, central and southeastern portions of the WVSP area have been identified as Highly Vulnerable Aquifer (HVA) areas under the local source protection plan (CTC SPR, 2015, see **Figure 3.4, Appendix C1**). An HVA is an aquifer that has the potential for increased risk of contamination due to its proximity to the ground surface or the presence of surrounding geological materials with high permeability. For instance, materials like sand and fractured bedrock are highly permeable and allow water to infiltrate from the surface into deeper strata, potentially impacting aquifers, whereas clay layers provide a natural barrier due to their low permeability and offer protection to underlying aquifers.

It is noted that the HVA mapping provided in the source protection plan was developed through desktop studies based on existing data (e.g., water well records, surficial geological mapping). However, site specific information helps to provide actual stratigraphic and hydrogeological conditions.

Typically, within the WVSP area the groundwater level is near surface. Proximity of groundwater level to ground surface is a factor that contributes to an area being classified as an HVA. Based on field investigation conducted within the WVSP area under Phase 1 of this study, the general stratigraphy in the areas mapped as HVAs are mainly clay and silt glacial till (Halton Till) which is considered relatively low permeability material and constitutes an aquitard. Consequently, the study area specific information indicates that the area would not be considered an HVA.

Regardless of whether these areas remain HVAs or not, the potential for contamination as a result of development activities must be considered as part of subsequent phases of development studies. For example, the risk associated with activities such as the application of handling and storage of road salt, fuel and snow must be evaluated in those future reports.

Any existing monitoring wells or domestic drinking water wells within the WVSP area that are no longer in use will need to be decommissioned per Ontario Regulation 903. This will prevent potential contamination from entering the deeper groundwater system through unused wells, especially for domestic wells screened within deeper drinking water aquifers.

A door-to-door private well survey was completed for the sixty-one (61) private wells identified within 500 m of the site in the Phase 1 LSS, but no responses were received.

MECP water well records mapped within 500 m of the WVSP area were reviewed to assess the general nature of groundwater usage in the vicinity of the WVSP area (see **Figures 3.5A, 3.5B, 3.5C, and 3.5D**, **Appendix C1**). Within the well record search area, most water well records indicating a supply usage were for domestic purposes, with several livestock wells and one public well (associated with St. Patrick school located southwest of the intersection of The Gore Road and Mayfield Road). Approximately one-third of the supply wells were identified as bedrock wells, having an average depth of over 25 m, while the remainder were overburden wells, having an average depth of about 18 m, though some wells have been identified at depths less than 10 m.

Overburden wells were noted to typically be screened in sand or sand and gravel deposits between 15.2 to 54.9 m below existing grade. Based on the well records with available stratigraphic information, the deeper sand and gravel units may potentially be part of the Oak Ridges Aquifer Complex (ORAC) but may also be associated with other deeper/older aquifer formations (e.g., Thorncliffe Formation) due to their depth and location typically being immediately above the bedrock surface.

Within the well record search area, most of the supply wells identified as being overburden wells were relatively deep (i.e., over 15 mbgs), were located to the east side of the West Humber River, or were located within the proposed WVSP area. Deeper wells are less susceptible to changes in water level; wells located to the east side of the West Humber River, which is interpreted to act as a local groundwater divide, are not expected to be influenced due to the separation provided by the river; and wells located within the WVSP area would eventually be provided with municipal water service as part of the proposed development, indicating a lesser need for long-term reliance on those supply wells. These factors generally indicate that the proposed development generally has low potential to impact the water quantity available to overburden well users, except possibly with respect to deep structures (e.g., deep basements in the urban corridor, trunk sewers) if such structures would require or induce long-term dewatering. This articulates the need for future study in these areas to confirm there is no impact.

Bedrock wells within the search area are generally relatively deep (most greater than 15 m) and as such are not likely to be impacted in terms of water quantity. However, water quality may be affected depending on proposed stormwater management details. The potential for water quality impacts should be assessed as part of detailed design to determine whether mitigation measures should be implemented, such as lined ponds or quality requirements for water to be infiltrated (e.g., whether it should be limited to "clean" sources such as rooftops and rear-yards, or whether other sources can be used based on the provision of pre-treatment).

As previously noted, relatively little recharge from the WVSP area is expected to reach the ORAC based on the general stratigraphy consisting primarily of glacial till (i.e., the surficial Halton Till and underlying Newmarket Till) which has been shown to be of relatively low permeability (on the order of 10^{-7} to 10^{-8} m/s) and constitutes an aquitard setting. Furthermore, the ORAC deposits (if any do exist) are expected to be local and potentially discontinuous as discussed in the Phase 1 LSS. A reduction in groundwater quantity to nearby wells is expected to be minimal to negligible even if pre-development quantities of recharge cannot be maintained post-development.

Even if impacts to nearby domestic wells are not anticipated, future reports should include a contingency plan with measures to implement during construction in case private well owners issue complaints about potential well shortages or other interference with their well. This could include investigating the complaint, assessing ongoing data collected from site during construction, addressing the complaint, and providing a temporary supply of potable water until the groundwater levels recover or the complaint is addressed.

3.5 Mitigation Measures

Based on the impact assessment, the proposed development is expected to require certain mitigation measures with respect to groundwater, mainly related to four aspects:

- Construction dewatering
- Long-term drainage
- Water Balance (deep recharge and shallow seepage for wetlands)
- Private Wells

The following sections will address potential requirements for mitigation measures and provide recommendations for their selection and implementation.

3.5.1 Construction Dewatering

During detailed design or at the time of Site Plan application, further hydrogeological study shall be undertaken to evaluate the expected quantity of dewatering required to facilitate construction. Applicable monitoring and mitigation plans should be developed to address potential impacts associated with the water taking and discharge activities associated with construction dewatering.

Depending on the quantity of dewatering required during construction, an EASR registration may be required (i.e., dewatering rates exceeding 50,000 L/d). EASR registrations must be supported by a report meeting the requirements specified in O.Reg. 63/16, including hydrogeological information, an assessment of potential impacts related to the dewatering, proposed monitoring and mitigation plans as well as details of the proposed location of discharged flows.

Due to the prevalence of dense, fine-textured till throughout the WVSP area, it is expected that dewatering rates and zones of influence will be generally manageable and that dewatering activities would, with the implementation of appropriate monitoring and mitigation measures, be feasible to conduct without causing negative impacts to receptors (ecological communities, private well users, or water resources generally).

The details of the monitoring and mitigation plans required will depend on the specifics of the location and type of construction work under consideration because those factors will affect the discharge outlets that are available, the volume of water to be managed, and the receptors nearby. Therefore, the bulk of these details are expected to be determined at the detailed design stage and in accordance with the applicable regulatory framework the governs the activity (i.e., PTTW or EASR).

In general, it is expected that the following will be applicable to most dewatering activities that are carried out during development within the WVSP:

- Erosion and Sediment Control and Discharge Management, which should generally be implemented in accordance with
    - OPSS.MUNI 805 *Construction Specification of Temporary Erosion and Sediment Control Measures*
    - OPSS.MUNI 518 *Construction Specification for Control of Water from Dewatering Operations*
- Monitoring during Dewatering
    - Typical requirements: turbidity monitoring, visual monitoring of discharge quality (e.g., hydrocarbon sheen, discoloration indicative of groundwater impacts), inspection of erosion and sediment controls and discharge management structures, measurement of water-taking quantities
    - Where shallow private wells are in use and within the estimated zone of influence: water level monitoring (whether in the private well or at a sentry well at the property line)
    - Where discharge is released within 30 m of a surface water body and may ultimately flow into that body: additional discharge water quality testing and/or baseline surface water quality testing
    - Where discharge is released to a municipal sewer: water quality testing to confirm compliance with the standards applicable to that sewer.

The monitoring and mitigation activities described above are expected to be generally applicable throughout the WVSP area; however, details such as frequency of monitoring, sizing and type of sediment controls, discharge locations, and other items must be confirmed at detailed design and based on the specifics of the ecological and hydrogeological setting and the project requirements (e.g., drawdowns, dewatering duration).

The list above is not exhaustive: additional measures may be applicable to address site specific conditions (e.g., sensitive receivers), reviewer comments (e.g., from TRCA regarding applications regarding works in regulated areas) or to address regulatory requirements (e.g., operating conditions and plan imposed by O.Reg. 63/16).

3.5.2 Long-Term Drainage

Long-term drainage may occur where basements or other structures requiring or inducing drainage are built below pre-development groundwater levels. Due to the prevalence of shallow groundwater levels observed across the WVSP study area, it is expected that most structures with basements or subsurface-occupiable structures (e.g., underground parking) would require drainage unless constructed as a waterproof structure capable of resisting the ingress of seepage and capable of counteracting the hydrostatic forces (e.g., basement slab uplift).

For structures with shallow basements (e.g., townhouses, single-detached dwellings), the impacts of long-term drainage associated with foundation drains is expected to be minimal. As discussed in Section 3.1.3 above, though the installation of these drains may result in a local lowering of the shallow water table in the immediate vicinity of these structures, it is not expected that this lowering will have a significant impact on seepage flow rates, aquifer recharge or baseflow to groundwater-fed features (e.g., West Humber River), provided that the enhanced recharge targets are met (see Section 3.2.4 for targets). These recharge targets will be met through the incorporation of LID features in the stormwater management design to address both the maintenance of recharge generally across the WVSP area and also locally at wetland features that will be retained or built as compensation wetland areas. Refer to Sections 4.4.1.1 and 4.4.1.2 for additional information on the LID measures.

Where basements are proposed to extend below pre-development groundwater levels, applicable mitigation would include:

- ensuring that the receiving drainage infrastructure (storm sewer or weeping tile collector) is sufficiently sized to accept the flows; and,
- robust foundation drains, with accessible cleanouts to allow for maintenance or inspection and with appropriate bedding and filter material to prevent fines loss and reduce the likelihood of drain clogging.

For structures with deeper basements (e.g., underground parking structures as may occur in the urban corridor areas), there is potential that a basement extending several meters below surface would intersect the Newmarket Till, which may (due to its sandy texture) have a higher hydraulic conductivity and, coupled with a greater depth below groundwater and corresponding drawdown requirement, may result in greater potential for impacts associated with a larger zone of influence, more extensive lowering of the water table, and higher drainage rates. The impacts of long-term drainage for these types of buildings would need to be assessed in detail on a site-specific basis. Basements would be required to obtain a Permit to Take Water (PTTW) if the foundation drainage rate is expected to exceed, on any given day, 379,000 L/d or 50,000 L/d for residential buildings or other buildings, respectively. The application for PTTW would require a detailed assessment of potential impacts as well as a fulsome monitoring and mitigation plan which would be enforceable by the MECP. However, drainage rates below the applicable PTTW limit may still have potential to impact the hydrogeological system.

Therefore the design of any deep basement structure (>3 m) should be accompanied by a hydrogeological impact assessment to confirm whether foundation drainage or waterproofing is a more appropriate solution for deep basements constructed below groundwater.

The construction of services (e.g., storm and sanitary sewers, watermains) may result in the development of preferential flow patterns which could induce drainage and may have a similar effect as foundation drains. However, this can be mitigated by installing trench plugs (also referred to as clay collars) on all services that are proposed to be constructed at elevations below the pre-development groundwater level.

3.5.3 Water Balance

Based on water balance calculations provided in Section 3.2.4, it is expected that the development of the WVSP area will result in reduced recharge (-71.1% relative to pre-development) and increased runoff (+185% relative to pre-development) across the developed lands. At the feature-catchment level, it is noted that development may also affect the amount or distribution of runoff that is conveyed to wetlands.

Wetland features in the WVSP area are mainly closed depression areas, and as such the preservation of some of these features (Wetlands 8, 33, and 34) and the relocation and/or compensation of others (Wetlands 3, 4, 5, and 6 via CA1 and CA2) will help to retain some of the topographic elements that encourage retention and infiltration. This will help to support the maintenance of recharge in the post-development condition. However, additional mitigation measures are required to limit the reduction in recharge caused by the development.

To mitigate the effect of the development on the water balance of the WVSP area, it is proposed that the SWM design incorporate LID measures (e.g., infiltration galleries, soak-away pits, etc.) to meet the general area (deep recharge) and catchment-specific (wetland shallow infiltration) recharge targets provided in Section 3.2.4 above. Additional details regarding infiltration type LIDs to mitigate impacts to deep recharge and shallow interflow are provided in **Section 4.4.1** of this report. Due to the identification of the wetland features within the WVSP as being predominantly dependent on surface water inputs, surface water type LID measures have been considered in conjunction with the groundwater infiltration type LID measures. Refer to Sections 4.4.1.1 and 4.4.1.2 for information on these types of LID measures. Subsequent investigation and analysis (i.e., at later stages of development design) is required in order to provide additional information about the hydrogeological conditions of the proposed development areas and about the potential response of the hydrogeological system based on the availability of additional details of the proposed development designs for participating lands and site specific information for non-participating lands.

Furthermore, additional investigation should be conducted to verify the subsurface conditions of the proposed development(s) at locations where infiltration type LID measures are proposed so that these features can be designed appropriately. Based on existing information, the WVSP area predominantly has shallow seasonal high groundwater levels and soils of low hydraulic conductivity, the combination of which leads to adverse conditions for the design and effectiveness of engineered infiltration structures. Additional investigation can provide greater detail of the conditions within the proposed development area(s) and allow for the optimization of LID designs for the mitigation of the infiltration deficit and impacts to the water balance. Refer to Section 4.4.1 below for additional information on LID measures.

3.5.4 Private Water Well Supplies and Well Decommissioning

The proposed development will be municipally serviced and the existing groundwater supply wells within the WVSP area will be decommissioned as the development proceeds. In the interim, it is important to ensure that construction does not adversely affect local groundwater supplies while the private water supply wells are still in use.

The Region of Peel requires monitoring of private wells throughout the construction period. Typically monitoring of private wells within 500 m of proposed construction works is required, subject to well owner consent. However, this may be modified based on the zone of influence assessed at the time of detailed design: a zone of influence larger than 500 m would necessitate a larger scope of private well monitoring.

Prior to the commencement of earthworks and servicing construction activities, it will be necessary to contact all properties that rely on, or are inferred to rely on, groundwater supply wells for their water supply. It is recommended that this contact be via hand-delivered notice, including a questionnaire by which owners/occupants can provide information about the location, construction, and condition of their wells and provide consent to the monitoring program.

Construction dewatering plans should include provisions for the supply of an alternate source of drinking water in the event that dewatering results in impacts to a private well.

Prior to construction, it will be necessary to ensure that all inactive water supply wells, within the development footprint, have been located and properly decommissioned by a licensed water well contractor in accordance with Ontario Regulation 903. In addition, all groundwater monitoring and observation wells installed for the WVSP area must be decommissioned in accordance with provincial regulations prior to or during the site development, unless they are maintained throughout the construction period for monitoring purposes.

