Clair Maltby Secondary Plan and Master Environmental Servicing Plan (CMSP / MESP) Comprehensive Environmental Impact Study (CEIS)

Phase 3 Impact Assessment
City of Guelph
Project # TPB168050

Prepared for:

City of Guelph
1 Carden Street, Guelph, Ontario N1H 3A1

3/6/2019

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3/6/2019

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Executive Summary

1. Introduction

The City of Guelph currently preparing the Clair-Maltby Secondary Plan. As part of this process, the City is preparing a Comprehensive Environmental Impact Study (CEIS), which establishes the existing environmental conditions within the Secondary Plan Area (SPA), determines the environmental impacts from the proposed land use (Community Structure) and then recommends mitigative and management measures to prevent and / or manage impacts (ref. Figure EX 1) The CEIS is being conducted by the Wood Team, comprised of Wood Environment & Infrastructure Solutions, Matrix Solutions and Beacon Environmental.

A Master Environmental Servicing Plan (MESP) is also being prepared concurrently. The MESP is intended to concurrently satisfy the requirements of the Municipal Engineers Environmental Assessment Act and the Planning Act. The MESP will determine the preferred servicing strategies (water, wastewater, stormwater and mobility) required for the Clair-Maltby SPA.

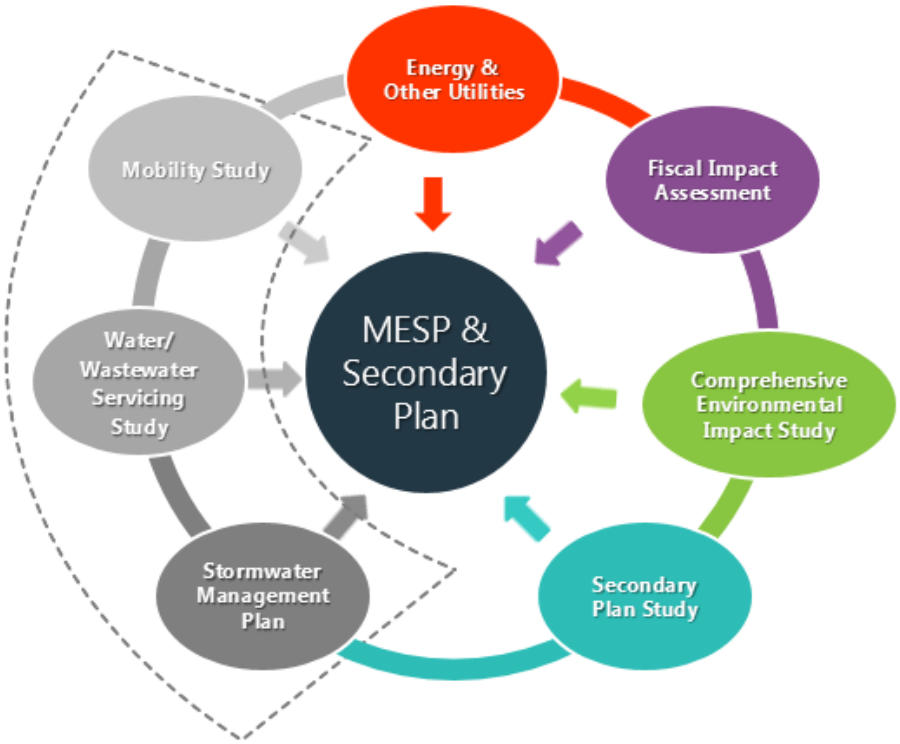


Figure EX.1: Clair-Maltby Study Components

The Secondary Plan Area (SPA): (ref. Figure EX.2) constitute the lands within which land use change will occur in accordance with an approved Secondary Plan. The SPA includes the lands south of Clair Road East, north of Maltby Road East, approximately 1 km east of the Hanlon Expressway near the City of Guelph and west of Victoria Road South but excluding the Rolling Hills Community in the corner of Victoria Road and Clair Road East. Notably, the Rolling Hills Community was originally included in the SPA for this project, and was originally reported under the Phase 1 and 2 Characterization reporting. However, based on feedback from the Community and other planning considerations, it was removed by decision of Council in June 2018 (Ref. Map NH-1, Appendix E).

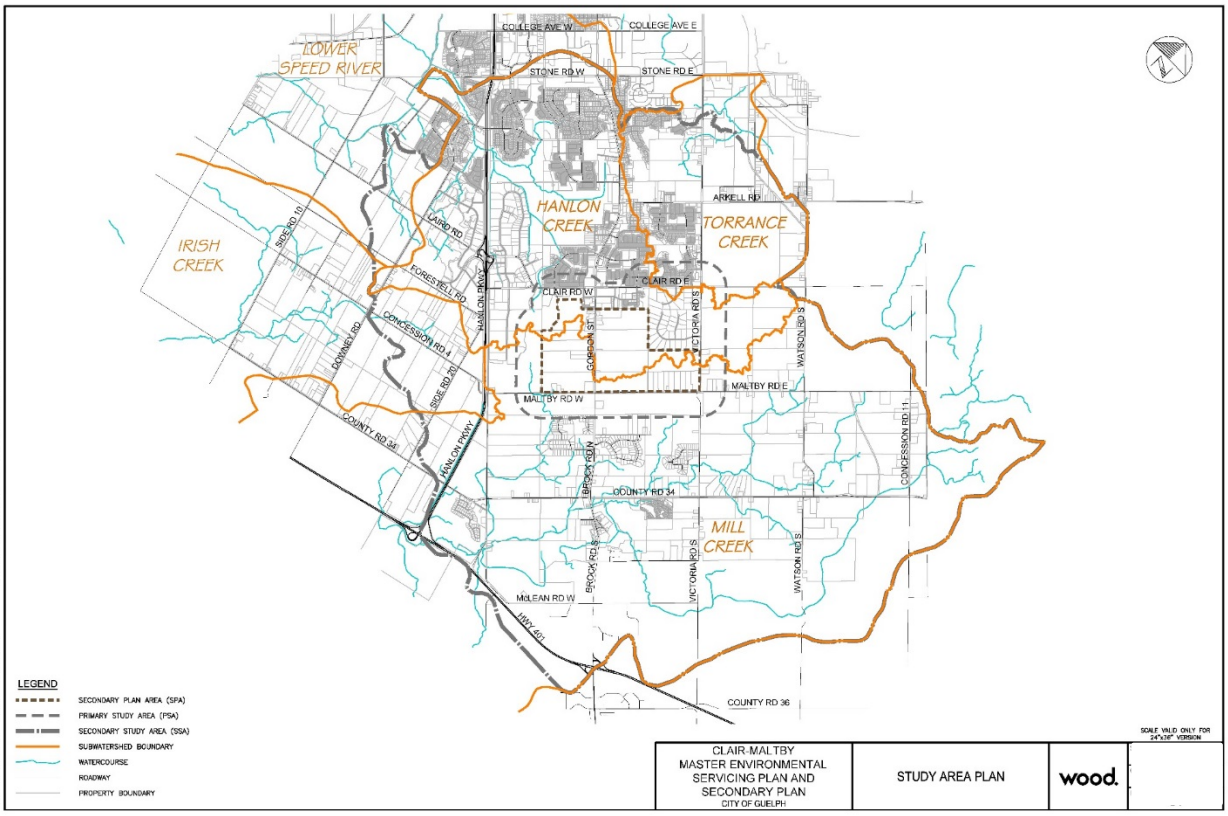


Figure EX.2: Study Area Plan

The purpose of the CEIS is to serve as a comprehensive and strategic document to address natural heritage and water resource protection and management based on a subwatershed scale assessment to inform environmental, land use and infrastructure planning and associated decision-making, as part of a broader integrated development framework for informing the Secondary Plan and its policies. The process and timing for developing the Secondary Plan is outlined in Figure EX.3.

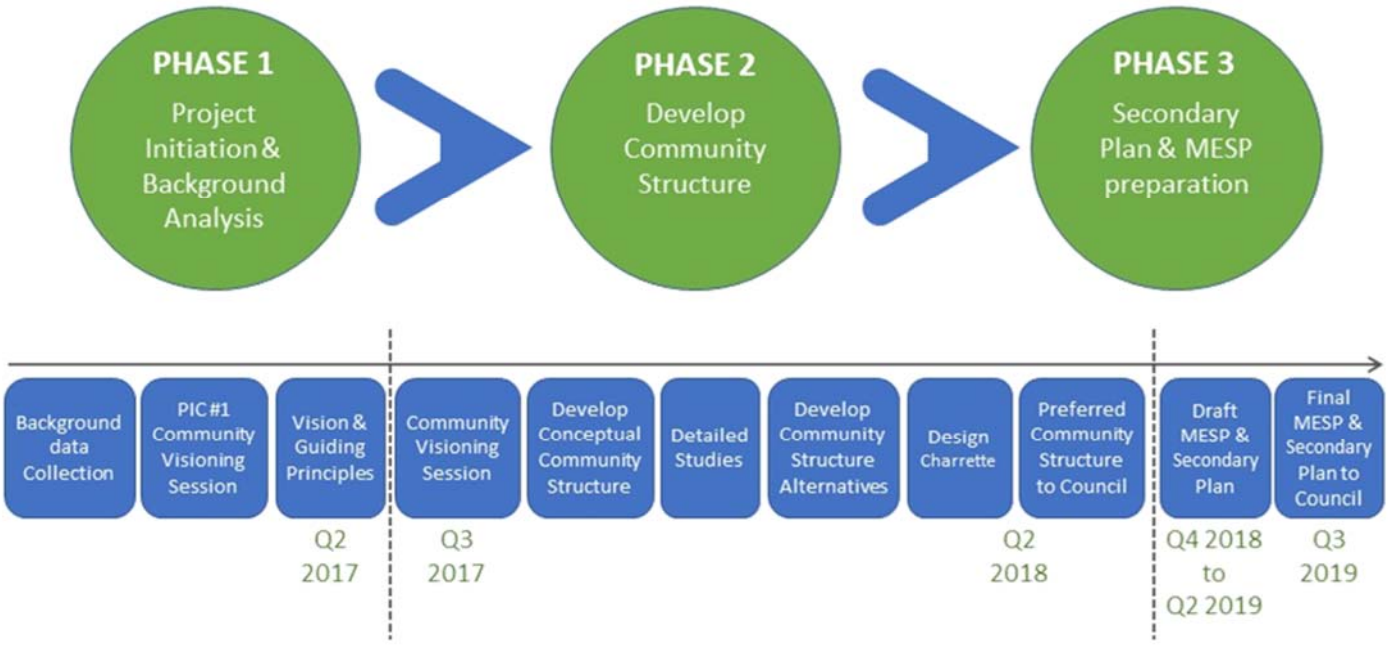


Figure EX.3 Clair-Maltby Secondary Plan Process

2. Summary of Phase 1/2 Characterization

The Phase 1/2 Characterization and Integration Report (September 2018) provided a summary of existing conditions associated with each discipline and a related integrated process to established guidance in developing and assessing various Conceptual Community Structures. The following provides a summary of key information from the Phase 1/2 Characterization discipline findings.

a. Hydrology (Surface Water)

The purpose of assessing the surface water systems for urbanizing subwatersheds is to provide a better understanding of the operative factors which influence the amount and movement of water in the system, both under existing land use and proposed future land use conditions. By developing representative numerical models, which reasonably predict seasonal and storm-based runoff response, the impacts of proposed future urbanization can be better quantified and thereby appropriate management strategies can be established in the future, as part of integrated management plans. Through this process, a hydrologic model was developed (PCSWMM) that determines the peak flows, runoff volumes, infiltration and evaporation that occurs within the existing drainage system in the Clair-Maltby SPA.

The Clair-Maltby SPA is located at the headwaters of the Hanlon Creek, Torrance Creek and Mill Creek and is characterized by a significant number of the depressional features and a general lack of overland drainage routes and watercourses. Surface runoff is predominantly infiltrated or evaporated. Each creek system annually has a loss (infiltration and evaporation) of 93% to 98% of the total precipitation, with Torrance Creek infiltrating the least, due to some existing development within its limits. The remaining surface water (not infiltrated or evaporated) ends up as discharge/ runoff from the system, which for Hanlon Creek is 0.4% and Mill Creek is 9%. Each creek system exhibits high annual infiltration, due to the depressional features and greenways, which will need to be considered within the Clair-Maltby SPA.

b. Hydrogeology

A background review of existing hydrogeological data and documentation, including regional and local scale information was completed to provide a preliminary understanding of the local and regional hydrogeological setting. The conceptual understanding derived from existing information was used to inform the groundwater field program and modelling for simulating existing and future conditions.

The conceptual model of groundwater flow developed in Phase 1 and 2 provides a summary of the existing spatial and temporal understanding of the groundwater flow system in the Secondary Plan Area (SPA) and the linkage with intermediate and regional flow system connections with the Primary (PSA) and Secondary Study (SSA) areas. The conceptual model was informed by existing information and reports on regional and local hydrogeology.

The Secondary Plan Area (SPA) is predominantly within the Horseshoe Moraine physiographic region and transitions into the Guelph Drumlin Field to the north in proximity to Clair Road. The main features of the Horseshoe Moraine are the Paris and Galt Moraines occurring as a broad composite moraine through the SPA and are responsible for the rough, hummocky terrain and often steep, irregular slopes. As noted earlier, streams and creeks are absent in the SPA reflecting the high infiltration capacity of the area. The headwaters of Hanlon, Mill and Torrance Creek form on the north and south slopes of the moraine. Flow measurements, seep observations, and presence of riparian wetlands in these headwater areas, indicate the groundwater discharge supports these creeks.

A groundwater field program was completed to support refinements to the understanding of groundwater function within the SPA and PSA. The understanding of the groundwater flow systems under existing conditions provided support for the design of future land use plans to minimize potential impacts to the groundwater system function. In Phase 2 the conceptual model of existing groundwater flow system was represented in an integrated surface water and groundwater flow model (MIKESHE).

The MIKESHE model represents all the relevant processes to represent existing and future conditions including rainfall, snow melt, runoff, infiltration, evapotranspiration, flow above and below the water table and ponding of water. The model inputs include surface and subsurface conditions in three-dimensions, using a 25 x 25 m grid and daily time step to represent spatial variation in spatial properties and rainfall and snowmelt events. The inputs were calibrated based on field measurements such as hydraulic conductivity and comparison of simulated water levels, groundwater discharge, or ponding to observed conditions.

The calibrated model simulation represents linkage of features and processes and provides a three-dimensional and time-varying understanding of infiltration, recharge, evapotranspiration, recharge, groundwater flow directions, and groundwater discharge. Based on the conceptual model and calibrated integrated model recharge (water table, shallow and deep bedrock amounts) within in the SPA and regional groundwater flow provides the following groundwater functions:

- Groundwater discharge to wetlands and headwaters in Mill Creek outside the SPA.
- Groundwater discharge to wetland north of Hall's pond within the SPA.
- Groundwater flow and discharge to Hanlon, Torrance, Mill Creeks
- Recharge to the water table, shallow (Guelph Formation) and deep (Gasport Formation) bedrock aquifers

The permeable nature of the surficial sediments, as well as the interconnected permeable nature throughout the thickness of overburden allows for significant infiltration, subsequent recharge to the water table (overburden aquifer) and shallow and deep bedrock aquifers. Groundwater flow tends to radiate out from the SPA to contribute groundwater flow to the Mill Creek and Hanlon Creek watersheds.

Closed depressional features are shown to provide enhanced infiltration and recharge.

Water budget analysis of Neumann's Pond, Hall's Pond and Halligan's Pond indicate these features are predominantly maintained by direct precipitation and minor overland flow contribution to these features which reflects the lower groundwater levels near these wetlands. Groundwater discharge appears to be derived locally and during spring melt or longer-term precipitation events. Wetlands within the SPA can exhibit perched conditions such as Neumann's Pond (i.e. unsaturated zone beneath the pond) or be connected to the water table such as Hall's Pond, Halligan's Pond (i.e. saturated zone beneath the pond) and other wetland/pond features within the SPA (i.e. northwestern portion of SPA).

Groundwater quality analysis indicates the overburden water consistently represents a calcium-magnesium carbonate system with no significant difference in most basic anions and cations between the shallow and deeper groundwater in the overburden monitoring wells. In addition, the basic anions and cations within the two PGMN bedrock wells appears to be like the overburden monitoring wells. Localized elevated levels of chloride and nitrate reflect potential quality degradation related to winter de-icing or agricultural applications.

The thick overburden provides a degree of groundwater quality protection from potential contaminant sources particularly those species that are considered conservative (i.e. those that do not biodegrade or are not adsorbed such as chloride). The Vinemount aquitard provides greater protection for the municipal aquifer.

c. Surface Water Quality

The purpose of the water quality assessment has been to characterize the water quality health of the Clair-Maltby SPA based both available (desk top) information from the associated subwatershed studies and also study data collection with respect to contaminant loadings under existing land use conditions. Most of the surface water drains to depressional features including natural features (i.e. wetlands and woodlots), as such surface water impacts from land use change could impact groundwater quality, that said it should be noted that Guelph's water supply is not linked to the groundwater sourced within the Clair-Maltby SPA.

A three (3) year water quality monitoring program commenced as of June 2016 and extended to late 2018. As part of the monitoring program, surface water quality monitoring has been conducted at key locations within the Clair-Maltby SPA and beyond to characterize the surface water chemistry under existing land use conditions. Based on the monitoring results, existing surface water quality within the Clair-Maltby SPA and immediately downstream is generally of reasonable quality, with exceedances to Provincial and Federal water quality guidelines in parameters linked to agricultural and golf course land uses and roadways.

d. Natural Heritage

As part of Guelph's Natural Heritage Strategy, Natural Heritage System (NHS) mapping and policies were developed for the entire City, including the Clair-Maltby Secondary Plan (CMSP) Area. These NHS policies and maps were included in the City's updated Official Plan in 2010, refined through the Ontario Municipal Board process, and finalized in June 2014.

From a natural heritage perspective, the CMSP Area is unique in the City because it is dominated by the Paris Moraine. This area has no watercourses and is dominated by hummocky topography that supports woodlands, wetlands and transitional habitats scattered among lands that are currently being farmed.

As part of the CMSP project, the natural heritage experts on the consulting team were asked to:

a) make refinements to the NHS mapping and characterization in the Secondary Plan Area (SPA) based on a combination of existing and new information collected, and current environmental legislation / policies / guidelines;

b) help design the Community Structure and Land Use Plan to avoid and minimize negative impacts to the NHS to the greatest extent possible while still accommodating the various Secondary Plan requirements; and

c) provide recommendations for avoiding, minimizing and managing for impacts anticipated in relation to the final Community Structure and Land Use Plan, including identification of, measures specifically tailored to the CMSP Area to protect, enhance and restore the unique natural heritage features and areas in the Secondary Plan Area.

The natural heritage work undertaken between June 2016 and December 2018 in support of this project within and adjacent to the CMSP Area included:

- Assessments of the range of water levels, water temperatures and water quality in selected wetlands;
- A review and analysis of current air photos to help refine vegetation community mapping;
- A review of background from all available environmental studies undertaken since about 2004; and
- Scoped field surveys of plants, wildlife and their associated habitats to further refine mapping and inform analyses of the significance of the various natural heritage features and areas.

The results of this natural heritage work (as documented in annual Monitoring Reports and in the Comprehensive Environmental Impact Studies completed for this project) have resulted in a Refined NHS consisting of the following components:

i. Significant Natural Areas (including Significant habitat for Provincially Endangered and Threatened species; Surface Water Features and Fish Habitat (warm water) plus a 15 m minimum buffer; Provincially Significant Wetlands (PSWs) plus minimum 30 m buffer); Significant Woodlands plus minimum 10 m buffers; Significant Landform; Confirmed Significant Wildlife Habitat (SWH);

ii. Ecological Linkages; and

iii. Potential Natural Areas (mapped as an Overlay) (including Candidate SWH; Cultural Woodlands plus minimum 10 m buffers; and Habitat of Significant Species).

A "Draft 1" Refined NHS based on information collected through to the end of 2017 was presented the spring of 2018. The Phase 3 Impact Assessment Report includes the "Draft 2" Refined NHS based on information collected through to the end of 2018. This version is expected to be very close to the Final Refined NHS to be used as a primary development constraint for the Secondary Plan.

3. Preliminary Community Structure

The Conceptual Community Structure (land use plan) for Clair-Maltby has been developed by the City through a highly consultative process, with input from government agencies, stakeholder groups, the public and the Wood Team. The process for developing the Community Structure is outlined in Figure EX.4.

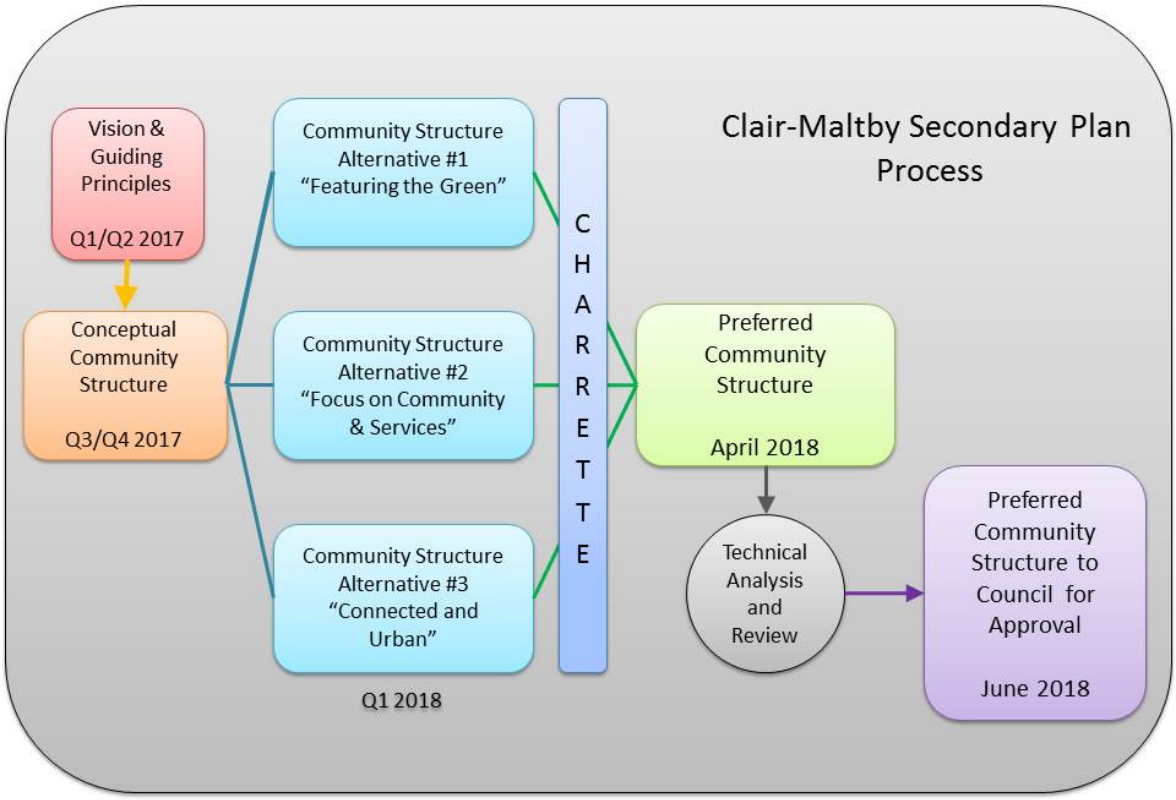


Figure EX.4. Clair Maltby Community Structure Development Process

In 2017 the City established a vision as per the following: *Clair-Maltby will be a vibrant, urban community that is integrated with Guelph's southern neighbourhoods, as well as having strong connections to Downtown, employment areas and the rest of the City. The Natural Heritage System and the Paris Moraine provide the framework for the balanced development of interconnected and sustainable neighbourhoods. This area will be primarily residential in character with a full range and mix of housing types and a variety of other uses that meet the needs of all residents. A system of parks, open spaces and trails will be interwoven throughout to provide opportunities for active and passive recreation. Guiding Principles in developing Community Structure included, Vibrant and Urban, Green and Resilient, Healthy and Sustainable, Interconnected and Interwoven, Balanced and Liveable.*

In April 2018, the City held a Clair-Maltby Planning and Design Charrette (ref. Figure EX.4). The purpose of the charrette was to develop a Preferred Community Structure (ref. EX.5) with input from the public, Wood Team and stakeholder agencies. The Charrette included tours of SPA, technical working sessions, stakeholder sessions, input from City of Guelph departments, Council and the attending Public. The Preferred Community Structure was then made available to the Wood Team for the Phase 3 Impact Assessment.

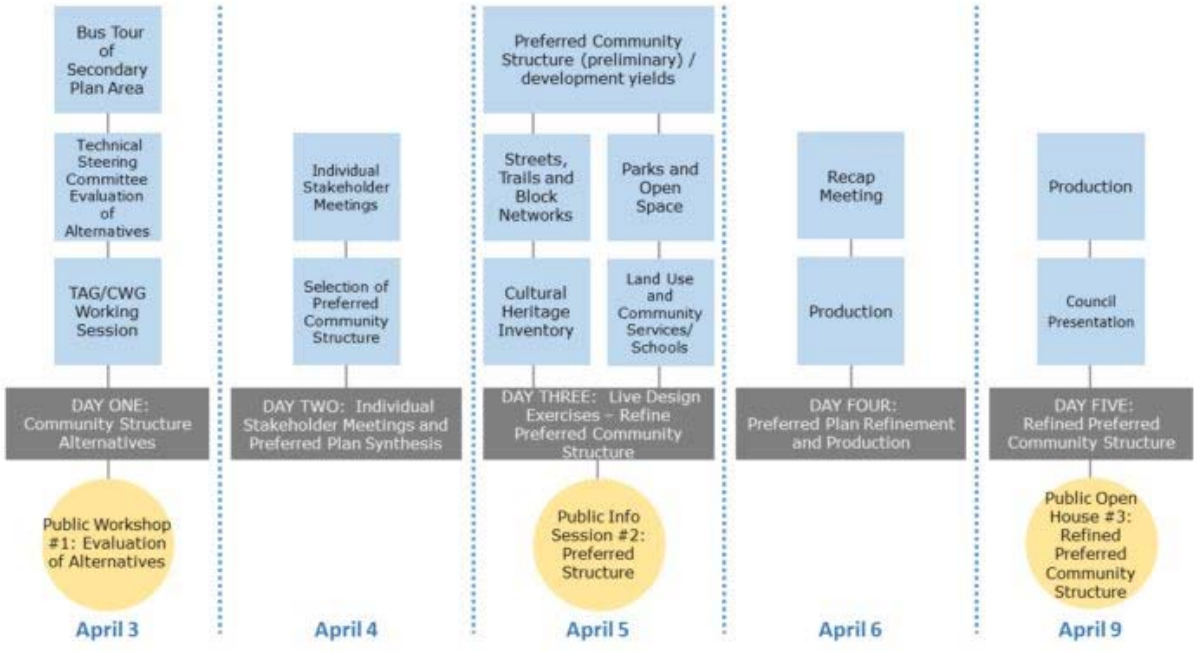
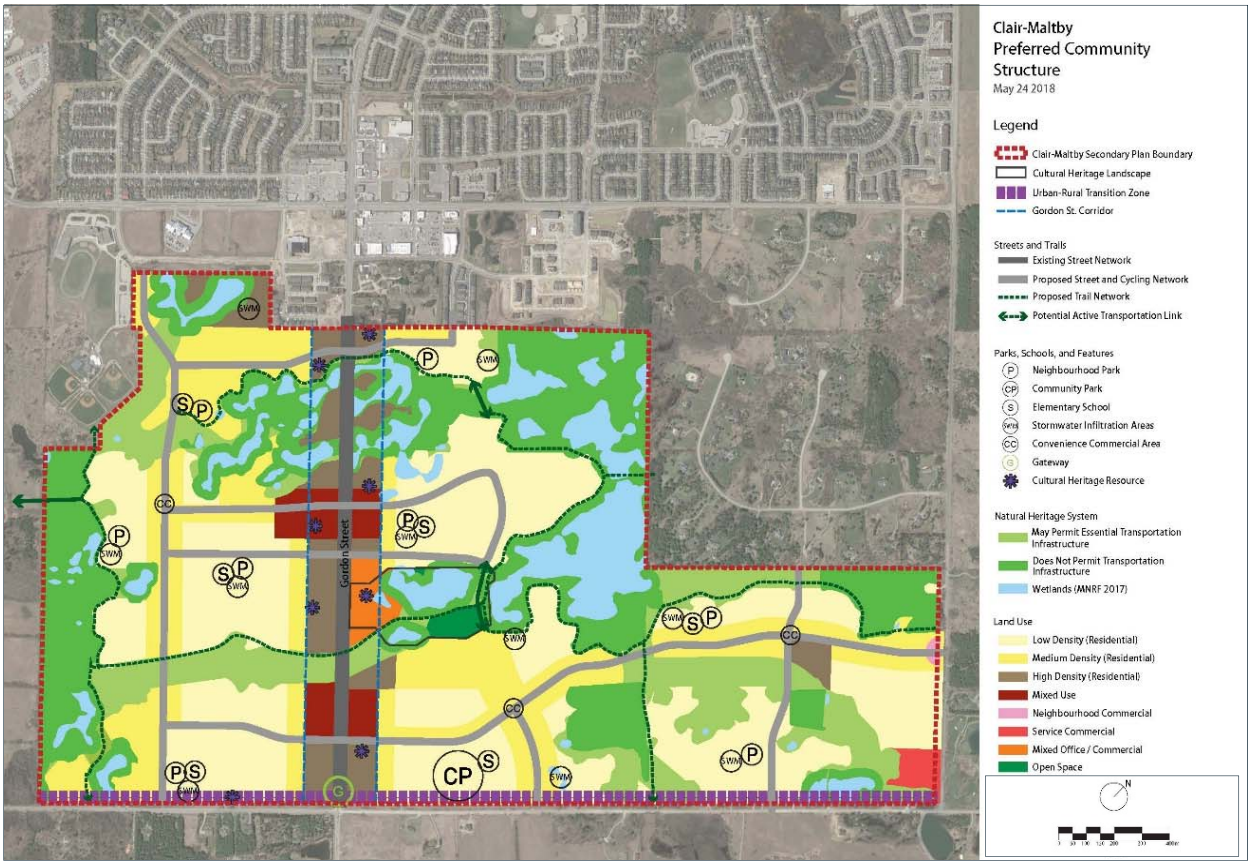


Figure EX.5 Clair-Maltby Planning and Design Charette Process



4. Phase 3 Impact Assessment and Management

A detailed assessment of the Preferred Community Structure (ref. Figure 3.5) has been completed to determine the potential impacts of the future planned development to the local and neighbouring environmental systems and features, and to establish preliminary management requirements accordingly, as detailed in the following sections. The key findings of this assessment serve as input to the land use refinement process to update and finalize the Preferred Community Structure and ultimately establish the recommended (preferred) management strategies.

a. Hydrology (Surface Water)

The hydrologic model (PCSWMM) has been used to assess the hydrologic impacts from the preliminary Community Structure. Typical impacts from urbanization include additional runoff, less infiltration and higher peak flows. As noted, the Clair-Maltby SPA is characterized by a significant number of depressional features, with certain features providing over 300 mm capture of runoff, which is greater than the Regional Storm (Hurricane Hazel) at 285 mm of precipitation. To mimic the existing depressional features, a distributed approach has been advanced of using low impact development (LID) best management practices (BMPs) capturing 27 mm runoff (captures up to 90% of all storm events) and designated surface water capture areas (SWCAs), for capturing and infiltrating drainage not captured by the LID BMPs. Hydrologic modelling results indicate that peak flows (external to the SPA) within Hanlon Creek and Mill Creek would be maintained at predevelopment levels. In addition, the amount of water available for infiltration would match existing drainage conditions.

b. Hydrogeology

The conceptual understanding of groundwater flow conditions within the SPA and PSA was used to inform the location of future land use types found in the preferred community structure (PCS). This understanding also informed the development of the Stormwater Management (SWM) plan and associated Low Impact Development (LIDs) and Best Management Practices (BMPs) plan for the PCS. As noted above, the Stormwater Management (SWM) plan takes advantage of the high infiltration capacity of the soils and thick unsaturated zone to replicate the function of existing depression features in the landscape which would be removed in development. Additional depression storage depth is incorporated into all development areas, outside of the NHS, to facilitate infiltration. Centralized SWM infiltration facilities or Stormwater Management Capture Areas (SWCAs) are planned to capture excess runoff and infiltrate additional runoff during precipitation events within the development area.

The PCS future conditions scenario was simulated using the MIKE SHE model developed as part of the Existing Conditions Characterization. The representation of the development area was updated to reflect changes in topography, imperviousness, reduced vegetation and new stormwater management practices. Additional depression storage was incorporated to all development areas to represent the role of onsite LID and BMP practices which facilitate infiltration. Stormwater volumes in excess of local depression storage were simulated to be routed to the centralized Storm Water Capture Areas (SWCAs) consistent with the proposed SWM plan.

Impacts of the PCS future conditions scenario and effectiveness of the LID BMPs and SWM measures were assessed by comparison to the existing conditions simulations for the period of 1998-2002. The impacts of the future land use change associated with the PCS were based on changes to:

- Water budgets in the SPA, PSA and key NHS features in, and adjacent to, the SPA,
- Groundwater flow directions and depth to water table,
- Recharge to the water table, shallow and deep bedrock aquifers

- Groundwater discharge to streams and wetlands.

The LID BMP and SWCA as simulated, combined with reductions in evapotranspiration due to reductions in vegetation in future land uses, are predicted to result in slight increases in recharge within the SPA and lateral groundwater outflow to Mill Creek subwatershed. A small reduction in groundwater outflow to Hanlon Creek subwatershed overall. While localised increases and decreases in groundwater recharge to the water table are predicted within the SPA the distributed detention storage in development areas and the additional capture capacity provided by the SWCA is predicted to maintain or slightly increase recharge and maintain overall groundwater flow directions and recharge to shallow and deep bedrock aquifers by infiltrating water as close to source as possible. By maintaining groundwater flow, gradients and linkages between recharge and discharge areas the PCS with LID BMP and SWCA, is predicted to maintain groundwater function within the study areas.

c. Surface Water Quality

Water quality from urban land uses has been characterized by various studies that runoff from roads, agriculture and golf courses, as having the highest contaminant loadings. The Preferred Community Structure includes various densities of residential land uses, commercial, institutional (schools) and parks, instead of the existing predominant agriculture land use and one golf course. As such, contaminant loadings typically associated with agriculture and golf courses, should be reduced, but contaminants from urban areas (typically from road areas) will increase.

To address the water quality impacts of the urbanized land use, drainage will be conveyed through a series of LID BMPs, with the overflow being directed towards surface water capture areas that will infiltrate the captured drainage. The foregoing approach has been described below:

i. Apply a distributed approach for 27 mm capture within LID BMPs

ii. Separate 'clean' water (rooftop and landscaped areas runoff) from dirty water, with dirty water typically resulting from roadways and parking areas

iii. Apply water quality measures in series to protect the surface water capture area's function of infiltration

iv. LID BMP selection and locations to be determined based on land ownership, land use, development form and grading (public and private realm)

v. Reduce the use of salt through the City of Guelph Salt Management Plan

vi. Low impact development measures and other stormwater quality management measures would need to be reviewed and refined through the MESP/EA process:

d. Natural Heritage

The identified NHS is a well-connected system that occupies more than 45% of the land base in the CMSP Area. "Environment first" strategies that have influenced the development of the Community Structure to date and will be carried forward into the final Community Structure and Land Use Plan include:

- Respecting the limits of the NHS by excluding all proposed land uses from identified natural heritage features and areas, and their applicable minimum buffers;
- Keeping municipal roads from crossing through Significant Wetlands and Significant Woodlands and generally limiting road crossings of the NHS to the greatest extent possible;
- Keeping the proposed trail network along the outer edges of the NHS (i.e., largely within buffers to protected features and not within the features themselves) and limiting trail crossings of NHS features and buffers while still accommodating connectivity for active transportation;

- Co-location of stormwater capture areas (SWCAs) with schools and parks to maximize infiltration in existing closed depressions and sustain local hydrologic and hydrogeologic functions; and
- Placement of SWCAs / parks / schools adjacent to the NHS where possible to provide some open spaces in the immediately adjacent lands, further "buffering" the NHS from more intensive residential and commercial land uses.

In addition, "Restoration Areas" as defined in the City's Official Plan have not yet been identified in the CMSP Area, but opportunities will be explored as part of the Community Structure and Land Use Plan finalization process, and other opportunities for habitat naturalization and restoration in other components of the NHS will be strongly supported through the Secondary Plan policies.

Although the strategies listed above will help avoid and mitigate most major potential development-related impacts to the NHS, there are still some anticipated unavoidable impacts related to implementation of the Secondary Plan. The primary challenges to maintaining and enhancing existing NHS functions in the CMSP Area are expected to be related to:

- Maintaining the local amphibian and reptile populations as population density and traffic increases;
- Effectively integrating the protected Significant Landform into the CMSP Area so that its visual uniqueness and hydrologic functions are maintained;
- Protecting the NHS from encroachments from adjacent land uses while supporting community connectivity and access to nearby natural areas.

A series of recommendations for measures to help avoid, minimize and manage potential negative impacts to the NHS at the Secondary Plan scale are included in this Phase 3 Report. In addition, as part of the implementation of the Secondary Plan, site-specific impacts will need to be addressed as part of area or site-specific studies undertaken as part of the development process.

The Refined NHS is expected to undergo one more round of minor edits based on feedback from the City, GRCA, MNRF, Technical Advisory Group, Technical Steering Committee, stakeholder groups, and the public. The final Refined NHS will then be integrated in the final version of the Community Structure to be developed over 2019.

5. Next Steps

The Phase 3 Impact Assessment has been reviewed and updated based upon input from the City and GRCA. Further review from the Technical Advisory Group, Technical Steering Committee, stakeholder groups and the public, may result in additional revisions, with the input to be considered into the revised Draft Secondary Plan (Community Structure) to be presented to the public at a PIC in April 2019. The Phase 3 Impact Assessment will then be updated for the revised Community Structure during April to July 2019.

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- Figure IA HYD2 Preliminary Conceptual Stormwater Management and Grading Plan
- Figure IA HYD3 Surface Water Capture

Appendix D: Surface Water Quality

- Map SW-1 Surface Water Monitoring Location

Appendix E: Natural Heritage Mapping

- Map NH-1 OPA 42 Approved Natural Heritage System (NHS)
- Map NH-2 Refined Ecological Land Classification
  - Map NH-2 (A1): Refined Ecological Land Classification: Northwest Quadrant
  - Map NH-2 (A2): Refined Ecological Land Classification: Northwest Quadrant
  - Map NH-2 (B1): Refined Ecological Land Classification: Southwest Quadrant
  - Map NH-2 (B2): Refined Ecological Land Classification: Southeast Quadrant
- Map NH-3 Refined Fish Habitat Mapping
- Map NH-4A Scoped Headwater Drainage Feature Assessment
- Map NH-4B Confirmed Headwater Drainage Features
- Map NH-5A Refinements to GRCA Wetlands Mapping
- Map NH-5B Refinements to MNRF Wetlands Mapping
- Map NH-6 Refined City Wetlands Mapping
- Map NH-7 Refinements to City Woodlands Mapping
- Map NH-8 Refined City Woodlands Mapping
- Map NH-9 Detailed Significant Wildlife Habitat (SWH) Mapping
- Map NH-10 Significant Wildlife Habitat (SWH) Mapping
- Map NH-11 Ecological Linkages Assessment
- Map NH-12 Significant Landform (2014) and Slope Classes
- Map NH-13 Significant Landform
- Map NH-14A Refined Natural Heritage System (NHS) for Secondary Plan Area
- Map NH-14B Comparison of OPA 42 Approved NHS and Refined NHS (2018)

1.0 Introduction

The City of Guelph is in the process of preparing the Clair-Maltby Secondary Plan which is supported by Comprehensive Environmental Impact Study (CEIS) and Master Environmental Servicing Plan (MESP) to comprehensively plan the last greenfield area in the City (Figure 1.1). The MESP is intended to satisfy the requirements of the Environmental Assessment Act and the Planning Act. A key component of the Clair-Maltby MESP and Secondary Plan process is the Comprehensive Environmental Impact Study (CEIS) being conducted by the Wood Team, comprised of Wood Environment & Infrastructure Solutions, Matrix Solutions and Beacon Environmental.

Three scales of study area (Figure 1.3) have been identified for the CEIS, as per the following:

The Secondary Plan Area (SPA): The SPA is the area within which land use change will occur in accordance with an approved Secondary Plan. The SPA includes the lands south of Clair Road East, north of Maltby Road East, approximately 1 km east of the Hanlon Expressway in the City of Guelph and west of Victoria Road South but excluding the Rolling Hills Community in the corner of Victoria Road and Clair Road East.

The Primary Study Area (PSA): The PSA includes the SPA plus a 500 m (+/-) zone beyond this boundary to allow for consideration of natural heritage functions and connectivity in the landscape.

The Secondary Study Area (SSA): The SSA includes the PSA plus the surface water / groundwater receiving systems beyond the Clair-Maltby SPA. This area has been defined based on the area's hydrology and hydrogeology to ensure that landscape scale connectivity is considered from a groundwater and surface water perspective. The SSA is based on appropriate groundwater and surface water model boundaries, which inherently consider subwatershed boundaries (Mill Creek, Hanlon Creek, Torrance Creek, Irish Creek and Lower Speed River), as well as groundwater flow divides.

Notably, the Rolling Hills Community was originally included in the SPA for this project, and reported under the Phase 1 and 2 Characterization reporting. However, based on feedback from the Community and other planning considerations, it was removed by decision of Council in June 2018 (Map NH-1, Appendix E). Although the SPA boundary has been changed to reflect the decision by Council, the boundaries of the PSA and the SSA have not been modified. From the outset of the study process, the biophysical connections between the SPA and the broader landscape, with respect to groundwater, surface water and natural heritage, was identified as an important consideration. The PSA and the SSA, as originally defined, continue to reflect where field work and analyses have been completed in support of the Secondary Plan process, irrespective of the removal of the Rolling Hills Community from the SPA. It is anticipated that the natural heritage refinements identified as part of this process in the Rolling Hills Community will be brought forward as part of a future Official Plan Update through the City's Municipal Comprehensive Review process.

The SPA (and the City as a whole) has an identified Natural Heritage System (NHS) which was incorporated into the City's Official Plan in 2010 through Official Plan Amendment (OPA) 42, refined through the Ontario Municipal Board (OMB) settlement process, and finalized through approval of OPA 42 in June 2014 by the OMB.

The purpose of this CEIS is to serve as a comprehensive and strategic document to address natural heritage and water resource protection incorporating subwatershed scale assessments to inform environmental, land use and infrastructure planning and associated decision-making, as part of a broader integrated development framework for informing the Secondary Plan and its policies.

1.1 Phase 1 and Phase 2 Characterization Report

In September 2018, the CEIS Characterization from Phases 1 and 2 of the study process (Figure 1-2) was provided to the City and Public. This report was developed based on 2016 and 2017 field data, and updated in response to comments received from the City and GRCA in July and August of 2018, and released to stakeholders and the community in September 2018. The CEIS Phase 1 and Phase 2 Characterization Report focused on the characterization of the SPA and specifically included:

a. Characterization of all aspects of the SPA, with consideration for the PSA and SSA as appropriate, with respect to surface water, ground water and natural heritage features and associated functions in the context of the applicable environmental legislation, policies and guidelines;

b. Updates and refinements to the NHS based on new information gathered through the CMSP process (as detailed in the 2016 and 2017 Monitoring Reports for this project) and based on the direction set out in the approved OPA 42; and

c. Preliminary targets and objectives for protecting, maintaining and enhancing the local water and natural heritage assets through the development process.

1.2 Phase 3 Impact Assessment Report

As envisioned at the outset of the CMSP, the technical studies and the planning process are fully integrated and have included:

- The Conceptual Community Structure incorporating input from the Community Charrette (April 2018) presented to, and approved by Council, in June 2018;
- Groundwater and surface water monitoring data collected over 2018[1] (i.e., between April and November 2018) and initial modelling and impact assessments completed based on the Conceptual Community Structure as approved in April 2018; and
- Additional natural heritage data collection (focused primarily on vegetation community / wetland mapping refinements, Map NH-2 and Maps NH-2 Pages A-1, A-2, B-1 and B-2 in Appendix E) undertaken between April and October 2018 on properties where access was not granted in 2016 but where site visits were requested in response to the Draft 1 NHS updates released in the spring of 2018.

This report, which constitutes the Impact Assessment of the Preferred Community Structure, builds on the work completed for the CEIS Phase 1 and Phase 2 Characterization Report by:

a. Incorporating the results of the 2018 ground and surface water monitoring;

b. Incorporating further refinements to the NHS (referred to as the "Draft 2" series of NHS maps) based on additional information collected over 2018 as well as input from the Grand River Conservation Authority (GRCA), Ministry of Natural Resources and Forestry (MNRF) and other stakeholders;

c. Including an evaluation of the impacts to existing surface water, ground water and natural heritage features and functions based on the currently approved Conceptual Community Structure (June 2018) and associated MESP servicing alternatives;

d. Refining targets and objectives for protecting, maintaining and enhancing the local water and natural heritage assets through the development process; and

[1] In the Terms of Reference for the CEIS the GRCA had identified a need for three years of water monitoring data to account for some of the expected year-to-year variability based on differing climactic conditions.

e. Developing recommendations and approaches to protect, maintain and, where possible, enhance the NHS and associated water resources in the SPA through implementation of the Secondary Plan.

This report also outlines next steps with respect to how the findings of this CEIS will inform the MESP and Secondary Plan as the other study moves towards completion.

The details of the additional field work completed in 2018 are available in the 2018 Monitoring Report, which is the third and final Monitoring Report in support of this study.

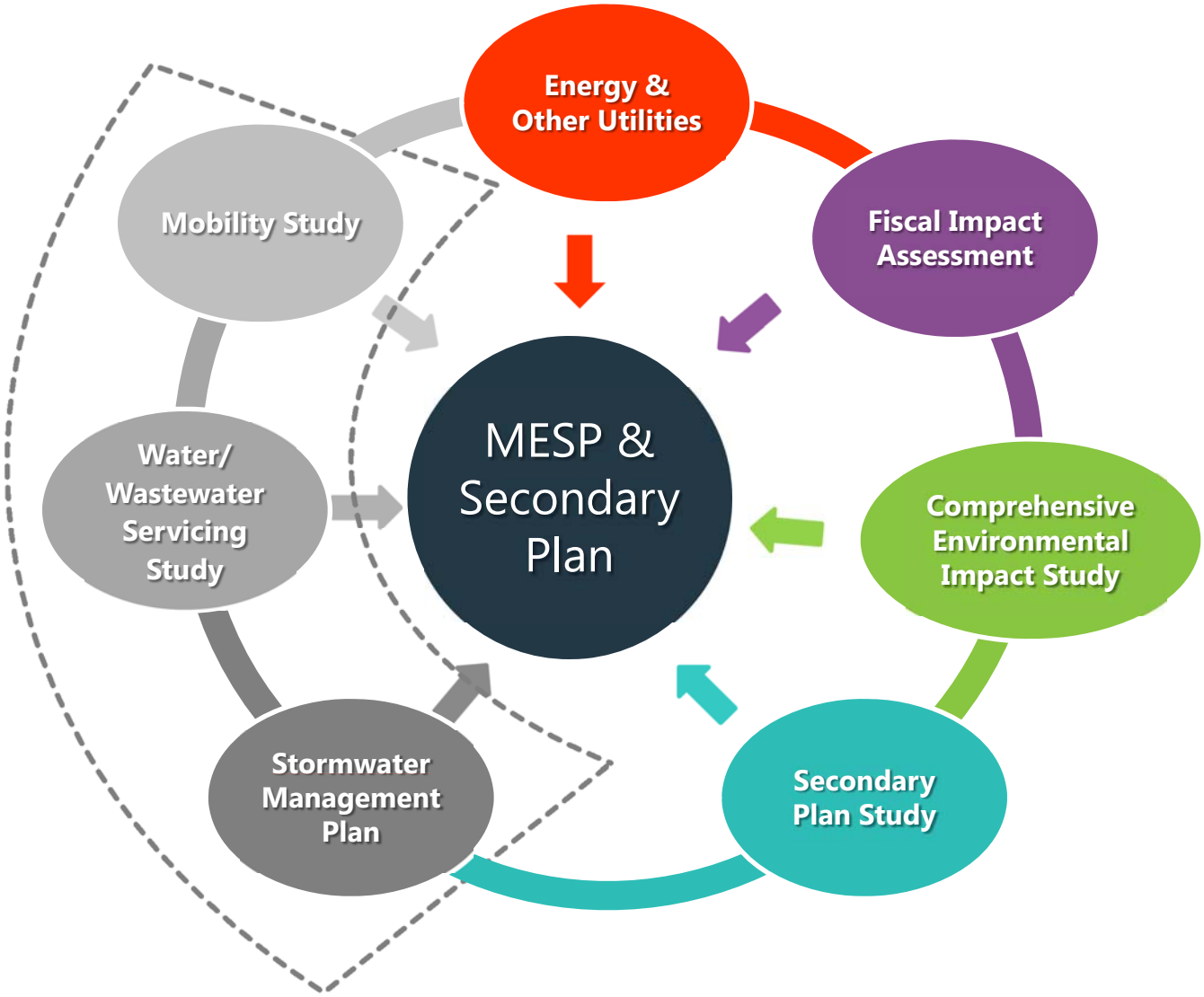

Figure 1.1: Clair-Maltby Study Components

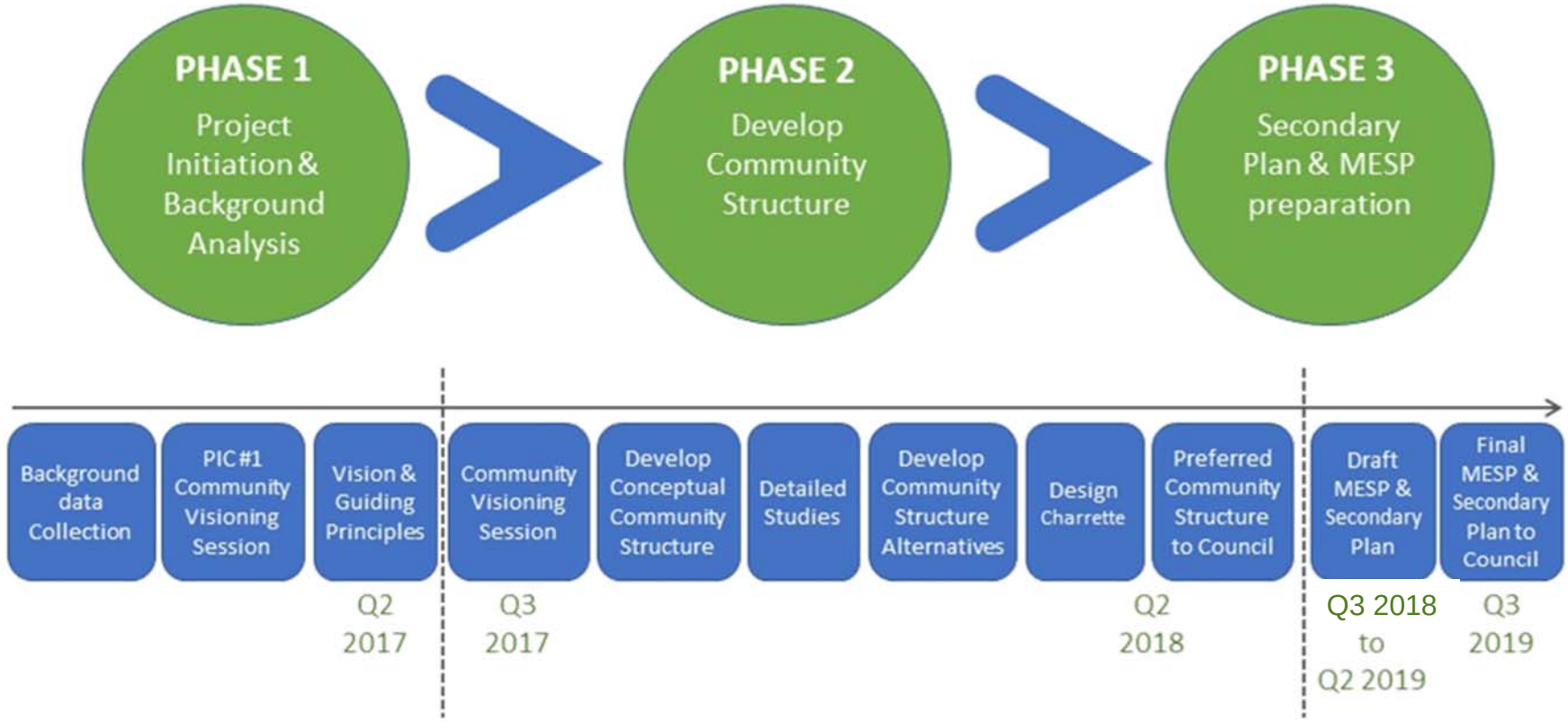

Figure 1.2: Clair-Maltby Secondary Plan Process

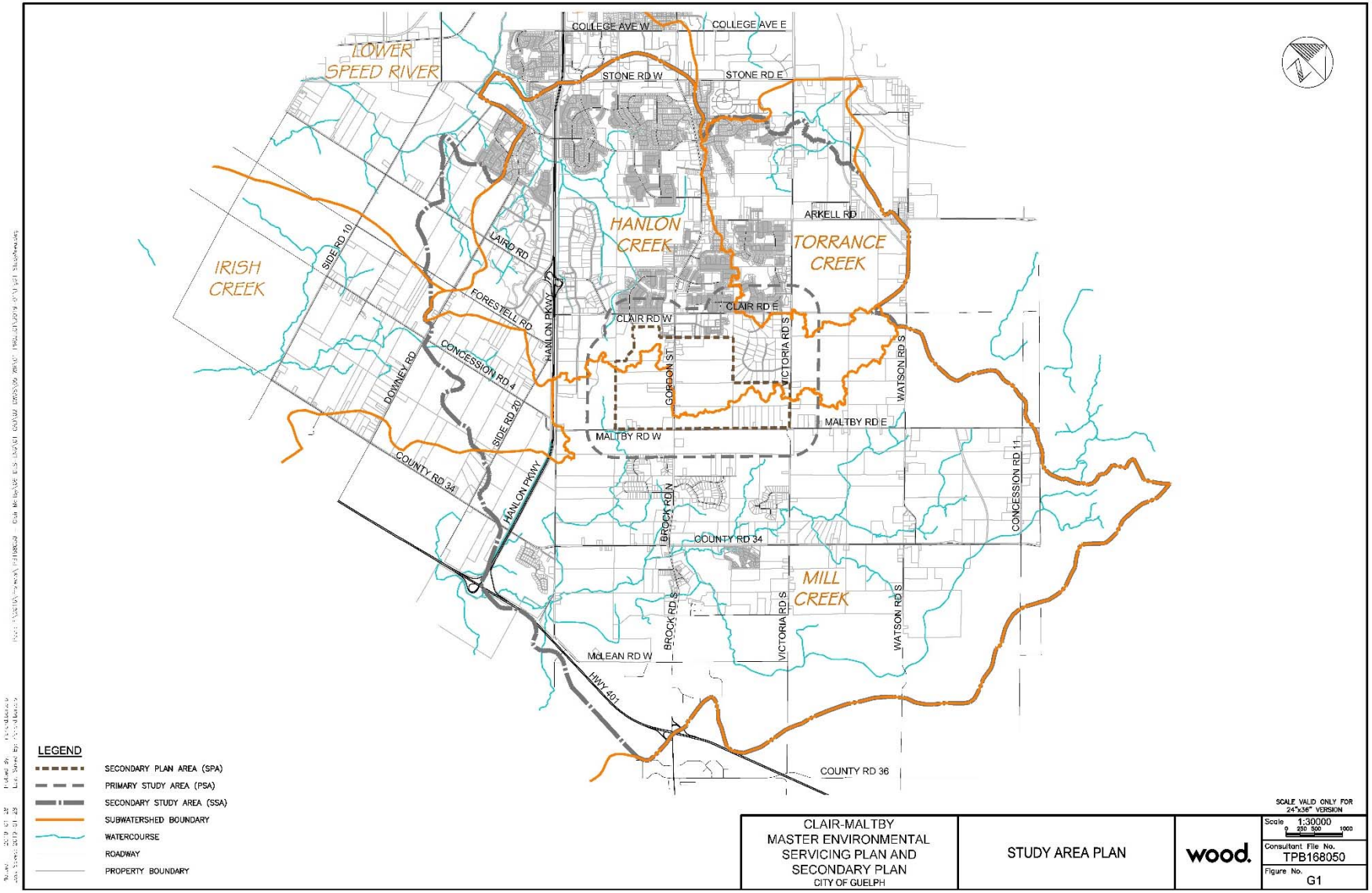

Figure 1.3: CMSP Study Areas

2.0 Summary of Phase 1/2 Characterization and Integration

2.1 Synopsis of Discipline Findings

The Phase 1/2 Characterization and Integration Report provided the existing conditions findings from each discipline and integrated the discipline specific findings to established guidance in developing and assessing various Conceptual Community Structures. The following provides a summary of key information from the Phase 1/2 Characterization discipline findings.

2.1.1 Hydrology

The purpose of developing hydrologic and hydraulic models for urbanizing subwatersheds is to provide a better understanding of the operative factors which influence the amount and movement of water in the system, both under existing land use and proposed future land use conditions. By developing representative numerical models, which reasonably predict seasonal and storm-based runoff response, the impacts of proposed future urbanization can be better quantified and thereby appropriate management strategies can be established in the future, as part of integrated management plans.

2.1.1.1 Drainage Systems

The Clair-Maltby SPA is located within the headwaters of the Torrance Creek Subwatershed, the Hanlon Creek Subwatershed and the Mill Creek Subwatershed, within the mid portion of the Grand River Watershed. The approximate contributing drainage areas within each Subwatershed within the Clair-Maltby SPA are summarized in Table 2.1.1.

Table 2.1.1 Summary of Contributing Drainage Areas within the Clair-Maltby SPA by Subwatershed

Subwatershed	Approximate Total Drainage Area (ha)	Percentage of the Clair Maltby SPA (%)
Torrance	5.24	1.0
Hanlon	320.90	60.0
Mill	209.17	39.0
Total Area	535.31	100

The lands within the Hanlon Creek Subwatershed generally drain overland to the northwest corner of the Clair-Maltby SPA. As per the Torrance Creek Subwatershed, the lands within the Hanlon Creek Subwatershed represent the headwaters of that subwatershed. Within the Hanlon Creek Subwatershed, the area within the Clair-Maltby SPA is also characterized by depressional features that result in little to no overland runoff to the defined watercourse system located north of the Clair-Maltby SPA, instead drainage is largely conveyed from the Clair Maltby SPA to the open watercourse via groundwater contributions.

The lands within the Mill Creek Subwatershed represent the headwaters of that Subwatershed and discharge toward the open watercourse system located south of Maltby Road South. The Mill Creek Subwatershed has a significant number of depressional features that contribute to the local ground water system (Figure HYD1).

2.1.1.2 Field Monitoring

To understand and assess the Clair Maltby study area's unique surface water / ground water system and associated natural heritage character, a three (3) year monitoring program (2016-2018) had been conducted as part of the Comprehensive Environmental Impact Study (CEIS). The monitoring program was conducted

to supplement the available data from existing studies and reports and instrumentation. For the purpose of validating the hydrologic model, rainfall and flow monitoring (Stations 9A, 9B, 14 and 15) was conducted in addition to spot flow measurements (Figure HYD2). Stations 14 and 15 in Mill Creek and Hanlon Creek respectively were the only two (2) stations that flow was observed during the monitoring period.

Based on the significant number of depressional features, most storm events do not result in a surface water response at the flow monitoring locations. The runoff response at the monitoring locations is considered largely a result of the local catchments immediately upstream of monitoring locations. In addition, both flow monitoring locations, Hanlon Creek (Station 15) and Hammersly (Station 14) are located downstream of groundwater discharge locations, which after certain storm events exhibit groundwater discharge conditions above the normal baseflow, therefore adding to the surface water response.

2.1.1.3 Hydrologic Modelling

A hydrologic analyses for the Clair-Maltby SPA was prepared using the PCSWMM modelling platform. The PCSWMM modelling completed for the Clair-Maltby SPA has been developed using the 2012 DEM with the subcatchment boundary plan for the overall PCSWMM hydrologic model presented in Figures HYD1 and HYD2. Subcatchments had been developed to represent the drainage areas within each subwatershed, Hanlon Creek, Mill Creek and Torrance Creek to specific monitoring locations, which are located outside of the SPA. To develop subcatchment boundaries, the significant number of natural depressional features located within and adjacent to the Clair-Maltby SPA have been assessed to establish their cumulative storage volume for the contributing area, resulting in a depth (mm) of storage for each depressional feature.

The validation of the PCSWMM hydrologic model has proceeded based on parameterization using the flow data collected for the Hanlon Creek monitoring site (Station 15) and the Mill Creek (Station 14) monitoring site for the 2016 to 2017 monitoring period.

The validated PCSWMM hydrologic model had been executed for a continuous simulation for the simulation period of 1950 to 2017 (67 years). Frequency flows determined using the Log Pearson Type III Distribution for both flow monitoring locations had been provided in Tables 2.12 and 2.1.3. Frequency flows for both Mill Creek and Hanlon Creek are low (<1.5 m^3/s) for the 100 year, based on the significant influence of depressional features and the existing greenway systems, infiltrating most of the 100 year storm runoff.

In addition to determining frequency flows and design event peak flows at the two (2) monitoring locations, the 1950-2017 climate data set had been used to determine an annual water balance (surface based water modelling) within the Clair-Maltby SPA and to the monitoring locations (flow and spot flow) within the Clair-Maltby Secondary Study Area (SSA) (ref. Figure HYD2). The annual water balance assessment has been conducted for each subwatershed based on the subcatchments contributing to the monitoring locations within Hanlon Creek, Torrance Creek and Mill Creek.

The Clair-Maltby SPA is located at the headwaters of the Hanlon Creek, Torrance Creek and Mill Creek and with the significant number of the depressional features and lack of overland drainage routes and watercourses, surface runoff is predominantly infiltrated or evaporated. Each creek system annually has a loss (infiltration and evaporation) of 93% to 98% of the total precipitation, with Torrance Creek infiltrating the least, due to some existing development. The remaining minimal surface water not infiltrated or evaporated ends up as discharge/ runoff from the system, which for Hanlon Creek is 0.4% and Mill Creek is 9%. Each creek system exhibits high annual infiltration, due to the depressional features and greenways, which will have to be replicated within the Clair-Maltby SPA. There are forty -seven (47) depressional features that have over 300 mm storage, of which only seven (7) features have been modelled to discharge during the 67 year continuous modelling period. The water balance results for Hanlon Creek and Mill Creek are in Tables 2.1.4 and 2.1.5. Torrance Creek (based on Rolling Hills not being in the Conceptual Community Structure) would not exhibit a change in water balance and as such has not been depicted. The existing

water balance for Hanlon Creek and Mill Creek provides a guide for associated targets for the future land use condition.

Table 2.1.2 Frequency Peak Flows (m^3/s)

Location (Map SW-1, Appendix D)	Return Period								
	1.003	1.050	1.25	2	5	10	20	50	100
Hanlon Creek Monitoring Site (Station 15)	0.008	0.036	0.100	0.250	0.530	0.760	0.990	1.310	1.550
Mill Creek Monitoring Site (Station 14)	0.035	0.038	0.039	0.045	0.069	0.100	0.160	0.290	0.480

Table 2.1.3 Design Storm Event Peak Flows (m^3/s)

Location (Map SW-1, Appendix D)	2	5	10	25	50	100	Regional
Hanlon Creek Monitoring Site (Station 15)	0.50	0.67	0.70	0.71	0.72	0.74	0.82
Mill Creek Monitoring Site (Station 14)	0.04	0.06	0.08	0.32	1.37	2.81	4.75

Table 2.1.4 Hanlon Subwatershed Annual Water Balance Summary

	Precipitation (mm)	Infiltration/ Transpiration (mm)	Evaporation (mm)	Discharge/Runoff (mm)
Mean	856.46	842.98	26.94	0.42
Median	846.34	828.41	26.34	0.01
Min	543.18	532.00	19.26	0.00
Max	1137.70	1127.13	38.38	5.74
Std Dev.	126.26	124.58	4.10	1.00

Table 2.1.5 Mill Creek Subwatershed Annual Water Balance Summary

	Precipitation (mm)	Infiltration/ Transpiration (mm)	Evaporation (mm)	Discharge/ Runoff (mm)
Mean	856.46	843.18	11.95	9.69
Median	846.34	830.49	11.70	8.91
Min	543.18	537.71	8.44	4.39
Max	1137.70	1125.45	17.35	21.10
Std Dev.	126.26	122.88	1.87	2.94

2.1.2 Hydrogeology

It is important to understand the interrelationship between the hydrogeologic conditions, the ecosystem and the use of groundwater for anthropogenic needs, to assess and manage potential impacts from future land use changes on the groundwater flow system.

A background review of existing hydrogeological data and documentation, including regional and local scale information was completed to provide a preliminary understanding of the local and regional hydrogeological setting. The conceptual understanding derived from existing information was used to inform the groundwater field program and modelling exercise.

The groundwater field program was designed to support refinements to the existing local hydrogeological characterization and establish baseline conditions within the SPA and PSA. The field program provided input for an understanding of the three dimensional and time-varying (e.g., seasonal) characteristics of the surface water and groundwater flow systems and provides support to a water balance evaluation of groundwater function, identification of constraints and opportunities, and provides monitoring locations that will form part of the long-term monitoring network.

The groundwater field work was coordinated with the work being completed by the other disciplines in recognition of the inter-relationship between the hydrogeological and hydrologic systems, other users of water for anthropogenic needs, and the local ecosystem.

Groundwater field work completed as part of the Study included:

- Borehole Drilling and Monitoring Well Installations
- Downhole Geophysical Logging
- Drive Point Mini Piezometer Installations
- Groundwater Level Monitoring
- Groundwater Quality Sampling
- Enriched Tritium Analysis
- Single Well Hydraulic Response Testing
- Guelph Permeameter Testing
- Surface Water Base Flow Measurements
- Pond Bathymetry Surveys
- Seeps and Springs Observations

2.1.3 Geology and Stratigraphy

The Secondary Plan Area (SPA) is predominantly within the Horseshoe Moraine physiographic region and transitions into the Guelph Drumlin Field to the north in proximity to Clair Road. The main features of the Horseshoe Moraine are the Paris and Galt Moraines occurring as a broad composite moraine through the SPA and are responsible for the rough, hummocky terrain and often steep, irregular slopes. Streams and creeks are absent in the SPA reflecting the high infiltration capacity of the area. The headwaters of Hanlon, Mill and Torrance Creek form on the north and south slopes for the moraine. Flow measurements, seep observations, and presence of riparian wetlands in these headwater areas, indicate the groundwater discharge supports these creeks.

The bedrock surface beneath the SPA slopes north to south from approximately 320 to 300 masl. The Paleozoic bedrock stratigraphy consists of sedimentary Silurian aged dolostones, shales, limestones, and associated interbedded sedimentary bedrock formations that dip regionally to the southwest. The sub-cropping bedrock is predominantly of the Guelph Formation with exposures of the Eramosa Formation (including the Vinemount Member). The City of Guelph bedrock groundwater supplies are derived primarily from the Guelph and underlying Goat Island and Gasport Formations. The Carter Wells to the northwest of the PSA extract their supplies from the Guelph Formation and overburden. The Burke Wells to the Northwest of the PSA extract their supplies from the Guelph Formation. Domestic wells supplies are typically derived from the Guelph or Goat Island Formations in the PSA.

The regional surficial geology mapping indicates that, in general, till is the dominant material on the higher elevations of Paris Moraine, however, within the moraine in the SPA, the texture of the Wentworth Till becomes coarser and the distinction between poorly-sorted kame gravel and coarse till is often arbitrary. The moraine may overlie till deposited by previous ice advances (Port Stanley Till). The overburden within the SPA ranges in thickness from 15 m to 50 m. The drilling program for the current study investigation and borehole logs from previous studies indicate that the Paris Moraine in the project area predominantly consists of glaciofluvial sand and gravels deposited in an ice-contact environment with a thin non-continuous till layer at the bedrock contact. Coarse-grained glaciofluvial sediments (sand- and gravel-rich units) dominate the overburden in the SPA, however, there is no lateral commonality to the sediment stratigraphy based on existing boreholes stratigraphic logs. The units comprising the Paris Moraine are horizontally and vertically variable in terms of texture and thickness due to their deposition in an unstable, rapidly changing setting. This resulted in units that have highly variable thickness and lateral extent that may overlap and/or inter-finger. Sediments within the wetlands and the bottom of ponds throughout the SPA can be made of up of organic and peat like deposits.

2.1.4 Conceptual Groundwater Flow System Model

Regional Groundwater Flow

Previous regional groundwater flow system characterization indicates a lateral component of groundwater flow into the SPA through the deep overburden and bedrock. The overburden tends to flow from the east/northeast into the SPA. Larger scale components show northeast flow towards the Eramosa River, south towards Mill Creek within the study area and east of the study area, and west through the study area towards the Speed River. Flow within the upper bedrock (Guelph and Eramosa Formations) tends to follow the same pattern. The direction of flow in the Gasport Formation (municipal aquifer) below the Vinemount Member aquitard is similar as well. Also indicated are downward hydraulic gradients between the upper bedrock and the lower Gasport Formation (across the Vinemount Member). This regional flow particularly within the lower overburden and upper bedrock Guelph Formation is expected to influence water levels in the deeper overburden within the study area as well as provide for groundwater discharge to Hanlon and Mill Creek. The capture zone of the Burke well is within municipal aquifer below the Vinemount aquitard extends to the eastern boundary of the SPA.