3.6 Climate Change Impacts on Groundwater

Climate trends were discussed in the Humber River Watershed Plan (TRCA, 2008) and were based on an analysis of climate parameters between two climate periods (1961-1990 and 1981-2010). The findings as described in the Watershed Plan are:

- Air temperature is increasing (0.7 degrees Celsius on average between the two time periods).
- Very hot days above 30 degrees Celsius and 35 degrees Celsius have increased.
- Very cold days between -10 degrees Celsius and -20 degrees Celsius have decreased.
- Total annual precipitation generally increased in the watershed by 3.3%.
- The growing season is increasing.

Local projections published by the TRCA (Taking Action on Climate Change in Toronto Region) indicate that by 2100:

- Average annual precipitation may increase by between 2.9% and 31%
- Average annual temperature may increase by between 2.5°C and 8.5°C
- Storm intensity may increase with maximum single-day precipitation amounts increasing by between 60% and 102%.

There is potential for climate change to impact the natural environment in that increased precipitation and more intense storms will further affect the distribution of runoff and infiltration in the WVSP area. Using the mid-range estimated increases in average annual precipitation (16%) and temperature (6°C), the post-development water balance was recalculated (see **Appendix C5**). The results of this recalculation indicate that the increase in evapotranspiration (due to increased temperature) and increase in precipitation will nearly offset each other with respect to the impact to infiltration. Accounting for these climate change effects, post-development infiltration is estimated at 124,450 m^3/year, compared to 123,535 m^3/year when not accounting for climate change effects (a difference of less than 1%). Therefore, impacts to groundwater may not be significant. However, significant increases in runoff are expected, with climate change potentially resulting in an increase in post-development runoff of 322,037 m^3/year (15%).

It is noted that these estimates are based on annual averages. However, there is potential that climate change will result in more variability from year to year and cause more precipitation to fall in fewer storms of higher intensity. Though in the long term the average infiltration rate may be stable, there is potential for extended periods of lower infiltration due to hot, dry weather as well as for periods of higher infiltration due to increased precipitation. These effects could affect ecological communities, particularly wetlands that are less tolerant of fluctuation in soil moisture, temperature, depth to groundwater or hydroperiod. Under projected climate conditions, short-duration high-intensity precipitation events may result in temporary surface ponding and increased runoff, rather than sustained increases in subsurface recharge, due to the low permeability of the fine-textured soils and low-relief topography in the Study Area. These short-term fluctuations are not anticipated to result in significant adverse ecological effects. Although periodic dry conditions may occur, they are not expected to be sufficiently prolonged or frequent to drive persistent reductions in soil moisture or groundwater levels and therefore are unlikely to result in long-term changes to wetland extent or function.

Where LID features are provided to mitigate reductions in recharge, there may be a decrease in effectiveness of these structures if they do not account for potential changes in the frequency of precipitation events. For example, if the features are built with a certain capacity (e.g., to capture events up to 10-mm) but climate change causes more precipitation to fall in fewer but larger events, then the overall quantity of enhanced recharge may be reduced because of losses to overflow and runoff. Therefore, during design of LID measures that depend on a “retain and infiltrate” concept, the designer should consider incorporating adaptability features (i.e., outlet elevation changes, reserve space for added retention volume) to accommodate future conditions.

Climate change may affect water availability at water wells in the vicinity of the WVSP in that increased temperatures and a shift in storm patterns toward more intense events may result in widespread reductions in net groundwater recharge. Increased temperatures and evapotranspiration may also result in increased water-taking by well users for irrigation or other purposes. As the proposed development will be municipally-serviced via the Lake-based municipal water supply system, the latter effect is not expected to be exacerbated by the proposed development. However, the former effect (i.e., reductions in groundwater recharge) may be exacerbated by the proposed development due to the increased impervious area that would be associated with the developed area. Most water wells in the area are low intensity uses (e.g., domestic) and on average have a substantial water column (average water column above bottom of well is approximately 11.2 m). Therefore, it is expected that the potential for water quantity impacts to nearby well users is limited, though some users may be more susceptible, such as those with shallow wells or with wells installed in poorly productive formations (e.g., shale; till) which require large drawdowns to produce sufficient flows.

In terms of water quality, it is not expected that climate change will impact water quality available to local wells, except potentially insofar as it may affect the rates of application of road salt for winter road maintenance.

4.0 Surface Water

4.1 Hydrologic Assessment

4.1.1 Proposed Drainage

Under future development conditions, the proposed grading and drainage for the WVSP area will need to maintain existing drainage conditions as described in Section 4.1.1 of the Phase 1 LSS. The proposed Land Use Plan, **Figure 1.3** (**Appendix A2**) provides collector road locations and general land use, with local road layout and lotting to be established later through the Draft Plan of Subdivision stage of the development process. In accordance with the approved TOR (**Appendix A1**), and further outlined in Section 5.1 below, preliminary grading completed in support of the Secondary Plan only includes centerline collector road grades and as such, does not include future conditions drainage areas.

For the purposes of identifying potential impacts of the proposed land use on water resources, and determining a SWM strategy to mitigate those impacts, it is therefore assumed that the existing drainage patterns will generally be maintained under future development conditions. However, considering the existing drainage patterns, in addition to the location and sizing of existing culverts, land ownership, natural heritage features, and the proposed Land Use Plan (**Figure 1.3, Appendix A2**), there are five (5) subcatchments that are proposed to be diverted to new outlets. This results in ten (10) separate storm outlets proposed for development of the WVSP area, as shown on **Figure 4.1** (**Appendix D1**). The existing conditions drainage areas to each of these future storm outlets are also shown on **Figure 4.1**, colour coded by outlet.

In determining the outlet locations and drainage areas, consideration was given to the location and sizing of future SWM facilities to mitigate surface water impacts. This included the following considerations:

- Ensuring feature-based water balance for receiving headwater drainage features (HDFs), where possible.
- Avoiding drainage area diversions between Humber River catchments and minimizing drainage area exchanges between subcatchments.
- Where possible, minimizing the drainage areas to end-of-pipe SWM facilities to less than 65 ha. With drainage areas greater than this, capacity within the public right-of-way (ROW) for conveyance of major system flows becomes limited which then leads to capture of 100 year storm event flows and corresponding increases in storm sewer sizing.
- Minimizing the number of SWM facilities to reduce the Town of Caledon’s long-term maintenance requirements.

- Utilizing existing culverts as outlets where feasible, taking into consideration existing grading constraints and future road widening and urbanization.
- Consideration of ownership, i.e. participating versus non-participating landowners, as it relates to phasing and construction of SWM facilities.
- Minimizing the amount of municipal infrastructure required for SWM facility outfalls while being cognizant of the location of these outfalls (i.e. public property within the existing municipal ROW versus private property).
- Consideration of the proposed Land Use Plan, specifically:
    - The location of parks and the potential to co-locate SWM facilities within parks (subject to approval by the Town of Caledon).
    - Future Collector Road layout and maintenance access to SWM facilities.
    - Low density residential versus mixed use corridor land uses, as it relates to whether the SWM facility would be municipally or privately owned and operated.

4.1.1.1 Drainage Diversions

Although future conditions grading and delineation of proposed conditions drainage areas have not been completed as part of this LSS, the proposed drainage strategy does include five (5) subcatchments diverted to different outlets as outlined above in Section 4.1.1. The assessment of potential impacts of the drainage diversions on flooding, erosion and feature-based water balance, are discussed below in Sections 4.1.2, 4.2.3 and 4.3, respectively. The diversions to accommodate the future development of the WVSP area are outlined below, as well as being illustrated on **Figure 4.1** (**Appendix D1**).

- The combined drainage from subcatchments 36.11.1 and 36.11.2 will drain to Culvert #6 at Outlet 1.
    - Under existing conditions subcatchment 36.11.2, 8.14 ha in size, drains southwesterly to Culverts #7 and #8 discharging to the ditch on Mayfield Road.
    - There are no features downstream of the WVSP area that would be impacted by diverting the proposed drainage to Outlet 1.
    - Due to the small size of the drainage area and to minimize the number of SWM facilities, the drainage from Subcatchment 36.11.2 will be combined with drainage from Subcatchment 36.11.1 discharging to Outlet 1.
- The combined drainage from subcatchments 38.04.10, 38.04.11 and 38.04.12 will drain to Culvert #10 at Outlet 4.
    - Subcatchment 38.04.12 is approximately 9.24 ha and drains under existing conditions to the north ditch of Mayfield Road. To minimize municipal infrastructure for a storm outfall from this area, it is proposed to direct the flows to Culvert #10 at Outlet 4.

  - Based on ownership and to minimize the number of SWM facilities, it is proposed to combine the drainage from Catchment 38.04.11 with subcatchments 38.04.10 and 38.04.12.
  - The potential impact of the diversion on the wetland (Wetland 43 on **Figure 2.3, Appendix B1**) and watercourse downstream of Culvert #9 south of Mayfield Road is discussed further in Section 4.3 with mitigation of impacts discussed in Section 4.4.1.1.
  - Although Culvert #9 is larger than Culvert #10, the latter was chosen for Outlet 4 due to the existing elevation being approximately 2.67 m lower facilitating grading and earthworks cut/fill balance for the development.
- The combined drainage from Subcatchments 38.04.20 and 38.05.10 will drain to Culvert #11 at Outlet 5.
  - Subcatchment 38.05.10 is small in size, approximately 5.80 ha and drains under existing conditions to Culvert #12 which is only 350 mm diameter in size. Based on the size of the catchment and the culvert, it is proposed to divert the drainage from this subcatchment downstream to Culvert #11 which is a 1500 mm diameter CSP.
  - Due to the small size of the drainage area and the absence of wetlands downstream of Culvert #12 potential impacts of the diversion are not anticipated.
  - Consideration of maintaining a feature-based water balance for Tributary H5S1/S2/S3 has also been considered in the SWM facility #5 outfall location for these subcatchments. Refer to Section 4.3 and 4.4.2 for further discussion.
- The combined drainage from Subcatchments 38.06.10 and 38.06.11 will drain to Culvert #14 at Outlet 6.
  - Subcatchment 38.06.10 drains to Culvert #13 (650 mm diameter) combining with flows from Subcatchment 38.06.11 immediately downstream of Culvert #14 (1300 mm diameter) east of The Gore Road. The diversion of drainage from Culvert #13 to #14 will therefore not have any ecological impacts downstream of The Gore Road.
  - To minimize the number of SWM facilities, the drainage from both subcatchments will be combined and discharged to the larger culvert, Culvert #14, at Outlet 6.
- The combined drainage from Subcatchments 38.06.20 and 38.06.22 will drain to Culvert #15 at Outlet 7.
  - Subcatchment 38.06.22 is small in size, approximately 3.65 ha and drains under existing conditions to Culvert #16 which is only 600 mm diameter in size. Based on the size of the catchment and the culvert, it is proposed to divert the drainage from this subcatchment downstream to Culvert #15 which is a 1000 mm diameter CSP.

- There is no watercourse, HDF or wetland located at Culvert #16 and as such, the diversion will not have a negative ecological impact locally.
- The diversion of drainage from Catchment 38.06.22 to Culvert 16 will not impact the riparian wetland, Wetland 26B (Figure 4.1, Appendix D1B) due to the increases in runoff associated with development within upstream Catchment 28.06.21. This is demonstrated by a review of the Area (A) x Runoff Coefficient (RC) in existing and proposed conditions as follows: Ex. A x RC = 26.67 ha @ 0.2 RC = 5.33; Prop. A x RC = 21.92 ha @ 0.70 RC = 15.28, indicating a 300% increase in runoff volume to the feature.
- To minimize the number of SWM facilities, the drainage from both subcatchments will be combined and discharged to the larger culvert, Culvert #15, at Outlet 7.

It is also noted that Subcatchment 36.11.3 sheet drains southwesterly under existing conditions towards the east Centreville Creek Road ditch. Flows are then conveyed southerly within the ditch, crossing the road at Culvert #5, joining with flows from Subcatchment 36.11.1 immediately downstream of Culvert #6. To maintain existing drainage patterns, taking into consideration the location of the proposed mid-block east-west collector road, as shown on the proposed Land Use Plan (**Figure 1.3, Appendix A2**), and property ownership (participating versus non-participating, as shown on **Figure 1.2**, **Appendix A2**), it is proposed to maintain the drainage from Subcatchment 36.11.3 to the ditch at Outlet #2. However, it is noted that it would be possible to combine the drainage from Subcatchments 36.11.1, 36.11.2 and 36.11.3 discharging to Culvert #6 at Outlet #1. This would eliminate one SWM facility and the future trunk storm sewer required on Centreville Creek Road once the road is urbanized and the ditch removed (Outlet 2). This can be further investigated through the Comprehensive Servicing and Stormwater Study (CSSS) at the next stage of the development process.

It is proposed to maintain existing drainage patterns for all remaining subcatchments within the WVSP area (i.e. 36.10.1, 38.04.30, 38.06.21 and 38.06.30), as well as for all external subcatchments (i.e. 36.10.2, 36.10.3, 36.10.4 and 36.06). The proposed drainage strategy outlined above is based on the preferred Land Use Plan and the information available as part of this LSS. Post development drainage areas will be established through subsequent grading, servicing and SWM designs at the next stage of the development process.

Ultimately, the Draft Plan drainage strategy may differ from that presented in this LSS provided that the existing drainage patterns are maintained to the extent possible. Every attempt should be made to avoid drainage area diversions between catchments of the West Tributary and the West Humber River and drainage area exchanges between subcatchments are to be minimized. Where drainage area diversions differ substantially from those presented in this LSS, additional analysis will be required to establish impacts to flooding, erosion and feature-based water balance, in addition to confirming required mitigation measures.

4.1.1.2 Future Highway 413 Drainage

As noted in Section 4.1.1 of the Phase 1 LSS, external drainage is conveyed into the WVSP area from the north including drainage from the Future Highway 413 corridor. Preliminary design information for the highway is available and excerpts have been provided in **Appendix D2.** Based on a review of the available preliminary design information, the highway drainage will be directed easterly towards a dry pond located west of The Gore Road, and a wet pond located east of The Gore Road. The outlet locations for these SWM facilities are not known at this time but it is anticipated that the easterly facility will potentially discharge directly to the West Humber River and the westerly facility will potentially discharge to Culvert #17 on The Gore Road (refer to **Figure 4.2, Appendix D1**). As such, at this time, any external drainage from the highway itself is assumed to not enter the WVSP area, and any external drainage from north of the highway will be conveyed under the highway into the WVSP area via culverts.

Future studies in support of Draft Plan of Subdivision applications will be required to confirm the MTO drainage and SWM strategy. Infrastructure including storm sewers and SWM facilities within the WVSP area will be required to accommodate any existing drainage (up to the Regional storm event) from the external areas north of the highway, or from the highway, as required. Refer to Section 4.1.1.2 of the Phase 1 LSS for a summary of the existing conditions peak flows that may need to be accommodated.

4.1.1.3 Existing Arterial Roads

Within the WVSP area, Centreville Creek Road, Mayfield Road, and The Gore Road, all arterial roads, will be widened and urbanized in the future. Centreville Creek Road is a municipal right-of-way and as such drainage, SWM and culvert crossings must be designed in accordance with Town of Caledon design standards. This includes maintaining existing drainage patterns to the extent feasible, providing SWM, and ensuring culvert crossings can convey the 100 year or Regional storm event (whichever peak flow governs).

Mayfield Road and The Gore Road are Regional roads, and as such drainage, SWM and culvert crossings must be designed in accordance with Region of Peel design standards. An Environmental Assessment was completed for the widening and urbanization of Mayfield Road by the Region of Peel in 2015. The Environmental Study Report (Stantec, April 2015) provides guidance with respect to the design of culverts crossing Regional arterial roads as follows: “culverts that cross an arterial roadway are to be designed for a 25 year storm and should have a minimum diameter of 600 mm. Major crossings (drainage areas greater than 50 ha) are to be designed for a Regional Strom event.” As with Municipal roads, Regional roads are to be accommodated, where feasible, within the drainage and SWM strategy for developments within the WVSP area.

4.1.2 Hydrologic Modelling

In order to determine the hydrologic impact of the proposed Land Use Plan (**Figure 1.3, Appendix A2**) on surface water resources, the peak flow to each of the ten (10) outlets was determined utilizing the Visual Otthymo Version 6.2 hydrologic model. As noted in the Phase 1 LSS, the most recent calibrated hydrologic model for the Humber River watershed was obtained from the TRCA in January 2024 and discretized to establish existing conditions quantity control targets for the Regional storm event. This same model has now been utilized to complete the proposed conditions hydrologic assessment of peak flows for this Phase 2 LSS.

For the proposed conditions model, percent imperviousness was determined for each catchment based on the land uses indicated on the proposed Land Use Plan (**Figure 1.3, Appendix A2**). The percent imperviousness for each catchment was calculated as a weighted Runoff Coefficient based on the Town of Caledon Development Standards Manual (Version 5, 2019) and then converted to imperviousness based on the formula $I = 0.7\ RC + 0.2$. The percent imperviousness for each catchment is identified on **Figure 4.1 (Appendix D1)** and summarized in **Table 4.1**. Percent impervious calculations will need to be updated based on Draft Plan of Subdivision level of detail at the next stage of the development process.

Table 4.1– Proposed Drainage Area Summary

Outlet ID[1]	Subcatchment ID[1]	Area (ha)	Runoff Coefficient[2]	Percent Imperviousness[3]
1	36.11.1	24.85	0.77	81%
	36.11.2	8.14	0.77	82%
2	36.11.3	22.49	0.72	74%
3	36.10.1	36.78	0.70	71%
	36.10.2 (External)	19.68	-[4]	1%
	36.10.3 (External)	5.27	-[4]	10%
	36.10.4 (External)	19.97	-[4]	6%
4	38.04.10	20.62	0.71	73%
	38.04.11	18.75	0.73	76%
	38.04.12	9.24	0.79	84%
5	38.04.20	54.88	0.73	76%
	38.05.10	5.80	0.70	71%
6	38.06.10	19.52	0.75	79%
	38.06.11	42.12	0.73	75%

Outlet ID[1]	Subcatchment ID[1]	Area (ha)	Runoff Coefficient[2]	Percent Imperviousness[3]
7	38.06.20	34.73	0.70	71%
	38.06.22	4.75	0.70	71%
8	38.06.21	21.92	0.70	71%
9	38.06.30	26.64	0.73	76%
	38.06 (External)	24.09	-[4]	5%
10	38.04.30	2.52	0.70	71%

[1] Refer to **Figure 4.1** for the Outlet and subcatchment locations.
[2] Weighted Runoff Coefficient calculated per Development Standards Manual, Town of Caledon, Version 5 (2019).
[3] Refer to **Appendix D3** for impervious calculations.
[4] Runoff Coefficient for external areas determined by delineating impervious areas to determine the total percent imperviousness for the catchment.

Per a meeting with TRCA on December 5, 2024, the Curve Number (CN) and Initial Abstraction (Ia) for pervious areas were updated in the hydrologic model to represent the proposed land use conditions for both AMCII and AMCIII conditions. Refer to **Appendix D3** for the model parameter summary sheets. It is noted that, as discussed at the meeting and per correspondence from TRCA, calibration of the WVSP hydrologic model is not required.

The five (5) subcatchments identified in Section 4.1.1.1 requiring modification for future development conditions were consolidated into drainage areas to each outlet in the hydrologic model (refer to **Figure 4.1**, **Appendix D1**). The percent imperviousness, CN and Ia values were then updated for each drainage area as provided in **Appendix D3**.

Using the updated hydrologic model, the 2 through 100 year and Regional storm events were simulated to determine the proposed conditions uncontrolled peak flows for each catchment. Refer to **Appendix D3** for the hydrologic model schematic, summary output for the catchments and a digital link to the hydrologic modelling files. The peak flows for each catchment under existing conditions, as established in the Phase 1 LSS, have been summarized in **Table 4.2**, with the uncontrolled total peak flow for each catchment summarized in **Table 4.3**.

Table 4.2– Existing Conditions Peak Flows (m^3/s)

Outlet ID	36.10		36.11		38.04		38.05		38.06	
Area (ha)	339.61		146.57		142.38		47.43		173.74	
	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr
2-year	0.233	0.326	0.229	0.296	0.251	0.322	0.09	0.115	0.134	0.185
5-year	0.45	0.573	0.444	0.524	0.483	0.567	0.174	0.202	0.259	0.325
10-year	0.621	0.764	0.615	0.702	0.667	0.757	0.24	0.27	0.357	0.434
25-year	0.861	1.025	0.854	0.946	0.923	1.016	0.333	0.362	0.495	0.582
50-year	1.055	1.232	1.049	1.14	1.131	1.221	0.408	0.435	0.606	0.699
100-year	1.257	1.449	1.252	1.345	1.346	1.437	0.485	0.512	0.723	0.823
Regional	23.674		10.904		10.896		5.139		12.867	

Table 4.3– Proposed Conditions Peak Flows – Uncontrolled (m^3/s)

Outlet ID	36.10		36.11		38.04		38.05		38.06	
Area (ha)	339.61		146.57		148.18		41.63		173.74	
	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr
2-year	2.66	2.097	3.926	2.595	7.406	4.886	0.245	0.265	9.624	6.402
5-year	4.188	3.204	5.567	3.524	10.576	6.639	0.481	0.477	13.822	8.781
10-year	5.288	4.012	6.668	4.174	12.712	7.835	0.668	0.643	16.65	10.393
25-year	6.769	5.093	8.169	5.003	15.533	9.345	0.931	0.873	20.314	12.467
50-year	7.94	5.964	9.345	5.617	17.603	10.459	1.144	1.056	23.215	14.051
100-year	9.14	6.839	10.466	6.233	19.649	11.618	1.367	1.249	26.277	15.596
Regional	24.194		12.368		18.007		4.511		23.860	

The proposed conditions peak flows for each catchment, as well as at downstream key flow nodes identified in the Phase 1 LSS, were compared to the existing conditions flow rates established in the Phase 1 LSS. As shown in **Tables 4.4** and **4.5,** the proposed conditions uncontrolled peak flows for each outlet exceed the pre-development levels; therefore, stormwater management (SWM) quantity controls for the 2 through 100 year and Regional storm events are required to mitigate downstream impacts. Refer to **Section 4.4.2** for further discussion on SWM to mitigate the impacts.

Table 4.4– Existing to Uncontrolled Proposed Peak Flow Comparison

Outlet ID	36.10		36.11		38.04		38.05		38.06	
Area (ha)	0%		0%		4%		-12%		0%	
	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr
2-year	1042%	543%	1614%	777%	2851%	1417%	172%	130%	7082%	3361%
5-year	831%	459%	1154%	573%	2090%	1071%	176%	136%	5237%	2602%
10-year	752%	425%	984%	495%	1806%	935%	178%	138%	4564%	2295%
25-year	686%	397%	857%	429%	1583%	820%	180%	141%	4004%	2042%
50-year	653%	384%	791%	393%	1456%	757%	180%	143%	3731%	1910%
100-year	627%	372%	736%	363%	1360%	708%	182%	144%	3534%	1795%
Regional	2%		13%		65%		-12%		85%	

Table 4.5– Existing and Uncontrolled Future Nodal Flow Comparison

Node	NHYD ID	Location	Existing Regional Peak Flows (m^3/s)	Proposed (Uncontrolled) Regional Peak Flows (m^3/s)	Change
A	1939	Mayfield Road	178.76	161.00	-9.9%
B	1935	The Gore Road	34.43	35.45	2.9%
C	1456	Confluence of Tributary and West Humber River	237.02	232.37	-2.0%
D	1776	Castlemore Road	351.37	374.12	6.5%
E	1366	Cottrelle Boulevard	352.42	378.84	7.5%
F	869	McVean Drive	351.79	379.44	7.9%
G	720	Queen Street	748.50	780.84	4.3%
H	1442	Highway 407	1041.49	1074.59	3.2%
I	2074	Highway 427	1049.98	1083.32	3.2%
J	1971	Highway 27	1078.33	1107.43	2.7%
K	1028	Islington Avenue	1125.09	1152.06	2.4%
L	1005	Albion Road	2229.70	2257.63	1.3%
M	975	Eglington Avenue	2259.07	2283.78	1.1%
N	1000	Lake Ontario	2808.50	2831.94	0.8%

4.1.3 Climate Change Impacts to Peak Flows

Further hydrologic assessment has been completed to evaluate the hydrologic impacts of the proposed land use under future climate change scenarios. The proposed conditions hydrologic model, outlined above in Section 4.1.2, was simulated utilizing the Statistically downscaled CMIP-6 climate data retrieved from the IDF CC Tool Online as instructed by the Town of Caledon and consistent with TRCA protocol. Refer to **Appendix D4** for the climate change model outputs.

Based on the "Summary of Climate Projections for the Humber River Watershed and If-Then-So Analysis" prepared by the TRCA, for watershed components incorporating climate change analysis, the high emissions scenario (and 2050s future climate data) will be the priority for assessment. Therefore, the SSP5-8.5 rainfall data was used for this analysis. The expected peak flows under the climate change scenario are summarized in **Table 4.6** and are compared to the post-development conditions per the proposed WVSP land use in **Table 4.7**. It was found that there is an increase of peak flows ranging from 7% in the lower storm events to 46% in the higher-level storm events.

Table 4.6– Proposed (Climate Change) Uncontrolled Peak Flows (m^3/s)

Outlet ID	36.10		36.11		38.04		38.05		38.06	
Area (ha)	339.61		146.57		148.18		41.63		173.74	
Storm	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr
2-year	2.89	2.346	4.221	2.816	7.948	5.33	0.281	0.312	10.305	6.965
5-year	4.763	3.842	6.149	4.042	11.748	7.658	0.578	0.608	15.307	10.059
10-year	6.22	4.974	7.652	4.916	14.544	9.287	0.833	0.848	18.963	12.242
25-year	8.592	6.665	9.977	6.112	18.817	11.554	1.265	1.21	24.7	15.288
50-year	10.803	8.074	11.759	7.08	22.444	13.346	1.646	1.524	29.64	17.703
100-year	13.670	10.037	14.158	8.394	27.235	15.756	2.192	1.968	35.955	20.95

Table 4.7– Proposed Peak Flow to Proposed (Climate Change) Peak Flow Comparison

Outlet ID	36.10		36.11		38.04		38.05		38.06	
	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr	6-hr	12hr
2-year	8%	12%	7%	8%	7%	8%	12%	15%	7%	9%
5-year	13%	20%	10%	14%	11%	14%	16%	22%	11%	14%
10-year	17%	24%	15%	17%	14%	17%	19%	25%	14%	18%
25-year	26%	31%	21%	21%	20%	22%	28%	30%	21%	22%
50-year	35%	35%	25%	25%	27%	26%	34%	34%	28%	26%
100-year	46%	47%	34%	33%	38%	33%	46%	43%	37%	34%

4.2 Erosion Analysis

4.2.1 Erosion Exceedance Analysis

In order to understand the potential impacts of the proposed land use plan on channel morphology, an erosion exceedance analysis was undertaken. In natural systems, watercourses regularly see flows that entrain and transport sediment. This is part of the natural process that maintains natural channel form (TRCA 2012, CVC 2015). The key to maintaining natural channel function is to match the frequency of exceedance or cumulative effective work in the post-development condition (TRCA 2012).

As outlined in Section 4.2.3 of the Phase 1 LSS, pre- to post-development exceedance has been evaluated using an approach involving three analyses including the cumulative effective erosion index (velocity exceedance), cumulative effective discharge index, and the cumulative effective work index.

The cumulative effective velocity (*CEV*) is calculated as:

$$CEV = \sum (V - V_c)$$

The cumulative effective discharge (*CED*) is calculated as:

$$CED = \sum (Q - Q_c)$$

The cumulative effective shear stress (*CESS*) is calculated as:

$$CESS = \sum (\tau - \tau_c)$$

where V is the mean channel velocity, V_c is the critical (permissible) velocity, Q is the channel's discharge, Q_c is the critical discharge, τ is the instantaneous shear stress, and τ_c is the threshold shear stress.

The cumulative effective work index (W_i) describes the cumulative effective work or stream energy expended above the critical value. W_i is calculated as:

$$W_i = \sum (\tau - \tau_c) \mathrm{V} \Delta t$$

where Δt is the timestep used in the analysis.

The continuous simulation hydrological modelling prepared as part of the Phase 1 LSS erosion exceedance analysis has been updated to represent future conditions based on the proposed land use plan (**Figure 1.3**, **Appendix A2**). This proposed conditions hydrologic model was then simulated to establish hydrographs for proposed conditions at the erosion threshold locations identified in Section 4.2.2 of the Phase 1 LSS and shown on **Figure 4.2 (Appendix D1)**. Rainfall data was provided by TRCA which included twenty-two (22) years of precipitation data from May 1986 to December 2007 from Buttonville Airport Weather Station. Refer to **Appendix D5** for the model schematic, model parameter summary and hydrographs. Refer to Section 4.2.2 and Appendix D6 of the Phase 1 LSS for the existing conditions modelling information.

As with the existing conditions modelling (Section 4.2.3 of the Phase 1 LSS), soil types have been assigned to each catchment based on the Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Soil Survey Complex. The land cover for each catchment in post-development conditions has been assigned as "Grass Land", as the pervious areas in post-development conditions will consist of grassed/landscaped areas (rear yards, boulevards etc.).

The proposed conditions hydrographs resulting from the continuous simulation modelling at the twelve (12) erosion threshold locations were utilized to calculate cumulative time of exceedance, cumulative effective velocity, cumulative effective discharge, and cumulative effective work.

The cumulative exceedance analysis results for the pre-development condition as outlined in Section 4.2.3 of the Phase 1 LSS, were compared to the uncontrolled post-development scenario. The results are presented in **Table 4.8** below. It should be noted that ETL-2 and ETL-8 were omitted from the analysis, as flows from ETL-2 is proposed to be routed to ETL-1, and ETL-8 outlets to reach WHT2(1)1-1c, which was an undefined feature lacking bed and banks.