SPA Groundwater Flow System

The geological and stratigraphic characterization within the SPA give rise to the following hydrogeologic / hydrostratigraphic factors:

- Layers of till within the Paris Moraine are likely to have restricted areal dimensions and may occur as lenses encased by permeable glaciofluvial deposits and bedrock. The till may contain thin layers of

coarse-grained sediment and/or grade laterally into stratified ice-contact material thus affecting its ability to act as an aquitard.

- The coarse-grained glaciofluvial units which form the bulk of the moraine in the SPA can be considered as an interconnected, highly permeable assemblage. Units logged as sandy silt, sand and sand and gravel can be treated as a single hydrostratigraphic unit.
- The fine-grained silt-rich units are likely of limited areal extent and do not serve as aquitards.
- The lowermost till unit is generally thin and discontinuous and as a result it does not act as a regional aquitard. On the scale of the SPA a direct connection exists between the overburden and upper bedrock aquifers (above the Vinemount Member), and surface recharge can migrate to bedrock.

The observed water table shows horizontal flow components radiating out from the centre of the SPA west towards Hanlon Creek and south towards Mill Creek as well as a shallower gradient to the north. A comparison of the vertical hydraulic gradients to the horizontal gradients indicate that the downward gradients are a greater controlling factor in groundwater flow Groundwater levels are consistently below ground level or in some cases at ground level in the vicinity of some ponds and wetlands.

A conceptual SPA hydrogeologic flow system is presented in cross-section in Figure GW-1. The depth to the water table varies from 0 m at Halls Pond to 20 m in the vicinity of Gordon Street. Conceptual groundwater flow lines generally reflect the relative vertical and horizontal groundwater gradients. The observed groundwater levels and hydraulic gradients do not indicate any large-scale connections of the groundwater flow system to the SPA wetlands or ponds although potential smaller scale groundwater flow adjacent to the ponds or wetlands may contribute limited discharge on a seasonal or event basis. Surface water levels and groundwater levels associated with Neumann's Pond and Hallligan's Pond indicate a perched water table condition whereas Hall's Pond and Tim Hortons Pond (see Map SW-1 in Appendix D for pond locations) do not appear to be perched and appear to be at the level of the seasonal water table or slightly above it, but in contact with the water table through a saturated zone. Groundwater recharge within the SPA contributes to components of groundwater flow in the lower overburden and shallow bedrock of the Guelph Formation (Figure GW-18, Phase 1 Characterisation Report GW-18), adding to the more regional groundwater flow entering the SPA and subsequently contributing to groundwater discharge to Hanlon Creek, Mill Creek and potentially a minor contribution to Torrance Creek and potential groundwater discharge to wetlands downgradient of the SPA. Potential hydraulic connections between the bedrock and overburden appear to be demonstrated in overburden observation wells during pumping of bedrock wells.

Groundwater quality analysis indicate the overburden water consistently represents a calcium-magnesium carbonate system with no significant difference in basic anions and cations between the shallow and deeper groundwater in the overburden monitoring wells. In addition, the basic anions and cations within the two PGMN bedrock wells appears to be like the overburden monitoring wells. Localized elevated levels of chloride and nitrate reflect potential quality degradation related to winter de-icing or agricultural applications. The enriched tritium results indicate that the overburden water can range in age from 2 to 63 years.

2.1.5 Surface Water Quality

The purpose of the water quality assessment has been to characterize the water quality health of the Clair-Maltby SPA based on both available (desk top) information from the associated subwatershed studies and study data collection with respect to contaminant loadings under existing land use conditions. The intent has been to establish a baseline condition which can be used for the impact assessment and as a reference for future area or site-specific environmental studies.

The Clair-Maltby SPA does not drain overland to an open watercourse system; rather the area drains to depressional features that in some cases are wet (and identified as wetlands and/or ponds) and in other cases infiltrate very quickly and are therefore generally considered dry. Both the wet and the dry depressional features, dispersed across the SPA, contribute to the capture of surface water and to the groundwater system. The local wetlands and/or ponds contribute to the groundwater recharge to the groundwater flow system by "downward leakage". The dry depressional features contribute to the groundwater by quickly infiltrating water to the water table. Therefore, if not managed appropriately, impacts to surface water quality associated with development of the SPA can occur in the wetlands and/or ponds as well as in the groundwater.

Changes in groundwater quality has the potential if unmanaged to impact drinking water, however Guelph's water supply is not linked to the groundwater within the Clair-Maltby SPA. Guelph's Source Water Protection Plan Policies are part of the GRCA's Source Water Protection Plan Policies that restrict land uses that may impact ground water and require preventative measures such as stormwater management measures that protect groundwater.

2.1.5.1 Water Quality Monitoring

A three (3) year water quality monitoring program commenced in June 2016 and extended to late 2018. As part of the monitoring program, surface water quality monitoring has been conducted at targeted locations within the Clair-Maltby SPA and beyond to characterize the surface water chemistry under existing land use conditions. The water quality monitoring locations are illustrated in in Figure SW-1 (Appendix D).

The water quality monitoring conducted in 2016 and 2017 indicates that the existing surface water quality within the Clair-Maltby SPA and immediately downstream is generally of reasonable quality. Repeat sampling conducted over 2018 confirms if these results are generally consistent from year to year under different weather conditions (see the 2018 Monitoring Report).

The instream water temperature for the Mill Creek Station 14 (south of the SPA) during 2016 to 2017 did not exceed 19°C, while the Hanlon Creek Station 15 (north of the SPA) exceeded 27°C. Water temperatures within Hanlon Creek flow monitoring station are impacted by runoff from existing residential development and the thermal impacts resulting from the permanent pool with the nearby stormwater management facility.

Wetlands are dynamic and surface water temperatures in wetlands will vary depending on a variety of factors including their size and depth, the extent to which the water levels in them vary over the year, air temperatures, the extent and type of natural, and the source(s) of their water (i.e., surface water, groundwater or both).

The larger wetlands sampled in the Hall's Pond subwatershed (as discussed in Section 4.2.7) have variable sources of water inputs other than direct precipitation depending on their location and the time of year. For example, while Neumann's Pond (Station 1) and Halligan's Pond (Station 13) appear to be largely surface water fed, Hall's Pond (Stations 6, 7 and 8) is being sustained by both groundwater and surface water contributions. In the Mill Creek Watershed, the "Tim Hortons Pond" (Station 10) is also being sustained by both groundwater and surface water contributions and the relatively cool temperatures documented in the remaining wetlands assessed over 2017 in both Hall's Pond Subwatershed (i.e., Stations 3, 4 and 5) and Mill Creek Watershed (i.e., Stations 11 and 12) suggests that these smaller wetlands are also being sustained to some extent by a direct connection to the groundwater table. The relationship of these results to the fish community in the SPA is discussed in Section 4.5.5.

With respect to water chemistry, Provincial Water Quality Objectives (PWQO), Canadian Environmental Quality Guidelines (CEQG) and Canadian Drinking Water Quality Guidelines (CDWQ) repeated exceedances

were documented at several stations and at different times of the year under existing conditions at both flowing and non-flowing wetland stations. During wet weather conditions exceedances for Total Phosphorus, Aluminum, Alum, Calcium, Cadmium, Iron, Manganese, Zinc and Ammonia across many sampling stations and multiple sampling events Exceedances can occur for various reasons, such as untreated runoff from roadways, application of fertilizers on agricultural and the golf course within the area and, in some cases (such as Zinc in Mill Creek watershed) due to naturally high occurrences. These exceedances and their potential causes are not being studied as part of the CMSP as this can be very complex and is not necessary to support decision-making with respect to land use planning and impact management. Exceedances are, however, being documented in order to contribute to a more complete picture of existing baseline conditions in the SPA to: (a) guide management directions and objectives with respect to water quality in the SPA, and (b) provide generalized baseline information against which to assess site-specific findings as part of future development applications and related technical studies. In addition, exceedances specifically related to Sodium and Chloride will need to be addressed in accordance with the applicable source water protection policies at both the Secondary Plan and the site-specific level.

2.1.6 Natural Heritage System

As noted in Section 1.0, there is already an identified Natural Heritage System (NHS) (see Map NH-1, Appendix E) and associated policies for the SPA (and the City as a whole). NHS policies and mapping were incorporated into the City's Official Plan in 2010 through OPA 42, refined through the OMB settlement process, and finalized through the OMB's approval of OPA 42 in June 2014.

As part of the CMSP process the consulting team was specifically asked to: (a) review the existing NHS in the context of the current and applicable environmental legislation, policies and guidelines and (b) make refinements to the NHS based on new information gathered through the CMSP process and the direction set out in the approved City Official Plan (2014). The details of the methods and findings of the aquatic and terrestrial habitat assessments undertaken in support of this refinement process are provided in the CMSP CEIS Monitoring Reports (i.e., 2016, 2017 and 2018). The overview of the NHS provided in this report builds on the assessments provided in the Phase 1 and Phase 2 Characterization Report (Section 4.6 in Wood et al., 2018) and incorporates updates based on additional data collected over 2018[2] (as provided in detail in the 2018 Monitoring Report, Wood et al., 2019) where appropriate.

From a natural heritage perspective, the SPA is unique in the City in that it contains no watercourses due to its morainal geology and generally "porous" soils. Rather it can be broadly characterized as an area dominated by hummocky topography that supports both significant infiltration and recharge, with woodlands, wetlands and successional habitats scattered among lands that are currently being farmed.

For the purposes of the CMSP CEIS, the various natural heritage features and areas have been assessed in accordance with the applicable City natural heritage policies (i.e., as approved under OPA 42) and the applicable Provincial and GRCA policies and guidance (including the Provincial guidance for significant wildlife habitat) in order to support the refinements to the NHS.

An additional and important consideration has been the treatment of settlement agreements reached as part of the OPA 42 OMB process (Map NH-1, Appendix E). Based on direction from the City's legal counsel, the overall approach taken to NHS refinements has been to respect agreements made related to

[2] The overall approach to NHS mapping refinements over 2016 and 2017 is provided in the CEIS Phase 1 and Phase 2 Characterization Report (Wood *et al.*, 2018). Additional work undertaken in 2018 to further inform refinements to the NHS included: vegetation assessments including wetland refinements (using the Ecological Land Classification [ELC] system for southern Ontario [Lee *et al.*, 1998]) on eight properties where access had not previously been provided (Map NH-2 series in Appendix F), wetland refinements in response to new information provided by MNRF and GRCA (through the landowner's consultants), and wildlife surveys in one of the larger parcels for which access was granted late in 2017.

interpretation of the applicable OPA 42 policies through the OMB process, while identifying refinements to the NHS (where appropriate) based on new information collected as part of the CMSP CEIS process (e.g., significant wildlife habitat). There is also a property (see Map NH-1, Appendix E) that is before the courts on matters related to the City's Tree Protection By-law. On this property the vegetation classification (i.e., Ecological Land Classification, or ELC) mapping in place at the time of approval of the City's NHS (2014) has been retained as the basis for the NHS refinements, as directed by the City.

Given this context, the NHS in the SPA and the refinements to it have been described using the NHS framework as established in the City's Official Plan (March 2018 Consolidation) and approved by the Province. The City's NHS is broadly divided into two categories of features and areas: Significant Natural Areas and Natural Areas, with the former generally being subject to more restrictive policies than the latter. City-defined NHS components that have been identified in the SPA through the CMSP CEIS process are as follows:

- Significant Natural Areas
  - Significant habitat for Provincially Endangered and Threatened species;
  - Surface Water Features[3] and Fish Habitat (warm water) plus 15 m minimum buffers;
  - Significant Wetlands (i.e., Provincially Significant Wetlands (PSWs)) plus minimum 30 m buffers;
  - Significant Woodlands plus minimum 10 m buffers;
  - Significant Landform;
  - Confirmed Significant Wildlife Habitat (SWH); and
  - Ecological Linkages;
- Natural Areas
  - Candidate SWH;
  - Potential Cultural Woodlands (note minimum 10 m buffers have not been applied); and
  - Potential Habitat of Significant Species.

City NHS components not known to occur in the SPA include Significant Areas of Natural and Scientific Interest (ANSIs), Significant Valleylands, Locally Significant Wetlands and Other Wetlands.

All of the NHS components listed above have been confirmed through the CMSP process, however with respect to the mapping the following should be noted:

- Significant habitat for Provincially Endangered and Threatened species and potential Habitat of (Locally) Significant Species has not been mapped (for reasons described in Section 2.1.6.1 below);
- Candidate SWH and potential Cultural Woodlands identified through the CMSP CEIS process, are currently mapped as overlays and not land use designations to indicate that their status will need to be assessed and reviewed as part of area or site-specific studies;
- Significant Wetlands, Significant Woodlands and Significant Landform as verified through the CMSP process are generally considered confirmed however their precise boundaries will require review and staking with the City and – where the feature falls within their regulated area - GRCA as part of area or site-specific studies;

[3] Ponds, headwater drainage features and seepage areas only – no rivers, streams or lakes.

- A few of small wetlands or ponds have not been recommended for complexing with the broader PSWs in the SPA as part of this process (as described in Section 2.1.6.3) and did not qualify as Locally Significant Wetland or Other Wetlands based on their size, but these features will need to be assessed in accordance with the applicable policies as part of area or site-specific studies;
- Minimum buffers applied to confirmed NHS features as prescribed in the City's Official Plan (March 2018 Consolidation) and indicated in the list above are not defined as part of the feature but are part of the overall NHS in both the City's Official Plan and the refined NHS mapping put forward through the CMSP CEIS; and
- To date, no Restoration Areas[4] have been identified in the SPA as part of the CMSP and CEIS process, however:
  - opportunities for the identification and integration of Restoration Areas into the SPA mapping and/or policies are being explored as part of the Secondary Plan finalization process (see Section 2.1.6.8 and Section 2.3.4.9); and
  - opportunities for habitat restoration and naturalization outside of formally identified "Restoration Areas" are supported by the existing City policies for buffers as well as other NHS features such as Ecological Linkages and Significant Landform.

Mapping and mapping refinements to these various components, and to Significant Natural Areas and Natural Areas as a whole, are illustrated in the NH-series maps provided in Appendix E and described below.

It has been considered appropriate to discuss some of the NHS feature components in a combined manner even though some are Significant Natural Areas and some are Natural Areas, since the assessments for these features were conducted concurrently using the same data sets and/or mapping. Therefore, for the purposes of this study, summaries of the NHS feature components within and adjacent to the SPA are organized as follows in this section of the report:

- Significant Habitat of Provincially and Locally Significant Species (Section 2.1.6.1);
- Surface Water Features and Fish Habitat (Section 2.1.6.2);
- Significant Wetlands and Other Wetlands (Section 2.1.6.3);
- Significant Woodlands and Cultural Woodlands (Section 2.1.6.4);
- Significant Wildlife Habitat (Section 2.1.6.5);
- Significant Landform (Section 2.1.6.6);
- Ecological Linkages (Section 2.1.6.7); and
- Restoration Areas (Section 2.16.8).

A summary of the refinements to the overall NHS mapping as approved through OPA 42 in the SPA is provided in Section 2.1.6.9.

[4] Notably, criteria for formally designating "Restoration Areas" through the City's Official Plan are very specific and only include: (1) existing and new stormwater management areas abutting the Natural Heritage System; (2) areas within City parkland (including portions of the Eastview Community Park) and GRCA lands which are not intended for active uses; and (3) isolated gaps within the Natural Heritage System. Naturalization and habitat restoration in other components of the NHS such as Buffers and Linkages is also supported through the City's policies and expected to occur as development in the SPA proceeds.

2.1.6.1 Significant Habitat of Provincially and Locally Significant Species

Species significance can be determined in a variety of manners and at a variety of scales, but generally indicates that the species is uncommon to rare in the area, and at risk of becoming more rare or extinct if nothing is done to address the current threats to the species and/or its habitat. In the City of Guelph, significant habitats for species can be divided into three groups in accordance with the applicable policies and regulations:

a. Significant habitat of Provincially Endangered and Threatened species;

b. Significant Wildlife Habitat (SWH) (ref. Section 2.1.4.5); and

c. Habitat of Locally Significant Species (i.e., in the County of Wellington).

Notably, this discussion focusses on terrestrial plants and wildlife and excludes aquatic species which are discussed in Section 2.16.2 under fish habitat.

a. Significant habitat of Provincially Endangered and Threatened species is broadly protected in the City's Official Plan in accordance with the Provincial Policy Statement (2014), however it is the Ministry of Natural Resources and Forestry (MNRF) who is ultimately responsible for implementing and enforcing the protection of such habitats in accordance with the Endangered Species Act (ESA) (2007) and related species-specific habitat regulations. Although the City is not the ultimate planning authority for this component of the NHS, the City and development proponents are required to be compliant with the ESA and therefore these species are considered and addressed through the CMSP CEIS.

b. Species that are Provincially significant but not listed as Endangered or Threatened (i.e., listed as S1, S2 or S3 by the Ontario's Natural Heritage Information Centre (NHIC)) and species considered Species at Risk (SAR) but not listed as Provincially Endangered or Threatened (i.e., species that are only listed as Endangered or Threatened Federally or are considered Special Concern Provincially or Federally) are captured under SWH (ref. Section 2.1.4.5).

c. In the City of Guelph, "locally significant" species are those listed in the significant plant and wildlife species lists for Wellington County (City of Guelph 2012). Although these may include species that are also Provincially Endangered or Threatened, or considered of conservation concern under SWH, the MNRF regulates the former category while the City is responsible for implementing SWH policies. These locally significant species lists are considered working lists that are subject to periodic review and updates as approved by Council.

The findings of the CMSP CEIS work related to (a) significant habitat of Provincially Endangered and Threatened species and (b) habitat of Locally Significant species is summarized below.

Habitat of Provincially Endangered and Threatened Species

There is confirmed or potential habitat for 13 Provincially Endangered and Threatened species in the SPA and/or PSA:

- As part of the field work done by Beacon or in site-specific studies completed over the last decade, the following six Provincially Endangered or Threatened species have been confirmed in the SPA and/or PSA (i.e., Butternut (*Cinerea juglans*), Yellow-breasted Chat (*Icteria virens*), Barn Swallow (*Hirundo rustica*), Bobolink (*Dolichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*) and Eastern Small-footed Myotis (*Myotis leibii*) (Wood *et al.,* 2018 and the 2017 and 2018 Monitoring Reports for the CMSP).
- Wood *et al.,* 2018 and the 2017 and 2018 Monitoring Reports for the CMSP).

- Screening work undertaken by Beacon also confirmed that there is potentially suitable habitat for seven other Provincially Endangered and Threatened species (i.e., Jefferson Salamander (*Ambystoma jeffersonianum*)5, Blanding's Turtle (*Emydoidea blandingii*), Chimney Swift (*Chaetura pelagica*), Little Brown Myotis (bat) (*Myotis lucifugus*), Northern long-eared Myotis (bat) (*Myotis septentrionalis*), Tri-Coloured Bat (*Perimyotis subflavus*) and Rusty-patched Bumble Bee (*Bombus affinis*).

Details about the current status, preferred habitats and known ranges of all the species listed above are provided in Appendix G2 of the 2018 Monitoring Report.

The specific locational data relating to the significant habitat of Provincially Endangered and Threatened species is generally considered sensitive and therefore is typically excluded from publicly available mapping. Furthermore, significant habitat of Provincially Endangered and Threatened species is typically confirmed as part of site-specific studies. Therefore, no such habitats or locations have been mapped in the City of Guelph's Official Plan to date, and none are proposed to be mapped in the SPA through this process. It is, however, assumed that screenings undertaken for properties within the SPA as part of future environmental studies will specifically screen for the above-referenced species, in addition to any others flagged by MNRF as potentially occurring in the area.

Habitat of Locally Significant Species

Based on the review of environmental studies prepared for various properties within and adjacent to the SPA, as well as site visits conducted by Beacon in 2017 and 2018 (ref. 2018 Monitoring Report) a total of 20 or 21 locally significant plant species[6] and 55 locally significant wildlife species were confirmed in the SPA and/or PSA.

The locally significant plant species are predominantly wetland species and include: Black Maple *(Acer nigrum)*, Awned Sedge *(Carex atherodes)*, Hop Sedge *(Carex lupulina)*, Fireweed *(Chamerion angustifolium ssp. angustifolium)*, Hairy Swamp Loosestrife *(Decadon verticillata)*, Downy Willowherb *(Epilobium strictum)*, Marsh Horsetail *(Equisetum palustre)*, Meadow Horsetail *(Equisetum pratense)*, Rough Avens *(Geum laciniatum)*, Butternut, Interrupted Fern *(Osmunda claytoniana)*, Canada Clearweed *(Pilea pumila)*, Yellow Water Crowfoot *(Ranunculus flabellaris)*, Small Yellow Water Buttercup *(Ranunculus gmelinii)*, Rough-leaved Goldenrod *(Solidago patula)*, Freshwater Cordgrass *(Spartina pectinatus)*, Heart-leaved Aster *(Symphyotrichum cordifolium)*, Highbush Blueberry *(Vaccinium corymbosum)*, Sky-blue Aster *(Symphyotrichum oolentangiense)*, Wood Lily *(Lilium philadelphicum)*, and Buttonbush *(Cephalanthus occidentalis)*.

- The 55 locally significant wildlife species (i.e., 41 species of birds, six amphibian species, three species of reptile, two mammals, two Odonates (i.e., dragonflies and damselflies) and one butterfly species)

[5] MNRF staff has reviewed Guelph District data and although the SPA (particularly in the Maltby Road West area) is known to support other species of salamanders, staff is of the opinion that there is a very low likelihood of there being any regulated habitat for this species within the SPA. Based on the information available, it appears that the area has been extensively surveyed and no recent records have been documented. Based on this information, MNRF did not require surveys for this species as part of the CMSP (ref. T. McKenna, September 29, 2015). However, the status of this species and related species with which it hybridizes is under review and MNRF should be consulted for future site-specific studies.

[6] One of the previously completed environmental studies in the PSA that was reviewed listed Highbush Blueberry (*Vaccinium corymbosum*) as a documented plant species. However, two experienced Botanists with knowledge of Wellington County flora (i.e., Charles Cecile and Daniel Westerhof), consider this species to be a very unlikely occurrence in the County and a probable misidentification. Therefore, it has not been included in the list of locally significant plants for the SPA/PSA and 20 (not 21) locally significant plant species are reported for the study area.

include a mix of wildlife species reflective of the diversity of natural and cultural vegetation communities in the PSA, as well as the mix of meadow, woodland and wetland habitats. A complete list of locally significant wildlife species documented in the SPA and/or PSA is included in the 2018 Monitoring Report. Examples of the types of birds documented in the PSA and/or SPA include: Pied-billed Grebe (*Podilymbus podiceps*), Broad-winged Hawk (*Buteo platypterus*), Least Flycatcher (*Empidonax minimus*), Magnolia Warbler (*Setophaga magnolia*), Scarlet Tanager (*Piranga olivacea*), Eastern Towhee (*Pipilio erythrophthalmus*) and Grasshopper Sparrow (*Ammodramus savannarum*);

- The six (6) locally significant amphibian species recorded in the SPA and/or PSA include: Bullfrog (*Rana catesbeiana*), Pickerel Frog (*Rana palustris*), Blue-spotted Salamander/Blue-Spotted Dominated Polyploid Salamander (identified as *Ambystoma laterale* or *Ambystoma (2) laterale - jeffersonianum* based on visual observation); Yellow-spotted Salamander (*Ambystoma maculatum*) and Red-spotted Newt *Notophtalmus viridescens viridescens*);
- The three (3) locally significant snake species recorded in the SPA and/or PSA include: Northern Water Snake (*Nerodia sipedon sipedon*), Brown Snake (*Storeria dekayi dekayi*) and Red-bellied Snake (*Storeria occipitomaculata*); and
- The two (2) locally significant mammals recorded are Long-tailed Weasel (*Mustela frenata*) and Woodland Jumping Mouse (*Napaeozapus insignis*).

No refinements to the City's mapping are provided based on the locations of locally significant species as this information is incomplete and will, irrespective, need to be verified as part of future area or site-specific studies. In addition, specific locations were not available for species drawn from background sources, and those identified during field studies were limited to the properties where access was provided and surveys completed from the right-of-way. These lists help characterize the current species diversity in the SPA and also provide the range of locally significant species that could be encountered at the site-specific level.

2.1.6.2 Surface Water Features and Fish Habitat

"Surface Water Features" as defined in the City's Official Plan (2014), broadly includes "headwaters, rivers, stream channels, inland lakes and ponds, seepage areas, recharge/discharge areas, springs, wetlands and associated riparian lands that can be defined by their soil moisture, soil type, vegetation and topographic characteristics". As discussed in Section 2.1.2, no rivers, stream channels or inland lakes have been identified in the SPA. Therefore, aquatic assessments focused on potential headwaters and collection of existing fisheries data. Wetlands are discussed in Section 2.1.4.3, while seeps and springs are discussed in the context of SWH in Section 2.1.6.5 below. Recharge and discharge areas are discussed in Section 2.1.1 above.

Headwater Drainage Features

The SPA is recognized as an important headwater drainage area for both Hanlon Creek Watershed and Mill Creek Watershed. As part of the CEIS work program, a scoped assessment of headwater drainage features (HDFs) was undertaken over 2017 and 2018 using the current standard guidelines for the evaluation of HDFs (CVC and TRCA 2014). No such work had been previously completed in the SPA. The purpose of this assessment was to (a) identify any potential or actual drainage pathways, particularly those connected to wetlands or ponds that may support fish based on desktop information and "drive-by" field assessments and (b) field verify the potential HDFs where access was provided.

The characterization of the HDFs in the SPA based on the available background information and scoped field verification can be summarized as follows:

- A total of seven (7) potential HDFs were identified in the SPA (ref. Map NH-4A in Appendix E). Potential HDFs west of Gordon Street (i.e., H1, H2 and H4) could not be field verified due to access limitations. However, east of Gordon Street, H3, H7 and portions of H5 and H6 were field verified in spring 2018 within lands for which access was provided. All of the reaches assessed were identified as having a standing water or dry hydrologic condition (i.e., no flow) with the exception of portions of H3.
- Reach HC-H3-R2 (ref. Map NH-4B in Appendix E) was observed to be flowing in April 2018, was also incidentally observed by Beacon as having flowing water during basking turtle surveys undertaken in April and May 2017 and was dry when this area was reviewed with GRCA on August 17, 2018. This reach is therefore thought to provide a seasonal (i.e., spring) hydrologic connection between the two PSW units along the property line.
- Reach HC-H3-R2 (ref. Map NH-4B in Appendix E) was also confirmed by GRCA (on Aug. 17, 2018) to be part of the broader wetland, and as part of the CMSP CEIS work is being recommended as an addition to the Halls Pond PSW Complex (ref. Map NH-5B in Appendix E).
- Field assessments completed in April 2018 in potential HDFs east of Gordon Street also determined that all HDF reaches identified for protection in accordance with the CVC and TRCA 2014 Guidelines (i.e., HC-H3-R1, HC-H3-R2, HC-H3-R3, HC-H3-R4, HC-H5-R1, HC-H6-R1 and HC-H7-R1) (see Table 4.5.1 in the Phase 1 and 2 CEIS [Wood *et al.,* 2018], and Map NH-4B in Appendix E) occur within short reaches also identified as wetlands that either are already and are being recommended for inclusion with the broader Hall's Pond PSW Complex.

Fish Habitat

Given the absence of permanent watercourses in the SPA due to the unique geology, topography, soils and drainage in the area, field work to assess fish habitat was not included as part of the scope of the CEIS work plan and findings were based on available background data.

In the broader SSA, there are creeks and tributaries that provide fish habitat. These are primarily associated with the Hanlon Creek Watershed, which has tributaries to Hanlon Creek associated with the Hanlon Creek Provincially Significant Wetland (PSW) complex just north of the SPA, and the Mill Creek Watershed, which has tributaries to Mill Creek just south of the SPA.

The characterization of the fisheries in the SPA and in the broader SSA, based on the available background information, can be summarized as follows:

- Within the SPA there are ponds and/or wetlands capable of supporting fish and benthic invertebrates. These ponds and/or wetlands are, in some cases, connected to other ponds and/or wetlands but are not hydrologically connected to any permanent or intermittent surface water drainage features and are therefore considered isolated.
- In Hanlon Creek Watershed and in the SPA, there are records of warm water fish species in Neumann Pond (which is also a PSW) (see Map NH-3 in Appendix E), one of the larger ponds / wetlands in the northwest quadrant of the SPA (Wood *et al.,* 2018), and it is possible that other ponds and/or wetlands in the PSA also support fish.
- The SPA represents an important headwaters area for both Hanlon Creek and Mill Creek Watersheds. Irrespective of the fish habitat in the SPA, the recharge function provided by the ponds and/or wetlands

in this area is thought to contribute to baseflows in the broader SSA, particularly in Hanlon Creek to the northwest and Mill Creek to the south and southwest.

- Based on the data and mapping from MNRF, GRCA and the available background reports:
  - Hanlon Creek Watershed contains tributaries supporting a mixture of communities including cool and cold water fisheries. Such species have been documented in Tributary E located in the Hanlon Creek PSW just north of the SPA (ref. Wood *et al.,* 2018), under existing conditions.
  - Mill Creek Watershed contains tributaries located south of the SPA supporting cold water fisheries under existing conditions.
- Current fisheries data are lacking for Hanlon Creek Watershed north of the SPA, with the most recent records dating back to 1999. However, there was evidence of cold water fisheries in the Hanlon Creek Watershed west of the Hanlon Expressway as recently as 2016 (NRSI 2016 as cited in Wood *et al.,* 2018).

Features is the SPA confirmed as providing warm water fish habitat based on available data are illustrated in Map NH-3 (Appendix E) with a 15 m minimum buffer, in accordance with the applicable City policies. These confirmed habitats, without their buffers, represent 1.18 ha (or 0.2% of the SPA). No fish habitat has been identified in the Rolling Hills Community. However, additional fish habitat (and associated buffers) may be identified through future are or site-specific studies undertaken in support of the development process.

2.1.6.3 Significant Wetlands and Other Wetlands

One of the most prevalent natural heritage features in the SPA are its wetlands and ponds, Most of these features are identified as Provincially Significant and captured within the Hall's Pond Provincially Significant Wetland (PSW) Complex (in the Hanlon Creek Watershed) or the Mill Creek PSW Complex (within the Mill Creek Watershed).

At the outset of the CMSP process, it was recognized that there were inconsistencies between the wetland mapping in the City's Official Plan (as based on the approved OPA 42 mapping from 2014) and wetland mapping from both the MNRF and GRCA. One of the objectives of the CEIS work in the SPA was to review and update the wetland mapping in the SPA to create a reasonably accurate layer based on the most current available information with input from the agencies that could then be shared with MNRF and GRCA.

The City of Guelph Official Plan (2018 Consolidation) includes the following three categories of wetlands to be included within the NHS:

1. Provincially Significant Wetlands (PSWs): as identified by MNRF plus minimum 30 m buffers;
2. Locally Significant Wetlands (LSWs): non-PSWs and unevaluated wetlands of at least 0.5 ha plus minimum 15 m buffers; and
3. Other Wetlands: unevaluated wetlands between 0.2 and 0.5 ha that meet one or more of the established criteria for protection plus minimum 15 m buffers, with the criteria being: (i) located within a floodplain or riparian community, (ii) identified as a bog or fen, (iii) providing habitat for locally significant species, (iv) part of an ecologically functional corridor or linkage between Significant Natural Areas, or (v) part of a seep or spring or is hydrologically linked to a Significant Wetland (PSW or LSW).

Minimum buffers are not defined as part of the feature but are part of the minimum requirement regarding mitigation for these features, as established in the Official Plan. As stated in the City's Official Plan, buffers are identified to help prevent damage and degradation to the natural heritage features and areas that are part of the NHS. Buffers are to be actively or passively restored or maintained to support the ecological and/or hydrologic functions of protected natural heritage features and areas. Minimum and/or established

buffers are also mapped as part of the applicable land use designation in the City's Official Plan, although different policies may apply to the buffer related to the Significant Natural Area or Natural Area.

The City and members of the Consulting Team met with MNRF and GRCA on January 11, 2017, and again with the GRCA on August 18, 2018, to discuss the approach to updating the wetland mapping through the CMSP process. The outcome of these discussions, and the agreed to approach, are described in the CEIS Phase 1 and Phase 2 Characterization Report (Wood *et al.,* 2018). In summary, it was agreed that the Consulting Team would:

For the areas mapped as PSW:

a. Update the vegetation community mapping for the SPA and, where more current Ecological Land Classification (ELC)7 mapping is available, for the PSA; and

b. Use this updated ELC base to refine and reconcile the identified PSW boundaries, as well as confirm or identify any additional wetland units not currently identified as PSW.

For non-PSW and unevaluated wetlands:

a. Complex units with the closest PSW in the given watershed where they were physically connected to a PSW unit (by being immediately adjacent or connected through a surface water connection) and/or contained within the NHS (for reasons other than being a wetland); and

b. Leave the remaining "isolated" unevaluated wetlands between 0.2 and 0.5 ha identified as "Other Wetlands" overlays with the intent that their status would be reviewed as part of the future area or site-specific assessment process and subject to the applicable policies. Notably, all unevaluated wetlands or ponds, irrespective of size are regulated by GRCA and will also need to be reviewed as part of the area or site-specific assessment process and subject to the applicable policies.

Based on this approach, wetland mapping refinements were undertaken by applying the following five steps which have been updated iteratively over the course of this study as new information has become available.

- **Step 1:** Mapping of all apparent and confirmed wetlands as accurately as possible based on air photo interpretation supplemented by scoped field verification;
- **Step 2:** Changes to classifications of several units from "wetland" to "non-wetland" units where it was confirmed that the given feature did not qualify as a wetland[8]:
- **Step 3:** Comparison of the refined ELC mapping with the current GRCA wetland mapping in the SPA (Map NH-2 series and Map NH-5A in Appendix E);
- **Step 4:** Comparison of the refined ELC mapping with the current MNRF wetland mapping in the SPA (Map NH-2 series and Map NH-5B in Appendix E);
- **Step 5:** Conformity with any site-specific agreements related to wetlands made as part of an OPA 42 settlement before the OMB and reversion to the City's 2014 ELC mapping for one property before the courts (see Map NH-1, Appendix A); and

7 Although it is recognized by the Consulting Team that ELC wetland boundaries do not always correspond to wetland boundaries mapped, based on the application of the Ontario Wetland Evaluation System (OWES) guidance, it was agreed with GRCA that for the purposes of the Secondary Plan refinements based on this approach would suffice with the understanding that final wetland boundaries would need to be staked and confirmed in the field with GRCA, as part of each development application or process.

[8] Four units previously identified as wetlands based on air photo interpretation were changed to "ponds" based on correspondence from GRCA and MNRF shared with the City by landowners related to two different properties in 2018.

- **Step 6:** Incorporation of various refinements into the City's framework for wetlands plus inclusion of all mapped wetlands with the applicable minimum buffers (Map NH-2 series and Map NH-6 in Appendix E).

Maps NH-5A and NH-5B illustrate the changes from the most current available wetland mapping from GRCA and MNRF respectively based on this approach. Map NH-6 illustrates the resulting refined City wetlands mapping based on the approach above (see Appendix E).

In general, the changes are appropriately characterized as refinements with the majority of refinements occurring within, or immediately adjacent to, the wetlands as mapped in the City's 2014 NHS. These refinements consisted of: additions to and removals from PSW units, as well as a number of transitions of unevaluated wetlands to PSW units and a few removals of unevaluated wetlands. Notably, proposed "additions" and "removals" in the SPA do not imply actual wetland creation or removal, but simply reflect corrections to the accuracy of the existing mapping (i.e., removal of features mapped as wetland that are not in fact wetland, and addition of features currently not mapped as wetland that were found to qualify as wetlands in the field). The City's refined wetland mapping in the SPA (Map NH-6, Appendix E) only includes PSWs as there are no features qualifying as Locally Significant Wetlands or Other Wetlands. The few small isolated wetlands not complexed as PSWs are shown on the GRCA and MNRF wetland maps (Maps NH-5A and 5B, Appendix E) for reference. These features, along with any unmapped wetlands, will require review and assessment as part of future area or site-specific studies.

As currently mapped (Map NH-6, Appendix E), the City's refined wetlands mapping in the SPA includes a total of 33.33 ha of PSWs (not including their minimum 30 m buffers) representing 8.0% of the SPA. An additional 5.82 ha of wetlands (PSWs) have been identified in the Rolling Hills Community. These PSWs overlap with fish habitat, Significant Woodlands / Cultural Woodlands, SWH and Significant Landform.

2.1.6.4 Significant Woodlands and Cultural Woodlands

Woodlands are another principal natural heritage component in the SPA and the PSA. About half of these wooded areas are "natural" coniferous, mixed and deciduous forest types with the other half consisting of cultural woodlands and plantations. Wooded wetlands (i.e., swamps) also contribute to the overall woodland cover in the area.

The City of Guelph Official Plan includes two categories of woodlands to be included in the NHS:

1. Significant Woodlands include:
    a. Woodlands (not identified as Cultural Woodlands or plantations) of 1 ha or greater in size, plus a 10 m minimum buffer;
    b. Woodlands 0.5 ha in size or greater consisting of Dry-Fresh Sugar Maple Deciduous Forest plus a 10 m minimum buffer; or
    c. Woodland types ranked as S1 (critically imperilled), S2 (imperilled) or S3 (vulnerable) by the NHIC plus a 10 m minimum buffer.
2. Cultural Woodlands that are at least 1.0 ha and not dominated by non-indigenous, invasive species plus minimum 10 m buffers.

A review of, and refinements to, the City's woodlands mapping was undertaken as part the updates to the City's NHS based on a combination of air photo interpretation and scoped field assessments[9].. Woodland

[9] Although access for ELC review was limited to two large parcels and two smaller parcels in the SPA in 2017, access was provided to an additional seven parcels in 2018 which allowed for much greater coverage for verification of vegetation community boundaries and status (Map NH-2, Appendix F).

mapping refinements were undertaken by applying the following steps which have been updated iteratively over the course of this study as new information has become available.

- **Step 1:** Mapping of all apparent and confirmed woodlands and forests (including plantations) as accurately as possible based on air photo interpretation supplemented by scoped field verification (ref. Map NH-2 series in Appendix E);
- **Step 2:** Screening the ELC mapping against the City's policies for Significant Woodlands and Cultural Woodlands[10] (as detailed in the Phase 1 and Phase 2 Characterization Report, Wood *et al.,* 2018);
- **Step 3:** Compliance with any site-specific agreements related to Significant Woodlands made as part of an OPA 42 settlement before the OMB, and reversion to the City's 2014 ELC mapping for one property before the courts (Map NH-1 series in Appendix E);
- **Step 4:** Identification of refinements as compared to the City's 2014 woodlands mapping (ref. Map NH-7 in Appendix E); and
- **Step 5:** Incorporation of the refinements as appropriate into the City's framework for NHS woodlands with the applicable minimum buffers (ref. Map NH-8 in Appendix E).

Based on this approach, woodland mapping refinements included (outside of the OPA 42 settlement properties): proposed additions to Significant Woodlands, proposed transitions from Cultural Woodlands to Significant Woodlands, proposed transitions from Significant Woodlands to Cultural Woodlands, and proposed additions or removals of Significant Woodlands and Cultural Woodlands. As with wetlands, refinements involving removals to woodland areas were identified based on areas previously mapped as either Significant or Cultural Woodland no longer meeting the criteria for these features based primarily on desktop assessments supplemented with scoped field reviews on some properties where access was granted. Further refinements to woodlands mapping are anticipated as part of future area or site-specific studies.

As shown on Map NH-7 (Appendix E), many refinements fall within the existing NHS but a number that extend beyond the current NHS have been identified in the parcels along Maltby Road East within the SPA and, outside the SPA, in the Rolling Hills Community.

Notably, Significant Woodlands, which have been identified exclusively on the established size threshold of 1.0 ha, are considered confirmed whereas Cultural Woodlands have generally been mapped in accordance with the Ecological Land Classification (ELC) system, in many cases based on desktop assessments. Therefore, these features are being mapped as overlays as they still need to be screened through the City's policies which require collection of site-specific data before being confirmed. In addition, all woodlands identified for protection as part of the NHS will be subject to field verification and staking with City staff as part of future area or site-specific studies.

As currently mapped (Map NH-8, Appendix E), the City's refined woodlands mapping in the SPA includes a total of 70.14 ha of Significant Woodlands (not including their minimum 10 m buffers) and 1.54 ha of Cultural Woodlands (with no buffers applied) representing 17.3% of the SPA. An additional 67.22 ha of Significant Woodlands and 4.58 ha of Cultural Woodlands have been identified in the Rolling Hills Community. These Significant and Cultural Woodlands overlap with fish habitat, Significant Wetlands, SWH and Significant Landform.

[10] Woodlands are treated as contiguous in the City's policies unless they are separated by a gap of greater than 20 m. Cultural Woodlands, as defined in the City's Official Plan, that are contiguous with or separated by less than 20 m from a woodland considered significant are considered part of the Significant Woodland.

2.1.6.5 Significant Wildlife Habitat (SWH)

SWH is the most complex natural heritage feature category in the PPS (2014) and, in many municipalities, the one that is the most challenging to implement. No SWH was previously mapped in the SPA as part of the City's NHS (2014). Therefore, the SWH assessments and mapping completed as part of the CMSP CEIS process are new.

SWH is an overarching term for a wide range of unique and specialized habitat types that are often, but not always, captured within other significant natural heritage features and areas. SWH may be identified as "candidate" areas where suitable habitat is present but actual species or species numbers required to meet the established criteria have not been confirmed, or "confirmed" once an area meeting the established criteria have been field-verified.

Although guidance for identifying SWH is provided by MNRF, it is ultimately the municipal planning authority (in this case, the City of Guelph) who is responsible for confirming SWH. The criteria for designation of SWH in the City of Guelph are as follows:

1. Wildlife Habitat that is the most ecologically important in terms of function, representation or amount in contributing to the quality and diversity of the natural heritage system, and falls into one or more of the following categories:
    i) seasonal concentration areas, including deer wintering and waterfowl overwintering areas identified by the MNRF;
    ii) rare vegetation communities or specialized habitat for wildlife;
    iii) habitat for species of conservation concern (excluding significant habitat of endangered and threatened species), specifically: globally significant species, federally significant species and provincially significant species.
2. Ecological linkages.

Notably, the "Ecological Linkages" category was included as part of the SWH feature in recognition of primary function of these areas being animal movement corridors, as per the Provincial guidance. However, given their distinct function and policy framework, Ecological Linkages within and adjacent to the SPA are discussed separately in Section 2.1.6.7 below.

The SWH Criteria Schedules for Ecoregion 6E (OMNR 2015) were used as the basis for screening the various types of SWH in the PSA. The approach and criteria in the overarching Significant Wildlife Habitat Technical Guide (MNRF 2000) as well as the Natural Heritage Reference Manual (MNRF 2010) have also been used as a source of guidance for the approach to identifying Candidate and Confirmed SWH in the PSA.

In summary, of the 37 types of SWH identified for Ecoregion 6E, 20 types have been Confirmed and/or have been identified as Candidate SWH in the SPA and/or adjacent PSA, as summarized in Table 2.1.6. Based on the current assessment, Confirmed and Candidate SWH overlap fairly extensively with PSWs, Significant Woodlands, Cultural Woodlands and Significant Landform, but also extend beyond these features in a few locations.

As currently mapped (Map NH-10, Appendix E), the City's SWH mapping in the SPA includes a total of 23.99 ha of Confirmed SWH (with no buffers applied) and 64.21 ha of Candidate SWH (with no buffers applied) representing 21.3% of the SPA. An additional 0.55 ha of Confirmed SWH and 24.84 ha of Candidate SWH have been identified in the Rolling Hills Community. These SWH overlap with fish habitat, Significant Wetlands, Significant and Cultural Woodlands and Significant Landform.

Table 2.1.6 Summary of Candidate and Confirmed Significant Wildlife Habitat (SWH) in the PSA		
SWH Type* (ref. 2018 Monitoring Report for details)	**Confirmed and/or Candidate or Potential SWH, Both or Neither**	**Mapped or Not Mapped (see Maps NH-9 and NH-10, Appendix E)**
Seasonal Concentration Areas		
1. Waterfowl Stopover and Staging Areas (Aquatic)	Candidate	Mapped
2. Raptor Wintering Area	Several Candidate SWH areas are shown approximately	Mapped with asterisks[1]
3. Bat Maternity Colonies	Candidate	Mapped
4. Turtle Wintering Areas	Candidate and Confirmed	Mapped
5. Reptile Hibernaculum	Candidate	Mapped with asterisk[1]
6. Colonially-Nesting Bird Breeding Habitat (Tree/Shrubs)	This type of SWH may occur	Not mapped
7. Deer Winter Congregation Areas	This type of SWH may occur	Not mapped
Rare Vegetation Communities		
8. Other Rare Vegetation Communities	One Confirmed; others may be identified	Mapped
Specialized Habitat for Species		
9. Waterfowl Nesting Area	Candidate	Mapped with asterisk[1]
11. Bald Eagle and Osprey Nesting, Foraging and Perching Habitat	This type of SWH may occur	Not mapped
12. Turtle Nesting Areas	This type of SWH occurs	Not mapped
13. Seeps and Springs	One seep Confirmed; others may be identified	Mapped
14. Amphibian Breeding Habitat (Woodland)	Candidate and Confirmed	Mapped
15. Amphibian Breeding Habitat (Wetland)	Candidate	Mapped
Habitat for Species of Conservation Concern		
16. Marsh Bird Breeding Habitat	This type of SWH may occur	Not mapped
17. Shrub/Early Successional Bird Breeding Habitat	Several Candidate SWH areas are shown approximately	Mapped with asterisks[1]
18. Terrestrial Crayfish	This type of SWH may occur	Not mapped
19. Special Concern and Rare Wildlife Species[2]	This type of SWH may occur	Not mapped
Wildlife Corridors		
20. Amphibian Movement Corridors	This type of SWH may occur	Not mapped but may be captured, at least in part, through mapped Ecological Linkages

Notes: [1] Future area or site-specific studies will be needed to capture the best and most representative area(s) in the SPA, assuming more than one of the Candidate areas meets the established criteria.

[2] Based on the work completed as part of the CMSP CEIS, this category of SWH is triggered by the potential presence of the following species in the SPA: Western Chorus Frog (*Pseudacris triseriata*), Eastern Ribbon Snake (*Thamnophis sauritus sauritus*), Snapping Turtle (*Chelydra serpentine*), Wood Thrush (*Hylocichla mustelina*), Eastern Wood-pewee (Contopus virens), Monarch (*Danaus plexippus*) and Yellow Banded Bumble Bee (*Bombus terricola*).

As noted in Table 2.1.6, all types of SWH that potentially occur in the SPA could not be confirmed or mapped as part of the CMSP CEIS process. Where possible with the available information, Confirmed or Candidate SWH have been mapped, as per the Provincial guidance, within the ELC polygon(s) in which it has been documented or in which suitable habitat occurs, with the exception of raptor wintering areas (SWH category #2 above) and shrub/early successional bird breeding habitat (SWH category #17 above) for which candidate areas are illustrated with asterisks (see Wood *et al.,* 2018 for explanatory notes). The ELC base mapping is provided in the NH-2 Map series in Appendix E.

Map NH-9 (Appendix E) illustrates all of the potential Candidate and Confirmed SWH types in the SPA that could be mapped. Map NH-10 (Appendix E) lumps all of the Confirmed and all of the Candidate SWH to illustrate these areas in relation to the current NHS (2014). As with the wetland and woodland refinements, most proposed refinements fall within or immediately adjacent to the current NHS. However, there are a few Candidate SWH areas (e.g., SWH for bat maternity colonies, SWH for woodland/wetland amphibian breeding) that fall outside of the 2014 NHS. All Candidate SWH are to be mapped as overlays indicating the need for these areas to be assessed based on data collected as part of future area or site-specific studies.

No minimum buffers are prescribed for SWH in the City's NHS policies due to the range of habitat types, however established buffers to Confirmed SWH are to be determined based on future area or site-specific studies.

2.1.6.6 Significant Landform

The lands in the portion of Guelph south of Clair Road are dominated by the Paris Moraine, a landform complex which is part of the broader Paris-Galt Moraine that extends from just south of Orangeville to the Brantford area. The south Guelph – Puslinch area provides some of the best examples of the Paris Moraine and its associated functions (Chapman and Putnam 1966), a fact underscored by the designation of a portion of the moraine east of Victoria Road just outside of the SPA limits in Wellington County as an Earth Science Provincially Significant ANSI for this feature (Map NH-11, Appendix E).

The City of Guelph formally defined, protected, mapped and designated portions of the Paris Moraine complex in the SPA as Significant Landform, as part of its NHS in the south end of the City through the OPA 42 process. Although Significant Landform may be refined in accordance with the applicable City policies, no such refinements are being proposed as part of the CMSP CEIS process. Therefore, the Significant Landform mapping being carried forward into the refined NHS being developed for the CMSP, is the same mapping that was approved through the OPA 42 process in 2014 (Maps NH-12 and NH-13 in Appendix E).

In addition to contributing to the visual uniqueness of the SPA, the Paris Moraine in the south end of Guelph supports important hydrogeologic, hydrologic and ecological functions. The hummocky topography of the Paris Moraine is characterized by closed depressions where organics have accumulated to create areas that can hold water (i.e., creating wetlands and ponds) and other closed depressions (i.e., that do not support wetlands and ponds) that provide relatively high levels of infiltration and recharge (as discussed in Sections 2.1.1 and 2.1.2 above). In identifying significant portions of the Paris Moraine as Significant Landform, consideration was also given to capturing the natural northeast-southwest linear nature of the moraine to help provide ecological connectivity among and between otherwise disconnected wetlands and woodlands in the area. The morainal topography also defines the various catchment areas, as discussed in Section 2.1.2. As such, protection of portions of the Paris Moraine in the City also contributes to the protection of local wetlands, groundwater resources, wildlife linkages and local biodiversity.

The City's current Significant Landform mapping in the SPA (Map NH-13, Appendix E) has not changed since it was approved in 2014 and has simply been carried forward through the CMSP process as a component of the NHS. In the SPA, Significant Landform represents 122.55 ha (29.6% of the SPA). An

additional 28.21 ha has been identified in the Rolling Hills Community. Significant Landform overlaps with fish habitat, Significant Wetlands, Significant and Cultural Woodlands and SWH.

2.1.6.7 Ecological Linkages

Maintaining ecological connectivity between natural heritage features and areas in the landscape is generally recognized in both the science and current Provincial policies as an approach that helps sustain various natural heritage functions, particularly in an urbanizing landscape. This "connectivity" can be considered at various scales ranging from Provincial (e.g., the Greenbelt which includes the Niagara Escarpment and the Oak Ridges Moraine) to regional (e.g., the Speed River corridor) to local (e.g., terrestrial and aquatic linkages in the City of Guelph's NHS). The type of connectivity required also varies among groups of species (e.g., forest breeding birds move across the landscape very differently from woodland breeding amphibians).

In the City of Guelph, the importance of trying to sustain ecological connectivity at the local and Regional scales is recognized through the City's NHS policies and in the specific identification of Ecological Linkages as features that can support the movement and dispersal of plants and wildlife in response to life cycle requirements where it is otherwise lacking in the NHS. As part of the development of an NHS for the City, Ecological Linkages, as well as wildlife (i.e., specifically deer and amphibian) crossing locations across existing roads, were defined, identified and mapped in the City's Official Plan (2014).

Outside the City of Guelph, the County of Wellington has also developed a Greenlands System comprised of Core and non-core areas that, among other things, supports ecological connectivity between natural heritage features and areas within the City and in the surrounding County lands.

As part of the CMSP CEIS process, the ecological connectivity provided by the existing NHS within the SPA and to the natural heritage features and areas in the adjacent City and County lands, was reviewed. This connectivity was reviewed to verify if the Ecological Linkages and overall system connectivity adequately captured areas where: (a) movement of wildlife had been well-documented through field work conducted as part of the CMSP CEIS and/or recent background studies under existing conditions, and (b) corridors in which substantial movement would be expected to continue to occur in an urbanized context (assuming appropriate mitigation measures were put in place as part of the development process if needed and appropriate).

Given the absence of watercourses and valleys in the SPA, this review focused on terrestrial connectivity both within the SPA and between the SPA and the surrounding PSA in the City and County (Map NH-11, Appendix E). This review also focused on accommodation of movement of the types and groups of wildlife known to occur in the SPA requiring some type of accommodations, namely amphibians and reptiles, small mammals and deer.

Hydrologic connections between surface water and ground water in the SPA, to surface water and groundwater in the broader SSA, are discussed in Section 2.1.1, and from an aquatic habitat perspective in Section 2.1.4.2.

Map NH-11 in Appendix E illustrates in the SPA and in the broader PSA context:

- the 2014 NHS in the City against the refined NHS (2018) including the associated refined wetlands mapping and Ecological Linkages[11];

[11] Refinements made to Ecological Linkages in response to refinements to Significant Natural Areas and Natural Areas as part of the CMSP CEIS process (as shown in Map NH-14B, Appendix F) were very minor and are hardly discernible at the scale of this mapping.

- the current County of Wellington Greenlands System, including the Paris Moraine Earth Science ANSI just east of Victoria Road;
- crossings for deer and amphibians, as well as other wildlife crossing opportunities, identified over existing roads through the OPA 42 NHS process (in narrow orange and black arrows);
- new amphibian / turtle crossing areas identified over existing roads through the CMSP CEIS process (in narrow pink arrows);
- NHS / Ecological Linkages within the SPA (in bold orange arrows); and
- NHS / Ecological Linkages between the SPA and the City or County NHS / Greenlands in the PSA (in bold yellow arrows).

In general, the amphibian and reptile wildlife movement data collected through the CMSP CEIS (detailed in the 2017 and 2018 Monitoring Reports) confirm that the connectivity and amphibian / other wildlife crossings identified in the 2014 NHS capture most of the locations where substantial movement of amphibians and reptiles (i.e., frogs and toads, snakes and turtles) has been, and continues to be, documented across existing roads, with some locations appearing to support greater concentrations of movement than others. Four new amphibian / turtle crossing locations have been added to Map NH-11 (Appendix E) based on the data collected for the CMSP CEIS[12]. The types of accommodations that would be introduced to these locations as opportunities arise (e.g., specialized culverts introduced as part of road improvements, like those installed along Clair Road East) would also be expected to support movement of small mammals.

Although targeted deer movement studies were not within the scope of the CMSP CEIS work, the 2017 and 2018 winter wildlife surveys (2017 and 2018 Monitoring Reports) documented deer tracks in various agricultural fields and forested features in the SPA and PSA, including the Rolling Hills Area. The majority of background data from the PSA and SPA (Appendix A from Wood *et al.,* 2018) also noted the presence of deer, but no specific concentration areas. Although the SPA is not thought to support any deer wintering or concentration areas, these mammals are still known to move through the landscape to feed and travel. Based on the available information, linkages 2 / 6 and 4 in the current NHS (see Map NH-11, Appendix E) are in locations that could support deer movement in an urbanized context, and deer movement between the City and the County / Puslinch Township along linkages H and G along Victoria Road, and along linkages C, D, E and F across Maltby Road also likely occurs under existing conditions and could persist in an urbanized context.

These findings suggest that the terrestrial ecological connectivity provided by the NHS in the City, including Ecological Linkages, as well as the County's Greenlands System (Map NH-11, Appendix E) which captures the primary locations where movement of amphibians, reptiles, small mammals and deer occur under existing conditions and would be expected to persist in an urbanized context provided that mitigation measures based on the science of road ecology are implemented. Discussion of the increased risks of such movement in an urbanized context and potential mitigation measures is provided in Section 4.4.

[12] As noted in the Phase 1 and Phase 2 Characterization Report (Wood *et al.,* 2018), Maltby Road West in the vicinity of linkages C and D (Map NH-11, Appendix F) had the greatest concentration of amphibian movement in the road surveys done in 2017, followed by the other linkages and crossings along Maltby Road. Substantial amphibian (as well as some reptile) movement has also been documented across Clair Road East in the direction of linkages I and J through other ongoing monitoring work (NSEI 2015, 2016). Movement was however also documented by the CEIS Study Team in the vicinity of linkage H between the Rolling Hills woodlands and the Paris Moraine ANSI, and across Gordon Street between the complexes of wetlands and woodlands on either side in two areas corresponding to linkages 6, 2 and 4.

Notably, the CEIS studies targeted collection of data on amphibian and reptile movement across existing roads. Amphibian and reptile movement between suitable habitats where future roads may be located were not be assessed as part of CMSP CEIS. Therefore, some additional work in this regard will be required as part of future area or site-specific studies where appropriate.

2.1.6.8 Opportunities for Restoration and Naturalization

Opportunities for restoration and naturalization in the SPA, exist (a) through the formal designation of Restoration Areas as defined in the City's Official Plan (e.g., associated with stormwater management areas), (b) though the restoration and naturalization of other NHS components (e.g., Ecological Linkages, buffers and Significant Landform that are not already naturalized), and (c) through the identification of additional restoration and/or naturalization opportunities outside identified NHS components.

Currently identified Restoration Areas in the City outside of the SPA include stormwater areas / corridors that abut and connect the NHS and isolated gaps in the NHS (e.g., areas within and around Hanlon Creek Wetlands). In the SPA, consideration must also be given through the CMSP process to balancing opportunities for restoration and naturalization with other land uses that must be accommodated. Furthermore, some types of restoration and/or naturalization (e.g., Restoration Areas that provide Stormwater Management (SWM) or Low Impact Development (LID) functions, and those outside identified NHS components) may be better identified at the site-specific stage when the details of a given development are known. Going forward, opportunities to ensure various types of Restoration Areas and naturalization areas are integrated into the SPA through mapping, policies and management strategies, will be explored in relation to the Preferred Community Conceptual Plan, as outlined in Section 4.4. Any areas confirmed as suitable Restoration Areas, as a result of multi-disciplinary discussions among the Consulting Team and the City, will be mapped in the final iteration of the Refined NHS developed for the CMSP.

2.1.6.9 Summary of NHS Refinements

The refinements to the various NHS components have been synthesized as follows to create a Refined NHS for the SPA:

- Significant Natural Areas have been mapped to include:
  - Confirmed warm water Fish Habitat + a minimum 15 m buffer (Map NH-3, Appendix E),
  - Provincially Significant Wetlands (PSWs) + a minimum 30 m buffer (Map NH-6, Appendix E),
  - Significant Woodlands + a minimum 10 m buffer (Map NH-8, Appendix E),
  - Confirmed Significant Wildlife Habitat (SWH) (Map NH-10, Appendix E), and
  - Significant Landform (Map NH-13, Appendix E).
- Natural Areas have been mapped to include:
  - Potential Cultural Woodlands (Map NH-8, Appendix E), and
  - Candidate Significant Wildlife Habitat (SWH) (Map NH-10, Appendix E).
- Ecological Linkages from the 2014 NHS were carried forward and refined minimally as needed in response to refinements to Significant Natural Areas and Natural Areas (Map NH-11, Appendix E).. A few new Wildlife (Amphibian) crossing locations were also identified based on new data collected through road mortality surveys (see the 2018 Monitoring Report).

Restoration Areas have not yet been added to the NHS, although (as noted above) opportunities will be identified through the process to finalize the Refined NHS for the SPA, and it is understood that

opportunities for naturalization and restoration in other components of the identified NHS (i.e., primarily buffers, Ecological Linkages and Significant Landform not overlapping with other Significant Natural Areas), will be pursued through the implementation of the Secondary Plan.

Significant Habitats for Provincially Endangered and Threatened Species, and Habitats for Locally Significant Species were not mapped as part of this process for the reasons noted in Section 2.1.6.1. Habitats for such species will need to be screened for as part of future area and/or site-specific studies, in consultation with MNRF.

The Refined NHS developed for this report (also referred to as the Draft 2 Refined NHS) is illustrated in Map NH-14A (Appendix E), with the overall refinements from the 2014 NHS illustrated in NH14-B (Appendix E). A summary of the areal changes to the NHS Components is provided in Table 2.1.7 below.

Table 2.1.7: Comparisons of the City of Guelph 2014 Natural Heritage System (NHS) and the Refined NHS (Draft 2) in the Secondary Plan Area (SPA) and Rolling Hills Community (RHC)

NHS Component	2014 NHS in the SPA (ha)	Refined NHS in the SPA (ha)	2014 NHS in RHC (ha)	Refined NHS in RHC (ha)
Significant Natural Areas	160.22	173.87	40.96	63.05
Natural Areas Overlay	0.76	4.31	1.58	3.74
Ecological Linkages	14.01	11.19	1.19	0.93
TOTALS	**174.99**	**189.37** (14.38 net gain)	**43.73**	**67.72** (23.99 net gain)

Overall, the Refined NHS has resulted in some net gains to the system in both the SPA (14.38 ha) and the Rolling Hills Community (23.99 ha). In the SPA, which is 414.27 ha, the 2014 NHS represented 42.2% of the SPA while the Refined NHS (Draft 2) represents 45.7%. These changes relate primarily to some small net gains in Significant Woodlands / Cultural Woodlands and Significant Wetlands as well as newly identified Candidate SWH outside of the 2014 NHS. Notably, the Natural Areas Overlays in the SPA (and in the Rolling Hills Community) may or may not ultimately be included in the NHS depending on the findings of future area or site-specific studies. In addition, the small reductions in Ecological Linkage areas between 2014 and 2018 are not a result of actual reductions in these features, but rather a result of portions of Ecological Linkages being transitioned to either a Significant Natural Area or a Natural Area through the updates and refinement process.

2.2 Integration Approach

In order to better understand the biophysical context of the Clair-Maltby SPA, in terms of the environmental features, attributes and associated functions, it is necessary to integrate the respective disciplines and associated characterization assessments into a cohesive framework. Each of the environmental features is principally linked by the hydrologic water cycle (surface water and groundwater) operating in a landscape dominated by morainal topography and drainage, as the primary integrating mechanism.

The focus of the approach adopted in this assessment has been to identify key features on the landscape which require an integrated assessment, and based on internal CEIS Team consultation, develop an

enhanced understanding of significance and sensitivity of the respective units. This approach has also been used to assess impacts and identify appropriate management and protection approaches associated with the future land use condition.

Primary environmental elements stemming from the discipline-specific characterization work described in the previous report sections include:

- Wetland/woodland features;
- Significant Landform and associated depressional features; and
- Recharge and discharge areas.

Absent from the foregoing list are watercourses which typically provide conveyance of drainage, provide riparian corridors and connect wetland and woodlot features. As the Clair-Maltby SPA does not include open watercourse systems (a core component of most NHS in southern Ontario), the CEIS Team has included Significant Landform and the associated depressional features, as the key environmental element that is integrated to the hydrologic cycle (topographic feature). This approach is consistent with the City's approach to integrating the terrestrial components (i.e., woodlands, wetlands and wildlife habitat) of the NHS which also integrated portions of the Paris Moraine in the SPA identified as Significant Landform to help support both the connectivity and the ecological functions of the system. Continuing to recognize the landform in the SPA as what helps define the area's unique terrestrial, surface and groundwater interactions through the CMSP process provides a sound basis for effectively protecting and mitigating these functions in an urbanizing context.

Each of the following three (3) environmental elements to varying degrees requires an integrated assessment in order to establish the significance and associated sensitivity of the features, particularly in the context of an urbanizing setting. The following provides some associated guidance in this regard:

1. Wetland/Woodland Units
    - diversity and significance of species (flora and fauna)
    - potential for corridor linkage and benefits to key biota
    - presence/absence of surface drainage features
    - local catchment area (size and land use)
    - feature size, wildlife functions and proximity to other features
2. Significant Landform including depressional features
    - presence/absence of form/stability
    - storage volume (stage/storage relationship) – surface water capture potential
    - groundwater discharge/ recharge
    - water quality and temperature
3. Recharge and discharge areas (non depressional)
    - rate of infiltration/recharge
    - location of functional recharge areas
    - functional relationship to wetland or woodland
    - quantity of groundwater flux

The foregoing factors/considerations (and others) have been summarized as they relate to the respective environmental units or features. The following section elaborates on the details of the various functions and forms of ecological and hydrologic integration related to these units or features. These units or features and their related functions ultimately provide the basis for the impact assessment and related mitigation and management measures provided in Section 4.

2.3 Principles of Integration

The fieldwork and accompanying assessments, associated with the Clair-Maltby characterization, have been used to establish various principles, unique to the overall study area. These principles reflect certain properties and characteristics of the Clair-Maltby SPA, which depending on their nature have led to certain implications for management associated with proposed future land use changes. The following sections provide insights related to integration principles and the implications for management where relevant. ***Text in bold italics is representative of the constraints and opportunities discussed further through the impact assessment and mitigation in Section 4.***

2.3.1 Groundwater Characterization and Functions

i. The characterization, Conceptual Model of Groundwater Flow and MIKE SHE integrated numerical model results presents the significant hydrogeological characteristics related to recharge and its functional connection to groundwater discharge and connection to the underlying municipal aquifer. This then provides the context for associated groundwater constraints and opportunities for future development.

   The permeable nature of the surficial sediments, as well as the interconnected permeable nature throughout the thickness of overburden allows for significant infiltration, subsequent recharge to the water table and potential hydraulic connections within the groundwater flow system to surface water features and the deeper bedrock. The conceptual model flow system subsequently quantified by the integrated groundwater model indicate recharge within and adjacent to the PSA contribute groundwater flow to the Mill Creek and Hanlon Creek watersheds as well as the municipal aquifer.

   Infiltration should be maintained to provide for existing recharge and the opportunity exists to enhance infiltration without creating unacceptable increases in groundwater levels. Infiltration practices must consider Source Water Protection Policies to support good groundwater quality.

ii. Groundwater flow tends to radiate out from the SPA to contribute groundwater flow to the Mill Creek and Hanlon Creek watersheds.

   The larger scale groundwater flow divide associated with the SPA should be considered for maintaining recharge associated with contributing discharge areas.

iii. Closed depressional features are shown to provide enhanced infiltration and recharge.

   These features should be maintained if functionally significant on a local scale (i.e. related to an adjacent wetland). Opportunities for depressional features to provide stormwater management function should be considered.

iv. The hydrogeological characterization, related groundwater modelling and associated water budgets for Neumann's Pond, Hall's Pond and Halligan's Pond indicate these features are predominantly maintained by direct precipitation and minor overland flow and minor groundwater contribution to these features which reflects the lower groundwater levels in the vicinity of these wetlands. Groundwater discharge appears to be derived locally and during spring melt or longer-term precipitation events. Wetlands within the SPA can exhibit perched conditions such as Neumann's Pond (i.e. unsaturated zone

beneath the pond) or be connected to the water table such as Hall's Pond, Halligan's Pond (i.e. saturated zone beneath the pond) and a number of other wetland/pond features within the SPA (i.e. western portion of SPA).

Maintenance of the overall hydrologic function within the localized subcatchments to these features to preserve the water levels associated with these features.

v. A large portion of the SPA has a thick unsaturated zone and the depth to water is greater 9 metres. There are areas where groundwater is closer to surface typically within and adjacent to the wetland features previously described.

Infrastructure trenches should be designed using best management practices to minimize water table lowering and redirection of shallow flows.

vi. The recharge water within the SPA provides a portion of the total recharge to the various municipal shallow and deeper aquifer units including the Guelph Formation, Goat Island Formation and Gasport Formation.

Infiltration should be maintained to provide for existing recharge and the opportunity exists to enhance infiltration without creating unacceptable increases in groundwater levels. Infiltration practices must consider Source Water Protection Policies.

vii. There is limited groundwater quality protection within the overburden from potential contaminant sources particularly those species that are considered conservative (i.e. those that do not biodegrade or are not adsorbed such as chloride). The Vinemount aquitard provides greater protection for the municipal aquifer.

Best management practices to maintain infiltrating water quality should be applied.

2.3.2 Surface Water Characterization and Functions

i. Surface water from local subcatchments contributes to the wetland features. Terrestrial units (not necessarily in depressional areas) receive overland drainage, which contributes to the features water balance. Drainage catchments located within or adjacent to terrestrial units may also contribute sediments and nutrients, important for sustainability of the ecosystem health.

Flood protection (stormwater quantity controls) for the SPA should be integrated with planning of the NHS terrestrial units, based on the existing feature based water balance.

ii. Woodlands located within depressional areas and wetlands provide temporary flood storage. The temporary storage of overland surface runoff results in infiltration (within woodlots), evaporation and reduced overland runoff volumes and the attenuation of peak flows.

The existing flood storage function of wetlands and woodlands should be appropriately mitigated within the terrestrial units for the proposed land use, by replicating the existing contributing overland drainage conditions.

iii. If unmitigated, the proposed urban land uses will increase the rate and volume of stormwater runoff locally within the Clair-Maltby SPA. The Clair-Maltby SPA provides a significant infiltration function at the headwaters of the Mill Creek, Torrance Creek and Hanlon Creek subwatersheds.

Stormwater management and drainage systems should be implemented to appropriately manage the increased rate and volume of runoff from future development resulting in no increase in peak flows and runoff volume to Mill Creek, Torrance Creek and Hanlon Creek. As part of the

stormwater management system, source, conveyance and end-of-pipe measures that promote infiltration, should be implemented.

iv. The significant infiltration that occurs within Clair-Maltby from the depressional features contributes to baseflow and cool surface water temperatures within the creek systems downstream of the Clair-Maltby SPA.

The significant infiltration function of the depressional features should either be preserved or replicated within stormwater management measures including source, conveyance and end-of-pipe controls, including low impact development (LID) best management measures. The stormwater management system should appropriately maintain and if possible augment baseflows, and mitigate thermal impacts from future development. Depressional wetlands are not to be considered for stormwater management.

v. In some locations headwater drainage features contribute and convey sediment to the downstream drainage system (i.e., via wetlands and/or other depressional features) while also removing contaminants.

Headwater drainage features, where they occur in the SPA and are identified for mitigation, should be replicated by using innovative drainage systems and BMPs that ensure their hydrologic contributions and water quality functions are maintained.

2.3.3 Water Quality Characterization and Functions

i. The water quality monitoring conducted in 2016, 2017, and 2018 indicates that the existing surface water quality within the Clair-Maltby SPA and immediately downstream is generally of reasonable quality. Exceedances of the PWQO, CEQB and CDWQ occur for various reasons, such as untreated runoff from roadways and application of fertilizers on agricultural fields and the golf course within the area, as well as naturally occurring exceedances (as is the case with Zinc in the Mill Creek Watershed).