Table 4.8: Exceedance Analysis Results, Tributaries of the West Humber River

Location	Reach	Condition	Number of Exceedances	Duration	Cumulative Effective Velocity	Cumulative Effective Discharge	Cumulative Effective Shear Stress	Cumulative Effective Work Index
ETL-1	WHT3(5)2-1	Pre	35	84	86	24	4.10×10^3	4.38×10^6
		Post	969	1827	2058	798	8.38×10^4	1.59×10^8
		% Change	2669	2075	2282	3262	1945	3529
ETL-3	WHT3(7)1-1	Pre	66	101	74	73	2.43×10^3	1.81×10^6
		Post	327	451	330	333	1.10×10^4	8.40×10^6
		% Change	395	347	347	359	353	364
ETL-4	WHT2-1-2	Pre	102	178	192	55	1.48×10^4	1.87×10^7
		Post	935	1699	1981	690	1.08×10^5	2.13×10^8

Location	Reach	Condition	Number of Exceedances	Duration	Cumulative Effective Velocity	Cumulative Effective Discharge	Cumulative Effective Shear Stress	Cumulative Effective Work Index
		% Change	817	854	932	1150	629	1038
ETL-5	WHT2-4	Pre	30	83	0	38	3.28×10^5	1.27×10^8
		Post	735	1235	4	785	4.50×10^5	1.75×10^8
		% Change	2350	1388	N/A*	1977	37	38
ETL-6	WHT2(1)2-1	Pre	109	270	284	56	2.09×10^4	2.92×10^7
		Post	1179	2565	3180	947	1.82×10^5	4.87×10^8
		% Change	982	850	1021	1587	767	1569
ETL-7	WHT2(1)1-1b	Pre	6	8	6	5	6.18×10^2	3.22×10^5
		Post	251	318	265	230	1.92×10^4	1.56×10^7
		% Change	4083	3875	3994	4867	3008	4750
ETL-9	WHT2(1)1-1a	Pre	259	702	726	151	4.80×10^4	8.09×10^7
		Post	1347	3448	3954	1387	2.38×10^5	5.98×10^8
		% Change	420	391	444	818	396	640
ETL-10	WHT2	Pre	8	44	59	525	4.75×10^3	4.51×10^6
		Post	36	73	98	895	9.27×10^3	8.12×10^6
		% Change	350	66	67	70	95	80

* N/A due to a pre-development value of 0

The results indicate that the proposed uncontrolled condition results in an increase in erosion potential throughout the reaches receiving flow from the WVSP area. There will also be increases in erosion potential downstream of proposed SWM facilities where there are drainage diversions as outlined in Section 4.1.1.1 above. The increases vary for the different parameters, but the cumulative effective work index parameter represents the most important parameter to assess potential impacts. This is because, unlike simpler exceedance metrics, such as the cumulative time of exceedance, it provides a more rigorous assessment of the erosive force of flows once erosion thresholds are surpassed.

The cumulative effective work index varies between an increase of 38% for ETL-5 (reach WHT2-4) to 4750% for ETL-7 (reach WHT2(1)1-1b). At lower levels, impacts could be observed through localized bank erosion and bed scour. However, at more extreme levels, excessive incision, widening and sediment mobilization could occur, which could destabilize entire reaches. These impacts are particularly exacerbated in headwater and lower order streams, where increased flow energy disrupts existing sediment transport processes, leading to downstream sedimentation and loss of instream and riparian habitat.

It is proposed to mitigate the increase in erosion potential caused by changes in land use and diversion of storm flows through the implementation of end-of-pipe SWM facilities providing extended detention of frequent flows as further outlined in **Section 4.4.2.2**. Additionally, LID measures specified for feature-based water balance and mitigation of impacts to groundwater recharge (refer to **Section 4.4.1**) will decrease runoff volumes thus working with the SWM facilities to mitigate potential erosion impacts.

As the LSS does not provide drainage areas or SWM facility design, the post-development SWM scenario will be completed through the Comprehensive SWM and Servicing Study (CSSS). In order to inform the SWM strategy, an erosion exceedance analysis is required, comparing the baseline results from this LSS, to ensure that mitigation measures are appropriate and that existing rates of erosion are not exacerbated in the post-development condition. The erosion exceedance analyses should consider the parameters considered as part of this study, namely, the number of exceedances, cumulative duration of exceedance, cumulative effective velocity, cumulative effective discharge, cumulative effective shear stress, and cumulative effective work.

The erosion exceedance analysis should be undertaken for those watercourses proposed to receive flows from stormwater management facilities. The hydrologic model should be calibrated as per TRCA requirements, provided there is sufficient flow data to substantiate a valid calibration.

4.2.2 Impacts of Drainage Diversions on Erosion Potential

Diversions of drainage within the WVSP area, as described in **Section 4.1.1.1**, have the potential to alter existing flow regimes within receiving watercourses and therefore influence the magnitude and distribution of erosion potential. Under existing conditions, drainage boundaries have developed in alignment with topographic divides and channel capacities, resulting in an equilibrium between flow energy, sediment supply, and channel form. Modifying these boundaries through the redirection of runoff from one catchment to another alters both flow volume and timing, which can affect the erosive power of the receiving reaches.

Where subcatchments are diverted to larger outlets, the receiving watercourses may experience increases in contributing drainage area and therefore higher peak and frequent flows. These changes are expected to increase the cumulative effective velocity and shear stress, potentially leading to elevated rates of bed and bank erosion if unmitigated. Conversely, reaches losing contributing area may experience reduced baseflow and sediment supply, potentially resulting in localized channel infilling, vegetation encroachment, and adjustments to channel stability.

The impact of these diversions can potentially result in a shift from a natural, diffuse pattern of runoff to concentrated inputs, leading to the following erosional mechanisms:

- Headwater and confined reaches are particularly sensitive to even small increases in discharge. The higher stream power resulting from drainage diversions can accelerate bed incision and bank scour, disrupting the natural sediment transport balance.
- Medium- and low-gradient systems may experience downstream sediment deposition if increased erosion upstream is not balanced by corresponding transport capacity, potentially leading to aggradation, loss of habitat diversity, and reduced conveyance capacity.
- Artificial or undefined channels (e.g., roadside ditches or ephemeral features) receiving new or increased drainage inputs may transition from intermittent to perennial flow regimes, which could initiate channelization processes not currently present.

Preliminary results of the erosion exceedance analysis (Section 4.2.1) demonstrate substantial increases in cumulative effective work indices (W_i) across several erosion threshold locations under the uncontrolled post-development condition, ranging from 38% to over 4700%. Although these increases primarily reflect the aggregate impact of urbanization, drainage diversions act as a localized driver that can amplify erosive response in specific reaches. In particular, diversions concentrating multiple subcatchments into a single outlet will increase the frequency and duration of flows exceeding erosion thresholds.

Changes in sediment supply between diverted and receiving catchments also have potential downstream implications. Increased energy in receiving reaches can mobilize finer sediment, while the reduction in flow energy in donor reaches may promote deposition and partial infilling. Over time, these shifts may propagate downstream, altering channel morphology, habitat conditions, and sediment delivery to larger systems such as the West Humber River.

The mitigation strategy for these impacts includes proposed end-of-pipe SWM facilities and LID measures as outlined in **Section 4.4**.

4.2.3 Climate Change and Erosion

Climate change is intensifying the drivers of erosion by shifting precipitation regimes, increasing temperatures, and contributing to more frequent and intense extreme weather events, all of which can alter surface runoff and channel dynamics. Heavier and more concentrated rainfall events can increase the volume and velocity of overland flow, potentially accelerating soil detachment and sediment transport. Extended dry periods followed by intense storms may reduce vegetation cover and destabilize soils, further increasing susceptibility to erosion. More pronounced freeze-thaw cycles could weaken soil structure and contribute to bank and slope instability. These projected changes may be especially challenging in areas already prone to erosion due to land use pressures or underlying geomorphic conditions. Incorporating climate-informed insights into erosion risk assessment and stormwater management measures, can support more adaptive land use planning and long-term watershed resilience under changing climatic conditions.

As outlined above in Section 4.2.1, the proposed erosion mitigation measures include end-of-pipe extended detention SWM facilities. SWM facilities are typically designed for extended detention of the first flush flows resulting from a 25 mm 4 hour rainfall event using an orifice control to detain the flows for 24 to 48 hours. Future study in support of the next stages of the development process will establish the required detention volume and duration to mitigate the potential erosion impacts caused by the proposed land use. Further to this, it is possible in the future, for the Town of Caledon to adjust orifice sizing to increase or decrease either the volume or duration of extended detention to mitigate erosion impacts associated with climate change. This will not impact SWM facility sizing as the facilities size will be dictated by the quantity control requirements for the Regional storm event.

4.3 Feature Based Water Balance

4.3.1 Wetland Screening and Water Balance Risk Evaluation

A wetland water balance risk evaluation (TRCA 2017) was completed for retained wetlands within the WVSP area (Wetland 8_9, 33, 34, and 10_11) and wetlands located outside of the WVSP area, with catchments inside the WVSP area (wetland numbers 17, 22, 24, 25, 29, 30, 31, 32, 35, 37, 38 and 43). This corresponds to a total of fifteen (15) wetlands assessed as part of the Wetland Water Balance Risk Evaluation. Refer to **Table 4.9** for the Wetland Water Balance Risk Evaluation Summary.

Wetlands on non-participating lands (wetland numbers 12, 16, 21, 23, 26, 27, 28, 39, 40, 41, 44, A, B41A and 41B) require future studies before they can be removed. From a desktop analysis, it appears as though these wetlands consist of small (usually much smaller than 0.5 ha), secluded features in an agricultural and residential land use setting, generally comprised of Meadow Marsh and Shallow Marsh wetland types. The wetland screening and water balance risk evaluation for these wetland can be completed as part of future study in support of the individual Draft Plan applications for the non-participating properties and does not warrant an update to this LSS.

Wetlands on participating lands proposed for removal and compensation or relocation (wetland numbers 2, 3, 4, 5, 6, 7, part of 12, part of 13, part of 14, and 17) were excluded from the wetland risk evaluation.

The wetland risk evaluation further compared pre-development conditions with post-development without mitigation conditions. The risk level (low, medium, high) was assessed based on the potential magnitude of hydrological change and sensitivity of the wetland. Where there was incomplete ecological data, due to site access, the precautionary principle was applied, and the wetland sensitivity was assessed as high.

Table 4.9: Wetland Water Balance Risk Assessment

Wetland ID No.	Location	ELC Vegetation Community	Magnitude of Hydrological Change	Sensitivity of Wetland	Risk Assessment
WETLAND-8	Within Participating Property	Silver Maple Mineral Deciduous Swamp (SWD3-2)	High	High	High
WETLAND-22	Wetlands on 120 m adjacent lands	Shallow Marsh (MAS2)	Low	Full data not Available - assume High	Low
WETLAND-24	Wetlands on 120 m adjacent lands	Reed Canary Grass Mineral Meadow Marsh, Disturbed and Meadow Marsh (MAM2-2/DIST/MAM2)	High	Full data not Available - assume High	High
WETLAND-25	Wetlands on 120 m adjacent lands	Meadow Marsh (MAM2/MAM2)	Low	Full data not Available - assume High	Low
WETLAND-29	Wetlands on 120 m adjacent lands	Open Aquatic (OA)	Low	Full data not Available - assume High	Low
WETLAND-30	Wetlands on 120 m adjacent lands	Open Aquatic (OA)	Low	Full data not Available - assume High	Low

Wetland ID No.	Location	ELC Vegetation Community	Magnitude of Hydrological Change	Sensitivity of Wetland	Risk Assessment
WETLAND-31	Wetlands on 120 m adjacent lands	Meadow Marsh (MAM2)	High	Full data not Available - assume High	High
WETLAND-32	Wetlands on 120 m adjacent lands	Open Aquatic (OA)	Low	Full data not Available – assume High	Low
WETLAND-33	Wetlands on 120 m adjacent lands	Shallow Aquatic (SA)	High	High	High
WETLAND-34	Within Participating Property	Cattail Mineral Shallow Marsh (MAS2-1)	High	High	High
WETLAND-35	Wetlands on 120 m adjacent lands	Cultural Meadow and Open Aquatic (CUM1/OA)	High	Full data not Available - assume High	High
WETLAND-37	Wetlands on 120 m adjacent lands	Meadow Marsh (MAM2)	High	Full data not Available - assume High	High
WETLAND-38	Wetlands on 120 m adjacent lands	Open Aquatic (OA)	High	Full data not Available - assume High	Low
WETLAND-43	Wetlands on 120 m adjacent lands	Meadow Marsh (MAM2)	High	Full data not Available - assume High	High
WETLAND-10_11	Within Participating Property	Forb Mineral Meadow Marsh and Meadow Marsh (MAM2-10/MAM2)	High	Medium	Medium

The wetland water balance risk evaluation (refer to **Table 4.10**) assessed eight (8) wetlands as high risk (Wetlands 8, 33, 34; 24, 31, 35, 37 and 43), one wetland as medium risk (wetland 10_11) and six wetlands as low risk (wetlands 22, 25, 29, 30, 32, and 38).

Three (3) of the low risk wetlands assessed, Wetlands 29, 30, and 32, are riparian wetlands located on the West Humber River, north of Mayfield Road. There is only 0.81 ha of drainage area from the WVSP contributing flows to these wetlands, representing less than 0.1% of the total wetland drainage area. Potential impacts to these three (3) wetlands are considered negligible and have therefore, not been evaluated further within the continuous modelling scenarios.

Implementation of the proposed land use plan, and associated servicing, grading and SWM, will result in an overall increase of runoff volume to eight (8) of the wetlands due to the increase of impervious surfaces draining to them. This includes Wetlands 22, 24, 25, 31, 35, 37 and 38. As increased runoff will not negatively impact these wetlands, no further analysis has been completed. The remaining four (4) wetlands located within the WVSP area, Wetlands 8, 33, 34 and Wetland 10_11, require feature-based water balance assessment utilizing continuous simulation hydrologic modelling to assess the impact and develop mitigation measures. There is also one additional wetland that requires a feature-based water balance assessment that is located south of Mayfield Road outside of the WVSP area, Wetland 43 (**Figure 4.3**, **Appendix D1**). Under proposed conditions, storm drainage will be diverted away from this wetland towards Outlet 4 and as such an assessment of impacts is required.

The post-development modelling for these wetlands, noting that Wetlands 8, and 33 and 34 are considered one wetland complex, was prepared in order to determine the overall reduction and impact of the reduction on runoff volumes. Mitigation for runoff volume reduction to these features is discussed further in Section 4.4.1.1.