Hanlon Creek temperatures have been measured above 23°C due to existing development, a lack of canopy cover and the presence of a stormwater management facility with a permanent pool (online pond).

Based on future land use conditions within the study area, stormwater management infrastructure should be designed to maintain the current water quality conditions to the greatest extent possible and improve them where possible.

ii. Existing land use within Clair-Maltby SPA is primarily agricultural, with large areas being considered part of the natural heritage system, resulting in reasonable water quality. The existing soils, particularly the sand and loams, provide a water quality function as filtration mediums based on the significant infiltration within the Clair-Maltby SPA.

Adequate pre-treatment of surface runoff from paved surfaces should be provided prior to infiltration measures. Stormwater management measures within existing depressional features outside of protected woodlands and wetlands or replicating depressional features should have adequate pre-treatment of surface water drainage to protect groundwater quality. Treatment of surface water from paved surfaces via a treatment train process should also be provided prior to runoff entering wetlands, wooded areas and ponds to maintain the water quality entering those features (i.e., a "treatment train" approach").

iii. Wetland temperatures within most wetlands in the Mill Creek watershed support cool or coldwater temperature ranges, even during the summer months, suggesting some may be receiving groundwater inputs to sustain their hydrology.

Where significant in sustaining fish habitat, groundwater contributions to wetlands in the PSA should be maintained and surface water temperatures impacts from development should be mitigated. Stormwater management practices that mitigate thermal impacts from urban development should be implemented within the PSA.

2.3.4 Natural Heritage System Characterization and Functions

General Natural Heritage System (NHS) Characterization and Functions

i. The NHS in the SPA is within the headwaters of three subwatersheds (Hanlon Creek to the north, Mill creek to the south and Torrance Creek to the northeast). This landscape is very well drained with no surface water features except for the ponds and wetlands, and a few headwater drainage features (HDFs) flowing seasonally between and within wetlands (see Map NH-4A and NH-4B, Appendix E). The SPA provides baseflow to the Hanlon Creek Tributaries and the Mill Creek tributaries that continue to support cool and coldwater fisheries respectively in their upper reaches.

ii. The natural heritage areas and features in the SPA and the surrounding PSA (including within the County Greenlands) are characterized by a patchwork of wetlands of various shapes and sizes, upland woodlands and plantations, and successional meadows and thicket communities that support a diverse range of plant and wildlife species.

iii. The SPA is known to support a moderate level of plant diversity, although few species are considered significant at the Provincial or local level. A total of 472 plant species have been documented in the SPA and PSA, including one Provincially Endangered species (i.e., Butternut) and 20 locally significant species (i.e., in the County) which are primarily associated with the wetland habitats.

iv. The PSA and SPA also support a range of wildlife species including a robust amphibian population, numerous ponds and wetlands supporting turtles, and a diverse range of bird species.

v. A range of common mammals have also been recorded in the SPA and PSA including White-tailed Deer (*Odocoileus virginianus*) and Coyote (*Canis latrans*), as well as some less common records of Northern Short-tailed Shrew (*Blarina brevicauda*), Woodchuck (*Marmota monax*), Muskrat (*Ondatra zibethicus*) and Mink (*Mustela vison*) (see Appendix NH-5 in the 2018 Monitoring Report for details).

Policies and mapping for a City-wide NHS, including the SPA, was approved in 2014. This NHS has been reviewed as part of the CMSP CEIS and, where appropriate, recommendations are being made for refinements to this system based on information collected through background information and field studies. The Refined NHS has been used as the basis for the impact assessment and the related recommendations for management and monitoring and, once finalized, will also be used as a primary constraint for the Secondary Plan.

An overview of the recommendations for the implementation of each of the NHS components going forward is provided below.

2.3.4.1 Habitat of Provincially and Locally Significant Species

i. Habitat of Provincially and locally significant species relates to:

- significant habitat for Provincially Endangered and Threatened species (City of Guelph Official Plan (2018 Consolidation) policy 4.1.3.3); and
- habitat of significant species (i.e., habitat of locally or Regionally significant species not already captured as Provincially Endangered or Threatened or as SWH) (City of Guelph Official Plan policy 4.1.4.4).

ii. There is confirmed suitable habitat for a total of thirteen (13) Provincially Endangered or Threatened species in the SPA and/or PSA:

- significant habitat for six of these species hasbeen confirmed in the SPA and/or PSA either through field work undertaken over 2017 and 2018 or site-specific studies in the area undertaken over the past decade (i.e., one (1) tree species – Butternut; four (4) bird species – Yellow-Breasted Chat, Barn Swallow, Bobolink and Eastern Meadowlark; and one (1) mammal species – Eastern Small-footed Bat); and
- suitable habitat exists in the SPA or PSA for the seven (7) other Provincially Endangered and Threatened species but their presence has not been recently confirmed in the area (i.e., one (1) amphibian species - Jefferson Salamander; one (1) turtle species - Blanding's Turtle; one (1) bird species - Chimney Swift; three (3) mammal species - Little Brown Myotis, Northern Myotis and Tri-coloured Bat; and one (1) insect species - Rusty-patched Bumble Bee).

iii. No habitats for Provincially Endangered or Threatened have been mapped as part of the CMSP process due to: the sensitivity of mapping their locations, the fact that presence needs to be confirmed on a site-specific basis in consultation with MNRF, and the fact that in some cases in situ protection of the habitat may not be required by the applicable regulations. Notably, a number of the SAR listed above currently have species-specific regulations under the ESA that allow for the removal of their habitats if specific conditions (e.g., for habitat net gain, compensation and monitoring) are met, subject to MNRF's authorization.

Screening for all SAR listed above should be undertaken, in consultation with MNRF as part of future area or site-specific studies for all properties within or adjacent to suitable habitat.

iv. The City of Guelph's Official Plan also provides some protection for locally significant species (City of Guelph 2012) that are not Provincially Endangered or Threatened or SWH. This policy requires proponents to: (a) make reasonable efforts to protect the habitat in situ, (b) if (a) is not feasible, to consider alternatives to in situ protection (e.g., habitat restoration or transplanting).

v. Based on the review of environmental studies prepared for various properties within and adjacent to the SPA (see Appendix A), as well as site visits conducted by Beacon in 2017 and 2018, a total of 20 locally significant plant species and 55 locally significant wildlife species were confirmed in the SPA and/or PSA. Most of the significant plant species have wetland affinities. The significant wildlife species include a mix reflective of the diversity of natural and cultural vegetation communities in the PSA and include species (and particularly birds) associated with meadow, woodland and wetland habitats respectively.

vi. Although records of locally significant plant species have been linked to certain properties or, for field work completed as part of the CMSP, with specific ELC polygons (see the 2018 Monitoring Report), SPA-wide mapping of locally significant species was not developed. Lists of species documented in the

area (see the 2018 Monitoring Report) can serve as guidance when locally significant species are screened for as part of future area or site-specific studies.

2.3.4.2 Surface Water Features and Fish Habitat Within the SPA

i. The SPA contains no permanent or intermittent watercourses due to the unique geology, topography, soils and drainage in the area. However, the SPA represents an important headwaters area to the Hanlon and Mill Creeks which are both known to support coldwater fish habitat (although Hanlon Creek supports more of a mix of communities including some cool and warmwater fisheries as well).

Water balance and quality should be maintained to Hanlon Creek and Mill Creek to continue supporting the cool and coldwater fish habitats that exist in those watersheds.

ii. Some of the isolated wetlands and ponds in the SPA are capable of supporting fish and benthic invertebrates. Based on the available temperature data for the wetlands, it can be generally hypothesized that entirely perched systems (like the Neumann Pond / PSW (Aquafor Beech 2012)) that support fish are likely to provide warmwater conditions, while other ponds / wetlands that support fish and sit within the groundwater table for extended periods (like the Tim Hortons or portions of Hall's Pond) may support cooler temperature regimes.

Area or site-specific studies will be required to confirm the presence or absence of fish, and the nature of the fish communities, in these features. Temperature regimes within the wetlands and ponds should be maintained through appropriate stormwater management measures, including quality treatment (i.e. Level 1, Enhanced water quality treatment for areas draining to wetlands).

iii. Most surface water simply drains directly down except in depressions where organics have accumulated over time and wetlands have formed. However, several short reaches of headwater drainage features (HDFs) that flow in the spring between and within confirmed PSW units were confirmed, and additional potential HDFs that could not be field verified have been identified through this study.

Area or site-specific studies will be required to verify the status of potential HDFs. The hydrologic connections of HDFs identified for protection or conservation are to be maintained in situ while HDFs assessed as requiring mitigation should have their hydrologic function replicated within the same catchment area.

2.3.4.3 Surface Water Features and Fish Habitat Outside the SPA

i. Outside the SPA, the available fisheries data indicates that watercourses immediately north of the SPA in the Hanlon Creek system historically supported, and appear to continue to support, a coolwater thermal regime. In addition, the available fisheries data indicates that watercourses immediately south of the SPA in the Mill Creek system historically supported, and appear to continue to support, a coldwater thermal regime. The Regional groundwater flow that emerges from the SPA is thought to contribute groundwater discharge to both the Hanlon and Mill Creek systems. This discharge is, in turn, thought to be key to supporting baseflows and maintaining the coolwater and coldwater regimes in these systems.

Groundwater recharge is to be maintained in the SPA as development proceeds so as to maintain its role in supporting baseflows outside the SPA in the Mill and Hanlon Creek aquatic systems.

2.3.4.4 Significant Wetlands and Other Wetlands

i. In the City of Guelph Official Plan (2018 Consolidation) wetlands within the NHS fall into the following categories:

- Significant Wetlands: Provincially Significant Wetlands (PSWs) (as identified by MNRF) plus minimum 30 m buffers and Locally Significant Wetlands (LSWs) which include non-Provincially Significant Wetlands and unevaluated wetlands of at least 0.5 ha plus minimum 15 m buffers (policy 4.1.3.4); and
- Other Wetlands: non-PSWs between 0.2 and 0.5 ha that meet the established criteria for protection plus minimum 15 m buffers (policy 4.1.4.2).

ii. Wetlands and open water make up about 8% of the SPA, including treed swamps, thicket swamps, marshes, and shallow aquatic communities. Most of these areas are captured within the existing NHS (2014) with a few more areas proposed to be added through the recommended refinements.

iii. In some cases, these wetlands are connected to each other through seasonal or permanent surface water connections, and in other cases these wetland units are hydrologically isolated.

iv. An approach for reviewing and refining wetland mapping in the SPA was determined in consultation with GRCA, MNRF and the City (described in Section 2.3.4.2). This process resulted in the identification of some proposed refinements of mapped wetlands as shown in Maps NH-5A, NH-5B and NH-6 (Appendix E). Refinements are primarily related to (a) higher resolution air photos and digitization, and (b) new information collected through the CMSP process whereby areas previously mapped as wetland have been verified as not being wetlands, or whereby areas not previously mapped as wetlands have been identified as wetlands.

This mapping is to be finalized through the CMSP process with all identified PSWs being mapped with a 30 m minimum buffer .

The NHS mapping to be used as a basis for the Secondary Plan will have PSWs shown as Significant Natural Areas.

Once the Secondary Plan is finalized and approved, all mapped wetlands and ponds (as well as any unmapped wetlands and ponds) will still be subject to review, the applicable policies and boundary verification and staking with the GRCA and the City (where the feature is being protected) and may also be subject to further review by MNRF as part of future area or site-specific studies.

2.3.4.5 Significant Woodlands and Cultural Woodlands

i. In the City of Guelph Official Plan (2018 Consolidation) woodlands within the NHS fall into the following categories:

- Significant Woodlands: woodlands of at least 1.0 ha and rare or uncommon woodland types – as defined in the Official Plan - of at least 0.5 ha) plus minimum 10 m buffers (Policy 4.1.3.6); and
- Cultural Woodlands: Cultural Woodlands as defined in the Official Plan of at least 1.0 ha not dominated by non-indigenous, invasive species plus minimum 10 m buffers (Policy 4.1.4.3).

In accordance with the City's woodlands policies and Official Plan definitions, where Cultural Woodlands (as mapped using the ELC system) are contiguous (i.e., separated by no more than 20 m) with other woodlands determined to be significant, they are considered part of the broader Significant Woodland.

ii. An approach for reviewing and refining woodland mapping in the SPA was determined in consultation with the City (described in Section 2.1.4.4). This process resulted in the identification of proposed additions to both Significant Woodlands and Cultural Woodlands as well as some transitions from one designation to the other as shown in Maps NH-7 and NH-8 (Appendix E). This mapping is to be finalized through the CMSP process with all identified Significant Woodlands and Cultural Woodlands having a 10 m buffer applied to them to be mapped separately but included in the overall NHS mapping.

The NHS mapping to be used as a basis for the Secondary Plan will have Significant Woodlands shown as Significant Natural Areas and Cultural Woodlands shown as Natural Areas Overlays.

Once the Secondary Plan is finalized and approved, all mapped woodlands will be subject to review, the applicable policies and boundary verification and staking with the City (where the feature is being protected) as part of future area or site-specific studies.

2.3.4.6 Significant Wildlife Habitat (SWH)

i. An assessment of SWH in the SPA was undertaken for the first time through the CMSP. This assessment found that of the 37 types of SWH, 20 of them are Confirmed and/or Candidate and/or may occur in the SPA and adjacent PSA. Where possible, these areas have been mapped as shown in Maps NH-9 and NH-10 (Appendix E).

ii. An approach for SWH assessment and mapping in the SPA was determined based on the applicable MNRF guidance (MNRF 2015, MNRF 2000) and in consultation with the City. This process resulted in the identification of 16 SWH types as potential or Candidate SWH and of four (4) SWH types as Confirmed SWH. As expected, most mapped SWH areas fall within the current NHS (Map NH-10, Appendix E), although some areas do extend outside.

SWH mapping in the SPA is to be finalized through the CMSP process with Confirmed SWH being mapped as a designation and Candidate SWH being mapped as an overlay for future assessment. Buffer requirements vary for different types of SWH and will not be applied at this stage but will be determined as part of future area or site-specific studies.

The NHS mapping to be used as a basis for the Secondary Plan will have Confirmed SWH shown as Significant Natural Areas and Candidate SWH shown as Natural Areas Overlays for further study.

Once the Secondary Plan is finalized and approved, all mapped and unmapped SWH listed above will need to be assessed as part of site-specific studies in the context of the applicable policies. Feature boundary verification may also be required with the City and, where appropriate, GRCA (where the feature is being protected).

2.3.4.7 Significant Landform

i. The prominent topography of the Paris Moraine complex – both positive and negative relief – dominates the character of the SPA. The portions of this complex formally designated as Significant Landform in the City's Official Plan (Maps NH-12 and NH-13, Appendix E) capture some of the most representative and striking elements of the moraine contributing both visual and functional values.

ii. Physically, Significant Landform provides the backbone of the NHS in the City as expressed by prominent ridges in combination with marked closed depressions. Further, the northeast-southwest linearity of the moraine provides a natural connecting element completely crossing the NHS, figuratively tying the SPA together .

As development proceeds, it will be important to maintain the visual elements of the landform as well as its associated hydrologic, hydrogeologic and ecological functions.

iii. Functionally, the Significant Landform in the SPA provides:

- a variety of slopes, aspects and moisture regimes;
- hydrological conditions enhancing infiltration and groundwater recharge;
- Ecological Linkages between natural features and areas within the NHS and beyond; and
- tying together the various Significant Natural Areas composing the NHS.

The long-term protection of Significant Landform will help ensure the on-going function and integrity of the City's NHS. This should include adjacent lands strategies to guide appropriate transitions between protected Significant Landform areas and adjacent development and infrastructure.

2.3.4.8 Ecological Linkages

i. It is recognized in both landscape ecology and Provincial policy that it is important to maintain and possibly improve connections between and among protected natural features and areas, particularly within urbanizing areas (such as the SPA).

ii. Both aquatic and terrestrial ecological connections (often referred to as corridors or linkages) can support the movement of native plants and wildlife between natural areas and provide critical pathways for genetic exchange at various geographic scales.

iii. These connections can also support the movement of some undesirable natural elements (e.g., invasive species, plant pathogens). However, the risk is generally outweighed by the benefits and arguably the need to support the movement of species between natural areas, which for many species is critical to their annual life cycles as well as their long-term meta-population persistence. This is particularly true of certain groups like amphibians and reptiles which, unlike birds, cannot fly over intervening built-up landscapes.

iv. In general, both the background information reviewed and field data collected in support of the CMSP indicates that both the Ecological Linkages and Significant Natural Areas identified in the current SPA, as well as the City NHS and County Greenlands in the broader PSA (as shown in Map NH-11 (Appendix E)), provide connectivity in the locations where local wildlife movement (i.e., amphibians, reptiles, small mammals and deer) is occurring and/or would be expected to continue to occur in an urbanizing landscape.

v. In recognition of the need to facilitate safe movement of amphibians, reptiles and small mammals across roads the City has begun to install specialized wildlife culverts in locations known for movement of these species. In the PSA, several culverts recently installed across Poppy Drive East that are being monitored appear to be relatively effective. The use of mitigation measures such as these should continue to be an important consideration, where appropriate, as roads within the SPA are redeveloped and as new roads are introduced.

vi. White-tailed deer also move through the SPA and safely accommodating their movement may also need to be considered in some parts of the SPA as it becomes increasingly urbanized.

The effectiveness of these mitigation efforts and opportunities to introduce these, and other types, of mitigation to minimize impacts to local amphibian, reptile and mammal populations will need to be considered moving forward.

2.3.4.9 Restoration Areas and Naturalization Areas

i. Restoration Areas are a defined component of the City's NHS and are typically associated with stormwater management areas or small gaps in the identified NHS. In the SPA, the identification of Restoration Areas beyond the Refined NHS will be considered in relation to stormwater management areas and trails as part of the CMSP process.

Opportunities for identifying Restoration Areas close to the Refined NHS that may also serve other functions in the SPA (e.g., trail connectivity or storm water management) should be explored as part of the Secondary Plan process.

ii. Opportunities for the identification of Restoration Areas and naturalization in other components of the NHS (such as buffers, Ecological Linkages and Significant Landform not already overlapping with other Significant Natural Areas) will also exist through the area or site-specific planning process.

Identification of some Restoration Areas and naturalization areas within other NHS components (such as buffers, Ecological Linkages and Significant Landform) is to be undertaken at the site-specific study stage when opportunities in relation to a specific development proposal can be identified.

iii. In the SPA, it is recognized that some trees outside of the NHS will need to be removed and replaced within the SPA.

Buffers, Ecological Linkages and Restoration Areas are all recognized as potentially appropriate locations for tree replacements. There is also the need to accommodate and maintain some unforested areas in the City able to support species with life cycle needs in more open, successional habitats. Going forward, these different requirements will need to be balanced against other land use needs in the SPA.

2.4 Preliminary Targets and Objectives

Preliminary working targets and objectives have been summarized in Table 2.1.8 based on the existing conditions and previously documented objectives and targets.

Table 2.1.8 CEIS Study Working Targets

Integration Context	Discipline	Goal	Objective	Working Targets
Water	Groundwater	Groundwater of sufficient quantity and quality to support ecological functions, aquatic habitats, native fish communities and sustainable human needs, including drinking water, agricultural, industrial, and commercial uses.	1. Protect, Restore and enhance groundwater recharge and discharge	• Work toward maintaining pre-development groundwater recharge and groundwater discharge
			2. Protect, restore and enhance groundwater quality.	• Provide stormwater quality treatment for infiltrated surface water.
			3. Ensure sustainable rates of groundwater use.	• Work toward maintaining pre-development groundwater recharge to support groundwater supply function of local aquifers.
	Surface Water	Surface waters of a quality, volume and naturally variable rate of flow to: • Protect aquatic and terrestrial life and ecological functions; • Protect human life and property from risks due to flooding; • Protect and contribute to the local groundwater system within Guelph, and the domestic drinking water source; • Support sustainable agricultural, industrial, and commercial water supply needs	4. Protect and restore the natural variability of infiltration to significant depressional features (or surrogates).	• Work toward maintaining pre-development water budget.
			5. Maintain and restore natural levels of baseflow.	• Work toward maintaining pre-development water budget
			6. Maintain surface and groundwater flows to terrestrial features	• Work toward maintaining pre-development water budget
			7. Eliminate or minimize risks to human life and property due to flooding and erosion.	• Provide post-to-pre-development flood control for all events up to the Regional Storm event.
			8. Protect and restore surface water quality, with respect to toxic contaminants and other pollutants, to ensure protection of aquatic life, ecological functions, human health, and water supply needs.	• Meet or exceed stormwater quality control for future development in accordance with Provincial (MOECC – TSS based or updates to MOECC Guidelines) standards, with the following targets as per the Hanlon Creek Subwatershed Study: - Chloride levels to average below 100 mg/l during non-runoff (dry weather) conditions. - Zinc levels to average at or below 0.7 mg/l - Total Phosphorus levels to average up to 0.1 mg/l during non-runoff (dry weather) conditions, - Nitrate levels of 5 mg/l (Tributary E) and 3 mg/l elsewhere. As the Clair-Maltby SPA is internally draining, 3 mg/l should apply - Dissolved Oxygen of 6 mg/l - Stream Temperature (downstream of Clair-Maltby) to be 22°C, as such this temperature should be considered in developing the drainage and stormwater management systems
Natural Heritage	Aquatic System	A healthy aquatic system that supports a diversity of aquatic habitats and communities.	9. Surface Water Features and Fish Habitat 10. Protect, restore and enhance the health and diversity of native aquatic habitats, communities and species. 11. Ensure headwater drainage features (HDFs) and their functions are appropriately protected.	• Meet or exceed stormwater quality control for future development in accordance with Provincial (based on updates to MOECC Guidelines) standards. • Work toward maintaining pre-development groundwater discharge in all catchments. • Protect fish habitat in accordance with the applicable Federal regulations. • HDFs with a "protection" or "conservation" management regime should be protected *in situ*. • The function of HDFs with a "mitigation" management regime should be maintained within the catchment.
			12. Ensure development within the SPA does not negatively impact the health	• Development in the SPA does not result in negative impacts to baseflow in the PSA or SSA. • Development in the SPA does not result in negative impacts to water quality in the PSA or SSA.

Table 2.1.8 CEIS Study Working Targets				
Integration Context	**Discipline**	**Goal**	**Objective**	**Working Targets**
	Aquatic System		and diversity of coolwater and cold fish habitats in the SSA.	
Natural Heritage	Terrestrial System	Maintain, restore and enhance the Natural Heritage System including linkages between and among Significant Natural Areas, Natural Areas, surface water and groundwater features.	13. Habitat for Provincially and Locally Significant Species 14. Maintain, restore and enhance native biodiversity by protecting Habitat for Significant Species.	• Protect habitat for Provincially Endangered and Threatened species in accordance with the Endangered Species Act (2007) and in consultation with MNRF. • Protect habitat for locally significant species in accordance with the City of Guelph's Official Plan. • Protect the Significant Natural Areas and Natural Areas of the NHS that provide habitat for these species, including the Ecological Linkages within the City of Guelph and connections to Greenlands in the adjacent Wellington County. • Use site-appropriate native species for all naturalization and compensation plantings in the SPA. • Restore meadow, wetland and woodland habitats through the planning process for the CMSP.
			15. Significant Wetlands and Other Wetlands 16. Maintain, restore and enhance wetlands identified for protection	• Protect all Significant Wetlands and their established buffers. • Where studies confirm the identified wetland or pond warrants protection, protect Other Wetlands with their established buffers. • Ensure pre-development area-specific water balances within each catchment are maintained to protected wetland hydrology. • Ensure the water quality of all protected wetlands is maintained or improved. • Pursue opportunities to enhance local biodiversity through invasive species management, where appropriate, and naturalization of wetland buffers with native species.
			17. Significant Woodlands and Cultural Woodlands 18. Maintain, restore and enhance woodlands identified for protection	• Protect all Significant Woodlands and their established buffers. • Where studies confirm the identified Cultural Woodlands warrant protection, protect Cultural Woodlands with their established buffers. • Ensure pre-development area-specific water balances within each catchment are maintained to protected woodland hydrology. • Pursue opportunities to enhance local biodiversity through invasive species management and naturalization of woodland buffers (and in some cases of the woodlands themselves) with native species.
			19. Significant Wildlife Habitat 20. Maintain, restore and enhance Significant Wildlife Habitat (SWH) identified for protection	• Protect all Confirmed SWH and their established buffers. • Pursue opportunities to enhance local biodiversity through naturalization of SWH buffers with native species.
			21. Significant Landform 22. Protect Significant Landform and its' associated functions	• No net loss of Significant Landform area. • Protect the functional characteristics of the Significant Landform areas including any associated drainage and natural heritage functions. • Integrate Significant Landform into the community such that its visual uniqueness is not negatively impacted.
			23. Ecological Linkages 24. Maintain, restore and enhance ecological connectivity in the NHS	• Protect identified Ecological Linkages in accordance with City policies. • Maintain connections between and among Significant Natural areas and protected Natural Areas. • Pursue opportunities to enhance local biodiversity and connectivity through the restoration and naturalization of Ecological Linkages with native species.

2.5 Summary of Feedback on Characterization Report

Feedback on the Phase 1 and 2 Draft May 2018 Characterization Report was provided by both the City and Grand River Conservation Authority (GRCA) in August 2018. The CEIS Team prepared a response matrix in September 2018, along with an updated Characterization Report. The following summarizes the key feedback received from both the City and GRCA for each discipline.

Hydrogeology

Key comments received on the Phase 1 and 2 Characterization Report (Wood *et al.,* 2018) with respect to groundwater focused on the importance of maintaining the groundwater recharge within depressional areas outside of the NHS, as well as the protection of seasonal hydroperiods within the wetlands. The assessment of these functional integrated groundwater/surface water aspects was carried out within the overall Phase 3 Impact Assessment considering the temporal and spatial scale dependence of the current modelling. Management strategies have been coordinated with the hydrological assessment within Phase 3.

Surface Water and Surface Water Quality

The Phase 1 and 2 Characterization Report has been revised to indicate that impacts to surface water quality through development are expected to be predominantly related to groundwater. In addition, unmanaged water quality would have the potential to not only impact groundwater quality, but also natural features, as significant depressional features are often coincident with wetlands and woodlands within the study area. Text has been added regarding potential implications for drinking source water protection.

Based on many of the wetlands being perched, the surface water text has been revised to indicate that some of the wetlands receive localized shallow groundwater and/or interflow instead of being groundwater fed.

Natural System and Significant Landforms

Key comments received on the Phase 1 and 2 Characterization Report (Wood *et al.,* 2018) with respect to the refinements to the NHS and the recommendations related to the various NHS components included:

- More discussion to be provided with respect to wildlife movement in a landscape context, particularly as it relates to movement of turtles and deer.
- Even if all known NHS components are protected through the Secondary Plan mapping, indirect impacts to the NHS related to urbanization in the adjacent lands should be expected (e.g., informal trail creation, encroachments such as dumping of waste, etc.).
- A range of mitigation measures (including fencing, educational signs, enforcement of City by-laws) should be identified to address encroachment-related indirect impacts.
- Opportunities to improve the resilience of the NHS by identifying strategic Restoration Areas or enhancement areas in the adjacent lands should be considered through this process.
- Consideration should be given to requiring Block Plans (or "area" studies) rather than site-specific studies for broader areas where an integrated approach to NHS assessment and management may be more appropriate.

3.0 Preliminary Community Structure Alternative Development

The Conceptual Community Structure for Clair-Maltby has been developed by the City through a highly consultative process, with input from governmental agencies, stakeholder groups, the public and the Consultant Team. The process for developing the Community Structure is outlined in Figure 3.1.

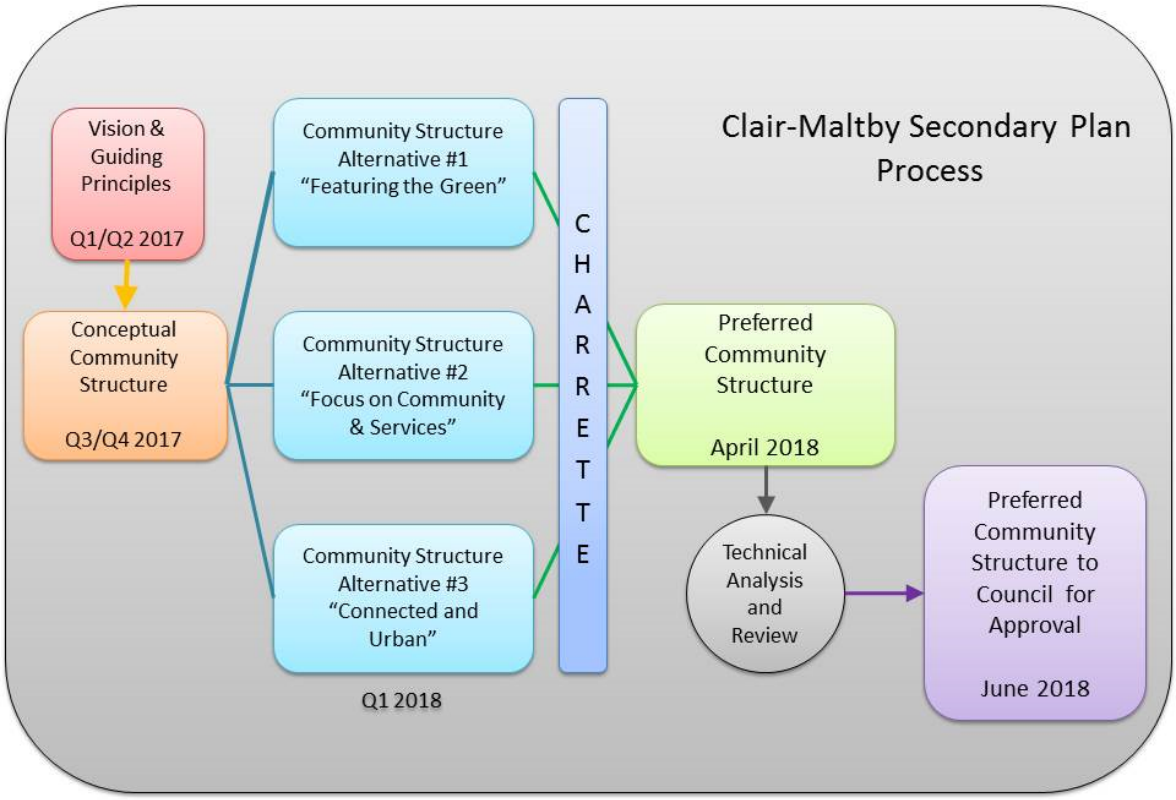

Figure 3.1 Clair Maltby Community Structure Development Process

In 2017 the City established a *vision* and *guiding principles* as per the following:

Vision

Clair-Maltby will be a vibrant, urban community that is integrated with Guelph's southern neighbourhoods, as well as having strong connections to Downtown, employment areas and the rest of the City. The Natural Heritage System and the Paris Moraine provide the framework for the balanced development of interconnected and sustainable neighbourhoods. This area will be primarily residential in character with a full range and mix of housing types and a variety of other uses that meet the needs of all residents. A system of parks, open spaces and trails will be interwoven throughout to provide opportunities for active and passive recreation.

Guiding Principles

Vibrant and Urban: Create identifiable urban neighbourhoods that are pedestrian oriented and humanscaled. Promote forward-thinking and innovative design that integrates new development into the rolling topography, while conserving significant cultural heritage resources.

Green and Resilient: Protect, maintain, restore, and where possible, improve water resources and the Natural Heritage System. Support resiliency and environmental sustainability through measures such as energy efficiency, water conservation and green infrastructure.

Healthy and Sustainable: Design the community for healthy, active living. Provide a mix of land uses including a diversity of housing choices at appropriate densities with appropriate municipal services to ensure long-term sustainable development which is fiscally responsible.

Interconnected and Interwoven: Establish a multi-modal mobility network that provides choice and connects neighbourhoods to each other and the rest of the City. Create a network of parks, open spaces and trails to provide opportunities for active and passive recreation, as well as active transportation choices.

Balanced and Liveable: A valued and livable community which reflects the right balance between protecting the environment and fostering a healthy, equitable and complete community.

The Conceptual Community Structure was developed based on the Vision and Guiding Principles and was further developed into three (3) Alternative Plans based on a focus of various community aspects and themes.

The first land use alternative, generally reflects the land uses as proposed in the Conceptual Community Structure, with the high density and mixed use focused on Gordon St, medium density located along proposed collector and/or arterial roads and low density in the interiors parts of the neighbourhoods. The roads have been shifted to be located beside the Natural Heritage System(NHS) in some locations with the right-of-way boulevard providing additional buffer to the NHS – and fewer connections through the NHS are proposed.

The second land use alternative increased the area of medium density residential by reducing the areas of lower density residential and moved the southern east/west collector roadway to the south to allow for development on each side of the right-of-way. The Proposed Trail Network east of Gordon Street was replaced with a Potential Active Transportation Link, therefore increasing the width of the link through the natural heritage system. The land use along the Gordon Street corridor was revised compared to Alternative 1 to include additional mixed use.

The third land use alternative provided additional connectivity by using south/north roadways through the natural heritage system in two (2) locations east of Gordon Street. In addition, high density residential land use, replaced medium density in select locations compared to Alternative 2. The Gordon Street corridor land use was also revised to provide mixed use land uses centred around roadway intersections.

The three (3) land use alternatives are depicted in Figures 3.2 to 3.4.

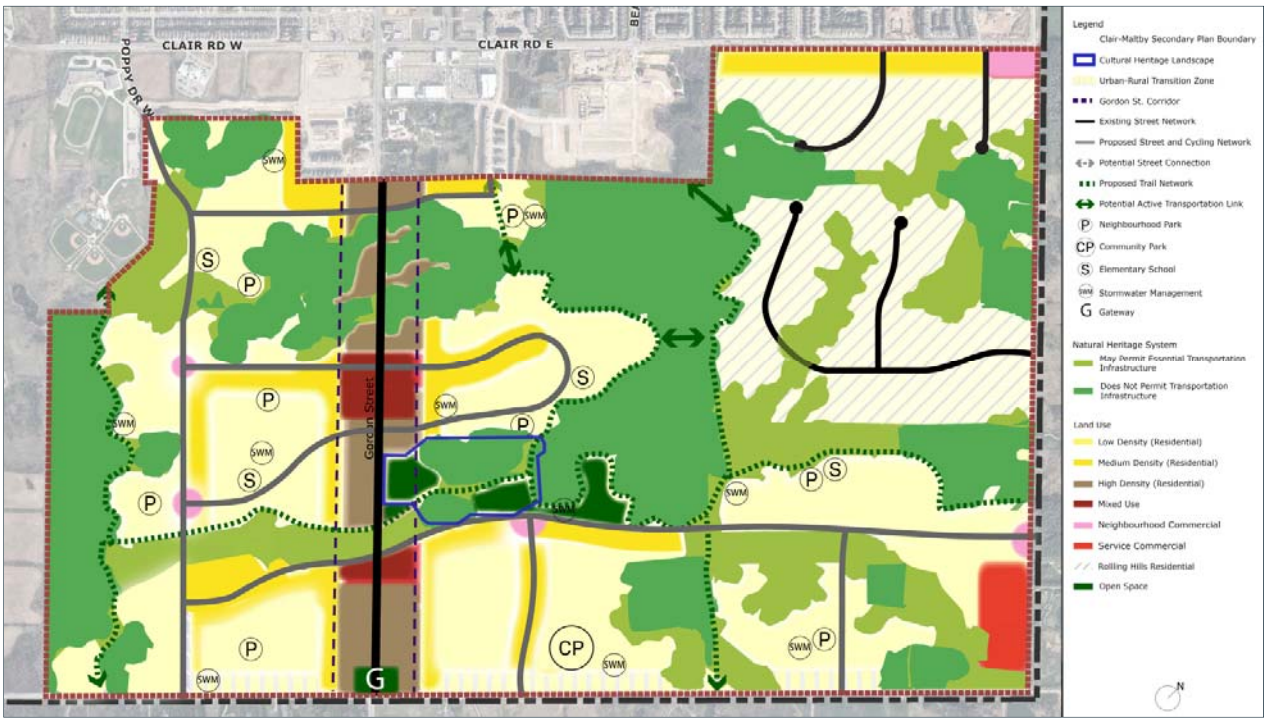

Figure 3.2 Alternative 1: Featuring the Green

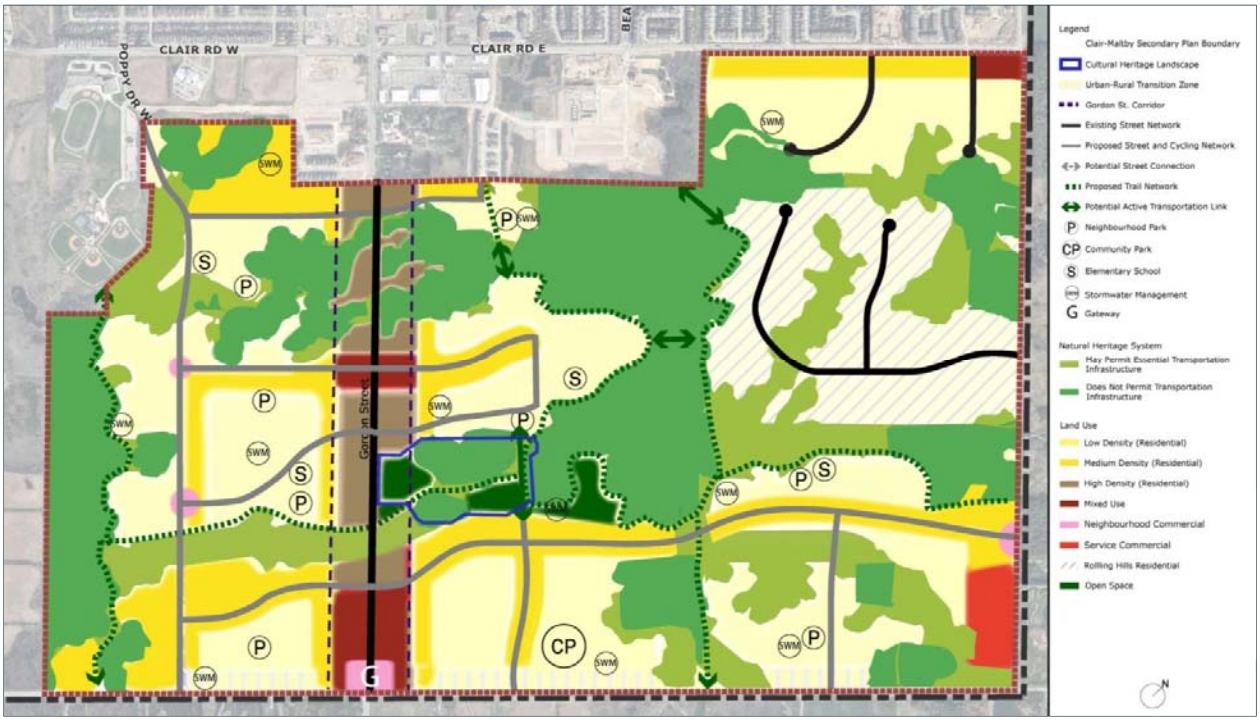

Figure 3.3: Alternative 2: Focus on Community and Services

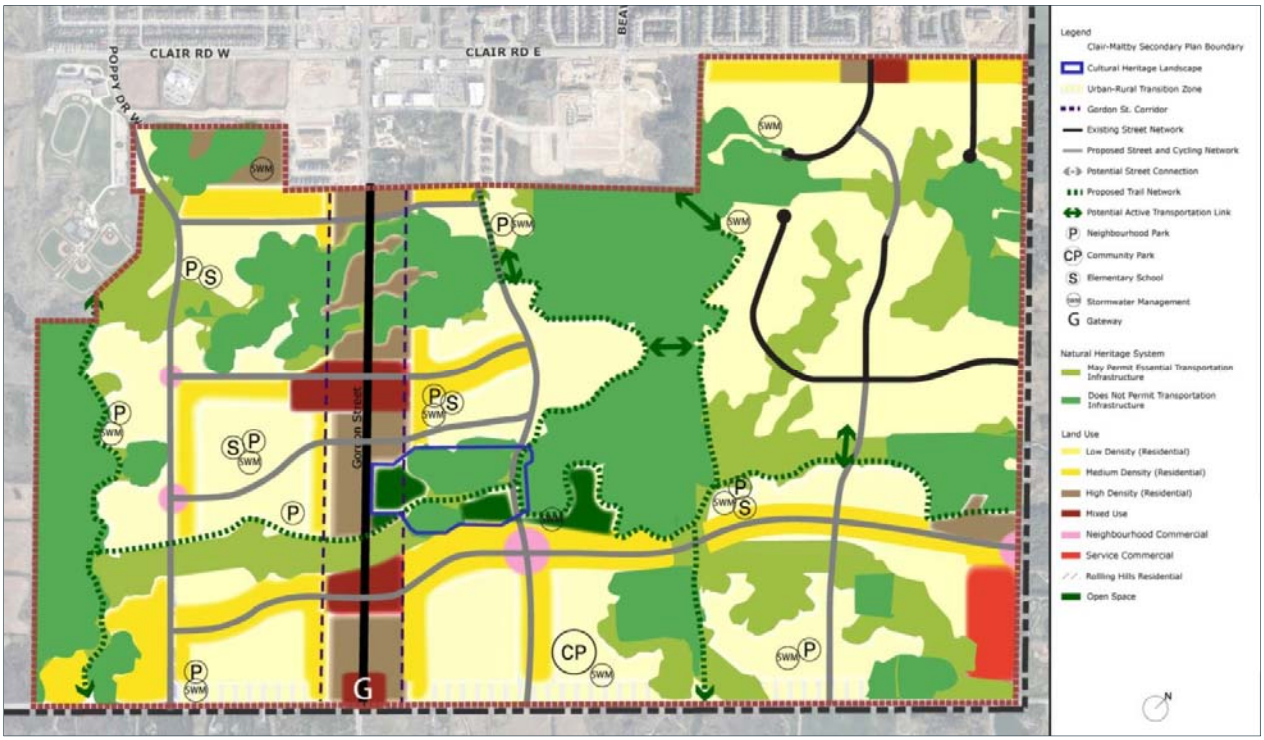

Figure 3.4: Alternative 3: Connected and Urban

In April 2018, the City held a five (5) day planning and design charrette, which used collaborative design and planning workshops with stakeholders and the public to evaluate the three (3) land use alternatives, leading to the Preliminary Preferred Community Structure for the SPA. Subsequently to the design charrette modifications were made to the Preliminary Preferred Community Structure, including removal of the Rolling Hills areas from the SPA and other land use revisions, resulting in the Preferred Community Structure. The Preferred Community Structure is provided in Figure 3.5.

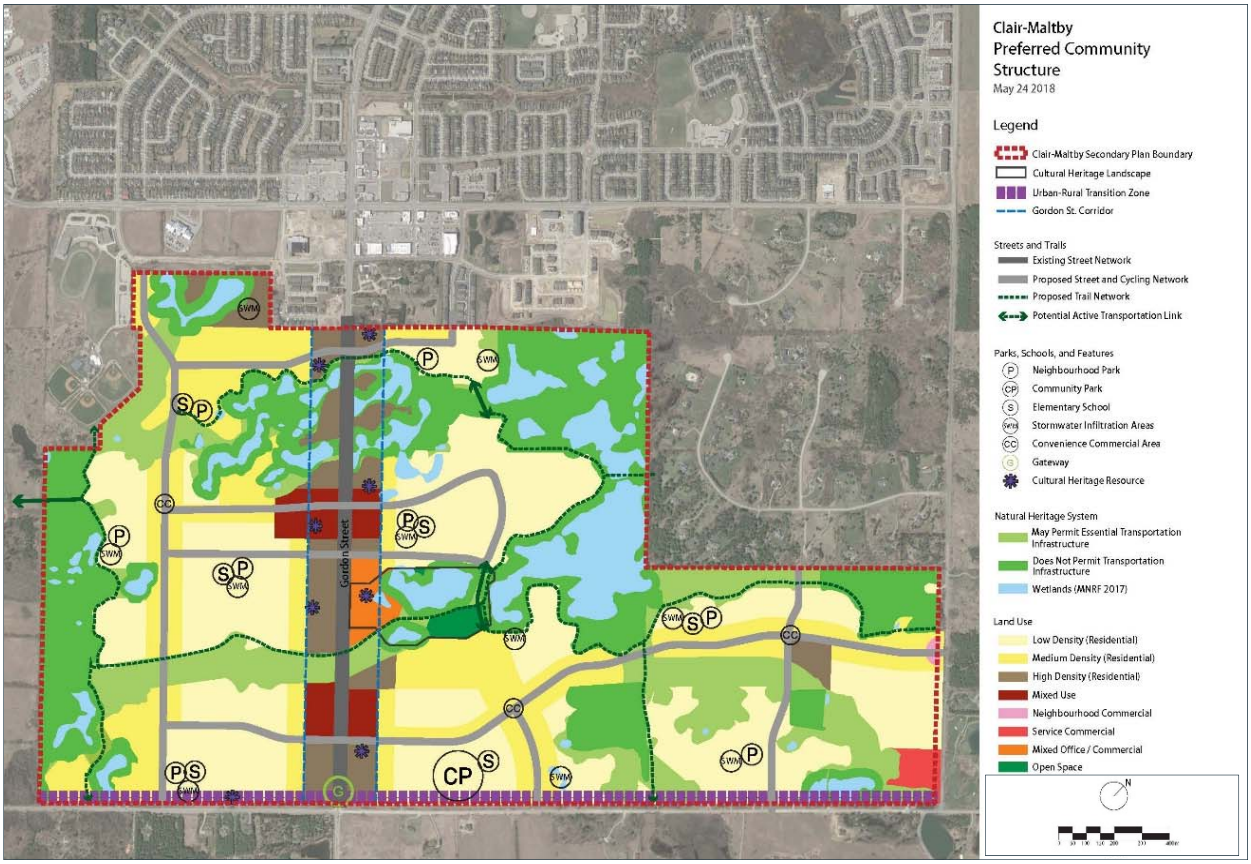

Figure 3.5: Preferred Community Structure

4.0 Phase 3 Impact Assessment

A detailed assessment of the Preferred Community Structure (ref. Figure 3.5) has been completed to determine the potential impacts of the future development to the local and neighbouring environmental systems and features, and to establish preliminary management requirements accordingly, as detailed in the following sections. The key findings of this assessment serve as input to the refinement process to update and finalize the Preferred Community Structure and ultimately establish the recommended management strategies.

4.1 Hydrology (Surface Water)

The Preferred Community Structure includes various land uses (distributed throughout the SPA. Four (4) land uses, namely Neighbourhood Parks (P), Community Parks (CP), schools (S) and stormwater infiltration areas or surface water capture areas (SWCA) have been provided as general locations within the Community Structure (i.e., through icons). To establish future drainage patterns, the preliminary location of parks and schools has been refined and sized based on the guidance from the City of Guelph. In accordance, with the guidance from the City each park or school site would be sized generally as per the following:

- Neighbourhood Park: 1 ha/park
- Community Park: 10 ha
- Schools: 2 ha/ school

Both parks and schools have been located as indicated in the Preferred Community Structure and then adjusted slightly based on existing topography, connections of the land use to the NHS and connections to the community via the proposed road network. The remaining land uses include residential (low, medium and high density), mixed use, commercial (neighbourhood, office and service) and the natural heritage system.

Surface Water Capture Areas (SWCAs) have been located based on the initial location within the Preferred Community Structure and then adjusted based on maintaining and preserving drainage areas and drainage patterns. SWCA'S where possible have been located adjacent to the NHS and the more porous land uses (i.e. parks and schools and linkages, with lower impervious coverages). The SWCAs will be dry during non-precipitation events, as such there is the potential to integrate and enhance the public usage (i.e. recreational) of SWCAs by being located adjacent to (i.e., these uses parks and schools). The locations for SWCA have also considered the most significant depressional features which currently provide 300 mm or greater runoff capture, and when feasible have been located within those depressional features. To maintain existing drainage patterns and hydrologic functions, the SWCAs have been located at, or near, existing drainage outlets to the NHS, or at the low points within the existing hummocky topography. The Preferred Community Structure with the parks, schools and SWCAs spatially laid out is provided in Figure LU1. The SWCA and associated other stormwater management measures would need to be evaluated through an EA process prior to the preferred stormwater management strategy being selected.

Hydrologic Impact Assessment

The validated PCSWMM existing condition hydrologic model prepared for the Phase 1 and 2 Characterization Report provides the base model from which to assess the Preferred Community Structure. In order to develop a preliminary drainage area plan, first the existing drainage boundaries and depressional features have been overlaid on the Preferred Community Structure (ref. Figure IA-HYD1) and then proposed drainage boundaries and preliminary grading were determined (ref. Figure IA- HYD2) with the objective of maintaining and preserving the existing drainage areas and patterns.

The SWCAs have been established to capture the Regional Storm, Hurricane Hazel, as such the initial sizing or area of each of the SWCA's has been approximated using 10% of the contributing drainage area, which is within the industry's typical range of areas for stormwater management facilities capable of controlling the Regional Storm, Hurricane Hazel. Each SWCA has also been sized to provide a buffer of approximately 5% to 10% area to allow for climate change impacts and a factor of safety. The location for relief systems for each SWCA and the associated outlet locations have been set, with the objective of maintaining the existing drainage patterns. It is important to emphasize that the relief systems would not be operative until extreme conditions, such as frozen grounds and multiple back to back significant storm events or an event greater than Hurricane Hazel (285 mm).

The foregoing drainage details were determined prior to revising the existing condition PCSWMM hydrologic model. The parameterization for the PCSWMM modelling impervious coverages for the proposed land uses within the SPA have been set as per Table 4.1.1. Impervious coverages outside of the SPA have been maintained as per the Phases 1 and 2 Characterization assessment. The impervious coverages represent the total impervious coverages and the percentage of the impervious coverages routed over pervious (landscaped lands). The directly connected impervious coverages can be determined by the difference of the total impervious coverage minus the routed impervious coverage.

Soil parameterization, as per the existing conditions in the PCSWMM model, has also been maintained within and outside of the SPA. The depressional areas located within the NHS have been maintained, while the depressional areas partially within the NHS and the developing area have been adjusted accordingly. Drainage catchment slopes range from 1% to 5% based on existing and proposed grades within the SPA.

Table 4.1.1 Proposed Land Use Impervious Coverages

Land Use Type	Total Imperviousness (%)	Routing Over Pervious (%)
Mixed Use	88	0
Office Commercial	85	0
Neighborhood Commercial	85	0
Service Commercial	85	0
School	65	40
High-density Residential	80	0
Medium density Residential	70	30
Low-density Residential	65	40
ROW (Local/Collector)	65	0
ROW(Arterial)	75	0
Park (neighborhood)	20	25
Park (Community)	35	25
Open Space	10	100
Natural Heritage	5	100
SWM	10	100

The PCSWMM hydrologic model, based on the foregoing, has been developed accordingly for the impact assessment. The remaining information required for analysis related to the stormwater capture volume and sizing for LID BMPs is provided in Section 4.1.1.

4.1.1 Stormwater Management Capture Zones and Low Impact Development Best Management Practices (LID BMPs) Sizing

In establishing stormwater management capture zones and low impact development (LID) best management practices (BMPs), replication of the significant number of existing depressional features on the landscape had to be considered. In addition, the most significant of these depressional areas (i.e., those with 300 mm of runoff capture) also became the primary focus to replicate existing drainage patterns and water balance conditions within the Clair-Maltby SPA. As such a stormwater management approach has considered the following:

- 27 mm (90th percentile storm event) capture via LID BMP to replicate the function of the numerous small depressional areas within the SPA and to provide for stormwater quality management. The 27 mm capture would apply to all development areas, including both public and private properties based on total impervious coverage (Figure IA-HYD3).
- For small development areas (typically less than 5 ha), drainage catchments where the main land use is porous (i.e. parks and schools), and/or existing depressional features exist downstream to receive drainage, capture of the 100 year storm (88.4 mm) runoff will be required in addition to the 27 mm capture. For development areas less than 5 ha, providing capture and storage up to the Regional Storm event would be considered impractical, based on the significant amount of storage required within a relatively small area.
- For all other remaining development areas, capture of the Regional Storm (285 mm) will be required in addition to the 27 mm capture through distributed LID BMPs.
- The surface water capture areas are proposed to have a 5% to 10% buffer to allow for climate change resilience and for extreme conditions such as frozen ground and back to back significant events. A relief system will function after the buffer has been used to discharge drainage to the existing NHS and to maintain existing drainage patterns. Adding 5% to 10% to the Regional Storm, the largest storm event to occur in Southern Ontario, ensures extreme events resulting from climate change would be controlled.

Each of the surface water capture areas (SWCAs) has been modelled with PCSWMM using a depth/area/discharge rating curve based on a maximum operating depth of 2.5 m to the invert of the relief system. The relief system elevations have been established by matching grades at the receiving drainage system (i.e. depressional feature) to allow for positive drainage.

The distributed 27 mm capture for impervious surfaces for each drainage catchment has been modelled using a storage element that uses the existing soil conditions and allows for evaporation, thus replicating at surface LID BMPs.

Table 4.1.2 provides a summary of the surface water capture areas for both the 100 year storm event capture and Regional Storm capture. Drainage areas (catchments) are depicted on Figure IA-HYD2. The SWCA Top Area / Drainage Area ratio ranges from 8% to 11% (apart from one SWCA), which is within the industry upper range for stormwater management facility sizing. Table 4.1.3 provides the unitary volumetric storage (m^3/ impervious. hectare) for the SWCAs for the 25 year, 100 year and Regional Storm events. Volumetric requirements for each storm event are within typical industry expected ranges.

Table 4.1.2 Summary of Surface Water Capture Areas						
Drainage Catchment	**Drainage Area (ha)**	**Imperviousness Coverage (%)**	**Top Area (ha)**	**Top Area / Drainage Area**	**Volume Provided (m^3)**	**Sizing Event**
43_SW	3.93	83.3	0.31	8%	4,981	100 Year
38_SW	8.11	46.1	0.31	4%	4,446	100 Year
48_SW	2.18	69.8	0.25	11%	3,210	100 Year
36_SW	15.67	55.6	1.54	10%	31,568	Regional
39_SW	5.71	61.2	0.45	8%	7,761	Regional
42_SW	21.92	63.0	1.86	8%	37,054	Regional
47_SW	7.42	60.5	0.62	8%	11,383	Regional
49_SW	15.00	60.6	1.33	9%	26,789	Regional
50_SW	14.12	63.3	1.16	8%	23,146	Regional
51_SW	13.15	62.2	1.00	8%	19,593	Regional
52_SW	5.80	62.3	0.53	9%	9,409	Regional
53_SW	5.93	61.5	0.51	9%	9,142	Regional
55_SW	11.18	59.5	0.86	8%	16,251	Regional
56_SW	5.15	62.3	0.46	9%	7,976	Regional
58_SW	11.22	65.7	0.94	8%	18,098	Regional
59_SW	5.16	60.7	0.46	9%	7,962	Regional
61_SW	27.25	61.4	2.27	8%	47,908	Regional
111_SW	32.98	57.9	2.93	9%	63,413	Regional

Table 4.1.3. Surface Water Capture Areas Volumetric Requirements									
Drainage Catchment	Drainage Area (ha)	Sizing Event	Volume Provided (m^3)	25 Year		100 Year		Regional Storm	
				Maximum Vol. (m^3)	Unitary Vol (m^3/imp.ha)	Maximum Vol. (m^3)	Unitary Vol (m^3/imp.ha)	Maximum Vol. (m^3)	Unitary Vol (m^3/imp.ha)
43_SW	3.93	100 Y	4,981	1,691	516	2,295	700	5,181	NA
38_SW	8.11	100 Y	4,446	2,702	723	3,940	1,054	4,749	NA
48_SW	2.18	100 Y	3,210	899	591	1,230	809	3,294	NA
36_SW	15.67	Regional	31,568	5,125	588	7,484	858	20,460	2,346
39_SW	5.71	Regional	7,761	2,001	573	2,874	823	4,822	1,381
42_SW	21.92	Regional	37,054	7,739	560	11,050	800	32,390	2,345
47_SW	7.42	Regional	11,383	2,573	574	3,698	825	10,640	2,373
49_SW	15.00	Regional	26,789	5,140	565	7,405	815	20,920	2,301
50_SW	14.12	Regional	23,146	5,017	561	7,160	801	21,260	2,377
51_SW	13.15	Regional	19,593	4,607	563	6,611	808	19,250	2,354
52_SW	5.80	Regional	9,409	2,047	567	2,922	809	8,590	2,379
53_SW	5.93	Regional	9,142	2,091	574	2,985	820	8,750	2,402
55_SW	11.18	Regional	16,251	3,849	579	5,547	835	15,770	2,373
56_SW	5.15	Regional	7,976	1,808	563	2,598	810	7,688	2,396
58_SW	11.22	Regional	18,098	4,029	546	5,743	778	17,230	2,336
59_SW	5.16	Regional	7,962	1,837	587	2,587	826	7,503	2,396
61_SW	27.25	Regional	47,908	9,262	554	13,450	804	38,280	2,288
111_SW	32.98	Regional	63,413	10,920	572	15,920	834	44,320	2,322

4.1.2 Hydrologic Modelling Results

Frequency and Design Event Peak Flows

The PCSWMM hydrologic model representative of the Preferred Community Structure and the 27 mm capture and surface water capture areas has been executed for the 67 year continuous period (1950-2017) as per the Phase 1 and 2 Characterization hydrologic modelling. The hydrologic model has been used to determine frequency flows at the Hanlon Creek and Mill Creek flow monitoring sites as per the Phases 1 and 2 Characterization Report.

Frequency analyses using Consolidated Frequency Analysis (CFA) have been completed using the Log Pearson Type III Distribution providing the best fit to the annual maximum peak flows. Frequency flows for both flow monitoring locations have been provided in Tables 4.1.4 and 4.1.5. Frequency flows for the future land use condition are comparable to those of the existing land use condition.

In addition to frequency flows, peak flows for the future land use condition have been determined using the City of Guelph 3 hour Chicago design storms for the 2 to 100 year storm events, along with the Regional Storm (Hurricane Hazel), with peak flows provided within Table 4.1.6 and 4.1.7. The future land use condition design event peak flows are also comparable to those of the existing land use condition. Both the future frequency flows and design event peak flows are comparable to the existing land use condition and are considered to be acceptable, based on little to no impact compared to existing conditions.

Table 4.1.4 Hanlon Creek Monitoring Site (Station 15) Frequency Flows for Existing and Proposed Land Use Conditions (m^3/s)									
Land Use Condition	**Return Period**								
	1.003	**1.05**	**1.25**	**2**	**5**	**10**	**20**	**50**	**100**
Existing	0.008	0.036	0.100	0.250	0.530	0.760	0.990	1.310	1.550
Future	0.009	0.036	0.096	0.230	0.490	0.710	0.940	1.260	1.510
Difference	-0.001	0.000	0.004	0.020	0.040	0.050	0.050	0.050	0.040

Table 4.1.5 Mill Creek Monitoring Site (Station 14)Frequency Flows for Existing and Proposed Land Use Conditions (m^3/s)									
Land Use Condition	**Return Period**								
	1.003	**1.05**	**1.25**	**2**	**5**	**10**	**20**	**50**	**100**
Existing	0.035	0.038	0.039	0.045	0.069	0.100	0.160	0.290	0.480
Future	0.035	0.038	0.039	0.045	0.069	0.100	0.160	0.290	0.480
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4.1.6 Hanlon Creek Monitoring Site (Station 15) Design Event Peak Flows for Existing and Proposed Land Use Conditions (m^3/s)							
Land Use Condition	**Return Period**						
	2	**5**	**10**	**25**	**50**	**100**	**Regional**
Existing	0.501	0.667	0.697	0.714	0.723	0.740	0.819
Future	0.457	0.662	0.693	0.711	0.722	0.738	0.812
Difference	0.044	0.005	0.004	0.003	0.001	0.002	0.007

Table 4.1.7 Mill Creek Monitoring Site (Station 14) Design Event Peak Flows for Existing and Proposed Land Use Conditions (m^3/s)							
Land Use Condition	**Return Period**						
	2	**5**	**10**	**25**	**50**	**100**	**Regional**
Existing	0.039	0.060	0.076	0.324	1.371	2.801	4.747
Future	0.039	0.060	0.076	0.324	1.369	2.798	4.747
Difference	0.000	0.000	0.000	0.000	0.002	0.003	0.000

Water Balance

In addition to determining frequency flows and design event peak flows at the two (2) monitoring locations, the 1950-2017 climate data set has been used to establish an annual water balance (surface water-based modelling) within the Clair-Maltby SPA and to the monitoring locations (flow and spot flow) within the Clair-Maltby Secondary Study Area (SSA) (Drawing HYD2). The annual water balance assessment has been conducted for each subwatershed based on the subcatchments contributing to the monitoring locations within Mill Creek, and Hanlon Creek for Preferred Community Structure, with results compared to the existing land use condition. The mean values for the annual water balance are provided in Tables 4.1.8 to 4.1.9, with detailed results provided in Appendix C.

The PCSWMM hydrologic modelling determines annual evaporation conditions using pan-evaporation and temperature data series sets. The evaporation does not include transpiration from vegetation, as such the transpiration is inherently included with infiltration, as the drainage that is infiltrated within the vegetation root zone would also be available for transpiration.

Baseflow within the PCSWMM hydrologic model is a continuous discharge in Clair Maltby, it represents groundwater discharge. Outflow represents baseflow and any other overland runoff response.

Based on a comparison of the existing and future land use conditions, the total amount of drainage available for infiltration and transpiration is maintained (i.e. no let loss) using the proposed stormwater management approach, including a distributed 27 mm capture and the proposed surface water capture areas.

Table 4.1.8 Hanlon Subwatershed Annual Water Balance Summary for Existing and Future Land Use Conditions (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Discharge/ Runoff
Existing	856.46	842.98	26.94	0.42
Proposed	856.46	839.41	32.45	0.37

Table 4.1.9 Mill Creek Subwatershed Annual Water Balance Summary for Existing and Future Land Use Conditions (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Discharge/ Runoff
Existing	856.46	843.18	11.95	9.69
Proposed	856.46	841.13	17.34	8.71

Notably, the locations of the SWC and the source control rate (27 mm), has been provided as input to the groundwater modelling (MIKE-SHE) to validate the movement of water through the system.

4.2 Hydrogeology

The conceptual understanding of groundwater flow conditions within the SPA and PSA described in Sections 2.1.2 and 2.3.2 and the Characterization Report (Wood et al, 2018) was used to inform the location of future land use types depicted in the Preferred Community Structure (PCS) and Surface Water Capture Areas (SWCA) and Low Impact Development (LID) measures to maintain groundwater function, as part of the overall stormwater management plan (Figure IA-HYD2).

Groundwater recharge in the SPA occurs through direct infiltration and via runoff and direct precipitation to ponds (e.g. Hall's Pond) and leakage/recharge from the ponds into the subsurface, where pond elevation is greater than the water table elevation. Direct precipitation and runoff from the existing NHS areas provide the majority inflow to the ponds supporting the recharge function of the ponds, and these areas are maintained in the future land use plan. Recharge within in the SPA and regional groundwater flow support the following groundwater functions:

- Groundwater discharge to Hanlon, Torrance, Mill Creeks
- Groundwater discharge to wetlands outside the SPA and one within the SPA.
- Deep recharge to the shallow and deep bedrock aquifers, supplying Guelph municipal wells

The Stormwater Management and Low Impact Development Plan (Section 4.1.1) for the future land use plan (PCS) takes advantage of the high infiltration capacity of the soils and thick unsaturated zone in the SPA to replicate function of existing depressional features that would be removed from the landscape through development. A minimum distributed LID BMP capture of 27 mm is proposed to be provided in all areas to be developed outside the NHS. Centralized SWM infiltration facilities (or SWCAs) are proposed to capture excess runoff and to infiltrate additional runoff from large precipitation events.

4.2.1 Assessment of Future Conditions

A Preferred Community Structure (PCS) future land use scenario was represented and evaluated using the MIKE SHE model developed as part of the Existing Conditions Characterization (Section 2.1.2). The Existing Conditions simulation and PCS simulation were completed using climate inputs for the period of 1998-2002. The impacts of the PCS and effectiveness of the Stormwater and LID measures was assessed by comparison to the existing conditions simulations. The impacts of the future land use change associated with the PCS were based on changes to water budgets in the SPA, PSA and key NHS features in, and adjacent to, the SPA, groundwater flow directions and depth to water table, recharge to the water table, recharge to the regional bedrock aquifer, as well as groundwater discharge to streams and wetlands.

Future land uses result in removal of depressions, decreases in vegetation and increased imperviousness resulting in less infiltration and more runoff compared to existing undeveloped and agricultural land uses within the SPA. To represent the future land uses and evaluate proposed LID BMP and SWCA management practices in MIKE SHE the following changes were made to the model:

- Topography was smoothed to represent loss of surface storage (depressions)
- Hydraulic conductivity was reduced to represent decreased infiltration capacity from impervious areas
- Leaf Area Index, rooting depth were reduced to reflect, grass, trees and shrubs
- Surface roughness and detention storage were reduced to reflect surface changes
- Detention storage was increased to represent proposed level of LID BMP capture to mitigate reduction in infiltration capacity and locations based on Section 4.1.1.

- Directly connected runoff was specified based on directly connected impervious area and routed to central SWCA locations based on recommendations per Section 4.1.1.
- Central SWM infiltration locations were represented as described in Section 4.1.1 which receive water during larger precipitation events.

Topography

Under future development conditions, grading will be necessary, and it will result in smoother/flatter topography in developed areas. The smoother topography will reduce the surface storage capacity and infiltration if not mitigated. The City of Guelph's existing NHS policies provide direction on grading plans in areas to be developed to maintain landforms associated with the moraine. The SWM plan described in the hydrologic section provides mitigation for the loss of surface storage due to changes in topography.

Post-development topography in the SPA was represented in the MIKE SHE model by smoothing topography to represent general grading approaches, whereby low lying/small depression areas are infilled, hills and ridges area reduced. This was done by resampling the gridded topography in areas to be developed to a grid resolution of 50 m and the existing 12.5 m resolution topography was updated with the smoothed 50 m resolution topography. Topography of areas within the SPA not being developed, e.g. NHS areas, were preserved at the 12.5 m scale and not smoothed. The smoother topography in MIKE SHE is representative of potential future conditions and is consistent with overall future flow patterns considered in the hydrologic analysis.

The smoothing of topography to represent post-development conditions represents a loss of depression storage equivalent to approximately 140 mm over the area of development. Depressional features act as storage for precipitation and overland runoff and may facilitate infiltration and evapotranspiration depending on factors such as the local surficial geology and vegetation. If no other changes occur in the development area the reduction of the volume associated with depressions is likely to increase overland runoff and decrease infiltration and evapotranspiration within the development area. The planned additional detention storage and stormwater management plan and associated SWCAs are in place to help mitigate the potential reduction in infiltration associated grading.

Infiltration Capacity

To reflect the reduction in infiltration capacity in the development areas, because of increased imperviousness, the conductivity of the unsaturated zone materials at ground surface was reduced for the first 1 m of depth. The reduced conductivity was based on an area weighting of the conductivity of the native material and the impervious area (directly connected fraction) that was approximated using a conservative asphalt conductivity value (Kz = 1E-9 m/s). The details of this calculation can be found in Appendix (B)

Vegetation and Surface Characteristics

To represent the future land use in the SPA, the model was updated to have vegetation characteristics representing the range of proposed conditions including residential, commercial, park and school areas. For future land uses, vegetation characteristics including leaf area index (LAI) and rooting depth (RD) were assigned to reflect a mixture of grasses, some shrubs and trees. Further to this, vegetation characteristics were adjusted to reflect the reduced area of vegetation present on development areas, relative to existing undeveloped or agricultural lands, estimated based on degree of total imperviousness prescribed for the

new land uses. These new land use areas were also prescribed a surface roughness in accordance with the general overland flow characteristics of the land use class. A summary of future land use characteristics used in the model is found in Table 4.2.1.

Table 4.2.1 Future Land Use Characteristics

Future - Land Use Type	Total Impervious Fraction	Directly Connected Impervious Fraction	Manning's N	Leaf Area Index ()		Rooting Depth (mm)	
				Min	Max	Min	Max
Low-density Residential	0.65	0.39	0.07	0.65	0.65	120	1200
Medium-density Residential	0.7	0.49	0.05	0.65	0.65	120	1200
High-density Residential	0.8	0.8	0.04	0.04	0.4	80	800
Mixed Use	0.88	0.88	0.033	0.035	0.35	40	400
Neighborhood Commercial	0.85	0.85	0.033	0	0	80	800
Office Commercial	0.85	0.85	0.033	0	0	80	800
Service Commercial	0.85	0.85	0.033	0	0	80	800
ROW (Local/Collector)	0.65	0.65	0.033	0	0	200	200
ROW(Arterial)	0.75	0.75	0.033	0	0	200	200
Stormwater management Facility	0.1	0	0.07	0.3	2.5	100	1000
School	0.65	0.39	0.15	0.3	3	120	1200
Park (Community)	0.35	0.2625	0.15	0.3	2.5	100	1000
Park (neighborhood)	0.2	0.15	0.15	0.3	2.5	100	1000
Open Space	0.1	0	0.15	0.3	2.5	100	1000

Low Impact Development

The role of infiltration based Low Impact Development Best Management Practices in managing runoff from impervious areas was represented through adding additional detention storage, 27 mm, to catchments with development according to the percentage total imperviousness area within a catchment. Figure IA-HYD2 depicts the location of each drainage area catchment. The additional detention storage applied to each catchment is summarized in Table 4.1.2. The additional 27 mm of detention storage is representative of the additional volume of capture planned for each catchment through various LID/BMPs designed to provide infiltration capacity as well as a leaky conveyance system (e.g. pervious pipes, bio-swales) from the point of runoff generation to the stormwater management capture areas. In catchments where stormwater management capture areas are planned, all runoff in excess of the additional detention storage was routed to the stormwater management capture area (SWCA). In areas where no SWCA is present the runoff was allowed to follow local topography to local depressions, or to adjacent Natural Heritage System lands, to

facilitate infiltration. If SWCA capacity is ever exceeded then excess runoff flows to adjacent Natural Heritage System. See Section 4.2.1 for more information on these measures.