4.3.2 Continuous Simulation Hydrologic Modelling

As outlined in Section 4.3.1 above, through the Wetland Screening and Water Balance Risk Evaluation, it was established that there would be risk for negative impacts to the form and/or function of four (4) retained wetlands within the WVSP area, and one (1) wetland located outside of the WVSP area, resulting from the proposed land use plan. Wetlands 8, 33 and 34, and Wetland 43, will potentially be impacted by redirection of drainage to Outlet 4, as outlined in Section 4.1.1 above. Similarly, Wetland 10_11 will potentially be impacted by redirection of drainage to Outlet 5.

To quantify the potential impacts resulting from a decrease in runoff volumes to the feature, the continuous simulation hydrologic model created in the Phase 1 LSS was utilized to determine future conditions and future conditions with mitigation average monthly, average annual and average seasonal (spring, summer, fall) runoff volumes to both wetlands. Refer to Section 4.3.2 of the Phase 1 LSS for the existing conditions modelling results.

The wetland model was simulated in continuous mode utilizing the same twenty-two (22) years of precipitation data utilized in the erosion exceedance model, (May 1986 to December 2007 from Buttonville Airport Weather Station). Refer to **Appendix D6** for the model schematic, parameter sheets along with the total annual, monthly and seasonal runoff volumes. The total annual runoff volumes for Wetland complex 8, 33, 34, Wetland 10_11 and Wetland 43, have been summarized in **Tables 4.10, 4.11** and **4.12**, illustrating a reduction in annual runoff volumes of 43%, 98% and 91%, respectively. Mitigation of potential impacts is therefore required with clean water augmentation to the wetlands through the implementation of LID measures. Refer to Section 4.4.1.1 below for information on the LID measures required for retained wetlands to mitigate these impacts.

Table 4.10 – Annual Runoff Volume Comparison for Wetland 8, 33, 34

Year	Existing Annual Runoff (m^3)	Proposed Annual Runoff (m^3)	% Change
1986	3729	2126	-43%
1987	670	382	-43%
1988	833	475	-43%
1989	1427	814	-43%
1990	1193	680	-43%
1991	1550	884	-43%
1992	2581	1472	-43%
1993	1845	1052	-43%
1994	645	368	-43%
1995	2305	1314	-43%
1996	4669	2662	-43%
1997	810	462	-43%
1998	988	563	-43%
1999	1937	1104	-43%
2000	5344	3047	-43%
2001	1624	926	-43%
2002	402	229	-43%
2003	1802	1028	-43%
2004	819	467	-43%
2005	247	141	-43%
2006	1557	888	-43%
2007	600	342	-43%

Table 4.11– Annual Runoff Volume Comparison for Wetland 10_11

Year	Existing Annual Runoff (m^3)	Proposed Annual Runoff (m^3)	% Change
1986	45,578	739	-98%
1987	8,191	133	-98%
1988	10,184	165	-98%
1989	17,444	283	-98%
1990	14,578	236	-98%
1991	18,941	307	-98%
1992	31,548	512	-98%
1993	22,553	366	-98%
1994	7,881	128	-98%
1995	28,179	457	-98%
1996	57,073	926	-98%
1997	9,906	161	-98%
1998	12,074	196	-98%
1999	23,670	384	-98%
2000	65,317	1,059	-98%
2001	19,854	322	-98%
2002	4,912	80	-98%
2003	22,028	357	-98%
2004	10,016	162	-98%
2005	3,016	49	-98%
2006	19,030	309	-98%
2007	7,328	119	-98%

Table 4.12– Annual Runoff Volume Comparison for Wetland 43

Year	Existing Annual Runoff (m^3)	Proposed Annual Runoff (m^3)	% Change
1986	53620	4717	-91%
1987	11968	1053	-91%
1988	17194	1513	-91%
1989	24561	2161	-91%
1990	26319	2315	-91%
1991	26479	2330	-91%
1992	43400	3818	-91%
1993	27061	2381	-91%
1994	13164	1158	-91%
1995	42425	3732	-91%
1996	59622	5245	-91%
1997	15030	1322	-91%
1998	18300	1610	-91%

Year	Existing Annual Runoff (m^3)	Proposed Annual Runoff (m^3)	% Change
1999	35052	3084	-91%
2000	61664	5425	-91%
2001	32342	2845	-91%
2002	5840	514	-91%
2003	35286	3104	-91%
2004	13347	1174	-91%
2005	4743	417	-91%
2006	30250	2661	-91%
2007	9681	852	-91%

In accordance with the approved LSS Terms of Reference (**Appendix A1**), and based on the amount of field data obtained to date, the wetland continuous simulation hydrologic model has not been calibrated at this time. Per Town correspondence and TRCA SWM Criteria, Appendix D (Water Balance for Protection of Natural Features), calibration will be required at the Draft Plan of Subdivision stage if sufficient additional data has been obtained.

4.3.3 Climate Change and Wetland Water Balance Risk Evaluation

Climate change is altering precipitation patterns, increasing temperatures, and intensifying extreme weather events. These changes can lead to periods of excessive flooding, prolonged drought, and shifts in groundwater recharge, impacting the hydrology and ecological function of wetlands. Increased impervious surfaces due to development can exacerbate these impacts by altering runoff patterns and reducing infiltration rates. As a result, wetlands may face hydrological imbalances that threaten their ability to support biodiversity, regulate water quality, and provide critical ecosystem services, like flood mitigation and carbon sequestration.

The wetland water balance risk evaluation provides a framework to address the above noted challenges. By categorizing wetlands into low, medium, and high-risk levels based on potential hydrological changes and sensitivity, appropriate hydrological modelling methods are applied to ensure a detailed understanding of each wetland's needs. The precautionary principle ensures that in cases of incomplete data, conservative assessments guide mitigation planning.

The use of continuous hydrological models for medium and high-risk wetlands, including those with groundwater interactions, allows for the prediction of hydrological responses under various scenarios. Additionally, the integration of LID measures can assist in maintaining natural hydrological functions post-development. Although LID measures will be designed to current standards (refer to Section 4.4.1), this approach supports wetlands in continuing to adapt to climate variability, preserving their resilience and capacity to provide essential ecosystem services in a changing climate.

4.4 Proposed Stormwater Management Plan

In accordance with the Stormwater Management Planning and Design Manual (MOE, 2003), and the Town of Caledon's CLI-ECA (2023), a review of stormwater management best practices including lot-level, conveyance system and end-of-pipe alternatives has been undertaken in order to develop a SWM plan to mitigate potential impacts. The SWM Plan has been developed to achieve the SWM criteria provided in Section 4.1.2 of the Phase 1 LSS and reproduced below as **Table 4.13**.

Table 4.13: Stormwater Management Criteria

Criteria	Control Measure	
Quantity Controls	Regional Storm	• Post- to pre- development controls are required for the Regional (Hurricane Hazel) Storm event where pre-development target peak flows are to be determined by pro-rating the Catchment flows utilizing TRCA's most recent calibrated Humber River hydrologic model on an area basis. • Ensure no increases in peak flow at downstream nodes in existing FVAs.
	2 through 100 Year Storms	Post-development peaks flows are to be controlled to the target flow rates established using the target unit release rates generated by Equation F for Sub-Basin 36 of the West Humber River as per TRCA Stormwater Management Criteria (2012). Refer to Appendix D5 of the Phase 1 LSS for the unit rate equations.

Criteria	Control Measure
Quality Control	As per the SWS (Wood, 2022) and the Town of Caledon CLI-ECA, minimize or where possible, prevent increases in Contaminant loads and impacts to receiving waters. In accordance with the Town of Caledon CLI-ECA, stormwater volumes generated from the geographically specific 90th percentile rainfall event on an annual average basis from all surfaces on the entire site are targeted for control. Control is in the following hierarchical order, with each step exhausted before proceeding to the next: 1) retention (infiltration, reuse, or evapotranspiration), 2) LID filtration, and 3) conventional Stormwater management. Step 3, conventional Stormwater management, should proceed only once Maximum Extent Possible has been attained for Steps 1 and 2 for retention and filtration. If conventional SWM is required, then an “Enhanced” level of quality control is to be provided based on MOE Guidelines (2003) to provide 80% Total Suspended Solids (TSS) removal.
Erosion Control	Using a calibrated continuous simulation hydrologic model complete an erosion exceedance analysis to compare pre- and post-development erosion impacts, and establish an appropriate erosion threshold and volume requirement for end-of-pipe SWM facilities. At a minimum, end-of-pipe SWM facilities must provide extended detention of the 25 mm rainfall event for 48 hours. Where conditions do not warrant an end-of-pipe SWM facility, a minimum of 5 mm of on-site retention is required.
Water Balance	In accordance with the Town of Caledon CLI-ECA, provide control as per the criteria/targets identified in the water balance assessment of this Local Subwatershed Study (LSS). Specifically, this will be implemented through the stormwater management design which will incorporate LID measures as applicable to achieve the infiltration targets specified in Section 3.5.3, above.

The following study area characteristics and constraints were taken into consideration in the evaluation:

- The topography is generally flat to undulating;
- Based on the geological setting, study area soils generally consist of clay and silt-textured till (Section 3.1.7.2, Phase 1 LSS);
- In-situ infiltration tests indicate that the native soils have a percolation rate ranging from 7.3 to 10.4 mm/hr (Section 3.1.9, Phase 1 LSS);
- Within the installed site wells, groundwater was observed at depths ranging between 0.06 m to 5.83 m below existing grade (Section 3.4.1, Phase 1 LSS);
- The proposed WVSP area is approximately 358.1 ha and the proposed land use plan consists of mixed use and residential development, collector roads, elementary schools, parks, environmental features and Stormwater Management (SWM) facilities;
- The WVSP area is located within five (5) catchments of the West Humber River subwatershed; and,
- Proposed drainage is to be directed to ten (10) storm outlets to maintain existing drainage patterns to the extent possible.

Based on this, the proposed SWM Plan for development within the WVSP area includes a treatment train of Low Impact Development (LID) measures, nine (9) end-of-pipe SWM facilities, and one (1) on-site control area (OSCA). Refer to **Sections 4.2.1, 4.2.2**, and **4.2.3** below, for additional information on LID measures, end-of-pipe SWM facilities, and the OSCA, respectively. The SWM Plan is illustrated on **Figure 4.4** (**Appendix D2**).

As outlined in Section 4.3.1 and illustrated on **Figure 4.3** (**Appendix D2**), there are two existing wetlands, one within the WVSP area (Wetland 8, 3, 34) and one external to the WVSP area (Wetland 43), which will be impacted by the proposed development. There are also two proposed Compensation Areas (CA) as shown on **Figure 2.2** (**Appendix B1**) and discussed in Sections 2.5.4.3 and 2.5.4.4. To mitigate impacts, these four (4) features require augmentation with clean water to maintain a feature-based water balance. The SWM Plan thus incorporates four Clean Water Collectors (CWC) and LID measures as shown on **Figure 4.5** (**Appendix D2**) and described in Sections 4.4.1.1 and 4.4.1.2. Refer to Section 5.4.1 for preliminary information on the CWC.

4.4.1 Low Impact Development Measures

Low Impact Development (LID) measures provide reduction of runoff and promote infiltration at the source. Each type of LID measure has the potential to provide water quality control including both Total Suspended Solids (TSS) and Phosphorous removal, erosion control, and water balance benefits for groundwater recharge and feature-based water balance. The type and location of LID measures is dependent on the purpose of the LID measure. The LID strategy for the WVSP area has been developed to mitigate development impacts to retained and compensation wetlands (both surface water and shallow groundwater impacts), and overall water balance (deep groundwater impacts), as outlined in the following sections.

Due to high groundwater elevations throughout the WVSP area, the feasibility of infiltration type LIDs will be limited. TRCA guidelines require 1.0 m of clearance from the bottom of infiltration type LID measures to the seasonally high groundwater elevation. Per discussions with TRCA and the Town of Caledon, this constraint is to be considered but does not preclude the ability to have LID measures should 1.0 m of clearance from the high groundwater not be achievable. **Figure 4.5 (Appendix D1)** provides the depth from proposed grades, established through this LSS as further outlined below in Section 5.1, to the seasonally high groundwater elevations across the WVSP area. This figure has been utilized to identify areas where the feasibility of infiltration type LID measures is higher (i.e. where the depth to groundwater is greater than 1.0 m).

Moving forward in the development process, future Draft Plan of Subdivision and/or Site Plan applications will need to evaluate the feasibility of the different types of LID measures based on site specific constraints and design information. Preliminary types, locations and design of LID measures will be required as part of the Functional Servicing and Stormwater Reports (FSSRs) prepared in support of individual Draft Plan of Subdivision applications. LIDs should be considered in the public realm first, and if all options are exhausted due to site constraints, then LID measures can be considered on private property.

4.4.1.1 Retained Wetland Water Balance Mitigation

As outlined in Sections 2.1.2.3 and 2.1.2.4, through the Wetland Screening and Water Balance Risk Evaluation, it was established that there would be risk for negative impacts resulting from the proposed land use plan to the form and/or function of four (4) retained wetlands within the WVSP area and one (1) within the 120 m adjacent lands (i.e. the Natural Heritage Study Area, NHSA). Wetlands 8, 33 and 34, Wetland 10_11, and Wetland 43 will potentially be impacted by redirection of drainage away from these wetlands.

Mitigation of these potential impacts is therefore required with augmentation of clean water to the wetlands through the implementation of LID measures. This may include a Clean Water Collector (i.e. third pipe) that conveys clean runoff from roof areas, rear yards, open space and/or parks towards Wetland 8, 33 and 34, and Wetland 10_11 within the WVSP area, and Wetland 43, outside of the WVSP area. The clean water will be delivered to the features via LID measures such as flow spreaders, bioswales, infiltration galleries (where groundwater is greater than 1.0 m below the base of the gallery) etc. The details of the type, size and location of LID measures are to be determined through future study at the next stage of the development process.

In addition to augmenting these wetlands with clean water, the proposed SWM Plan also includes capturing the water augmented to Wetland 8, 33 and 34, described above, and conveying the flow in a Clean Water Collector toward Culvert #9 at Mayfield Road in order to maintain flows to Wetland 43 and the watercourse downstream of Mayfield Road (refer to **Figure 4.5**, **Appendix D1**).

Preliminary continuous simulation hydrologic modelling of post development conditions with mitigation has been undertaken. Assuming mitigation takes the form of a CWC conveying roof runoff to the wetland, the model was utilized to establish an approximate roof area required to augment the wetlands for every hectare of drainage area diverted away from the feature. Refer to **Appendix D4** for the hydrologic modelling and **Table 4.12** below for the results.

The volume of water required to augment the wetland was determined by setting a target runoff volume based on the existing drainage area being redirected away from the wetland. Through continuous simulation hydrologic modelling, the average annual, seasonal and monthly runoff volumes were determined for the drainage area being redirected under existing conditions. For the proposed condition with mitigation, roof area was modelled with 100% imperviousness and the area was manipulated until the average annual, seasonal and monthly runoff in the proposed conditions exceeded the runoff in the existing condition.

Through this analysis it was determined that approximately 0.30 ha and 3.50 ha of roof area is required to augment Wetlands 8, 33 and 34 and Wetland 43, respectively. Wetland 43 will also be further augmented from the roof runoff and clean water being supplied to Wetlands 8, 33, 34. Approximately 7.9 ha of roof water will be required to augment Wetland 10_11. **Tables 4.15** and **4.16** below summarize the runoff volumes required to augment the wetlands.

Table 4.14 below summarize the runoff volumes required to augment the retained wetlands. A range is provided for the roof area required for augmentation with the minimum representing a post to pre match of average annual volumes, and the maximum representing the match of monthly runoff volumes for November. This has been done due to the fact that if the target for the water balance is based on average annual runoff volumes, the average spring, April, May, August, September and November months result in decreases in runoff to the wetlands. If alternatively, the amount of roof area required to augment the feature is based on matching the existing runoff volumes for the month with the most significant decreases, in this case November, then there will be no decreases in runoff volume.

Table 4.14 – Existing and Proposed Average Annual Runoff for Retained Wetlands with Mitigation

Wetland ID	Roof Area Required for Augmentation (ha)	Existing Average Annual Runoff (ha.m)	Proposed Average Annual Runoff (ha.m)	% Change
8, 33, 34	0.20 - 0.28	0.07	0.07 - 0.10	0% - 39%
43	2.30 - 3.21	1.02	1.02 - 1.35	0% - 33%
10_11	5.69 - 7.93	2.09	2.09 - 2.91	0% - 39%

The volume of water to be augmented to the wetland will need to be confirmed through additional continuous simulation hydrologic modelling at the next stage of the development process. The analysis is to include calibration of the continuous simulation hydrologic model based on the wetland monitoring data, as feasible.

4.4.1.2 Compensation Wetlands Water Balance Mitigation

As outlined in Sections 2.2.1 and 2.2.2, HDFs identified with having a management recommendation of Mitigation will be removed and compensated for with replication of function through constructed wetland features connected to downstream. One of the Mitigation HDFs (H12A1) provides ephemeral direct fish habitat, and all Mitigation HDFs provide baseflow contributions (ephemeral or intermittent flow) and limited supply of organic material and coarse sediments. There are two (2) Wetland Compensation Areas proposed, identified as CA1 and CA2 (refer to **Figure 4.5**). Wetlands 2, 3, 4, 5, 6, 7, part of 14, and 17, as well as HDF H1S1 (Mitigation), are planned to be compensated/ relocated within CA1. A portion of wetland 12, all of wetland 13, as well as HDF H12A1 (Mitigation), are proposed for removal and will be compensated at CA2. A CWC (i.e. third pipe) and LID measures will be required to convey and deliver clean water to the proposed wetland compensation areas in order to maintain HDF functions downstream. The details of the type, size and location of LID measures are to be determined through future study at the next stage of the development process.

As with the retained wetlands, preliminary continuous simulation hydrologic modelling of post development conditions with mitigation is required for both of the compensation wetlands (Compensation Areas CA1 and CA2 on **Figure 2.2**, **Appendix B1**) requiring augmentation of clean water. CA2 is to be located immediately upgradient of existing Wetland 10_11, which is being retained on the landscape. Feature-based water balance assessment and modelling was completed for CA2 as outlined above in Section 4.4.1.1. As such, additional continuous simulation hydrologic modelling has been completed for CA1 as outlined below. Assuming mitigation takes the form of a clean water pipe conveying roof runoff to the wetland compensation area, the model was utilized to establish an approximate roof area required to augment the wetland with the equivalent runoff volume that the HDF received under pre-development conditions. Details of the clean water drainage area to be conveyed to the compensation area will be determined through the next stage of the development process.

As with retained wetlands, the volume of water required to augment the wetland was determined by setting a target runoff volume based on the existing drainage area to the HDF to be mitigated. Through continuous simulation hydrologic modelling, the existing average annual, seasonal and monthly runoff volumes were determined for the drainage area being directed to the wetland compensation area in the proposed condition. For the proposed condition with mitigation, roof area was modelled with 100% imperviousness and the area was adjusted until the average annual, seasonal and monthly runoff in the proposed conditions exceeded the runoff in the existing condition. **Table 4.15** below summarize the runoff volumes required to augment the compensation wetlands. A range is provided for the roof area required for augmentation with the minimum representing a post to pre match of average annual volumes, and the maximum representing the match of monthly runoff volumes for November.

Table 4.15–Existing and Proposed Average Annual Runoff for Compensation Wetlands with Mitigation

Compensation Area ID	Roof Area Required for Augmentation (ha)	Existing Average Annual Runoff (ha.m)	Proposed Average Annual Runoff (ha.m)	% Change
CA1	3.65 - 4.95	1.34	1.34 - 1.82	0% - 35%
CA2 (Wetland 10_11)	5.69 - 7.93	2.09	2.09 - 2.91	0% - 39%

4.4.1.3 Groundwater Balance Mitigation

As outlined in Section 3.5.3, mitigation of impacts to recharge and groundwater must be undertaken through the implementation of LID measures that encourage the retention and recharge of stormwater, such as infiltration galleries and bioswales. Design standards and guidelines for LID measures for the WVSP area requires that the base of the features (e.g., the contact area for an infiltration gallery) maintain a minimum 1.0 m clearance above seasonally high groundwater levels (LID SWM Planning and Design Guide). Due to the occurrence of high groundwater levels throughout the WVSP area, as shown on **Figure 3.3**, (**Appendix C1),** there appear to be few locations, if any, that would be suitable to construct infiltration type LID measures that meet this clearance requirement.

A general review of soil type and depth to groundwater has been undertaken as part of the feasibility evaluation to evaluate the most suitable types of LID measures based on location with the WVSP area. It is important to look at depth to groundwater based on proposed grades. As further outlined in Section 5.1 below, a preliminary grading plan has been prepared for the WVSP area. This grading has been overlayed on the Depth to Groundwater Map to establish the most suitable locations for infiltration type LID measures based on future grades as shown on **Figure 4.5** (**Appendix D1).**

Figure 4.5 (**Appendix D1**) indicates that areas where maximum groundwater levels have been deepest and therefore are likely to be well-suited to the construction of infiltration type LID measures, are located in the southeastern and northeastern parts of the WVSP area. It should also be noted that the tight soils and high groundwater elevations do not preclude the implementation of non-infiltration type LID measures such as bioswales, permeable pavement, grassed swales, vegetated filter strips, filtration trenches etc. throughout the WVSP area. The siting of LID measures and design should be confirmed based on subsequent investigation conducted to support Draft Plan of Subdivision applications.

Despite the persistence of shallow groundwater levels, it is also recommended to consider constructing LID measures in locations where this clearance may only be met seasonally (e.g., in the summer and fall). Although the LID measures will be of reduced efficiency in wetter times of the year, infiltration will still occur during dry periods thus still mitigating the loss of recharge caused by development.

4.4.1.4 Climate Change and LID Measures

As noted throughout this LSS, climate change will generally increase the frequency and intensity of rainfall causing increased runoff. The implementation of LID measures in addition to end-of-pipe SWM facilities, as further outlined below in Section 4.4.2.5, will help to build climate resilience to mitigate impacts to the natural environmental from increased flooding and decreases in infiltration. Although LID measures will be designed based on criteria today, green infrastructure will generally provide additional benefits for climate adaptation including improving water quality, sequestering carbon, improving air quality and supporting biodiversity by creating green spaces within the WVSP area.

4.4.2 End-of Pipe SWM Facilities

As outlined above in Section 4.4, nine (9) SWM facilities are proposed to service the lands draining to the outlets identified (refer to **Figure 4.1**). Each SWM facility will provide the quality, erosion and quantity controls required to achieve the design criteria presented in **Table 4.14.** Facilities are to be designed to accommodate drainage from the WVSP area, in addition to external drainage, as required. Refer to **Figure 4.4** for the locations of the proposed SWM facilities.

4.4.2.1 Quality Control

Each of the SWM facilities proposed across the WSVP Area will provide quality controls through a permanent pool. The purpose of the permanent pool is to provide sediment removal for the stormwater conveyed to the pond. The SWM Facilities will be sized to provide an 'Enhanced' level of protection (80% TSS removal) based on Table 3.2 of the MOE Stormwater Management Planning and Design Manual (SWMP Manual, 2003).

Utilizing the preliminary percent imperviousness based on the proposed Land Use Plan (**Figure 1.3**, **Appendix A1**) for the existing conditions drainage areas contributing to each SWM facility, the required permanent pool volumes have been determined and are provided in **Table 4.18**. The percent imperviousness and total post development drainage areas contributing to each SWM facility will be determined as part of the CSSS, as well as being confirmed at the Draft Plan stage of the development process based on the proposed grading and SWM design for each Draft Plan.

Table 4.16: Water Quality Storage Requirements

SWMF ID	Catchment Area ID	Area (ha)	Percent Impervious	Required Permanent Pool Volume (m^3)
1	36.11.1 & 36.11.2 & 36.11.3	32.99	81%	6,767
2	36.11.4	22.49	73%	4,237
3	36.10.1	81.70	32%	7,853
4	38.04.10 & 38.04.11 & 38.04.12	48.61	76%	9,452
5	38.04.20 & 38.04.21	60.68	75%	11,685
6	38.06.10 & 38.06.11	61.64	76%	11,988
7	38.06.20 & 38.06.22	39.48	71%	7,217
8	38.06.21	21.92	71%	4,010
9	38.06.31	45.65	44%	5,642

4.4.2.2 Erosion Control

Through the Phase 1 LSS an erosion threshold and exceedance analysis at locations downstream of each outlet was prepared. It was found that there will be an increase in both erosion occurrences and duration associated with the proposed development of the WVSP area. To mitigate the potential for increases in erosion, the attenuation of the extended detention volume within each SWM facility will be required to provide erosion protection for the receiving downstream watercourses, mitigating for proposed changes in land use and drainage diversions, as well as promoting sediment removal for water quality.

As per the approved Terms of Reference (Phase 1 LSS), the extended detention volume and duration for each SWM facility is to be determined as part of the CSSS and confirmed at the Draft Plan application stage based on the proposed grading and SWM facility design. To determine the volume and extended detention time required for each SWM facility to ensure the downstream erosion impacts are mitigated, the continuous modelling for the erosion threshold and exceedance analysis prepared in the Phase 1 LSS will need to be updated on a SWM facility by SWM facility basis at that time. Future study requirements for the erosion assessment will be outlined in the Phase 3 LSS.

4.4.2.3 Quantity Control

As established in Section 4.1.2, the proposed conditions uncontrolled peak flows for each outlet exceed the pre-development levels; therefore, stormwater management quantity controls for the 2 through 100 year and Regional storm events are required to mitigate downstream impacts.

In the Phase 1 LSS, target release rates for the 2 through 100 year storm events were determined via unit flow relationships established for the West Humber River Watershed. As discussed with the TRCA, the WVSP area falls with Sub-Basin 36, and therefore Equation F was used to establish the target unit flow rate to each outlet for the 2 through 100 year storm event. For the Regional storm event (Hurricane Hazel), the target flows for the proposed conditions were established based on the post development drainage area to each outlet taking into consideration the proposed drainage area diversions discussed in Section 4.1.1.1.

It is noted that for the Regional storm event targets, that the Town and TRCA requested additional analysis to show that setting the targets based on post development drainage area to each outlet instead of the pre-development area would not impact flooding downstream of the WVSP area. The following provides a summary of the approach and conclusions of the analysis of the Regional SWM Outlet Control Targets. Please refer to **Appendix D7** for the results of the analysis and **Figure 4.4** (**Appendix D1**) for the location of the catchments and SWM facility locations.

- The TRCA Regional Humber River model is calibrated and validated but there are no unitary release rate targets for the Regional storm event like there is for the 2 through 100 year storm events.
- There is known flooding downstream of WVSP area and as such TRCA criteria is to provide post to pre control for the Regional storm event.
- Since the model is calibrated, and discretizing the model and updating parameters based on site specific data will inherently increase peak flows, it was decided by TRCA that the Regional flows from the TRCA calibrated model would be pro-rated on a catchment area basis and applied to Wildfield.

- The unitary flows based on pre-development and post development areas have been compared, as well as to pre-development modelled flows.
- The pre-development modelled flows were determined by taking the TRCA calibrated Regional model and discretizing the catchments within WVSP. Time to peak calculations were updated based on the discretized catchments; however, all other parameters were left per the parent catchment in the TRCA model.
- As shown in **Appendix D7**, the pre-development modelled flows are greater than the unit target flows based on post development areas, which in turn are greater than the unit target flows based on pre-development areas (for outlets where there is diversion of drainage; otherwise post development area equals pre-development area).
- If the pre-development unit targets were used, the SWM facilities would be over-controlling well below pre-development modelled flows.
- By applying the post development unit targets the total flow from the WVSP area will meet the total catchment flows from the TRCA hydrologic model thus meeting the TRCA criteria of post to pre control for the study area ensuring there are no downstream impacts through existing flood vulnerable areas.
- The post development hydrologic model has been updated to include SWM facilities controlled to the unit targets based on post development area, and flows have been compared to the TRCA calibrated model at key nodes downstream of WVSP to Lake Ontario.
- The determination of pre-development modelled flows shows that diversion of drainage from one outlet to another will not impact downstream reaches since the post development unit target flows are less than the modelled pre-development flows.
- The erosion assessment to be completed as part of the CSSS, including continuous simulation hydrologic modelling will establish extended detention duration and volumes to mitigate potential erosion impacts on downstream reaches caused by any diversion of drainage from one outlet to another. Refer to Section 4.2.3.
- The feature-based water balance assessment will ensure that features downstream of WVSP on reaches where water has been diverted away to a SWM facility discharging to a different reach, will have impacts mitigated through augmentation of clean water to the feature. Refer to Section 4.3.

For each SWM Facility, the target flows for the 2 through 100 year storm events based on the TRCA unit rates, and Regional storm event target flows based on the approach outlined above, are summarized in **Table 4.17**.

Table 4.17: Stormwater Management Facility Target Flow Rates (m^3/s)

SWMF ID	SWMF 1	SWMF 2	SWMF 3	SWMF 4	SWMF 5	SWMF 6	SWMF 7	SWMF 8	SWMF 9
Area (ha)	**32.99**	**22.49**	**81.70**	**48.61**	**60.68**	**61.64**	**39.48**	**21.92**	**26.64**
2-yr	0.231	0.163	0.518	0.326	0.398	0.403	0.271	0.160	0.190
5-yr	0.352	0.250	0.788	0.498	0.606	0.615	0.413	0.244	0.291
10-yr	0.434	0.308	0.973	0.614	0.747	0.758	0.509	0.301	0.358
25-yr	0.546	0.387	1.223	0.772	0.940	0.953	0.641	0.378	0.451
50-yr	0.636	0.452	1.421	0.898	1.093	1.109	0.746	0.441	0.526
100-yr	0.719	0.510	1.610	1.016	1.237	1.255	0.844	0.499	0.594
Reg.	2.454	1.673	5.695	3.720	4.200	4.565	2.922	1.623	1.973

The hydrologic modelling has been updated to include route reservoir commands for the areas draining to each outlet to control the peak flows to the targets provided above in **Table 4.17**. From this updated controlled model scenario, the amount of storage required to meet the target release rates has been determined and are summarized in **Table 4.18** below. The resulting Regional storm peak flows at the Catchment level were then compared to the pre-development Catchment flows to ensure that the proposed SWM facilities would provide the necessary control. Refer to **Table 4.19**.