Table 4.2.2	Future Land Use Catchments and Additional Detention Storage (LID/BMPs)				
Watershed Name	**Total Imperviousness (%)**	**Total Drainage Area (ha)**	**Watershed Type**	**Runoff Directed To**	**Additional detention storage (mm)**
37_SW	37	5.4	Park	Depression/Property	10
46_SW	20	1.0	Park	NHS	5
34_SW	62	3.0	Development	NHS	17
35_SW	46	2.5	Development	NHS	12
40_SW	57	0.8	Development	NHS	15
41_SW	64	1.2	Development	NHS	17
43_SW	83	3.9	Development	NHS	23
44_SW	63	1.6	Development	NHS	17
45_SW	58	1.3	Development	NHS	16
60_SW	88	0.7	Development	NHS	24
107_SW	72	4.9	Development	NHS	20
38_SW	46	8.1	Park	Depression/Property	12
48_SW	70	2.2	Development	Depression/Property	19
36_SW	56	15.7	Development	SWCA	15
39_SW	61	5.7	Development	SWCA	17
42_SW	63	21.9	Development	SWCA	17
47_SW	60	7.4	Development	SWCA	16
49_SW	61	15.0	Development	SWCA	16
50_SW	63	14.1	Development	SWCA	17
51_SW	62	13.2	Development	SWCA	17
52_SW	62	5.8	Development	SWCA	17
53_SW	61	5.9	Development	SWCA	17
55_SW	59	11.2	Development	SWCA	16
56_SW	62	5.2	Development	SWCA	17
58_SW	66	11.2	Development	SWCA	18
59_SW	61	5.2	Development	SWCA	16
61_SW	61	27.2	Development	SWCA	17
111_SW	58	33.0	Development	SWCA	16

4.2.2 Phase 3 Assessment Results

The Existing Conditions MIKE SHE model simulation and the Preferred Community Structure Future Conditions Simulation, including the 27 mm capture and Surface Water Capture Areas, were simulated using historical climate data for 1998 through 2002 as per the Phase 1 and 2 Characterization modelling. While a shorter simulation period was used for the evaluation, relative to Phase 1 and 2 modelling, this period still represents the range of climate conditions including drought and wet years representative of the longer-term conditions and suitable for evaluating potential impacts.

Tables 4.2.3 through 4.2.5 and Figures GW-2 through GW-16 (Appendix B) summarize the results of Existing Conditions and PCS Future Conditions simulations and provide a comparison of pre- and post-development average annual:

- water budgets for the SSA, SPA and NHS Features
- groundwater flow
- depth to groundwater
- recharge to the water table, infiltration, groundwater discharge
- recharge to the regional bedrock aquifers (shallow and deep)

To evaluate impacts to the following groundwater function in supporting:

- Groundwater flow and discharge to Hanlon, Torrance, and Mill Creek
- Groundwater discharge to wetlands outside the SPA and one within the SPA.
- Recharge to the regional bedrock aquifers (shallow and deep), supplying Guelph municipal wells

Water Budgets

Tables 4.2.3 a, b, c; 4.2.4 a, b, c and 4.2.5 present the simulated pre- and post-development water budgets and simulated recharge for the MIKE SHE model domain (which extends beyond the PSA into the Secondary Study Area (SSA)), the SPA, and for the Hall's, Halligan's and Neumann Ponds, respectively.

The SSA simulated water budget provides an indication of potential impacts to regional surface water and groundwater flow systems and receptors in the SPA and PSA in Hanlon, Mill and Torrance Creeks subcatchment areas. Existing conditions groundwater flow is simulated to be maintained in PCS future conditions, indicating that there is no simulated impact to regional groundwater flow in the bedrock or overburden.

Within the SSA, evapotranspiration is reduced from simulated existing conditions by approximately 1%. The reduction in evapotranspiration may contribute to the negligible increase in runoff (overland flow) in the SSA, and the 1-2% increase in recharge observed for portions of the SSA and portions of Mill and Hanlon Creek represented in the model and SSA. The pre- and post-development SSA water balance is a basic indicator that future conditions are simulated to be protective of regional groundwater functions, for areas in the SSA.

It should be noted that the small increases in recharge for existing conditions in Table 4.2.3c compared to the results from the Phase 1/2 report, relate to updates to the existing conditions development representation. These results will be updated when Phase 1/2 report is finalized, but they do not change the understanding of the existing conditions and groundwater function.

The SPA simulated water budget provides an indication of changes in local surface and groundwater flow systems and potential impacts to receptors within the SPA and highlights. The most notable changes in the future conditions water budget are in evapotranspiration, overland flow and smaller changes in groundwater flows out of the SPA into the PSA and SSA which demonstrate the dynamic response of the system to local changes.

Evapotranspiration in the SPA is reduced by 5% overall representing the change from undeveloped or agricultural conditions that exist at present to predominantly residential land uses. The change (decrease) in evapotranspiration and use of infiltration based LID BMPs and SWCAs to provide capture, results in a slight increase in recharge in the SPA (~9 mm/year).

The increased recharge from LID BMPs results in small decreases in lateral groundwater inflow to the SPA from the east through the overburden and bedrock. While lateral groundwater outflow increases by less than 1% in Mill Creek, it decreases by up approximately 5% in Hanlon Creek. In contrast there are increases in runoff/overland flow components into and out of the SPA. The increase in runoff into and out of the SPA occurs across wetland areas that are cross-cut by the SPA boundary (a non-physical boundary). The net change in overland flow increased by 11 mm from the SPA. . The simulated increase occurs on subcatchment boundaries due to the approximation of future topography and smaller catchments without SWCAs where runoff is provided to existing depressions. The increased runoff/overland flow also potentially reflects minor increases in groundwater discharge to Mill Creek and Hanlon headwater wetlands.

The water budgets for Hall's, Halligan's and Neumann's Ponds are simulated to maintain existing conditions under PCS Future conditions within the catchments local to these features. However, there are potentially increases in overland flow (runoff) to the ponds. The increased run-off for Hall's and Halligans pond is negligible representing less than 2 cm increase in water level in the ponds on an annual basis which is not expected to influence the hydroperiod of these features.

The water budget for Neumann's Pond indicates that runoff could increase water levels in the pond by as much as 10 cm on an annual basis which is also not expected to influence the temporal nature of the hydroperiod of these features. It may also increase the recharge from the pond to the underlying aquifer by 51 mm. Neumann pond catchment area includes areas to be developed and provides less of an NHS buffer for runoff to the ponded area - adjustments to this may be implemented in iteration 2 of the PCS impact assessment to maintain existing runoff.

Table 4.2.3 Water Budget for MIKE SHE Model Domain within Secondary Study Area (SSA) (Pre- and Post-Development) (1998-2002 in mm/year);
a) Existing conditions

Area / Catchment	Precipitation	Evapotranspiration	Overland Flow In	Overland Flow Out	Lateral Groundwater Flow				Vertical Groundwater Flow Across Regional Bedrock Aquifer		Pumping	Change in Storage
					Overburden		Bedrock Above Vinemount					
					Inflow	Outflow	Inflow	Outflow	Inflow	Outflow		
SSA	790	459	0	96	16	44	33	127	3	104	2	8
Mill Creek	790	477	1	185	41	36	135	190	4	69	7	6
Hanlon Creek	790	453	0	71	18	59	39	133	2	124	0	10
Torrance Creek	790	433	0	24	46	100	221	432	3	61	0	9

Explanation of Water budget terms:

Area – This is the region or catchment within which the inflows, outflows and change in storage of water are assessed for the period of the water budget.

Precipitation – This term represents rainfall or snowfall which falls within the catchment. Precipitation is an inflow of water to the catchment.

Evapotranspiration – This term represents water lost to evaporation and vegetation associated transpiration. Evapotranspiration is an outflow of water from the catchment.

Overland Flow In – This term represents water flowing as runoff or in channels which enters the catchment. This is an inflow of water to the catchment.

Overland Flow Out – This represents water flowing overland as runoff or in channels which exits catchment. This is an outflow of water from the catchment

Lateral groundwater Flow – These terms represent water flowing laterally through the overburden and bedrock units in the subsurface. Inflows represent water flowing into the catchment and outflows represent water flowing out of the catchment.

Vertical Groundwater Flow – These terms represent water flowing vertically across the regional bedrock aquifer unit in the subsurface. Inflows represent water flowing into catchment and outflows represent water flowing out of the catchment.

Pumping – This term represents water extracted from the catchment through groundwater pumping. Pumping represents an outflow of water from the catchment.

Change in storage – Throughout the catchment water is stored in various locations through time. Storage areas for water include storage on vegetation canopy, storage on the land surface (e.g. as ponds, lakes or wetlands) as water, and storage on the land surface as snow and finally storage in the subsurface material pores as groundwater.

Table 4.2.3 Water Budget for MIKE SHE Model Domain within Secondary Study Area (SSA) (Pre- and Post-Development) (1998-2002 in mm/year);
b) Future Conditions

Area / Catchment	Precipitation	Evapotranspiration	Overland Flow In	Overland Flow Out	Lateral Groundwater Flow				Vertical Groundwater Flow Across Regional Bedrock Aquifer		Pumping	Change in Storage
					Overburden		Bedrock Above Vinemount					
					Inflow	Outflow	Inflow	Outflow	Inflow	Outflow		
SSA	790	456	0	97	16	44	32	127	3	105	2	10
Mill Creek	790	472	1	187	41	36	135	190	4	70	7	7
Hanlon Creek	790	449	1	71	18	59	39	134	2	124	0	12
Torrance Creek	790	433	0	24	46	101	221	433	3	61	0	9

*overland flow includes amounts discharging to Mill Creek at headwaters and is not strictly runoff but includes runoff and stream flow in the headwaters.

Table 4.2.3 Water Budget for MIKE SHE Model Domain within Secondary Study Area (SSA) (Pre- and Post-Development) (1998-2002 in mm/year);
c) Recharge Summary

Area	Groundwater Recharge (mm/year) - 1998-2002		
	Pre-Development	Post Development	% - Change
SSA Model Domain	352	355	1%
Mill Creek	352	358	2%
Hanlon Creek	356	359	1%
Torrance Creek	352	353	0%

Table 4.2.4 Water Budget for MIKE SHE Model Domain within Secondary Plan Area (SPA) (Pre- and Post-Development) (1998-2002 in mm/year);
a) Existing conditions

Area / Catchment	Precipitation	Evapotranspiration	Overland Flow In	Overland Flow Out	Lateral Groundwater Flow				Vertical Groundwater Flow Across Regional Bedrock Aquifer		Pumping	Change in Storage
					Overburden		Bedrock Above Vinemount					
					Inflow	Outflow	Inflow	Outflow	Inflow	Outflow		
SPA	790	475	1	3	6	27	45	189	2	132	2	15
Mill Creek in SPA	790	481	2	2	40	53	299	481	2	104	0	11
Hanlon Creek in SPA	790	472	0	3	7	32	42	170	2	145	2	17

Table 4.2.4 Water Budget for MIKE SHE Model Domain within Secondary Plan Area (SPA) (Pre- and Post-Development) (1998-2002 in mm/year); b) Future Conditions												
Area / Catchment	Precipitation	Evapotranspiration	Overland Flow In	Overland Flow Out	Lateral Groundwater Flow				Vertical Groundwater Flow Across Regional Bedrock Aquifer		Pumping	Change in Storage
					Overburden		Bedrock Above Vinemount					
					Inflow	Outflow	Inflow	Outflow	Inflow	Outflow		
SPA	790	453	4	15	6	26	43	191	2	133	0	27
Mill Creek in SPA	790	447	15	33	38	53	300	486	2	105	0	20
Hanlon Creek in SPA	790	455	3	10	9	31	41	172	2	146	0	30

*overland flow includes amounts discharging to Mill Creek at headwaters and is not strictly runoff but includes runoff and stream flow in the headwaters.

Table 4.2.4 Water Budget for MIKE SHE Model Domain within Secondary Plan Area (SPA) (Pre- and Post-Development) (1998-2002 in mm/year); c) Recharge Summary			
c)	Groundwater Recharge (mm/year) - 1998-2002		
Area	Existing Conditions	Future Land Use	% - Change
SPA Model Domain	322	331	3%
Mill Creek	321	339	6%
Hanlon Creek	323	329	2%

Table 4.2.5 Water Budget for MIKE SHE Model Domain for Hall's, Halligan's and Neumann's Ponds (Pre- and Post-Development)							
NHS Feature Water Balances - 1998-2002 (mm-year)				Overland Net	Shallow GW (Layer 1) Net	Recharge	Storage Change
Subcatchment	Scenario	Precipitation	Evapotranspiration				
Hall's Pond	Existing Conditions	790	-489	-1	-3	-288	10
	Future Land Use	790	-490	22	-2	-289	30
	Future vs Existing	0	-1	23	0	-1	21
Halligan's Pond	Existing Conditions	790	-507	0	0	-280	3
	Future Land Use	790	-505	4	-1	-276	12
	Future vs Existing	0	2	4	0	3	9
Neumann's Pond	Existing Conditions	790	-519	0	2	-268	5
	Future Land Use	790	-516	119	7	-319	80
	Future vs Existing	0	2	119	5	-51	75

Groundwater Flow

Figures GW-2 and GW-3 show the simulated groundwater levels for Existing and PCS Future Conditions, respectively. In the simulated future conditions, groundwater levels are closely maintained and groundwater flow directions towards the Hanlon, Mill and Torrance Creek are similarly maintained. There is localized mounding of the water table (~1 metre) under future conditions on the east and west side of Gordon Street associated with ponds and SWCAs. This mounding is not significant, as it occurs away from potential receptors and flow gradient toward the receptors are maintained.

No changes in groundwater levels, gradients or water levels outside the SPA are evident in the results. The comparison of existing and future flow directions indicates that the distributed LID measures are having the effect of maintaining groundwater flow directions and gradients within, and adjacent to, the SPA. This comparison provides a basic indicator that modelled future conditions will be protective of groundwater functions and infiltration or recharge may be enhanced locally given the modelled capture.

Following review of the Phase 3 Impact Assessment additional simulations may be undertaken to refine the PCS and LID BMP and SWCA.

Depth to Groundwater

Figures GW-4 and GW-5 show the simulated depth to water table for Existing and PCS Future Conditions, respectively. Changes in depth to the water table occur local to land use changes in the SPA. In both Existing Conditions and PCS Future Conditions simulations the depth to groundwater within SPA exceeds 5 metres except near Hall's Pond and ponds along Gordon Street. The shallow water table near these features under existing conditions reflects leakage from these perched features that is primarily supported by runoff. Under future conditions recharge is increased overall in the SPA and this includes some additional leakage from the ponds along Gordon Street and Hall's Pond and SWCAs. The depth to water table will still exceed 5 metres in most areas and 2-3 metres below the ponds on Gordon Street.. The groundwater table is simulated to be similar in depth to existing conditions in the development area and as such is expected to maintain existing groundwater conditions.

Recharge to the Water Table, Infiltration, Groundwater Discharge

Figures GW-6 and GW-7 show the recharge and Figures GW-8 and GW-9 show infiltration under existing and future conditions. Within the SPA, the spatial variability of recharge and infiltration increases under future conditions due to differences in imperviousness and capture volumes associated with each land use. More pervious land uses have a larger volumetric capture than less pervious land uses. The highest density future land uses are located along Gordon Street in the PCS. Therefore infiltration and recharge are reduced most notably along Gordon Street. Recharge and infiltration are maintained or slightly increased in areas of more pervious development. Areas of increased recharge include remaining depressions where LID BMPs may further enhance infiltration, or at SWCAs. The reduction in vegetation under future conditions also supports the overall increase in recharge.

Existing and Future conditions discharge shown in Figures GW-10 and GW-11 show areas of groundwater discharge are maintained reflecting the effectiveness of the LIDs and SWCAs to compensate for changes in land use.

Ponded Water

Figures GW-12 and GW-13 show areas of simulated ponded water in Existing and Future Conditions simulations, respectively. These figures show little difference in ponded water locations supporting the water budget analysis interpretation that hydroperiods for these features would be maintained, as well as their function in supporting leakage to the groundwater system.

Recharge to the Deep Regional Bedrock Aquifer

Recharge to the regional bedrock aquifer refers to the water that recharges the Gasport and Goat Island Formations that are below the MIKESHE model domain, and support the majority of municipal supply wells in Guelph. The MIKESHE model simulates the vertical flow to the deep regional bedrock aquifer based on the difference in groundwater levels in the deep regional bedrock aquifer, derived from the Tier 3 model, and the groundwater levels simulated in the shallow bedrock and overburden flow systems. The potential for changes to recharge to the deep regional bedrock aquifer that might impact the municipal water supply wells can be evaluated by comparing the flux in and out of the bottom of the model between Existing and Future Conditions simulations.

Figures GW-14 and GW-15 show the Existing and Future Conditions simulated recharge to the deep regional bedrock aquifer and Figure GW-16 shows the difference of these two maps. The localized increases and decreases in recharge to the deep regional bedrock aquifer are small (< 5 mm reduction) and localized reflecting the dominant vertical flow direction in the moraine. The largest reduction shown on Figure GW-16 aligns with higher density development along Gordon Street. The increased flux locations align with SWCAs. The water budget indicates that there is an overall increase in recharge to the deep regional bedrock aquifer within the SPA based on the modelled LID BMP and SWCA conditions for the PCS.

Future Groundwater Quality

The proposed LID BMP and SWCA measures are designed to provide water quality treatment at source as described in Section 4.3. In addition on-going salt management strategies are being developed and implemented within the City of Guelph to reduce chloride due to road salt in water being infiltrated and recharged.

4.3 Water Quality

The Phase 1 and 2 Characterization Report characterized the water quality health of the Clair-Maltby SPA based on the associated subwatershed studies and surface water quality monitoring data to represent the contaminant loadings under existing land use conditions, and to establish a baseline condition. Surface water quality and ground water quality within the Clair-Maltby SPA are directly related as the most of the SPA does not drain overland to open watercourse systems, rather the area drains to depressional features that contribute largely to the groundwater system.

Changes in groundwater quality has the potential if unmanaged to impact drinking water, however Guelph's water supply is not linked to the groundwater within the Clair-Maltby SPA. Guelph's Source Water Protection Plan Policies are part of the GRCA's Source Water Protection Plan Policies that restrict land uses that may impact ground water and require preventative measures such as stormwater management measures that protect groundwater (ref. Figure 4.1).

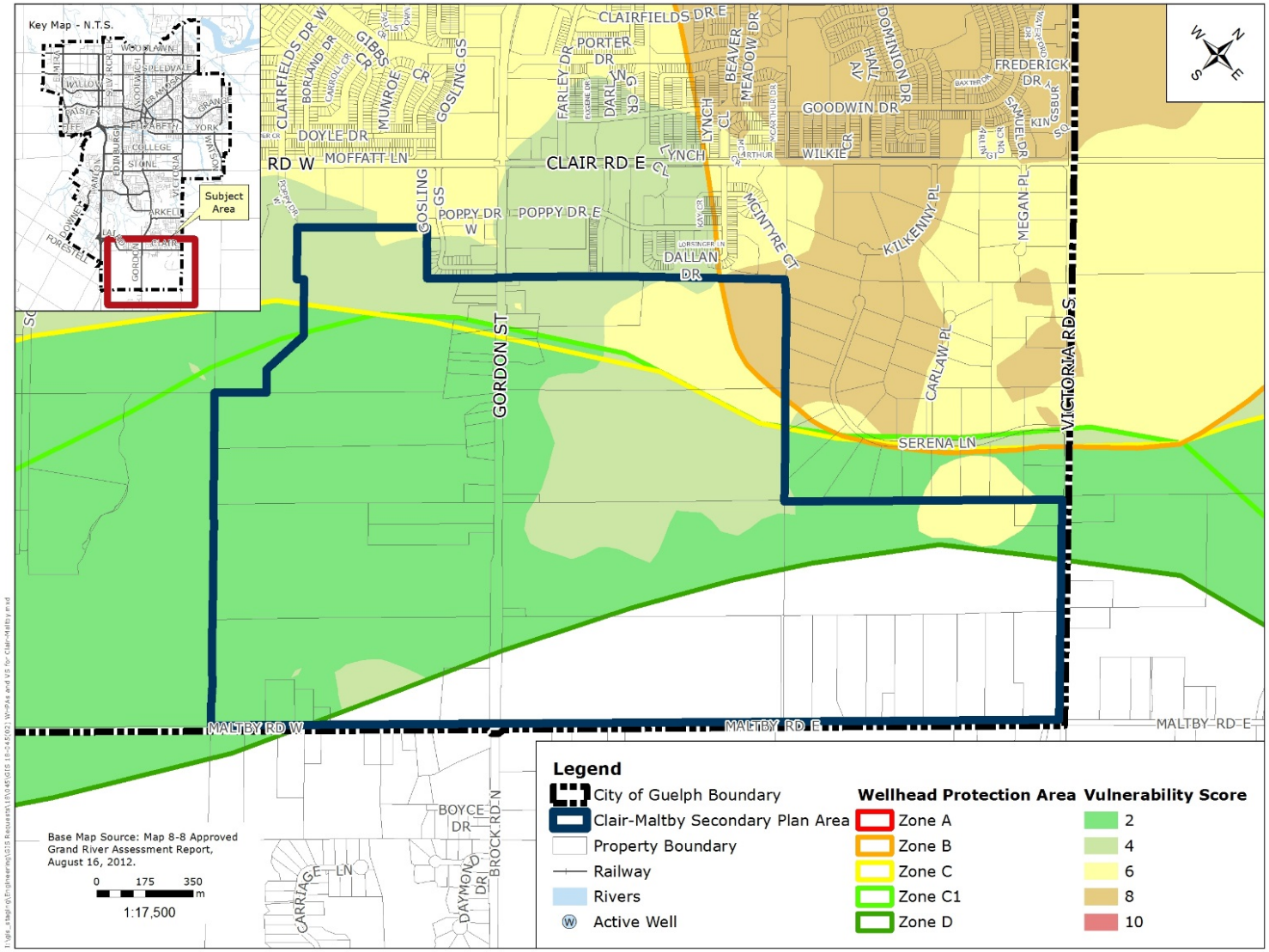

Figure 4.1 Hydrogeology: Groundwater Vulnerability

The City of Guelph's Official Plan provides the following guidance related to land use changes, stormwater management and water quality:

- Demonstrate how the design and construction of the stormwater management facility will protect, improve or restore the quality and quantity of surface and groundwater resources;
- The City will require appropriate use of on-site infiltration measures, within the stormwater management design.
- The City encourages the use of landscape-based stormwater management planning and practices (also referred to as Low Impact Development) including rainwater harvesting, green roofs, bioretention, permeable pavement, infiltration facilities and vegetated swales in the design and construction of new development where site conditions and other relevant technical considerations are suitable.
- The City encourages approaches to stormwater management that include a combination of lot level, conveyance and end-of-pipe stormwater controls to maintain the natural hydrologic cycle, protect water quality and quantity and minimize erosion and site alteration and flooding impacts.
- All development shall be required to adhere to any approved City policies, guidelines and standards including the Stormwater Management Master Plan (2011) and the Design Principles for Stormwater Management (1996), Development Engineering Manual (2016) and Environmental Impact Study Guidelines (2017)

In addition to City's policies on surface water quality and stormwater management, as per Table 3.2.1 Summary of Acts, Guidelines, Policy in the Phase 1 and 2 Characterization Report, Provincial and Federal polices also apply to water quality and the associated prevention of water quality impacts.

4.3.1 Impact Assessment

Existing Land Use Water Quality

The 2016-2018 (2016-2017 data summarized to-date) water quality monitoring program provided a baseline condition for the Clair-Maltby SPA for the surface water quality as a point of comparison. The following sets of established thresholds were used in Phases 1 and 2 assessment:

1. Provincial Water Quality Objectives (PWQO);
2. Canadian Environmental Quality Guidelines (CEQG) for the Protection of Aquatic Life as prescribed by the Canadian Council of Ministers of the Environment; and
3. The Canadian Drinking Water Quality (CDWQ) guidelines as prescribed by Health Canada.

Based on the subject thresholds, notable water quality results from water quality monitoring program included frequent Ammonia exceedances and exceedances for Total Phosphorus, Aluminium, Copper, Iron, Lead, and Zinc at various sampling stations at different times of the year in both 2016 and 2017. The following provides guidance as to the potential reasons for the existing water quality exceedances based on the existing land use condition.

The existing land uses within the Clair-Maltby SPA consist primarily of agriculture, fallow lands and golf course, with limited existing residential and commercial development along the major arterials of Gordon Street, Maltby Road and Victoria Street. The widespread exceedances of Ammonia may be attributed to runoff from adjacent agricultural or golf course nutrient applications in the spring. In addition, both the Hall's Pond subwatershed within the Hanlon Creek and the Mill Creek Subwatershed possess well-drained, hummocky headwater areas in the PSA which may facilitate leaching.

The Total Phosphorous exceedances are considered to be a result of the agriculture land and golf course uses, where additional nutrients may be introduced to the groundwater and surface water through leaching and runoff.

The widespread exceedances of Aluminum are partially related to runoff from active roadways. The source of Aluminum exceedances that occurred at monitoring stations further from roadways have not been determined.

For Lead, the source of the exceedance is considered to be runoff from active roadways.

The Mill Creek Subwatershed Plan (1996) groundwater quality samples documented high levels of Zinc. It is considered that the Zinc exceedances are a natural occurrence.

In summary the water quality exceedances have occurred for various reasons, including untreated runoff from roadways, application of fertilizers on agricultural and the golf course within the area and existing ground water quality within the SPA.

Future Land Use Water Quality

The Preferred Community Structure includes various densities of residential land uses, commercial, institutional (schools) and parks that will drain through a series of LID BMPs towards surface water capture areas, with the objective of maintaining the existing water balance within the SPA through significant levels of infiltration and capture of excess runoff. The Ammonia and Total Phosphorous exceedances from agriculture lands and the golf course would not be expected to reduce after the land use has been changed, however the proposed land use would typically result in other urban surface water quality concerns and need to be mitigated accordingly.

Water quality from urban land uses have been characterized by various studies such as the 2007 Credit River Water Management Study Update (CRWMSU) by Credit River Conservation which indicates water quality event mean concentrations (EMCs) for various contaminants and land uses as per Table 4.3.1, with the highest EMCs resulting from runoff from roads, agriculture and golf courses.

Table 4.3.1 Event Mean Concentration by Contaminant and Land Use as per CRWMSU (mg/l unless otherwise noted)

Land use	Contaminant						
	Total P	Nitrate + Nitrite	TKN	Copper	Zinc	E.Coli (#/100 ml)	TSS
Residential	0.36	1.75	1.92	0.025	0.123	25,000	91
Commercial	0.25	0.67	0.71	0.022	0.127	5,000	70
Industrial	0.30	1.16	1.06	0.027	0.220	1,138	67
Educational / Institutional	0.36	1.75	1.92	0.025	0.123	8,360	63
Open Space	0.12	0.54	0.97	0.016	0.098	4,100	70
City Parks	0.36	1.75	1.92	0.025	0.123	10,000	63
Golf/Cemetery	0.70	1.75	3.30	0.025	0.123	4,100	63
Agricultural	0.45	4.00	1.90	0.014	0.039	100,000	132
Highway	0.39	0.76	2.00	0.052	0.302	3,070	331

It is well known within the industry that most of the surface water contaminants that occur from runoff from urban areas occur from paved surfaces such as parking lots and roadways and from fertilizers applied to

landscaped areas. Contaminants can include metals, TSS, E. Coli, nitrates and nitrites, phosphates, salt and others. Contaminants from the landscaped areas within residential, commercial and institutional land uses often are sourced from the use of fertilizers.

Drainage to the existing ponds within the Clair-Maltby SPA, whether overland or via a storm sewer drainage system, would undergo various forms of water quality treatment to maintain and/or improve the existing fish habitats.

To mitigate potential surface water and ground water quality impacts from the proposed urban form within the Clair-Maltby SPA a water quality management strategy has to be developed (Section 4.3.2).

4.3.2 Water Quality Management Alternatives and Assessment

To replicate the significant number of depressional features within the Clair-Maltby SPA with the objective of maintaining the water balance for both Hanlon and Mill Creeks, a distributed approach of low impact development (LID) best management measures (BMPs) to capture the 27 mm storm runoff response is proposed. The LID BMPs would receive surface runoff prior to the excess runoff (i.e., greater than 27 mm) flowing to the surface water capture areas, which support the local water balance.

The application of LID BMPs and associated function of infiltration within Clair-Maltby without pre-treatment of contaminated runoff would lead to contaminated ground water; therefore the following approach to protecting this function and providing surface water quality in the SPA has been proposed:

1. Apply a distributed approach for 27 mm capture within LID BMPs
2. Separate 'clean' water (rooftop and landscaped areas runoff) from dirty water, with dirty water typically resulting from roadways and parking areas
3. Apply a treatment train approach and protect the surface water capture area's function of infiltration
4. LID BMP selection and locations to be determined based on land ownership, land use, development form and grading (public and private realm)
5. Reduce the use of salt through the City of Guelph Salt Management Plan
6. In establishing a list of available low impact development measures and other stormwater quality management measures the following have been considered, but would need to be reviewed and refined through the MESP/EA process:

a. Oil and Grit Separators (OGS):

These end-of-pipe systems tend to service smaller drainage areas (2 ha +\-) and provide varying levels of stormwater quality treatment depending on the model selected. OGS units are typically encouraged as part of a "treatment train" approach; many municipalities and regulators will not credit the full TSS removal function of OGS units accordingly (i.e. typical maximum credit of 50% to 70% TSS removal). The Environmental Technology Verification (ETV) Program as established by Toronto Region Conservation Authority (TRCA) has established an OGS testing approach that once completed by OGS manufactures results in an ETV certification. ETV OGS units typically provide up to 70% TSS removal and as such do not provide the required Enhanced level (80% TSS removal) as per the 2003 MOECC Stormwater Management Planning and Design Manual. ETV certified OGS units are required by the GRCA. The disadvantages of OGS units include the need for frequent maintenance, as well as relatively high capital costs and the ability to service smaller drainage areas. As a pre-treatment approach for other stormwater quality measures, or for providing water quality treatment for pavement areas, oil grit separators should be considered within the Clair Maltby SPA.

b. Catch Basin Shields (or equivalent):

Catch Basin (CB) Shields (or equivalent) have been tested by the ETV Program. A (CB) Shield is an insert into a CB that prevent sediment within the CB sump from being discharged from the CB. CB Shields are able to service an area up to 0.60 ha and provide up to 56% TSS removal and would be considered a pre-treatment to other stormwater management quality measures and LID BMPs.

c. Enhanced Grassed Swales:

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely un-maintained turf can provide excellent filtration and treatment for storm runoff from roadways, when adequate space is provided to implement the swales. It is generally conceded that treatment levels are at a minimum, Normal (formerly Level 2) water quality treatment, and combined with other practices can provide Enhanced (Level 1) stormwater quality treatment. Their application in linear corridors is also particularly appropriate and can be further enhanced through the introduction of check dams to provide additional on-line storage. Their application in urbanized roadway cross-sections (i.e. curb and gutter) often requires alternative grading and roadway configurations which can compromise the function of the roadway itself, and are therefore typically not preferred in those cases. Notwithstanding, gutter outlets along outside lanes have been demonstrated to function effectively where the right-of-way can accommodate the design.

d. Filter Strips:

Filter strips are typically designed for small drainage areas (less than 2 ha), and are applied as part of a treatment train. Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Flow leaving filter strips should be a maximum of 0.10 m depth, based on a 10 mm storm event. Based on the limited space within the typical urban form, filter strips would only be considered to be a practical stormwater quality solution for more porous land uses such as schools and parks.

e. Bioretention Systems:

Bioretention systems provide effective removal of pollutants by sedimentation, filtering, soil adsorption, microbial processes and plant uptake. Bioretention systems should be approximately 10 to 20% in size of the contributing drainage area, with typical drainage areas of 0.50 ha and a maximum drainage area of 0.80 ha. Slopes within bioretention systems are typically 1 % to 5 %. Bioretention systems are preferred in areas that have reasonable infiltration properties (15 mm/ hr, 1x10-6 cm/s), but can be implemented in all soil types as long as the water quality event can be temporarily stored (typical depths 0.15 m to 0.25 m) before infiltrating and an underdrain is provided. The selection of filter and mulch material can impact the water quality discharging from the bioretention system, as such the practitioner should review current LID guidelines (e.g. Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, 2011, prepared by CVC and TRCA).

Bioretention systems should have forebays for a form of surface water pre-treatment, however for the Clair-Maltby SPA, surface runoff from roads and parking areas that has not received any pre-treatment before entering a bioretention area, should require the bioretention area to be lined and therefore act as a water quality filtration measure. Bioretention areas that receive drainage from pre-treatment would not need to be lined.

f. Infiltration Trenches:

Infiltration Trenches could be implemented as they are similar to bioretention systems but would require pre-treatment of road and parking lot runoff, unless the trenches are lined, and then would act only as a filtration system. Infiltration trenches could also provide thermal mitigation of surface runoff.

g. Soakaway Pits:

Soakaway Pits may be implemented within Clair-Maltby for residential land uses, where space allows. Soakaway pits provide a method of increasing infiltration of clean water from roof areas in particular. With residential roof drainage being directed underground, thermal mitigation could be an additional benefit of soakaway pits.

h. Permeable Pavers/ Pavement:

Permeable pavement could be used within the Clair-Maltby SPA as long as a sand bed is provided for water quality filtration for areas where vehicular movements occur. As a standalone LID BMP, a permeable paved multiuse path would not provide a stormwater quality benefit, however it would reduce the runoff volume from the paved surface. Permeable pavers/pavement could reduce the amount runoff and the duration of runoff remaining on paved surfaces, as such this LID BMP could provide thermal mitigation.

i. Pervious Pipes:

Pervious pipes could be used in combination with either bioretention systems or infiltration trenches. As a standalone stormwater quality measure, pervious pipes can be a cost-effective and relatively simple method to accomplish infiltration requirements, while eliminating the need for surface space within the right-of-way. That said, pervious pipes within the Clair-Maltby SPA would require pre-treatment which can be provided vis-à-vis a hybrid roadway cross-section (urban / rural) and / or with catchbasin controls. Pervious pipes, with the surrounding stone media, could provide for thermal mitigation of drainage based on the contact with the cool stone media.

j. Increased Topsoil Depth:

Increasing topsoil depth from 0.10 m +/- to 0.25 m to 0.30 m within landscaped areas for residential and non-residential land uses provides a simple non-structural method of reducing runoff and increasing infiltration at source. Amending topsoil with compost can achieve further reductions in runoff and has the added benefit of creating a more drought tolerant landscaped area.

4.4 Natural Heritage System (NHS)

4.4.1 Impact Assessment Context

As the Secondary Plan is implemented in the SPA, it is understood that the Refined NHS will be protected in accordance with the applicable MNRF, GRCA and City policies and regulations. For the purposes of this Secondary Plan level, impact assessment, it is therefore important to understand the applicable policies and regulations, at least in terms of what types of activities are permitted within the NHS. A summary of the relevant and current applicable policies is provided in Table 4.4.1. It is understood that proposed development in the lands adjacent to a NHS component is generally permitted outside of the established buffer as long as an Environmental Impact Study (EIS) or comparable study demonstrates that there will be no negative impacts to the natural heritage component or its functions, and therefore these policies have not been re-iterated in Table 4.4.1.

As illustrated in Table 4.1.1, in general, development and site alteration are not permitted in any components of the NHS, including buffers to protected features, except for the general permitted uses listed in the City's Official Plan Policy 4.1.2. Some of these permitted uses would be subject to an EIS that demonstrates no negative impacts to the feature or its functions. In addition, some types of infrastructure may be permitted in certain natural heritage features and/or their buffers subject to an EIS that demonstrates no negative impacts to the feature or its functions. For example:

- Essential transportation infrastructure may be permitted within Significant Landform and/or Ecological Linkages, subject to specified conditions; and
- Essential linear infrastructure and stormwater management facilities may also be permitted in the buffers to some NHS features (e.g., Significant Wetlands and Significant Woodlands) subject to specified conditions.

Therefore, in general, permitted uses within the various NHS components will be limited to essential infrastructure and trails. The current City policies already require an EIS to address any impacts associated with infrastructure and/or trails in the NHS, and recommended mitigation and management measures in the context of the SPA are also provided in Table 4.4.2 below.

Although stormwater management facilities may be permitted in the buffers[13] to some NHS features, only outlets to such facilities are permitted in Significant Landform, and since Significant Landform underlies most of the NHS in the SPA (Map NH-13, Appendix E), stormwater management areas must be (and have been) identified outside the NHS. However, as noted above, opportunities to identify these facilities as Restoration Areas (in accordance with the applicable policies), will be examined as part of the process going forward.

[13] Where SWM facilities are permitted within NHS feature buffers, they are only permitted in the outer 15 m of a minimum 30 m buffer to a PSW and in the outer 7.5 m of a minimum 15 m buffer to a LSW.

Table 4.4.1 Summary of relevant City of Guelph Official Plan (2018 Consolidation) Natural Heritage System (NHS) policies

NHS Component	Development within the Feature	Development within the Buffer	Additional Considerations
General - NHS	Development and site alteration shall not be permitted within the NHS, including buffers, except for the following uses: i) legally existing uses, buildings or structures; ii) passive recreational activities; iii) low impact scientific and educational activities; iv) fish and wildlife management; v) forest management; vi) habitat conservation; and vii) restoration activities (4.1.2.1) General permitted uses may be further limited or expanded upon through the specific policies of the Significant Natural Areas (4.1.3) and Natural Areas (4.1.4) (4.1.2.3). Where two or more components of the Natural Heritage System overlap, the policies that provide the most protection to the natural heritage feature or area shall apply (4.1.2.5). Where infrastructure and/or trails are permitted within natural heritage features and areas … i) the area of construction disturbance shall be kept to a minimum; and ii) disturbed areas shall be re-vegetated or restored with site appropriate indigenous plants wherever opportunities exist (4.1.2.8).	With the exception of the uses permitted by this Plan, established buffers shall be actively or passively restored to, or maintained in, a natural state … (4.1.1.9) Where infrastructure and/or trails are permitted within buffers… i) works are to be located as far away from the feature boundary within the minimum or established buffer as possible; ii) the area of construction disturbance shall be kept to a minimum; and iii) disturbed areas of the … buffers shall be re-vegetated or restored with site-appropriate indigenous plants wherever opportunities exist (4.1.2.7).	Boundaries of Significant Natural Areas and Natural Areas confirmed for protection… are required to be field verified and staked as part of an EIS or EA, to the satisfaction of the City, in consultation with the OMNR and/or the GRCA, as applicable (4.1.1.17). Permitted works may require an Environmental Impact Study (EIS) (4.1.2.2).
Significant Natural Areas			
Significant Habitat of Provincially Endangered and Threatened Species (Policy 4.1.3.3)	No development or site alteration permitted within the feature except in accordance with the Endangered Species Act (2007) as enforced by MNRF (4.1.3.3.2).	Buffer to be determined in consultation with MNRF (4.1.3.3.3). No development or site alteration within the buffer except in accordance with the Endangered Species Act (2007) as enforced by MNRF.	
Significant Wetlands (Policy 4.1.3.4)	No development or site alteration permitted within the feature except for formalization of existing trails where they are considered essential and have been subject to an EIS.	Minimum 30 m buffer to Provincially Significant Wetlands (PSWs). No development or site alteration permitted within the buffer except for essential linear infrastructure and stormwater management facilities in the outer half of the buffer, and formalization of existing trails and walkways.	
Surface Water Features and Fish Habitat (Policy 4.1.3.5)	No development or site alteration permitted within the feature except in accordance with the Fisheries Act (1985, 2013) as enforced by DFO (4.1.3.5.6).	Minimum 30 m buffer to cold and cool water fish habitat. Minimum 15 m buffer to warm water fish habitat. No development or site alteration permitted within the buffer except in accordance with the Fisheries Act (1985, 2013) as enforced by DFO.	
Significant Woodlands (Policy 4.1.3.6)	No development or site alteration permitted within the feature except for formalization of existing trails where they are considered essential and have been subject to an EIS.	Minimum 10 m buffer. No development or site alteration permitted within the buffer except essential linear infrastructure and stormwater management facilities, and formalization of existing trails and walkways.	
Significant Landform (Policy 4.1.3.8)	No development or site alteration permitted within the feature except for essential transportation infrastructure, essential linear	No minimum buffer,	*Essential linear infrastructure and underground water supply storage shall be designed to ensure that:*

Table 4.4.1 Summary of relevant City of Guelph Official Plan (2018 Consolidation) Natural Heritage System (NHS) policies			
NHS Component	**Development within the Feature**	**Development within the Buffer**	**Additional Considerations**
	infrastructure, municipal supply wells and essential stormwater management outlets for treated water subject to an EIS or EA.		*i) the Hummocky Topography of the Significant Landform will be maintained or restored to the greatest extent possible; ii) hydrological regimes will be maintained or restored, and iii) connectivity within the Natural Heritage System will be maintained.*
Significant Wildlife Habitat (SWH) (Policy 4.1.3.9) excluding Ecological Linkages	No development or site alteration permitted within the feature except for essential linear infrastructure, flood and erosion control and water supply wells subject to an EIS.	Buffer to be determined on a case-by-case basis. No development or site alteration permitted within the buffer except for essential linear infrastructure, flood and erosion control and water supply wells subject to an EIS.	
Ecological Linkages (Policy 4.1.3.9.8-13)	No development or site alteration permitted within the feature except for essential transportation infrastructure, essential linear infrastructure, and stormwater management facilities subject to an EIS or EA.	No minimum buffer.	*The location of Ecological Linkages may be modified and/or width refined … provided it is demonstrated through an EIS or EA… that … ii) proposed changes to the location or width of the Ecological Linkage will maintain or enhance functionality and connectivity… and iii) where a proposed refinement … would result in a width less than 50 metres [that] a) the Ecological Linkage is adjacent to land uses such as open space … b) the length of the refined area … is limited ..; and c) the Ecological Linkage provides a direct linear connection and incorporates any remnant natural heritage features and areas to the greatest extent possible.*
Natural Areas			
Other Wetlands (Policy 4.1.4.2)	No development or site alteration permitted within the feature (once confirmed as meeting the established criteria for protection).	Minimum buffer of 15 m. No development or site alteration permitted within the buffer except for essential linear infrastructure, stormwater management facilities and trails (subject to specified conditions).	GRCA regulates all wetlands (and their defined adjacent lands or "areas of interference") in their jurisdiction and therefore their policies also apply (GRCA 2015) to the SPA. Development is generally not permitted in wetlands but may be permitted in accordance with the GRCA's consolidated policies for the administration of Ontario Regulation 150/06 (2015). For example, development may be permitted within naturally occurring wetlands less than 0.5 ha in size and within anthropogenic wetlands less than 2 ha in size, subject to the criteria outlined in Policies 8.4.4 and 8.4.5, respectively. In addition, public infrastructure may be permitted within a wetland in accordance with Policies 8.4.6 and 8.4.7.
Cultural Woodlands (Policy 4.1.4.3)	No development or site alteration permitted within the feature (once confirmed as meeting the established criteria for protection) except for trails subject to an EIS.	Minimum buffer of 10 m. No development or site alteration permitted within the buffer except for stormwater management facilities and trails (subject to specified conditions).	
Habitat for Significant Species (Policy 4.1.4.4)	Development, site alteration and essential linear infrastructure may be permitted within all or portions of the feature where it has been demonstrated through an EIS or EA that there will be no negative impacts on the habitat or its ecological functions.	Buffer to be determined on a case-by-case basis.	*Where Habitat of Significant Species is to be protected, alternatives to in situ protection (i.e., habitat restoration or transplanting) may be considered where appropriate.*

Selected Definitions:

Essential means: that (1) there is a demonstrated need, and (2) it has been demonstrated that no other reasonable alternatives exist.

Linear Infrastructure means: corridors that include infrastructure such as the pipes necessary for the transmission and distribution of sewage (including stormwater) and water, communication, hydro, oil, and gas lines, but does not include transportation infrastructure. Essential linear infrastructure includes

Transportation Corridor means: a thoroughfare and its associated buffer zone for passage or conveyance of vehicles or people. A transportation corridor includes any or all of the following: a) Major roads, arterial roads, and highways for moving people and goods; b) Rail lines/railways for moving people and goods; c) Transit rights-of-way/transitways including buses and light rail for moving people

The impact assessment process also, as part of the mitigation and management recommendations, identifies some policy refinements or points of clarification as they relate specifically to the SPA (Table 4.4.2), which are recommended to be carried forward into the Secondary Plan policies for the area.

The primary source of indirect impacts to the NHS and its functions in the context of the CMSP is expected to be related to the changes in land uses in the adjacent lands from what is currently a predominantly rural / agricultural land use matrix to an urbanized matrix dominated by a mix of high, medium and low density residential developments and associated schools, parks / open spaces (including stormwater management areas) and commercial areas. These changes, their associated impacts and recommended mitigation measures will be examined in more detail at the area or site-specific scale through the planning process for the various development applications as they proceed. However, at the SPA scale it is generally understood that the anticipated land use changes will result in substantial changes outside the NHS including: grading, an increase in impervious surfaces, replacement of current vegetation cover (e.g., fields cropped with corn, hedgerows) with built and landscaped spaces, and significant increases in the number of people living adjacent to the NHS. These impacts are also expected to increase cumulatively as the number and extent of development increases in the area until full "build out" occurs.

Increased population density in the SPA is expected to result in much greater risks of encroachments into the NHS than under the current rural/agricultural land uses. Typical examples of encroachment activities that can negatively NHS features and their functions include: extensions of yards into adjacent protected natural areas and/or their buffers, dumping of yard waste and other types of residential waste, informal trail creation, disturbances to wildlife from pets off-leash, increased spread of invasive species and disturbances to wildlife related to lighting and noise.

The NHS in the SPA, under current conditions, is an assemblage of natural areas that have already been impacted by, or are still in the process of responding to, prior changes in the landscape associated with the shift from a largely forested / natural matrix to a largely agricultural matrix that occurred over the past century. In addition, the NHS and its associated functions in the SPA have also already been impacted by the introduction of, and improvements to, municipal roads in the SPA and PSA (i.e., Gordon Street, Victoria Road, Maltby Road and Clair Road). Nonetheless, the shift to an urbanized land use matrix is expected to require additional changes in the lands outside the NHS that will intensify some of the existing impacts (e.g., such as increased traffic on the existing roads) and increase the risks of encroachment-related impacts.

Ecological "carrying capacity" can be defined as the number of people that a given area can support without environmental degradation. Trying to establish an appropriate ecological carrying capacity in relation the natural heritage features and areas in the SPA is difficult because, among other reasons, the landscape is already disturbed and transitional. Nonetheless, the idea of establishing some targeted baseline conditions (e.g., wetland water quality, extent of different types of natural cover, levels of native species diversity for selected types of wildlife) and trying to ensure that these conditions are maintained through the urbanization process through the implementation of a range of mitigation and management measures is a common approach undertaken in southern Ontario and elsewhere. Such measures are discussed in Section 4.4.2 and presented in Table 4.4.2 in relation to the different NHS feature components below.

4.4.2 Impact Assessment, Mitigation and Management Recommendations

The identified NHS in the Clair-Maltby SPA is fairly extensive. The NHS occupies more than 40% of the land base in this area and is a well-connected system extending across the SPA. As part of the CMSP process to date there has been ongoing dialogue between the CEIS Team, the other members of the Consulting Team and the City to mitigate the impacts of the anticipated development on the NHS through the Secondary

Plan process. Approaches and strategies already integrated into the Preferred Community Structure and Conceptual Land Use Plan (LU1, Appendix A) include:

- Respecting the limits of the NHS by excluding all proposed land uses from identified natural heritage features and areas, and their applicable minimum buffers;
- Keeping municipal roads from crossing through significant Wetlands and Significant Woodlands and generally limiting road crossings of the NHS to the greatest extent possible;
- Keeping the proposed trail network along the outer edges of the NHS (i.e., largely within buffers to protected features and not within the features themselves) and limiting crossings of NHS features and buffers while still accommodating connectivity for active transportation;
- Co-location of stormwater capture areas (SWCAs) with schools and parks to maximize infiltration in existing closed depressions and sustain local hydrologic and hydrogeologic functions, and placement of SWCAs / parks / schools adjacent to the NHS where possible to provide some open spaces in the immediately adjacent lands, further "buffering" the NHS from more intensive residential and commercial land uses.

The impact assessment completed for this report builds on the mitigation work already done and is based on considerations related to the Preferred Community Structure and Conceptual Land Use Plan. Table 4.4.2 lists the identified potential or anticipated impacts of the changes in land uses associated with the Preferred Community Structure for the SPA to the various NHS components. Table 4.4.2 also includes the mitigation and management measures recommended to address these impacts.

Although this impact assessment is based on the City's 2014 NHS (see Map NH-1, Appendix E) and not the Refined NHS (see the Draft 2 Refined NHS in Map NH-14A, Appendix E) which is still being finalized, because the assessment applies at the broader Secondary Plan scale it is not considered sensitive to minor refinements in the NHS or Community Structure and the identified impacts and recommended mitigation and management measures are still expected to apply in the context of the Refined NHS. Furthermore, site-specific impacts will still need to be addressed as part of area or site-specific studies (e.g., EIS) in support of specific infrastructure and/or development plans in accordance with the applicable policies moving forward.

The Refined NHS, once completed, will be integrated into the final Community Structure and will form a "base constraint" for the Secondary Plan in accordance with the applicable Official Plan and Secondary Plan policies[14].

The NHS components listed in Table 4.4.2 are as identified within the SPA through the CMSP CEIS (NH-series maps in Appendix E) and as defined in the City's Official Plan. For the purposes of this impact assessment, it has been assumed that the City's current in effect NHS policies (Section 4.1 of the Official Plan, 2018 Consolidation) will be applied (as per Table 4.4.1). Potential requirements for specific policies, that may be needed to enhance the existing City NHS policies in relation to the specific biophysical context of the SPA, have been noted in the recommended management measures where appropriate.

This impact assessment focusses on impacts within the SPA but also considers impacts in the PSA and, where appropriate, the broader SSA.

[14] In the SPA, as for the entire Official Plan, the mapping identifies the NHS and its components based on the best available information, but the policies prevail.

Table 4.4.2 CMSP Natural Heritage System (NHS) Impact Assessment, Mitigation and Management Recommendations				
NHS Component	**Target Area**	**Anticipated Impacts**	**Recommended Mitigation**	**Recommended Management**
Significant Habitat of Provincially Endangered and Threatened Species	Secondary Plan Area (SPA) and Primary Study Area (PSA)	Provincially Endangered and Threatened species either confirmed or that have suitable habitat in the SPA include four species that have species-specific regulations allowing for potential removal for habitat in exchange for a net gain type of compensation (i.e., Butternut, Barn Swallow, Eastern Meadowlark and Bobolink) as well as four bat species whose habitat, under current MNRF practices, may also be removed in exchange for net gain compensation. • Development in areas where habitat for any of these species is confirmed will potentially trigger such processes. • For any other Significant Habitat of Provincially Endangered and Threatened species that has been confirmed, potential impacts will need to be avoided as directed by MNRF (presumably by prohibiting development within the identified significant habitat).	• Avoidance • Net gain compensation for permitted removal of habitat in accordance with the applicable species-specific regulations and/or MNRF approval. • For any other Significant Habitat of Provincially Endangered and Threatened species that has been confirmed, potential impacts will need to be avoided as directed by MNRF (presumably by prohibiting development within the identified significant habitat) and indirect impacts will also need to be mitigated to the satisfaction of MNRF through measures such as buffers, development design and providing for safe species movement if appropriate.	• Screenings for Significant Habitat of Provincially Endangered and Threatened Species should be undertaken within the SPA as part of future area or site-specific environmental studies. These studies should specifically screen for the species noted in this report (Section 2.1.4.1, unless their status changes), in addition to any others flagged by MNRF as potentially occurring in the area. • Any confirmed Significant Habitat of Provincially Endangered and Threatened Species will need to be addressed in accordance with the requirements of the Endangered Species Act (2007) in a manner that is consistent with direction provided by MNRF.
Surface Water Features and Fish Habitat	SPA	<u>Headwater Drainage Features (HDFs)</u> • No direct impacts are anticipated to the HDFs in the SPA that have been assessed and identified for protection to date (as they all occur within Provincially Significant Wetlands (PSWs) and/or buffers and will therefore be protected) except for potential active transportation links. • Potential direct impacts to HDFs outside of other protected Significant Natural Areas, if such features are confirmed, relate to grading and changes in land use, resulting in loss of their hydrologic and any associated aquatic functions. • Potential indirect impacts to HDFs relate to changes in the hydrology of the catchment in which they occur, resulting in loss of their hydrologic and any associated aquatic functions. <u>Fish Habitat</u> • No direct impacts are anticipated to fish habitat in the SPA that falls within protected wetlands in the NHS. • Fish habitat not regulated by DFO that falls outside of protected wetlands, if it occurs, may be directly impacted by changes in land uses. • Potential indirect impacts to protected fish habitat relate to changes in the hydrology of the catchment in which the habitat occurs, resulting in loss of their biomass and any associated aquatic functions.	• Where active transportation links are proposed across HDFs or fish habitat identified for protection, crossings must (a) be screened to ensure compliance with applicable Department of Fisheries and Oceans regulations, (b) assessed to confirm no other feasible alternatives exist, and (c) designed to avoid and mitigate anticipated impacts to the HDF and/or fish habitat. • For any confirmed HDFs and/or fish habitat outside of protected Significant Natural Areas, any potential direct impacts should be mitigated in a manner consistent with the most current and applicable guidelines (currently CVC and TRCA 2014). This may include: *in situ* maintenance, relocation, replication of functions through lot level conveyance or no mitigation required depending on the feature's assessment. • Potential indirect impacts to HDFs and fish habitat within protected Significant Natural Areas in the SPA can be mitigated by: - maintaining pre-development runoff to the protected feature; - maintaining groundwater infiltration in the local catchment; - providing stormwater quality treatment for runoff and infiltrated surface water in accordance with Provincial standards. In cases where protected fish habitat is associated with a cool or coldwater regime, measures for temperature mitigation of any treated runoff being directed to the feature should be implemented.	• Where active transportation links are approved across HDFs or fish habitat approaches that limit disturbances in the NHS during and following construction (such as installation of span bridges, educational signs) should be required. • Ensure the most current and applicable guidelines (currently CVC and TRCA 2014) related to HDFs are applied in the SPA in areas where potential HDFs have been identified through this process as part of area or site-specific studies to guide their assessment and management. • Fisheries work was not undertaken as part of the CEIS. However, based on the existing conditions and biophysical context, it is likely that additional ponds and/or wetlands other than the two features identified in the PSA also support fish. This will need to be verified as part of area or site-specific environmental studies, and findings will need to be screened against the applicable Federal policies to determine if the feature in question is considered fish habitat and if it is regulated by the Department of Fisheries and Oceans (DFO).
	PSA and Secondary Study	<u>Fish Habitat</u> • Development within the SPA has the potential to indirectly negatively impact the health and diversity of coolwater and	<u>Fish Habitat</u> • Potential indirect impacts to coldwater fish habitat in the adjacent PSA and SSA can be mitigated by:	<u>Fish Habitat</u> • Collect some more current baseline fisheries and baseflow data in the Hanlon Creek tributaries within the City north of the SPA

Table 4.4.2 CMSP Natural Heritage System (NHS) Impact Assessment, Mitigation and Management Recommendations				
NHS Component	**Target Area**	**Anticipated Impacts**	**Recommended Mitigation**	**Recommended Management**
Surface Water Features and Fish Habitat	Area (SSA)	cold water fish habitats in the SSA (i.e., Hanlon Creek Watershed to the north and Mill Creek Watershed to the south).	- Implementing a distributed approach to stormwater management that maintains pre-development runoff and infiltration levels within each of the numerous discrete catchment areas; - Providing stormwater quality treatment for runoff and infiltrated surface water in accordance with Provincial standards using a distributed approach through a combination of treatment trains directed to catchment-specific stormwater management areas and at source LID treatment measures.	prior to implementation of the CMSP, and monitor the status of this baseflow and the fisheries as development in the SPA proceeds, potentially in collaboration with GRCA. • Consider working with GRCA to undertake the same work in portions of Mill Creek tributaries south of the SPA.
Significant Wetlands and Other Wetlands	SPA and PSA	Wetlands in the Mill Creek Watershed appear to be supported by groundwater in so far as they appear to be sitting, for at least a good part of the year very close to or within the water table. Wetlands in the Hanlon Creek Watershed in the SPA are more variable and include (a) perched wetlands that rely entirely on surface flows and precipitation (e.g., Neumann's Pond), (b) wetlands that are connected to the water table for portions of the year, and (c) wetlands that are connected to the groundwater table for most of the year and may even receive discharge. Many of these wetlands also provide habitat for the robust population of amphibians and reptiles in the SPA. • No direct impacts are anticipated to either PSWs identified for protection within the NHS except for formalization of existing trails and potential active transportation links. Note no Other Wetlands were identified through the CMSP process). • Indirect impacts to protected wetlands may occur as a result of: - changes in the hydrology and/or hydrogeology of the catchment in which the habitat occurs, resulting in changes to wetland area and hydroperiod; - untreated runoff being directed to these features; - encroachments from adjacent land uses.	Direct impacts to the wetlands related to trail formalization can be mitigated by minimizing trail access to the most direct and well-used routes, closing informal trails (e.g., with logs, prickly plants), raising trails through wet areas, and educating users about feature sensitivities. Where active transportation links are proposed across wetlands identified for protection, crossings should be assessed to confirm no other feasible alternatives exist, and designed to avoid and mitigate anticipated impacts to the wetlands. Potential indirect impacts to protected wetlands' hydrology and water quality in the SPA can be mitigated by: • maintaining pre-development runoff to the protected feature in terms of both volume and hydroperiod; • maintaining groundwater infiltration in the local catchment; • providing stormwater quality treatment for runoff and infiltrated surface water in accordance with Provincial standards; • naturalizing the established buffer to the feature; and • ensuring that temporary disturbances in buffers (e.g., related to installation of linear infrastructure) are fully restored with native species. Potential indirect impacts to protected wetlands' habitat functions can be mitigated by: • erecting fences between the development limit and the protected feature's buffer; • minimizing and managing trail access (e.g., keeping trails in the outer portions of buffers to the greatest extent possible, ensuring trails within features are raised boardwalks);	• Where active transportation links are approved across HDFs or fish habitat approaches that limit disturbances in the NHS during and following construction (such as installation of span bridges, educational signs) should be required. • As a precautionary approach to wetland assessment, all areas identified as "wetland" based on the work done as part of the CMSP CEIS have been mapped as either PSWs (see Map NH-6, Appendix E) or unevaluated or GRCA wetlands (see Maps NH-5A and 5B).Boundaries of PSWs will need to be verified and staked in the field with GRCA, and unevaluated wetlands will need to be assessed to verify if they (a) warrant complexing with the closest PSW, (b) qualify as an Other Wetland or some type of Significant Wildlife Habitat (SWH), or (c) do not qualify for any type of protection within the NHS. • Some wetlands may be biologically degraded by invasive species under existing conditions. Opportunities to enhance local biodiversity through invasive species management, where appropriate, should be explored through the planning process. • Ongoing management with respect to appropriately accessing protected wetlands (e.g., through formal boardwalks, trails and lookouts in buffers) and educating those who live near and access the areas how to be good stewards (e.g., signs, City by-law enforcement, education on-line and through social media, etc.) should be undertaken by the City and local partners. This could include edge management plans to deter *ad hoc* access and prevent invasive plants and domestic animals encroaching into protected natural areas. • Secondary Plan policies related to trails should be clarified to describe the types of trails that may be permitted within wetlands (e.g., boardwalks in place of existing ad hoc trails, where appropriate) and the types of trails that may be permitted in buffers to wetlands.

Table 4.4.2 CMSP Natural Heritage System (NHS) Impact Assessment, Mitigation and Management Recommendations				
NHS Component	**Target Area**	**Anticipated Impacts**	**Recommended Mitigation**	**Recommended Management**
Significant Wetlands and Other Wetlands	SPA and PSA		• improving the resilience of these features through naturalization with native species; and • educating nearby residents and those accessing the wetlands about the feature sensitivities and good stewardship. Where the protected wetlands also provide habitat for amphibians and reptiles, considerations for maintaining safe and suitable linkages between nearby breeding, foraging and overwintering habitats will also be required.	• Where wildlife crossings for amphibian and reptiles have been identified over existing or planned roads, road retrofits / improvements / passage structures should be incorporated.
Significant Woodlands and Cultural Woodland	SPA	Woodlands in the SPA include deciduous, mixed and coniferous forests as well as cultural woodlands scattered across the landscape and often closely associated with wetland habitats. • No direct impacts are anticipated to either Significant Woodlands or Cultural woodlands identified for protection within the NHS except for formalization of existing trails. • Indirect impacts to protected woodlands may occur as a result of: o changes in the hydrology and/or hydrogeology of the catchment in which the habitat occurs; o encroachments from adjacent land uses that introduce invasive species and yard waste or result in unwanted management of or uses within the feature (e.g., sheds, forts).	Direct impacts to the woodlands related to trail formalization can be mitigated by minimizing trail access to the most direct and well-used routes, closing informal trails (e.g., with logs, prickly plants), avoiding steep and erosion prone slopes, and educating users about feature sensitivities. Potential indirect impacts to woodland functions in the SPA can be mitigated by: • maintaining pre-development runoff to the protected feature; • naturalizing the established buffer to the feature; • ensuring that temporary disturbances in buffers (e.g., related to installation of linear infrastructure) are fully restored with native species; • minimizing and managing trail access (e.g., keeping trails in the outer portions of buffers to the greatest extent possible); • improving the resilience of these features through naturalization with native species; • erecting fences between the development limit and the protected feature's buffer and other types of edge management; and • educating nearby residents and those accessing the woodlands about the feature sensitivities and good stewardship. Where the protected woodlands also provide habitat for amphibians and reptiles, considerations for maintaining safe and suitable linkages (e.g., such as wildlife tunnels / culverts) between nearby breeding, foraging and overwintering habitats will also be required.	• As part of area or site-specific studies, boundaries of Significant Woodlands and Cultural Woodlands confirmed for protection will need to be verified and staked in the field with City. • Treed areas that are outside of protected woodlands but within the boundaries of other Significant Natural Areas should also be protected in accordance with the appropriate policies. • Treed areas outside of the identified NHS may be approved for removal and compensated either on an areal basis (e.g., 0.2 ha of woodland restoration for 0.2 ha of plantation removed) or at 3:1 compensation ratios for individual trees, or a combination of both, depending on the given site context. • Some protected woodlands may be biologically degraded by invasive species under existing conditions. Opportunities to enhance local biodiversity through invasive species management should be explored through the planning process. • Ongoing management with respect to providing appropriate access to protected woodlands (e.g., use of woodchip and narrower trails within features, keeping wider multi-use trails outside the features) and educating those who live nearby and access the areas how to be good stewards (e.g., signs, City by-law enforcement, education on-line and through social media, etc.) should be undertaken by the City and local partners. • Secondary Plan policies related to trails should be clarified to describe the types of trails that may be permitted within woodlands (i.e., narrow, woodchip), the types of trails that may be permitted in buffers to woodlands, and scenarios where special buffer treatments and/or additional buffer widths may be required to prevent loss of function.
Significant Wildlife Habitat (SWH)	SPA and PSA	SWH captures a wide range of diverse habitats (as described in Section 2.1.4.5 above) and so it is difficult to describe anticipated impacts as a whole to this category. Therefore the impacts are described generally by associated habitat type.	Where active transportation links are proposed through confirmed SWH, crossings should be assessed to confirm no other feasible alternatives exist, and designed to avoid and mitigate anticipated impacts to the SWH.	• As part of area or site-specific studies, boundaries of confirmed SWH will need to be verified and staked in the field with City and, where the features are also wetlands, GRCA.

Table 4.4.2 CMSP Natural Heritage System (NHS) Impact Assessment, Mitigation and Management Recommendations				
NHS Component	**Target Area**	**Anticipated Impacts**	**Recommended Mitigation**	**Recommended Management**
Significant Wildlife Habitat (SWH)	SPA and PSA	• No direct impacts are anticipated to Confirmed SWH identified for protection within the NHS except for potential active transportation links. • Indirect impacts to Confirmed SWH associated with wetlands may occur as a result of: - changes in the hydrology and/or hydrogeology of the catchment in which the habitat occurs, resulting in changes to wetland area and hydroperiod; and - untreated runoff being directed to these features. • Indirect impacts to Confirmed SWH associated with woodlands may occur as a result of changes in the hydrology and/or hydrogeology of the catchment in which the habitat occurs; • Indirect impacts to Confirmed SWH associated with wetlands, woodlands, shrublands or meadows may occur as a result of encroachments from adjacent land uses that result in disturbances to the species who rely on the habitat.	Potential indirect impacts Confirmed SWH associated with can be mitigated by: • maintaining pre-development runoff to the protected feature; • maintaining groundwater infiltration in the local catchment; and • providing stormwater quality treatment for runoff and infiltrated surface water in accordance with Provincial standards. Potential indirect impacts to Confirmed SWH associated with woodlands can be mitigated by: • maintaining pre-development runoff to the protected feature; Potential indirect impacts to Confirmed SWH associated with encroachments into all habitat types can be mitigated by: • naturalizing the established buffer to the feature; • ensuring that temporary disturbances in buffers (e.g., related to installation of linear infrastructure) are fully restored with native species; • minimizing and managing trail access (e.g., keeping trails in the outer portions of buffers to the greatest extent possible); • improving the resilience of these features through naturalization with native species, where appropriate; • erecting fences between the development limit and the protected feature's buffer; and • educating nearby residents about the feature sensitivities and good stewardship. Where the Confirmed SWH provide habitat for amphibians and reptiles, considerations for maintaining safe and suitable linkages (such as wildlife tunnels or culverts) between nearby breeding, foraging and overwintering habitats will also be required.	• Some Confirmed SWH may be biologically degraded by invasive species under existing conditions. Opportunities to enhance local biodiversity through invasive species management should be explored through the planning process. • In general, access to Confirmed SWH should be limited as these areas tend to support functions that can be somewhat sensitive to human disturbances. Ongoing management with respect to providing limited access and educating those who live nearby and access the areas how to be good stewards (e.g., signs, City by-law enforcement, education on-line and through social media, etc.) should be undertaken by the City and local partners. • Where active transportation links are approved in SWH approaches that limit disturbances in the NHS during and following construction (such as installation of span bridges, educational signs) should be required. • Consideration should be given to strategic identification of dog parks outside the NHS, particularly near NHS features that support wildlife sensitive to the presence of dogs. • Identify at least one Restoration Area for to be maintained as meadow/shrub habitat, ideally adjacent to upland woodland, to provide SWH for both raptor wintering and shrub/early successional breeding birds. • Secondary Plan policies related to trails should be clarified to describe the types of trails that may be permitted in buffers to different types of SWH. • Consider requiring wildlife friendly development and construction measures to be implemented where appropriate (e.g., lighting, bird friendly guidelines).
Significant Landform	SPA and PSA	Significant Landform (SL) mapping for the City of Guelph sought to capture: slopes of 20% and greater; concentrations of slopes; slopes located in association with closed depressions greater than 1 m deep; and lands overlapping with or close proximity to other Significant Natural Areas. Although the policies do allow for modifications to SL mapping, these modifications must be outside of other Significant Natural Areas, must maintain the connectivity of the system and must result in no net loss of SL area.	• In accordance with the applicable City policies, direct and indirect impacts to the SL can be mitigated by: - ensuring no net loss of SL area; - minimizing grading in the lands immediately adjacent to the SL; - maintaining or restoring the Hummocky Topography of the SL to the greatest extent possible; - maintaining pre-development runoff volumes to the areas of protected SL;,	• Consider undertaking area-specific management plans within targeted portions of the SPA that include multiple properties to help ensure NHS connectivity supported by EL and SL is appropriately maintained through the development process. • Explore opportunities to align linear Restoration Areas for SWM and/or trails adjacent to portions of the NHS to facilitate integration of the SL into the developed portions of the SPA such that its visual uniqueness is not negatively impacted. • Develop Secondary Plan policies to guide integration of the SL within the adjacent residential, commercial and institutional

Table 4.4.2 CMSP Natural Heritage System (NHS) Impact Assessment, Mitigation and Management Recommendations				
NHS Component	**Target Area**	**Anticipated Impacts**	**Recommended Mitigation**	**Recommended Management**
Significant Landform	SPA and PSA	• As such, direct impacts to the area and visual form of the SL may result from: - modifications to the location of the SL; and - the installation of linear infrastructure or transportation infrastructure or active transportation or municipal supply wells in the SL. - Indirect impacts to the SL's function in supporting local infiltration (and recharge) may result from: - changes in the hydrology and/or hydrogeology of the catchment in which the feature occurs; and - untreated runoff being directed to the SL. • Indirect impacts to the SL's function in supporting local ecological connectivity may result from: - modifications to the location of the SL; - changes in vegetation cover to the SL.	- use of best practices to ensure a high level of contaminant and sediment removal and minimize chloride loadings in runoff; - maintaining the linear terrestrial connectivity provided by the SL within the NHS, and - ensuring that at least good portion of the SL remains in a naturalized state.	land uses on a site-specific basis, particularly within the 50 m adjacent lands to the SL. • Explore opportunities to integrate portions of SL within the developed areas (e.g., City parks) where feasible to maintain to visual uniqueness of the area. • In accordance with the applicable City policies, require the implementation of a monitoring and contingency plan for potential impacts to groundwater quality and quantity on receiving lands associated with SL being used for stormwater management overflows. • Consider a range of habitat restoration types as opportunities arise (e.g., woodland, shrubland and meadow) so as to support a comparable range of species as exist under current conditions.
Ecological Linkages	SPA and PSA	Ecological Linkages (EL) are intended to "bridge the gaps" between Significant Natural Areas and protected Natural Areas to ensure linear connectivity is provided in the NHS in the SPA. The policies also allow for the mapped linkages, which are generally 100 m wide in the SPA, to be modified or refined in terms of location and width as long as the established criteria (e.g., maintaining connectivity) are met. • As such, direct impacts to the area of EL may result from: - modifications to the location and/or width of the EL; - the installation of linear infrastructure or transportation infrastructure or active transportation in EL. • Indirect impacts to EL's function in supporting local ecological connectivity may result from modifications to the location of EL and changes in vegetation cover to EL.	• In accordance with the applicable City policies, direct and indirect impacts to EL can be mitigated by: - limiting road crossings of EL; - ensuring maintenance of functional connectivity through the identification of Wildlife Crossings where appropriate in the NHS mapping; - incorporating remnant successional and/or treed areas into EL; - ensuring that at least good portion of EL are maintained in or restored to a naturalized state; - pairing EL adjacent to land uses such as parks, schools and stormwater management areas that can support the EL functions; and - protecting Significant Natural area and EL connectivity to the broader PSA within the City of Guelph and to the Greenlands System in the adjacent Wellington County.	• Consider undertaking area-specific management plans within targeted portions of the SPA that include multiple properties to help ensure NHS connectivity supported by EL and SL is appropriately maintained through the development process. • Consider adding Secondary Plan policies to establish firm minimum widths for EL, • Design EL with target wildlife in mind incorporating appropriate wildlife crossing structures, where EL are bisected by transportation corridors. • Explore opportunities to align linear Restoration Areas for SWM and/or trails adjacent to portions of EL to support and enhance their function. • Ensure integration of mitigation measures to accommodate safe wildlife movement (e.g., through provision of culverts for amphibians, reptiles and small mammals) in appropriate locations across roads as opportunities arise through road improvements and/or new road installation. • Pursue opportunities to enhance local biodiversity and connectivity through the restoration and naturalization of Ecological Linkages with native species. • Consider a range of habitat restoration types as opportunities arise (e.g., woodland, shrubland and meadow) so as to support a comparable range of species as exist under current conditions.

Table 4.4.2 CMSP Natural Heritage System (NHS) Impact Assessment, Mitigation and Management Recommendations				
NHS Component	**Target Area**	**Anticipated Impacts**	**Recommended Mitigation**	**Recommended Management**
Habitat for Locally Significant Species		It is anticipated that most of the Habitat for Locally Significant Species is already captured within another type of Significant Natural Area or Natural Area, however there may be a few cases where this does not occur. As with SWH, this category includes a broad range of species and taxonomic groups (e.g. birds, amphibians, snakes and small mammals) and so it is difficult to describe anticipated impacts as a whole to this category. In general: • direct impacts are anticipated to Habitat of Locally Significant Species where it does not occur within another type of Significant Natural Area or Natural Area identified for protection within the NHS; and • indirect impacts to Habitat of Locally Significant Species may occur as a result of: - changes in the hydrology and/or hydrogeology of the catchment in which the habitat occurs, and - encroachments from adjacent land uses that result in disturbances to the species who rely on the habitat.	Potential direct impacts can be mitigated by: • for some plants, transplanting the specimen(s) into a comparable habitat nearby; • for some birds, ensuring the site or perhaps the adjacent lands already contain adequate quantities of suitable habitat for the species; Potential indirect impacts can be mitigated by: • maintaining pre-development runoff to the protected habitat; • providing stormwater quality treatment for runoff and infiltrated surface water in accordance with Provincial standards; • naturalizing the established buffer to the habitat; • ensuring that temporary disturbances in buffers (e.g., related to installation of linear infrastructure) are fully restored with native species; • minimizing and managing trail access (e.g., keeping trails in the outer portions of buffers to the greatest extent possible); • erecting fences between the development limit and the protected habitat; and • educating nearby residents about the feature sensitivities and good stewardship.	• Monitor the establishment and success of any transplanted species. • Consider a range of habitat restoration types as opportunities arise (e.g., woodland, shrubland and meadow) so as to support a comparable range of species as exist under current conditions. • Opportunities to enhance local biodiversity through invasive species management should be explored through the planning process. • Ongoing management with respect to providing limited access and educating those who live nearby and access the area how to be good stewards (e.g., signs, City by-law enforcement, education on-line and through social media, etc.) should be undertaken by the City and local partners. • Consider requiring wildlife friendly development and construction measures to be implemented where appropriate (e.g., lighting, bird friendly guidelines).

The primary challenges to maintaining and enhancing existing NHS functions in an urbanized landscape in this moraine-dominated SPA are expected to be related to:

- Maintaining the local amphibian and reptile populations; and
- Grading requirements to accommodate transportation infrastructure (including trails that need to be accessible and therefore have slope constraints or require larger areas to accommodate switchbacks) without unduly impacting the appearance and form of the Significant Landform or the functions of the various NHS components.

The CEIS Study Team, as described in Table 4.4.2 above, has already identified a range of mitigation and management measures that can address these impacts at a Secondary Plan scale. Furthermore, as part of the Implementation reporting (see Figure 1.2) the CEIS Study Team will work with the broader multi-disciplinary team to identify management measures as part of the CMSP process and identify policies to provide for an appropriate balance between development of the SPA and retention of the biophysical attributes and natural heritage that make this area unique.

Included in the forthcoming management measures will be a framework for monitoring key aspects of the NHS to measure the extent to which the features and functions of the NHS are being sustained and enhanced as development in the SPA proceeds.

Finally, as part of the implementation of the Secondary Plan, area or site-specific studies will be required to provide recommendations for addressing anticipated impacts to the NHS as well as related surface and groundwater resources at the site-specific scale.

5.0 Summary

The following section summarizes the Impact Assessment findings for each discipline as reported within Section 4.

5.1 Hydrology

The Phase 1 and 2 existing conditions hydrologic assessment included a 3 year 2016-2018 flow monitoring program with 1 flow station located in both the Hanlon Creek and Mill Creek outside of the Clair-Maltby SPA, due to the lack of watercourses located within the SPA. The flow monitoring data were used to validate and support the preparation of a PCSWMM hydrologic model based on the existing hummocky topography, land use and soil conditions. The existing conditions PCSWMM hydrologic model was used to determine frequency flows for a 67 year (1950-2017) climate data set and to establish annual water balance conditions.

For the Phase 3 Impact Assessment, the existing conditions PCSWMM hydrologic model has been revised to represent the Preferred Community Structure land use. Drainage catchments have been refined with the objective of maintaining drainage areas to the Hanlon Creek and Mill Creek subwatersheds and preserving existing drainage patterns. To maintain frequency of flows to the Hanlon Creek and Mill Creek, and to maintain the existing water balance, the following approach to drainage and stormwater management has been developed:

- 27 mm, 90th percentile storm event is to be captured using low impact development techniques in the Public and Private realm to replicate the numerous small depressional areas within the SPA. The 27 mm capture would apply to all development areas and be sized for the total impervious coverage (Figure IA-HYD3)
- For small development areas (typically less than 5 ha), drainage catchments where the main land use is porous (i.e. parks and schools), and/or existing depressional features exist downstream to receive drainage, capture of the 100 year storm runoff within surface water capture areas will be required in addition to the 27 mm capture.
- For all other remaining development areas capture of the Regional Storm (285 mm) within designated surface water capture areas will be required in addition to the 27 mm capture through distributed LID BMPs.

The foregoing approach has been assessed using the updated PCSSWMM hydrologic model and has demonstrated that peak flows and water balance (based on surface water modelling) would be maintained.

5.2 Hydrogeology

The PCS Future Conditions simulations including Surface Water Capture Areas (SWCA) and Low Impact Development (LID) measures is simulated to maintain groundwater discharge and streams and wetlands that are currently supported by groundwater, as well as recharge to the regional bedrock aquifer which supports municipal wells in the City of Guelph when compared to existing conditions simulations.

The LID BMP and SWCA as simulated, combined with reductions in evapotranspiration due to reductions in vegetation in future land uses, are simulated to result increased recharge within the SPA and increased lateral groundwater outflow to Mill Creek subwatershed and small reduction in groundwater outflow to Hanlon Creek subwatershed. The majority of groundwater discharge occurs outside of the SPA (with the exception of a small area in the north part of Hall's Pond complex). The groundwater discharge is simulated to be maintained in all of these areas.

The distributed approach to providing capture and the additional capture capacity provided by the SWCA in areas of existing depression is simulated to maintain overall groundwater flow directions by infiltrating water as close to source as possible. By maintaining groundwater flow, gradients and linkages between recharge and discharge areas the PCS with LID BMP and SWCA, is simulated to maintain groundwater function within the study areas with negligible impacts to the regional flow system.

5.3 Water Quality

Surface water quality baseline conditions were established using a three (3) year water quality monitoring program (2016-2018) and supporting background information from existing studies. The water quality monitoring program indicated that exceedances (based on Provincial and Federal guidelines) in Ammonia and exceedances for Total Phosphorus, Aluminum, Copper, Iron, Lead, and Zinc at various sampling stations at different times of the year occurred both 2016 and 2017 (2018 data remain under review). The water quality exceedances have occurred due to existing agriculture practices, roadways, the golf course and existing groundwater quality.

The Preferred Community Structure land use plan will result in urbanization of non-natural heritage system lands, with a different suite of potential water quality contaminants. To address and mitigate potential water quality impacts and groundwater quality impacts an approach to stormwater quality treatment has been developed as per the following:

1. Apply a distributed approach for 27 mm capture within LID BMPs
2. Separate 'clean' water from dirty water, with dirty water typically resulting from roadways and parking areas
3. Apply a treatment train approach and protect the surface water capture area's function of infiltration
4. LID BMP selection and locations to be determined based on land ownership, land use, development form and grading

5.4 Natural Heritage System

Between 2016 and 2018, the aquatic and terrestrial natural heritage features and areas in the SPA, as well as connections within and between these areas, and to the broader landscape, were assessed. These assessments have included a review of the available background mapping and data supplemented by a range of targeted field studies of the vegetation and wildlife communities. These studies have occurred within, and adjacent to, the SPA to verify existing biophysical conditions at a scale and level of detail appropriate for a Secondary Plan Area of about 415 ha. More detailed area or site-specific studies will be required at a later stage when development is proposed within the CMSP area.

The findings of these assessments were then: (a) screened against the identified 2014 NHS in the context of the current and applicable environmental legislation, policies and guidelines and (b) used to inform refinements to the NHS based on new information gathered through the CMSP process and the direction set out in the approved City Official Plan policies.

As part of the ongoing iterative CMSP process, a Refined "Draft 1" NHS based on information collected through to the end of 2017 was presented in the Phase 1 and Phase 2 Characterization Report (Wood *et al.,* 2018). This Phase 3 Impact Assessment Report includes the Refined "Draft 2" NHS based on information collected through to the end of 2018. The Refined "Draft 2" NHS has provided the basis for the impact assessment and related mitigation and management recommendations in relation to the Preferred Community Structure and conceptual Land Use Plan (Appendix A).

The Refined NHS is expected to undergo one more round of minor edits based on feedback from the City, GRCA, MNRF, Technical Advisory Group, Technical Steering Committee, stakeholder groups, and the public. The final Refined NHS will then be integrated as a "base constraint" to the final version of the Community Structure to be developed over the spring of 2019.

6.0 Next Steps

In general, the Phase 3 Impact Assessment will be reviewed and updated based upon input from the City, GRCA, Technical Advisory Group, Technical Steering Committee, stakeholder groups and the public. The findings of the Phase 3 Impact Assessment will then be used to refine, update and finalize the Preliminary Preferred Community Structure and Conceptual Land Use Plan (Appendix A) for a second and final impact assessment.

Hydrology

The PCSWMM hydrologic modelling of the preferred Community Structure has been established based on a preliminary level of proposed grading. Updates to the PCSWMM modelling will include refined drainage catchments based on a more detailed grading plan and potential adjustments to the locations of the surface water capture features. The proposed 27 mm capture from impervious surfaces may be refined based on a sensitivity assessment per the MIKE SHE groundwater modelling, while maintaining water balance and outflow to both the Hanlon Creek and Mill Creek.

Hydrogeology

Following review of the Phase 3 Impact Assessment additional simulations may be undertaken to refine the PCS and LID BMP and SWCA. Based on the results from the current iteration there may be potential to reduce capture volumes in some areas while maintaining groundwater function and this could be tested with additional simulations. Additional simulations or results analysis may also be undertaken to evaluate or refine the understanding of alternative land uses and LID/SWCA strategies or to provide additional confidence in the current strategy through evaluation of:

- seasonal variation in infiltration, ponding, recharge, groundwater discharge
- the runoff/overland flow to ponds
- climate for a different time period
- alternative representations of smoothed topography
- alternative representations of storage volumes of SWCAs
- alternative representations of future infiltration capacity
- alternative land use plans, developed based on other considerations (e.g. transportation)

Water Quality

The water quality management approach may be refined based on input provided by the City and GRCA on the selected list of stormwater management measures. Additional detail on the approach to water quality measures for paved surfaces including the City's roadways will be provided within the next version of the water quality assessment.

Natural Heritage System

As part of the ongoing iterative CMSP process, the Refined "Draft 2" NHS as presented in this report is to be refined once more in response to feedback from the City, GRCA, MNRF, Technical Advisory Group, Technical Steering Committee, stakeholder groups, and the public. The final refined NHS will then be

integrated as a "base constraint" to the next iteration of the Community Structure to be developed over the spring of 2019. With the understanding the further refinements to the NHS will be minor in nature, the impact assessment and related mitigation and management recommendations will be considered equally applicable to the Draft 2 and the final Refined NHS for the CMSP.

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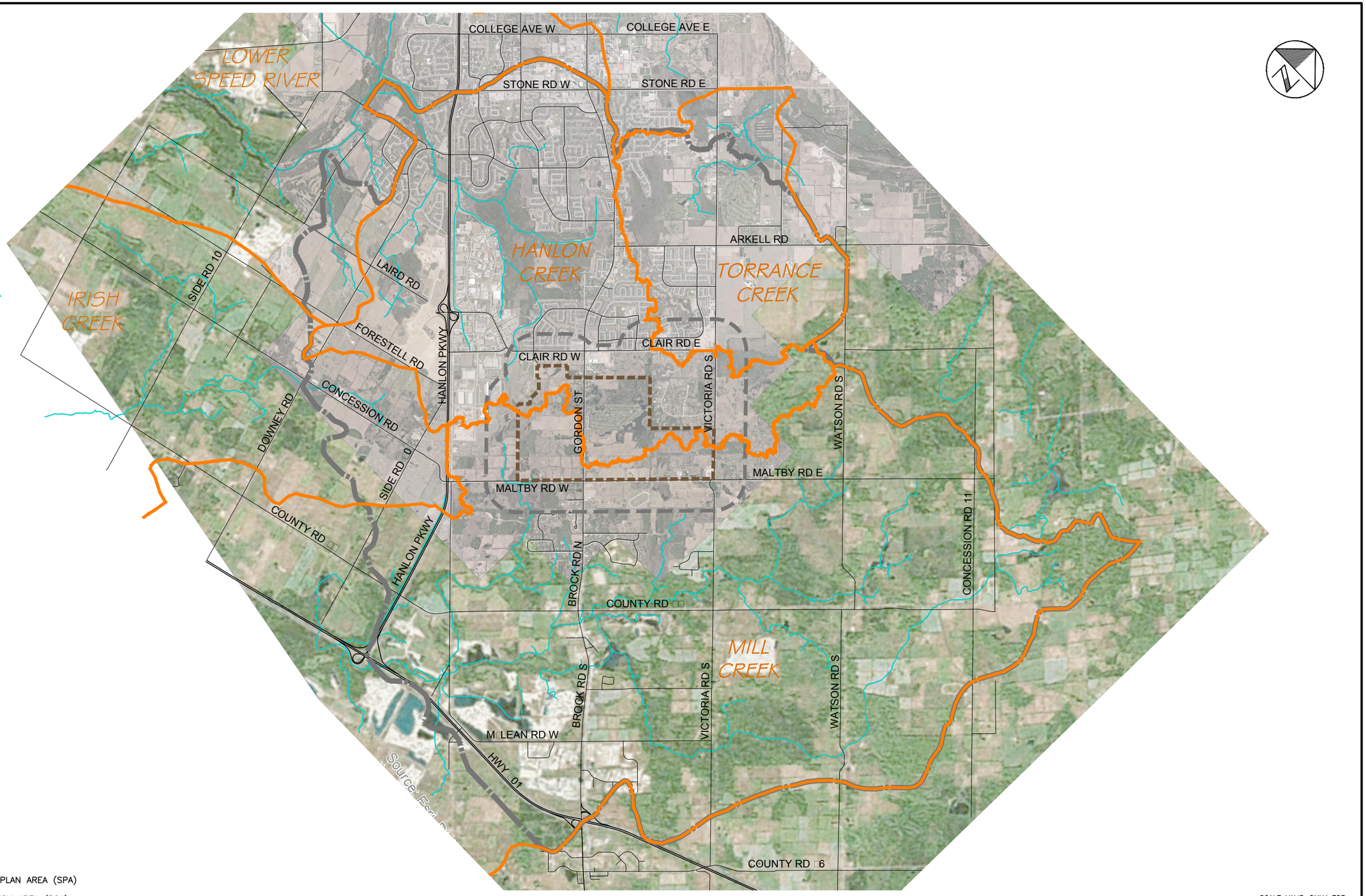

LEGEND

- SECONDARY PLAN AREA (SPA)
- PRIMARY STUDY AREA (PSA)
- SECONDARY STUDY AREA (SSA)
- SUBWATERSHED BOUNDARY
- WATERCOURSE
- ROADWAY

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	STUDY AREA PLAN	wood.	Scale 1:30000 (0 250 500 1000) Consultant File No. TPB168050 Figure No. G1

Plotted: 2019-01-25 Plotted By: richard.bartolo
Last Saved: 2019-01-25 Last Saved By: richard.bartolo
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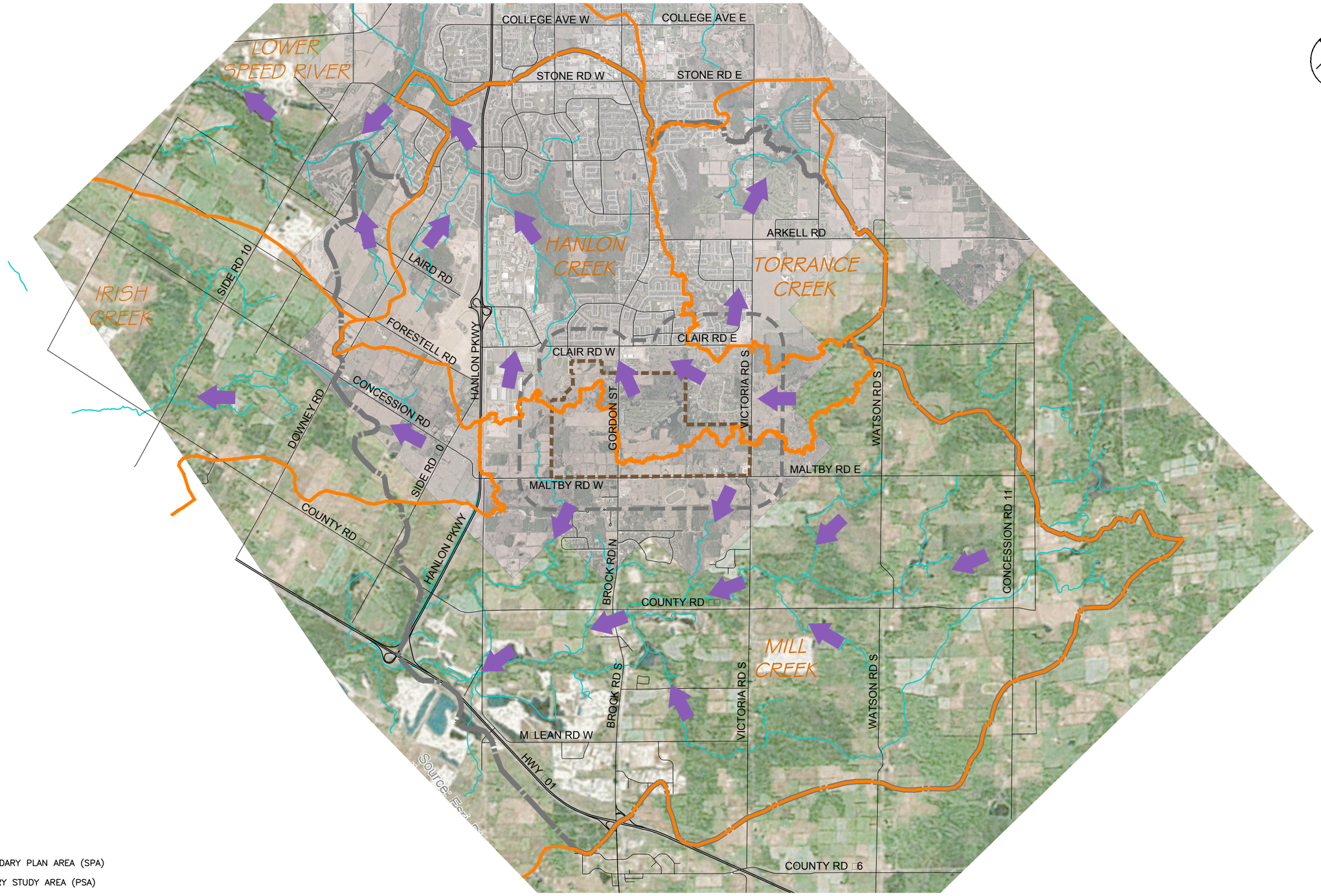

LEGEND

- SECONDARY PLAN AREA (SPA)
- PRIMARY STUDY AREA (PSA)
- SECONDARY STUDY AREA (SSA)
- SUBWATERSHED BOUNDARY
- WATERCOURSE
- ROADWAY
- MAJOR OVERLAND FLOW DIRECTION

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

SUBWATERSHED DRAINAGE PATTERN PLAN

wood.

Scale 1:30000 (0 250 500 1000)
Consultant File No. TPB168050
Figure No. HYD8

Plotted: 2019-01-25
Last Saved: 2019-01-25
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
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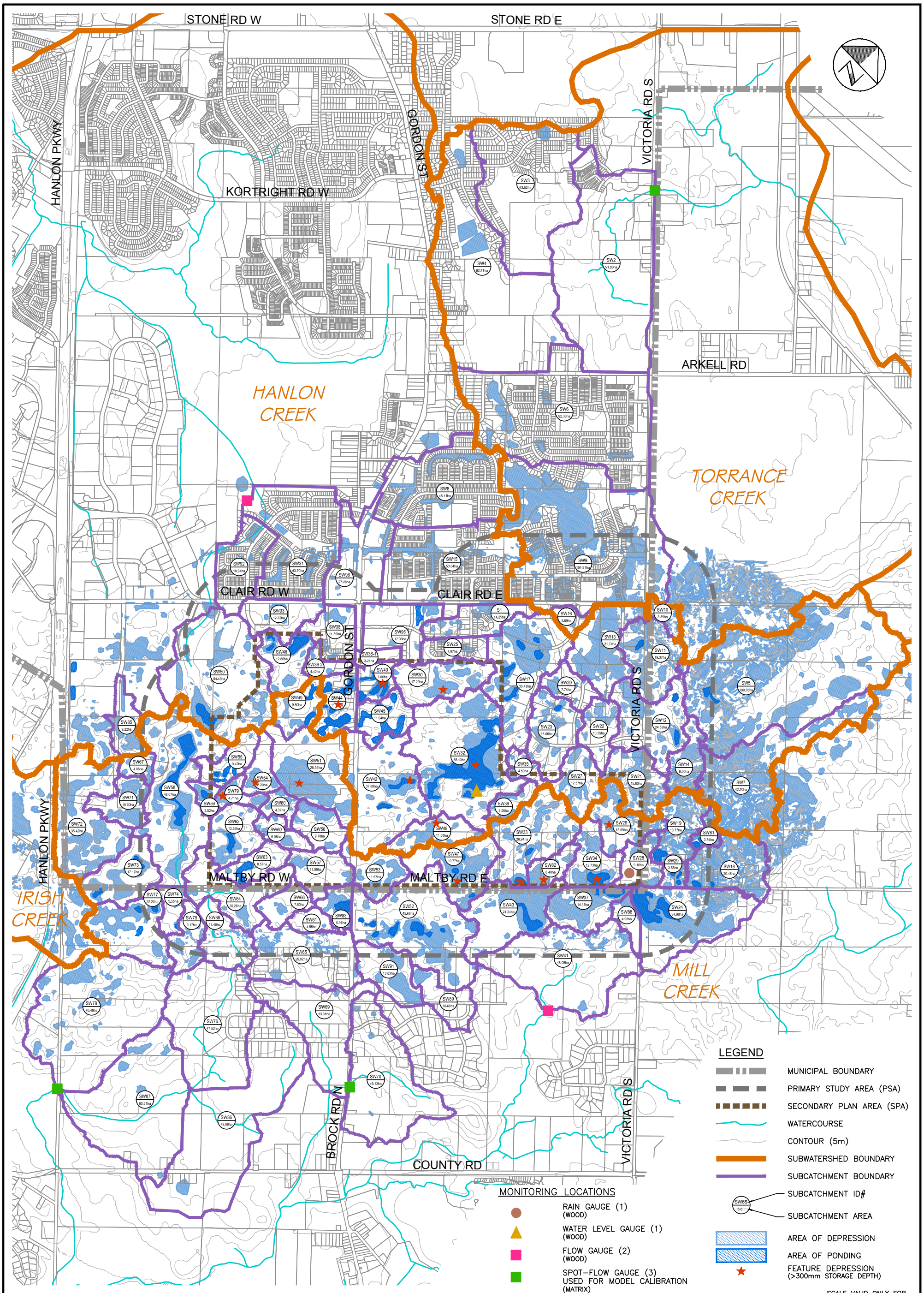


CLAIR-MALTBY
MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

MONITORING LOCATION AND DRAINAGE BOUNDARY PLAN
(EXISTING CONDITION)

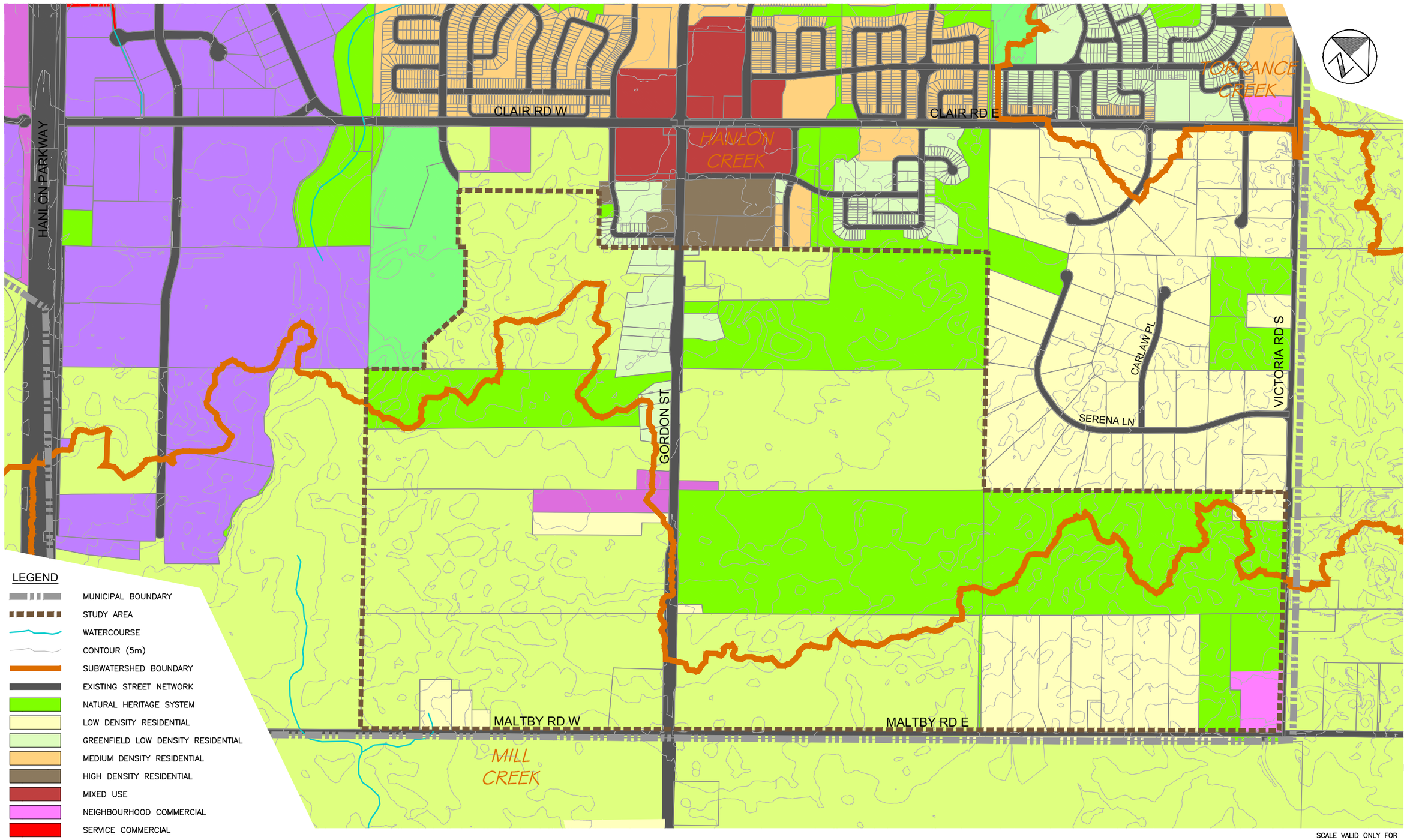
wood.

Scale 1:12500
0 125 250 500

Consultant File No.
TPB168050

Figure No.
HYD2

Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\HYD1-2 ExistingDrainage.dwg
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Plotted By: richard.bartolo
Last Saved: 2019-01-25



LEGEND

- MUNICIPAL BOUNDARY
- STUDY AREA
- WATERCOURSE
- CONTOUR (5m)
- SUBWATERSHED BOUNDARY
- EXISTING STREET NETWORK
- NATURAL HERITAGE SYSTEM
- LOW DENSITY RESIDENTIAL
- GREENFIELD LOW DENSITY RESIDENTIAL
- MEDIUM DENSITY RESIDENTIAL
- HIGH DENSITY RESIDENTIAL
- MIXED USE
- NEIGHBOURHOOD COMMERCIAL
- SERVICE COMMERCIAL
- CORPORATE BUSINESS PARK
- INDUSTRIAL
- OTHER LANDS
- OPEN SPACE AND PARK

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY
MASTER ENVIRONMENTAL
SERVICING PLAN AND
SECONDARY PLAN
CITY OF GUELPH

EXISTING
LAND USE
PLAN

wood.

Scale 1:6000
0 50 100 200

Consultant File No.
TPB168050

Figure No.
HYD3

Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\HYD3_ExistingLanduse.dwg
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Plotted: 2019-01-25
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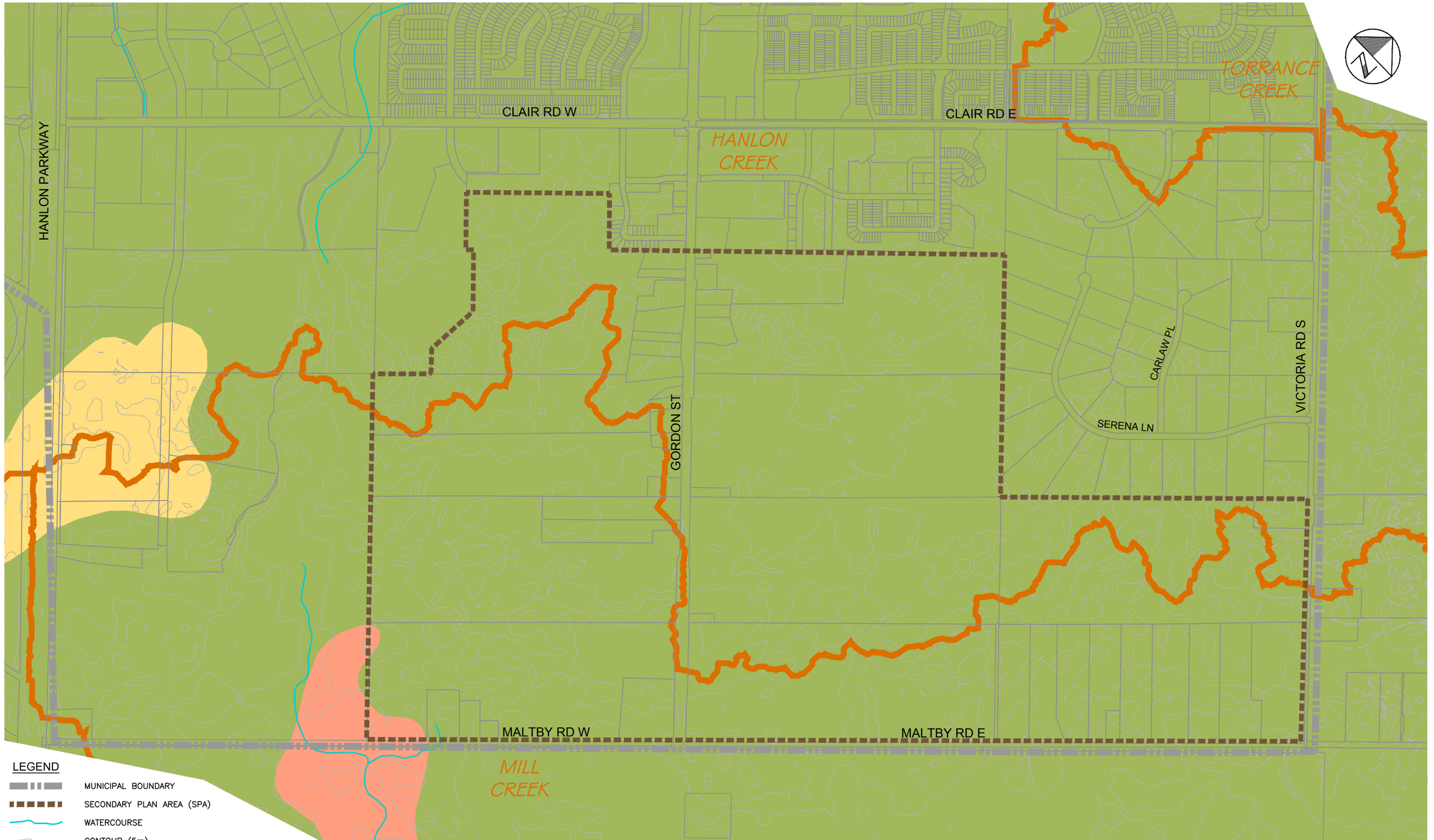

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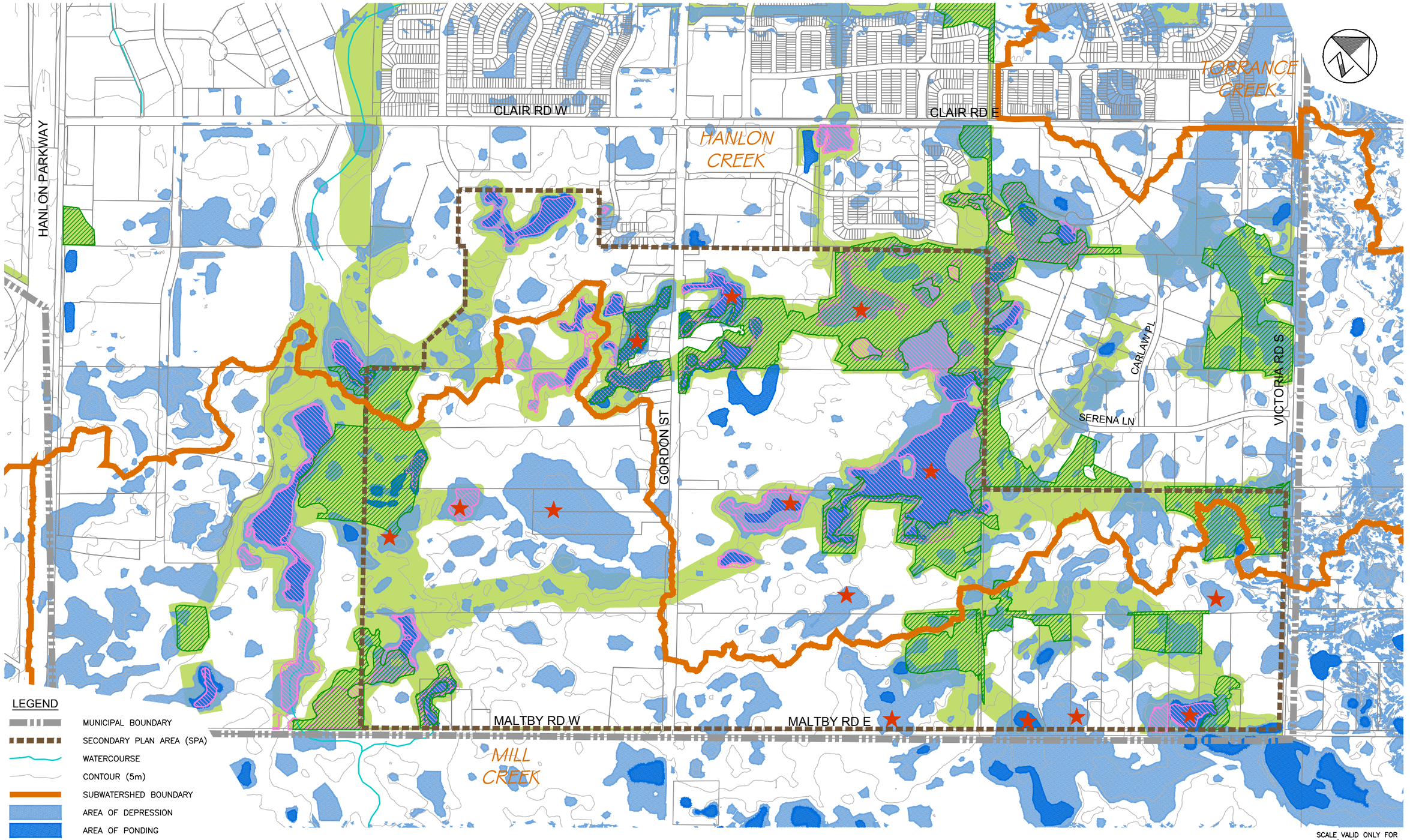
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-25

SCALE VALID ONLY FOR 24"x36" VERSION

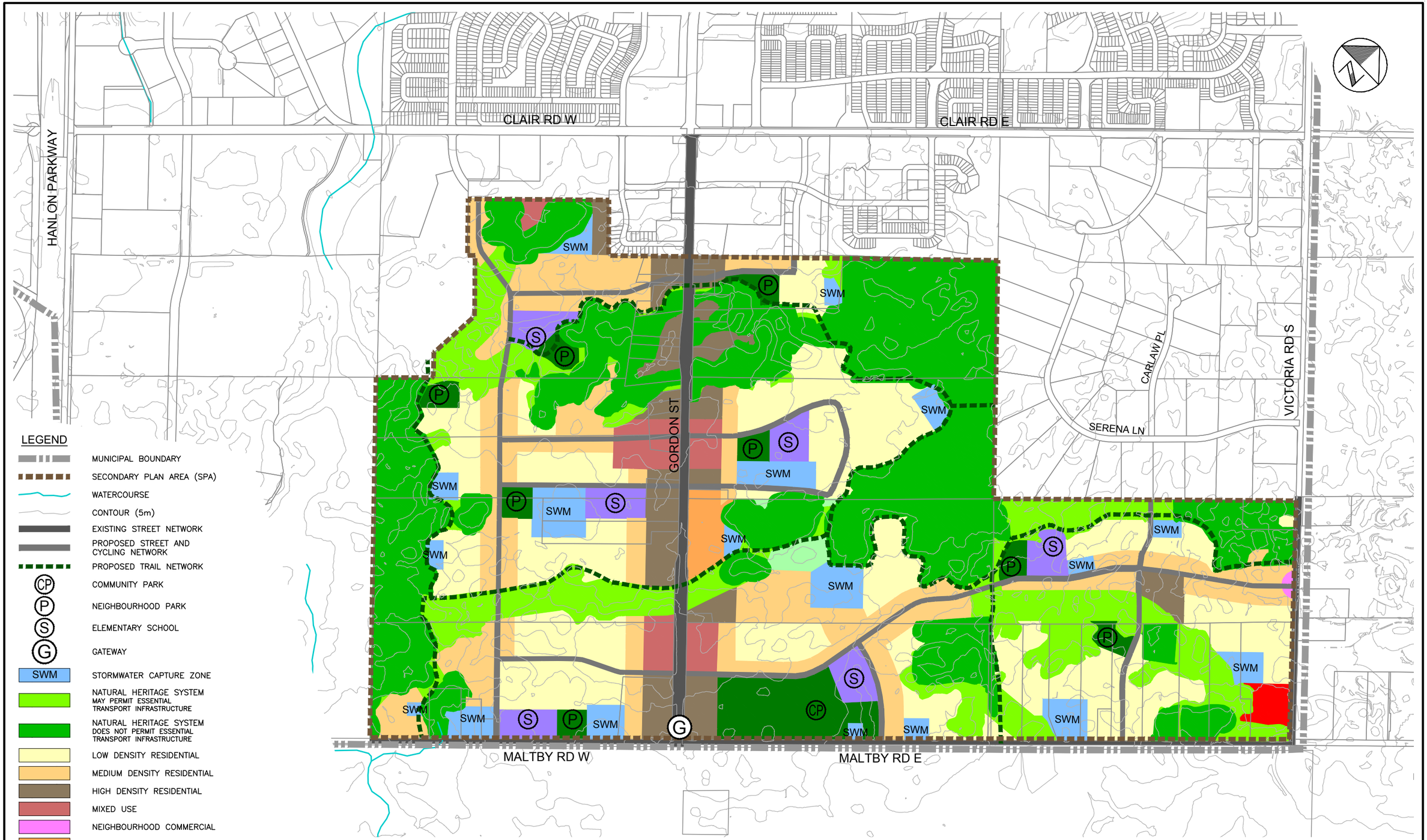
CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	EXISTING SOILS CLASSIFICATION PLAN	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. HYD4



SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	DEPRESSION AREAS WITH NATURAL HERITAGE SYSTEM (EXISTING CONDITION)	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. HYD7

Plotted: 2019-01-25
Last Saved: 2019-01-25
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\HYD7 NHS-Depressions.dwg



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Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-16

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY
MASTER ENVIRONMENTAL
SERVICING PLAN AND
SECONDARY PLAN
CITY OF GUELPH

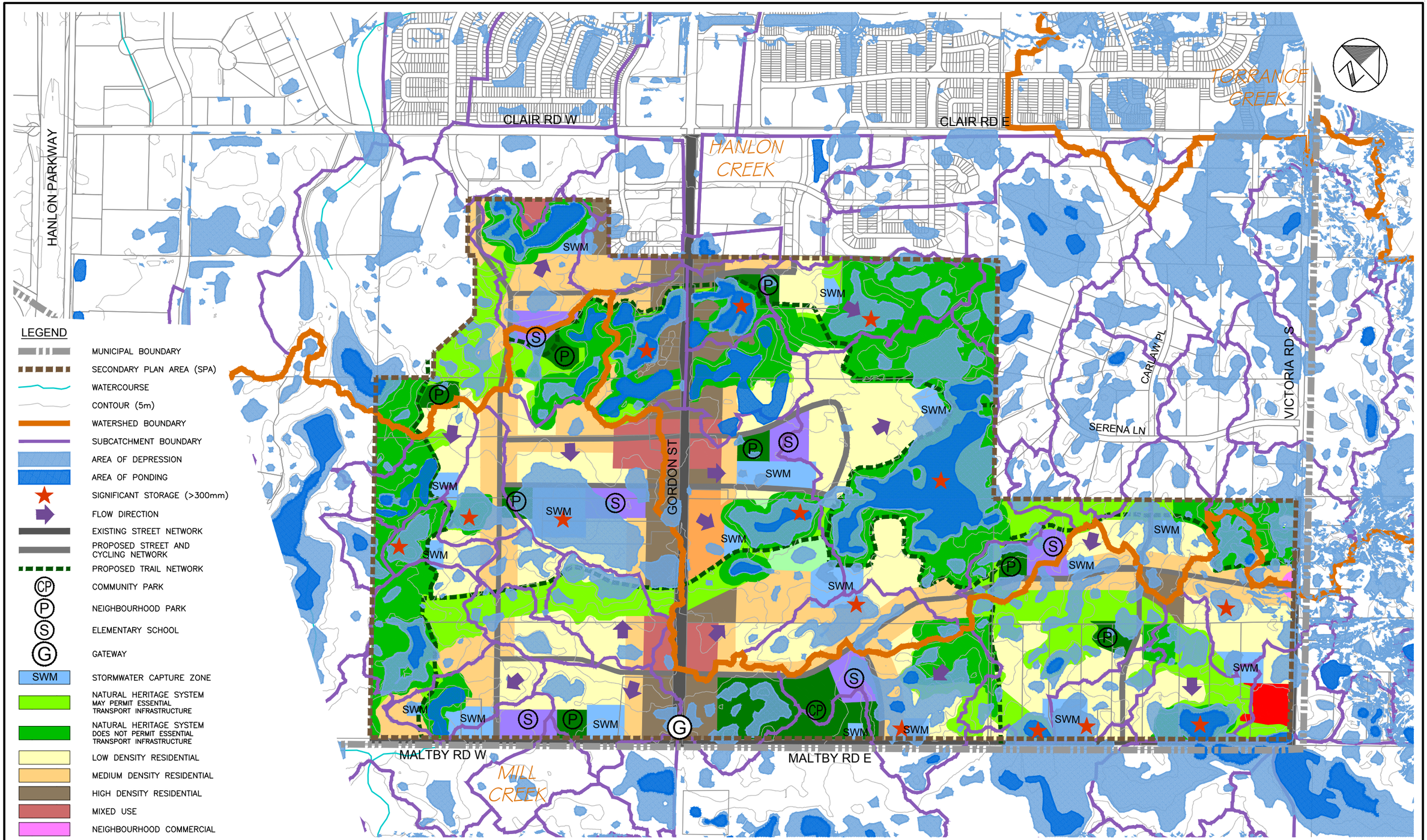
CONCEPTUAL
LAND USE
PLAN

wood.

Scale 1:6000
0 50 100 200

Consultant File No.
TPB168050

Figure No.
LU1



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Last Saved By: mary.kelly
Plotted: 2019-03-05
Last Saved: 2019-03-05

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY
MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

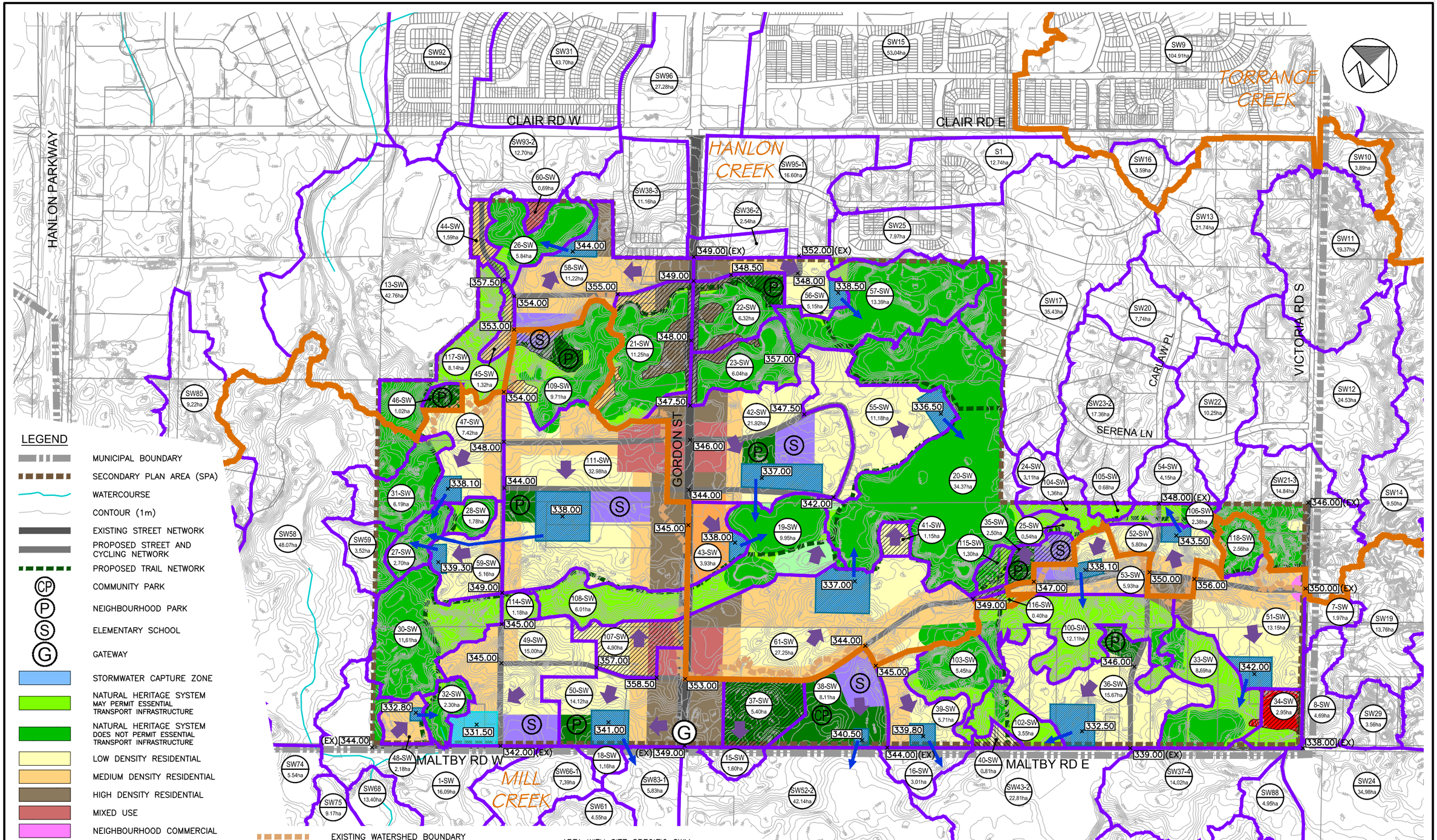
EXISTING DRAINAGE FEATURES AND CONCEPTUAL LAND USE PLAN

wood.

Scale 1:6000
0 50 100 200

Consultant File No.
TPB168050

Figure No.
IA-HYD1



LEGEND

- MUNICIPAL BOUNDARY
- SECONDARY PLAN AREA (SPA)
- WATERCOURSE
- CONTOUR (1m)
- EXISTING STREET NETWORK
- PROPOSED STREET AND CYCLING NETWORK
- PROPOSED TRAIL NETWORK
- (CP) COMMUNITY PARK
- (P) NEIGHBOURHOOD PARK
- (S) ELEMENTARY SCHOOL
- (G) GATEWAY
- STORMWATER CAPTURE ZONE
- NATURAL HERITAGE SYSTEM MAY PERMIT ESSENTIAL TRANSPORT INFRASTRUCTURE
- NATURAL HERITAGE SYSTEM DOES NOT PERMIT ESSENTIAL TRANSPORT INFRASTRUCTURE
- LOW DENSITY RESIDENTIAL
- MEDIUM DENSITY RESIDENTIAL
- HIGH DENSITY RESIDENTIAL
- MIXED USE
- NEIGHBOURHOOD COMMERCIAL
- OFFICE COMMERCIAL
- SERVICE COMMERCIAL
- SCHOOL
- PARK
- OPEN SPACE

- EXISTING WATERSHED BOUNDARY
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- 100-SW 12.11ha — SUBCATCHMENT ID# / SUBCATCHMENT AREA
- FLOW DIRECTION
- AREA WITH SITE SPECIFIC SWM (DRAINAGE AREA LESS THAN 5ha)
- CONCEPTUAL SWM FACILITY (CONVENTIONAL DESIGN)
- CONCEPTUAL SWM FACILITY (FULL CAPTURE)
- SWM FACILITY RELIEF OUTLET
- ×333.00 PROPOSED GRADE ELEVATION

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

PRELIMINARY CONCEPTUAL STORMWATER MANAGEMENT AND GRADING PLAN

wood.

Scale 1:6000 (0 50 100 200)
Consultant File No. TPB168050
Figure No. IA-HYD2

Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\Fig\A-HYD2 FutDrnGrd.dwg
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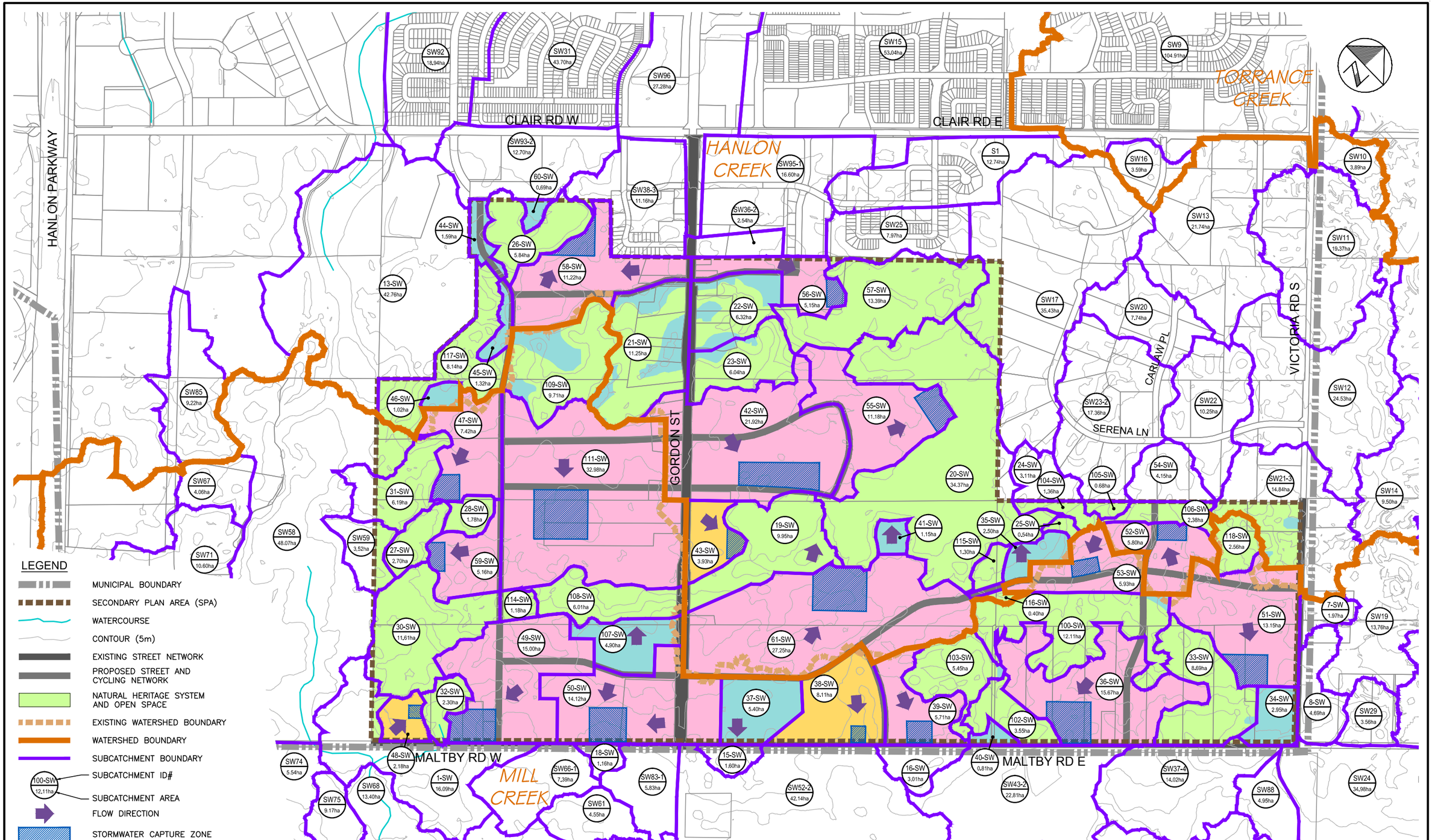
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-16



LEGEND

- MUNICIPAL BOUNDARY
- SECONDARY PLAN AREA (SPA)
- WATERCOURSE
- CONTOUR (5m)
- EXISTING STREET NETWORK
- PROPOSED STREET AND CYCLING NETWORK
- NATURAL HERITAGE SYSTEM AND OPEN SPACE
- EXISTING WATERSHED BOUNDARY
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- 100-SW 12.11ha — SUBCATCHMENT ID# / SUBCATCHMENT AREA
- FLOW DIRECTION
- STORMWATER CAPTURE ZONE

SURFACE WATER CAPTURE

- 27mm
- 27mm + 88mm (100 YEAR)
- 27mm + 285mm (REGIONAL)

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	SURFACE WATER CAPTURE	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. IA-HYD3

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Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-16

Appendix A

Conceptual Community Structure Alternative

Clair-Maltby
Preliminary Preferred Concept

May 23 2018

Legend

- Clair-Maltby Secondary Plan Boundary
- Cultural Heritage Landscape
- Urban-Rural Transition Zone
- Gordon St. Corridor

Streets and Trails

- Existing Street Network
- Proposed Street and Cycling Network
- Potential Street Connection
- Road Link Assessment Area
- Proposed Trail Network
- Potential Active Transportation Link

Parks, Schools, and Features

- (P) Neighbourhood Park
- (CP) Community Park
- (S) Elementary School
- (SWM) Stormwater Infiltration Areas
- (CC) Community Commercial Area
- (G) Gateway
- Cultural Heritage Resource

Natural Heritage System

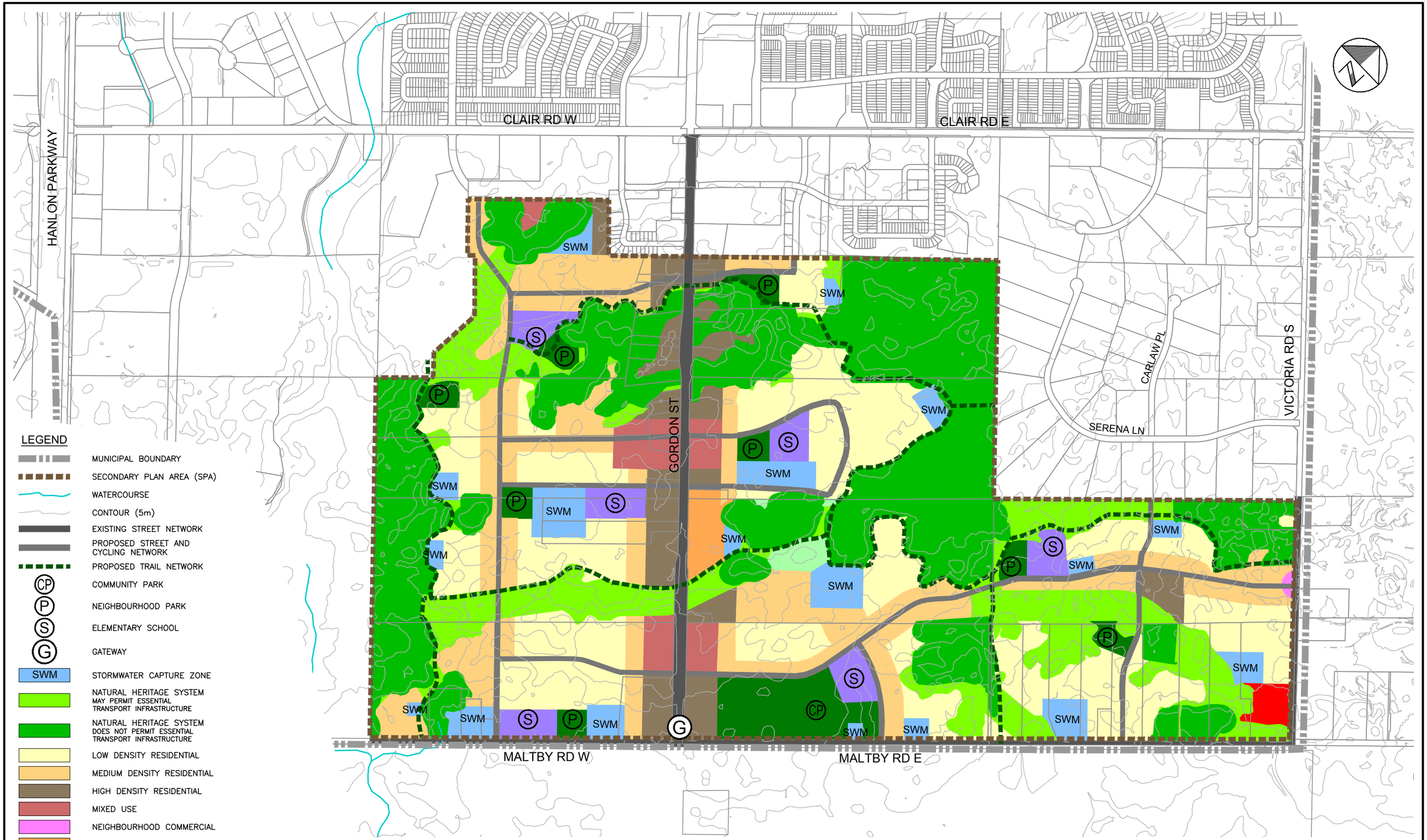
- May Permit Essential Transportation Infrastructure
- Does Not Permit Transportation Infrastructure
- Wetland

Land Use

- Low Density (Residential)
- Medium Density (Residential)
- High Density (Residential)
- Mixed Use
- Neighbourhood Commercial
- Service Commercial
- Mixed Office / Commercial
- Reserve Lands
- Open Space

N

0 50 100 150 200 300 400 m



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Last Saved By: richard.bartolo
Plotted: 2019-01-16
Last Saved: 2019-01-16

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY
MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

CONCEPTUAL LAND USE PLAN

wood.

Scale 1:6000
0 50 100 200

Consultant File No.
TPB168050

Figure No.
LU1

Appendix B

Hydrogeology (Groundwater)

ADJUSTMENT OF UNSATURATED ZONE CONDUCTIVITY IN IMPERVIOUS AREAS

In an effort to better represent the hydrologic effects of development and increased overland associated with increased impervious areas a revised unsaturated vertical hydraulic conductivity (Kz) has been applied in the model. The revised unsaturated Kz value is based on the an area weighted geometric mean of the native material Kz and a representative Kz value from asphalt of 1E-9 m/s (Aboufoul and Garcia, 2017). The value used for asphalt is considered conservative from the perspective of not underestimating runoff from impervious areas as it is at the lower end of a range of values that may be encountered for asphalt. The area fractions used for the weighting in the geometric mean calculation are based on the directly connected impervious fraction. In this way the additional runoff associated with directly connected impervious areas, which do not have an opportunity to infiltrate in the local area by definition, is factored into the model by reducing the conductivity value on the local area (cell) to generate additional runoff.

$$K_{Z-ADJ} = (K_{ZN})^{A_N} \times (K_{ZI})^{A_I}$$

Where:

K_{Z-ADJ}- is the adjusted saturated vertical hydraulic conductivity
K_{ZN}- is the native materials saturated vertical hydraulic conductivity
K_{ZI}- is the impervious are saturated vertical hydraulic conductivity (assigned Kz = 1E-9 m/s)
A_N- is the area fraction of native material
A_I- is the area fraction of impervious material

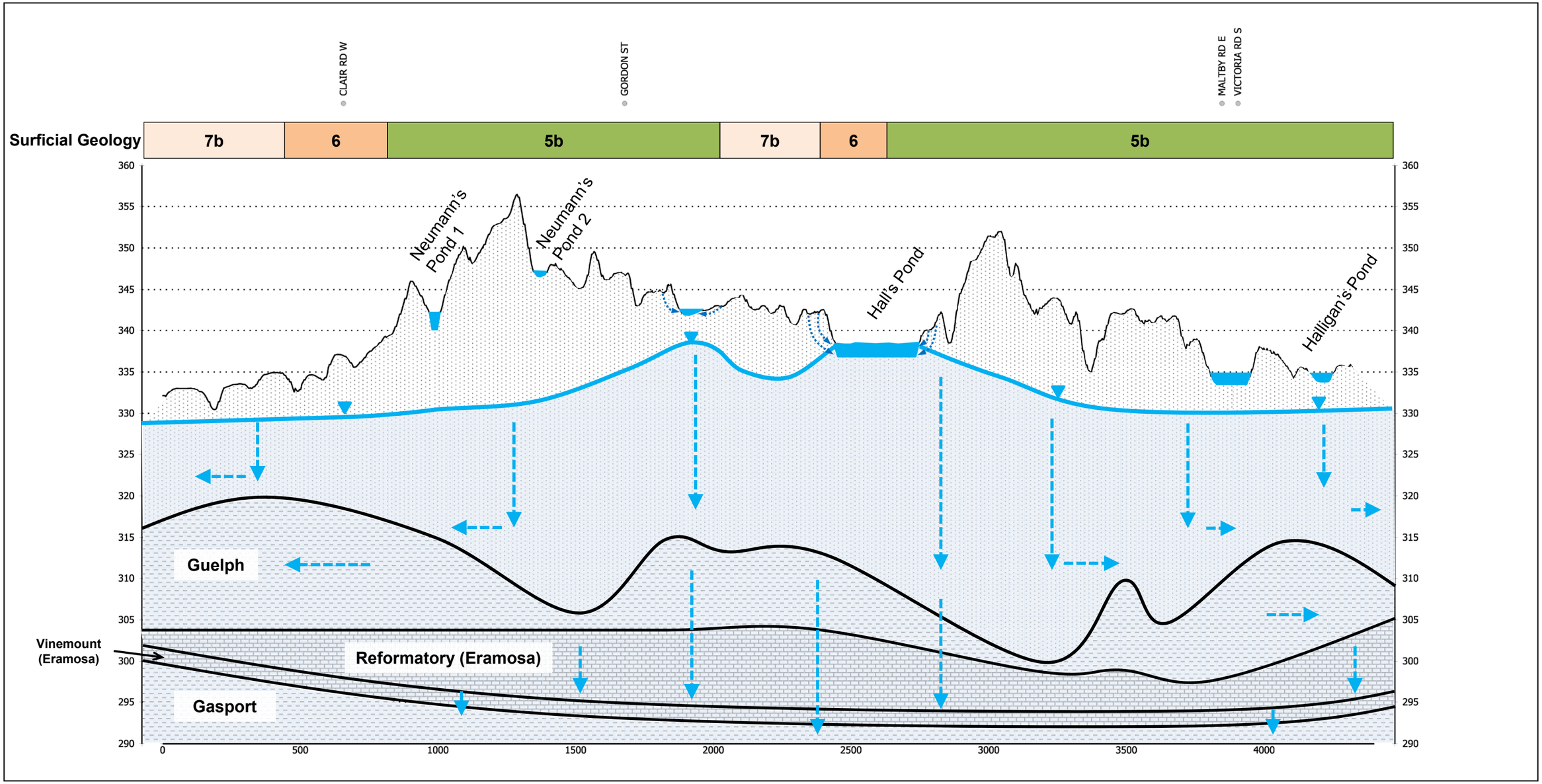
Area fractions use in the exponent portion of the equation must sum to a value of 1 for each area. Thus if a value of 0.15 directly connected fraction is present in an area then a value of 0.85 is used for native material.

Surficial Geology Type	Directly Connected Impervious Fraction Average ()	Native Material Vertical Hydraulic Conductivity (K_{ZN} - m/s)	Reduced Vertical Hydraulic Conductivity ($K_{Z\text{-}ADJ}$ - m/s) - Area Weighted Geomean
Outwash Sand and Gravel	0.15	1.2E-05	2.9E-06
Outwash Sand and Gravel	0.35	1.2E-05	4.5E-07
Outwash Sand and Gravel	0.45	1.2E-05	1.8E-07
Outwash Sand and Gravel	0.65	1.2E-05	2.7E-08
Outwash Sand and Gravel	0.75	1.2E-05	1.0E-08
Outwash Sand and Gravel	0.85	1.2E-05	4.1E-09
Organics	0.45	5.0E-08	8.6E-09
Organics	0.75	5.0E-08	2.7E-09
Wentworth Till	0.15	1.0E-05	2.5E-06
Wentworth Till	0.25	1.0E-05	1.0E-06
Wentworth Till	0.35	1.0E-05	4.0E-07
Wentworth Till	0.45	1.0E-05	1.6E-07

Wentworth Till	0.65	1.0E-05	2.5E-08
Wentworth Till	0.75	1.0E-05	1.0E-08
Wentworth Till	0.85	1.0E-05	4.0E-09

References

M. Aboufoul and A. Garcia. 2017. Factors affecting hydraulic conductivity of asphalt mixture. Materials and Structures. April 2017, 50:116.