Table 4.18 – SWMF Controlled Release Rates (m^3/s)

SWMF ID	SWMF 1	SWMF 2	SWMF 3	SWMF 4	SWMF 5	SWMF 6	SWMF 7	SWMF 8	SWMF 9
Area (ha)	**32.99**	**22.49**	**81.70**	**48.61**	**60.68**	**61.64**	**39.48**	**21.92**	**26.64**
	6 hour								
2-yr	0.219	0.156	0.496	0.306	0.376	0.379	0.256	0.152	0.297
5-yr	0.344	0.248	0.784	0.486	0.588	0.596	0.403	0.241	0.465
10-yr	0.434	0.305	0.972	0.610	0.744	0.753	0.507	0.299	0.579
25-yr	0.544	0.384	1.223	0.772	0.938	0.953	0.639	0.377	0.724
50-yr	0.633	0.451	1.419	0.895	1.090	1.105	0.743	0.440	0.843
100-yr	0.719	0.506	1.604	1.015	1.236	1.253	0.840	0.497	0.955
	12 hour								
2-yr	0.222	0.156	0.477	0.312	0.384	0.387	0.258	0.151	0.285
5-yr	0.350	0.250	0.784	0.496	0.602	0.611	0.409	0.242	0.464
10-yr	0.433	0.303	0.957	0.610	0.745	0.754	0.504	0.296	0.569
25-yr	0.534	0.375	1.186	0.758	0.922	0.937	0.625	0.368	0.705
50-yr	0.613	0.434	1.363	0.870	1.059	1.076	0.719	0.423	0.812

SWMF ID	SWMF 1	SWMF 2	SWMF 3	SWMF 4	SWMF 5	SWMF 6	SWMF 7	SWMF 8	SWMF 9
Area (ha)	**32.99**	**22.49**	**81.70**	**48.61**	**60.68**	**61.64**	**39.48**	**21.92**	**26.64**
100-yr	0.692	0.487	1.537	0.980	1.195	1.212	0.809	0.476	0.917
	Regional								
-	2.448	1.671	5.691	3.714	4.196	4.560	2.916	1.617	3.376

Table 4.19 – Catchment Regional Storm Peak Flow Summary (m^3/s)

Catchment[1]	NHYD ID[2]	Existing Regional Storm Total Catchment Peak Flow[2] (m^3/s)	Proposed Controlled Regional Storm Total Catchment Peak Flow[2] (m^3/s)	Comparison of Regional Catchment Peak Flows (%)
36.10	560	23.674	23.217	-2%
36.11	561	10.904	10.574	-3%
38.04	577	10.896	10.636	-2%
38.05	578	5.139	4.511	-14%
38.06	579	12.867	12.617	-2%

The proposed conditions peak flow at downstream key flow nodes identified in the Phase 1 LSS (SCS and GEI), have been compared to the existing conditions peak flows for the 2 through 100 year and Regional storm event to ensure that the proposed WVSP will not impact downstream through existing flood vulnerable areas. As shown in **Table 4.20** below, there are no increases; therefore, the proposed stormwater management quantity controls for the WVSP Area will be effective for the 2 through 100 year and Regional storm events.

Table 4.20 – Existing and Controlled Future Nodal Flow Comparison

Node	NHYD ID	Location	Existing Regional Peak Flows (m^3/s)	Proposed Controlled Regional Peak Flows (m^3/s)	Change
A	1939	Mayfield Road	178.76	174.07	-2.6%
B	1935	The Gore Road	34.43	33.58	-2.5%
C	1456	Confluence of Tributary and West Humber River	237.02	231.29	-2.4%
D	1776	Castlemore Road	351.37	347.55	-1.1%

Node	NHYD ID	Location	Existing Regional Peak Flows (m^3/s)	Proposed Controlled Regional Peak Flows (m^3/s)	Change
E	1366	Cottrelle Boulevard	352.42	351.38	-0.3%
F	869	McVean Drive	351.79	352.27	0.1%
G	720	Queen Street	748.50	749.79	0.2%
H	1442	Highway 407	1041.49	1042.21	0.1%
I	2074	Highway 427	1049.98	1050.60	0.1%
J	1971	Highway 27	1078.33	1077.46	-0.1%
K	1028	Islington Avenue	1125.09	1123.58	-0.1%
L	1005	Albion Road	2229.70	2228.57	-0.1%
M	975	Eglington Avenue	2259.07	2252.95	-0.3%
N	1000	Lake Ontario	2808.50	2801.50	-0.2%

It can be concluded that the proposed SWM facilities will provide sufficient control to meet the quantity control criteria provided in **Table 4.17**. As part of the CSSS, and at the Draft Plan of Subdivision stage of the development process for non-participating lands, the hydrologic modelling and storage requirements will need to be updated based on the proposed grading and drainage areas. Future study requirements will be provided in the forthcoming Phase 3 LSS.

4.4.2.4 SWM Facility Outlets and Culvert Improvements

With the exception of SWM Facilities #5 and #9, seven of the proposed nine SWM facilities will outlet to existing culverts located along Centreville Creek Road, Mayfield Road and The Gore Road. Refer to **Figure 4.4** for the locations of the culverts and SWM facilities. SWM facilities #5 and #9 will discharge directly to existing watercourses within the WVSP area identified as Reaches S1/S2/S3 and WHT2(1)1-1, respectively (refer to **Figure 2.6**) and are thus not discussed further as it relates to culvert improvements. It should be noted that SWM facilities must discharge to the watercourse and not to Compensation Wetlands due quality control concerns regarding salt from road drainage.

Centreville Creek Road is a Town arterial road, and both Mayfield Road and The Gore Road are Regional arterial roads. Per Town and Region standards, culverts crossing arterial roads must be designed to convey the greater of the 100 year and Regional storm events. As the SWM facilities will control the post development discharge to the pre-development target release rates noted above in **Table 4.19**, and ultimately the existing arterial roads will be urbanized, it is assumed that the SWM facility outlets will discharge directly to the culverts crossing the arterial roads. It is therefore required to determine the existing conveyance capacity of the culverts to understand if infrastructure upgrades are required.

The existing conveyance capacity of these seven culverts have been assessed under future development conditions for the 100-year and Regional storm events utilizing CulvertMaster. Refer to **Appendix D3** for the outputs of the hydrologic modelling used for the culvert capacity analysis. The maximum flow the culvert can convey without flows overtopping the road has been established using CulvertMaster. The capacity of each culvert is summarized below in **Table 4.23**. Refer to **Appendix D8** for the CulvertMaster outputs.

Table 4.21 – SWM Facility Outlets and Culvert Capacity

SWM Facility ID	SWM Facility Discharge (m^3/s)	Outlet Culvert ID	Outlet Culvert Capacity (m^3/s)	Culvert Capacity Exceeded?
1	2.448	6	1.23	Yes
2	1.671	5	0.28	Yes
3	5.691	3	2.17	Yes
4	3.714	10	1.51	Yes
6	4.560	14	3.33	Yes
7	2.916	15	2.58	Yes
8	1.617	17	2.49	No

As summarized above the capacity of the culvert has been exceeded during the Regional storm event for all of the SWM facility outlets with the exception of SWM Facility #8. It is therefore recommended that culverts 3, 5, 6, 10, 14 and 15 be upsized to ensure the conveyance of the flows from the SWM facilities. The required size of the culverts is to be determined through the CSSS.

4.4.2.5 Climate Change and SWM Facilities

Further hydrologic assessment has been completed to evaluate the hydrologic impacts of the proposed land use under future climate change scenarios. The proposed conditions hydrologic model, was simulated utilizing the Statistically downscaled CMIP-6 climate data retrieved from the IDF CC Tool Online as instructed by the Town of Caledon and consistent with TRCA protocol. The SWM scenario hydrologic model developed as outlined above in Section 4.2.2.3 has been simulated with this climate change data. Refer to **Appendix D4** for the climate change model outputs.

The expected peak flows under the climate change scenario (2 through 100 year storm events) are summarized in **Table 4.24.** These flows were then compared to the post-development Regional storm flows with the proposed SWM facilities providing post to pre quantity control shown in **Table 4.21**. It was found that the Regional controlled flows (i.e. pre-development levels) are significantly greater than the 100 year Climate Change scenario flows. As such, existing Regulatory floodplain limits will protect existing development downstream of the WVSP area should the 100 year Climate Change scenario storm event occur once the WVSP area has been fully developed.

Table 4.22– Climate Change Scenario – Comparison of Peak Flows

Catchment	36.10	36.11	38.04	38.05	38.06
Storm	**6 hr**	**6 hr**	**6 hr**	**6 hr**	**6 hr**
2-yr	1.237	0.550	0.808	0.281	1.233
5-yr	2.329	0.972	1.381	0.578	2.077
10-yr	3.226	1.292	1.804	0.833	2.699
25-yr	4.730	1.816	2.461	1.265	3.672
50-yr	6.007	2.338	3.224	1.646	4.750
100-yr	7.917	3.114	4.348	2.192	6.360
Storm	**12 hr**	**12 hr**	**12 hr**	**12 hr**	**12 hr**
2-yr	1.497	0.645	0.920	0.312	1.346
5-yr	2.706	1.092	1.501	0.608	2.189
10-yr	3.645	1.421	1.911	0.848	2.789
25-yr	5.046	1.904	2.488	1.210	3.638
50-yr	6.233	2.345	3.137	1.524	4.536
100-yr	7.968	3.016	4.101	1.968	5.886
Regional	**23.217**	**10.581**	**10.641**	**4.511**	**12.983**

4.4.2.6 General SWM Facility Design Criteria

The following general design criteria are provided for SWM facilities within the WVSP area. Criteria should be confirmed with the Town of Caledon and TRCA prior to site development.

- A 5.0 m wide maintenance access road will be provided from a proposed municipal road with a maximum longitudinal slope of 8% and a crossfall of 2% (max). It will be used to facilitate machinery to access the forebay during scheduled maintenance as well as to access the outlet structure for maintenance purposes;
- The minimum length-to-width ratio shall be 4:1;
- A maximum of 2.0 m of storage for the 2 through 100 year storm events and a maximum of 3.0 m of storage for the Regional storm event, for a total maximum of 3.0 m of active storage;
- A 3.0 m deep permanent pool that meets the requirements of the MECP with respect to Redside Dace;
- Extended detention and quantity control storage volumes are not stacked unless the erosion assessment to be completed as part of the CSSS shows detention times in excess of 72 hours;

- A maximum slope of 4:1 from the pond bottom to 0.5 m below the normal water level will be provided;
- A maximum slope of 7:1 above the 4:1 sloping zone up to the 100 year water surface elevation;
- A maximum slope of 3:1 above the 100 year storm water surface elevation up to the Regional storm water surface elevation or top of pond; and,
- A maximum 4:1 slope where the slope backs on to the rear yard lot line, adjacent a road system or valley

The following design elements will be taken into consideration during detailed design in consultation with the Town, TRCA and MECP:

- Strategic planting plan to achieve naturalization and provide shade for cooling; and,
- Cooling trenches and/or wetland pockets at the outfall.

SWM facilities will also be designed with reference to the following guidelines:

- Municipal Consolidated Linear Infrastructure Environmental Compliance Approvals, Ministry of Environment, Conservation and Parks (MECP), (June 2023);
- Development Standards Manual, Town of Caledon, Version 5 (2019);
- Stormwater Management Criteria, Toronto and Region Conservation Authority Version 1.0 (August 2012);
- Stormwater Management Planning and Design Manual (SWMP Manual) prepared by the Ministry of Environment, March 2003;
- Guidance for Development Activities in Redside Dace Protected Habitat, Ontario Ministry of Natural Resources and Forestry, Version 2.1, March 2016; and,
- Thermal Mitigation Checklist for Stormwater Management Ponds Discharging into Redside Dace Habitat, Ontario Ministry of Natural Resources and Forestry, 2014.

4.4.3 On-Site Control Area

There is one (1) On-Site Control Area (OSCA) identified within the WVSP area, located at the northeast corner of Mayfield Road and The Gore Road. As shown on **Figure 4.1 (Appendix D1)**, Catchment 38.04.30, approximately 2.52 ha in size, drains southwesterly towards Outlet 10 at Mayfield Road. It is not feasible to drain these lands to an end-of-pipe SWM facility, and the area is too small for its own end-of-pipe SWM facility. As such the parcel must be treated as an OCSCA.

As with lands draining to an end-of-pipe SWM facility, OSCAs must achieve the SWM criteria listed above in **Table 4.14**, through the use of on-site controls. Quantity control can be achieved through the use of orifice controls and a combination of either underground storage in tanks or oversized storm sewers, or above ground storage in parking lots or on rooftops. LID measures including Manufactured Treatment Devises (MTD) can be utilized for quality and erosion control.

5.0 Grading and Municipal Servicing

5.1 Grading

Per the topographic survey provided in Appendix D2 of the Phase 1 LSS (SCS and GEI), the WVSP area is generally comprised of rolling agricultural lands with a grade range of less than 1% to approximately 7%. The topographic elevations vary from approximately 249.0 m at the northwestern limit of WVSP area to approximately 220.0 m at the southeastern limit. The WVSP area is divided by a ridge running north to south. The lands to the west of the ridge slope west towards Centreville Creek Road. The lands to the east of the ridge slope east towards The Gore Road. The rolling topography generates several distinct low points along Centreville Creek Road, the Gore Road, and Mayfield Road. Existing culverts are located at each of the distinct low points to convey stormwater runoff outside the limits of the WVSP area (refer to **Figure 4.1, Appendix D1**).

A preliminary grading concept showing centerline road grades based on the proposed Land Use Plan is provided on **Figure 5.1, Appendix E1**. Due to the relatively flat grades through portions of the study area, a minimum road grade of 0.5% has been utilized where necessary to achieve continuous overland drainage towards the anticipated low points of the WVSP development. The local road network will coincide with the collector road low points to provide a continuous overland flow path to the ultimate storm outfall locations. Where capture of the 100-year storm event is required, the proposed grading will allow for emergency flows to be directed overland to the ultimate storm outfall or adjacent arterial road right-of-way. The proposed grading concept generally matches the existing topography to the extent possible to minimize the cut and fill volumes.

Per the current Highway 413 preliminary concept mapping, one (1) SWM facility is planned at the north end of the WVSP area, approximately midway between Centreville Creek Road and The Gore Road. The outlet location for the SWM facility is not known at this time but it is anticipated that flows will be conveyed easterly within the Highway 413 right-of-way towards The Gore Road and Culvert #18 and ultimately to the West Humber River, therefore no additional grading considerations are required. It is anticipated that some transition grading will be required within the MTO's 14m structural setback allowance to regulate the limit of development due to the steeper slopes adjacent to the MTO SWM facility block. The design of Highway 413 is ongoing and therefore subject to change. The grading requirements along the MTO structural setback allowance will be provided as part of future draft plan applications for affected properties.