Overburden – Silt/Sand/Sand/Gravel Till (minor clay)

Bedrock – Aquifer unit

Bedrock - Aquitard unit

Saturated zone

5b: Stone-poor, sandy silt to silty sand till (Wentworth Till)

6: Ice-contact stratified sand and gravel deposits

7b: Glaciofluvial gravel deposits

Ponded areas

Approximate water table

Interpreted groundwater flow

Local groundwater flow (seasonal)

Approximate geological contact

Matrix Solutions Inc.
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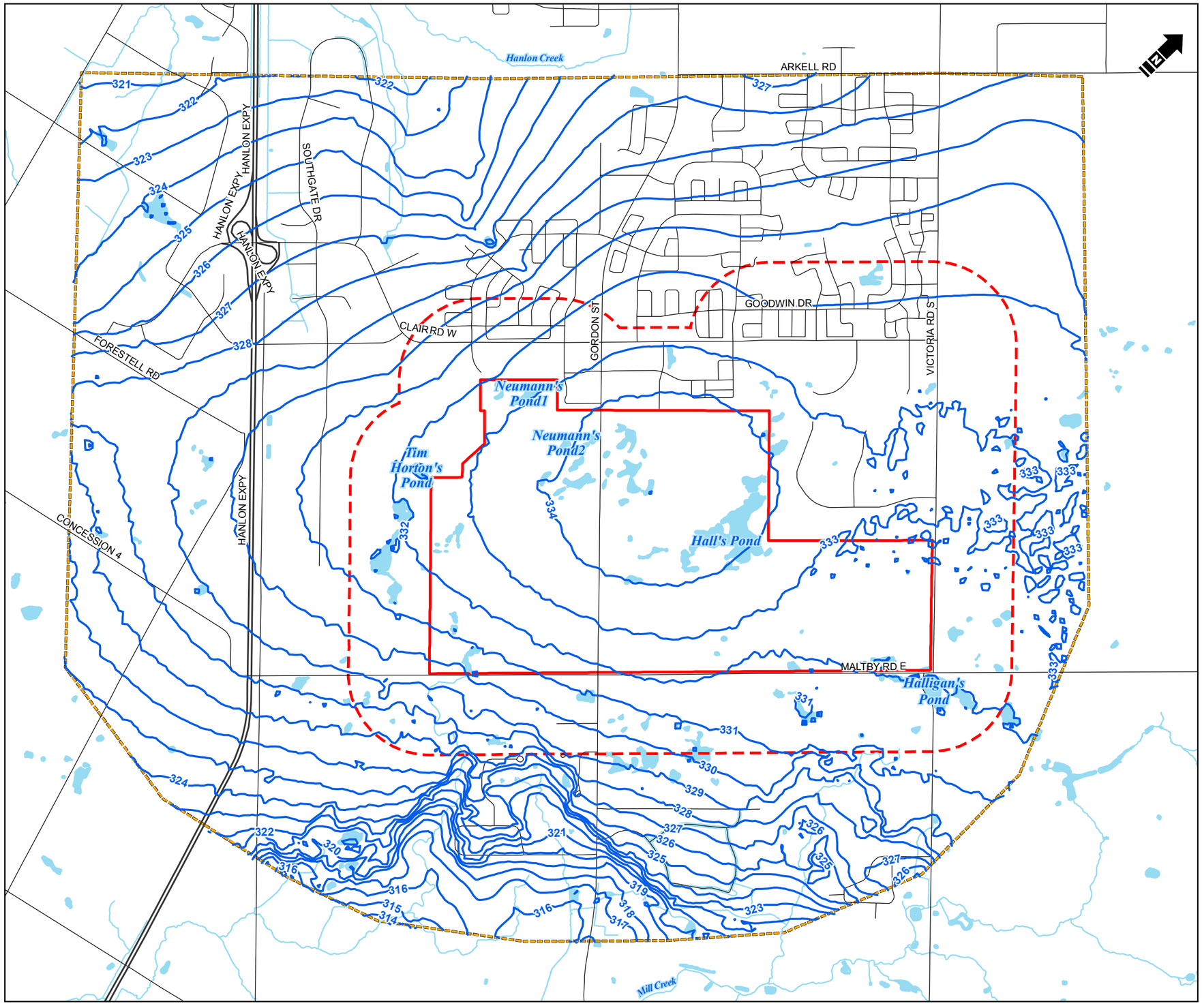
City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Conceptual Groundwater Flow System

Date:	Project:	Submitter:	Reviewer:
Mar 2018	23089	D. Martin	B. Blackport

Figure: GW-1



Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Groundwater Contour (1 mASL)
Highway
Road

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

Reference: Data provided b y the City o f Guelph, Geo Base® and Province of Ontario used under license.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

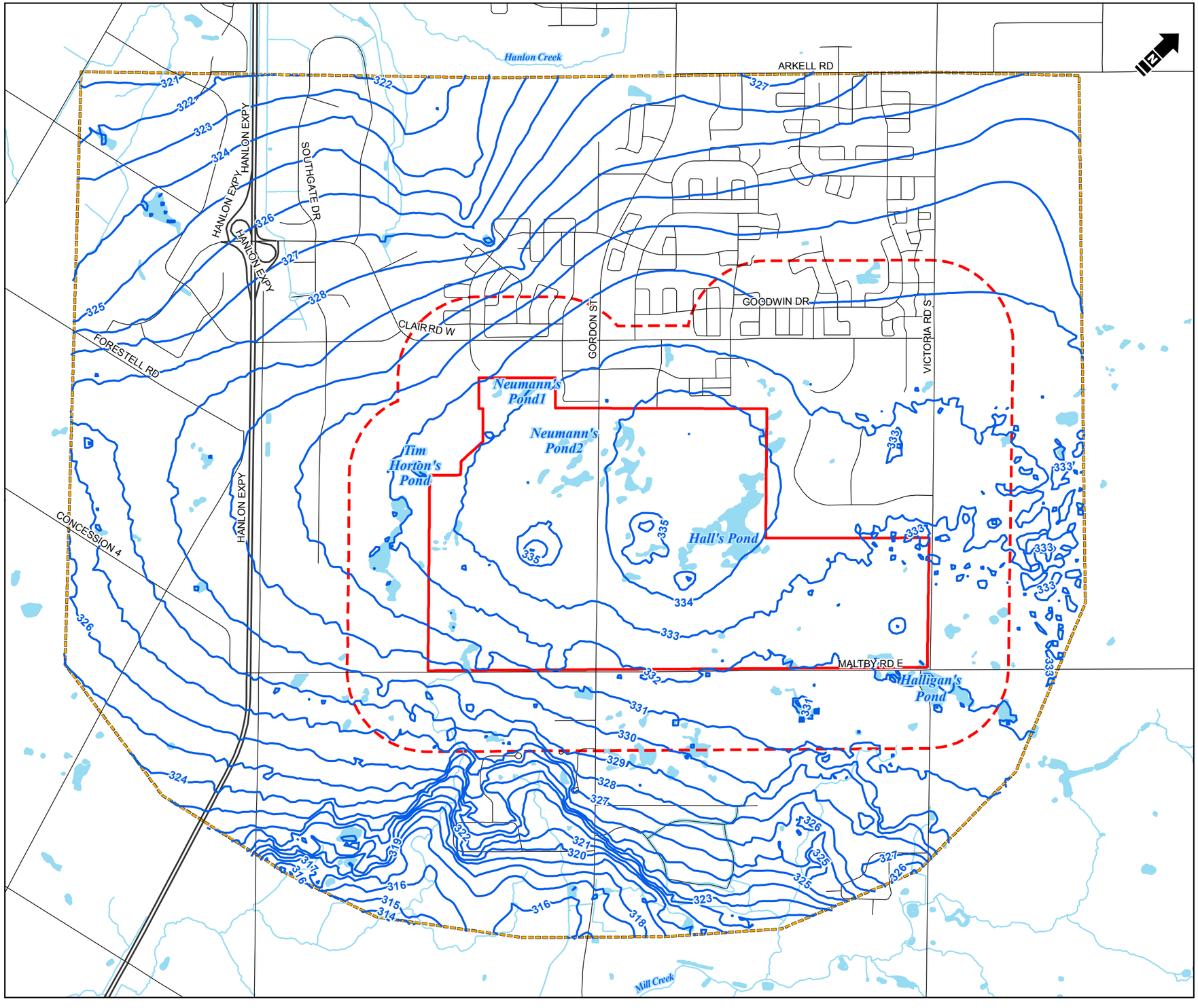
City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Average Groundwater Levels Existing Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
January, 2019	23089	S. Murray	B. Blackport

Figure GW-2



Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Groundwater Contour (1 mASL)
Highway
Road

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

Reference: Data provided b y the City o f Guelph, Geo Base® and Province of Ontario used under license.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

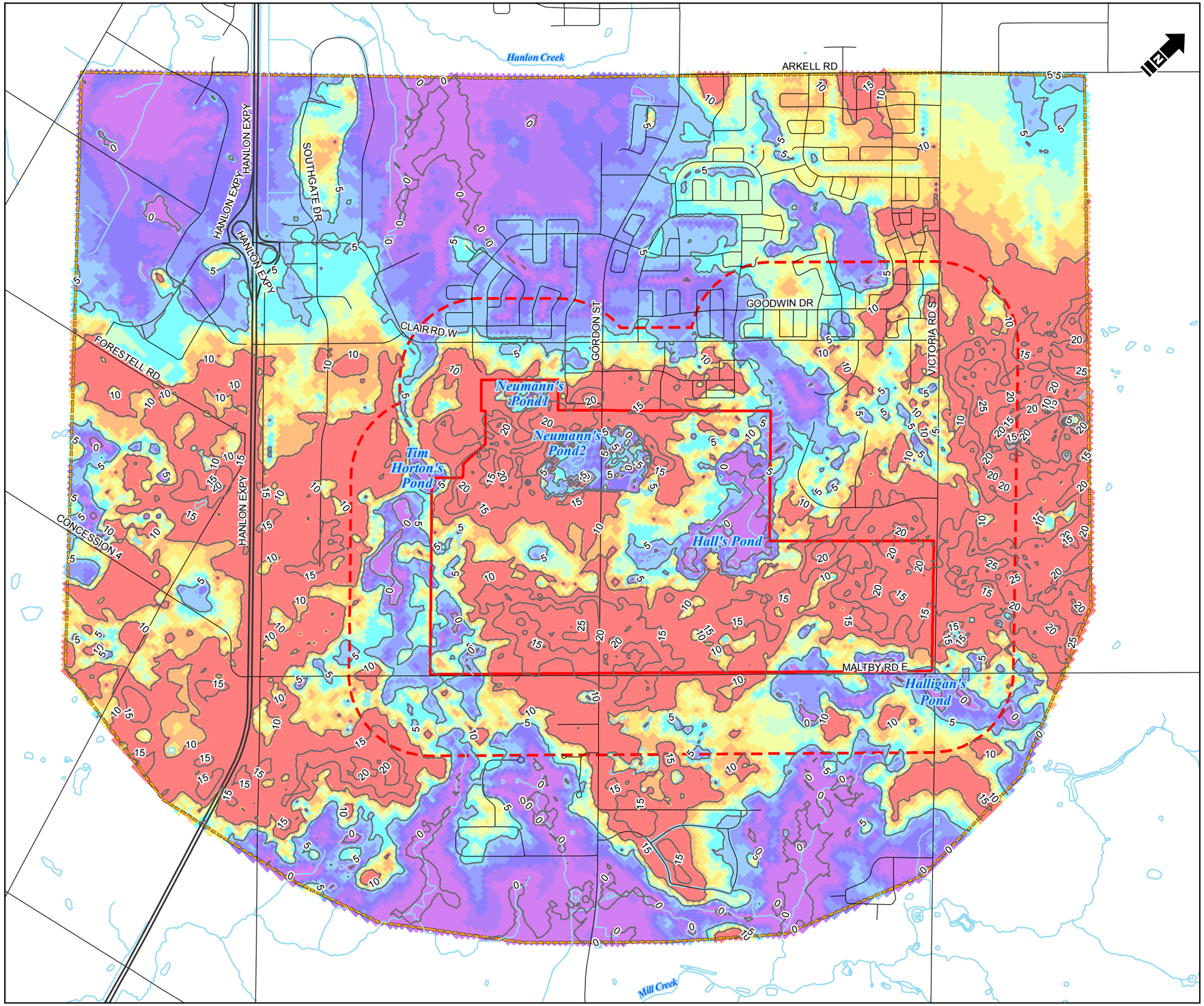
City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Average Groundwater Levels Future Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
January, 2019	23089	S. Murray	B. Blackport

Figure GW-3



Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Highway
Road
Average Depth to Water Table Contour (5m)

Simulated Average Depth to Water Table (m)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- > 10

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

Reference: Da ta pro vided b y the City o f Guelph, Geo Base® and Province of Ontario used under license.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

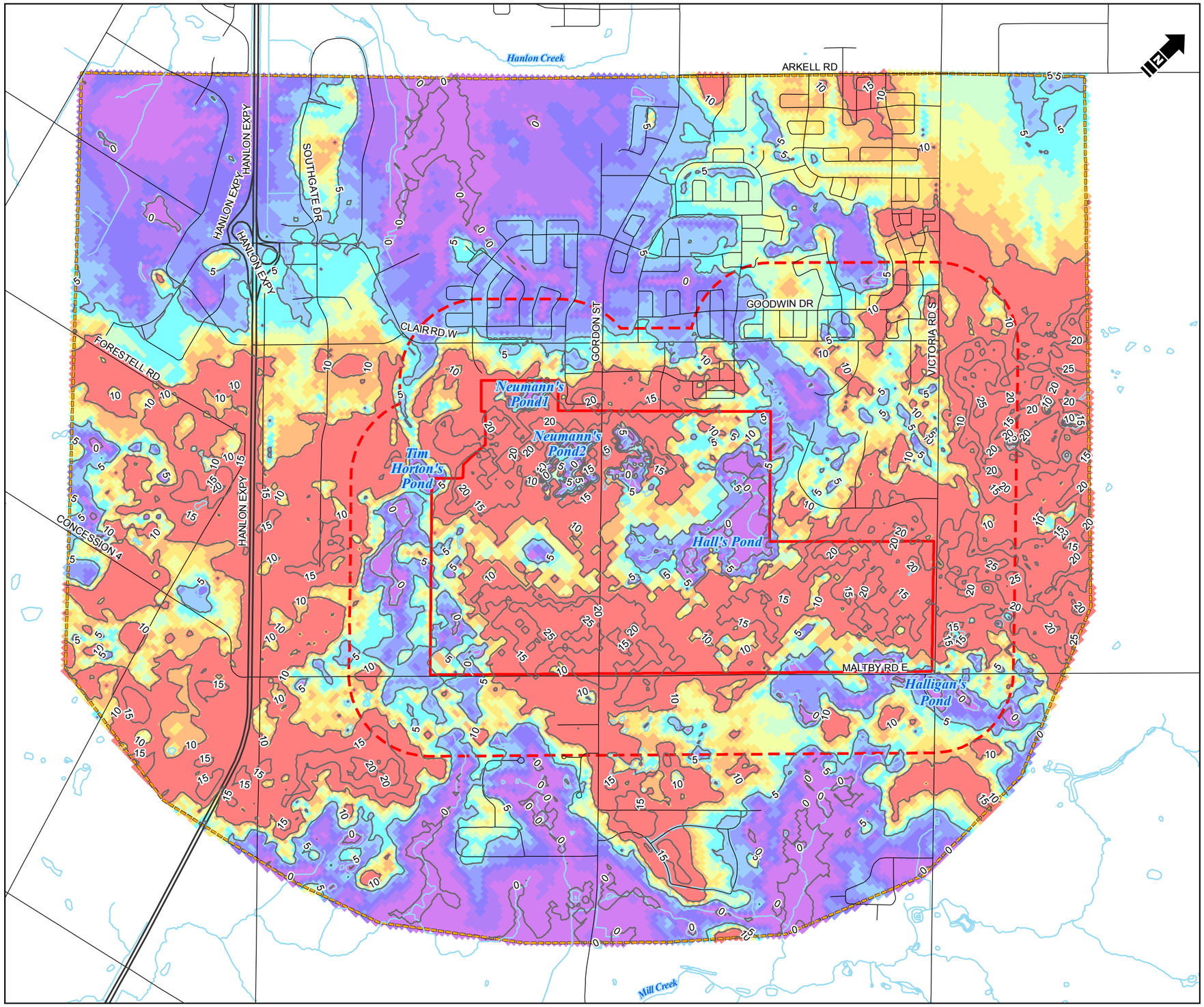
City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Average Depth to Water Table Existing Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
January, 2019	23089	S. Murray	B. Blackport

Figure GW-4



Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Highway
Road
Average Depth to Water Table Contour (5m)

Simulated Average Depth to Water Table (m)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- > 10

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

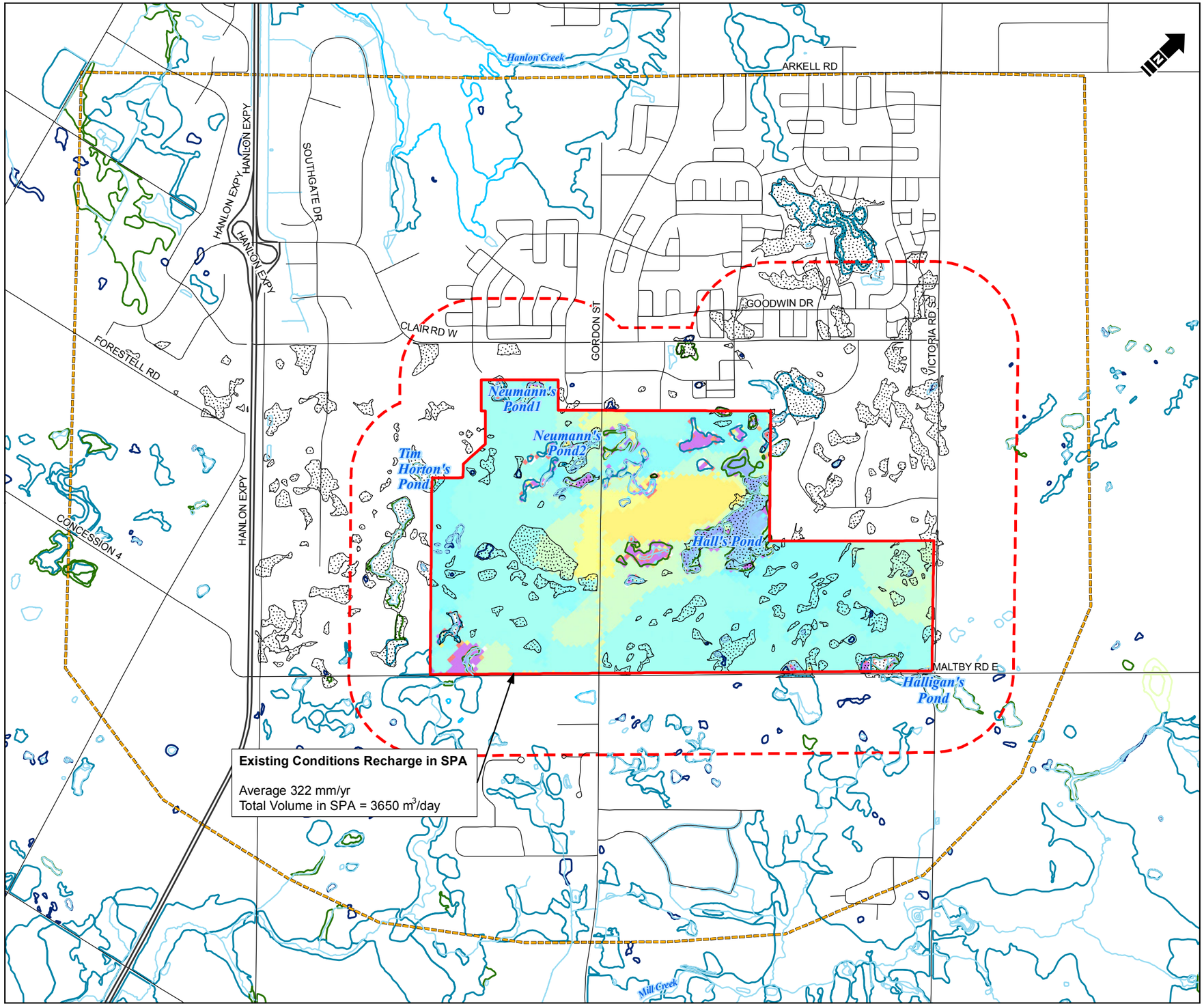
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Average Depth to Water Table Future Conditions (1998 to 2002)

Date:	Project:	Submitter:	Reviewer:
January, 2019	23089	S. Murray	B. Blackport

Figure GW-5



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Closed Depression
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Watercourse
- Highway
- Road

Groundwater Recharge (mm/year)

> 500

< 100

Recharge Definition:

R=P-RO-ET -△S_s

Recharge (R) is the portion of Precipitation (P) that infiltrates (INFIL) into the ground and reaches the water table; after losses to Runoff (RO) at the ground surface and Evapotranspiration (ET) from surfaces and the root zone and change in soil moisture storage (△S_s).

1:25,000 metres

260 0 260 520

NAD 1983 UTM Zone 17N

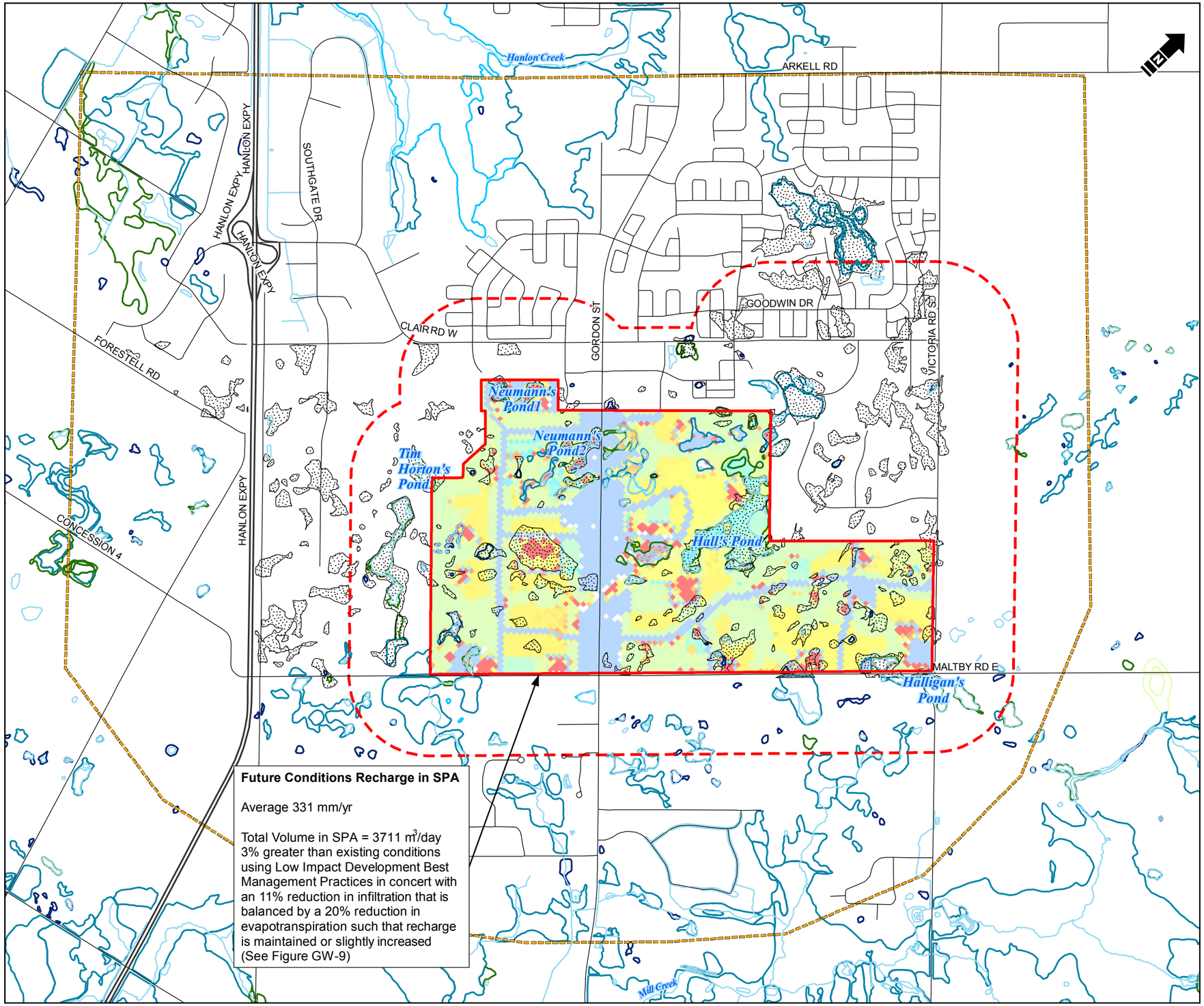
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Groundwater Recharge Existing Conditions (1998 to 2002 Climate Data)

Date:	Project:	Submitter:	Reviewer:
March, 2019	23089	S. Murray	B. Blackport

Figure GW-6



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Closed Depression
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Watercourse
- Highway
- Road

Groundwater Recharge (mm/year)

> 500

< 100

Recharge Definition:

R=P-RO-ET -$\triangle S_s$

Recharge (R) is the portion of Precipitation (P) that infiltrates (INFIL) into the ground and reaches the water table; after losses to Runoff (RO) at the ground surface and Evapotranspiration (ET) from surfaces and the root zone and change in soil moisture storage ($\triangle S_s$).

1:25,000 metres

260 0 260 520

NAD 1983 UTM Zone 17N

Reference: Da ta pro vided b y the City o f Guelph, Geo Base® and Province of Ontario used under license.

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City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Groundwater Recharge Future Conditions (1998 to 2002 Climate Data)

Date:	Project:	Submitter:	Reviewer:
March, 2019	23089	S. Murray	B. Blackport

Figure GW-7

Hanlon Creek
ARKELL RD
HANLON EXPY
SOUTHGATE DR
GORDON ST
GOODWIN DR
VICTORIA RD S
CLAIR RD W
FORESTELL RD
CONCESSION 4
Neumann's Pond1
Neumann's Pond2
Tim Horton's Pond
Hall's Pond
MALTBY RD E
Halligan's Pond
Mill Creek

Exsting Conditions Infiltration in SPA

Infiltration = 676 mm/yr; 7814 m^3/day

- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Closed Depression
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Watercourse
- Highway
- Road

Infiltration (mm/yr)

- 0 - 250
- 250 - 800
- > 800

Infiltration Definition:

INFIL=P-RO-E -△S

Infiltration (INFIL) is the portion of Precipitation (P) that enters the subsurface after losses to Runoff (RO) at the ground surface. Net infiltration and Evaporation (E) from ground surface and change in surface water storage (△S).

1:25,000 metres

260 0 260 520

NAD 1983 UTM Zone 17N

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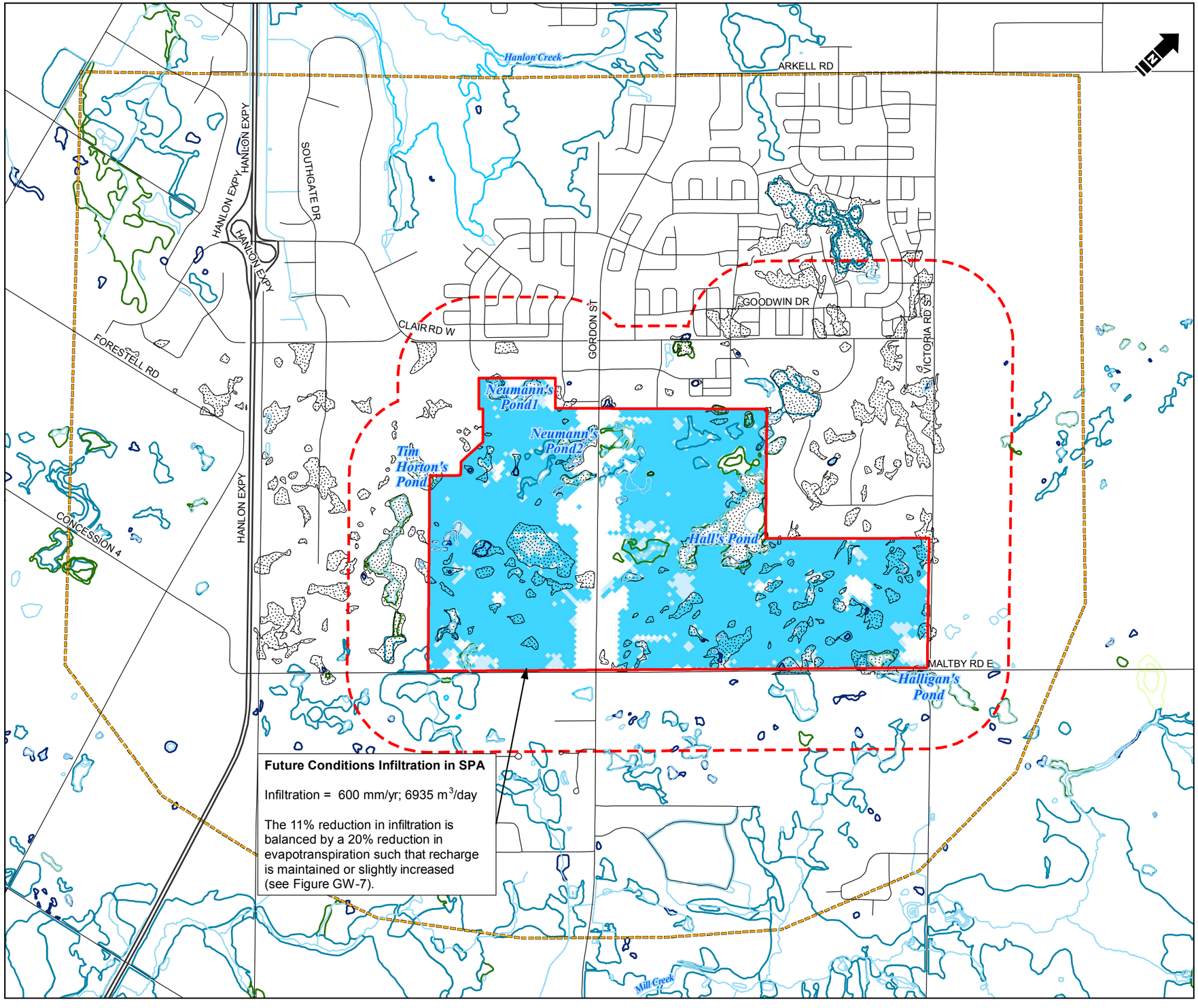
Phase 3 Impact Assessment Report

Simulated InfiltrationExisting Conditions (1998 to 2002 Climate Data)

Date:	Project:	Submitter:	Reviewer:
March, 2019	23089	S. Murray	B. Blackport

Figure GW-8



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Closed Depression
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Watercourse
- Highway
- Road

Infiltration (mm/yr)

- 0 - 250
- 250 - 800
- > 800

Infiltration Definition:

INFIL=P-RO-E -△S

Infiltration (INFIL) is the portion of Precipitation (P) that enters the subsurface after losses to Runoff (RO) at the ground surface. Net infiltration and Evaporation (E) from ground surface and change in surface water storage (△S).

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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Phase 3 Impact Assessment Report

Simulated Infiltration Future Conditions (1998 to 2002 Existing Conditions)

Date:	Project:	Submitter:	Reviewer:
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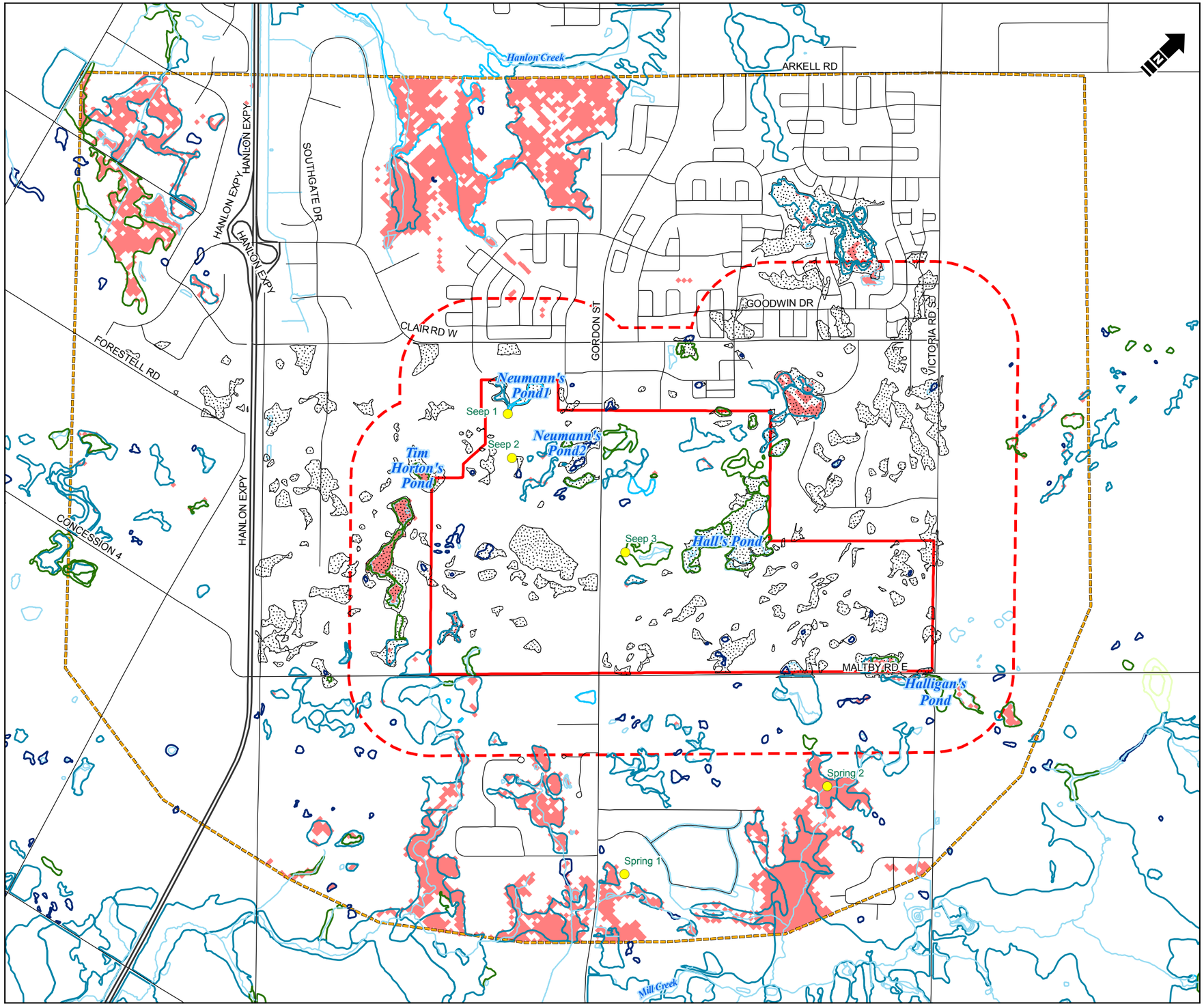
Figure GW-9



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Closed Depression
- Groundwater Discharge
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Watercourse
- Highway
- Road
- Observed Seep and Spring

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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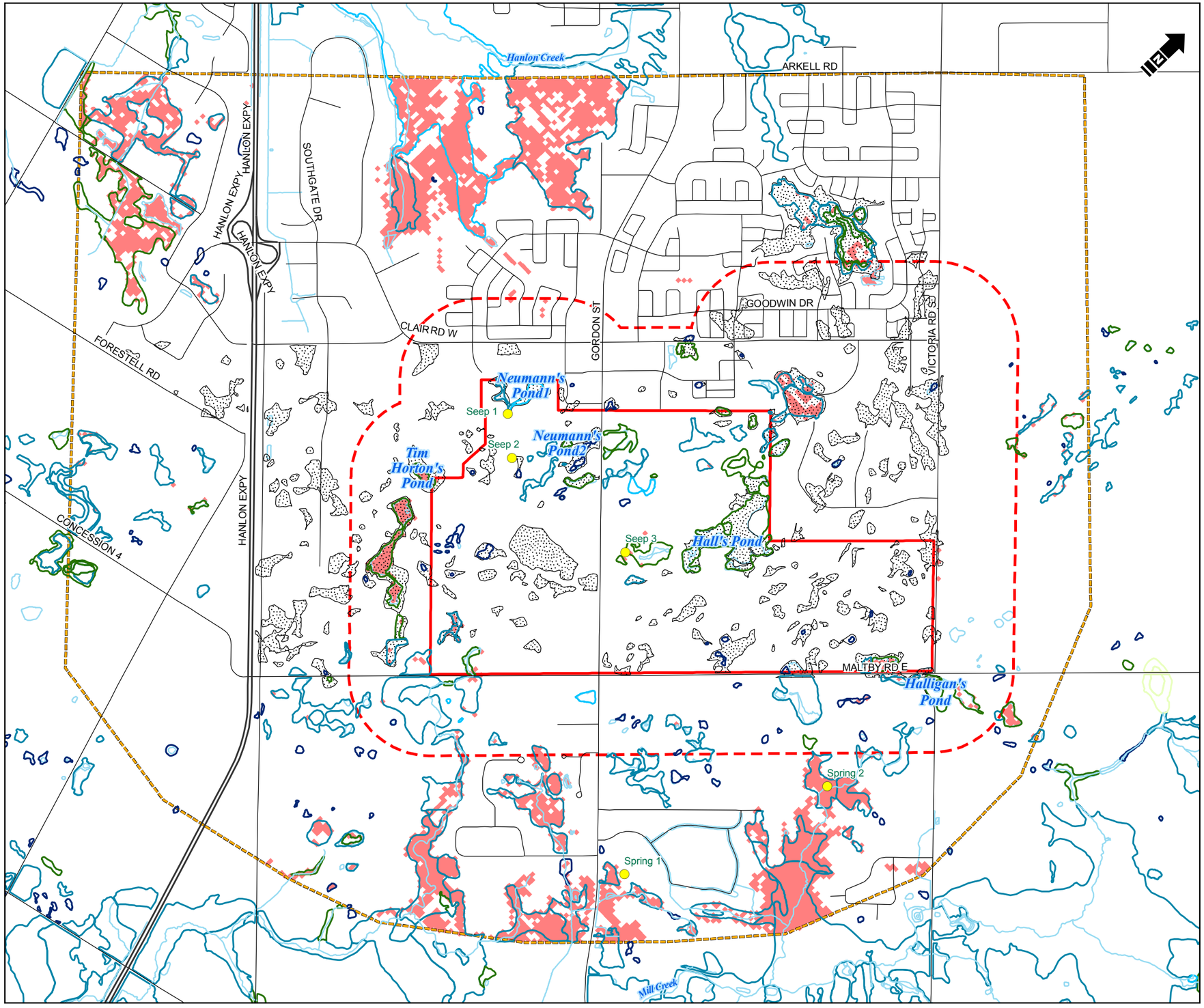
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Groundwater Discharge Existing Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
January, 2019	23089	S. Murray	B. Blackport

Figure GW-10



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Closed Depression
- Groundwater Discharge
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Watercourse
- Highway
- Road
- Observed Seep and Spring

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Groundwater Discharge Future Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
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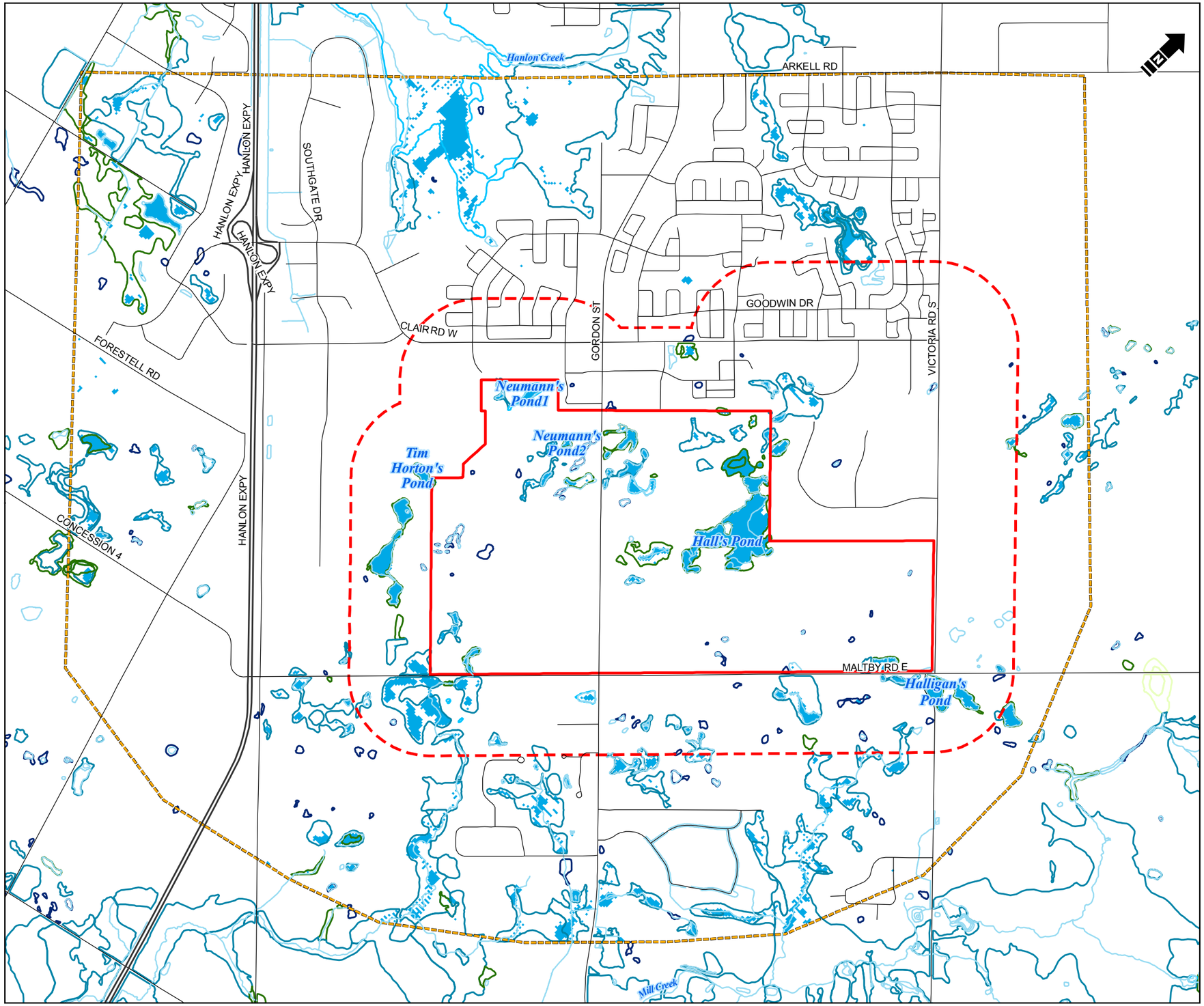
Figure GW-11

I:\Cityof Guelph\23089\Figures and Tables\OHG\2019 Report\Phase 3_Impact_Assesment\Figure GW-11-Simulated_Groundwater_Discharge_Future_Conditions_1998_2002.mxd - Tabloid_L - 24-Jan-19, 09:10 AM - courry - TID005



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Area not Ponded
- Ponded Area
- Watercourse
- Highway
- Road

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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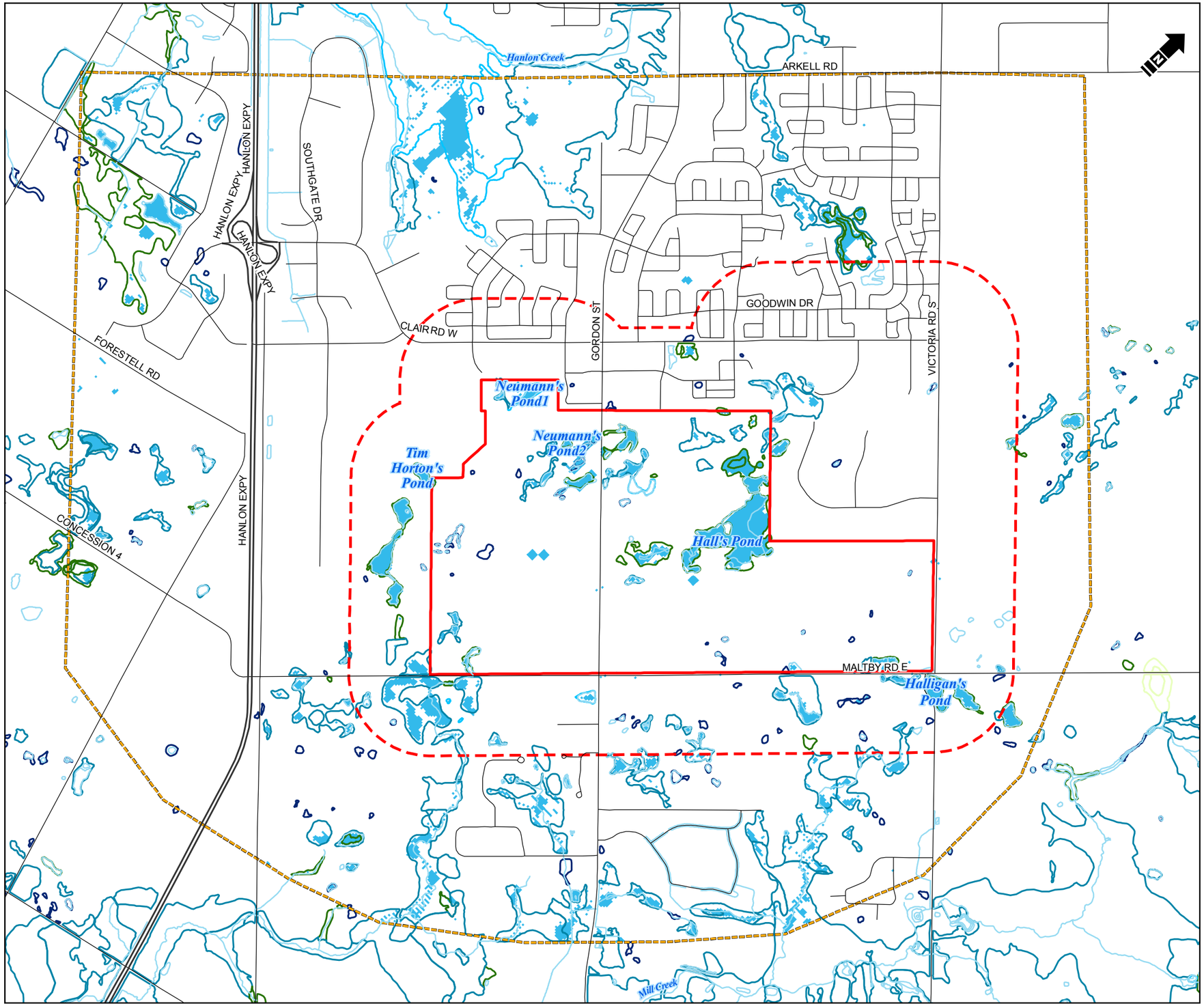
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Ponded Water Locations Existing Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
January, 2019	23089	S. Murray	B. Blackport

Figure GW-12



- Primary Study Area Boundary
- Secondary Plan Area Boundary
- MIKE SHE Model Domain
- Fen
- Bog
- Swamp
- Marsh
- Open Water
- Unknown Wetland
- Water Body
- Area not Ponded
- Ponded Area
- Watercourse
- Highway
- Road

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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Phase 3 Impact Assessment Report

Simulated Ponded Water Locations Future Conditions (1998 to 2002)

DRAFT

Date:	Project:	Submitter:	Reviewer:
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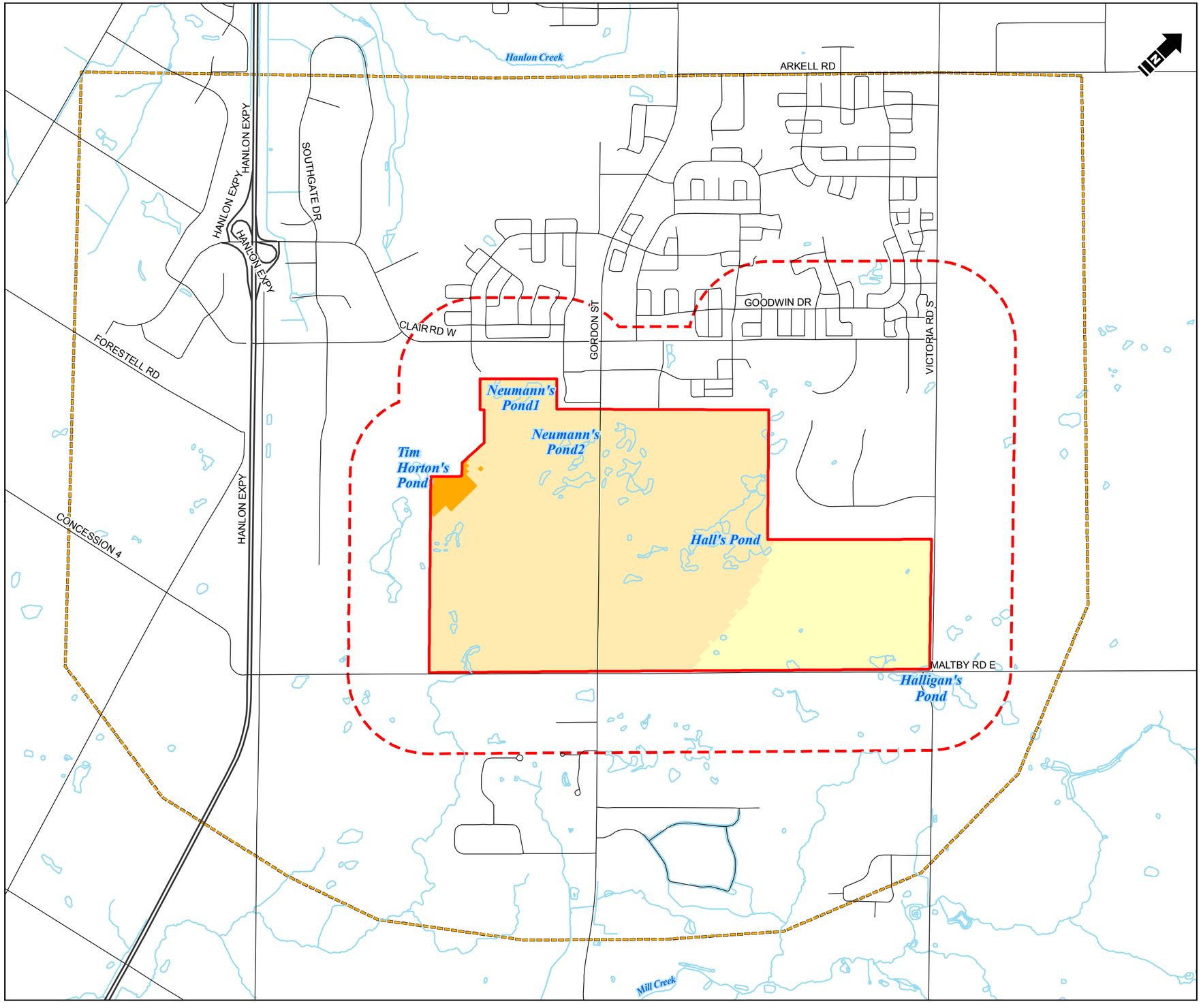
Figure GW-13



Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Highway
Road

Vertical Flux (mm/year)

- < -25 Upward Flow
- -25 - 25
- 25 - 50
- 50 - 100
- 100 - 200
- 200 - 350
- > 350 Downward Flow

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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Phase 3 Impact Assessment Report

Simulated Recharge to Regional Bedrock Aquifer Existing Conditions (1998-2002)

Date:	Project:	Submitter:	Reviewer:
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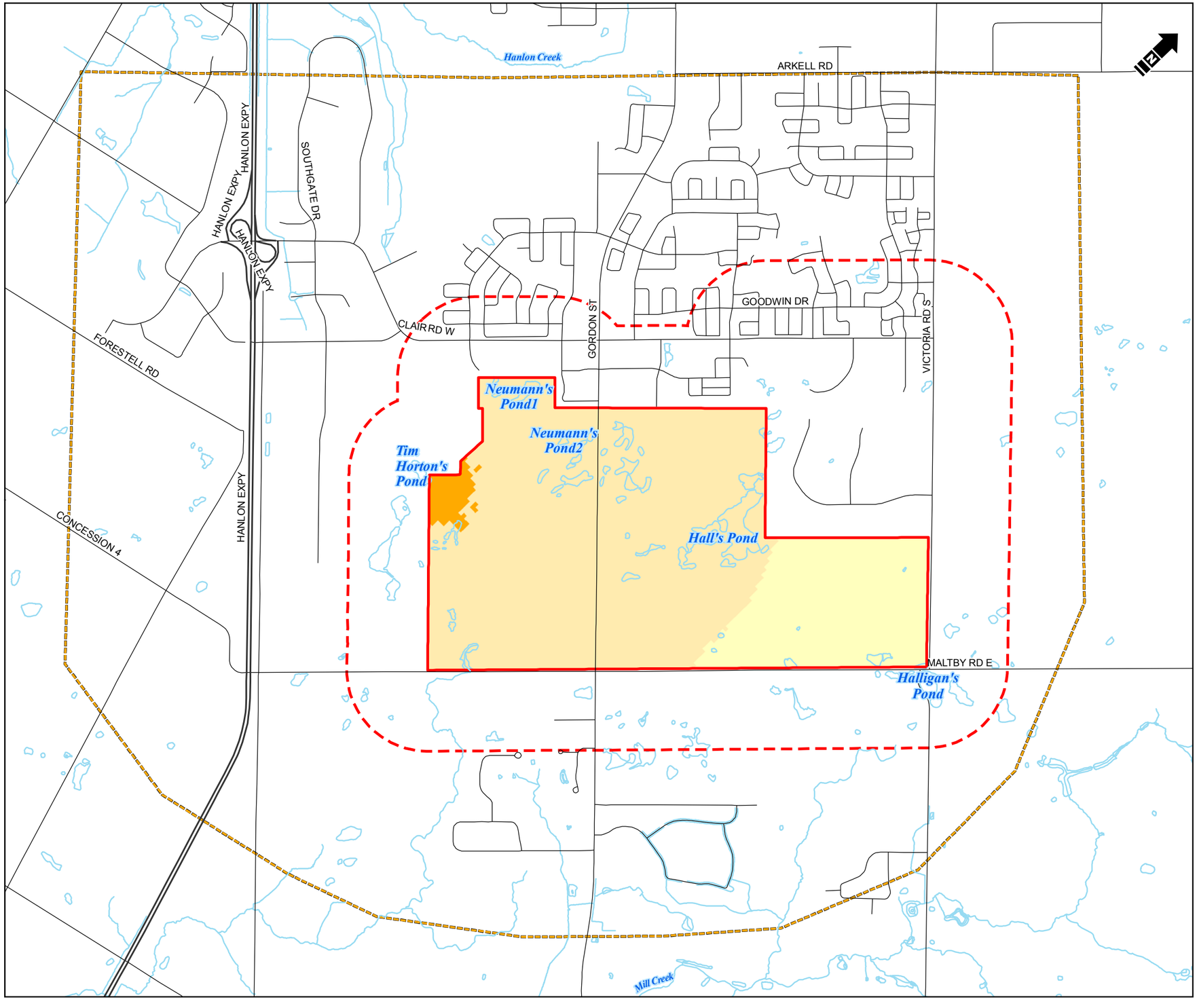
Figure GW-14



Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Highway
Road

Vertical Flux (mm/year)

- < -25 Upward Flow
- -25 - 25
- 25 - 50
- 50 - 100
- 100 - 200
- 200 - 350
- > 350 Downward Flow

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

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Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Simulated Recharge to Regional Bedrock Aquifer Future Conditions (1998 to 2002)

Date:	Project:	Submitter:	Reviewer:
March, 2019	23089	S. Murray	B. Blackport

Figure GW-15

Primary Study Area Boundary
Secondary Plan Area Boundary
MIKE SHE Model Domain
Water Body
Watercourse
Highway
Road

Flux - Existing vs Future Conditions Difference (mm/year)

- < -5 Decrease in Flux
- --5 - -2
- -2 - 2
- 2 - 5
- > 5 Increase in Flux

1:25,000 metres
260 0 260 520
NAD 1983 UTM Zone 17N

Reference: Da ta pro vided b y the City o f Guelph, Geo Base® and Province of Ontario used under license.

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City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

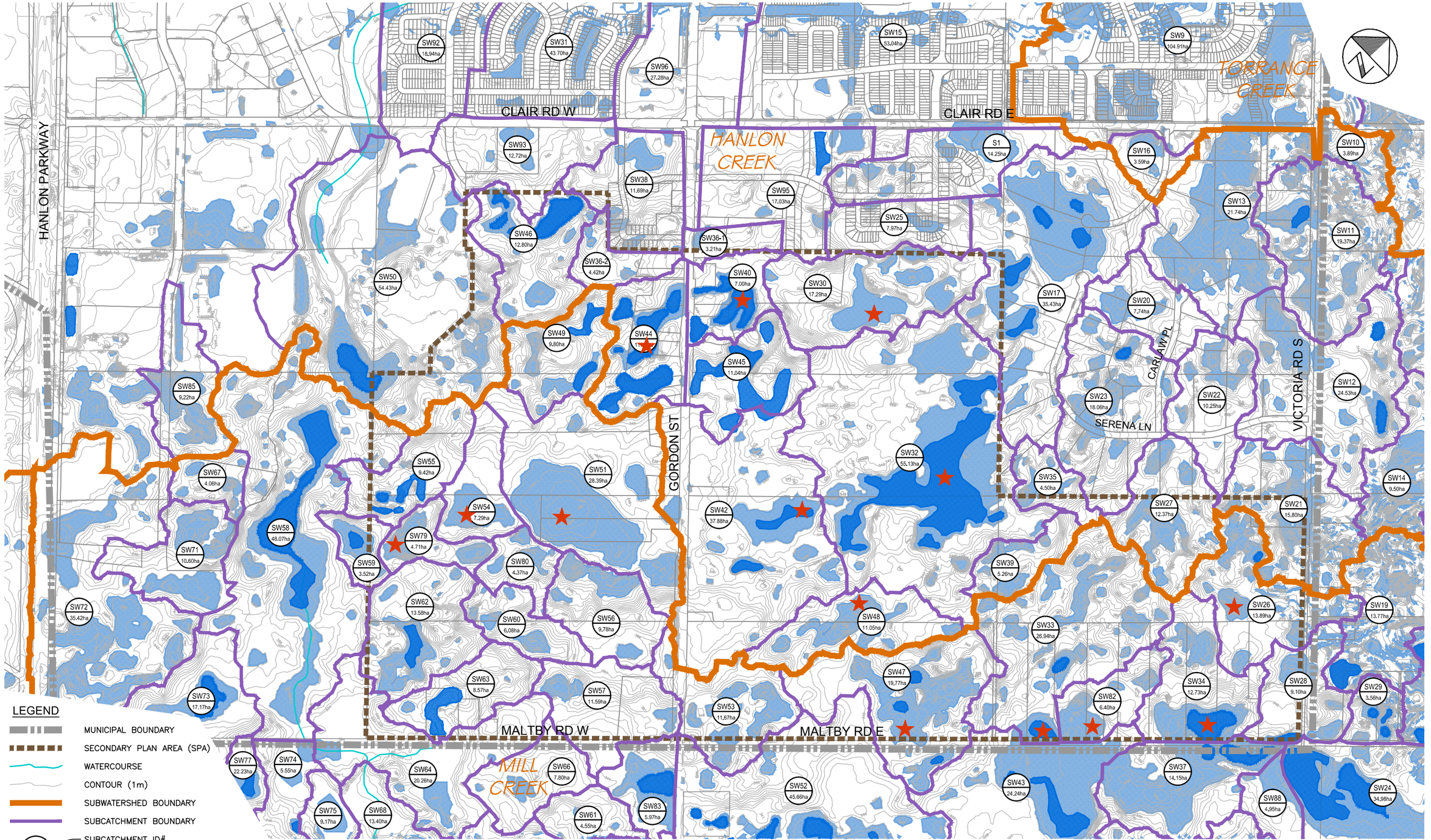
Simulated Recharge to Regional Bedrock Aquifer Future vs Existing Conditions Difference (1998-2002)

Date:	Project:	Submitter:	Reviewer:
March, 2019	23089	S. Murray	B. Blackport

Figure GW-16

Appendix C

Hydrology (Surface Water)



LEGEND

- MUNICIPAL BOUNDARY
- SECONDARY PLAN AREA (SPA)
- WATERCOURSE
- CONTOUR (1m)
- SUBWATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- SW65 5.01ha — SUBCATCHMENT ID# / SUBCATCHMENT AREA
- AREA OF DEPRESSION
- AREA OF PONDING
- FEATURE DEPRESSION (>300mm STORAGE DEPTH)

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	LOCAL SCALE DRAINAGE BOUNDARY PLAN (EXISTING CONDITION)	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. HYD1

Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\HYD1-2 ExistingDrainage.dwg
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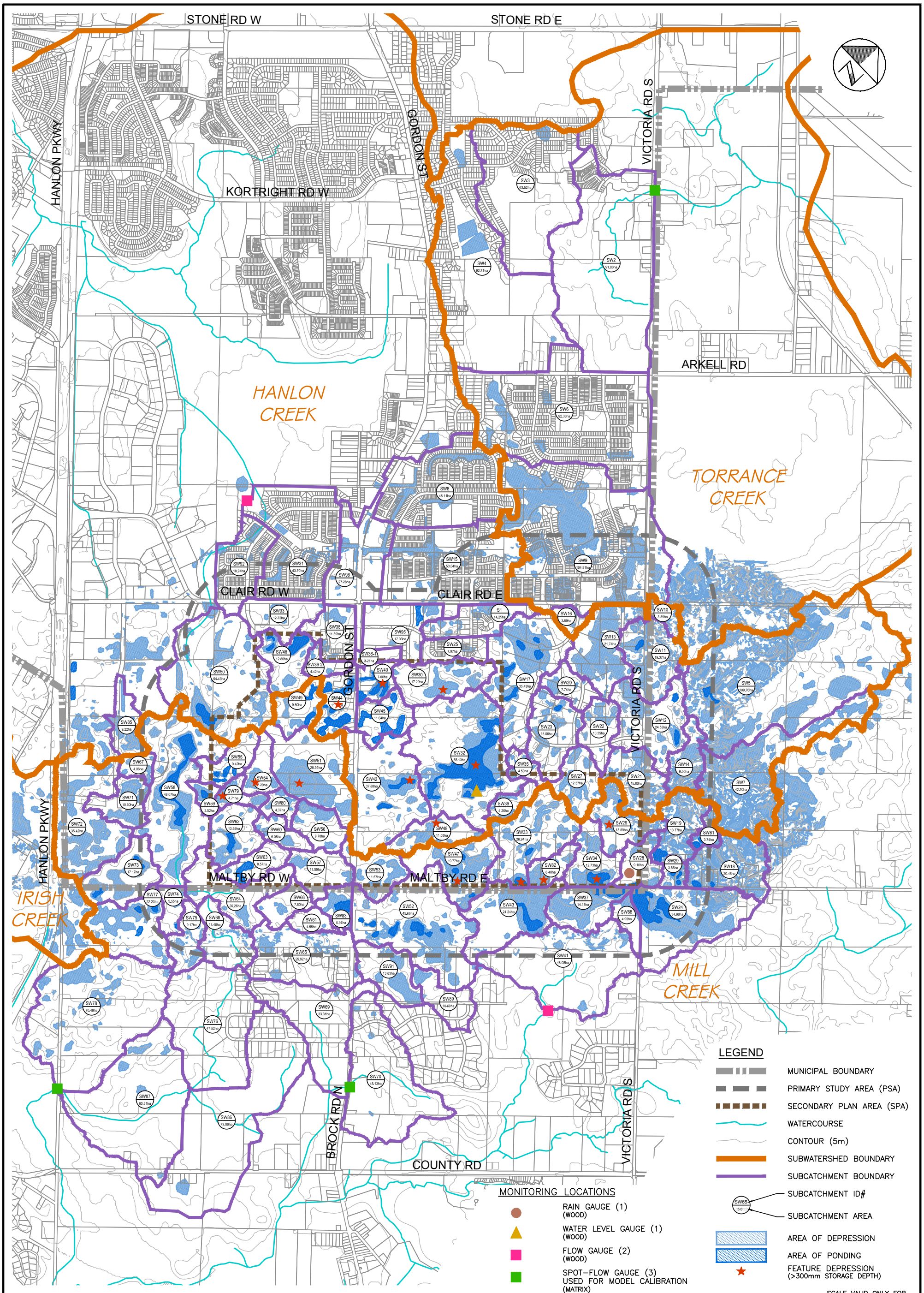
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-25



CLAIR-MALTBY
MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

MONITORING LOCATION AND DRAINAGE BOUNDARY PLAN
(EXISTING CONDITION)

wood.

Scale 1:12500
0 125 250 500

Consultant File No.
TPB168050

Figure No.
HYD2

Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\HYD1-2 ExistingDrainage.dwg
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Plotted: 2019-01-25
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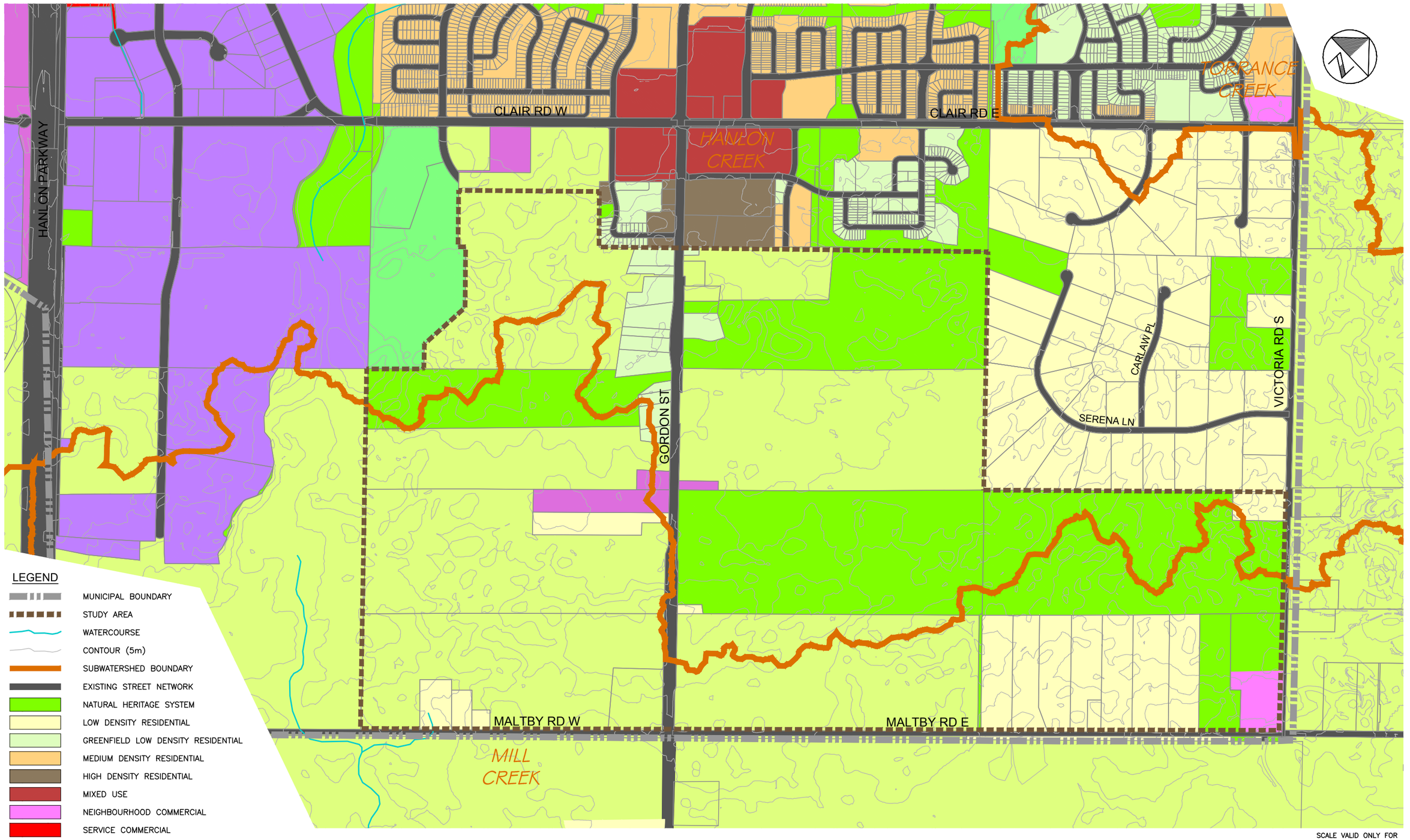
Last Saved: 2019-01-25



LEGEND

- MUNICIPAL BOUNDARY
- STUDY AREA
- WATERCOURSE
- CONTOUR (5m)
- SUBWATERSHED BOUNDARY
- EXISTING STREET NETWORK
- NATURAL HERITAGE SYSTEM
- LOW DENSITY RESIDENTIAL
- GREENFIELD LOW DENSITY RESIDENTIAL
- MEDIUM DENSITY RESIDENTIAL
- HIGH DENSITY RESIDENTIAL
- MIXED USE
- NEIGHBOURHOOD COMMERCIAL
- SERVICE COMMERCIAL
- CORPORATE BUSINESS PARK
- INDUSTRIAL
- OTHER LANDS
- OPEN SPACE AND PARK

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY
MASTER ENVIRONMENTAL
SERVICING PLAN AND
SECONDARY PLAN
CITY OF GUELPH

EXISTING
LAND USE
PLAN

wood.

Scale 1:6000
0 50 100 200

Consultant File No.
TPB168050

Figure No.
HYD3

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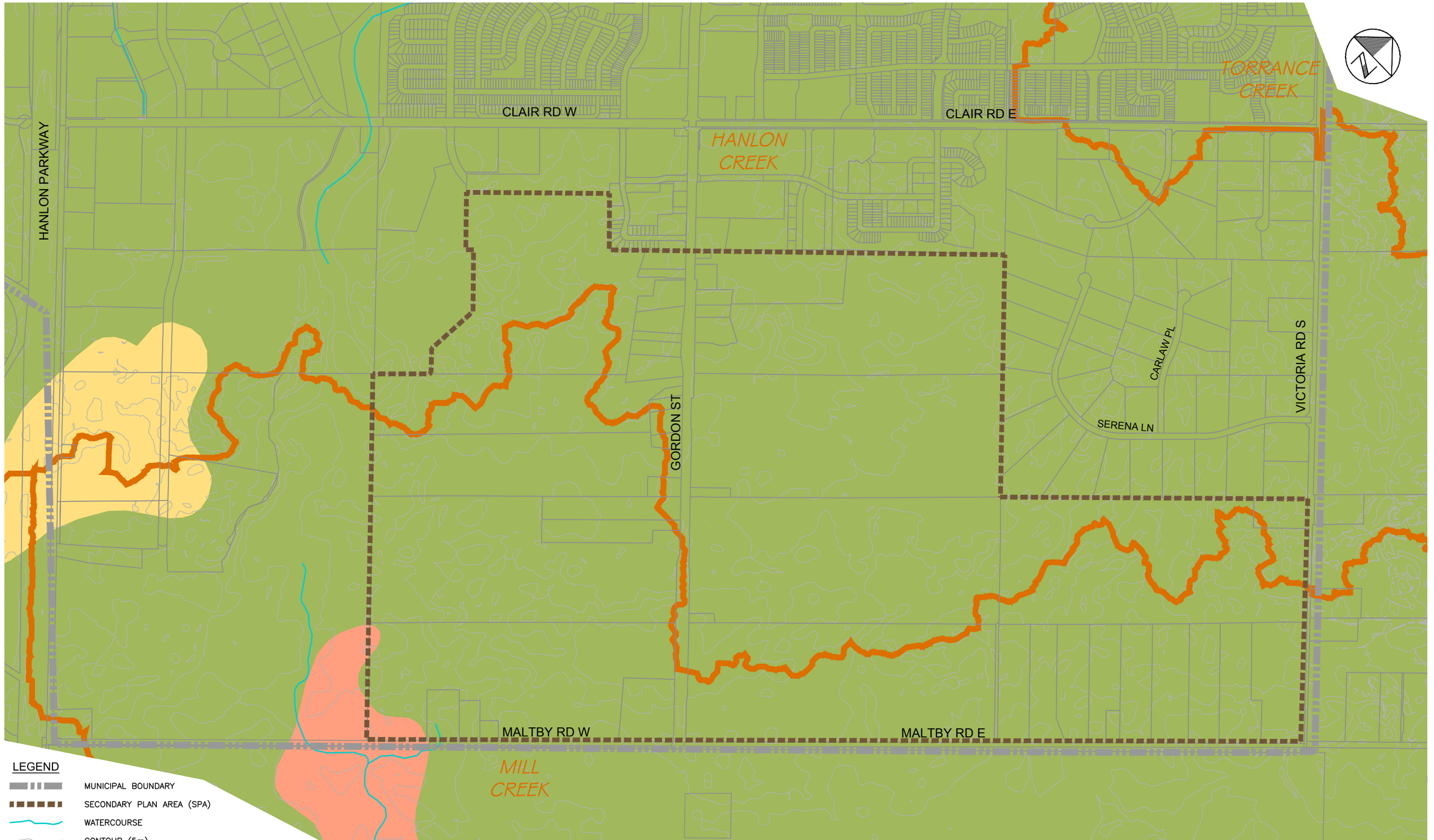
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-25



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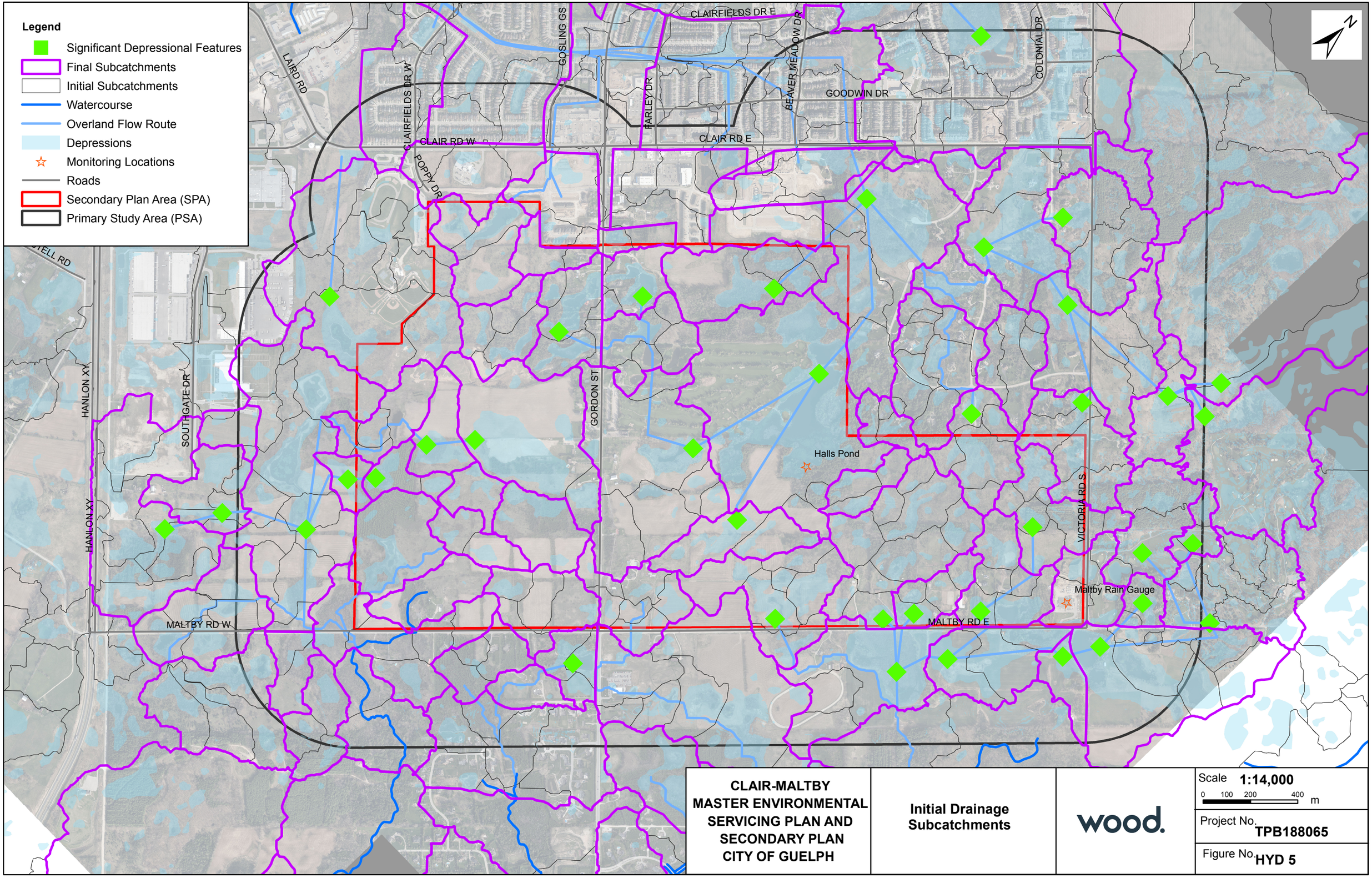
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-25

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	EXISTING SOILS CLASSIFICATION PLAN	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. HYD4



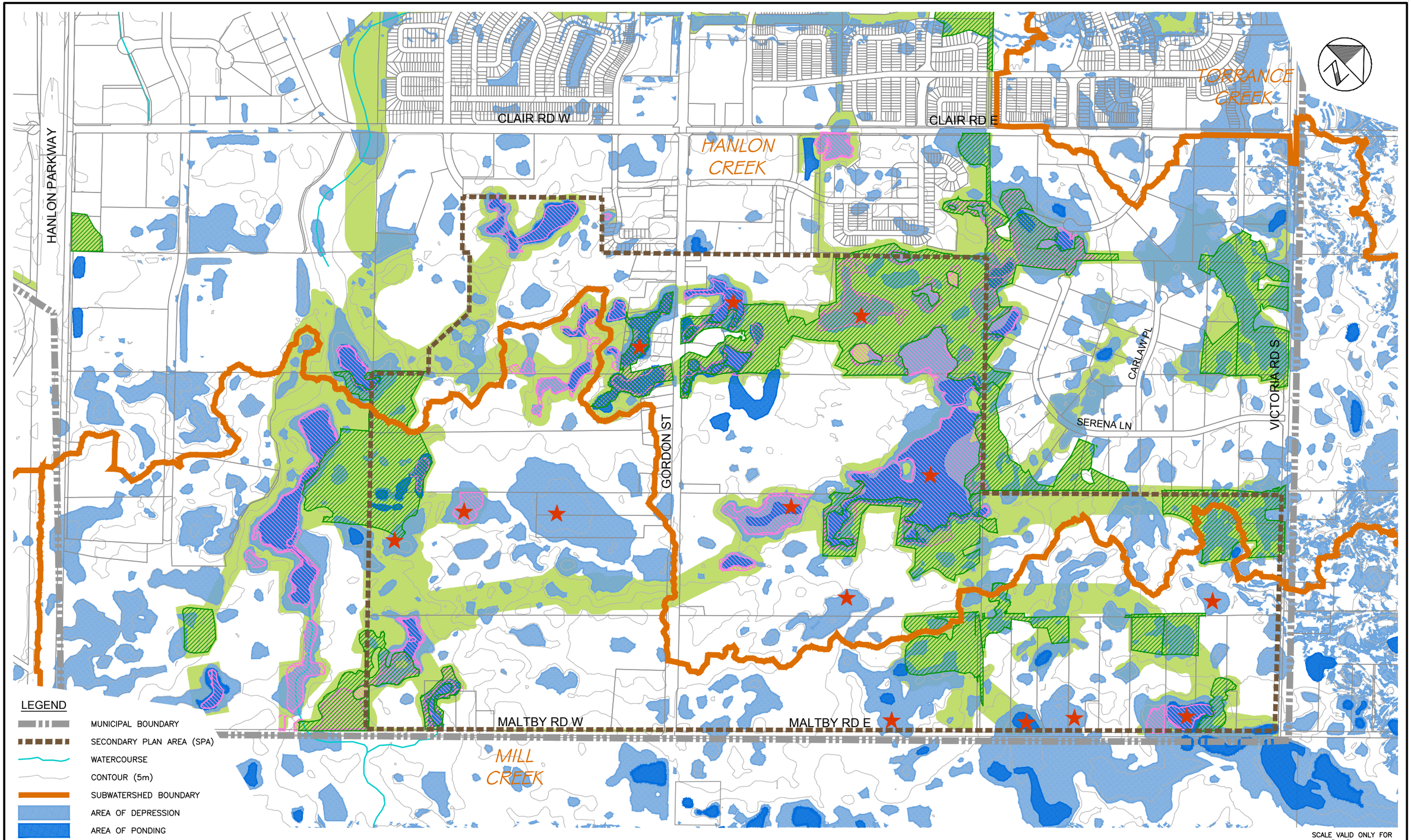
CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	**Initial Drainage Subcatchments**	wood.	Scale **1:14,000** (0 100 200 400 m) Project No. **TPB188065** Figure No. **HYD 5**

Legend

- Monitoring Locations
- Final Subcatchments
- Significant Depressional Features
- Roads
- Watercourse
- Overland Flow Route
- Secondary Plan Area (SPA)
- Primary Study Area (PSA)

LAIRD RD
CLAIRFIELDS DR W
GOSLING GS
CLAIRFIELDS DR E
FARLEY DR
BEAVER MEADOW DR
COLONIAL DR
GOODWIN DR
CLAIR RD W
CLAIR RD E
POPPY DR
FORESTELL RD
HANLON XY
SOUTHGATE DR
GORDON ST
Halls Pond
VICTORIA RD S
Maltby Rain Gauge
MALTBY RD W
MALTBY RD E

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	**shaded Relief**	wood.	Scale **1:14,000** 0 100 200 400 m Project No. **TPB188065** Figure No. **HYD 6**



SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	DEPRESSION AREAS WITH NATURAL HERITAGE SYSTEM (EXISTING CONDITION)	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. HYD7

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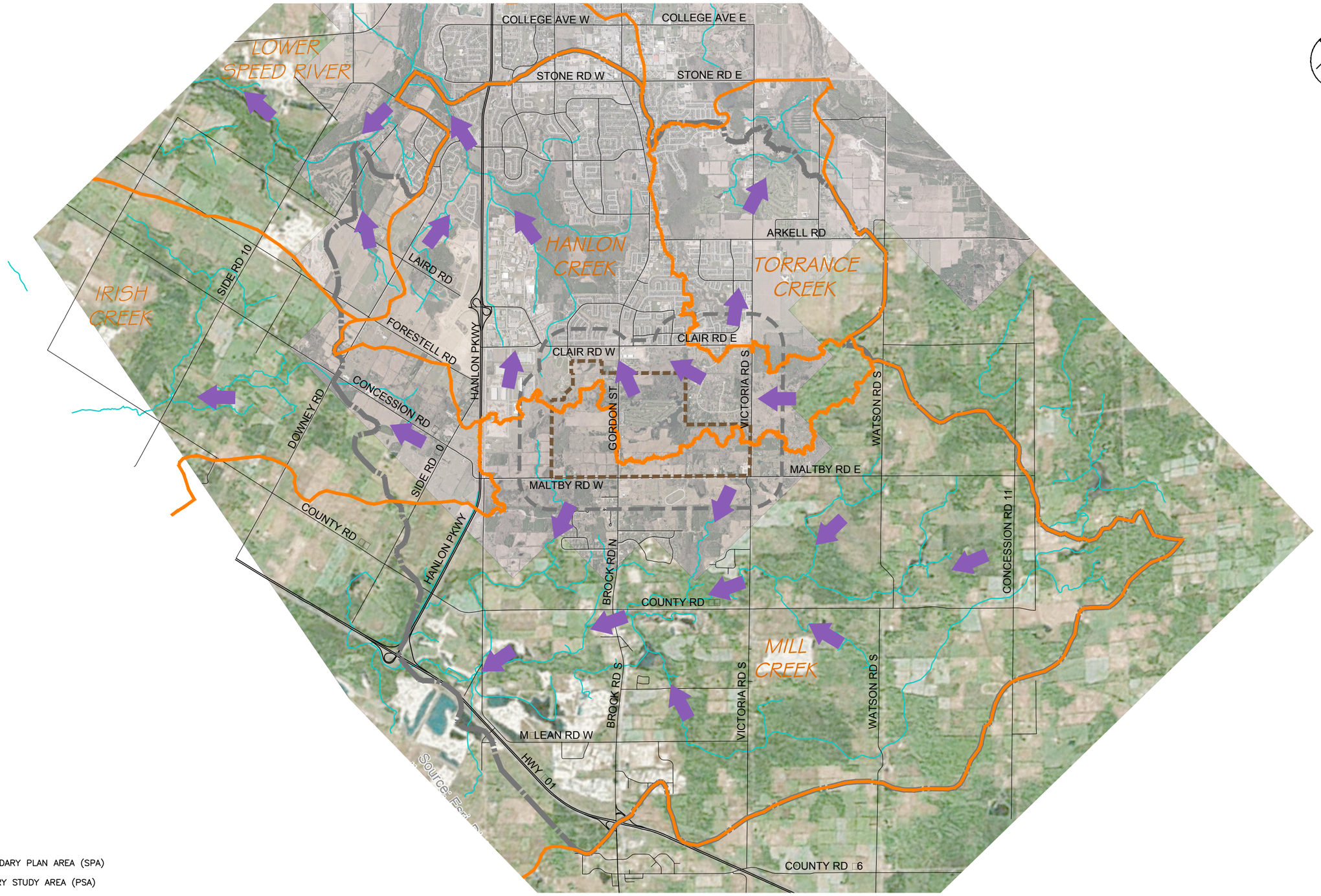
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2019-01-25
Last Saved: 2019-01-25



LEGEND

- SECONDARY PLAN AREA (SPA)
- PRIMARY STUDY AREA (PSA)
- SECONDARY STUDY AREA (SSA)
- SUBWATERSHED BOUNDARY
- WATERCOURSE
- ROADWAY
- MAJOR OVERLAND FLOW DIRECTION

Plotted: 2019-01-25
Last Saved: 2019-01-25
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\HYD8_DrainageAreaPattern.dwg

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

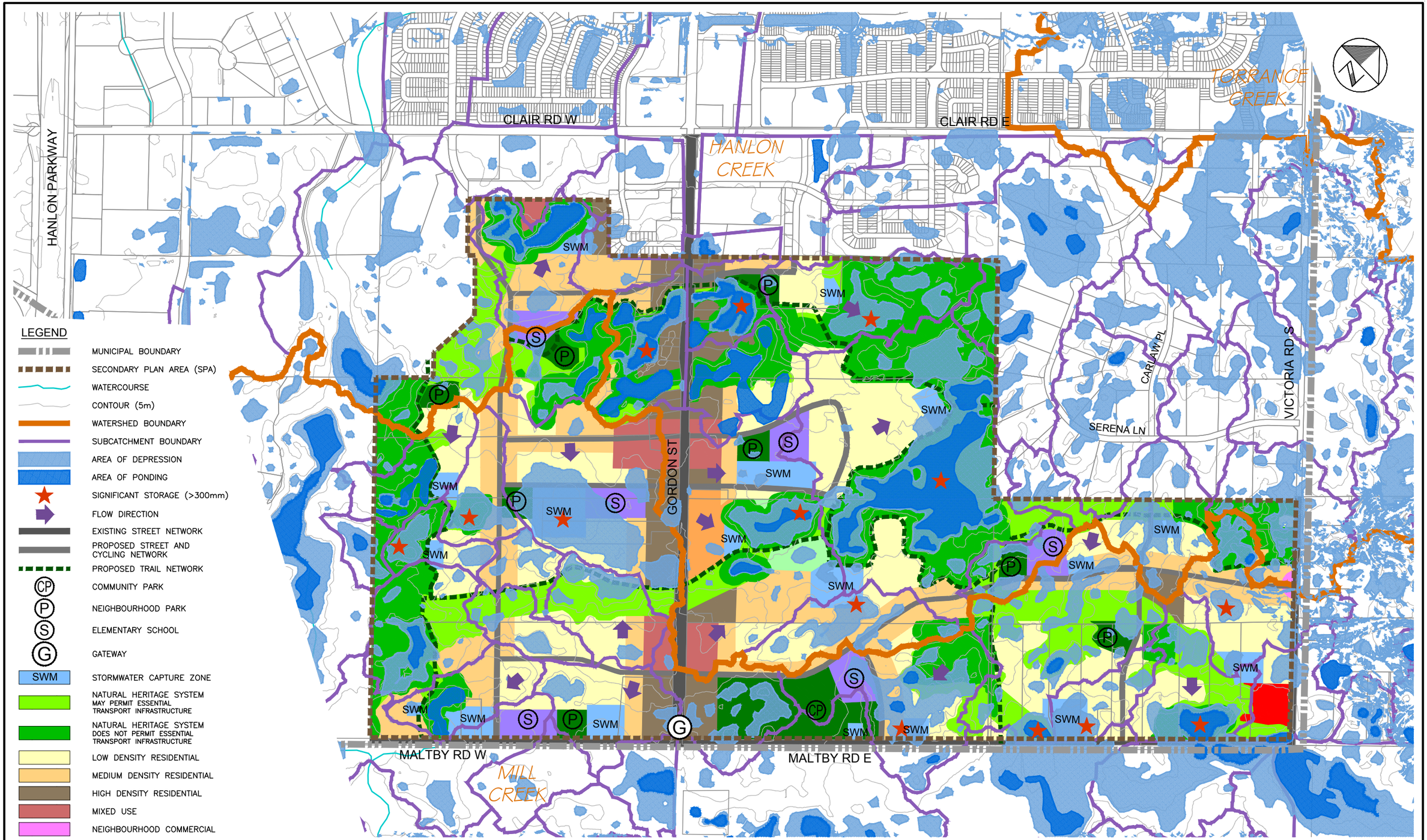
SUBWATERSHED DRAINAGE PATTERN PLAN

wood.

Scale 1:30000
0 250 500 1000

Consultant File No.
TPB168050

Figure No.
HYD8



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Last Saved By: mary.kelly
Plotted: 2019-03-05
Last Saved: 2019-03-05

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY
MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN
CITY OF GUELPH

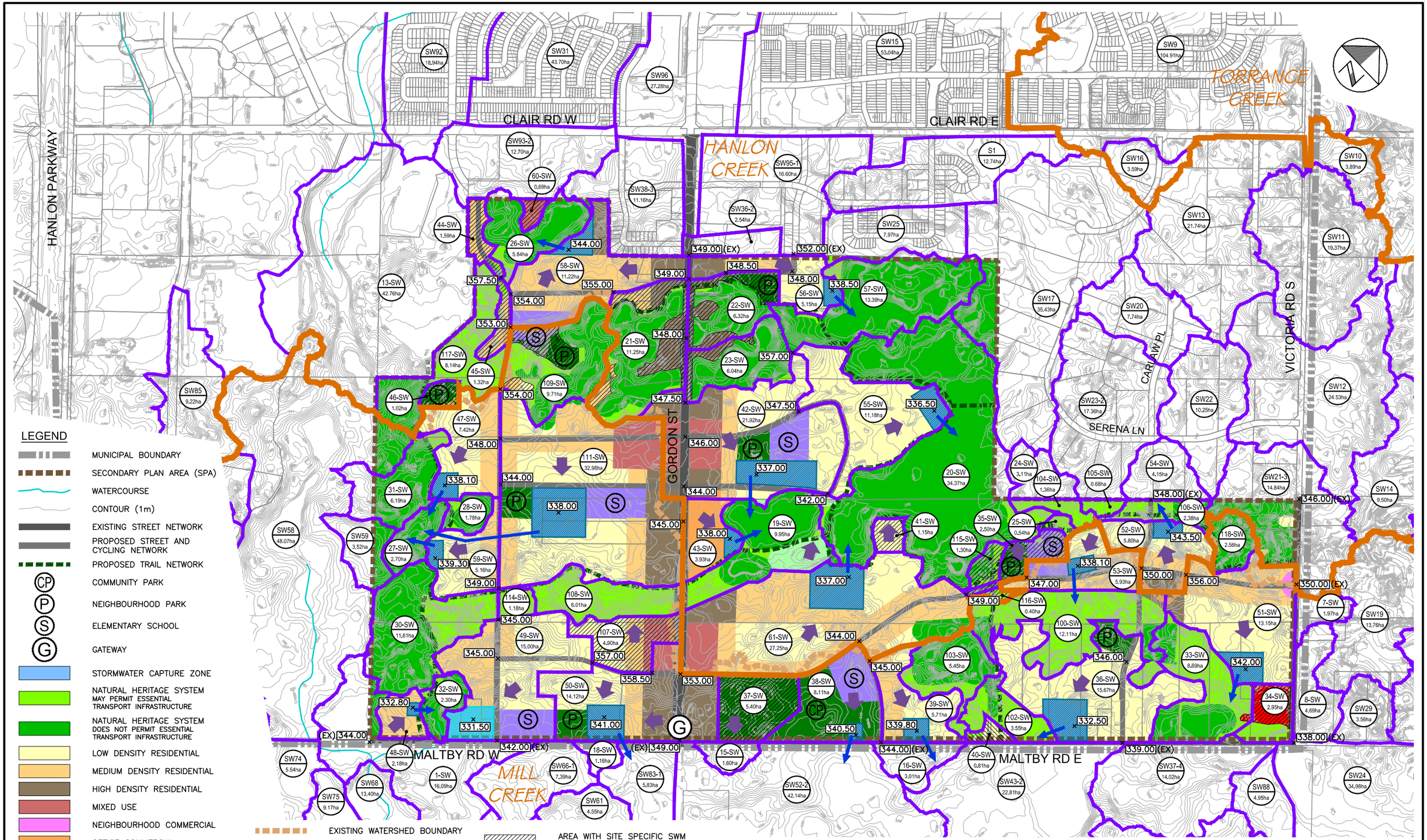
EXISTING DRAINAGE FEATURES AND CONCEPTUAL LAND USE PLAN

wood.

Scale 1:6000
0 50 100 200

Consultant File No.
TPB168050

Figure No.
IA-HYD1



LEGEND

- MUNICIPAL BOUNDARY
- SECONDARY PLAN AREA (SPA)
- WATERCOURSE
- CONTOUR (1m)
- EXISTING STREET NETWORK
- PROPOSED STREET AND CYCLING NETWORK
- PROPOSED TRAIL NETWORK
- (CP) COMMUNITY PARK
- (P) NEIGHBOURHOOD PARK
- (S) ELEMENTARY SCHOOL
- (G) GATEWAY
- STORMWATER CAPTURE ZONE
- NATURAL HERITAGE SYSTEM MAY PERMIT ESSENTIAL TRANSPORT INFRASTRUCTURE
- NATURAL HERITAGE SYSTEM DOES NOT PERMIT ESSENTIAL TRANSPORT INFRASTRUCTURE
- LOW DENSITY RESIDENTIAL
- MEDIUM DENSITY RESIDENTIAL
- HIGH DENSITY RESIDENTIAL
- MIXED USE
- NEIGHBOURHOOD COMMERCIAL
- OFFICE COMMERCIAL
- SERVICE COMMERCIAL
- SCHOOL
- PARK
- OPEN SPACE

- EXISTING WATERSHED BOUNDARY
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- 100-SW 12.11ha — SUBCATCHMENT ID# / SUBCATCHMENT AREA
- FLOW DIRECTION
- AREA WITH SITE SPECIFIC SWM (DRAINAGE AREA LESS THAN 5ha)
- CONCEPTUAL SWM FACILITY (CONVENTIONAL DESIGN)
- CONCEPTUAL SWM FACILITY (FULL CAPTURE)
- SWM FACILITY RELIEF OUTLET
- ×333.00 PROPOSED GRADE ELEVATION

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN

CITY OF GUELPH

PRELIMINARY CONCEPTUAL STORMWATER MANAGEMENT AND GRADING PLAN

wood.

Scale 1:6000 (0 50 100 200)

Consultant File No. TPB168050

Figure No. IA-HYD2

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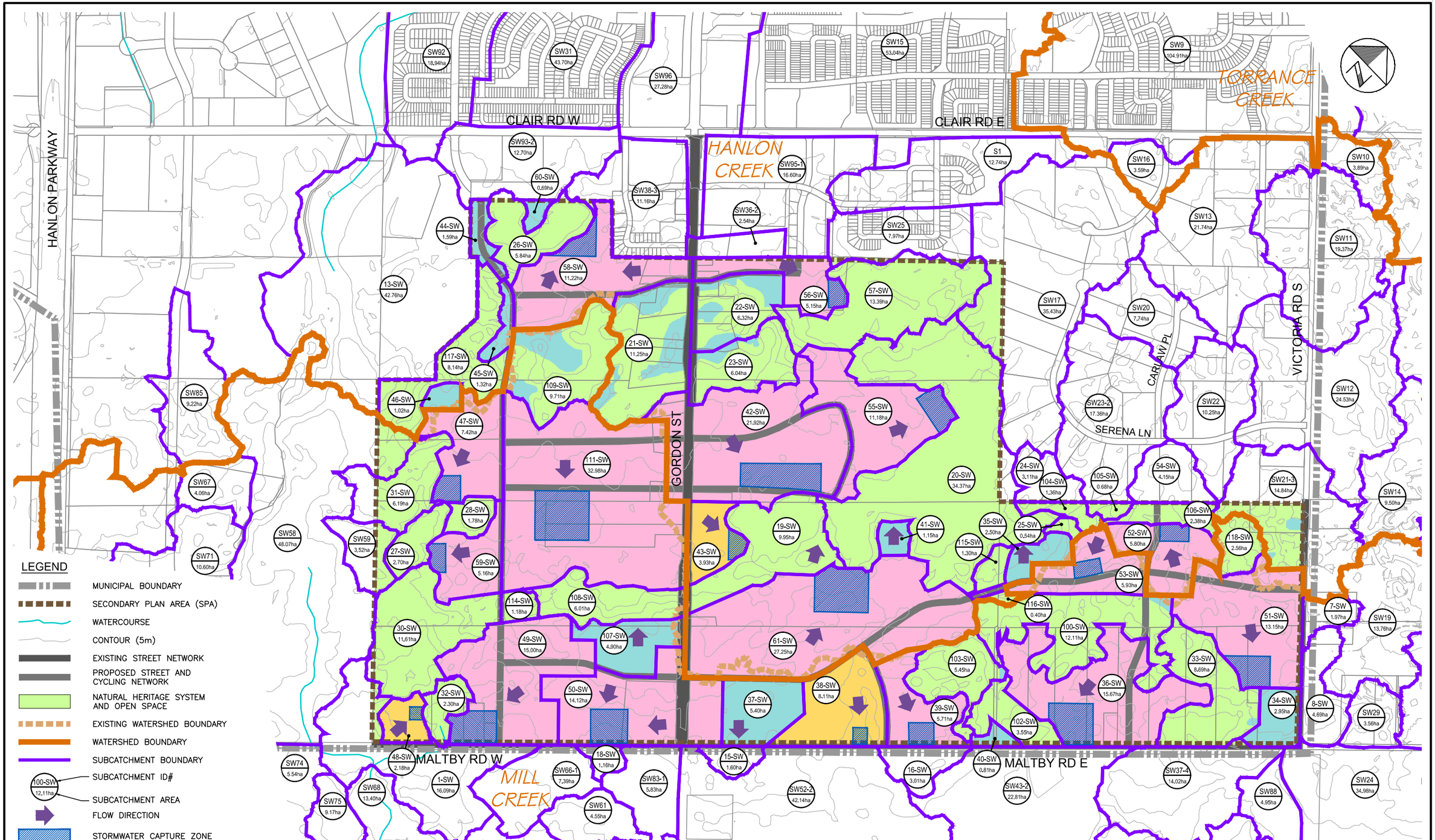
Last Saved By: richard.bartolo

Plotted: 2019-01-16
Last Saved: 2019-01-16



LEGEND

- MUNICIPAL BOUNDARY
- SECONDARY PLAN AREA (SPA)
- WATERCOURSE
- CONTOUR (5m)
- EXISTING STREET NETWORK
- PROPOSED STREET AND CYCLING NETWORK
- NATURAL HERITAGE SYSTEM AND OPEN SPACE
- EXISTING WATERSHED BOUNDARY
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID# (e.g. 100-SW)
- SUBCATCHMENT AREA (e.g. 12.11ha)
- FLOW DIRECTION
- STORMWATER CAPTURE ZONE

SURFACE WATER CAPTURE

- 27mm
- 27mm + 88mm (100 YEAR)
- 27mm + 285mm (REGIONAL)

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIR-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN AND SECONDARY PLAN CITY OF GUELPH	SURFACE WATER CAPTURE	wood.	Scale 1:6000 (0 50 100 200) Consultant File No. TPB168050 Figure No. IA-HYD3

Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2019-01\Fig\A-HYD3 StrmWtrCpt.dwg
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2019-01-16
Last Saved: 2019-01-16

Hanlon Subwatershed Annual Water Balance Under Future Land Use Conditions									
Year	**Precipitation (mm)**	**Baseflow (mm)**	**Starting Snow Depth (mm)**	**Infiltration (mm)**	**Evaporation (mm)**	**Ending Snow Depth (mm)**	**Outflow (mm)**	**Net (mm)**	**% Error**
1950	1,001.10	115.34	0.00	890.05	32.70	85.80	115.36	-7.46	-0.75%
1951	962.01	115.35	85.80	935.05	39.46	79.20	115.32	-5.87	-0.61%
1952	739.31	115.67	79.29	812.71	32.62	0.00	115.63	-26.70	-3.61%
1953	857.80	115.35	0.00	824.25	39.33	0.00	115.04	-5.46	-0.64%
1954	1,032.11	115.35	0.00	1,001.79	38.19	11.77	118.11	-22.40	-2.17%
1955	812.01	115.35	11.77	763.11	31.82	36.50	115.18	-7.49	-0.92%
1956	977.02	115.67	36.60	978.97	46.24	9.78	117.39	-23.09	-2.36%
1957	897.11	115.35	10.21	902.67	34.73	0.00	116.15	-30.87	-3.44%
1958	728.02	115.35	0.00	644.45	29.88	67.42	115.56	-13.93	-1.91%
1959	845.30	115.35	67.62	859.49	37.63	25.50	115.01	-9.35	-1.11%
1960	760.49	115.67	25.50	767.27	28.14	2.09	115.48	-11.31	-1.49%
1961	770.10	115.35	2.09	745.61	29.55	10.52	115.42	-13.56	-1.76%
1962	685.39	115.35	10.60	680.84	27.70	0.00	115.14	-12.33	-1.80%
1963	564.79	115.35	0.00	549.44	23.19	0.00	115.05	-7.54	-1.33%
1964	825.89	115.67	0.61	838.74	25.88	0.00	116.07	-38.51	-4.66%
1965	925.29	115.35	0.32	900.24	30.83	0.00	115.06	-5.17	-0.56%
1966	760.60	115.35	0.00	698.02	30.32	38.18	115.23	-5.79	-0.76%
1967	880.40	115.35	38.18	890.76	31.75	18.05	115.42	-22.04	-2.50%
1968	1,022.39	115.67	18.12	1,056.97	28.99	34.06	120.94	-84.78	-8.29%
1969	781.09	115.35	34.40	757.87	24.98	36.55	115.13	-3.69	-0.47%
1970	846.09	115.35	36.66	804.93	28.31	63.57	115.27	-13.98	-1.65%
1971	774.99	115.35	63.58	803.32	30.64	23.89	115.47	-19.39	-2.50%
1972	930.59	115.67	23.91	876.17	30.48	51.78	115.39	-3.64	-0.39%
1973	846.59	115.35	52.08	840.79	28.92	40.20	115.05	-10.93	-1.29%
1974	779.31	115.35	40.28	789.99	30.68	12.33	115.31	-13.37	-1.72%
1975	895.31	115.35	12.51	855.46	27.18	33.67	116.37	-9.50	-1.06%
1976	889.40	115.67	33.67	875.56	34.03	22.15	115.40	-8.40	-0.94%
1977	1,091.59	115.35	22.34	1,009.04	29.79	72.30	115.08	3.07	0.28%
1978	790.00	115.35	72.66	846.10	30.66	4.22	115.28	-18.25	-2.31%
1979	953.00	115.35	4.19	930.14	31.07	6.79	115.08	-10.55	-1.11%
1980	866.10	115.67	6.79	824.64	28.97	28.60	115.42	-9.08	-1.05%
1981	876.50	115.35	28.85	859.18	34.97	15.67	115.04	-4.15	-0.47%
1982	1,094.30	115.35	16.27	1,103.06	35.40	0.00	117.77	-30.31	-2.77%
1983	943.00	115.35	0.00	802.54	31.73	103.60	115.00	5.48	0.58%
1984	895.79	115.67	103.72	975.63	37.21	1.56	115.44	-14.65	-1.64%
1985	1,137.70	115.35	1.56	1,078.86	35.97	51.89	115.60	-27.70	-2.43%
1986	1,118.39	115.35	51.89	1,125.04	37.76	48.02	117.31	-42.49	-3.80%
1987	790.30	115.35	48.23	818.09	32.99	3.93	115.10	-16.23	-2.05%
1988	843.11	115.67	3.95	827.62	33.00	7.08	116.04	-21.01	-2.49%
1989	740.01	115.35	7.08	707.64	37.02	0.00	115.01	2.77	0.37%
1990	1,055.60	115.35	0.00	1,032.19	40.57	2.76	115.48	-20.05	-1.90%
1991	924.50	115.35	2.76	878.93	37.18	17.17	115.27	-5.93	-0.64%
1992	1,126.49	115.67	17.17	1,107.40	44.58	0.00	115.47	-8.11	-0.72%
1993	834.10	115.35	0.00	796.81	40.16	0.00	115.03	-2.55	-0.31%
1994	763.20	115.35	0.00	721.25	37.22	4.19	115.06	0.84	0.11%
1995	868.19	115.35	4.69	844.86	29.48	35.07	115.82	-36.99	-4.26%
1996	1,021.60	115.67	35.09	1,010.76	42.68	12.16	115.37	-8.61	-0.84%
1997	849.60	115.35	12.31	813.94	32.96	19.01	115.05	-3.71	-0.44%
1998	668.30	115.35	19.02	665.43	26.10	6.56	115.20	-10.61	-1.59%
1999	862.69	115.35	6.61	863.82	30.94	0.00	115.58	-25.69	-2.98%
2000	883.30	115.67	0.00	795.05	36.54	62.74	115.66	-11.02	-1.25%
2001	770.80	115.35	62.74	812.80	30.04	0.00	115.75	-9.69	-1.26%
2002	763.40	115.35	0.00	748.84	32.07	2.10	115.34	-19.60	-2.57%
2003	773.19	115.35	2.20	751.91	27.28	0.00	115.03	-3.47	-0.45%
2004	779.01	115.67	0.00	733.48	36.99	6.53	115.35	2.33	0.30%
2005	797.00	115.35	6.47	760.22	34.45	35.70	118.84	-30.37	-3.81%
2006	931.60	115.35	35.79	949.01	34.70	2.25	115.50	-18.73	-2.01%
2007	543.18	115.35	6.03	528.37	24.20	2.49	114.96	-5.45	-1.00%
2008	991.09	115.67	3.54	985.11	34.41	2.00	116.33	-27.54	-2.78%
2009	792.89	115.35	2.00	794.76	29.91	8.72	115.74	-38.88	-4.90%
2010	761.79	115.35	8.72	764.63	28.87	0.00	115.52	-23.15	-3.04%
2011	900.60	115.35	0.00	866.97	28.87	9.20	115.06	-4.14	-0.46%
2012	638.40	115.67	9.19	615.51	23.85	14.63	115.34	-6.06	-0.95%
2013	945.70	115.35	14.63	917.17	30.01	34.04	115.61	-21.15	-2.24%
2014	696.00	115.35	34.05	716.44	27.48	0.00	115.74	-14.25	-2.05%
2015	787.70	115.35	0.00	797.63	24.93	9.16	115.60	-44.27	-5.62%
2016	769.40	115.67	9.16	766.71	35.35	8.02	116.13	-31.98	-4.16%
2017	809.50	115.35	8.02	788.05	33.98	6.30	115.01	-10.47	-1.29%

Hanlon Subwatershed Annual Water Balance Under Future Land Use Conditions Summary									
	Precipitation (mm)	**Baseflow (mm)**	**Starting Snow Depth (mm)**	**Infiltration (mm)**	**Evaporation (mm)**	**Ending Snow Depth (mm)**	**Outflow (mm)**	**Net (mm)**	**% Error**
Mean	856.46	115.43	19.88	839.41	32.45	19.82	115.66	-15.57	-1.80%
Median	846.34	115.35	9.18	824.44	31.74	9.18	115.39	-11.17	-1.54%
Min	543.18	115.34	0.00	528.37	23.19	0.00	114.96	-84.78	-8.29%
Max	1137.70	115.67	103.72	1125.04	46.24	103.60	120.94	5.48	0.58%
Std Dev.	126.26	0.14	24.30	123.95	4.91	24.26	0.98	14.21	1.54%

Mill Creek Subwatershed Annual Water Balance Under Future Land Use Conditions									
Year	**Precipitation (mm)**	**Baseflow (mm)**	**Starting Snow Depth (mm)**	**Infiltration (mm)**	**Evaporation (mm)**	**Ending Snow Depth (mm)**	**Outflow (mm)**	**Net (mm)**	**% Error**
1950	1,001.10	24.69	0.00	895.85	17.74	85.80	35.02	-8.63	-0.86%
1951	962.01	24.69	85.80	937.38	21.29	79.20	34.46	0.18	0.02%
1952	739.31	24.76	79.29	815.51	17.56	0.00	32.66	-22.38	-3.03%
1953	857.80	24.69	0.00	829.78	20.91	0.00	32.04	-0.23	-0.03%
1954	1,032.11	24.69	0.00	1,001.21	20.71	11.77	40.96	-17.84	-1.73%
1955	812.01	24.69	11.77	766.11	17.14	36.50	32.05	-3.32	-0.41%
1956	977.02	24.76	36.60	984.62	24.99	9.78	37.19	-18.19	-1.86%
1957	897.11	24.69	10.21	901.96	18.77	0.00	36.22	-24.93	-2.78%
1958	728.02	24.69	0.00	650.40	16.05	67.42	30.97	-12.13	-1.67%
1959	845.30	24.69	67.62	865.28	20.00	25.50	32.45	-5.61	-0.66%
1960	760.49	24.76	25.50	775.82	15.15	2.09	32.26	-14.57	-1.92%
1961	770.10	24.69	2.09	748.28	15.67	10.52	31.31	-8.91	-1.16%
1962	685.39	24.69	10.60	685.04	14.74	0.00	30.51	-9.61	-1.40%
1963	564.79	24.69	0.00	552.63	12.36	0.00	29.35	-4.86	-0.86%
1964	825.89	24.76	0.61	835.69	13.98	0.00	33.60	-32.00	-3.87%
1965	925.29	24.69	0.32	901.82	16.45	0.00	33.39	-1.35	-0.15%
1966	760.60	24.69	0.00	702.18	16.10	38.18	31.73	-2.90	-0.38%
1967	880.40	24.69	38.18	891.14	17.08	18.05	34.19	-17.19	-1.95%
1968	1,022.39	24.76	18.12	1,040.71	15.94	34.06	44.09	-69.53	-6.80%
1969	781.09	24.69	34.40	757.62	13.41	36.55	32.38	0.21	0.03%
1970	846.09	24.69	36.66	805.04	15.00	63.57	32.44	-8.61	-1.02%
1971	774.99	24.69	63.58	807.90	16.52	23.89	33.11	-18.15	-2.34%
1972	930.59	24.76	23.91	877.83	16.29	51.78	33.28	0.08	0.01%
1973	846.59	24.69	52.08	840.50	15.27	40.20	33.11	-5.71	-0.67%
1974	779.31	24.69	40.28	792.58	16.23	12.33	32.49	-9.36	-1.20%
1975	895.31	24.69	12.51	849.99	14.58	33.67	34.69	-0.42	-0.05%
1976	889.40	24.76	33.67	877.41	17.76	22.15	32.77	-2.26	-0.25%
1977	1,091.59	24.69	22.34	1,006.49	15.64	72.30	35.59	8.60	0.79%
1978	790.00	24.69	72.66	843.52	16.13	4.22	32.39	-8.92	-1.13%
1979	953.00	24.69	4.19	928.80	16.32	6.79	34.35	-4.38	-0.46%
1980	866.10	24.76	6.79	825.97	15.17	28.60	32.46	-4.56	-0.53%
1981	876.50	24.69	28.85	861.65	18.33	15.67	32.20	2.19	0.25%
1982	1,094.30	24.69	16.27	1,098.01	19.11	0.00	39.67	-21.53	-1.97%
1983	943.00	24.69	0.00	804.78	16.93	103.60	31.74	10.64	1.13%
1984	895.79	24.76	103.72	976.19	19.95	1.56	34.30	-7.73	-0.86%
1985	1,137.70	24.69	1.56	1,077.16	19.51	51.89	37.13	-21.74	-1.91%
1986	1,118.39	24.69	51.89	1,125.11	20.69	48.02	38.46	-37.31	-3.34%
1987	790.30	24.69	48.23	819.68	17.56	3.93	32.04	-10.00	-1.26%
1988	843.11	24.76	3.95	831.81	17.56	7.08	32.91	-17.54	-2.08%
1989	740.01	24.69	7.08	715.22	19.66	0.00	30.40	6.50	0.88%
1990	1,055.60	24.69	0.00	1,038.84	21.70	2.76	34.90	-17.92	-1.70%
1991	924.50	24.69	2.76	882.77	20.05	17.17	33.83	-1.86	-0.20%
1992	1,126.49	24.76	17.17	1,109.71	23.67	0.00	35.28	-0.24	-0.02%
1993	834.10	24.69	0.00	803.60	21.24	0.00	31.64	2.31	0.28%
1994	763.20	24.69	0.00	727.28	19.88	4.19	30.40	6.14	0.80%
1995	868.19	24.69	4.69	850.44	15.89	35.07	33.95	-37.77	-4.35%
1996	1,021.60	24.76	35.09	1,016.53	22.66	12.16	33.89	-3.79	-0.37%
1997	849.60	24.69	12.31	816.35	17.63	19.01	32.40	1.20	0.14%
1998	668.30	24.69	19.02	669.37	13.94	6.56	30.74	-8.59	-1.29%
1999	862.69	24.69	6.61	864.93	16.76	0.00	33.83	-21.52	-2.49%
2000	883.30	24.76	0.00	802.79	19.60	62.74	32.16	-9.24	-1.05%
2001	770.80	24.69	62.74	811.22	16.12	0.00	33.23	-2.33	-0.30%
2002	763.40	24.69	0.00	754.66	17.29	2.10	32.00	-17.97	-2.35%
2003	773.19	24.69	2.20	753.85	14.60	0.00	31.42	0.21	0.03%
2004	779.01	24.76	0.00	737.65	19.65	6.53	30.90	9.04	1.16%
2005	797.00	24.69	6.47	747.39	19.02	35.70	40.33	-14.27	-1.79%
2006	931.60	24.69	35.79	951.06	18.52	2.25	35.35	-15.09	-1.62%
2007	543.18	24.69	6.03	534.82	12.34	2.49	28.59	-4.34	-0.80%
2008	991.09	24.76	3.54	984.63	18.45	2.00	34.75	-20.44	-2.06%
2009	792.89	24.69	2.00	794.19	15.83	8.72	32.87	-32.03	-4.04%
2010	761.79	24.69	8.72	763.72	15.64	0.00	32.68	-16.85	-2.21%
2011	900.60	24.69	0.00	862.74	14.78	9.20	32.74	5.83	0.65%
2012	638.40	24.76	9.19	617.57	12.59	14.63	29.95	-2.39	-0.37%
2013	945.70	24.69	14.63	914.73	15.85	34.04	34.14	-13.75	-1.45%
2014	696.00	24.69	34.05	718.14	14.61	0.00	32.05	-10.06	-1.45%
2015	787.70	24.69	0.00	797.64	13.48	9.16	32.25	-40.14	-5.10%
2016	769.40	24.76	9.16	769.60	19.08	8.02	32.02	-25.40	-3.30%
2017	809.50	24.69	8.02	796.14	17.91	6.30	31.56	-9.71	-1.20%

Mill Creek Subwatershed Annual Water Balance Under Future Land Use Conditions Summary									
	Precipitation (mm)	**Baseflow (mm)**	**Starting Snow Depth (mm)**	**Infiltration (mm)**	**Evaporation (mm)**	**Ending Snow Depth (mm)**	**Outflow (mm)**	**Net (mm)**	**% Error**
Mean	856.46	24.71	19.88	841.13	17.34	19.82	33.41	-10.66	-1.23%
Median	846.34	24.69	9.18	827.87	17.01	9.18	32.71	-8.77	-1.09%
Min	543.18	24.69	0.00	534.82	12.34	0.00	28.59	-69.53	-6.80%
Max	1137.70	24.76	103.72	1125.11	24.99	103.60	44.09	10.64	1.16%
Std Dev.	126.26	0.03	24.30	122.50	2.67	24.26	2.68	13.43	1.48%

Torrance Creek Subwatershed Annual Water Balance Under Future Land Use Conditions									
Year	**Precipitation (mm)**	**Baseflow (mm)**	**Starting Snow Depth (mm)**	**Infiltration (mm)**	**Evaporation (mm)**	**Ending Snow Depth (mm)**	**Outflow (mm)**	**Net (mm)**	**% Error**
1950	1,001.10	0.00	0.00	855.66	41.75	85.80	34.18	-16.30	-1.63%
1951	962.01	0.00	85.80	896.87	50.01	79.20	31.65	-9.91	-1.03%
1952	739.31	0.00	79.29	777.79	41.15	0.00	27.51	-27.86	-3.77%
1953	857.80	0.00	0.00	795.25	50.52	0.00	23.43	-11.39	-1.33%
1954	1,032.11	0.00	0.00	929.39	48.18	11.77	52.93	-10.16	-0.98%
1955	812.01	0.00	11.77	729.09	39.84	36.50	24.40	-6.06	-0.75%
1956	977.02	0.00	36.60	920.04	58.40	9.78	42.34	-16.94	-1.73%
1957	897.11	0.00	10.21	853.30	44.31	0.00	38.44	-28.72	-3.20%
1958	728.02	0.00	0.00	620.69	37.82	67.42	20.98	-18.90	-2.60%
1959	845.30	0.00	67.62	827.24	47.70	25.50	24.57	-12.08	-1.43%
1960	760.49	0.00	25.50	748.27	36.41	2.09	25.18	-25.95	-3.41%
1961	770.10	0.00	2.09	714.62	38.21	10.52	22.98	-14.14	-1.84%
1962	685.39	0.00	10.60	655.30	35.41	0.00	20.04	-14.75	-2.15%
1963	564.79	0.00	0.00	533.64	30.07	0.00	16.04	-14.95	-2.65%
1964	825.89	0.00	0.61	791.01	33.19	0.00	32.21	-29.91	-3.62%
1965	925.29	0.00	0.32	871.68	39.14	0.00	27.17	-12.38	-1.34%
1966	760.60	0.00	0.00	665.82	38.59	38.18	23.78	-5.76	-0.76%
1967	880.40	0.00	38.18	850.67	40.98	18.05	33.45	-24.56	-2.79%
1968	1,022.39	0.00	18.12	958.84	37.07	34.06	59.22	-48.68	-4.76%
1969	781.09	0.00	34.40	723.85	31.85	36.55	24.68	-1.44	-0.18%
1970	846.09	0.00	36.66	779.85	37.06	63.57	24.84	-22.57	-2.67%
1971	774.99	0.00	63.58	777.40	39.26	23.89	28.94	-30.92	-3.99%
1972	930.59	0.00	23.91	843.05	39.21	51.78	27.64	-7.17	-0.77%
1973	846.59	0.00	52.08	817.08	37.51	40.20	26.17	-22.29	-2.63%
1974	779.31	0.00	40.28	758.36	39.94	12.33	27.97	-19.02	-2.44%
1975	895.31	0.00	12.51	812.53	35.54	33.67	36.88	-10.80	-1.21%
1976	889.40	0.00	33.67	853.20	44.26	22.15	24.15	-20.68	-2.33%
1977	1,091.59	0.00	22.34	981.43	39.61	72.30	31.62	-11.03	-1.01%
1978	790.00	0.00	72.66	812.33	39.81	4.22	26.95	-20.66	-2.62%
1979	953.00	0.00	4.19	897.71	40.87	6.79	30.20	-18.38	-1.93%
1980	866.10	0.00	6.79	809.95	38.22	28.60	23.80	-27.69	-3.20%
1981	876.50	0.00	28.85	833.32	45.80	15.67	23.39	-12.82	-1.46%
1982	1,094.30	0.00	16.27	1,051.46	46.09	0.00	49.99	-36.98	-3.38%
1983	943.00	0.00	0.00	773.57	40.41	103.60	21.95	3.46	0.37%
1984	895.79	0.00	103.72	949.47	47.69	1.56	30.63	-29.83	-3.33%
1985	1,137.70	0.00	1.56	1,028.69	46.30	51.89	40.93	-28.54	-2.51%
1986	1,118.39	0.00	51.89	1,057.66	48.58	48.02	49.91	-33.89	-3.03%
1987	790.30	0.00	48.23	787.01	42.88	3.93	24.50	-19.80	-2.50%
1988	843.11	0.00	3.95	793.88	43.22	7.08	27.66	-24.79	-2.94%
1989	740.01	0.00	7.08	685.18	47.52	0.00	18.38	-4.00	-0.54%
1990	1,055.60	0.00	0.00	986.21	51.70	2.76	33.46	-18.53	-1.75%
1991	924.50	0.00	2.76	847.34	48.05	17.17	30.46	-15.76	-1.70%
1992	1,126.49	0.00	17.17	1,069.55	57.39	0.00	34.75	-18.03	-1.60%
1993	834.10	0.00	0.00	769.29	51.65	0.00	21.12	-7.97	-0.96%
1994	763.20	0.00	0.00	698.49	47.35	4.19	18.93	-5.75	-0.75%
1995	868.19	0.00	4.69	798.34	38.17	35.07	34.41	-33.11	-3.81%
1996	1,021.60	0.00	35.09	979.24	54.22	12.16	28.76	-17.68	-1.73%
1997	849.60	0.00	12.31	791.22	41.82	19.01	23.42	-13.57	-1.60%
1998	668.30	0.00	19.02	643.07	33.33	6.56	21.13	-16.77	-2.51%
1999	862.69	0.00	6.61	821.24	39.79	0.00	33.86	-25.59	-2.97%
2000	883.30	0.00	0.00	770.54	47.28	62.74	26.48	-23.75	-2.69%
2001	770.80	0.00	62.74	776.37	37.98	0.00	29.91	-10.72	-1.39%
2002	763.40	0.00	0.00	722.57	40.47	2.10	23.06	-24.80	-3.25%
2003	773.19	0.00	2.20	727.54	34.57	0.00	21.69	-8.41	-1.09%
2004	779.01	0.00	0.00	710.07	47.10	6.53	20.01	-4.70	-0.60%
2005	797.00	0.00	6.47	687.43	43.49	35.70	49.23	-12.36	-1.55%
2006	931.60	0.00	35.79	905.76	44.70	2.25	32.58	-17.90	-1.92%
2007	543.18	0.00	6.03	507.78	32.67	2.49	13.18	-6.91	-1.27%
2008	991.09	0.00	3.54	944.10	44.38	2.00	33.65	-29.49	-2.98%
2009	792.89	0.00	2.00	748.96	39.15	8.72	29.25	-31.19	-3.93%
2010	761.79	0.00	8.72	722.53	37.20	0.00	28.32	-17.54	-2.30%
2011	900.60	0.00	0.00	851.56	38.94	9.20	24.65	-23.74	-2.64%
2012	638.40	0.00	9.19	600.82	31.10	14.63	16.18	-15.13	-2.37%
2013	945.70	0.00	14.63	885.30	39.48	34.04	30.44	-28.93	-3.06%
2014	696.00	0.00	34.05	683.90	35.61	0.00	24.76	-14.22	-2.04%
2015	787.70	0.00	0.00	756.89	32.16	9.16	27.63	-38.14	-4.84%
2016	769.40	0.00	9.16	725.04	44.63	8.02	28.18	-27.31	-3.55%
2017	809.50	0.00	8.02	761.98	43.84	6.30	21.79	-16.40	-2.03%

Torrance Creek Subwatershed Annual Water Balance Under Future Land Use Conditions Summary									
	Precipitation (mm)	**Baseflow (mm)**	**Starting Snow Depth (mm)**	**Infiltration (mm)**	**Evaporation (mm)**	**Ending Snow Depth (mm)**	**Outflow (mm)**	**Net (mm)**	**% Error**
Mean	856.46	0.00	19.88	804.64	41.74	19.82	28.87	-18.73	-2.19%
Median	846.34	0.00	9.18	792.55	40.44	9.18	27.57	-17.79	-2.23%
Min	543.18	0.00	0.00	507.78	30.07	0.00	13.18	-48.68	-4.84%
Max	1137.70	0.00	103.72	1069.55	58.40	103.60	59.22	3.46	0.37%
Std Dev.	126.26	0.00	24.30	116.42	6.10	24.26	8.73	9.73	1.09%

Mill Creek Monitoring Site Frequency Analysis

Year	Max Flow (m^3/s)
1950	0.06009
1951	0.05490
1952	0.04537
1953	0.04276
1954	0.28127
1955	0.05323
1956	0.09179
1957	0.06633
1958	0.05229
1959	0.04099
1960	0.04514
1961	0.06354
1962	0.04257
1963	0.04158
1964	0.07205
1965	0.03595
1966	0.05636
1967	0.06063
1968	0.48446
1969	0.04942
1970	0.05240
1971	0.05786
1972	0.03552
1973	0.04440
1974	0.05764
1975	0.07807
1976	0.03559
1977	0.04390
1978	0.04484
1979	0.04952
1980	0.03480
1981	0.03501
1982	0.11608
1983	0.03405
1984	0.04322
1985	0.05447
1986	0.05800
1987	0.04559
1988	0.08438
1989	0.03368
1990	0.05583
1991	0.05601
1992	0.04999
1993	0.04137
1994	0.03913
1995	0.05775
1996	0.03162
1997	0.03892
1998	0.04228
1999	0.05726
2000	0.04525
2001	0.05656
2002	0.04230
2003	0.03092
2004	0.03960
2005	0.71298
2006	0.07239
2007	0.03357
2008	0.06628
2009	0.07377
2010	0.05405
2011	0.03486
2012	0.05313
2013	0.06071
2014	0.06623
2015	0.04898
2016	0.07995
2017	0.03146

Log Pearson Type III Distribution

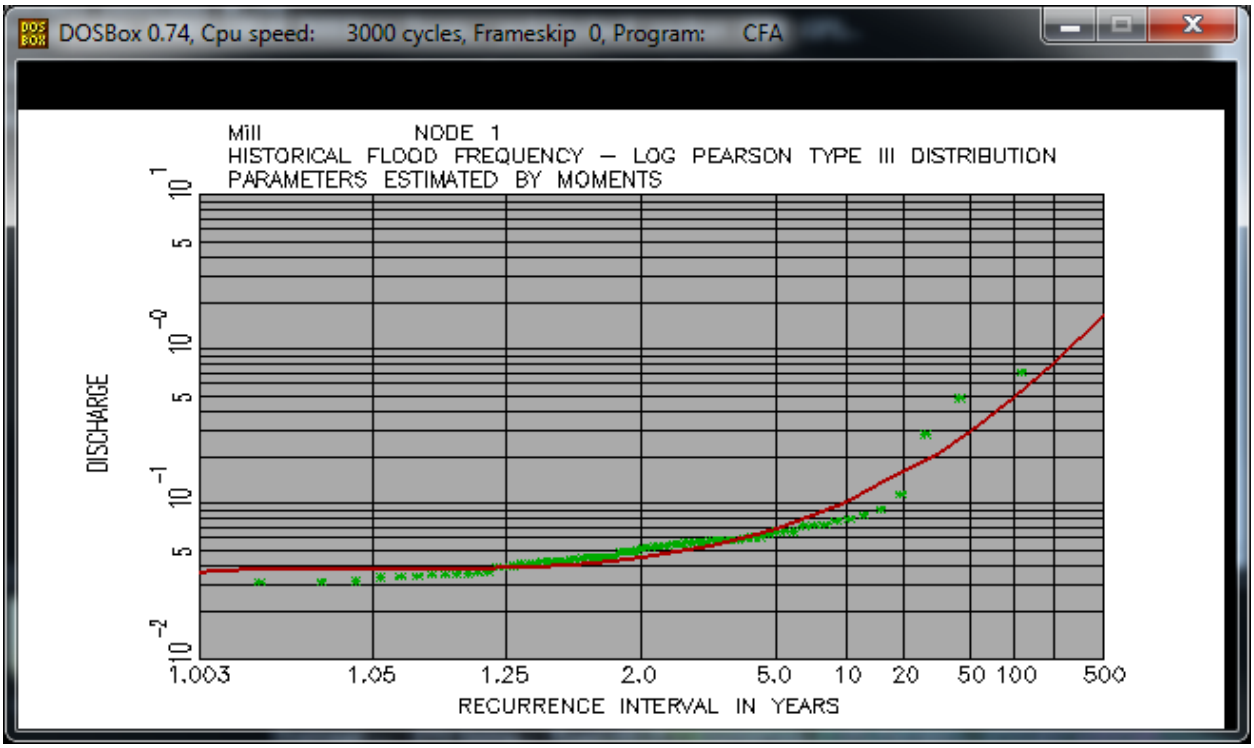
DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: CFA

SOLUTION OBTAINED VIA MOMENTS
LP3 PARAMETERS: A= 0.7988 B= 0.4615 LOG(M)= -3.270
M = 0.3801E-01

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	0.035
1.050	0.952	0.038
1.250	0.800	0.039
2.000	0.500	0.045
5.000	0.200	0.069
10.000	0.100	0.100
20.000	0.050	0.160
50.000	0.020	0.290
100.000	0.010	0.480
200.000	0.005	0.810
500.000	0.002	1.66

Press RETURN to continue_



Hanlon Creek Monitoring Site Frequency Analysis

Year	Max Flow (m^3/s)
1950	0.31004
1951	0.35893
1952	0.28474
1953	0.07937
1954	0.66417
1955	0.26283
1956	0.67035
1957	0.63389
1958	0.58072
1959	0.03000
1960	0.13617
1961	0.61088
1962	0.19427
1963	0.12577
1964	0.65856
1965	0.11470
1966	0.30043
1967	0.47275
1968	0.70589
1969	0.18603
1970	0.15832
1971	0.32240
1972	0.06001
1973	0.10758
1974	0.34126
1975	0.64528
1976	0.02999
1977	0.07522
1978	0.33199
1979	0.14402
1980	0.10908
1981	0.05360
1982	0.67426
1983	0.03146
1984	0.14590
1985	0.62020
1986	0.56719
1987	0.14277
1988	0.64111
1989	0.02999
1990	0.28388
1991	0.37448
1992	0.15284
1993	0.05992
1994	0.11964
1995	0.38013
1996	0.09486
1997	0.06069
1998	0.20663
1999	0.57468
2000	0.23739
2001	0.18629
2002	0.25726
2003	0.05022
2004	0.04006
2005	0.68218
2006	0.61286
2007	0.03560
2008	0.63299
2009	0.66247
2010	0.59460
2011	0.11214
2012	0.10946
2013	0.61326
2014	0.60305
2015	0.28560
2016	0.65554
2017	0.07056

Log Pearson Type III Distribution

DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: CFA

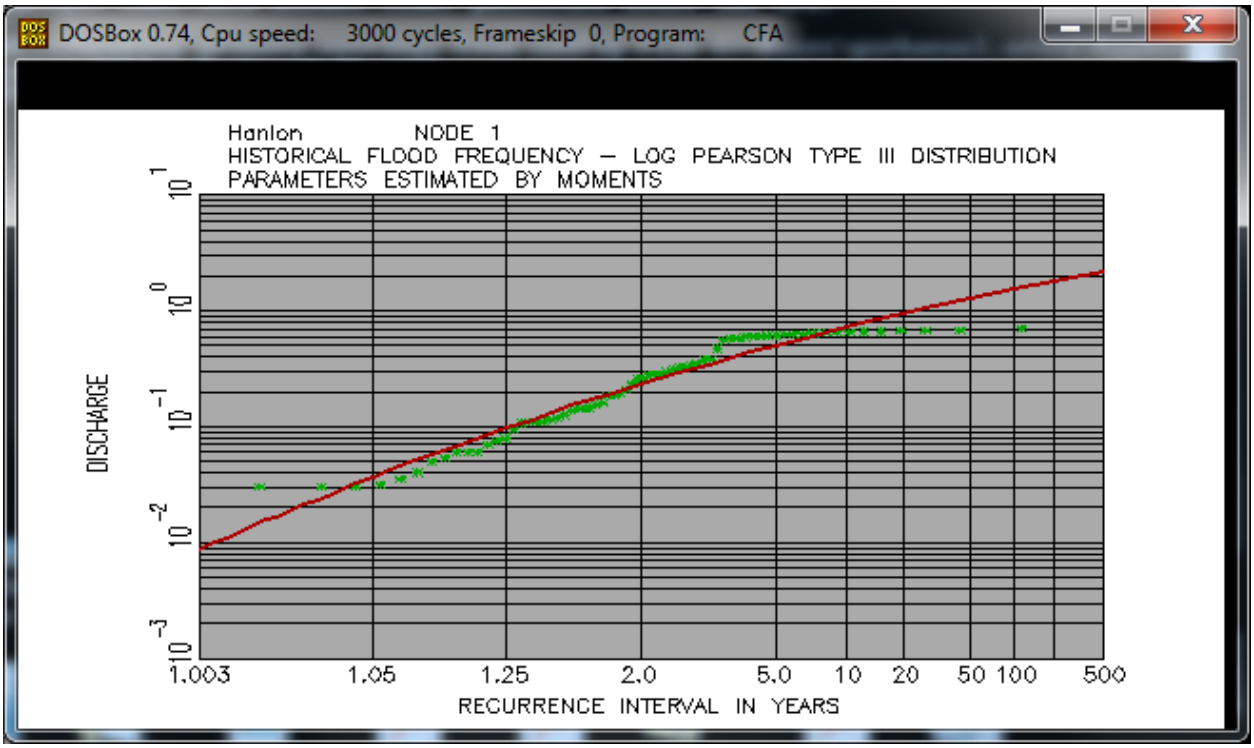
SOLUTION OBTAINED VIA MOMENTS
DISTRIBUTION IS UPPER BOUNDED AT M= 15.62
LP3 PARAMETERS: A=-0.2267 B= 18.95 LOG(M)= 2.748
M = 15.62

FLOOD FREQUENCY REGIME

RETURN PERIOD	EXCEEDANCE PROBABILITY	FLOOD
1.003	0.997	0.009
1.050	0.952	0.036
1.250	0.800	0.096
2.000	0.500	0.230
5.000	0.200	0.490
10.000	0.100	0.710
20.000	0.050	0.940
50.000	0.020	1.26
100.000	0.010	1.51
200.000	0.005	1.78
500.000	0.002	2.14

Press RETURN to continue

DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: CFA



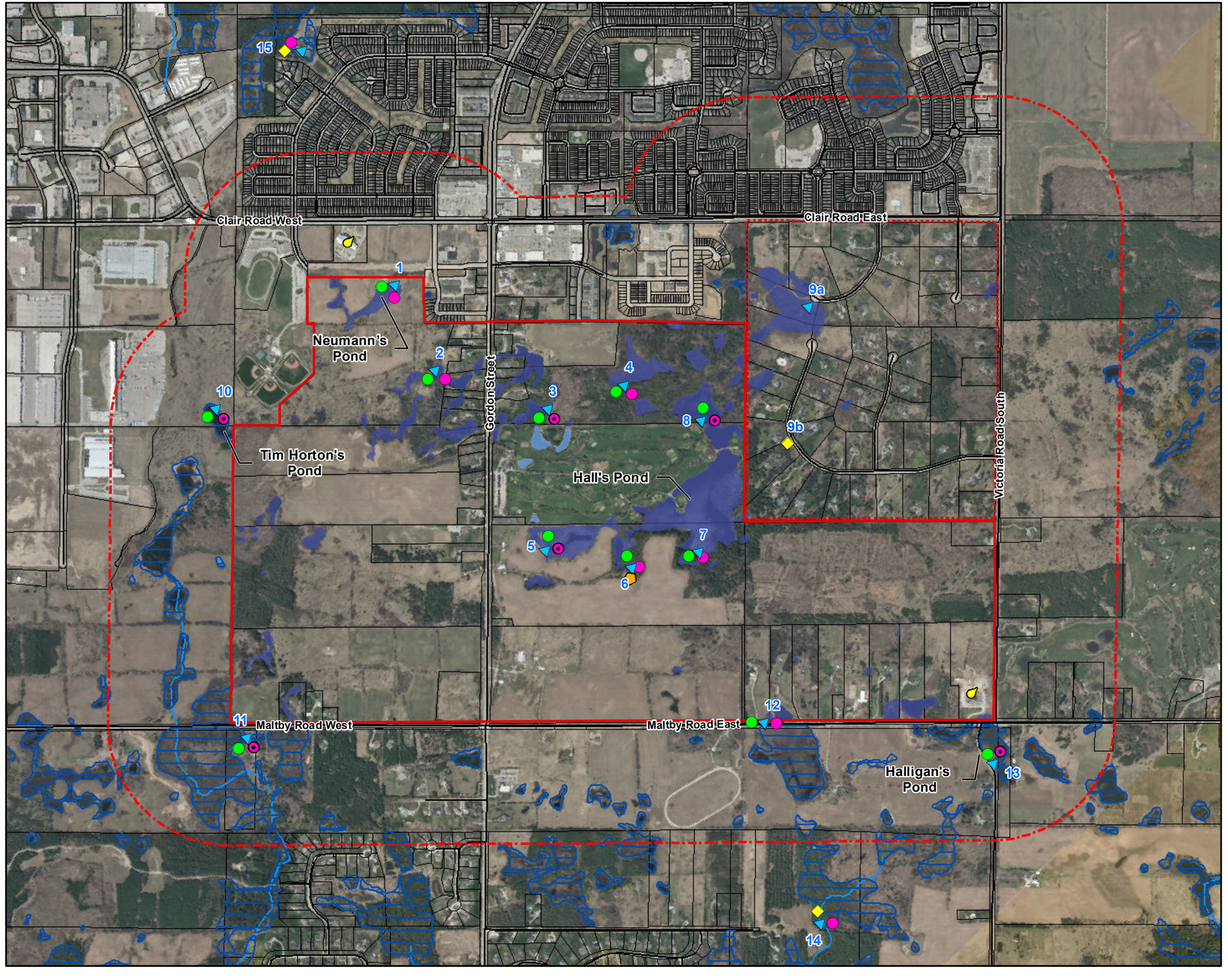
Side slope for SWM 5:1

									Regional Storm		
WS Name	**SWM Name**	**Imperviousness (%)**	**Routed Through Pervious(%)**	**Total Drainage Area (m2)**	**SWM Top Area (m2)**	**SWM Base Area (m2)**	**Sizing Storm**	**Total Volume of the SWM**	**Maximum Sorage Volume (m3)**	**Depth (m)**	**Wier Flow (cms)**
43_SW	43STN	83.3	1.3	39,338	3,131	853	100 Y	4,981	NA	>2.5	1
38_SW	38STN	46.1	25.7	81,110	3,100	457	100 Y	4,446	NA	>2.6	1
48_SW	48STN	69.8	30.2	21,772	2,500	68	100 Y	3,210	NA	>2.7	<1
36_SW	36STN	55.6	43.8	156,722	15,421	9,833	Regional	31,568	20,460	1.74	0.00
39_SW	39STN	61.2	40.1	57,073	4,469	1,740	Regional	7,761	4,822	1.78	0.00
42_SW	42STN	63.0	28.6	219,233	18,620	11,023	Regional	37,054	32,390	2.24	0.00
47_SW	47STN	60.5	41.3	74,160	6,211	2,896	Regional	11,383	10,640	2.38	0.00
49_SW	49STN	60.6	39.5	149,985	13,347	8,084	Regional	26,789	20,920	2.04	0.00
50_SW	50STN	63.3	23.8	141,207	11,646	6,870	Regional	23,146	21,260	2.34	0.00
51_SW	51STN	62.2	37.4	131,519	10,029	5,646	Regional	19,593	19,250	2.47	0.00
52_SW	52STN	62.3	34.6	57,957	5,300	2,227	Regional	9,409	8,590	2.34	0.00
53_SW	53STN	61.5	34.9	59,263	5,144	2,169	Regional	9,142	8,750	2.42	0.00
55_SW	55STN	59.5	44.5	111,791	8,559	4,442	Regional	16,251	15,770	2.44	0.00
56_SW	56STN	62.3	34.7	51,488	4,600	1,781	Regional	7,976	7,688	2.44	0.00
58_SW	58STN	65.7	28.8	112,218	9,350	5,128	Regional	18,098	17,230	2.41	0.00
59_SW	59STN	60.7	40.6	51,638	4,597	1,772	Regional	7,962	7,503	2.40	0.00
61_SW	61STN	61.4	37.1	272,488	22,689	15,638	Regional	47,908	38,280	2.06	0.00
111_SW	111STN	57.9	37.4	329,750	29,339	21,391	Regional	63,413	44,320	1.82	0.00

SubCatchments				LID Storages	
Name	Outlet	Area (ha)	Imperv. (%)	Volume m3 (27mm	Coefficient m2 (Area)
21_SW	21STN	11.2515	47.979	1457.55644	4858.521467
22_SW	22STN	6.32061	43.309	739.0961059	2463.653686
23_SW	23STN	6.04058	33.495	546.2889132	1820.963044
34_SW	34STN	2.95082	61.967	493.7043499	1645.681166
35_SW	20STN	2.50387	46.21	312.4003483	1041.334494
36_SW	36STN	15.6722	55.65	2354.826411	7849.42137
37_SW	15STN	5.40176	37.38	545.1780298	1817.260099
38_SW	38STN	8.11102	46.07	1008.921667	3363.072223
39_SW	39STN	5.70733	61.171	942.6323253	3142.107751
40_SW	102STN	0.811033	56.605	123.953012	413.1767067
41_SW	20STN	1.15436	64.366	200.6141466	668.7138218
42_SW	42STN	21.9233	63.002	3729.271716	12430.90572
43_SW	43STN	3.93381	83.348	885.2630289	2950.876763
44_SW	26STN	1.58752	63.391	271.7130969	905.7103229
45_SW	117STN	1.32074	57.564	205.2731089	684.2436962
46_SW	117STN	1.02052	19.974	55.0364395	183.4547983
47_SW	47STN	7.41604	60.458	1210.569155	4035.230517
48_SW	48STN	2.1772	69.806	410.3503826	1367.834609
49_SW	49STN	14.9985	60.61	2454.45953	8181.531765
50_SW	50STN	14.1207	63.34	2414.893873	8049.646242
51_SW	51STN	13.1519	62.173	2207.771312	7359.237708
52_SW	52STN	5.79568	62.31	975.0478162	3250.159387
53_SW	53STN	5.92632	61.462	983.4573956	3278.191319
55_SW	55STN	11.1791	59.456	1794.594338	5981.981126
56_SW	56STN	5.1488	62.326	866.4410938	2888.136979
58_SW	58STN	11.2218	65.74	1991.847056	6639.490188
59_SW	59STN	5.1673	60.653	846.2130666	2820.710222
60_SW	26STN	0.693598	87.592	164.0348172	546.7827241
61_SW	61STN	27.2488	61.407	4517.821066	15059.40355
107_SW	108STN	4.90477	72.237	956.6258503	3188.752834
109_SW	109STN	9.71318	18.977	497.6829455	1658.943152
111_SW	111STN	32.975	57.871	5152.399808	17174.66603

Appendix D

Surface Water Quality



Surface Water Monitoring Locations

Map SW-1

Clair-Maltby Secondary Plan
Comprehensive Environmental Impact Study (CEIS)

Legend

- Primary Study Area
- Secondary Plan Area
- Rolling Hills Community
- Parcel Fabric

Monitoring Stations

- Surface Water Quality*
- Surface Water Quality* + Pesticides
- Surface Water Quantity
- Mini.piezometer
- Surface Water Flow
- Rain Gauge
- Baro Logger
- Watercourse (MNRF 2017)
- Ponds (Beacon 2018)
- Refined Provincially Significant Wetlands (PSWs) (Beacon 2018)
- PSW and Other Wetlands Outside SPA (GRCA 2018)

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, Existing Natural Heritage System, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 175 350 700 Metres

1:16,000

BEACON ENVIRONMENTAL

Project 216002
February, 2019
Draft #2

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Appendix E

Natural Heritage System (NHS)

OPA 42
Approved Natural Heritage System (NHS)

Map NH-1

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Parcel Fabric
- Properties with Appeals Settled under OPA 42
- City and Owner Currently Before the Courts

City of Guelph Natural Heritage System (2014)

- Significant Natural Areas
- Natural Areas
- Ecological Linkages
- Restoration Areas

Notes

NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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1:10,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

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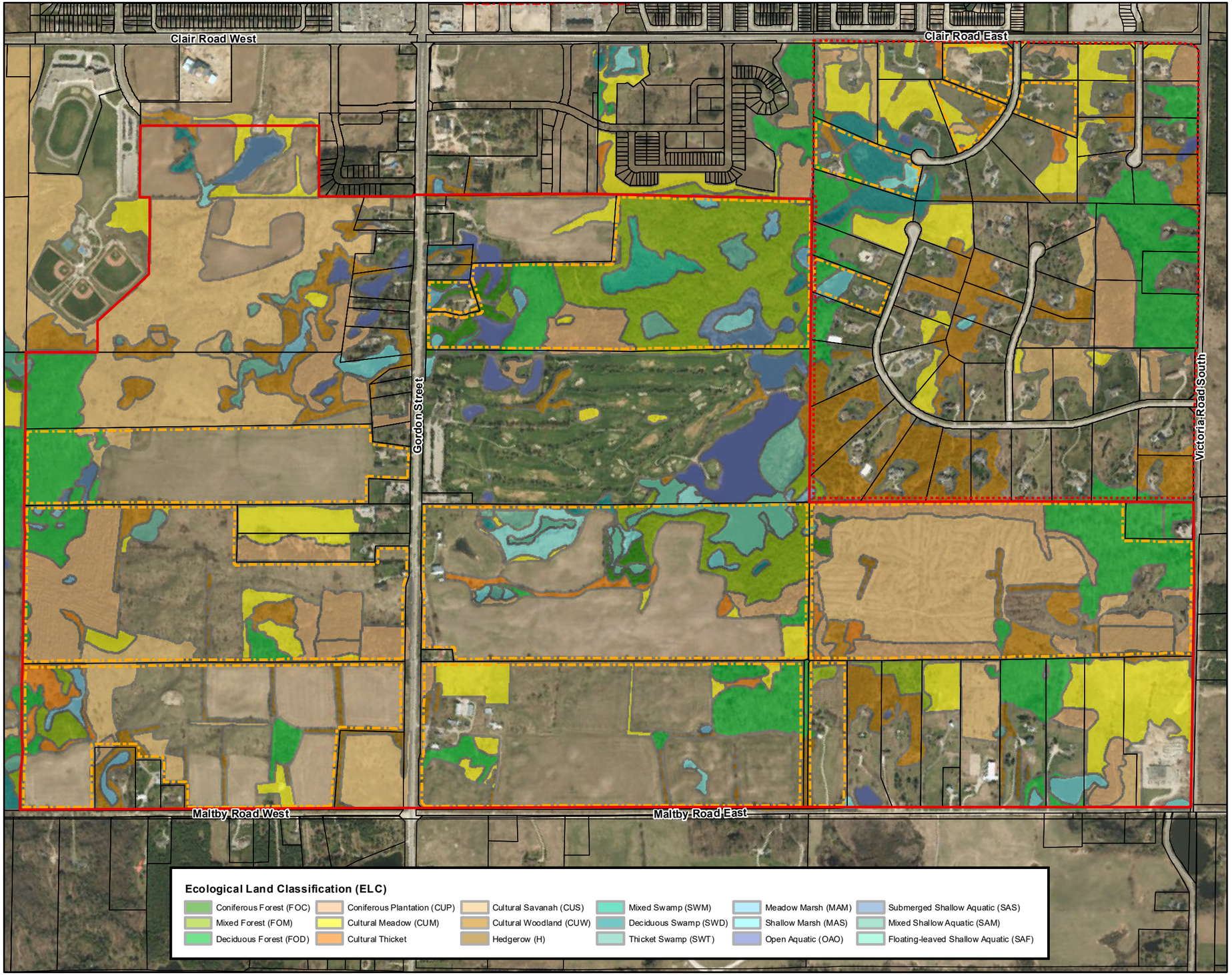
Refined Ecological Land Classification

Map NH-2

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)



Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Access to Field Verify ELC Provided
- Parcel Fabric

Note: All ELC mapping has been updated from the City's 2014 ELC mapping using 2017 aerial photography except for the 2021 Gordon Street property where the City has indicated the 2014 ELC should be retained as the City and Owner are currently before the courts under the City's Tree By-law.