In general, proposed development within the WVSP area must be graded in a manner which will satisfy the following goals:

- Satisfy the Town of Caledon lot and road grading criteria including:
    - Minimum Road Grade: 0.75% (exceptions proposed as necessary as outlined above)
    - Maximum Road Grade: 6.0%
    - Minimum Lot Grade (split lots): 2%
    - Minimum Lot Grade (front draining lots): 3%
    - Maximum Lot Grade: 5%
    - Maximum slope between houses in any direction: 4:1
    - Provide a 0.6 m wide gently sloped area at 2.0% away from the house on at least one side of the building where side yard setbacks permits;
- Provide continuous road grades for overland flow conveyance;
- Minimize the need for retaining walls;
- Minimize the volume of earth to be moved and minimize cut/fill differential;
- Minimize the need for rear lot catchbasins; and
- Achieve the stormwater management objectives required for the proposed development.

A more detailed grading utilizing the criteria noted above will be provided as part of the CSSS. The preliminary grading shown on **Figure 5.1, Appendix E1** will be used as the basis for grading within individual parcels. The collector road grading is subject to change as part of the CSSS and subsequent to that at the Draft Plan of Subdivision application stage, as required for non-participating properties, to balance the cut and fill volumes and minimize slopes and walls.

Grading is not anticipated to be required within the NHS for the implementation of infrastructure, trails, or roads. Transition grading may be required within buffers to compensation wetlands to satisfy the goals listed above provided it is demonstrated that the grading does not impact the long-term viability and function of the wetlands. Any grading proposed within the buffers to compensation wetlands will be confirmed as part of the future draft plan applications for affected properties.

5.2 Sanitary Sewer Servicing

5.2.1 Existing and Planned Sanitary Servicing

As noted in the Phase 1 LSS (SCS and GEI), there are no existing sanitary sewers within the WVSP area or on the arterial roads immediately surrounding the WVSP area. An existing 1200 mm diameter sanitary sewer is located on The Gore Road approximately 615 m south of Mayfield Road. There is also an existing sanitary sewer (size to be confirmed) located on McVean Drive at the intersection with Countryside Drive approximately 1.25 km south of the WVSP area.

The planned sanitary servicing improvements in the Region of Peel and Town of Caledon have been determined through the Region of Peel Water and Wastewater Master Plan (2020), Region of Peel Settlement Boundary Expansion (SABE) Water and Wastewater Servicing Analysis (2022), and ongoing coordination with Region of Peel staff. The WVSP Area is identified as Secondary Plan area G2 in the Town of Caledon Official Plan. Relevant figures from the Region documents and coordination noted above are provided in **Appendix E2**. Through the documents and discussions outlined above, it can be confirmed that the WVSP has been accounted for by the Region with regard to wastewater servicing through the extension of existing services.

The Region of Peel Water and Wastewater Master Plan (2020) identifies the servicing needs of future development to 2041. The Master Plan projects proposed in this document include watermain and sanitary sewer projects throughout the Region, including the planned growth areas in Caledon north of Mayfield Road and in west Bolton, but do not include the development area surrounding the anticipated Bolton GO station. Several wastewater projects are noted in the immediate vicinity of the WVSP including: T-085 (The Gore Road from current termination to Mayfield Road) and ST-256 (McVean Drive from current termination to Mayfield Road).

The Region of Peel SABE Water and Wastewater Servicing Analysis (2022) identifies the servicing needs of the anticipated growth areas in Caledon from 2041 to 2051 including the development area surrounding the anticipated Bolton GO Station. The analysis focused on conveyance infrastructure and did not include a summary of water treatment plant and wastewater treatment plant improvements required beyond those identified in the Region of Peel Master Plan (2020). The WVSP Area was identified as part of sanitary servicing area 3. No additional wastewater projects were noted in the immediate vicinity of the WVSP beyond those identified in the Region of Peel Water and Wastewater Master Plan (2020).

Draft DC Project Mapping (2024) was obtained from Region of Peel staff which illustrates preliminary sanitary projects to support the full buildout of the SABE including the WVSP. It should be noted that the projects and construction timing shown are preliminary only and subject to change. The Draft DC Mapping shows The Gore Road Trunk Sewer (T-085) extending north of Mayfield Road to King Street and the McVean Drive trunk sewer extending north of Mayfield Road on Centreville Creek Drive to immediately south of the planned Highway 413, refer to **Appendix E2.1**.

A first submission of the detailed design of project T-085 has been completed and reviewed by Region of Peel staff. The proposed 1200 mm diameter concrete sanitary sewer will extend north on The Gore Road from the current termination point approximately 80 m north of Beamish Court to immediately south of the planned Highway 413. The design drawings show individual plugs at the proposed maintenance hole structures to accept sanitary flows from the WVSP Area at the anticipated collector road locations and at the intersection with Mayfield Road. The latest version of the design drawings has been provided in **Appendix E2.2** for reference.

5.2.2 Proposed Sanitary Servicing

The Proposed Sanitary Drainage Plan (**Figure 5.2, Appendix E1**) shows local wastewater mains (i.e. sanitary trunk sewers) and drainage boundaries per the latest Region of Peel Draft DC Project Mapping (2024). The WVSP Area will be serviced via several connections to the future wastewater main on the Gore Road (project T-085) at each of the proposed collector road intersections. The internal alignment and location of the stubs for the proposed sanitary sewers are preliminary only and subject to change at the Draft Plan of Subdivision stage. No external drainage is proposed to be conveyed through the WVSP area in accordance with the latest Region of Peel Draft DC Project Mapping (2024).

The sanitary sewers within the WVSP Area are anticipated to have slopes ranging between 0.5% and 2% (typically). Preliminary grades and inverts are as illustrated on (**Figure 5.3, Appendix E1**). Slopes of less than 0.5% may be required for trunk sanitary sewers to limit the depth of trunk infrastructure while meeting minimum velocity criteria. The alignment and invert design of the trunk infrastructure is preliminary only and will be refined through the Draft Plan approval process to limit overall sewer depth.

The sanitary sewer system will be designed in accordance with the Region of Peel and MECP criteria, including but not limited to:
Residential Sanitary Generation Rate: 290 L/c/d,

- Commercial Sanitary Generation Rate: 270 L/emp/ha
- Population Density:
    - Single detached: 4.2 person/unit,
    - Semi-detached: 4.2 person/unit,
    - Townhouse: 3.4 person/unit,
    - Large Apartment (greater than 1 bedroom): 3.1 person/unit,
    - Small Apartment (less than or equal to 1 bedroom): 1.7 person/unit,
- Peaking Factor: Harmon (Max. 4.0),
- Infiltration Rate: 0.26 L/s/ha,
- Minimum Pipe Size: 200 mm diameter,
- Minimum Pipe Cover: 2.5 m below centerline road elevation,
- Minimum Actual Velocity: 0.75 m/s, and
- Maximum Velocity: 3.0 m/s.

A preliminary sanitary design sheet has been prepared based on the proposed Land Use Plan for the WVSP area and assumed land-use statistics. The sanitary design sheet is provided in **Appendix E3**. The WVSP Area sanitary drainage boundaries as defined by the limits of development in the Phase 1 Local Subwatershed Study will be refined through the Secondary Plan and Draft Plan approval process. Therefore, the populations and design flows are preliminary only and are subject to change.

5.3 Water Supply and Distribution

5.3.1 Existing and Planned Water Servicing

As noted in the Phase 1 LSS (SCS and GEI, November 2024), there are existing watermains on several arterial roads surrounding the WVSP area including: a 200 mm diameter watermain on Centreville Creek Road, Healey Road, and The Gore Road; and a 300 mm diameter watermain, 600 mm diameter watermain (Pressure Zone 5), and 750 mm diameter watermain (Pressure Zone 6) on Mayfield Road. The WVSP Area is located entirely within Pressure Zone 6 which has a serviceable elevation of 214.5 m to 259.1 m. The WVSP is located within the East Region of Peel transmission system. The system is fed from Lake Ontario and treated at the Arthur P. Kennedy Water Treatment Plant (HLP1C, HLP2C). Water storage and distribution for the WVSP area is provided by the Tullamore Reservoir (ES4) and Pumping Station (LLP5E, HLP6E) and the Bolton Elevated Tanks (BS6).

The planned water servicing improvements in the Region of Peel and Town of Caledon have been determined through the Region of Peel Water and Wastewater Master Plan (2020), and the Region of Peel Settlement Boundary Expansion (SABE) Water and Wastewater Servicing Analysis (2022). The WVSP Area is identified as Secondary Plan area G2 in the Town of Caledon Official Plan (OP, 2024). Relevant figures from the Region documents are provided in **Appendix E2.1**. Through the documents and discussions outlined above, it can be confirmed that the WVSP area has been accounted for by the Region with regard to water servicing through the extension of existing services and planned water servicing improvements.

The Region of Peel Water and Wastewater Master Plan (2020) identifies the servicing needs of future development to 2041. Several water projects are noted in the immediate vicinity of the Secondary Plan including: D-085 (Mayfield Road from Centreville Creek Road to the Gore Road), and D-184 (Centreville Creek Road from Mayfield Road to a mid-block connection). Per correspondence with Region of Peel staff, it is understood that project D-085 has been completed.

The Region of Peel SABE Water and Wastewater Servicing Analysis (2022) identifies the servicing needs of the anticipated growth areas in Caledon from 2041 to 2051 including the development area surrounding the anticipated Bolton GO Station. The WVSP Area was identified as part of water pressure subzone 6E. No additional water projects were noted in the immediate vicinity of the Secondary Plan beyond those identified in the Region of Peel Water and Wastewater Master Plan (2020).

Draft DC Project Mapping (2024) was obtained from Region of Peel staff which illustrates preliminary watermain projects to support the full buildout of the SABE including the Secondary Plan. It should be noted that the projects and construction timing shown are preliminary only and subject to change. The Draft DC Mapping shows a proposed 600 mm diameter distribution main extending north of Mayfield Road to Healey Road and a mid-block 400 mm diameter distribution main from Centreville Creek Drive to the Gore Road. A 400 mm diameter distribution main and 900 mm diameter transmission main are proposed on Healey Road however these projects are located outside of the WVSP Area.

A first submission of the detailed design of the distribution mains on Centreville Creek Road and the Gore Road has been completed by Schaeffers Consulting Engineers and reviewed by Region of Peel staff. The proposed 400 mm diameter PVC watermain on Centreville Creek Road will extend north from Mayfield Road to the future mid-block collector road. The proposed 600 mm diameter concrete pressure pipe watermain on the Gore Road will extend north from Mayfield Road to the future mid-block collector road. The design drawings show proposed chambers for future connections from the WVSP area at anticipated collector road intersection locations. The latest version of the design drawings has been provided in **Appendix E2.2** for reference.

5.3.2 Proposed Water Servicing

The Master Water Servicing Plan (**Figure 5.4, Appendix E1**) shows proposed local distribution mains and future Regional distribution and transmission mains per the latest Region of Peel DC Project Mapping (2024), and the approximate pressure zone boundaries. As noted above, the WVSP Area is located in Pressure Zone 6.

Servicing for the WVSP area will be provided by the distribution mains planned by the Region with connections to the existing distribution mains on Mayfield Road and the future distribution mains on Centreville Creek Road and The Gore Road.

The watermain system will be designed in accordance with the Region of Peel and MECP criteria including:

- Residential water usage rate: 280 L/c/d,
- Commercial water usage rate: 300 L/emp/ha,
- Population Density:
  - Single detached: 4.2 person/unit,
  - Semi-detached: 4.2 person/unit,
  - Townhouse: 3.4 person/unit,

    - Large Apartment (greater than 1 bedroom): 3.1 person/unit,
    - Small Apartment (less than or equal to 1 bedroom): 1.7 person/unit,
- Minimum Pipe Size: 150 mm diameter,
- Minimum Pipe Depth: 1.7 m, and
- Maximum Hydrant Spacing: 150 m.

Preliminary population estimates for the development blocks of the WVSP Area have been prepared based on the latest structure plan and assumed land-use statistics. The preliminary population estimates are provided in **Appendix E4** to be incorporated into the Region of Peel water model. The WVSP Area boundaries as defined by the limits of development in the Phase 1 Local Subwatershed Study will be refined through the Secondary Plan and Draft Plan approval process. Therefore, the populations are preliminary only and are subject to change.

The alignment of the proposed local distribution mains are within the future collector road rights-of-way only and therefore will not impact the NHS.

5.4 Storm Sewer Servicing

5.4.1 Existing Storm Sewer Servicing

There are no existing storm sewers within the WVSP Area or on the arterial roads immediately surrounding the WVSP Area. Under existing conditions, the drainage along Centreville Creek Road, Mayfield Road and The Gore Road are conveyed via roadside ditches.

5.4.2 Proposed Storm Sewer Servicing

The storm sewer system (minor system) within the WVSP area must be designed for the 10 year design storm as per the Town of Caledon standards and MECP guidelines, including the following:

- Pipes to be sized to accommodate runoff from a 10 year storm event, and up to the 100 year event where major flows are captured,
- Minimum Pipe Size: 300 mm diameter,
- Maximum Flow Velocity: 4.0 m/s,
- Minimum Flow Velocity: 0.75 m/s,
- Minimum Pipe Depth: minimum 1.0 m below basement floor elevations.

5.4.3 Proposed Clean Water Collector Systems

As outlined in Section 2.1.2.3, 2.5.4 and 4.4.1, there are three (3) Clean Water Collector (CWC) systems required to service the participating lands within the WVSP area. Refer to **Figure 4.5, Appendix D1**, for the location of the CWC systems on participating lands. Additional CWC systems may be required on non-participating lands, the need for which will be established through future Draft Plan of Subdivision application for these lands.

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SECTION 1: BACKGROUND INFORMATION

APPENDIX A1

LSS TERMS OF REFERENCE

scs consulting group ltd

GEI Consultants

APPENDIX A2

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APPENDIX A3

PUBLIC OPEN HOUSE POSTER BOARDS

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SECTION 4: SURFACE WATER

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CLIMATE CHANGE HYDROLOGIC MODELLING

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EROSION THRESHOLD ASSESSMENT

APPENDIX D6

WETLAND HYDROLOGIC ASSESSMENT

APPENDIX D7

REGIONAL SWM OUTLET CONTROL TARGET ANALYSIS

APPENDIX D8

CULVERT CAPACITY ANALYSIS

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APPENDIX E

SECTION 5: GRADING AND MUNICIPAL SERVICING

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APPENDIX E1

FIGURES

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SERVICING BACKGROUND INFORMATION

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APPENDIX E2.2

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SANITARY DESIGN SHEETS

APPENDIX E4

WATERMAIN CALCULATIONS

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