City of Guelph: Secondary Plan Area Boundary, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

1:10,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

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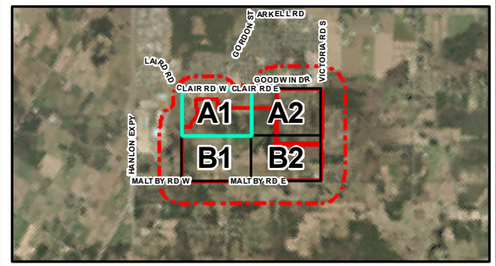
Refined Ecological Land Classification

Map NH-2 Page A1

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Access to Field Verify ELC Provided
- Parcel Fabric



Note: All ELC mapping has been updated from the City's 2014 ELC mapping using 2017 aerial photography except for the 2021 Gordon Street property where the City has indicated the 2014 ELC should be retained as the City and Owner are currently before the courts under the City's Tree By-law.

City of Guelph: Secondary Plan Area Boundary, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 62.5 125 250 Metres

1:6,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

Ecological Land Classification (ELC)

Coniferous Forest (FOC)	Coniferous Plantation (CUP)	Cultural Savanah (CUS)	Mixed Swamp (SWM)	Meadow Marsh (MAM)	Submerged Shallow Aquatic (SAS)
Mixed Forest (FOM)	Cultural Meadow (CUM)	Cultural Woodland (CUW)	Deciduous Swamp (SWD)	Shallow Marsh (MAS)	Mixed Shallow Aquatic (SAM)
Deciduous Forest (FOD)	Cultural Thicket	Hedgerow (H)	Thicket Swamp (SWT)	Open Aquatic (OAO)	Floating-leaved Shallow Aquatic (SAF)

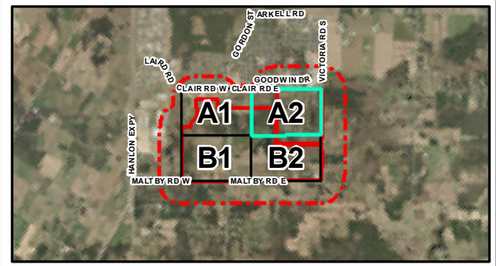
Refined Ecological Land Classification

Map NH-2 Page A2

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Access to Field Verify ELC Provided
- Parcel Fabric



Note: All ELC mapping has been updated from the City's 2014 ELC mapping using 2017 aerial photography except for the 2021 Gordon Street property where the City has indicated the 2014 ELC should be retained as the City and Owner are currently before the courts under the City's Tree By-law.

City of Guelph: Secondary Plan Area Boundary, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 62.5 125 250 Metres

1:6,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

Ecological Land Classification (ELC)

Coniferous Forest (FOC)	Coniferous Plantation (CUP)	Cultural Savanah (CUS)	Mixed Swamp (SWM)	Meadow Marsh (MAM)	Submerged Shallow Aquatic (SAS)
Mixed Forest (FOM)	Cultural Meadow (CUM)	Cultural Woodland (CUW)	Deciduous Swamp (SWD)	Shallow Marsh (MAS)	Mixed Shallow Aquatic (SAM)
Deciduous Forest (FOD)	Cultural Thicket	Hedgerow (H)	Thicket Swamp (SWT)	Open Aquatic (OAO)	Floating-leaved Shallow Aquatic (SAF)

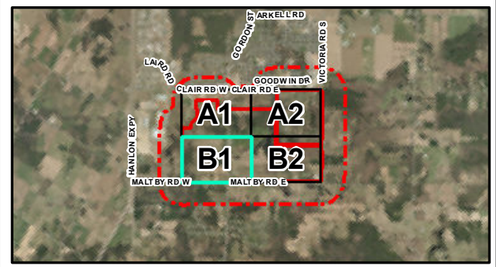
Refined Ecological Land Classification

Map NH-2 Page B1

Clair-Maltby Secondary Plan Comprehensive Environmental Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Access to Field Verify ELC Provided
- Parcel Fabric



Note: All ELC mapping has been updated from the City's 2014 ELC mapping using 2017 aerial photography except for the 2021 Gordon Street property where the City has indicated the 2014 ELC should be retained as the City and Owner are currently before the courts under the City's Tree By-law.

City of Guelph: Secondary Plan Area Boundary, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 62.5 125 250 Metres

1:6,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

Gordon Street

Maltby Road West

Maltby Road East

Ecological Land Classification (ELC)

Coniferous Forest (FOC)	Coniferous Plantation (CUP)	Cultural Savanah (CUS)	Mixed Swamp (SWM)	Meadow Marsh (MAM)	Submerged Shallow Aquatic (SAS)
Mixed Forest (FOM)	Cultural Meadow (CUM)	Cultural Woodland (CUW)	Deciduous Swamp (SWD)	Shallow Marsh (MAS)	Mixed Shallow Aquatic (SAM)
Deciduous Forest (FOD)	Cultural Thicket	Hedgerow (H)	Thicket Swamp (SWT)	Open Aquatic (OAO)	Floating-leaved Shallow Aquatic (SAF)

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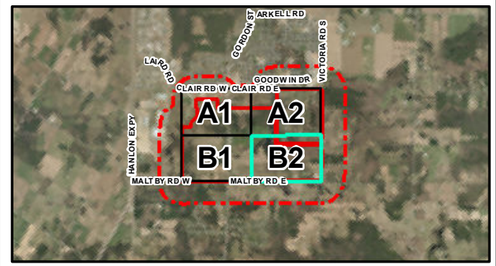
Refined Ecological Land Classification

Map NH-2 Page B2

Clair-Maltby Secondary Plan Comprehensive Environmental Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Access to Field Verify ELC Provided
- Parcel Fabric



Note: All ELC mapping has been updated from the City's 2014 ELC mapping using 2017 aerial photography except for the 2021 Gordon Street property where the City has indicated the 2014 ELC should be retained as the City and Owner are currently before the courts under the City's Tree By-law.

City of Guelph: Secondary Plan Area Boundary, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 62.5 125 250 Metres

1:6,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

Victoria Road South

Maltby Road East

Ecological Land Classification (ELC)

Coniferous Forest (FOC)	Coniferous Plantation (CUP)	Cultural Savanah (CUS)	Mixed Swamp (SWM)	Meadow Marsh (MAM)	Submerged Shallow Aquatic (SAS)
Mixed Forest (FOM)	Cultural Meadow (CUM)	Cultural Woodland (CUW)	Deciduous Swamp (SWD)	Shallow Marsh (MAS)	Mixed Shallow Aquatic (SAM)
Deciduous Forest (FOD)	Cultural Thicket	Hedgerow (H)	Thicket Swamp (SWT)	Open Aquatic (OAO)	Floating-leaved Shallow Aquatic (SAF)

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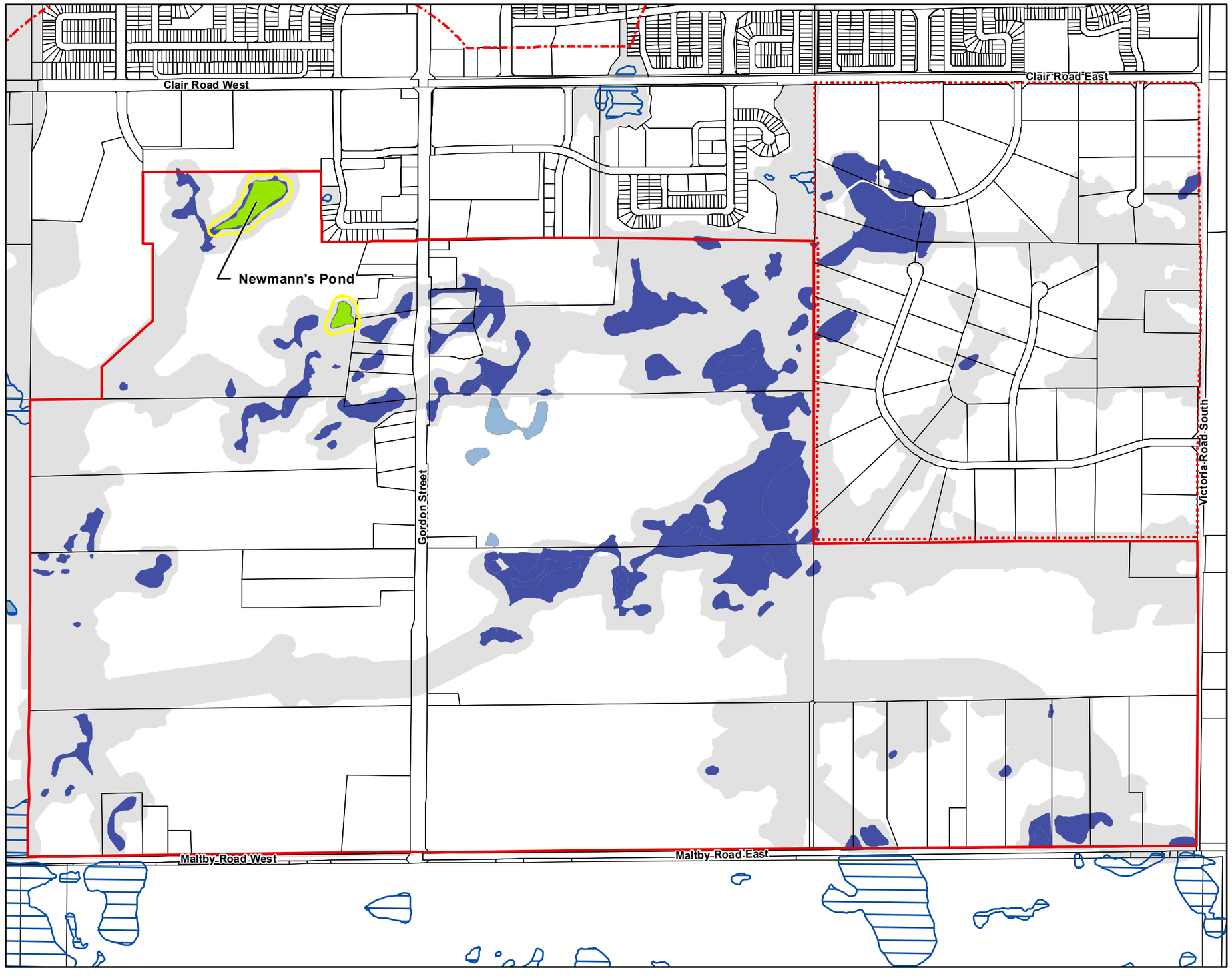

Refined Fish Habitat Mapping

Map NH-3

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Area
- Warm Water Fish Habitat
- Warm Water Fish Habitat 15 m Buffer

Wetlands

- Refined Provincially Significant Wetlands (PSWs) (Beacon 2018)
- Ponds (Beacon 2018)
- GRCA Wetlands (2018) outside of SPA and Rolling Hills
- City of Guelph Natural Heritage System (2014)

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

2. Confirmed warm water fish habitat as identified in the 132 Clair Road West Scoped EIS (North-South Environmental Inc. 2015). Although there are no watercourses in the SPA, additional fish habitat may occur within other ponds not surveyed as part of this study.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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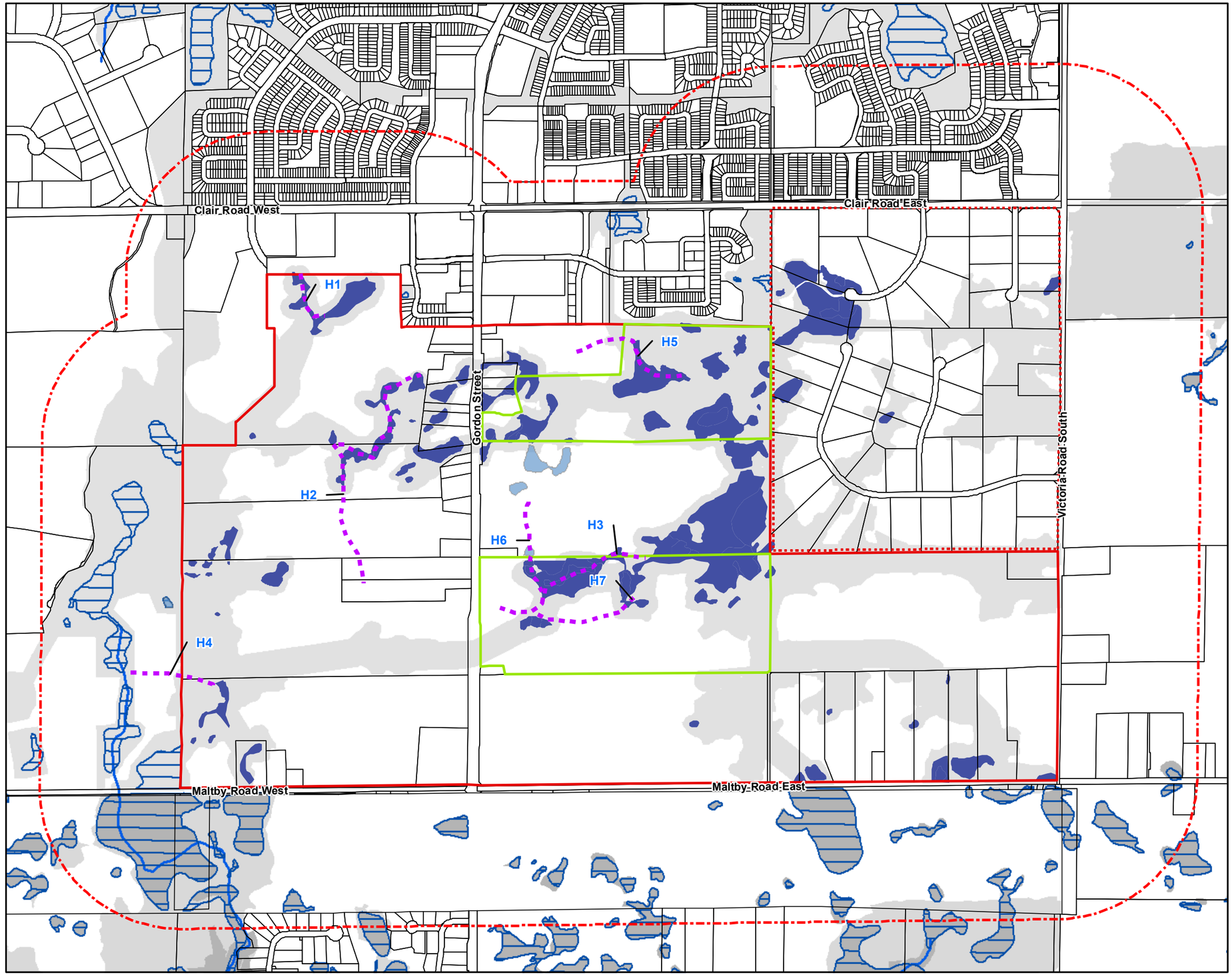
Scoped Headwater Drainage Feature Assessment (Potential HDFs)

Map NH-4A

Clair-Maltby Secondary Plan
Comprehensive Environmental Impact Study (CEIS)



Legend

- Primary Study Area
- Secondary Plan Area
- Rolling Hills Community
- Parcel Fabric
- Access Provided for HDF Assessment
- Refined Provincially Significant Wetlands (PSWs) (Beacon 2018)
- Ponds (Beacon 2018)
- GRCA Wetlands (2018) outside of SPA and Rolling Hills
- City of Guelph Natural Heritage System (2014)

County of Wellington Greenlands Systems

- Core Greenlands
- Greenlands
- Potential Headwater Drainage Feature (HDF) (Beacon 2018)
- Watercourse (MNRF 2017)

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, Existing Natural Heritage System, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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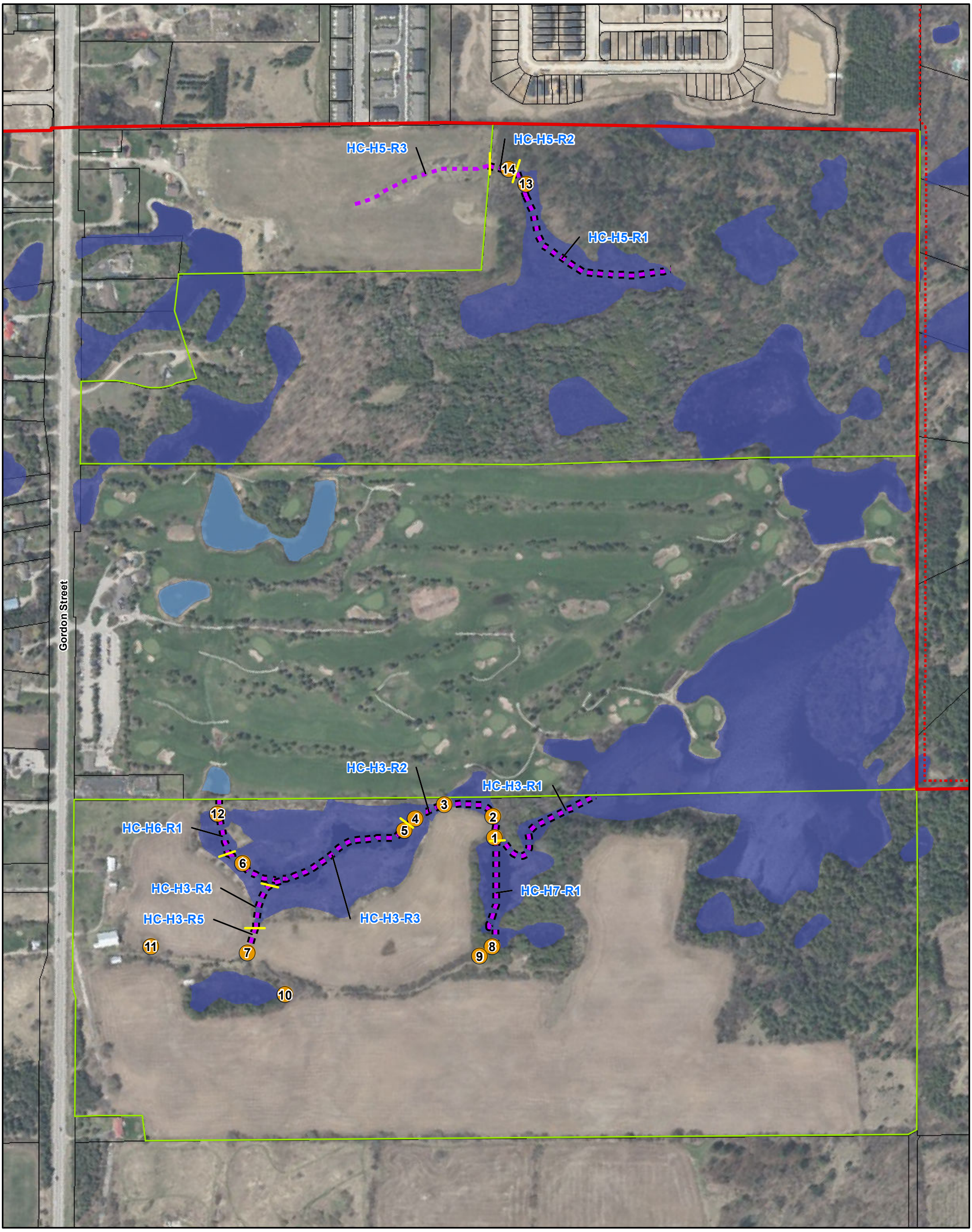

Legend

- Secondary Plan Area
- Rolling Hills Community
- Parcel Fabric
- Access Provided for HDF
- Photo Location
- Refined Provincially Significant Wetlands (PSWs) (Beacon 2018)
- Ponds (Beacon 2018)
- Reach Break
- Potential Headwater Drainage Feature (HDF) (Beacon 2018)
- Confirmed Headwater Drainage Feature (HDF) (Beacon 2018)

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, Existing Natural Heritage System, 2016.

Confirmed Headwater Drainage Features

Figure 4B

Clair-Maltby Secondary Plan
Comprehensive Environmental Impact Study (CEIS)

BEACON ENVIRONMENTAL

Project: 216002
Last Revised: February, 2019

Client: City of Guelph

Prepared by: DU
Checked by: MU

1:4,500

0 75 150 m

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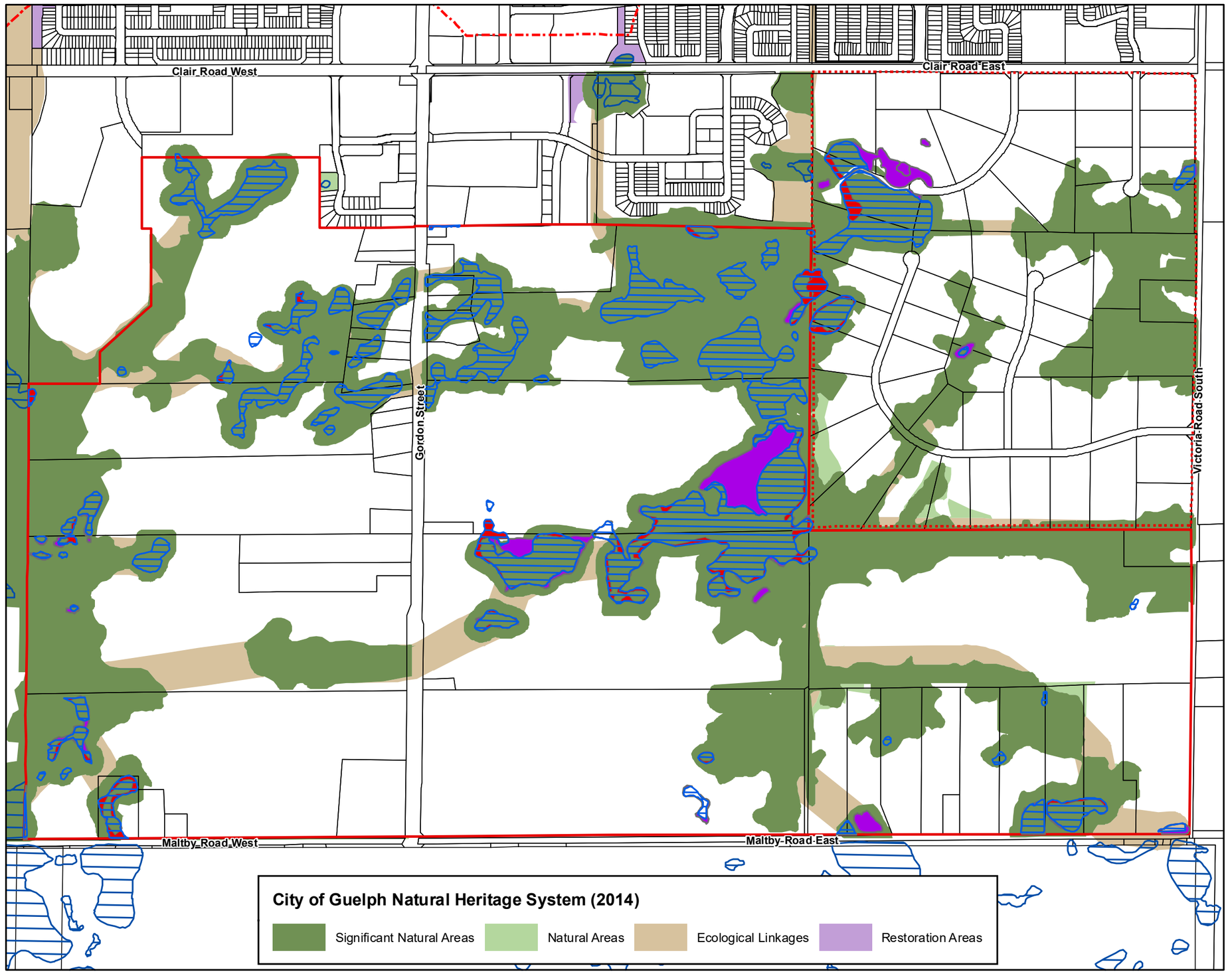
Refinements to GRCA Wetlands Mapping

Map NH-5A

Clair-Maltby Secondary Plan
Comprehensive Environmental Impact Study (CEIS)



Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- GRCA Wetlands (2018)
- Additions to GRCA Wetlands
- Removals from GRCA Wetlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

2. Proposed "additions" and "removals" to wetlands as mapped by the GRCA reflect corrections based on new information collected as part of this study. "Removals" are areas previously identified as wetland determined not to be wetland. "Additions" are areas meeting the criteria for wetlands as per the study report. Wetland mapping may still be verified as part of future studies and planning applications.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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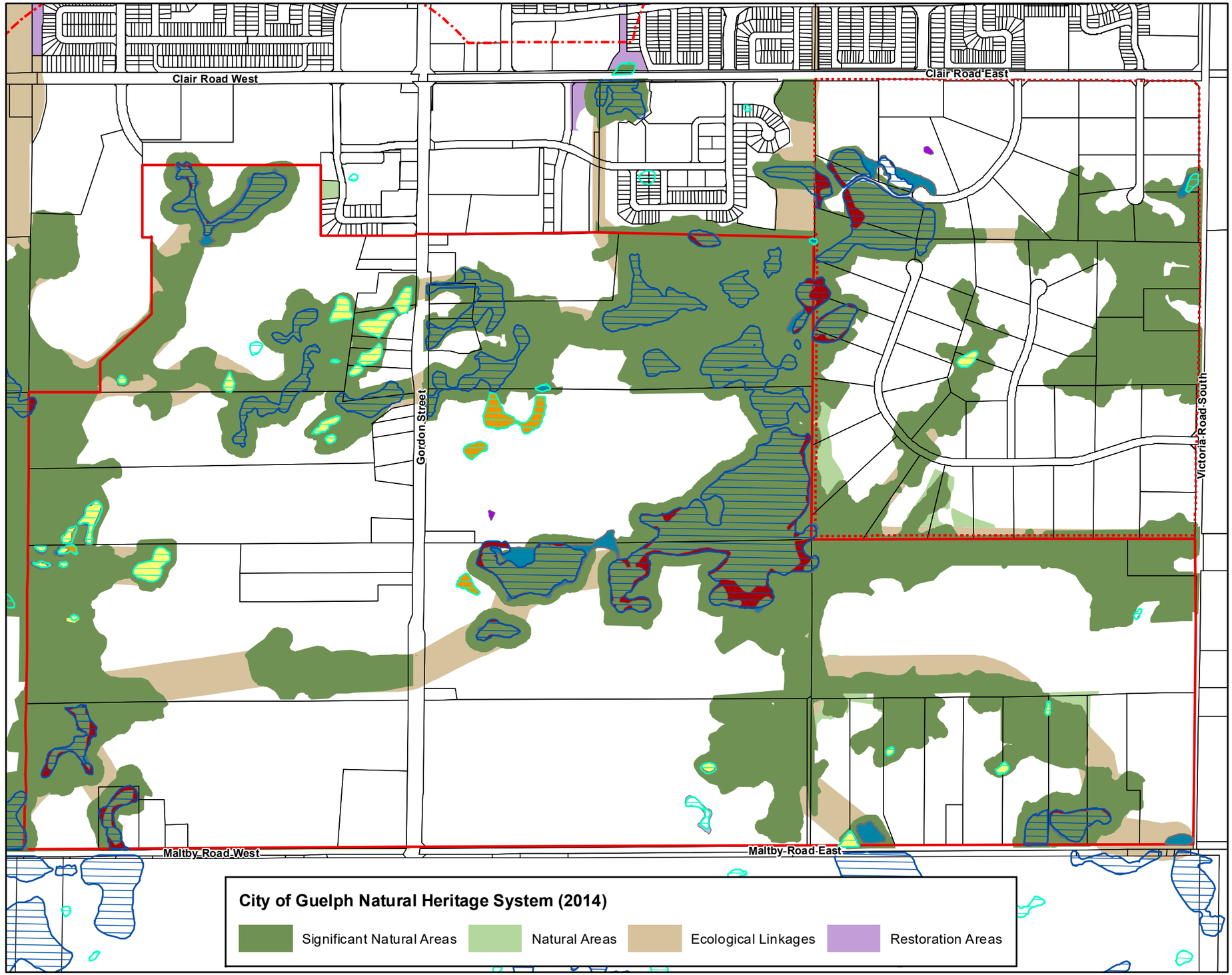
Refinements to MNRF Wetlands Mapping

Map NH-5B

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)



Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Provincially Significant Wetlands (PSW) (MNRF 2018)
- Unevaluated Wetlands (MNRF 2018)
- Additions to PSWs
- Additions to Unevaluated Wetlands
- Additions to PSW Transitions from Unevaluated Wetlands
- Removals from PSWs
- Removals of Unevaluated Wetlands
- Transitions from Unevaluated Wetlands to PSWs

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

2. Proposed “additions” and “removals” to wetlands as mapped by the MNRF reflect corrections based on new information collected as part of this study. “Removals” are areas previously identified as wetland determined not to be wetland. “Additions” are areas meeting the criteria for unevaluated wetlands or PSW as per the study report. Wetland mapping may still be verified as part of future studies and planning applications.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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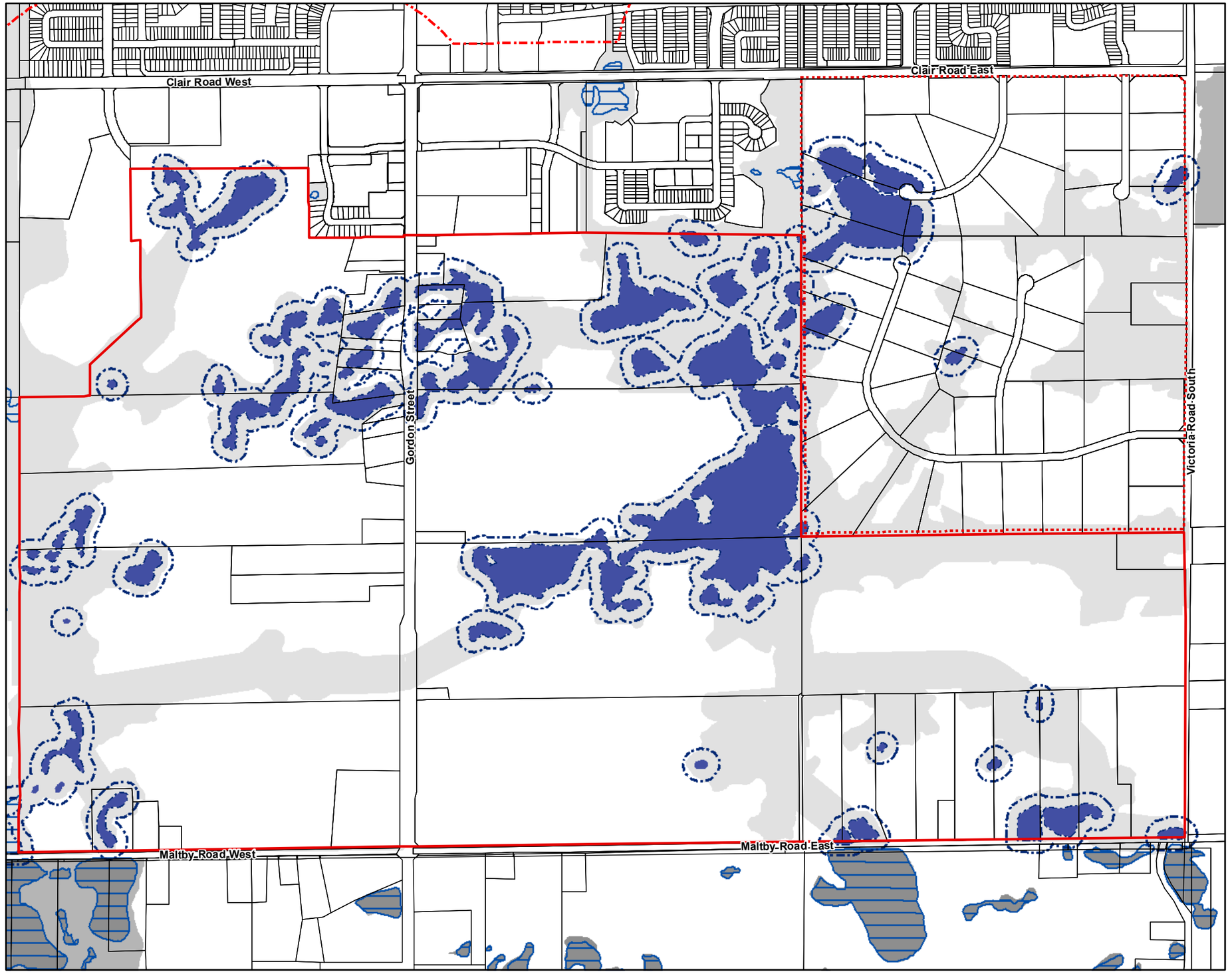

Refined City Wetlands Mapping

Map NH-6

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Parcel Fabric
- Refined Provincially Significant Wetlands (PSWs) (Beacon 2018)
- GRCA Wetlands (2018) outside of SPA and Rolling Hills
- 30 m PSW Buffer
- City of Guelph Natural Heritage System (2014)

County of Wellington Greenlands Systems

- Core Greenlands
- Greenlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, Existing Natural Heritage System, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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Clair Road West

Clair Road East

Victoria Road South

Gordon Street

Maltby Road West

Maltby Road East

City of Guelph Natural Heritage System (2014)

Significant Natural Areas | Natural Areas | Ecological Linkages | Restoration Areas

Refinements to City Woodlands Mapping

Map NH-7

Clair-Maltby Secondary Plan
Comprehensive Environmental Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Woodlands Mapping from City 2014 NHS
- Parcel Fabric
- Additions to Significant Woodlands (Beacon 2018)
- Additions to Cultural Woodlands (Beacon 2018)
- Removals from Significant Woodlands (Beacon 2018)
- Removals from Cultural Woodlands (Beacon 2018)

City of Guelph Natural Heritage System (2014)

- Significant Woodlands
- Cultural Woodlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

2. Woodlands mapping from the City's 2014 NHS has not been altered on properties with settlements under OPA 42.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

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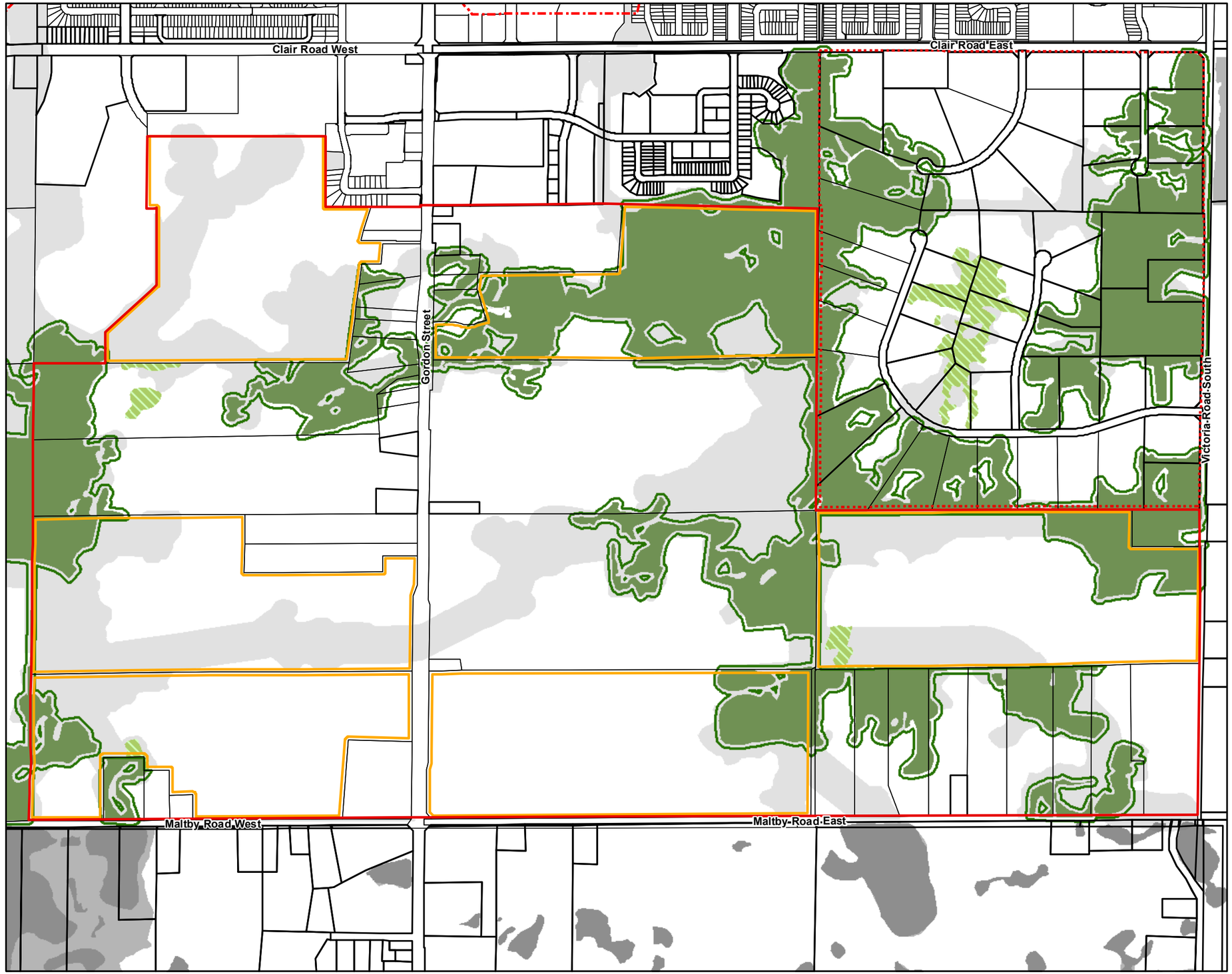
BEACON ENVIRONMENTAL

Project 216002
February, 2019



Refined City Woodlands Mapping

Map NH-8

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Parcel Fabric
- Woodlands Mapping from City 2014 NHS
- Significant Woodland
- Cultural Woodland Overlay
- 10 m Significant Woodland Buffer
- City of Guelph Natural Heritage System (2014)

County of Wellington Greenlands System

- Core Greenlands
- Greenlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

2. Woodlands mapping from City NHS (2014) has been retained on properties with settlements under OPA 42 or that are currently before the courts.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

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BEACON ENVIRONMENTAL

Project 216002
February, 2018

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Detailed Significant Wildlife Habitat (SWH) Mapping

Map NH-9

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Clair Road West

Clair Road East

Gordon Street

Victoria Road South

Maltby Road West

Maltby Road East

Legend

- Primary Study Area Boundary (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Area
- Parcel Fabric

Significant Wildlife Habitat

- Candidate Amphibian Breeding Habitat (Woodland)
- Confirmed Amphibian Breeding Habitat (Woodland)
- Candidate Amphibian Breeding Habitat (Wetland)
- Candidate Turtle Winter Areas
- Confirmed Turtle Winter Areas
- Candidate Waterfowl Stopover and Staging Habitat (Aquatic)
- Confirmed Seeps and Springs
- Confirmed Rare Vegetation Community
- Candidate Bat Maternity Colonies
- Candidate Shrub/Early Successional Bird Breeding Habitat *
- Candidate Raptor Wintering Areas *
- Candidate Reptile Hibernaculum *
- Candidate Waterfowl Nesting Area *
- Halligan's Pond**

* Several Candidate SWH areas are shown approximately with asterisks; Site-specific studies will be needed to a) capture the best and most representative area(s) in the SPA or b) confirm the significance and extent of these habitats.

** Halligan's pond could be considered Candidate SWH for amphibian breeding, waterfowl stopover and turtle wintering but has not been mapped as such as it is outside the City of Guelph.

City of Guelph: Secondary Plan Area Boundary, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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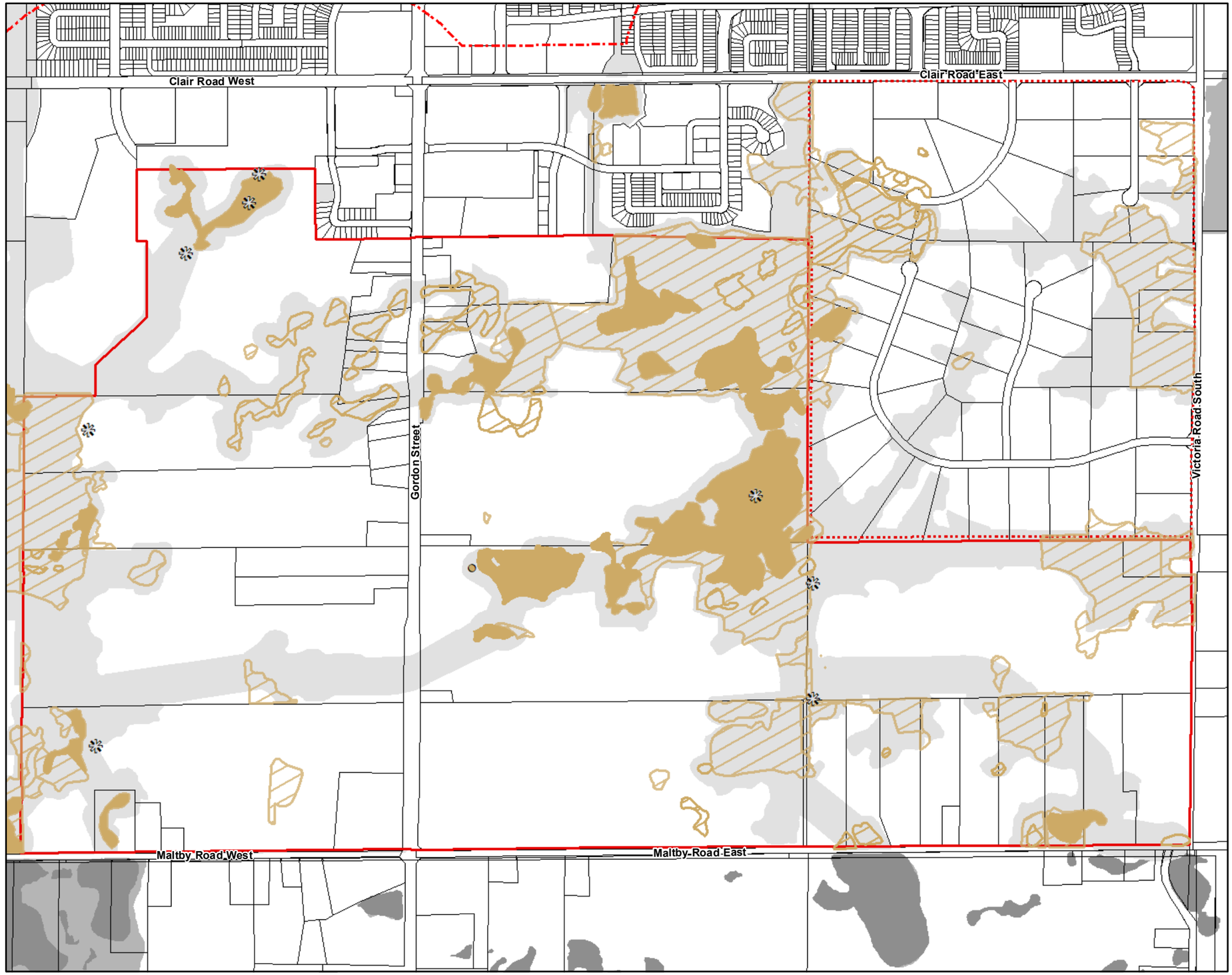

Significant Wildlife Habitat (SWH) Mapping

Map NH-10

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Parcel Fabric
- Confirmed Significant Wildlife Habitat
- Candidate Significant Wildlife Habitat
- Candidate Significant Wildlife Habitat *
- City of Guelph Natural Heritage System (2014)

County of Wellington Greenlands Systems

- Core Greenlands
- Greenlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

* Several Candidate SWH areas are shown approximately with asterisks; Site-specific studies will be needed to a) capture the best and most representative area(s) in the SPA or b) confirm the significance and extent of these habitats.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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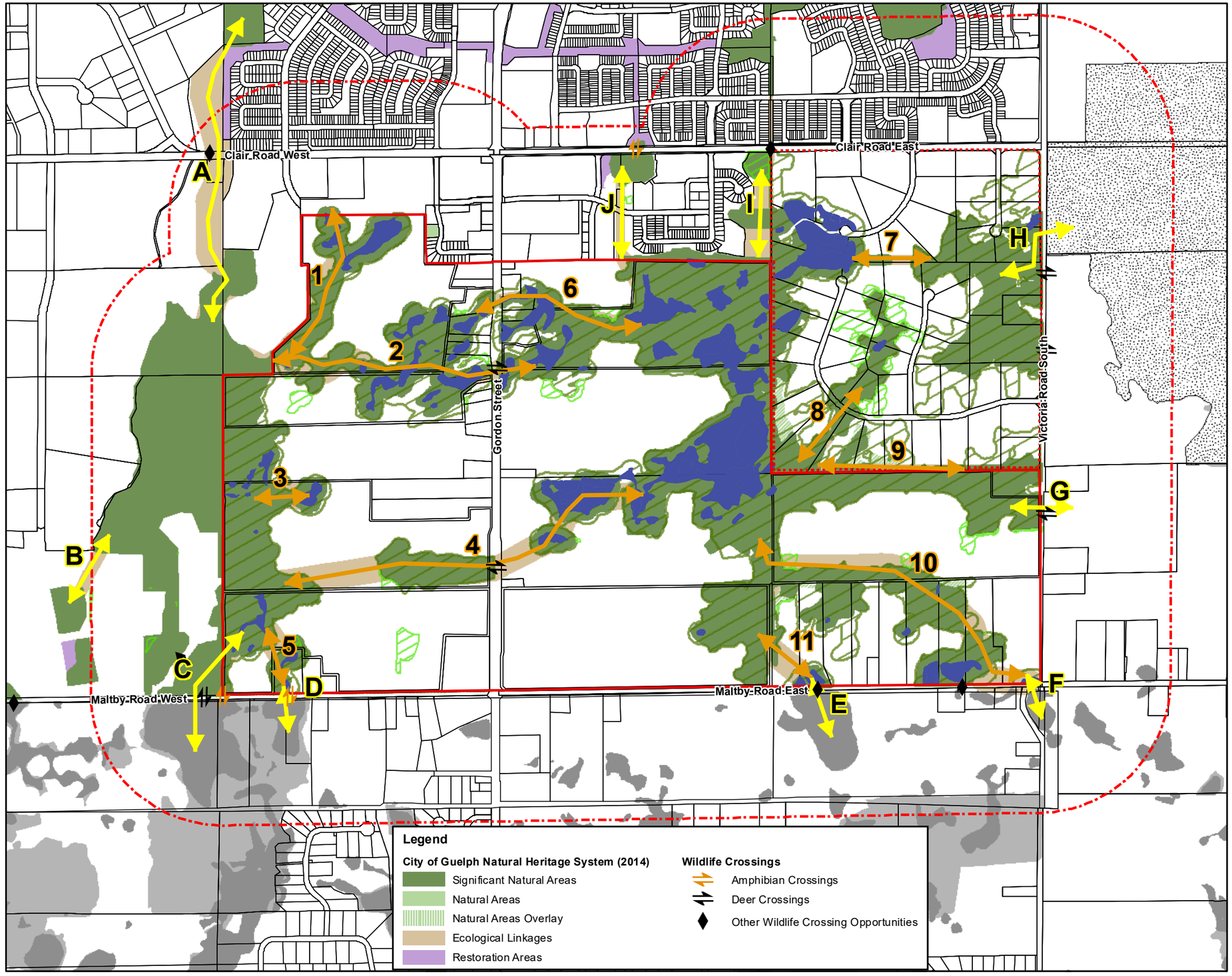

Ecological Linkages Assessment

Map NH-11

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Ecological Linkages within the PSA
- Ecological Linkages within the SPA

Refined Natural Heritage System

- Significant Natural Areas
- Natural Areas Overlay

County of Wellington Greenlands System

- Core Greenlands
- Greenlands
- Paris Moraine Earth Science ANSI (MNRF 2016)

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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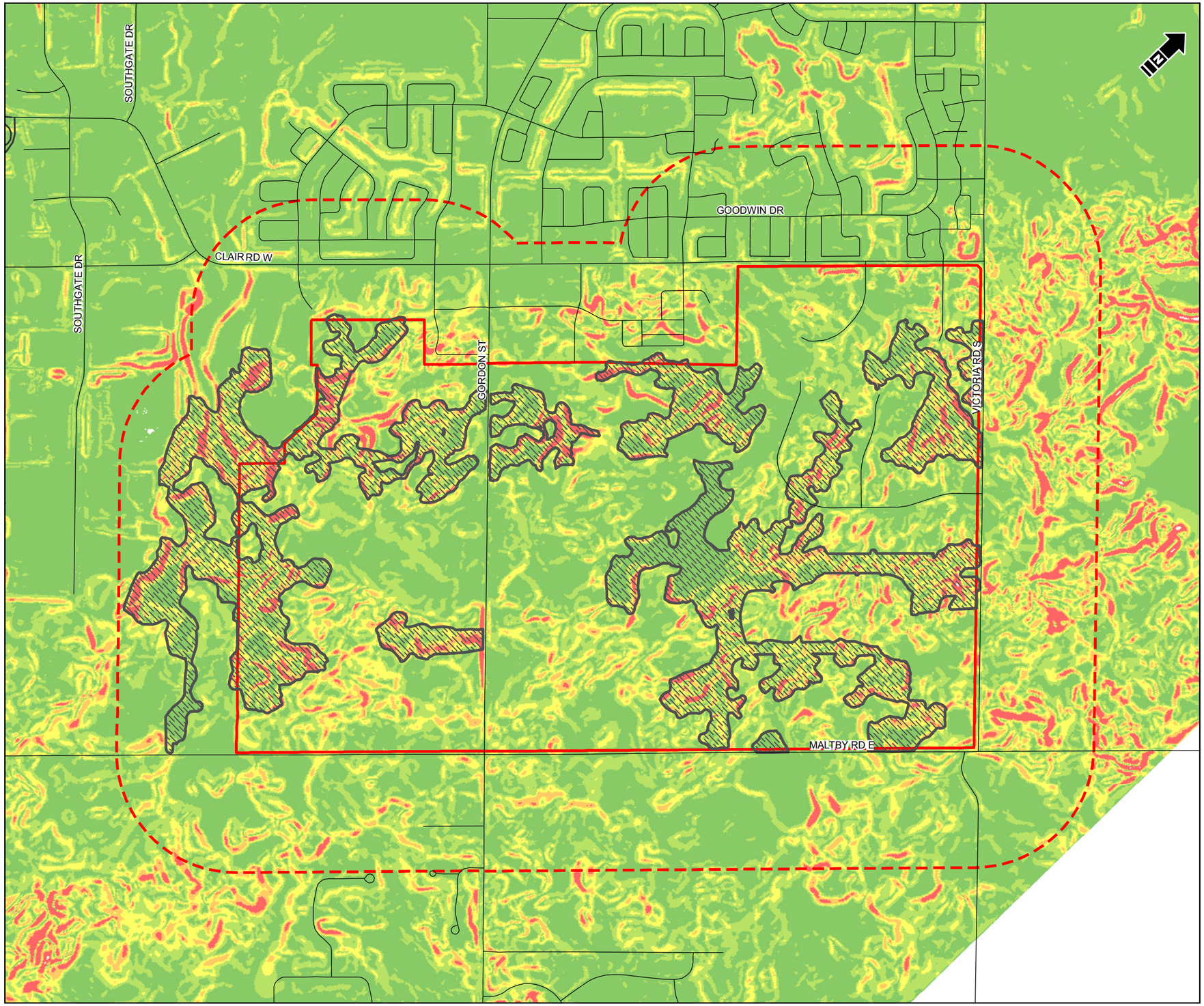


Primary Study Area Boundary
Secondary Plan Area Boundary
Significant Landform (City of Guelph, 2014)
Highway
Road

Elevation Slope Class (%)

< 5.0
5.0 - 10.0
10.0 - 15.0
15.0 - 20.0
> 20.0

1:17,000 metres
180 0 180 360
NAD 1983 UTM Zone 17N

Reference: Da ta pro vided b y the City o f Guelph, Geo Base® and Province of Ontario used under license.

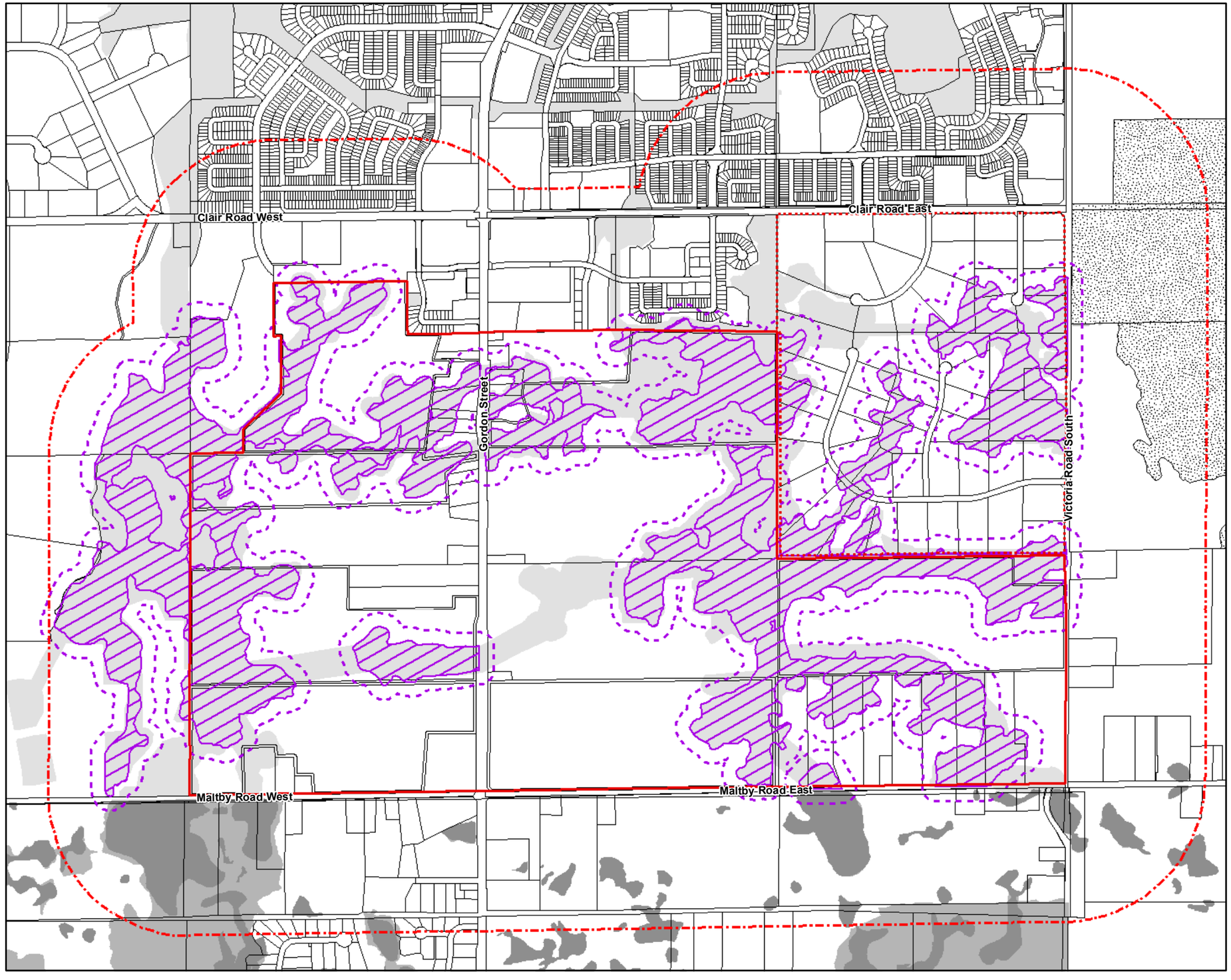
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
Clair- Maltby Comprehensive Environmental Impact Study
Phase 3 Impact Assessment Report

Significant Landform (2014) and Slope Classes

Date:	Project:	Submitter:	Reviewer:
Feb 2019	23089	D. Martin	B. Blackport

Figure NH-12



Significant Landform

Map NH-13

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Significant Landform (City of Guelph 2014)
- Significant Landform (2014) 50 m Adjacent Lands Setback
- Paris Moraine Earth Science ANSI (MNRF 2016)
- City of Guelph Natural Heritage System (2014)

County of Wellington Greenlands Systems

- Core Greenlands
- Greenlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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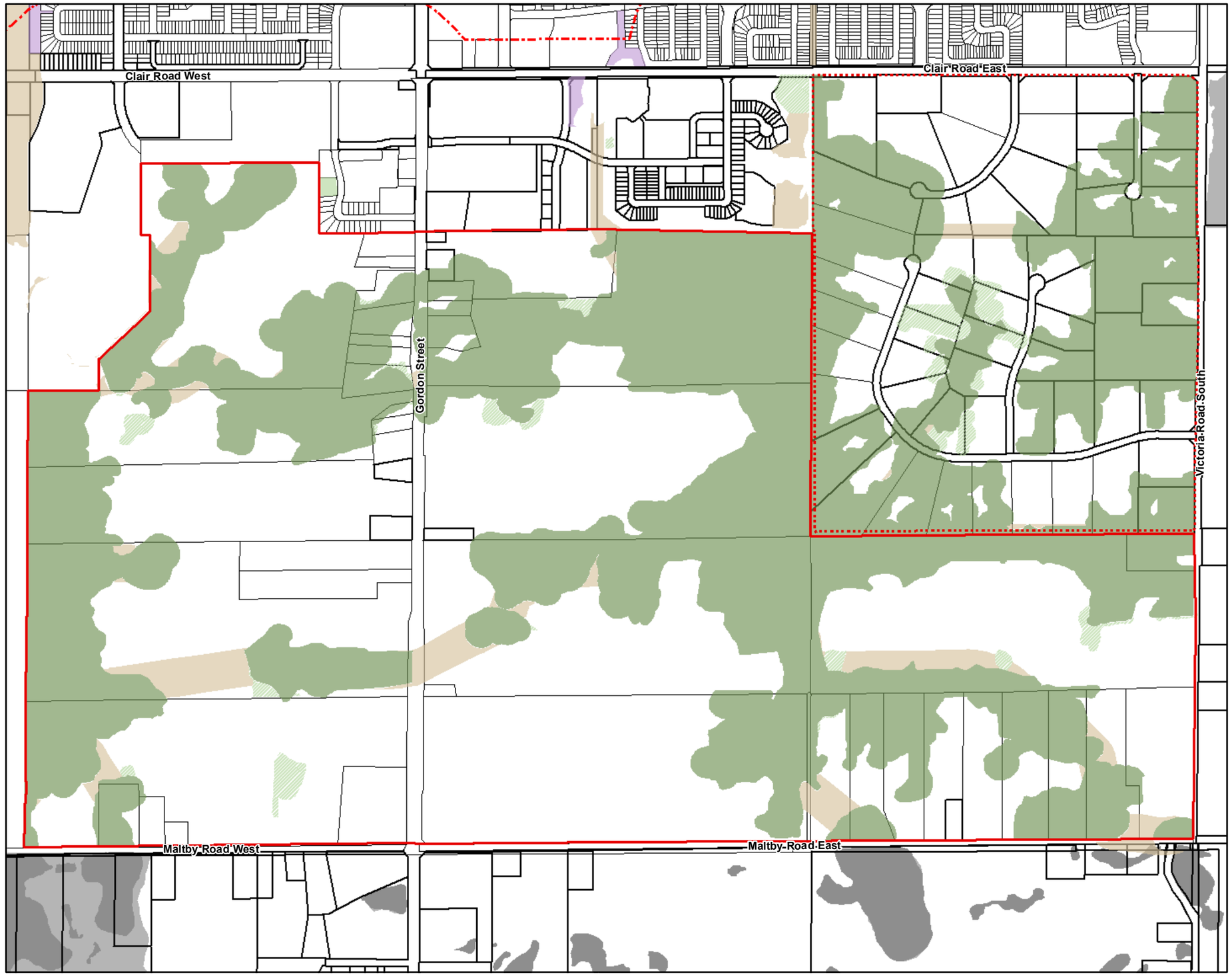
BEACON ENVIRONMENTAL

Project 216002
February, 2019



Refined Natural Heritage System (NHS) for Secondary Plan Area

Map NH-14A

Clair-Maltby Secondary Plan
Comprehensive Environmental Impact Study (CEIS)

Legend

- Primary Study Area
- Secondary Plan Area
- Rolling Hills Community
- Parcel Fabric

Refined Natural Heritage System

- Significant Natural Areas
- Ecological Linkages
- Natural Areas
- Natural Areas Overlay
- Restoration Areas

County of Wellington Greenlands System

- Core Greenlands
- Greenlands

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, Existing Natural Heritage System, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

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BEACON ENVIRONMENTAL

Project 216002
February, 2019

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Comparison of OPA 42 Approved NHS and Refined NHS

Map NH-14B

Clair-Maltby Secondary Plan
Comprehensive Environmental
Impact Study (CEIS)

Legend

- Primary Study Area (PSA)
- Secondary Plan Area (SPA)
- Rolling Hills Community
- Parcel Fabric
- Significant Natural Areas (SNA) Additions
- Natural Areas (NA) Additions
- Significant Natural Areas Removals
- Natural Areas to Significant Natural Areas
- Linkages to SNA or NA
- SNA or NA to Linkages

Refined Natural Heritage System

- Significant Natural Areas
- Ecological Linkages
- Natural Areas
- Natural Areas Overlay
- Restoration Areas

Notes

1. NHS refinements in the Rolling Hills area (outside of the revised Secondary Plan Area boundary) will be incorporated as part of a future Official Plan update rather than through the Clair-Maltby Secondary Plan process.

City of Guelph: Secondary Plan Area, Parcel Fabric, Existing Natural Heritage System, 2016.

First Base Solutions
Web Mapping Service 2017

UTM Zone 17 N, NAD 83

0 100 200 400 Metres

1:10,500

BEACON ENVIRONMENTAL

Project 216002
February, 2019

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